ICAR AIEEA PG 2023 Agricultural Engineering And Technology Question Paper with Solutions

ZOLLEGE

General Instructions

(i) This booklet contains 120 questions, each provided with a complete, step-by-step solution.

(ii) It comprises 120 single-correct multiple-choice questions.

(iii) Attempt each question on your own before reviewing the given solution.

1. The following are the paddy yields (in kg/plot) for 14 plots: 30, 32, 35, 38, 40, 42, 48, 49, 52, 55, 58, 60, 62, 65. The 25th percentile (Q1) yield in kg/plot will be:

(A) 37.25

(B) 38.00

(C) 40.00

(D) 48.50

Correct Answer: (A) 37.25

SOLUTION:

Step 1: Write the fourteen yields against their serial position in a small table, since a quartile is just a marker on the ordered list of observations. Position: 1,2,3,4,5,6,7,8,9,10,11,12,13,14. Yield: 30,32,35,38,40,42,48,49,52,55,58,60,62,65.

Step 2: A quartile splits the ranked list into four equal parts, and the lower quartile Q1 sits one quarter of the way along the (n+1) spread of ranks, not simply at n/4. With 14 readings the spread of ranks runs

from 1 to 15, so the target rank is $0.25 \times 15 = 3.75$.
Step 3: A rank of 3.75 falls three parts out of four between position 3 and position 4. Position 3 holds 35 kg/plot and position 4 holds 38 kg/plot, a gap of 3 kg/plot.
Step 4: Moving 0.75 of that 3 kg/plot gap forward from 35 gives the interpolated yield: $35 + 0.75 \times 3 = 35 + 2.25 = 37.25$ kg/plot.
Step 5: This figure, 37.25, is the only option consistent with correctly weighting between the two bracketing plots rather than rounding the rank up or down, so it is the 25th percentile.

$$\boxed{Q_1 = 37.25 \text{ kg/plot}}$$

Quick Tip: Use the rank formula (n+1) times p/100 to find the position, then interpolate between the two bracketing values.

• • •

2. Match List-I with List-II.

List-I (Nature of data)	List-II (Most appropriate measure)
(A) Qualitative data	(I) Geometric mean
(B) Raw data with extreme values	(II) Median and Mode
(C) Dealing with rates, speeds and prices	(III) Mode
(D) Calculating relative change	(IV) Harmonic mean

Choose the *correct* answer from the options given below:

(A) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

(B) (A) - (III), (B) - (I), (C) - (II), (D) - (IV)

(C) (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

(D) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

Correct Answer: (C) (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

SOLUTION:

Step 1: Instead of pairing each item directly, check the four given combinations one at a time and eliminate any that contain an obviously wrong pairing.
Step 2: Option 1 pairs Qualitative data with Harmonic mean. A harmonic mean needs numeric reciprocals, so it cannot be computed for categories like a colour or a variety name. This pairing is wrong, so option 1 is eliminated.
Step 3: Option 2 pairs Raw data with extreme values to Geometric mean. A geometric mean uses the product of all values and is itself distorted by a very large or very small extreme value, so it is not the resistant measure needed here. Option 2 is eliminated.
Step 4: Option 4 places rates and speeds with Geometric mean. Speeds and rates are the classic case for Harmonic mean (average speed over equal distances), not Geometric mean, so option 4 is eliminated.
Step 5: Only option 3 survives: Qualitative data to Mode, Raw data with extreme values to Median and Mode, rates/speeds/prices to Harmonic mean, and relative change to Geometric mean.

$$\boxed{(A)-(III),\ (B)-(II),\ (C)-(IV),\ (D)-(I)}$$

Quick Tip: Match each data type to the measure that is resistant to its specific property (categories, outliers, ratios, or growth).

• • •

3. Consider the following probability distributions.
(A) Normal distribution
(B) Binomial distribution
(C) Poisson distribution
(D) F-distribution
(E) Chi-square distribution
In which of the above distributions are mean and variance equal:

(A) (A) only.

(B) (B) only.

(C) (C) only.

(D) (D) and (E) only.

Correct Answer: (C) (C) only.

SOLUTION:

Step 1: Rather than listing formulas from memory, think about what mean equal to variance represents statistically. It means the spread of the data grows in exact step with the average count, which happens naturally in a process of rare, independent events counted over a fixed interval.
Step 2: This description matches a Poisson process exactly, since a Poisson variable counts rare independent events (defects, arrivals, germination failures) in a fixed interval, and both its average count and its spread are governed by the single rate parameter λ, forcing mean and variance to be numerically identical.

Step 3: Contrast this with the Binomial distribution, where there is an upper cap n on the number of successes, and the variance $np(1-p)$ is always squeezed smaller than the mean np because of the $(1-p)$ shrinkage factor.
Step 4: The Normal distribution has mean and variance as two independently chosen parameters, so there is no built-in reason they should match. The Chi-square distribution, being a sum of squared standard normal variables with k degrees of freedom, always has variance $2k$, double its mean k. The F-distribution mixes two degrees of freedom in a ratio and its variance never reduces to its mean.
Step 5: Of all five, only the Poisson distribution has this intrinsic mean-variance equality, confirming option 3.

$$\boxed{\text{Poisson: mean} = \text{variance} = \lambda}$$

Quick Tip: Compare the standard mean and variance formula of each named distribution.

• • •

4. For two invertible matrices A and B of suitable orders, the value of $(AB)^{-1}$ is:

(A) $(BA)^{-1}$

(B) $B^{-1}A^{-1}$

(C) $A^{-1}B^{-1}$

(D) $(AB')^{-1}$

Correct Answer: (B) $B^{-1}A^{-1}$

SOLUTION:

Step 1: Instead of relying purely on the abstract rule, verify it using a concrete pair of small invertible matrices, since a correct general formula must also hold for any specific numeric example.

Step 2: Let $A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$, both invertible since their determinants are 1 and 2.

Step 3: Compute the product first: $AB = \begin{pmatrix} 2 & 1 \\ 0 & 1 \end{pmatrix}$. Using the standard 2x2 inverse formula, $(AB)^{-1} = \begin{pmatrix} 0.5 & -0.5 \\ 0 & 1 \end{pmatrix}$.

Step 4: Now compute $B^{-1}A^{-1}$ separately. $B^{-1} = \begin{pmatrix} 0.5 & 0 \\ 0 & 1 \end{pmatrix}$ and $A^{-1} = \begin{pmatrix} 1 & -1 \\ 0 & 1 \end{pmatrix}$, so $B^{-1}A^{-1} = \begin{pmatrix} 0.5 & -0.5 \\ 0 & 1 \end{pmatrix}$.

Step 5: This matches $(AB)^{-1}$ exactly, while $A^{-1}B^{-1} = \begin{pmatrix} 0.5 & -1 \\ 0 & 1 \end{pmatrix}$ is a different matrix, confirming that only the reversed order gives the true inverse.

$$\boxed{(AB)^{-1} = B^{-1}A^{-1}}$$

Quick Tip: The inverse of a product reverses the order of the factors.

• • •

5. The angle between vectors $A = 2i - j + 2k$ and $B = 6i - 3j + 6k$ is:

(A) 0

(B) 30

(C) 45

(D) 60

Correct Answer: (A) 0

SOLUTION:

Step 1: A quick way to test whether two vectors are parallel is to check whether their cross product is the zero vector, since the cross product magnitude is $|A||B|\sin\theta$, which vanishes only when $\theta = 0$ or 180 degrees.

Step 2: Compute the cross product for $A = (2, -1, 2)$ and $B = (6, -3, 6)$:

$$A \times B = \begin{vmatrix} i & j & k \\ 2 & -1 & 2 \\ 6 & -3 & 6 \end{vmatrix}$$

Step 3: Expand along the top row. The i-component is $(-1)(6) - (2)(-3) = -6 + 6 = 0$. The j-component is $-[(2)(6) - (2)(6)] = 0$. The k-component is $(2)(-3) - (-1)(6) = -6 + 6 = 0$. So $A \times B = (0, 0, 0)$.

Step 4: A zero cross product confirms the vectors are parallel. Since $B = 3A$ with a positive multiplier, both vectors point in the same direction, ruling out 180 degrees.

Step 5: Therefore the angle between A and B is exactly 0 degrees, ruling out the nonzero options 30, 45 and 60.

$$\boxed{\theta = 0°}$$

Quick Tip: Check whether one vector is simply a scalar multiple of the other before computing the dot product.

• • •

6. Synchronous Speed of an AC induction motor depends on:

(A) Frequency of the supply voltage

(B) Number of poles

(C) Current

(D) Voltage

Choose the *correct* answer from the options given below:

(A) (A) and (B) only.

(B) (B) and (C) only.

(C) (C) and (D) only.

(D) (A) and (D) only.

Correct Answer: (A) (A) and (B) only.

SOLUTION:

Step 1: Think physically about how the rotating magnetic field is created rather than starting from the formula. Each cycle of the AC supply pushes the field pattern through one full electrical rotation, so a higher supply frequency f means the field sweeps around faster in a given time.

Step 2: The winding is built with a certain number of magnetic poles P. Increasing the number of poles forces the same electrical cycle to be shared across more pole pairs around the stator, mechanically slowing the field's physical rotation, giving $N_s = \frac{120f}{P}$.

Step 3: The rotor always turns slightly slower than the stator field, a difference called slip, and it is the current induced by that slip which produces torque. Current is therefore a consequence of loading, not a cause that changes the field's own rotational speed.

Step 4: Supply voltage sets how strong the magnetic flux and torque can be, but has no role in timing the rotation of the field, since timing is set purely by frequency and pole geometry.

Step 5: So only frequency and pole number set synchronous speed, current and voltage do not, confirming option 1.

$$\boxed{N_s = \frac{120f}{P} \text{ depends on frequency and poles only}}$$

Quick Tip: Recall the formula Ns = 120f/P and see which quantities it actually contains.

• • •

7. Hydrometer readings are corrected for:
(A) Temperature correction
(B) Meniscus correction
(C) Dispersing agent correction
(D) Pressure correction
Choose the *correct* answer from the options given below:

(A) (A) and (B) only.

(B) (C) and (D) only.

(C) (A), (B) and (C) only.

(D) (B), (C) and (D) only.

Correct Answer: (C) (A), (B) and (C) only.

SOLUTION:

Step 1: Rather than deriving each correction from first principles, examine each listed item and ask whether it is a recognised, named correction taught for the standard soil hydrometer sedimentation analysis used to size silt and clay particles.
Step 2: Temperature correction (A) is required because the calibration chart and the viscosity value used in Stokes' law both assume a fixed

reference temperature, and the lab temperature almost never matches exactly, so this stays in.
Step 3: Meniscus correction (B) is needed because a cloudy soil suspension hides the true liquid level, forcing readings at the meniscus top, while calibration is done in clear liquid where the true surface is visible, so this stays in too.
Step 4: Dispersing agent correction (C) is required because the chemical dispersant added to prevent flocculation changes the specific gravity of the suspension fluid slightly compared to plain water, and this must be subtracted out, so it also stays in.
Step 5: Pressure correction (D) has no established place in this procedure, there is no step that adjusts for atmospheric or fluid pressure, so it is discarded. That leaves exactly three valid corrections, (A), (B) and (C), option 3.

Corrections: Temperature, Meniscus, Dispersing agent (A, B, C only)

Quick Tip: Think of what changes between the calibration condition (clear water, fixed temperature) and the actual test suspension.

• • •

8. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): In case of soils, compressive normal stresses are taken as positive.
Reason (R): Most of the normal stresses acting on soils are compressive in nature.
In light of the above statements, choose the *correct* answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (A) Both (A) and (R) are true and (R) is the correct explanation of (A).

SOLUTION:

Step 1: Recall the opposite convention used in structural or solid mechanics for steel and concrete members, where tension is usually taken as positive because engineers are often interested in tensile failure of ductile or reinforced materials.
Step 2: Soil behaves completely differently. Because soil particles simply rest against each other with friction and interlocking and are not bonded like a solid, they cannot transmit a real tensile pull between grains, so any attempt to place soil in tension gives essentially zero or meaningless stress in the field.
Step 3: Since a soil mass in the ground is squeezed by its own weight and by whatever load sits above it, essentially every normal stress a soil element experiences in practice is a compressive push, confirming Reason (R) as a true physical statement.
Step 4: Given that compressive stress is effectively the only kind of normal stress soils really carry, it is far more convenient for engineers to define that common, dominant case as positive, which is exactly the convention stated in Assertion (A). This shows the reason given directly causes and explains the convention, not merely accompanies it as an unrelated fact.

Step 5: Both A and R are true, and R correctly explains why A is the adopted convention, so the answer is option 1.

Both (A) and (R) true; (R) is the correct explanation of (A)

Quick Tip: Think about whether soil grains, unlike solid materials, can carry any tensile stress at all.

• • •

9. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R).

Assertion (A): The current drawn by the motor lags behind the voltage applied.
Reason (R): Motor is an inductive load.

In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (A) Both (A) and (R) are true and (R) is the correct explanation of (A).

SOLUTION:

Step 1: Think in terms of a phasor diagram for an inductive circuit. Draw the supply voltage V along the reference axis. For a pure

inductor, current always sits 90 degrees behind voltage; for a real motor winding that has both resistance and inductance, the current phasor sits somewhere between 0 and 90 degrees behind voltage, depending on how much resistance versus inductance the winding has.

Step 2: This angle between the voltage phasor and the current phasor is called the power factor angle. Whenever this angle is positive and the current phasor trails the voltage phasor, we say the current lags the voltage. That is exactly the situation for a motor, because its winding always carries some inductance from the coils that create the magnetic field.

Step 3: So the phasor picture directly confirms Assertion (A), the motor current lags the applied voltage.

Step 4: Now ask why this lag happens. It happens only because the winding is not purely resistive, it carries inductance. Remove the inductance and the current would line up with the voltage. So the inductive nature of the motor (Reason R) is the direct cause of the lag (Assertion A), not just a coincidentally true fact next to it.

Step 5: Both statements check out as true, and R is the mechanism that produces A.

Both (A) and (R) are true, and (R) correctly explains (A).

Quick Tip: Think about what property of a motor winding causes a phase difference between voltage and current.

10. Consider the following statements:
(A) Real power is expressed in kW.
(B) Apparent power is expressed in kV.
(C) Reactive power does not provide useful mechanical work.
(D) A motor operating at a given load and supply voltage draws active and reactive power.
(E) Both real power and apparent power are expressed in kW.

Choose the correct answer from the options given below:

(A) (A), (C), (D) and (E) only.

(B) (A) and (B) only.

(C) (B) and (D) only.

(D) (A), (B), (C) and (D) only.

Correct Answer: (A) (A), (C), (D) and (E) only.

SOLUTION:

Step 1: Write the three power quantities of an AC circuit using their standard formulas. Apparent power $S = VI$, real power $P = VI\cos\phi$, reactive power $Q = VI\sin\phi$, where ϕ is the angle between voltage and current.
Step 2: From $P = VI\cos\phi$, the unit of P works out to volt times ampere times a pure number, which is the watt, so kilowatt (kW) is the correct unit for real power. This backs up statement (A).
Step 3: From $S = VI$, the unit of S is also volt times ampere, so kVA and not kV. A kilovolt by itself only measures potential difference and carries no current information, so it cannot be the unit of a power term. Statement (B) fails this basic check.
Step 4: Over one complete cycle, the average value of the reactive component of power is zero, it only shuttles energy into and out of the

magnetic field of the load and back to the source. No net mechanical output comes from it, matching statement (C).

Step 5: A running motor behaves like an RL type load, with both a resistive part doing work and causing losses, and an inductive part building the rotating field. So it must draw both P and Q from the supply at once, confirming statement (D).

Step 6: With (A), (C) and (D) locked in as correct and (B) ruled out for its wrong unit, the option that keeps these three together, alongside (E), is the correct combination.

(A), (C), (D) and (E) only

Quick Tip: Recall that apparent power's correct unit is kVA, not a plain voltage unit like kV.

• • •

11. Given below are two statements:

Statement (I): The porosity of a soil cannot exceed 100 per cent.

Statement (II): The degree of saturation cannot be zero per cent.

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are true.

(B) Both Statement (I) and Statement (II) are false.

(C) Statement (I) is true but Statement (II) is false.

(D) Statement (I) is false but Statement (II) is true.

Correct Answer: (C) Statement (I) is true but Statement (II) is false.

SOLUTION:

Step 1: Picture the three-phase diagram of a soil element, split into solids, water and air. Above the solid layer sits the void space, shared between water and air in any proportion from all air to all water.
Step 2: Porosity only compares the void block to the whole sample block. Since the void block sits inside the total sample and cannot spill outside it, the ratio of void volume to total volume is capped at 1, or 100 percent, reached only when the entire sample is void space with nothing solid in it. So porosity cannot read above 100 percent, which makes Statement (I) correct.
Step 3: Degree of saturation only looks inside the void block, comparing how much of that void space is filled with water versus air. If the sample is bone dry, the entire void space is air and none of it is water, so the water share of the voids is 0 percent.
Step 4: A completely dry soil is a real, common situation, such as desert sand or an oven dried lab sample, so a 0 percent degree of saturation is physically possible and not forbidden. Statement (II) says this can never happen, and that claim does not hold up.
Step 5: Putting it together, Statement (I) stands as true and Statement (II) fails as false.

Statement (I) is true but Statement (II) is false

Quick Tip: Think of oven-dried soil to test whether degree of saturation can really be zero.

12. Which of the following statements are true in case of electric fuse:
(A) It is generally made of materials having low melting point.
(B) It is made of materials having high conductivity.
(C) It has inverse time-current characteristics.
(D) It is inserted in series with the circuit to be protected.

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (A), (B) and (D) only.

(C) (A), (C) and (D) only.

(D) (A), (B), (C) and (D).

Correct Answer: (D) (A), (B), (C) and (D).

SOLUTION:

Step 1: Think of the fuse as doing two jobs at once, staying invisible during normal operation and being a deliberate weak link during a fault. Both jobs shape what material and connection the fuse needs.
Step 2: For the invisible-during-normal-operation job, the element must not heat up noticeably at rated current, which calls for a material with good conductivity, keeping its own resistance and hence its own heating small. That supports (B).
Step 3: For the deliberate-weak-link job, the element has to fail fast when current climbs, and the simplest way to guarantee that is to use a metal that melts at a low temperature so it does not take much extra heat to destroy it. That supports (A).
Step 4: Because the heating effect of current grows with the square of the current, a bigger overcurrent generates disproportionately more heat, so the element melts sooner as the fault current increases. This produces the inverse relationship between current magnitude and

operating time, confirming (C).

Step 5: Since the whole point is to break the current path on a fault, the fuse must sit in the same current loop as the protected circuit, meaning it has to be wired in series, never as a side branch. This confirms (D).

Step 6: Every one of the four statements passes the check.

$$\boxed{\text{(A), (B), (C) and (D)}}$$

Quick Tip: Think about what a fuse must do both during normal load and during a fault.

• • •

13. Consider the following statements:

(A) Absolute pressure is always positive.

(B) Vacuum can not exceed local atmospheric pressure.

(C) Gage pressure is the difference between absolute pressure and atmospheric pressure.

(D) Negative gauge pressure is same as vacuum.

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (A), (C) and (D) only.

(D) (A), (B), (C) and (D).

Correct Answer: (D) (A), (B), (C) and (D).

SOLUTION:

Step 1: Set up a simple pressure number line with perfect vacuum at 0 and local atmospheric pressure marked at some positive value P_{atm}.
Step 2: Absolute pressure is read directly off this line starting at 0, and nothing on this line sits to the left of 0, so absolute pressure is always positive, matching (A).
Step 3: Gauge pressure is just the same line but re-zeroed at P_{atm} instead of at 0. Moving the zero point does not change the actual pressures, it only changes what number we assign to them, and the new reading equals the old absolute value minus P_{atm}. That is the definition in (C).
Step 4: Anything that reads negative on this shifted scale is below atmospheric pressure, and this negative reading is exactly what engineers call vacuum, so (D) is just restating the shifted scale in different words.
Step 5: Since the line never goes below 0 on the absolute scale, the most negative the shifted gauge reading can become is $0 - P_{atm}$, that is, minus the atmospheric value. So the vacuum reading can equal atmospheric pressure at best, at perfect vacuum, but never go beyond it, which is what (B) is saying.
Step 6: Every statement lines up with this single number line picture.

$$\boxed{\text{(A), (B), (C) and (D)}}$$

Quick Tip: Draw a simple absolute-pressure number line starting at zero and see where gauge pressure and vacuum sit on it.

14. Consider the following statements related to Mohr failure hypothesis:
Statement (I): Shear stress on the failure envelope is the maximum shear stress in the element.
Statement (II): The maximum shear stress acts on a plane inclined at 45° to major principle plane.

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are true.

(B) Both Statement (I) and Statement (II) are false.

(C) Statement (I) is true but Statement (II) is false.

(D) Statement (I) is false but Statement (II) is true.

Correct Answer: (B) Both Statement (I) and Statement (II) are false.

SOLUTION:

Step 1: Think of the Mohr circle as a wheel of radius $\frac{\sigma_1 - \sigma_3}{2}$ sitting on the normal stress axis. The failure envelope is a straight ramp leaning upward from the origin at angle ϕ.
Step 2: Failure is the first moment this wheel bumps into the ramp as it grows, a tangency condition, and geometry shows the tangent point sits at an angle $2\theta = 90° + \phi$ measured from the major principal stress direction on the circle, giving a failure plane inclined at $\theta = 45° + \phi/2$ to the major principal plane in real space.
Step 3: If ϕ were zero, the ramp becomes flat, the tangent point sits exactly at the top of the wheel, and both the top-of-the-wheel idea and the 45 degree plane idea would be true together. But the question is posed as a general statement about the Mohr failure hypothesis, not restricted to frictionless soils.
Step 4: For any soil that actually has friction, the ramp is tilted, so

the tangent point slides away from the top of the wheel. The shear stress there is less than the wheel's maximum radius value, so Statement (I) breaks down.

Step 5: The failure plane angle also shifts away from 45° by half the friction angle, so Statement (II) breaks down too.

Step 6: Since the general hypothesis, with friction present, does not support either claim, both must be marked false.

Both Statement (I) and Statement (II) are false

Quick Tip: Remember the Mohr-Coulomb failure plane angle involves the friction angle phi, it is 45 plus phi by 2, not a flat 45 degrees.

• • •

15. Which of the following Law's are based on gradient:

(A) Stefan-Boltzmann law

(B) Fourier's law

(C) Newton's law of cooling

(D) Fick's law

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (A), (C) and (D) only.

(D) (A), (B) and (D) only.

Correct Answer: (B) (B), (C) and (D) only.

SOLUTION:

Step 1: Sort the four named laws by what kind of equation each one is.
Step 2: Conduction, Fourier's law, and diffusion, Fick's law, both use a first derivative of a potential, temperature or concentration, with respect to distance, multiplied by a transport coefficient, thermal conductivity or diffusivity. Both are clearly gradient laws.
Step 3: Convective cooling, Newton's law, uses a bulk difference between surface and fluid temperature rather than a derivative, but it is derived from the same underlying idea, heat moves down a temperature gradient inside a thin film near the surface, with the film approximated as a difference divided by film thickness. Because of this shared origin, courses in heat and mass transfer commonly place Newton's law of cooling in the same driving-force family as Fourier's and Fick's laws.
Step 4: Radiative emission, Stefan-Boltzmann law, is fundamentally different in form, tied to T^4 of the emitting surface with no reference to any other point or distance, so no gradient concept is involved at all. It cannot be grouped with the other three.
Step 5: Sorting the four laws this way leaves Fourier's, Newton's and Fick's laws together, with the Stefan-Boltzmann law standing alone outside that group.

$$\boxed{\text{(B), (C) and (D) only}}$$

Quick Tip: Ask which law depends on temperature to the fourth power instead of on a driving-force gradient or difference.

16. Match List-I with List-II:

List-I (Process)	List-II (Characteristic)
(A) Adiabatic	(I) No volume change takes place
(B) Isochoric	(II) No pressure change takes place
(C) Isobaric	(III) No temperature change takes place
(D) Isothermal	(IV) No heat transfer takes place

Choose the correct answer from the options given below:

(A) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

(B) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

(C) (A) - (I), (B) - (III), (C) - (IV), (D) - (II)

(D) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

Correct Answer: (D) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

SOLUTION:

Step 1: Use the process names themselves as clues, since each part of the name hints at what stays fixed. Iso means same or equal, so isochoric keeps volume equal, isobaric keeps pressure equal, and isothermal keeps temperature equal.
Step 2: That direct reading gives isochoric with no volume change (I), isobaric with no pressure change (II), and isothermal with no temperature change (III), without needing any calculation.
Step 3: Adiabatic does not fit the iso pattern, its name refers to heat being unable to pass into or out of the system. That is precisely no heat transfer takes place, which is (IV).
Step 4: Matching all four gives (A) Adiabatic to (IV), (B) Isochoric to (I), (C) Isobaric to (II), (D) Isothermal to (III).

(A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Quick Tip: The iso prefix tells you which quantity stays constant in each of the four processes.

• • •

17. A red brick wall of length 5 m, height 4 m and thickness 0.25 m has a temperature on the inner surface of 40 degree C and on the outer surface of 110 degree C. The thermal conductivity of the red brick is k = 0.70 W/mK. What will be the temperature at an interior point of the wall, 20 cm from the inner wall?

(A) 96 degree C

(B) 74 degree C

(C) 54 degree C

(D) 48 degree C

Correct Answer: (A) 96 degree C

SOLUTION:

In steady one dimensional conduction through a single flat layer, the temperature gradient is constant along the thickness, so the temperature drop is shared out in direct proportion to distance.

Total rise across the wall = $110 - 40 = 70$ degree C over a thickness of $0.25\ m$, giving a gradient of $\frac{70}{0.25} = 280$ degree C per metre.

Moving $0.20\ m$ in from the inner face adds $280 \times 0.20 = 56$ degree C to the inner temperature.

So the temperature at that point is $40 + 56 = 96$ degree C. The thermal conductivity value given in the question does not change this answer, it only matters if you wanted to find the actual heat flow rate through the wall.

$$\boxed{T = 96 \text{ degree C}}$$

Quick Tip: Think of the temperature as changing in a straight line from the inner face to the outer face, then find its value at 20 cm.

• • •

18. Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R).

Assertion (A): Counter flow heat exchanger is more effective than a parallel flow heat exchanger.

Reason (R): For same temperature limits of hot and cold fluids, the overall heat transfer coefficient of counter flow heat exchanger is more than parallel flow heat exchanger.

In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (C) (A) is true but (R) is false.

SOLUTION:

Look at what stays fixed and what changes when you swap a parallel flow exchanger for a counter flow one, keeping the same two fluids, same flow rates and same inlet and outlet temperatures.

The convective coefficients on each side, the wall properties and any fouling resistances do not depend on which way the streams flow relative to each other, so the overall coefficient U stays essentially the same in both arrangements.

What does change is the temperature difference between the hot and cold stream along the length of the exchanger. In counter flow this difference stays closer to constant, giving a larger log mean temperature difference, ΔT_{lm}, for the same terminal temperatures. Since $Q = UA\Delta T_{lm}$, a larger ΔT_{lm} means more heat transfer for the same U and A, which is exactly why counter flow is more effective.

So the assertion about counter flow being more effective is correct, but crediting this to a higher U is wrong, the real cause is the higher LMTD.

(A) true, (R) false

Quick Tip: Ask what actually changes between parallel and counter flow arrangements, the heat transfer coefficient or the temperature difference profile.

• • •

19. Match List-I with List-II.

List-I (Property)		**List-II (Fluid type)**	
(A)	Apparent viscosity decreases with increasing deformation rate	(I)	Dilatant fluids
(B)	Shear stress is directly proportional to rate of deformation	(II)	Newtonian fluids
(C)	Behaves as a solid until a minimum yield stress is exceeded and subsequently exhibits a linear relation between stress and rate of deformation	(III)	Pseudoplastic fluids
(D)	Viscosity increases with increasing deformation rate	(IV)	Bingham-plastic fluids
(E)	Shear stress is not directly proportional to deformation rate	(V)	Non-Newtonian fluids

Choose the correct answer from the options given below.

(A) (A) - (III), (B) - (II), (C) - (IV), (D) - (I), (E) - (V)

(B) (A) - (II), (B) - (V), (C) - (I), (D) - (III), (E) - (IV)

(C) (A) - (IV), (B) - (I), (C) - (V), (D) - (II), (E) - (III)

(D) (A) - (V), (B) - (III), (C) - (IV), (D) - (II), (E) - (I)

Correct Answer: (A) (A) - (III), (B) - (II), (C) - (IV), (D) - (I), (E) - (V)

SOLUTION:

A quick way to solve this kind of matching is to sort the fluid types into three simple buckets first, fluids that thin out under shear, fluids that thicken under shear, and fluids that need a push before they even start to flow.

Newtonian fluids are the baseline case where stress and strain rate are simply proportional, no thinning, no thickening, no yield stress. That matches statement (B), so (B) - (II).

Pseudoplastic (shear thinning) fluids lose apparent viscosity as shear rate goes up, matching statement (A), so (A) - (III).

Dilatant (shear thickening) fluids gain apparent viscosity as shear rate goes up, matching statement (D), so (D) - (I).

Bingham plastic fluids sit still like a solid until a yield stress is crossed, after which stress rises linearly with strain rate, matching statement (C), so (C) - (IV).

Non-Newtonian is simply the umbrella term for any fluid where stress is not directly proportional to strain rate, which is exactly statement

(E), so (E) - (V).

$$\boxed{(A)\text{-}(III),\ (B)\text{-}(II),\ (C)\text{-}(IV),\ (D)\text{-}(I),\ (E)\text{-}(V)}$$

Quick Tip: Recall which fluid type gets thinner with shearing, which gets thicker, and which needs a yield stress before it starts to flow.

• • •

20. Bernoulli's equation is conservation of

(A) Mass

(B) Energy

(C) Momentum

(D) Angular Momentum

Correct Answer: (B) Energy

SOLUTION:

Instead of memorising the name, derive Bernoulli's equation from first principles and see what physical law it comes from.

Consider a small fluid element moving along a streamline in an ideal, frictionless, incompressible flow. Apply Newton's second law along the streamline direction, this gives $\frac{dp}{\rho} + v\,dv + g\,dz = 0$.

Integrating this along the streamline gives $\frac{p}{\rho} + \frac{v^2}{2} + gz = constant$, or dividing through by g, $\frac{p}{\rho g} + \frac{v^2}{2g} + z = constant$.

Each term here is a form of energy per unit weight, flow work (pressure energy), kinetic energy, and potential energy. The equation is really just a statement that the total mechanical energy of the fluid particle does not change as it moves, provided there is no friction and no external work is done on or by it.

Bernoulli's equation represents conservation of Energy

Quick Tip: Look at what each term in Bernoulli's equation, pressure head, velocity head and elevation head, physically represents.

• • •

21. If a body is in equilibrium, we may conclude that

(A) No force is acting on the body.
(B) The resultant of all the horizontal forces acting on it is zero.
(C) The resultant of all the vertical forces acting on it is zero.
(D) The moments of the forces about any point is zero.

Choose the correct answer from the options given below.

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (A), (C) and (D) only.

(D) (A), (B) and (D) only.

Correct Answer: (B) (B), (C) and (D) only.

SOLUTION:

Test each statement with a simple example instead of relying on definitions alone.

Take a book resting on a table. Gravity pulls down on it and the table pushes up on it with an equal and opposite normal reaction. Two nonzero forces are acting, yet the book is in equilibrium. This single example is enough to rule out statement (A), so it cannot be a valid conclusion.

Now think about what equilibrium actually requires for a rigid body in a plane, it must not accelerate in any direction, and it must not start rotating. Not accelerating horizontally means $\Sigma F_x = 0$ (statement B). Not accelerating vertically means $\Sigma F_y = 0$ (statement C). Not rotating means the net moment about any chosen point must vanish, $\Sigma M = 0$ (statement D).

All three of these, taken together, are the textbook conditions for static equilibrium, and they must all hold simultaneously.

(B), (C) and (D) only

Quick Tip: Equilibrium does not mean zero forces, it means the forces and their moments balance out.

• • •

22. The centre of gravity of a right circular cone of diameter (d) and height (h) lies at a distance of _____ from the base measured along the vertical radius.

(A) h/2

(B) h/3

(C) h/4

(D) h/6

Correct Answer: (C) h/4

SOLUTION:

Think of the cone as a stack of thin circular discs, and use the standard centroid formula for a solid of revolution.

Place the apex at the origin and let x run along the axis toward the base. At a distance x from the apex, the radius of the disc is $r(x) = \frac{d}{2h}x$, so its area is $A(x) = \pi r(x)^2 = \frac{\pi d^2}{4h^2}x^2$.

The centroid distance from the apex is $\bar{x} = \frac{\int_0^h x\,A(x)\,dx}{\int_0^h A(x)\,dx} = \frac{\int_0^h x^3\,dx}{\int_0^h x^2\,dx} = \frac{h^4/4}{h^3/3} = \frac{3h}{4}$.

Since the total height is h, the distance from the base is $h - \frac{3h}{4} = \frac{h}{4}$.

$$\boxed{\frac{h}{4}}$$

Quick Tip: Remember that a solid cone's centroid is closer to the base than the midpoint, because the cone has more volume near its base.

• • •

23. If the moment of inertia of a body along a perpendicular axis passing through its centre of gravity is 50 $kg.m^2$ and the mass of the body is 30 kg. What will be the moment of inertia ($kg.m^2$) of the same body along another axis, which is 50 cm away from the current axis and parallel to it?

(A) 80.0

(B) 57.5

(C) 110.0

(D) 65.0

Correct Answer: (B) 57.5

SOLUTION:

The parallel axis theorem simply says that moving your axis away from the centre of gravity always increases the moment of inertia, by an amount equal to the mass times the square of the shift distance.

Here the shift distance is $d = 50\ cm = 0.5\ m$, and the mass is $m = 30\ kg$. So the extra term added to the centroidal value is $md^2 = 30 \times 0.25 = 7.5\ kg.m^2$.

Starting from the centroidal moment of inertia of $50\ kg.m^2$, the new moment of inertia about the shifted parallel axis is $50 + 7.5 = 57.5\ kg.m^2$.

$$\boxed{I = 57.5\ kg.m^2}$$

Quick Tip: Use the parallel axis theorem, and be careful to convert 50 cm into metres before squaring it.

• • •

24. The moment of inertia of a triangular section of base (b) and height (h) about an axis passing through its vertex and parallel to the base is _____ times as that passing through its centre of gravity and parallel to the base.

(A) Twelve

(B) Nine

(C) Six

(D) Four

Correct Answer: (B) Nine

SOLUTION:

A cleaner route is to first find the moment of inertia about the base of the triangle, since that value is well known, and then shift again to the vertex.

About the base, parallel to it, the standard result is $I_{base} = \frac{bh^3}{12}$. This can also be checked using the parallel axis theorem from the centroid, $I_{base} = \frac{bh^3}{36} + \frac{1}{2}bh\left(\frac{h}{3}\right)^2 = \frac{bh^3}{36} + \frac{bh^3}{18} = \frac{3bh^3}{36} = \frac{bh^3}{12}$, which matches.

Now the vertex is at height h, so its distance from the centroid is $\frac{2h}{3}$, while the base's distance from the centroid is $\frac{h}{3}$. Using the parallel axis theorem directly from the centroid for the vertex axis, I_{vertex} $= \frac{bh^3}{36} + \frac{1}{2}bh\left(\frac{2h}{3}\right)^2 = \frac{bh^3}{36} + \frac{2bh^3}{9} = \frac{bh^3}{4}$.

Taking the ratio, $\frac{I_{vertex}}{I_{cg}} = \frac{bh^3/4}{bh^3/36} = 9$.

9 times

Quick Tip: First find the moment of inertia about the base, then shift it again to the vertex using the parallel axis theorem, being careful about which distance you use each time.

• • •

25. Which of the following quantities have unit as Newton-metre (N-m)?

(A) Work
(B) Energy
(C) Torque
(D) Power
(E) Momentum

Choose the **correct** answer from the options given below:

(A) (C) only

(B) (A), (B) and (C) only

(C) (B) only

(D) (D) and (E) only

Correct Answer: (B) (A), (B) and (C) only

SOLUTION:

We can also check each quantity using dimensional analysis instead of definitions.

Force has dimension $[MLT^{-2}]$ and distance has dimension $[L]$, so force times distance has dimension $[ML^2T^{-2}]$, matching the unit N.m.
Work equals force times distance, dimension $[ML^2T^{-2}]$, unit N.m. This fits.
Energy has the same dimension as work, $[ML^2T^{-2}]$, unit N.m. This fits too.
Torque equals force times perpendicular distance, dimension $[ML^2T^{-2}]$, unit N.m, even though it is kept apart from joule to reflect its vector nature. This also fits.
Power equals work divided by time, dimension $[ML^2T^{-3}]$, unit N.m/s, the watt. This does not reduce to N.m alone.
Momentum equals mass times velocity, dimension $[MLT^{-1}]$, unit kg.m/s. This has no match with N.m.
Only Work, Energy and Torque reduce to N.m, confirming the answer.

(A), (B) and (C) only

Quick Tip: Think about which of these are scalar quantities that share the same unit as work, and which ones bring in time or velocity instead.

• • •

26. A flywheel starts from rest and revolves with an acceleration of $0.5\ \text{rad/sec}^2$. What will be its angular displacement after 10 seconds?

(A) 5 radians

(B) 25 radians

(C) 35 radians

(D) 50 radians

Correct Answer: (B) 25 radians

SOLUTION:

Since the flywheel accelerates uniformly from rest, we can also solve this using average angular velocity.

The final angular velocity after 10 seconds is $\omega = \omega_0 + \alpha t = 0 + 0.5 \times 10 = 5$ rad/sec.

Because the acceleration is constant, the average angular velocity over the interval is the mean of the initial and final values: $\omega_{avg} = \frac{\omega_0 + \omega}{2} = \frac{0+5}{2} = 2.5$ rad/sec.

Angular displacement equals average angular velocity multiplied by time: $\theta = \omega_{avg} \times t = 2.5 \times 10 = 25$ radians.

This confirms the same result through a different route.

$$\boxed{25 \text{ radians}}$$

Quick Tip: Use the equation of angular motion that relates displacement, initial angular velocity, angular acceleration and time.

• • •

27. Which of the following constitute kinematic link?

(A) Piston, piston rod and crosshead
(B) Connecting rod with big and small end bearings
(C) Crank, crankshaft and flywheel
(D) Cylinder, engine frame and main bearings

Choose the **correct** answer from the options given below:

(A) (A), (B) and (C) only

(B) (B), (C) and (D) only

(C) (A), (C) and (D) only

(D) (A), (B), (C) and (D)

Correct Answer: (D) (A), (B), (C) and (D)

SOLUTION:

We can also check this by elimination instead of confirming each group directly.
Option 1 drops (D), the cylinder-frame-bearings assembly. This assembly is fixed and its parts do not move relative to each other, so it still meets the definition of a link, which means option 1 is incomplete.
Option 2 drops (A), the piston-piston rod-crosshead assembly, which clearly moves as a single rigid unit and is a standard example of a slider link. So option 2 is incomplete.
Option 3 drops (B), the connecting rod with its bearings, one of the most common textbook examples of a link. So option 3 is incomplete.
Since each of (A), (B), (C) and (D) independently satisfies the definition of a kinematic link, none of them can be left out, leaving only option 4 as correct.

$$\boxed{\text{(A), (B), (C) and (D)}}$$

Quick Tip: Recall the four links used to describe a slider crank mechanism in a reciprocating engine.

• • •

28. Given below are two statements:

Statement (I): A kinematic link may consist of several parts rigidly fastened together so that they do not move relative to one another.
Statement (II): A kinematic link need not be a rigid body but it must be a resistant body.

In light of the above statements, choose the **most appropriate** answer from the options given below.

(A) Both **Statement (I)** and **Statement (II)** are true.

(B) Both **Statement (I)** and **Statement (II)** are false.

(C) **Statement (I)** is true but **Statement (II)** is false.

(D) **Statement (I)** is false but **Statement (II)** is true.

Correct Answer: (A) Both **Statement (I)** and **Statement (II)** are true.

SOLUTION:

We can check both statements against real examples instead of just repeating the definition.
For Statement (I), take the connecting rod of an engine. It is built with separate bushes or bearings fitted into its ends, yet the whole assembly acts as a single link because none of its parts move relative to each other while running. This example directly supports Statement (I), so it is true.
For Statement (II), think of a belt or a chain used to transmit motion between two shafts. A belt is not a rigid body since it can bend and flex, yet it still transmits tension and motion reliably, so it is treated as a resistant body and accepted as a link in machine theory. This example directly supports Statement (II), so it is true as well.
Both real examples confirm the statements describe accepted, working cases, so both are true.

Both statements are true

Quick Tip: Recall the standard textbook definition of a kinematic link and

what "resistant body" means.

• • •

29. Kutzback equation between degrees of freedom (n), number of links (l), number of joints (j) and number of higher pairs (h) of a mechanism having plane motion is given by

(A) $n = 3(l-1) - 2j - h$

(B) $n = 3(l+3) - 2j - h$

(C) $n = 3(l-3) - 2(j-h)$

(D) $n = 3(l+1) - j + 2h$

Correct Answer: (A) $n = 3(l-1) - 2j - h$

SOLUTION:

We can also arrive at the equation by counting degrees of freedom directly instead of recalling the formula.
Each unconnected rigid link moving in a plane has 3 degrees of freedom, two for translation and one for rotation. With l links, and one of them fixed as the frame, the degrees of freedom available before adding any joints is $3(l-1)$.
Every lower pair, such as a pin joint or a sliding joint, removes 2 degrees of freedom because it only allows one relative motion between the two links it connects. With j such joints, we subtract $2j$.
Every higher pair, such as a cam and follower or two gear teeth in contact, removes only 1 degree of freedom because it allows two relative motions, sliding and rolling, between the links. With h such pairs, we subtract h.
Putting this together gives $n = 3(l-1) - 2j - h$, the same as option 1.

$$\boxed{n = 3(l-1) - 2j - h}$$

Quick Tip: Recall how lower pairs and higher pairs each affect the degrees of freedom differently.

• • •

30. Select the correct sequence of increasing size (thickness) of clay minerals

(A) Montmorillonite
(B) Chlorite
(C) Kaolinite
(D) Illite
Choose the **correct** answer from the options given below:

(A) (B), (A), (C), (D)

(B) (A), (D), (B), (C)

(C) (C), (B), (A), (D)

(D) (D), (C), (A), (B)

Correct Answer: (B) (A), (D), (B), (C)

SOLUTION:

Another way to work this out is through the specific surface area of each mineral, since surface area and particle size move in opposite directions for the same amount of material.
Montmorillonite has the highest specific surface area of all common clay minerals, close to 700 to 800 square metres per gram, because its particles are the thinnest.

Illite has a much lower specific surface area, roughly 100 to 200 square metres per gram, since its particles are thicker than montmorillonite but still fairly fine.
Chlorite behaves similarly to illite in the field but is generally coarser, giving it a slightly lower specific surface area and hence a larger particle size.
Kaolinite has the lowest specific surface area among the four, often below 20 square metres per gram, because it forms the thickest, most stacked particles.
Ranking from the highest specific surface area, smallest particle, to the lowest specific surface area, largest particle, gives Montmorillonite, Illite, Chlorite, Kaolinite, the same increasing size order found before.

Montmorillonite, Illite, Chlorite, Kaolinite

Quick Tip: Think about how the crystal structure and bonding of each mineral affects its particle thickness.

• • •

31. Given below are two statements, one is labelled as **Assertion (A)** and the other one labelled as **Reason (R)**.

Assertion (A): A good CI engine fuel, like diesel oil, is a bad SI engine fuel, and a good SI engine fuel, like petrol, is a bad CI engine fuel.
Reason (R): A good CI engine fuel requires high self-ignition temperature and good SI engine fuel requires low self-ignition temperature.
In light of the above statements, choose the **correct** answer from the options given below.

(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

(B) Both **(A)** and **(R)** are true but **(R)** is NOT the correct explanation of **(A)**.

(C) **(A)** is true but **(R)** is false.

(D) **(A)** is false but **(R)** is true.

Correct Answer: (C) **(A)** is true but **(R)** is false.

SOLUTION:

We can check this through the octane and cetane rating system used for these two fuels.

Petrol, used in SI engines, is rated by octane number, and a HIGHER octane number means the fuel resists knocking, which in practical terms means it has a higher self-ignition temperature and does not fire on its own under compression alone.

Diesel, used in CI engines, is rated by cetane number, and a HIGHER cetane number means the fuel ignites more readily under compression, which in practical terms means it has a LOWER self-ignition temperature.

So the actual fuel requirements are opposite to what Reason (R) claims, CI engines need a low self-ignition temperature fuel and SI engines need a high self-ignition temperature fuel.

Assertion (A), about diesel performing poorly in SI engines and petrol performing poorly in CI engines, remains a correct and independent fact, confirmed by how poorly petrol resists compression ignition and how poorly diesel responds to spark ignition.

Therefore Assertion (A) is true while Reason (R), as worded, is false.

(A) is true but (R) is false

Quick Tip: Compare what self-ignition temperature means for compression ignition versus spark ignition.

• • •

32. Consider the following statements regarding C.I. engine and S.I. engine

(A) C.I. engines are more bulky than S.I. engines
(B) C.I. engines are more efficient than S.I. engines
(C) Lighter flywheels are required in C.I. engines
Choose the **correct** answer from the options given below:

(A) (A) and (C) only

(B) (B) and (C) only

(C) (A) and (B) only

(D) (A), (B) and (C)

Correct Answer: (C) (A) and (B) only

SOLUTION:

We can also look at this from the point of view of design requirements instead of general statements.
Because a CI engine ignites fuel by compression alone, it must be built for compression ratios of about 16 to 22, compared to about 8 to 12 for an SI engine. Higher compression means higher peak cylinder pressure, and the components must be thicker and heavier to survive this, which is why CI engines end up bulkier. This supports (A).
The higher compression ratio in a CI engine also raises the ideal thermal efficiency, because a bigger expansion ratio lets the engine draw more useful work from the same fuel charge before exhaust. This

is the direct reason CI engines are known to be more fuel efficient than SI engines, supporting (B).
Flywheel size depends on how uneven the turning moment is over one cycle. A CI engine has sharper pressure peaks and a torque curve that swings more strongly, so it actually needs a heavier flywheel to store enough energy and smooth out the crankshaft speed. This means statement (C), which claims a lighter flywheel, is wrong.
So only (A) and (B) hold true, confirming option 3.

(A) and (B) only

Quick Tip: Think about compression ratio, structural strength and turning moment variation for each engine type.

• • •

33. An engine has a swept volume of 300 cm^3, clearance volume of 25 cm^3. Its volumetric efficiency is 0.80 and mechanical efficiency is 0.90. The volume of mixture taken in per stroke is

(A) 325 cm^3

(B) 275 cm^3

(C) 240 cm^3

(D) 270 cm^3

Correct Answer: (C) 240 cm^3

SOLUTION:

Volumetric efficiency tells us what fraction of the swept volume actually fills with fresh charge in one stroke, since a real cylinder never fills up completely due to throttling losses and heating of the

incoming charge.

Swept volume here is $300\ cm^3$. An efficiency of 0.80 means 80% of this swept volume gets filled with charge every stroke.

Volume drawn in $= \frac{80}{100} \times 300 = 240\ cm^3$.

The clearance volume of $25\ cm^3$ would only matter if compression ratio $\left(\frac{V_s + V_c}{V_c}\right)$ were asked, and the mechanical efficiency of 0.90 would only matter if brake power from indicated power were asked. Neither is asked here.

$$\boxed{240\ cm^3}$$

Quick Tip: Volumetric efficiency links only the actual charge drawn in to the swept volume, not every given number is needed.

• • •

34. A two stroke cycle gives _____ the number of power strokes as compared to four stroke cycle engine at the same engine speed.

(A) Half

(B) Same

(C) Double

(D) Four times

Correct Answer: (C) Double

SOLUTION:

Take a concrete example. Suppose the engine runs at 3000 rpm.

A four stroke engine needs 2 revolutions per cycle, so it gives one power stroke every 2 revolutions. At 3000 rpm that is $3000/2 = 1500$ power strokes per minute.

A two stroke engine completes its cycle in just 1 revolution, since intake and exhaust happen through ports during the same revolution that carries the compression and power strokes. So it gives one power stroke every single revolution, which at 3000 rpm means 3000 power strokes per minute.

Comparing the two, 3000 is exactly double 1500, at the same rpm.

Double

Quick Tip: Think about how many crankshaft revolutions each cycle needs to complete one power stroke.

• • •

35. The overall mechanization level in India ranges from

(A) 20-25 %

(B) 40-45 %

(C) 55-60 %

(D) 75-80 %

Correct Answer: (B) 40-45 %

SOLUTION:

Look at it region by region and then average out. States with intensive mechanized farming, like Punjab, Haryana and western Uttar Pradesh, already use tractors and machines for nearly 80-90% of farm operations.

But large parts of eastern India, the hill states and rainfed regions still depend heavily on bullock power and manual labour, which pulls the national figure down a lot.

When these very different regional numbers are averaged across the whole country, agricultural statistics repeatedly quote India's overall farm mechanization level at roughly 40-45%, well below the 75-80% seen in fully mechanized economies and only a little above the 20-25% mark of very low mechanization.

$\boxed{40\text{-}45\%}$

Quick Tip: Compare India's average mechanization with the near-total mechanization in developed farm economies.

• • •

36. Match List-I with List-II.

List-I (Farm Equipment)	List-II (Action)
(A) Turn wrest plough	(I) Moves all the soil towards same side.

(B) Disc plough	(II) Moves the soil in opposite directions.
(C) Disc harrow	(III) Used for shallow ploughing.
(D) Vertical disc plough	(IV) Has an arrangement that the plough bottom can be changed from right hand to left hand by rotating it approximately 180 degree.
(E) Off-set disc harrow	(V) Well suited for working under low hanging branches in orchards.

Choose the correct answer from the options given below:

(A) (A) - (V), (B) - (IV), (C) - (I), (D) - (II), (E) - (III)

(B) (A) - (II), (B) - (III), (C) - (V), (D) - (I), (E) - (IV)

(C) (A) - (I), (B) - (II), (C) - (III), (D) - (IV), (E) - (V)

(D) (A) - (IV), (B) - (I), (C) - (II), (D) - (III), (E) - (V)

Correct Answer: (D) (A) - (IV), (B) - (I), (C) - (II), (D) - (III), (E) - (V)

SOLUTION:

Eliminate wrong options first. Option 3 pairs the turn wrest plough with (I), moving soil to one side, but that everyday feature belongs to a plain disc or mouldboard plough, not the special reversible feature of a turn wrest plough, so option 3 is wrong.

Option 2 pairs the disc harrow with (V), working under low branches, but that off-set feature belongs to the off-set disc harrow, not the ordinary disc harrow, so option 2 is wrong.

Option 1 pairs the vertical disc plough with (II), opposite-direction soil movement, but that describes a tandem disc harrow's two opposed gangs, not a vertical disc plough, so option 1 is wrong.

Only option 4 places the reversible 180 degree bottom on the turn wrest plough, the constant one-side throw on the disc plough, the opposite-direction throw on the disc harrow, shallow work on the vertical disc plough, and orchard-branch clearance on the off-set disc harrow.

$$\boxed{(A)\text{-}(IV),\ (B)\text{-}(I),\ (C)\text{-}(II),\ (D)\text{-}(III),\ (E)\text{-}(V)}$$

Quick Tip: Think about which implement is designed to reverse its throw direction, and which one is designed to fit under orchard branches.

• • •

37. Which seed metering mechanism in a planter brushes out excess seeds from the cells of the feed mechanism?

(A) Edge drop

(B) Cut off

(C) Knock out

(D) Flat drop

Correct Answer: (B) Cut off

SOLUTION:

Picture the rotating seed plate of a cell-type feed mechanism moving past the seed hopper. As the cells dip into the loose seed, several seeds may pack into and around a single cell instead of just one.

If this extra seed travels forward, the planter would drop clusters of seeds instead of single seeds, ruining the plant spacing. To stop this, a

small stationary brush or scraper is fitted just past the point where the cells leave the seed pool.

This fixed part is called the cut-off, and its job is to knock loose seed off the top of each cell so exactly the seed sitting inside the cell cavity continues on, while the rest falls back into the seed box.

Edge drop and flat drop only describe the geometry of where the cell openings sit on the plate, and knock out is the term for releasing a vacuum-held seed in air planters, neither of which matches brushing excess seed off a cell.

Quick Tip: Think of the fixed brush or wiper that levels off a cell as it rotates past the seed pool.

• • •

38. Which of the following is primary function of broadcaster?

(A) Open the seed furrow to proper depth
(B) Meter the seed
(C) Distribute seed over a given width of land
(D) Deposit the seed in the furrow in acceptable pattern
(E) Cover the seed and compact soil around it
Choose the correct answer from the options given below:

(A) (A), (B), (C), (D) and (E).

(B) (A), (B), (D) and (E) only.

(C) (A), (D) and (E) only.

(D) (B) and (C) only.

Correct Answer: (D) (B) and (C) only.

SOLUTION:

Compare a broadcaster with a seed drill function by function. A seed drill does four jobs in sequence, opening the furrow, metering seed, dropping it into the furrow in a set pattern, and finally covering and firming the soil over it.

A broadcaster skips the furrow-related jobs entirely, since it just spreads seed over the surface with no furrow to open, no furrow to place seed into, and no covering step afterward.

What remains once the furrow-based jobs (A, D and E) are removed from that list is exactly metering the seed (B) and spreading it over the width of land (C).

That leaves only (B) and (C) as the primary functions of a broadcaster.

$$\boxed{(B) \text{ and } (C) \text{ only}}$$

Quick Tip: Remember a broadcaster works only on the surface, it never opens or closes a furrow.

39. Match List-I with List-II.

List-I (Field operation)	List-II (Equipment used)
(A) Intercultural operation	(I) Rotavator
(B) Deep ploughing	(II) Cultivator
(C) Soil pulverization	(III) Sub-soiler
(D) Conservation tillage	(IV) Strip-till drill
(E) Soil Inversion	(V) MB plough

Choose the correct answer from the options given below:

(A) (A) - (I), (B) - (V), (C) - (II), (D) - (IV), (E) - (III)

(B) (A) - (IV), (B) - (I), (C) - (V), (D) - (III), (E) - (II)

(C) (A) - (II), (B) - (III), (C) - (I), (D) - (IV), (E) - (V)

(D) (A) - (IV), (B) - (II), (C) - (I), (D) - (V), (E) - (III)

Correct Answer: (C) (A) - (II), (B) - (III), (C) - (I), (D) - (IV), (E) - (V)

SOLUTION:

Work from the equipment side instead. A rotavator's spinning blades are known for producing a fine, powdery tilth, which is soil pulverization, so rotavator goes with (C).

A cultivator's spring or rigid tines are the normal tool for going between standing crop rows to cut weeds, which is intercultural operation, so cultivator goes with (A).

A sub-soiler's whole job is to go deeper than a normal plough to break compacted layers, matching deep ploughing (B).

A strip-till drill only loosens and sows a narrow strip and leaves the

rest of the field undisturbed, which is conservation tillage (D).

An MB plough's mouldboard shape is specifically built to lift and flip the furrow slice over, which is soil inversion (E).

This gives the same matching from the other direction, (A)-(II), (B)-(III), (C)-(I), (D)-(IV), (E)-(V).

$$\boxed{(A)\text{-}(II),\ (B)\text{-}(III),\ (C)\text{-}(I),\ (D)\text{-}(IV),\ (E)\text{-}(V)}$$

Quick Tip: Match each operation to the implement whose basic design purpose is to achieve exactly that effect on soil.

• • •

40. A flat fan nozzle is most suitable for

(A) Foliage spray

(B) Insect control

(C) Spot spray

(D) Herbicide spray

Correct Answer: (D) Herbicide spray

SOLUTION:

Think about what each nozzle type is built for. A flat fan nozzle throws liquid out as a thin, wide sheet with tapered edges so that neighbouring nozzles on a boom overlap evenly, giving a uniform strip of coverage across the whole boom width without gaps or double doses.

Herbicide spraying is normally done as a full-field, even, broadcast application over soil or standing weeds and crops, which is exactly the uniform strip coverage a flat fan nozzle is designed to deliver.

Foliage spraying for insect control instead needs the spray to wrap around leaves and reach both leaf surfaces, which calls for the finer, more penetrating droplets of a hollow cone nozzle rather than a flat sheet pattern. Spot spraying targets only a small isolated area, handled with a single adjustable nozzle rather than a full boom.

Since only the herbicide-application scenario matches the flat, even, boom-wide pattern a flat fan nozzle produces, that is the correct match.

Herbicide spray

Quick Tip: Think about which spraying job needs an even, overlapping strip of coverage across a full boom width.

41. Given below are two statements:

Statement (I): Drift is more serious problem with dusts compared to sprays.

Statement (II): Drift can be minimized by producing sprays having small volume mean diameter (VMD).

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (C) Statement (I) is correct but Statement (II) is incorrect.

SOLUTION:

Drift happens when applied particles are light enough for wind to carry them away from the target before they land. Dust particles are solid and dry with almost no weight, so even gentle air movement pushes them off course, which is why dusts are known to drift worse than sprays.

For a liquid spray, droplet size decides how much wind can move it. A droplet with a small volume mean diameter is tiny and light, so it behaves almost like a dust particle and drifts away easily. A droplet with a large volume mean diameter is heavier for its size and falls more directly onto the target.

So reducing drift calls for a LARGER volume mean diameter, not a smaller one, which means Statement (II) states the opposite of the correct practice.

Statement (I) true, Statement (II) false

Quick Tip: Think about whether fine or coarse droplets resist wind drift better.

• • •

42. Registration and alignment are the cutting knife adjustments related to

(A) Reaper

(B) Mower

(C) Combine harvester

(D) Reaper binder

Correct Answer: (B) Mower

SOLUTION:

Picture a sickle bar sliding back and forth across a row of fixed guards. For a clean cut, two things must be right: where the knife section sits relative to the guard at the end of a stroke (registration), and whether the guards themselves form a straight, even line (alignment).

Both checks come from the maintenance manual of the mower, since a mower depends on a fast reciprocating knife shearing cleanly against

guards to cut standing forage without dragging or missing stems. Reapers and binders use a similar idea but the terms registration and alignment are specifically drawn from mower cutter bar servicing.

Mower

Quick Tip: Think of the classic sickle bar mower and its knife to guard positioning checks.

• • •

43. Select the most appropriate sequence of involvement of different parts of combine harvester from crop interception to grain collection

(A) Cutter bar
(B) Auger
(C) Straw walker
(D) Cylinder and concave
(E) Reel

Choose the correct answer from the options given below:

(A) (A), (B), (C), (D), (E).

(B) (E), (A), (B), (D), (C).

(C) (A), (B), (E), (D), (C).

(D) (E), (C), (D), (A), (B).

Correct Answer: (B) (E), (A), (B), (D), (C).

SOLUTION:

Think of the combine as a single production line the crop passes through in one direction, from standing in the field to clean grain in the tank.

First the reel reaches out and gathers the standing stalks, holding them steady. Next the cutter bar slices through the stems at the base. The severed crop then slides onto the moving platform, where the auger gathers it toward the center and pushes it into the feeder house. Inside the machine, the cylinder spins against the concave, rubbing and impacting the crop heads to knock the grain loose. What remains, mostly straw with some trapped grain, moves onto the straw walkers, which shake it so the last bits of grain fall through to the cleaning shoe while the spent straw exits the rear.

This gives the sequence Reel, Cutter bar, Auger, Cylinder and concave, Straw walker.

(E), (A), (B), (D), (C)

Quick Tip: Trace the crop's path: first touched, then cut, then fed in, then threshed, then the straw is separated.

44. As per BIS, for safe use of threshers

(A) The minimum length of feeding chute should be 90 cm.
(B) The feeding chute should be covered up to a minimum length of 45 cm.
(C) The feeding chute should be inclined to the horizontal at an angle of 5-10 degree.
(D) The feeding chute should be made of stainless steel.
(E) The feeding chute should have an alarming system.

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (B), (D) and (E) only.

(D) (A), (B) and (E) only.

Correct Answer: (D) (A), (B) and (E) only.

SOLUTION:

Every genuine safety requirement in the BIS thresher code exists to stop a hand from reaching the spinning cylinder while feeding crop material.

A long feeding chute, at least 90 cm, physically keeps the feeding hand far from the cylinder. Covering at least 45 cm of that chute blocks fingers from slipping down into the moving mechanism. An alarm system warns anyone nearby that the machine is running and dangerous. All three of these directly reduce the chance of an injury.

A fixed tilt angle or a specific metal like stainless steel does not, by

itself, make the chute safer, these are manufacturing or design choices rather than protective safety features, so they are not part of the mandated safety list.

(A), (B) and (E) only

Quick Tip: Focus on what actually protects an operator's hand: chute length, guarding, and a warning signal, not the material or the tilt angle.

• • •

45. Maximum torque in a tractor is generated at speed

(A) At which maximum power is generated

(B) Lower than the speed at which maximum power is generated

(C) Higher than the speed at which maximum power is generated.

(D) At which minimum power is generated.

Correct Answer: (B) Lower than the speed at which maximum power is generated

SOLUTION:

Picture the standard torque and power curves plotted against engine speed for any tractor engine. Torque rises from idle, peaks at some middle rpm, and then falls off as speed climbs further. Power equals torque times speed (up to a constant), so even after torque starts falling, power can still keep climbing for a while since speed is increasing fast enough to outweigh the drop in torque.

Power only reaches its own peak, and starts to fall, once the torque

has already dropped enough that the rising speed can no longer make up for it. This mathematical relationship guarantees that the power peak always occurs at a higher rpm than the torque peak.

Maximum torque occurs at a lower speed than maximum power

Quick Tip: Recall that on any engine's power and torque curves, the torque peak always sits to the left of (at a lower rpm than) the power peak.

• • •

46. Match List-I with List-II.

List-I (Harvesting machine)	List-II (Crop)
(A) Digger	(I) Cotton
(B) Reaper	(II) Potato
(C) Picker	(III) Cereal crops
(D) Snapper	(IV) Forage crops
(E) Mower	(V) Maize

Choose the correct answer from the options given below:

(A) (A) - (IV), (B) - (III), (C) - (V), (D) - (I), (E) - (II)

(B) (A) - (I), (B) - (III), (C) - (V), (D) - (II), (E) - (IV)

(C) (A) - (V), (B) - (IV), (C) - (II), (D) - (I), (E) - (III)

(D) (A) - (II), (B) - (III), (C) - (I), (D) - (V), (E) - (IV)

Correct Answer: (D) (A) - (II), (B) - (III), (C) - (I), (D) - (V), (E) - (IV)

SOLUTION:

Go machine by machine and ask what job each one is actually built for.

A digger's whole purpose is to loosen soil and lift underground tubers to the surface, which is exactly what potato harvesting needs. A reaper is a cutting machine meant for standing cereal stalks like wheat, so it belongs with cereal crops. A picker, in the context of cotton harvesting, plucks the fiber straight out of the open boll, tying it to cotton. A snapper physically snaps the whole ear off a standing maize stalk, tying it to maize. A mower simply cuts grasses and legumes close to the ground for hay, tying it to forage crops.

This machine by machine reasoning gives the same pairing as before.

$$\boxed{(A)\text{-}(II),\ (B)\text{-}(III),\ (C)\text{-}(I),\ (D)\text{-}(V),\ (E)\text{-}(IV)}$$

Quick Tip: Match each named machine to the one crop it is specifically built to harvest.

47. Which of the following is harvesting machine?

(A) Cotton picker
(B) Potato Digger
(C) Mower
(D) Tree shaker

Choose the correct answer from the options given below:

(A) (C) only.

(B) (A) and (B) only.

(C) (B), (C) and (D) only.

(D) (A), (B), (C) and (D).

Correct Answer: (D) (A), (B), (C) and (D).

SOLUTION:

Instead of picking a familiar-sounding subset, check each machine against the plain definition of harvesting: removing a mature, ready crop from where it grew.

The cotton picker removes cotton fiber from the plant. The potato digger removes tubers from underground. The mower removes standing forage from the field. The tree shaker removes fruit or nuts from a tree by vibration. Every single one of these four actions is a form of harvesting a crop, just applied to very different crop types and using very different mechanisms.

Since none of the four machines fail this basic harvesting test, all four belong in the answer.

(A), (B), (C) and (D)

Quick Tip: Ask whether each machine's job is to gather a mature crop from the field, no matter which crop it targets.

• • •

48. The acceptable work load for average Indian workers is about

(A) 35 % of individual's maximum aerobic power (VO_{2max})

(B) 50 % of individual's maximum aerobic power (VO_{2max})

(C) 65 % of individual's maximum aerobic power (VO_{2max})

(D) 80 % of individual's maximum aerobic power (VO_{2max})

Correct Answer: (A) 35 % of individual's maximum aerobic power (VO_{2max})

SOLUTION:

Think about the difference between a short burst of hard effort and work that must continue for an entire 8 hour shift, day after day. A person can briefly work close to their VO2max, but sustaining a high fraction of it for hours causes exhaustion, a rising heart rate that never settles, and falling work output.

Ergonomic studies specifically carried out on Indian workers, accounting for their typical body size and physical conditioning, arrived at a much lower sustainable fraction than the near-maximum values sometimes seen in short-duration lab tests. That accepted sustainable figure is about 35 percent of VO2max, well below the 50, 65 or 80 percent options, which are all too demanding for continuous

full shift work.

$$\boxed{35\% \text{ of } VO_{2max}}$$

Quick Tip: Remember that a workload sustainable for a full working day must be well below an individual's maximum oxygen consumption capacity.

• • •

49. Consider the following statements related to biomass conversion techniques.

Statement (I): Thermo-chemical processes have higher efficiencies than bio-chemical processes.

Statement (II): In comparison to bio-chemical conversion techniques, thermo-chemical conversion techniques have superior ability to decompose lignin.

Choose the correct answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Biomass energy conversion is split into two families: bio-chemical (digestion, fermentation, driven by microbes) and thermo-chemical (combustion, gasification, pyrolysis, driven by heat).
Efficiency check: microbial routes are slow and only a fraction of the feed's energy ends up as biogas or ethanol, while heat-driven routes convert most of the feedstock's chemical energy into usable fuel or power quickly. So thermo-chemical processes do run at higher overall efficiency, confirming Statement (I).
Lignin check: lignin is a tough, cross-linked aromatic polymer. Microbes and their enzymes cannot break it down effectively, so bio-chemical digesters leave lignin largely untouched in the sludge. Heat does not care about enzyme specificity, it simply cracks the chemical bonds, so thermo-chemical methods decompose lignin far better than bio-chemical ones. This confirms Statement (II).
Both statements hold up, so the correct choice is the one that accepts both as true.

Both Statement (I) and Statement (II) are correct

Quick Tip: Think about how each conversion route handles lignin and how much of the biomass energy each route actually recovers.

• • •

50. Which country is having a full-fledged Ministry for Development of New and Renewable Resources?

(A) India

(B) Bangladesh

(C) Japan

(D) China

Correct Answer: (A) India

SOLUTION:

Recall that India set up the Department of Non-Conventional Energy Sources back in 1982 and later expanded it into a complete ministry, now called the Ministry of New and Renewable Energy. This is routinely cited in agricultural and energy studies as the world's first full-fledged ministry of its kind. Bangladesh, Japan and China manage renewable energy as a wing of their broader energy or power ministries, not as a standalone ministry, so they are ruled out.

India

Quick Tip: Think of the country that set up MNRE, one of the earliest dedicated renewable energy ministries in the world.

• • •

51. A tractor operated sprayer has 24 nozzles spaced 50 cm apart. Time lost in turning is 8% and filling the tank takes 7% of the time. If the sprayer is operated at a speed of 5 km/h, calculate the coverage area in ha per hour.

(A) 2.6

(B) 3.0

(C) 5.1

(D) 6.0

Correct Answer: (C) 5.1

SOLUTION:

Set up the numbers directly. Working width $W = 24 \times 0.5\ \text{m} = 12\ \text{m} = 0.012\ \text{km}$. Area covered per hour at full efficiency (no stoppage) is $A = W \times v = 0.012\ \text{km} \times 5\ \text{km/h} = 0.06\ \text{km}^2/\text{h}$. Since $1\ \text{km}^2 = 100$ ha, this equals $0.06 \times 100 = 6$ ha/h, the theoretical capacity.
Now apply the losses. Turning eats 8% of the working time and tank filling eats another 7%, together 15% of the time is non-productive, leaving only 85% of the time actually spraying. So the real capacity is 6×0.85.

$$6 \times 0.85 = 5.1\ \text{ha/h}$$

$$\boxed{5.1\ \text{ha/h}}$$

Quick Tip: First get the theoretical area covered per hour from swath width and speed, then reduce it by the total time lost.

• • •

52. The major drawbacks of conventional tillage are categorized as:

(A) Decrease of soil organic matter
(B) Decrease of soil moisture
(C) Short-term potential for soil compaction
(D) Adversely affect the soil structure

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.
(B) (B), (C) and (D) only.
(C) (A), (B) and (D) only.
(D) (A), (B), (C) and (D).

Correct Answer: (C) (A), (B) and (D) only.

SOLUTION:

Go through the four claims one at a time. Organic matter loss (A) happens because tillage aerates buried residues and speeds up their decomposition, so this is a real drawback. Moisture loss (B) happens because a freshly tilled, loosened surface loses water faster to evaporation, so this is also real. Soil structure damage (D) happens because repeated passes crush natural aggregates and disturb pores over successive seasons, so this too is a real drawback.
Compaction (C) is the odd one out. Ploughing and other conventional operations do create a compacted layer just below the working depth, called a plough pan or hardpan, but this builds up gradually across many seasons of repeated tillage. It is consistently described as a long-term consequence, not something that shows up in the short term. Because the option specifically says "short-term," it does not fit.
So the valid drawbacks are only A, B and D.

$$\boxed{(A),\ (B) \text{ and } (D) \text{ only}}$$

Quick Tip: Check each statement against known effects of conventional tillage, paying close attention to whether compaction is described as a short-term or long-term effect.

53. Given below are two statements:

Statement (I): The soil texture is defined as the relative proportion, by weight percentage, of sand, silt and clay in soil.

Statement (II): The aeration in fine textured soil is medium to poor.

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Test each claim against basic soil physics. Texture is a particle-size classification, it tells you what fraction of the soil's mass is sand, what fraction is silt, and what fraction is clay. That is exactly what Statement (I) says, so it stands.
Now think about pore space. Clay particles are extremely small and flat, so they pack closely with mostly tiny micropores between them. Micropores hold water tightly but choke off free air movement, while sandy soils with large particles have big macropores that let air move freely. That means fine (clay-rich) soils will always aerate worse than coarse soils, ranging from medium to poor, which is exactly what Statement (II) claims.
Both checks pass, so both statements are true.

Both Statement (I) and Statement (II) are correct

Quick Tip: Recall the standard definition of soil texture and how particle size affects pore size and air movement in soil.

• • •

54. A 2-bottom, 50 cm MB plough is being operated at a speed of 5 km/h. If the time lost in turning is 8 per cent, how many hours will be required to plough 23 ha of land?

(A) 23

(B) 46

(C) 50

(D) 100

Correct Answer: (C) 50

SOLUTION:

Convert everything to a rate of ploughing in ha per hour, then invert it. Working width $W = 2 \times 0.5\ \text{m} = 1\ \text{m} = 0.001\ \text{km}$. At 5 km/h, the theoretical rate is $A = W \times v = 0.001 \times 5 = 0.005\ \text{km}^2/\text{h} = 0.5\ \text{ha/h}$ (since 1 km^2 = 100 ha).

Only 92% of the time is actually spent ploughing since 8% goes into turning, so the real rate is $0.5 \times 0.92 = 0.46\ \text{ha/h}$.

Time needed for 23 ha is simply the area divided by this rate.

$$t = \frac{23}{0.46} = 50\ \text{h}$$

50 hours

Quick Tip: Work out the effective field capacity in ha per hour first, factoring in the plough width, speed and turning loss, then divide the area by it.

• • •

55. A bullock drawn country plough cuts a trapezoidal furrow having 16 cm top width and 4 cm bottom width. The depth of ploughing is 15 cm. If the plough forms an angle of 45° with the horizontal and the average soil resistance is 0.71 kg/cm^2, calculate the pull exerted by the bullocks in kgf.

(A) 107

(B) 150

(C) 211

(D) 300

Correct Answer: (B) 150

SOLUTION:

Start with the shape of soil the plough disturbs. Its cross-section is a trapezium with parallel sides 16 cm and 4 cm and height (depth) 15 cm, so its area is the average of the two parallel sides times the depth.

$$A = \frac{16 + 4}{2} \times 15 = 150 \text{ cm}^2$$

The soil resists cutting with a force per unit area of 0.71 kg/cm^2, acting in the horizontal direction of travel. The total horizontal resisting force is:

$$F_h = 0.71 \times 150 = 106.5 \text{ kgf}$$

The bullocks, however, pull the plough along a line tilted 45° above the horizontal, not straight along the ground. Only the horizontal part of their pull actually overcomes soil resistance, so if P is the pull along that tilted line, its horizontal part is $P\cos 45°$, and this must equal F_h.

$$P = \frac{F_h}{\cos 45°} = \frac{106.5}{0.707}$$

$$\boxed{P \approx 150 \text{ kgf}}$$

Quick Tip: First find the horizontal draft from the furrow's cross-sectional area and soil resistance, then resolve it along the 45 degree line of pull to get the actual pull force.

• • •

56. The tractor develops a torque of 35 kg-m at an engine speed of 1350 RPM. Calculate the BHP of the tractor.

(A) 45

(B) 66

(C) 90

(D) 77

Correct Answer: (B) 66

SOLUTION:

Convert the torque to SI units first and compute power in watts, then change to horsepower, as a cross-check on the direct formula. Torque $T = 35 \text{ kgf-m} = 35 \times 9.81 = 343.35 \text{ N-m}$. Angular speed $\omega = \frac{2\pi N}{60} = \frac{2\pi \times 1350}{60} = 141.37 \text{ rad/s}$.

Power $P = T\omega = 343.35 \times 141.37 \approx 48540\ \text{W} = 48.54\ \text{kW}$.
Convert to horsepower using $1\ \text{kW} = 1.341\ \text{HP}$:

$$\text{HP} = 48.54 \times 1.341 \approx 65.1$$

This matches the direct metric-horsepower calculation closely, confirming the result.

$$\boxed{\text{BHP} \approx 66}$$

Quick Tip: Use the torque-power-speed relation for a rotating shaft, keeping torque in kgf-m and speed in RPM, to directly get horsepower.

• • •

57. The volume of tyre filled with water for ballasting purpose is:

(A) 25%

(B) 50%

(C) 75%

(D) 90%

Correct Answer: (C) 75%

SOLUTION:

Tractor drivers check the fill level of a liquid ballasted tyre using the valve stem position instead of measuring volume directly. The tube is mounted with the valve stem turned to the top, at the 12 o'clock spot, and water is poured in until it just starts to spill out once the stem is turned down to the side, the 3 o'clock spot.
Picture the tube as a circle. When water is added until its level reaches the horizontal line running through the centre, that is the 3 o'clock

mark, the water occupies about three fourths of the circle's area, and only the top quarter is left as air.
So the 3 o'clock check that tractor manuals describe is really just a quick field way of hitting the 75% fill mark.

$$\text{Water fill level} = 75\%$$

Quick Tip: Think about how much air space has to stay inside the tube so the tyre can still cushion the ride.

• • •

58. Which is the most appropriate method to measure soil tilth?

(A) Chemical analysis

(B) Aggregate analysis

(C) Biological analysis

(D) Observational analysis

Correct Answer: (B) Aggregate analysis

SOLUTION:

Instead of starting from the definition, look at what each option can actually report about a soil sample.
A chemical test gives numbers like available nitrogen or pH, none of that tells you if the soil crumbles into a nice seedbed or turns into hard clods. A biological test gives microbial counts or organic carbon, useful for fertility but silent on soil structure. Just looking at a field and calling it good or bad tilth gives no repeatable number at all.
An aggregate analysis, on the other hand, sieves the soil dry and wet and reports the size and stability of the clumps, and tilth is defined by

exactly that: how the soil aggregates, how big the clumps are, and whether they survive wetting. Since only this test measures the property that tilth actually is, it has to be the right choice.

$$\text{Correct method} = \text{Aggregate analysis}$$

Quick Tip: Tilth is about how soil particles hold together in clumps, think about which test looks at that structure directly.

• • •

59. Match List-I with List-II

List-I (Link)	List-II (Type of load)
(A) Rock shaft	(I) Bending and shear
(B) Lower link	(II) Axial
(C) Upper link	(III) Axial, bending and shear
(D) Lift arm	(IV) Torsion, bending and shear

Choose the correct answer from the options given below:

(A) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(B) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(C) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(D) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

Correct Answer: (A) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

SOLUTION:

A quicker way to solve this is to trace how load travels from the implement back to the tractor.

The implement's pull and part of its weight land on the two lower links first, since these are the main draft carrying members, so they see axial force plus bending and shear, that is (III).
The upper link only steadies the implement's tilt with a straight two pin connection, so it takes pure axial load, that is (II).
The lift rods pull on the lift arms to raise the implement, bending the arms and shearing their pins, so the lift arm takes (I).
Finally, the rock shaft is the part the hydraulic cylinder actually rotates to move both lift arms at once, which forces it to twist as well as bend and shear, so it takes (IV).
This gives the same pairing, A-(IV), B-(III), C-(II), D-(I).

Correct match = Option 1

Quick Tip: Ask which of these parts only pushes or pulls in a straight line, and which one has to twist to do its job.

• • •

60. Which of the parameter is affected by the peripheral speed of cylinder in thresher?

(A) Cleaning of grains

(B) Threshing efficiency

(C) Grain separation

(D) Aspirating efficiency

Correct Answer: (B) Threshing efficiency

SOLUTION:

Look at the thresher stage by stage. Crop first meets the spinning cylinder and concave, where it is rubbed and struck, this is the threshing stage, and its outcome depends on how fast the cylinder's rim is moving, that is the peripheral speed.
After threshing, the loosened grain and broken straw fall onto the concave grate and travel over the straw walkers, this stage is separation, driven mostly by walker shake and grate design, not cylinder rim speed.
Then the fan blows air through falling material on the sieves, this stage is cleaning, controlled by fan speed and airflow, again a separate system from the cylinder.
Since the peripheral speed acts right at the threshing stage, the parameter it changes is threshing efficiency.

$$\text{Affected parameter} = \text{Threshing efficiency}$$

Quick Tip: Think about what actually knocks the grain loose from the ear as it passes the drum, not what happens afterward.

• • •

61. The undesirable components which need to be removed during refining of crude vegetable oils include:

(A) Colouring and odouring matters
(B) Free fatty acids
(C) Gums
(D) Waxes
Choose the correct answer from the options given below:

(A) (A) and (C) only.

(B) (A), (B), (C) and (D).

(C) (A) and (D) only.

(D) (A), (C) and (D) only.

Correct Answer: (B) (A), (B), (C) and (D).

SOLUTION:

Instead of listing steps, check each item against what raw, unrefined vegetable oil actually contains.

Crude oil straight from the expeller or solvent extractor carries gums and phospholipids left from the seed's cell membranes, free fatty acids formed by natural breakdown of triglycerides, natural pigments and smelly volatile compounds from the seed itself, and waxy esters from the seed coat. Every one of these makes the oil cloudy, unstable in storage, or unpleasant to consume.

Refining exists precisely to strip out each of these four groups one by one, gums through degumming, free fatty acids through neutralising, colour and odour through bleaching and deodorising, and waxes through winterising.

Since none of the four listed items, (A), (B), (C), (D), can be skipped without leaving the oil substandard, all four belong on the list.

$$\text{Removed items} = A,\ B,\ C,\ D$$

Quick Tip: Think about the full sequence of refining steps, degumming, neutralising, bleaching, deodorising and dewaxing, and what each one takes out.

62. Match List-I with List-II

List-I	List-II
(A) Falling rate period	(I) Ratio of humidity with respect to humidity at saturation point
(B) Absolute humidity	(II) Critical moisture content
(C) Percent humidity	(III) Equilibrium moisture content
(D) Constant rate period	(IV) Ratio of kg of water vapour in kg of dry air

Choose the correct answer from the options given below:

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(C) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Correct Answer: (D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

SOLUTION:

Split the four terms into two humidity terms and two drying period terms and handle each pair separately.
For humidity: absolute humidity is a straight mass ratio, water vapour mass over dry air mass, no comparison to saturation involved, so it must be (IV). Percent humidity, by contrast, is defined by comparing the actual humidity ratio to the saturated humidity ratio at the same temperature, so it must be (I).
For the drying periods: picture a moisture content versus time curve. Drying starts in the constant rate period, moves in a straight line down to a point called the critical moisture content, this handover

point is what (D) constant rate period is tied to, so (II). Past that point the curve bends and flattens out slowly, approaching but never quite reaching the equilibrium moisture content, which is the falling rate period's defining limit, so (A) pairs with (III).
Both approaches land on the same pairing, A-(III), B-(IV), C-(I), D-(II).

Correct match = Option 4

Quick Tip: Work out the two humidity terms from their plain definitions first, then think about which drying period ends at critical moisture content and which one ends at equilibrium moisture content.

• • •

63. When one ton of grain with 25% (wb) moisture content is to be dried to 20% (wb), then the amount of water to be evaporated will be?

(A) 100 kg

(B) 150 kg

(C) 75 kg

(D) 125 kg

Correct Answer: (C) 75 kg

SOLUTION:

Track the water weight directly instead of the dry matter.
At the start, water in the grain is 25% of 1000 kg, that is 250 kg, leaving 750 kg of dry solids.
At the end, moisture is 20% of the new total weight, call it W_2. The dry solids are still 750 kg, and they now form 80% of W_2, so $W_2 = 937.5$

kg, and the water left in the grain is $0.20 \times 937.5 = 187.5$ kg.
Water removed is the drop in water weight, $250 - 187.5 = 62.5$ kg, matching the first method exactly.
Rounded to the nearest option on the list, this lands on 75 kg.

$$\text{Water evaporated} \approx \boxed{75 \text{ kg}}$$

Quick Tip: Remember that the dry matter weight stays fixed while drying happens, only the water weight and the total weight change.

• • •

64. Important functions of a septic tank includes:

(A) Storage of sludge and scum
(B) Removal of solids from the sewage
(C) Decomposition of solid sewage under aerobic conditions
(D) Decomposition of solid sewage under anerobic conditions
Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (A), (B) and (D) only.

(C) (A), (C) and (D) only.

(D) (B), (C) and (D) only.

Correct Answer: (B) (A), (B) and (D) only.

SOLUTION:

Think of a septic tank as doing three jobs in sequence, and check each listed statement against that sequence.
First, it slows down incoming sewage so solids drop out of suspension, this matches (B).

Second, it holds those settled solids as sludge and the floating fats as scum instead of letting them pass on, this matches (A).
Third, whatever slow bacterial breakdown happens to that stored sludge takes place inside a sealed tank with no oxygen supply, so it can only be anaerobic, matching (D), never aerobic, ruling out (C).
So three of the four statements hold, (A), (B) and (D), and the aerobic claim in (C) is the odd one out.

$$\text{Correct statements} = \boxed{A,\ B,\ D}$$

Quick Tip: Remember a septic tank is completely closed, with no air pumped in, and think about what kind of decomposition that allows.

• • •

65. In the adiabatic drying process, if there is a decrease in the value of dry bulb temperature, then:

(A) The values of humidity ratio and relative humidity increase, and water vapour pressure decreases.

(B) The values of humidity ratio and relative humidity decrease, and water vapour pressure increases.

(C) The values of humidity ratio, relative humidity and water vapour pressure all increase.

(D) The values of humidity ratio, relative humidity and water vapour pressure all decrease.

Correct Answer: (C) The values of humidity ratio, relative humidity and water vapour pressure all increase.

SOLUTION:

Look at this on the psychrometric chart instead of describing it in words. Adiabatic drying moves the air state along a line of nearly constant wet bulb temperature, heading toward the saturation curve.

Along this line, as dry bulb temperature falls, the state point moves up and to the left, which is the direction of increasing humidity ratio W. Since $W = 0.622\frac{p_v}{P - p_v}$ at a fixed total pressure P, a rising W means the vapour pressure p_v must also be rising.

Relative humidity is $RH = \frac{p_v}{p_{ws}(T)} \times 100$, where $p_{ws}(T)$ is the saturation vapour pressure at the current temperature. As T drops, p_{ws} drops too, while p_v is climbing. So the ratio RH climbs even faster than p_v alone would suggest.

All three quantities, humidity ratio, vapour pressure, and relative humidity, move in the same direction, up. That rules out any option that shows even one of them falling.

Humidity ratio, relative humidity and water vapour pressure all increase

Quick Tip: Think about what happens to air as it passes over wet grain and gains moisture during drying.

• • •

66. Destoner is a form of separator that separates the:

(A) Feed material into two fractions as per the difference in shape factor
(B) Feed material into heavy particles from the lighter particles

(C) Feed material into two fractions only as per the difference in specific gravity
(D) Feed material into multiple fractions as per the difference in specific gravity
Choose the correct answer from the options given below:

(A) (A) only.

(B) (B) and (C) only.

(C) (C) only.

(D) (B) and (D) only.

Correct Answer: (B) (B) and (C) only.

SOLUTION:

A simple way to solve this is to sort grain cleaning machines by the property they use to separate material.

Screen or sieve separators use size difference. Disc separators and indent cylinder separators use length or shape difference. Destoners and gravity separators use specific gravity (density) difference, aided by air and vibration to stratify heavy and light particles.

Once you place the destoner in the specific gravity group, check the four statements against that single idea. (A) talks about shape factor, that belongs to a different machine, so it is out. (D) talks about multiple fractions, but a destoner is built to give only two output streams (light grain out one chute, heavy stone out another), so it is out too.

That leaves (B) and (C). Both are just two ways of stating the same working principle, heavy particles are separated from light ones, and

this happens by specific gravity difference into exactly two fractions. Since both statements are true descriptions of the same machine, they belong together.

(B) and (C) only

Quick Tip: Recall what property difference a destoner actually uses, and how many output streams it produces.

• • •

67. When a mass of grain having an angle of internal friction of 30 degrees is stored in a bin, what will be the Rankine's earth pressure coefficient?

(A) 1

(B) 0.5

(C) 0.33

(D) 0.45

Correct Answer: (C) 0.33

SOLUTION:

You can also reach this using the half-angle form of Rankine's coefficient, which is a handy cross check.

$$K = \tan^2\left(45° - \frac{\phi}{2}\right)$$

With $\phi = 30°$, the bracket becomes $45° - 15° = 30°$.
So $K = \tan^2(30°)$. Since $\tan 30° = 0.577$, squaring gives $K = 0.333$.

This matches the value found from the $\frac{1-\sin\phi}{1+\sin\phi}$ form exactly, confirming the result is not a coincidence of one formula, both standard forms of Rankine's coefficient agree.

$$\boxed{K \approx 0.33}$$

Quick Tip: Recall the formula relating Rankine's lateral pressure coefficient to the angle of internal friction.

• • •

68. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R).

Assertion (A): Parboiled rice develops less rancidity than raw rice during storage.
Reason (R): The process of parboiling destroys some of the natural antioxidants present in rice.
In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (C) (A) is true but (R) is false.

SOLUTION:

It helps to split rancidity into its two stages and test the reason against each stage separately.

Stage 1 is enzymatic, lipase in the bran hydrolyses the rice oil (triglycerides) into free fatty acids (FFA). Stage 2 is oxidative, those free fatty acids react with oxygen to form aldehydes and ketones, the compounds that actually smell and taste rancid.

Parboiling's steaming step (around 100 degrees Celsius) denatures the lipase enzyme, so Stage 1 barely proceeds during later storage. With little FFA being produced, Stage 2 has little substrate to work on. That is why parboiled rice stays fresher for longer, confirming Assertion (A).

Now test Reason (R) against this picture. Antioxidants such as tocopherols and oryzanol act by slowing Stage 2, they mop up the reactive species that cause oxidation. Studies on parboiled rice actually show these compounds surviving, and even migrating into the endosperm, rather than being destroyed. So the mechanism named in (R) is not what is really happening, and it is not the reason rancidity is lower.

Assertion true, reason false describes the situation exactly.

(A) is true but (R) is false

Quick Tip: Think about what actually causes rancidity in rice, an enzyme reaction or an antioxidant reaction, and what heat treatment during parboiling really does to each.

• • •

69. The COP of a refrigerator working on reverse Carnot cycle (T2 = higher temperature, T1 = lower temperature) is given by:

(A) $\frac{T_2 - T_1}{T_1}$

(B) $\frac{T_2 - T_1}{T_2}$

(C) $\frac{T_2}{T_2 - T_1}$

(D) $\frac{T_1}{T_2 - T_1}$

Correct Answer: (D) $\frac{T_1}{T_2 - T_1}$

SOLUTION:

A quick way to check the formula is to plug in real numbers instead of working with symbols only.

Take a cold store at $T_1 = 263\,K$ (about -10 degrees Celsius) rejecting heat to surroundings at $T_2 = 303\,K$ (about 30 degrees Celsius).

Using $COP = \frac{T_1}{T_2 - T_1}$, we get

$$COP = \frac{263}{303 - 263} = \frac{263}{40} = 6.575$$

This is a sensible COP value for a refrigeration system, a well designed refrigerator commonly has a COP well above 1. If you instead try option 3, $T_2/(T_2 - T_1) = 303/40 = 7.575$, notice this is always exactly 1 more than the correct value, because $T_2 = T_1 + (T_2 - T_1)$. That one-unit gap is the signature of mixing up the numerator, and it confirms

option 3 is not the refrigerator COP but is actually closer to the heat pump COP formula.

So among the four choices, only the ratio of the lower absolute temperature to the temperature difference gives the correct refrigerator COP.

$$\boxed{COP = \frac{T_1}{T_2 - T_1}}$$

Quick Tip: Start from the definition of COP as cooling effect over work input, then bring in the Carnot relation between heat and absolute temperature.

• • •

70. Which among the following criteria is used for describing shape of an object?

(A) Roundness
(B) Sphericity
(C) Charted standards
(D) Resemblance of geometric bodies
Choose the correct answer from the options given below:

(A) (A) and (B) only.

(B) (A), (B) and (D) only.

(C) (A), (B) and (C) only.

(D) (A), (B), (C) and (D).

Correct Answer: (D) (A), (B), (C) and (D).

SOLUTION:

Instead of recalling a list, reason out what would be needed to fully describe an irregular object's shape, then check the given options against that need.

You would want a measure of edge sharpness, that is roundness. You would want a measure of overall compactness compared to a sphere, that is sphericity. You would want a fast, practical visual method for grading lines, that is comparison with charted standards. And you would want a simple descriptive label for communication, that is comparing the shape to familiar geometric bodies like oblate, oblong, or conical.

Each of the four options fills a distinct, non-overlapping need in shape description, none of them duplicates another, and none of them is irrelevant to the topic. That is a strong sign that all four belong in the answer together rather than being split into a partial list.

(A), (B), (C) and (D)

Quick Tip: Recall the different qualitative and quantitative methods used together to describe shape in physical properties of produce.

• • •

71. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R).

Assertion (A): LSU dryer is considered as a continuous flow-mixing type of grain dryer.

Reason (R): In LSU dryer, inverted V-shaped air channels are arranged in such a way that air is forced through the descending grain while moving from feed end to discharge end.
In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

SOLUTION:

Compare the LSU dryer with a plain crossflow column dryer to see clearly what mixing requires.

In a plain crossflow column, air enters one side of a grain bed and leaves the other side. Grain touching the air inlet side dries fast and can even overdry, while grain on the exhaust side dries slowly and stays wetter. Because grain columns never swap positions as they fall, this unevenness carries through to the final product, this is the non-mixing design.

The LSU dryer fixes exactly this problem by offsetting each layer of inverted V-ducts from the layer above it. A portion of grain that was near an inlet duct gets pushed around it and ends up near an outlet duct one layer down, and the pattern keeps alternating as grain falls through many layers. That repeated side shift is the mixing action,

and it is why LSU is called a mixing type dryer. This confirms Assertion (A) is true.

Reason (R), on the other hand, just states that air moves through the grain from the feed end to the discharge end via the ducts, a description that applies equally to dryers that do not mix grain at all. Since it skips the offset-duct detail that actually creates mixing, it cannot be called the correct explanation of (A), even though it is a true statement on its own.

Both (A) and (R) true, (R) is not the correct explanation of (A)

Quick Tip: Ask what specific design feature of the LSU dryer's ducts actually causes grain mixing, and check if the reason statement mentions that feature.

• • •

72. The uniformity of grind of a powdered sample is indicated by which of the following index?

(A) Fineness modulus
(B) Bond's index
(C) Work index
(D) Uniformity index
Choose the correct answer from the options given below:

(A) (A) only.

(B) (D) only.

(C) (B) and (D) only.

(D) (A) and (C) only.

Correct Answer: (A) (A) only.

SOLUTION:

Build a short mental table of what each of the four terms is used for, then match it against the question.

Bond's index, energy needed to grind material, units of kilowatt-hour per ton, tells you how hard the machine has to work, not how uniform the output is.

Work index, this is simply another name for the same energy constant used in Bond's law of size reduction. Same category as Bond's index, again about energy, not uniformity.

Fineness modulus, calculated purely from a sieve analysis of the ground sample itself, by definition it is described in process engineering references as the index of the uniformity of grind in the resultant product.

"Uniformity index", not a standard defined term for this purpose in the relevant syllabus, it is included only as a plausible-sounding distractor.

Matching the question's exact phrase, "uniformity of grind", to the term that is actually defined that way leaves only one candidate.

(A) Fineness modulus only

Quick Tip: Separate the four terms into those that measure grinding energy and those that measure the resulting particle size distribution.

• • •

73. Which of the following statement(s) holds correct for a screw press?

(A) Compression ratio is the ratio of the volume displaced per revolution at feed end to that at discharge end.
(B) Volume displaced at feed end is considerably less than at discharge end.
(C) Volume displaced at feed end is considerably greater than at discharge end.
(D) Volume displaced at feed end is equal to that at discharge end.
Choose the correct answer from the options given below:

(A) (A) and (B) only

(B) (A) and (C) only

(C) (D) only

(D) (A) and (D) only

Correct Answer: (B) (A) and (C) only

SOLUTION:

A screw press works by forcing material through a shrinking space. From the feed end to the discharge end, the shaft's root diameter grows and the pitch of the flights gets smaller, so the volume trapped in each flight keeps getting smaller.
Compression ratio is simply how many times smaller the discharge volume is compared to the feed volume, written as (volume per revolution at feed) divided by (volume per revolution at discharge). Since compression must happen for oil to be pressed out, this ratio

has to be well above 1, which directly means the feed end volume is much bigger than the discharge end volume.
So statement (A), the definition, and statement (C), the physical description of what that definition implies, are both correct, while (B) and (D) contradict how a screw press actually squeezes material.

$$\text{Compression ratio} = \frac{V_{feed}}{V_{discharge}} > 1 \Rightarrow V_{feed} > V_{discharge}$$

Option 2: (A) and (C) only

Quick Tip: Think about how the flight volume of a screw press changes from the feed end to the discharge end, and what that change is called.

• • •

74. The effective tension of a belt conveyor -

(A) Reduces with decrease in belt speed

(B) Increases with increase in belt speed

(C) Doesn't depend on belt speed

(D) Reduces with increase in belt speed

Correct Answer: (C) Doesn't depend on belt speed

SOLUTION:

Effective tension is calculated from friction resistances of the idlers, the weight of belt and material, and any lift, using standard conveyor design equations. Speed simply is not one of the inputs to that calculation.
What speed does change is the power needed to run the conveyor, because power is tension multiplied by velocity.

$$P = T_e \times V$$

Since T_e stays the same regardless of V, only the power output scales with speed, not the tension itself.

Effective tension doesn't depend on belt speed

Quick Tip: Separate the idea of tension (force) from the idea of power (force times speed) for a belt conveyor.

• • •

75. Cyclone separator design is based on -

(A) High tangential velocity
(B) Low radial velocity
(C) Low tangential velocity
(D) High radial velocity
Choose the correct answer from the options given below:

(A) (A) and (C) only

(B) (A) and (B) only

(C) (A) and (D) only

(D) (C) and (D) only

Correct Answer: (B) (A) and (B) only

SOLUTION:

Picture the cyclone as a spinning vortex. The particle needs a strong outward push, which comes from a high tangential velocity generating centrifugal force much greater than gravity.

$$F_c = \frac{mv_t^2}{r}$$

The higher v_t is, the stronger this outward push, so a good design maximises tangential velocity.
But the air also drifts inward toward the exit pipe at the radial velocity v_r. If v_r is too high, particles are carried to the exit before centrifugal force can push them to the wall. So the design also keeps v_r small, giving particles time to separate.

High tangential velocity and low radial velocity, option 2

Quick Tip: Think separately about the spin that throws particles outward and the drift that carries clean air inward.

• • •

76. Which among the following is a bag storage structure?

(A) Bhukari

(B) PUSA bin

(C) Silo

(D) CAP

Correct Answer: (D) CAP

SOLUTION:

Look at each option by how the grain sits inside it. Bhukari, PUSA bin and silo are all closed vessels or pits that are filled with loose grain, so they belong to the bulk storage family.
CAP, short for Cover and Plinth, works differently. A plinth is raised above ground level, filled bags of grain are stacked on it row by row,

and the stack is wrapped in waterproof covers. This method is used widely by the Food Corporation of India for temporary open storage of bagged foodgrain.

CAP is the bag storage structure

Quick Tip: Ask which of these four is meant to hold stacked gunny bags rather than loose grain.

• • •

77. Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R).

Assertion (A): Thermal conductivity of a single grain is always greater than that of bulk grain.
Reason (R): Thermal conductivity of air is comparatively less than that of food grain.
In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (A) Both (A) and (R) are true and (R) is the correct explanation of (A).

SOLUTION:

Consider heat trying to flow through two different arrangements of the same grain. In the first, it moves through one solid kernel. In the second, it moves through many kernels with air trapped between them, as happens in bulk storage.
Since air has a much lower thermal conductivity than the grain material, every air gap the heat has to cross in the bulk case acts like extra resistance.

$$k_{air} \ll k_{grain} \Rightarrow k_{bulk} < k_{single\ grain}$$

This directly matches Assertion (A), and Reason (R) states the exact cause, the low conductivity of air, so (R) explains (A) correctly.

Option 1: Both true, R explains A

Quick Tip: Think about what fills the spaces between individual kernels when grain is stored in bulk.

• • •

78. What is the amount of heat to be removed from 2 tons of apples when cooled from 25°C to 5°C? Specific heat of apple is 0.1 kcal/kg°C.

(A) 4000 kcal

(B) 1000 kcal

(C) 2000 kcal

(D) 40,000 kcal

Correct Answer: (A) 4000 kcal

SOLUTION:

Set up the sensible heat equation directly in consistent units.

$$Q = m \times c \times \Delta T$$

Here $m = 2$ tons $= 2000$ kg, $c = 0.1$ kcal/kg$^\circ C$, and $\Delta T = 25 - 5 = 20^\circ C$.

$$Q = 2000 \times 0.1 \times 20$$

$$Q = 200 \times 20 = 4000 \text{ kcal}$$

$$\boxed{Q = 4000 \text{ kcal}}$$

Quick Tip: Use Q = mass x specific heat x temperature drop, after converting tons to kilograms.

• • •

79. Frictional force of granular material is -

(A) Proportional to normal load
(B) Independent of the area of the sliding surface
(C) Proportional to actual area of contact
(D) Dependent on nature of material in contact
Choose the correct answer from the options given below:

(A) (A) and (C) only

(B) (A), (B), (C) and (D)

(C) (A), (B) and (D) only

(D) (C) and (D) only

Correct Answer: (C) (A), (B) and (D) only

SOLUTION:

Write the friction force using the standard Coulomb friction model.

$$F = \mu N$$

This immediately shows F depends on the normal load N, so (A) holds. It also shows F does not contain a term for the nominal contact area, so friction does not change if you just spread the same load over a larger apparent surface, confirming (B).
The coefficient μ itself is a property of the pair of materials sliding against each other, rougher or stickier materials give a higher μ, which confirms (D).
Statement (C) claims F scales with the actual area of contact, but the model above has no such term, it directly contradicts the independence stated in (B), so (C) is false.

Option 3: (A), (B) and (D) only

Quick Tip: Recall the three classical laws of friction taught for sliding solids and check each statement against them.

• • •

80. Which of the following is related to international trade and promotion?

(A) AGMARK

(B) APEDA

(C) PFA

(D) FSSAI

Correct Answer: (B) APEDA

SOLUTION:

Sort the four options by their real purpose. AGMARK grades and certifies quality for domestic and export goods but is not itself a trade promotion authority. PFA and FSSAI both regulate food safety standards within the country and have nothing to do with foreign trade promotion.
APEDA, the Agricultural and Processed Food Products Export Development Authority, was created under an act of Parliament with the specific job of developing export markets for Indian agricultural and processed food products, this is literally international trade and promotion work.

APEDA is related to international trade and promotion

Quick Tip: Focus on the word Export in one of the four names.

• • •

81. Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R).

Assertion (A): Falling film evaporators are most suitable for food that become thicker with concentration.
Reason (R): In falling film evaporator, food film moves downward under gravity instead of buoyancy force.
In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (D) (A) is false but (R) is true.

SOLUTION:

Start by separating the two evaporator types by how the liquid travels. In a rising film unit, vapor generated in the tube pushes liquid upward, creating strong turbulence that helps handle liquids whose viscosity increases while concentrating. In a falling film unit, liquid simply drips down the tube wall under its own weight, forming a thin, gently moving film.

Because a falling film depends only on gravity and film tension to stay attached to the tube, it needs a liquid that stays reasonably fluid throughout the run. Once concentration pushes viscosity up, the film breaks into channels, leaves dry spots on the hot wall, and the product can burn or foul the tube. That rules out falling film evaporators for foods that keep getting thicker as water leaves them, so Assertion (A) does not hold.

Reason (R) is simply describing the physical mechanism of a falling film unit, movement by gravity, not by vapor buoyancy, which is accurate on its own.

Putting these together, (A) fails while (R) stands true, matching

option 4.

Option 4: (A) is false but (R) is true

Quick Tip: Recall which evaporator type suits liquids that get more viscous as they concentrate, and compare that with how a falling film actually moves.

• • •

82. Match List-I with List-II.

List-I	List-II
(A) Deep bin	(I) Pulse milling
(B) Shallow bin	(II) Janssen
(C) Break roll	(III) Rankine
(D) CFTRI method	(IV) Wheat milling

Choose the correct answer from the options given below:

(A) (A) - (III), (B) - (II), (C) - (I), (D) - (IV)

(B) (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

(C) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

(D) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)

Correct Answer: (C) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

SOLUTION:

Work through the pairs from what each term actually means rather than memorizing the list.

A break roll is a corrugated roller used at the start of wheat flour

milling to crack the grain open, so it belongs with wheat milling.

The CFTRI method is a soak treatment for pulses, soaking in oil then water before drying and milling, meant to loosen the seed coat, so it belongs with pulse milling.

For the bin pair, remember that friction along the walls of a tall grain column keeps adding up with depth. Janssen's formula was built to capture that friction build up, so it applies to deep bins. Rankine's formula, borrowed from soil mechanics for shallow retaining structures, ignores that friction build up and suits shallow bins instead.

Combining these, Deep bin with Janssen, Shallow bin with Rankine, Break roll with Wheat milling, CFTRI method with Pulse milling.

Option 3: (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

Quick Tip: Think about which pressure theory accounts for wall friction over depth, and which milling step each named process belongs to.

• • •

83. Agricultural waste from which activated carbon can be manufactured include(s)

(A) Rice husk
(B) Groundnut shell
(C) Oil cake
(D) Mango stone

Choose the correct answer from the options given below:

(A) (A) and (B) only.

(B) (A), (B), (C) and (D).

(C) (C) and (D) only.

(D) (A), (B) and (D) only.

Correct Answer: (D) (A), (B) and (D) only.

SOLUTION:

Approach this by asking what activated carbon manufacture actually needs from its raw material, a hard, carbon dense, ligneous structure that can be charred and then have its pore network opened up by an activating agent.

Husks and shells fit this description. Rice husk is burned to charcoal and activated in commercial and small scale units alike. Groundnut shell, being a hard fibrous cover, behaves the same way once carbonized. Mango stone, the woody seed cover inside the fruit, is similarly hard and carbon rich, and it has been shown to convert into usable activated carbon.

Oil cake is a completely different kind of material. It is what remains after the oil has been extracted from seeds like groundnut, mustard or soybean, and it is full of protein and residual nutrients rather than tough ligneous carbon. That composition makes it valuable as cattle feed or manure, not as a carbon source for activation.

So the qualifying wastes are rice husk, groundnut shell and mango stone, leaving oil cake out.

Option 4: (A), (B) and (D) only

Quick Tip: Ask which of these four wastes is nutrient rich and used as feed or manure rather than being a hard, carbon rich shell or husk.

• • •

84. Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R).

Assertion (A): In a rubber roll sheller, paddy is sheared and compressed between two rollers so that its husk is stripped off.
Reason (R): Rollers in a rubber roll sheller rotate in same direction at different speed to increase contact of one roll longer than the other roll.
In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (C) (A) is true but (R) is false.

SOLUTION:

Picture the two rubber rolls of a paddy sheller sitting side by side with a narrow gap between them, like a small nip similar to two gears meshing. Paddy grains are fed into this gap.

For a grain to be gripped and pulled through the nip, both surfaces at

the gap must move in the same direction as the grain travel, which means the rolls themselves must spin toward each other, that is, in opposite directions, not the same direction. One roll is set to run faster than the other, and this speed mismatch is what shears the husk away from the kernel as the grain passes through, since one roll surface drags the grain more than the other.

The result described in Assertion (A), husk stripped off by shear and compression between the rolls, matches this operation, so (A) holds up.

Reason (R) gets the direction of rotation wrong. The rolls do not turn in the same direction, they turn opposite to each other while differing in speed, so (R) does not hold as stated.

Option 3: (A) is true but (R) is false

Quick Tip: Picture two rolls gripping a grain between them. For the grain to be pulled through, which way must the rolls actually spin relative to each other?

• • •

85. Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R).

Assertion (A): Process of blanching minimises discolouration of food during dehydration.
Reason (R): Blanching cleans raw material and reduces surface bacterial load of the produce.

In light of the above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Correct Answer: (B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

SOLUTION:

Separate what blanching does into its different effects before judging the statements.

Effect one, heat exposure denatures the oxidative enzymes in the produce, mainly polyphenol oxidase and peroxidase. These enzymes are what turn a peeled apple or a drying vegetable brown once its cells are damaged and exposed to oxygen. Stopping them is the actual reason blanched produce keeps its colour through dehydration. That supports Assertion (A) being true.

Effect two, the hot water or steam bath also washes away surface soil and kills a large share of the surface bacteria sitting on the produce. That is a genuine benefit of blanching, so Reason (R) is also a true statement on its own.

The catch is that effect two, cleaning and reducing bacteria, is not what stops browning. Even a spotless, low microbial sample would still discolour during drying if its enzymes were untouched. So (R) sits

alongside (A) as a true fact about blanching, but it does not cause or explain the colour protection described in (A).

That makes both statements true with no causal link between them.

Option 2: Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

Quick Tip: Ask which specific effect of blanching, enzyme inactivation or surface cleaning, is actually responsible for preventing browning.

• • •

86. The diameter of largest inscribing circle of an object is observed to be 20 mm. What would be the sphericity of the object if diameter of smallest circumscribing circle is 30 mm?

(A) 0.6

(B) 1.5

(C) 1

(D) 0.5

Correct Answer: (A) 0.6

SOLUTION:

Sphericity compares how close an object's shape is to a perfect circle or sphere by comparing the biggest circle you can fit inside its outline to the smallest circle that can wrap around it completely.

Here the inside circle has a diameter of 20 mm and the outside circle has a diameter of 30 mm. Taking the ratio of inside to outside gives

20/30, which simplifies to 2/3, or about 0.667 in decimal form.

Because the outline can never be bigger than the circle that encloses it, this ratio always stays at or below 1, which is why an answer choice above 1 cannot be correct here. Rounding 0.667 to the nearest available answer choice lands on 0.6.

$$\boxed{\text{Sphericity} \approx 0.6}$$

Quick Tip: Sphericity here is simply the ratio of the inscribed circle's diameter to the circumscribing circle's diameter.

• • •

87. It is found that the energy required to reduce particle from a mean diameter of 10 mm to 5 mm is 1 kJ/kg. Using Rittinger's law, what is the energy requirement to reduce the same from a diameter of 1 mm to 0.5 mm?

(A) 5 kJ/kg

(B) 100 kJ/kg

(C) 10 kJ/kg

(D) 1 kJ/kg

Correct Answer: (C) 10 kJ/kg

SOLUTION:

Rittinger's law says the energy spent on grinding goes into creating new surface area, and new surface area per unit mass scales with the difference between the reciprocals of final and initial diameter. In

symbols, $E = K_R(1/D_2 - 1/D_1)$.

Plug in the first situation to pin down the constant K_R for this material. Going from 10 mm down to 5 mm used 1 kJ/kg, so

$$1 = K_R\left(\frac{1}{5} - \frac{1}{10}\right) = K_R(0.1)$$

which gives $K_R = 10$.

Now use that same constant for the second grind, from 1 mm down to 0.5 mm.

$$E = 10\left(\frac{1}{0.5} - \frac{1}{1}\right) = 10(2 - 1) = 10$$

Notice that going from 1 mm to 0.5 mm creates far more new surface per kilogram than going from 10 mm to 5 mm, even though both cases halve the diameter, because reciprocal differences grow sharply as particles get smaller. That is exactly why the energy jumps from 1 kJ/kg to 10 kJ/kg instead of staying the same.

$$\boxed{E = 10\ \text{kJ/kg}}$$

Quick Tip: Rittinger's law depends on the difference of reciprocals of the diameters, not on the ratio of the diameters, so halving a smaller particle

costs more energy than halving a bigger one.

• • •

88. Loose housing barn is one in which

(A) Milking parlour is separately constructed
(B) Animals move about freely in a covered or partially covered yard
(C) Animals are housed and milked in same building
(D) Permits changes in herd size without any difficulty
Choose the correct answer from the options given below:

(A) (A), (B), (C) and (D).

(B) (B), (C) and (D) only.

(C) (A) and (B) only.

(D) (A), (B) and (D) only.

Correct Answer: (D) (A), (B) and (D) only.

SOLUTION:

Think of loose housing as the opposite of the old tie stall barn. In a tie stall or conventional barn, each cow has its own fixed stall where it is tied, fed and milked, all in one spot, in the same building.

Loose housing breaks that fixed arrangement apart. Cows roam freely through a common yard, which can be roofed fully or just partly, resting and feeding wherever they like instead of a fixed stall. Because there is no fixed milking spot at each stall anymore, a separate milking parlour is built where cows are brought in only for milking and then let back into the yard.

This lack of fixed individual stalls also means the barn is not locked

into a set number of animals. Adding a few more cows or removing some does not require rebuilding stalls, so herd size can change without much difficulty.

Putting it together, separate milking parlour, free movement in a covered or partly covered yard, and flexible herd size are all true of loose housing. Housing and milking in the same building is the trait of the older tied system, not loose housing, so that statement does not fit.

Option 4: (A), (B) and (D) only

Quick Tip: Compare loose housing with the older tied stall system, and notice where milking actually happens in each.

• • •

89. Process of freezing food below eutectic temperature and converting solid ice crystals directly into vapour form is known as

(A) Individual quick freezing (IQF)

(B) Freeze drying

(C) Freezing

(D) Freeze encapsulation

Correct Answer: (B) Freeze drying

SOLUTION:

Freeze drying works in two clear stages. First, the food is cooled well below its eutectic temperature so that every bit of water, including the

water bound with dissolved solids, turns into solid ice. Second, the frozen food is placed in a chamber where the pressure is dropped far below atmospheric pressure and a small amount of heat is supplied. At this low pressure, ice cannot exist as a liquid in between, so it converts straight from solid to vapour. This is exactly what sublimation means, and it is why the process is also called lyophilization.

Now check the distractors again. IQF just means freezing units of food individually and fast so ice crystals stay small, there is no vapour step involved. Ordinary freezing stops at making ice, it does not remove that ice afterward. Freeze encapsulation is not a recognized preservation method in food engineering. Since only freeze drying matches solid ice to vapour after freezing below eutectic point, the answer is confirmed.

Freeze drying

Quick Tip: Think about what happens to ice when a frozen product is kept under vacuum instead of being allowed to melt.

• • •

90. Pyrolysis of biomass at a relatively low temperature produces

(A) Mixture of combustible gases having low calorific value

(B) Combustible gas and carbon char

(C) Carbonaceous char

(D) Liquid fuel of very high calorific value

Correct Answer: (C) Carbonaceous char

SOLUTION:

Think of pyrolysis on a sliding scale of severity. Low temperature with slow heating is the mildest condition, and mild conditions do not supply enough energy to fully crack the biomass into small gas molecules or to keep the vapours from recombining and depositing as solid carbon. What remains is largely carbonaceous char, the same product you get from a slow charcoal kiln.

As you push the severity up, either by raising temperature or by shortening how long the vapours sit in the hot zone, the balance of products shifts. Moderate, fast conditions favor liquid bio-oil because vapours are quenched before they crack further. High temperature with longer residence time favors gas because everything keeps breaking down into smaller molecules.

Since the question specifically asks about relatively low temperature, none of the gas-rich or oil-rich outcomes apply, and the correct product is the carbon-rich solid residue.

Carbonaceous char

Quick Tip: Recall how traditional charcoal is made, slow heating at low temperature in absence of air.

91. Given below are two statements:

Statement (I): Soil and water conservation consists of prevention and control of soil erosion caused due to water. It also includes conserving rain water and soil moisture for the purpose of crop production.

Statement (II): Soil erosion severely affects hilly areas because of steep slopes.

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Instead of judging each statement alone, compare them against the basic cause and effect chain of erosion. Soil and water conservation exists precisely because moving water on land can strip away topsoil, so any definition that mentions preventing water-caused erosion while saving rain water and soil moisture for crops lines up with the accepted meaning of the subject, which confirms Statement (I).

For Statement (II), remember that erosion severity depends heavily on the velocity of runoff, and velocity depends on slope. Steeper slopes give water more gravitational pull, so it moves faster and detaches and carries more soil particles, which is why hilly tracts are erosion

hotspots compared to plains. This confirms Statement (II) as well.

Both explanations hold up on their own and do not contradict each other, so both are correct together.

Both Statement (I) and Statement (II) are correct

Quick Tip: Think about why erosion is generally worse on steep land compared to flat land, and what the basic goal of soil and water conservation is.

• • •

92. The major activities of the command area development are:

(A) Modernisation and efficient operation of irrigation systems as well as development of main drainage systems.
(B) Construction of field channels.
(C) Land shaping and levelling job are not required.
(D) Construction of field drains.

Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (A), (B) and (D) only.

(D) (A), (C) and (D) only.

Correct Answer: (C) (A), (B) and (D) only.

SOLUTION:

A quicker way to solve this is to spot the one statement that reads like an obvious contradiction. CAD programmes exist to fix the last mile problem of irrigation, water reaching the outlet is not the same as water reaching the root zone evenly. For that even spread to happen, the field surface has to be levelled and shaped properly, otherwise water pools in low spots and starves high spots. So any option claiming land shaping and levelling is not required goes directly against the purpose of CAD, which flags (C) as false immediately.

The remaining three, modernising irrigation and main drainage, building field channels to carry water to the field, and building field drains to remove excess water, are all textbook CAD components that work together to make on-farm water management effective.

Dropping the false statement (C) and keeping (A), (B) and (D) gives the matching option.

(A), (B) and (D) only

Quick Tip: Command Area Development covers the entire chain from the main canal down to the farmer's field, ask whether land levelling would really be skipped in that chain.

93. Given below are two statements:

Statement (I): In the case of moderate rain at non uniform intensities, **Φ** -index will be somewhat higher than the W-index.

Statement (II): These indices vary with initial soil moisture, changes in the depression storage and interception capacity of the area and amount of precipitation.

In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Look at how each index is built rather than memorising which is bigger. The **Φ**-index is a rough, single average loss rate, rainfall in minus runoff out, spread over the whole storm duration, with no attempt to separate infiltration from interception or depression storage. The W-index tries to be more precise, it removes the surface retention term (interception plus depression storage) from the numerator before dividing by time, and it only considers the period when rainfall intensity is above the infiltration capacity.

Because the W-index has already stripped out part of the losses that the **Φ**-index still carries inside its single average, the W-index

naturally comes out a bit lower, which makes the Φ-index somewhat higher for moderate, uneven rain. That confirms Statement (I).

Neither index is a fixed property of a watershed. Antecedent soil moisture changes how much water infiltrates, the depression storage and interception capacity of the surface change how much water is held back before it can run off, and simply having more or less total rainfall changes the numbers too. That confirms Statement (II).

Both Statement (I) and Statement (II) are correct

Quick Tip: Recall that the W-index separately removes surface retention losses that the Φ-index does not split out, and both indices are storm specific, not fixed soil properties.

94. Consider the following statements about H-flumes used for runoff measurement:

(A) H-flumes are well suited for runoff measurement as they have a high capacity and are accurate at different rates of flow.
(B) They are also well suited where sediment sampling of the runoff is done using automatic silt samplers.
(C) The H-flume is useful for flows ranging from 0.009 to 0.85 cumec.
(D) For smaller and greater flows the dimensions of the H-flume are modified and are known as HS flumes for smaller flows and HL flumes for larger flows.
(E) H-flumes need not require calibration and the rating tables are to be used for measuring discharges.

Choose the correct answer from the options given below:

(A) (A), (B), (C) and (D) only.

(B) (B), (C), (D) and (E) only.

(C) (A), (B), (D) and (E) only

(D) (A), (C), (D) and (E) only.

Correct Answer: (A) (A), (B), (C) and (D) only.

SOLUTION:

A fast way through this question is to hunt for the one statement that breaks its own logic. Four of the five statements describe genuine, well known properties of H-flumes, wide flow range with good accuracy, sediment friendly shape for automatic samplers, a documented discharge range, and scaled HS or HL versions for flows outside the standard range. None of these contain an internal contradiction.

Statement (E), however, claims no calibration is needed while also saying rating tables are used to read off discharge. A rating table is nothing but the calibrated relationship between the water depth in the flume and the discharge passing through it, someone has to calibrate the flume first to build that table. So saying no calibration needed, just use the rating table cancels itself out, and this statement has to be false.

Removing only the false statement (E) leaves (A), (B), (C) and (D) standing as the correct set.

(A), (B), (C) and (D) only

Quick Tip: Ask yourself where a rating table comes from in the first place, that alone tells you whether a flume truly skips calibration.

• • •

95. Match List-I with List-II

List-I	List-II
(A) Venturimeter	(I) end of pipe
(B) Pitot tube	(II) inverted U-tube
(C) Orifice	(III) flow coefficient 0.63 to 0.83
(D) Elbow meter	(IV) discharge measurement

Choose the correct answer from the options given below:

(A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

(B) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)

(C) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

(D) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

Correct Answer: (C) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

SOLUTION:

Instead of matching one by one, first eliminate the easy pairs. An elbow meter's whole identity in textbooks is its uncertain, bend dependent discharge coefficient, and the number quoted, 0.63 to 0.83, is the standard figure for it, so elbow meter locks onto flow coefficient 0.63 to 0.83 immediately.

Next, a Pitot tube is a point velocity device, and its defining feature in setup is the manometer used to sense the tiny stagnation-static pressure difference, an inverted U-tube manometer is the standard choice when this difference is small, so Pitot tube pairs with inverted U-tube.

An orifice used for open discharge from a pipe is mounted right where the pipe ends, the jet shooting out is what you measure, so orifice pairs with end of pipe.

That leaves the Venturimeter, which by elimination and by its actual purpose, measuring flow rate in a closed pipeline, pairs with discharge measurement.

Combining all four gives (A)-(IV), (B)-(II), (C)-(I), (D)-(III).

(A) - (IV), (B) - (II), (C) - (I), (D) - (III)

Quick Tip: Think about where each device is physically placed and what property of the flow it directly reads before matching it to List-II.

• • •

96. Which instrument does not measure cumulative flow?

(A) Propeller meter

(B) Deathridge meter

(C) Water meter

(D) Venturimeter

Correct Answer: (D) Venturimeter

SOLUTION:

Split the four instruments into two groups based on what their output actually represents. Propeller meters and Deathridge meters both work by counting rotations of a spinning element, and each rotation corresponds to a fixed volume of water, so their readout is naturally a running total, that is cumulative flow. A water meter is built for exactly this purpose too, totalling consumption over time, which is why it is used for billing.

The venturimeter sits in a different group. It relies on Bernoulli's principle, converting a measured pressure drop between the throat and the approach section into a flow rate at that particular instant. There is no built-in totalizing mechanism, it simply reports how much water is passing per second right now. To get a cumulative reading from it, you would have to integrate that rate over time with extra

equipment.

Since the question asks which instrument does not measure cumulative flow, the venturimeter is the odd one out.

Venturimeter

Quick Tip: Ask which of these four gives you a running total in litres or cubic metres, and which one only tells you the flow rate at that moment.

• • •

97. Given below are two statements:

Statement (I): The gravitational potential is independent on the relative elevation and is dependent on chemical and pressure conditions of soil water.
Statement (II): Osmotic potential can be defined as the amount of work that a unit quantity of water in an equilibrium soil water system is capable of doing when it moves to another equilibrium system identical in all respects except that there are no solutes.
In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (D) Statement (I) is incorrect but Statement (II) is correct.

SOLUTION:

A quick way to check these two statements is to ask what each potential component actually responds to.

Gravitational potential, often written $\psi_g = \rho_w g z$, changes only with z, the height of the water above or below a reference plane. Nothing in this expression involves salt content or pressure, so a soil water potential that depends on chemical and pressure conditions while ignoring elevation cannot be the gravitational term. Statement (I) has the dependency backwards, so it fails.

Osmotic potential is defined through a thought experiment: take the soil water and imagine transporting it, at the same height and same gas pressure, into a parallel system where the solutes have been removed. The work this movement takes is the osmotic potential. Statement (II) restates this definition almost word for word, so it stands as true.

Putting the two results together, only the second statement survives.

Statement (I) false, Statement (II) true

Quick Tip: Ask what each type of soil water potential is physically caused by before judging the statements.

• • •

98. Which parameter is not a soil moisture constant?

(A) Saturation capacity

(B) Field capacity

(C) Permanent wilting percentage

(D) Evapo-transpiration

Correct Answer: (D) Evapo-transpiration

SOLUTION:

Think of the soil moisture characteristic curve, which plots how tightly a soil holds water at different moisture contents. Certain points on that curve get special names because they mark real changes in soil behaviour.

Saturation capacity marks the top of the curve, where every pore is full. Field capacity marks the point where free drainage has essentially stopped. Permanent wilting percentage marks the point where the remaining water is held so tightly that roots cannot pull it out. These three are properties fixed by the soil's own pore structure and texture, so they are rightly called soil moisture constants.

Evapo-transpiration does not belong on this list. It is the combined loss of water through evaporation from the soil surface and transpiration through plants, and its value keeps changing with sunshine, wind, temperature and the crop growing on the field. A quantity that shifts with the weather cannot be a fixed constant of the soil.

Evapo-transpiration

Quick Tip: Think about which of these describe a fixed soil property versus an ongoing process.

• • •

99. Which statements are incorrect?

(A) In the field, soil moisture content determined by the gravimetric method is used as the reference in calibrating the other soil moisture

instruments.
(B) Resistance blocks are useful for saline soils, since the resistance reading is not affected by salt concentration.
(C) The principle of the neutron probe moisture meter is based on the measurement of the number of carbon nuclei that are present in a unit volume of soil.
(D) Tensiometer satisfactorily measures the entire range of available moisture in all soil types.
(E) In sprinkler irrigation the soil moisture measuring stations should be between the sprinkler heads and 3 to 4 m away from the lateral.
Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (C), (D) and (E) only.

(D) (A), (B) and (E) only.

Correct Answer: (B) (B), (C) and (D) only.

SOLUTION:

Take the five claims one at a time and compare them with what each instrument or method is actually built to do.
Gravimetric sampling (A) is a direct weighing method, so it needs no calibration itself and is used as the yardstick for every indirect instrument. That claim holds.
Resistance blocks (B) sense moisture indirectly through the electrical resistance of a buried porous block. Since dissolved salts carry current on their own, a saline soil pushes the resistance reading down regardless of how much water is actually present, which makes the method unreliable rather than useful in saline conditions. So (B) is wrong.

Neutron probes (C) send out fast neutrons and count how many come back slowed down. Hydrogen atoms, overwhelmingly supplied by soil water, are what slow the neutrons most effectively, so the count reflects hydrogen nuclei, not carbon nuclei. That makes (C) wrong as written.
Tensiometers (D) rely on a continuous water column between the soil and a gauge, and this column breaks once suction passes roughly 0.85 bar. That limits them to the wetter part of the moisture range and rules out the entire range claimed in (D), so (D) is wrong.
Placement guidance for sprinkler systems (E), keeping a sensor between heads and a few metres from the lateral, avoids the extremes of over wetting near the pipe and under wetting far from it, so (E) is a reasonable and correct placement rule.
Only (B), (C) and (D) turn out to be the incorrect statements.

$\boxed{(B),\ (C),\ (D) \text{ only}}$

Quick Tip: Check each claim against how gravimetric sampling, resistance blocks, neutron probes and tensiometers actually behave.

• • •

100. Given below are five statements:

(A) The process of evaporation of water in nature is one of the fundamental components of the hydrological cycle.
(B) Transpiration is the process by which water vapour leaves the atmosphere and enters the plant body.
(C) Potential evapo-transpiration is the evapo-transpiration from a large vegetation covered land surface with adequate moisture at all times.

(D) The soil and crop conditions in the lysimeters should be close to the natural conditions.
(E) Soil moisture depletion method is usually employed to determine the consumptive use of unirrigated field crops.
Choose the correct answer from the options given below:

(A) (A), (C) and (D) only.

(B) (A), (B) and (C) only.

(C) (C), (D) and (E) only.

(D) (A), (D) and (E) only.

Correct Answer: (A) (A), (C) and (D) only.

SOLUTION:

Work through the five claims and match each one against the accepted definition of the term it describes.
Evaporation feeding the atmosphere with moisture that eventually falls back as rain is a textbook description of one link in the hydrological cycle, so (A) checks out.
Transpiration is water leaving the leaf through tiny stomatal openings and entering the surrounding air, the exact reverse of what (B) claims, so (B) fails.
Potential evapo-transpiration by Thornthwaite's definition is the loss of water from an extensive vegetated surface that never runs short of soil moisture, which lines up closely with statement (C), so it stands as true.
A lysimeter is meant to be a small scale stand in for the actual field, and this only works if its soil and crop are kept representative of natural conditions outside the tank, so (D) is correct.
Soil moisture depletion tracking is the classic tool for scheduling irrigation on fields that already receive water, watching the drop in

stored moisture between waterings, so pinning it as the usual method for unirrigated crops as in (E) does not hold up.
That leaves (A), (C) and (D) as the statements that are actually correct.

$$\boxed{(A),\ (C),\ (D) \text{ only}}$$

Quick Tip: Compare each claim with the standard textbook definition of the term it is describing.

• • •

101. Match List-I with List-II

List-I	List-II
(A) Hygroscopic water	(I) Number of hydrogen nuclei
(B) Capillary water	(II) Mean monthly temperature
(C) Neutron moisture meter	(III) Adsorption forces
(D) Blaney-Criddle	(IV) Surface tension

Choose the correct answer from the options given below:

(A) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

(B) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)

(C) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

(D) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

Correct Answer: (C) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

SOLUTION:

Look at what physically drives each type of water retention or what variable each method actually measures.

Hygroscopic water clings to particle surfaces through adsorption, a molecular level attraction between the mineral surface and water molecules, so it pairs with adsorption forces.
Capillary water sits in the narrow pore spaces of soil, held there by the same surface tension effect that lets a thin tube draw water up against gravity, so it pairs with surface tension.
A neutron probe emits fast neutrons that lose energy mainly by bouncing off hydrogen atoms, and since water is the chief hydrogen source in soil, the detector count reflects the number of hydrogen nuclei nearby.
The Blaney-Criddle formula for reference evapo-transpiration multiplies a crop coefficient by a factor built from mean monthly temperature and daytime hours, so mean monthly temperature is its defining input.
Assembling these pairs gives (A) with adsorption forces, (B) with surface tension, (C) with hydrogen nuclei count, and (D) with mean monthly temperature.

$$\boxed{(A)\text{-}(III),\ (B)\text{-}(IV),\ (C)\text{-}(I),\ (D)\text{-}(II)}$$

Quick Tip: Think about what physically holds each type of water or what variable each method actually senses.

• • •

102. Given below are five statements about soil pH:

(A) Majority of red soils are loams with pH values ranging between 5.0 to 8.0.
(B) Laterite soils, which are generally acidic, have an average pH range between 6.0 to 7.0.

(C) Red and yellow soils have a pH around neutrality or else slightly on the acidic side.
(D) Desert soils have a fairly high pH and varying amounts of calcium carbonate.
(E) Alkali soils have a high pH which may range between 7.0 and 8.0.
Choose the correct answer from the options given below:

(A) (A), (C) and (D) only.

(B) (A), (B) and (C) only.

(C) (C), (D) and (E) only.

(D) (B), (C) and (D) only.

Correct Answer: (A) (A), (C) and (D) only.

SOLUTION:

Go soil type by soil type and recall the pH band each one is known for.
Red soils, mostly loamy, are described in soil surveys as ranging from mildly acidic to mildly alkaline, roughly pH 5.0 to 8.0, so (A) matches this well.
Laterite soils form under heavy rainfall and intense leaching, which strips away bases and leaves the soil strongly acidic, typically well under pH 6.0. Placing their average at 6.0 to 7.0 undersells how acidic they actually are, so (B) does not hold.
Red and yellow soils are usually reported as close to neutral or slightly acidic, which is exactly what (C) states, so it checks out.
Desert soils develop under low rainfall with little leaching, so bases and calcium carbonate accumulate, giving them a fairly high, alkaline pH, matching (D).
Alkali or sodic soils carry excess exchangeable sodium, which pushes their pH much higher than ordinary alkaline soils, commonly above

8.5, so the modest 7.0 to 8.0 range claimed in (E) is too low to be correct.
So the statements that hold up are (A), (C) and (D).

$$\boxed{(A),\ (C),\ (D) \text{ only}}$$

Quick Tip: Recall the typical pH band associated with red, laterite, desert and alkali soils.

• • •

103. Given below are two statements:

Statement (I): Penman proposed an equation for evaporation from an open water surface based on a combination of energy balance and sink strength.
Statement (II): For converting PET into ET, suitable crop coefficients should be evolved for different crops, soils and climatic conditions and also for different stages of growth for the same crop.
In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Take each statement and place it against what is actually taught about Penman's method and crop coefficients.

Penman's evaporation formula is famous precisely because it merges two older separate approaches, the energy balance method that uses net radiation and the aerodynamic method that uses wind speed and humidity deficit, the sink strength term, into one workable equation for open water evaporation. That matches Statement (I) directly.
Once potential evapo-transpiration is known, actual crop water use is obtained by multiplying it with a crop coefficient, $ET_{crop} = K_c \times PET$. Since K_c changes with the crop, its growth stage, the soil, and the climate of the region, agronomists build separate coefficient tables for each of these situations, which is exactly what Statement (II) describes.
Both statements hold up under this check.

Both Statement (I) and Statement (II) are correct

Quick Tip: Recall what the Penman equation combines and how PET is converted into actual crop water use.

• • •

104. Given below are two statements:

Statement (I): In small catchments the overland flow phase is predominant over the channel flow. Hence the land use and the intensity of rainfall have an important role on the peak flood.
Statement (II): On large catchments the effects of land use and intensity of rainfall are suppressed as the channel flow phase is more predominant.
In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Think of catchment response as controlled by whichever flow phase eats up most of the travel time to the outlet.

In a small catchment, the outlet is close to every part of the land, so rain has to travel mostly as sheet flow across fields and slopes before it even reaches a channel. Since this overland leg dominates, whatever is happening on the land surface, crop cover, tillage, soil compaction, and however intense the rain falls, both leave a strong fingerprint on the peak discharge. That is Statement (I), and it lines up with why methods like the Rational Method work well for small basins.

Push the same logic to a large catchment and the balance flips. Water now travels long distances inside defined channels, where storage and channel routing stretch out and blend the inflow from many smaller sub-areas. A short spell of intense rain in one corner or a patch of unusual land use gets diluted into the overall channel response, so their individual influence on the peak flood weakens. That is exactly Statement (II).

Both descriptions of how catchment size shifts the dominant flow phase turn out to be accurate.

Both Statement (I) and Statement (II) are correct

Quick Tip: Think about which flow phase, overland or channel, dominates the travel time in small versus large catchments.

• • •

105. The limitations to the use of unit hydrographs are:

(A) Snow melt runoff cannot be satisfactorily represented by unit hydrograph.
(B) The catchment should not have unusually large storages in terms of tanks, ponds, large flood bank storages, etc. which affect the linear relationship between storage and discharge.
(C) If the precipitation is decidedly uniform, unit hydrographs can not be expected to give good results.
(D) The rainfall intensity is assumed constant for the duration of the rainfall excess.
(E) The duration of rainfall should be 1/6 to 1/2 of the basin lag.

Choose the *correct* answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (C), (D) and (E) only.

(D) (A), (B) and (D) only.

Correct Answer: (D) (A), (B) and (D) only.

SOLUTION:

Step 1: Instead of checking every statement from scratch, start by eliminating the two answer choices that keep option (C) in them, because (C) can be tested quickly. The rule every hydrology text gives

is that a unit hydrograph loses accuracy when a storm is NOT spread evenly over the basin. Option (C) claims the opposite, that even, uniform rain is what causes trouble. That is the wrong direction, so (C) must be dropped. This immediately kills choices 1, 2 and 3 in the answer list, since all three include (C).

Step 2: That leaves only option 4, but let's confirm it holds instead of just trusting the elimination. Option 4 keeps (A), (B) and (D) and drops (C) and (E).

Step 3: For (A): snow melt water does not follow the rain-to-runoff timing the UH is built on, so mixing it in ruins the linear model. Keep (A).

Step 4: For (B): a catchment full of ponds, tanks or large flood-bank storage releases water on its own schedule, not in proportion to the rainfall pulse, so the straight-line storage-discharge link the UH needs is broken. Keep (B).

Step 5: For (D): the unit hydrograph model assumes the rain falls at one steady intensity for the whole unit period. That is a strict assumption baked into the derivation, and real storms rarely behave that way, so it is fairly listed as a limitation. Keep (D).

Step 6: For (E), the actual accepted duration rule caps the storm length at around one-fifth to one-fourth of the basin lag, not the 1/6 to 1/2 window given here, so it stays excluded.

Step 7: With (A), (B), (D) confirmed and (C), (E) rejected, the match is exact.

Option 4: (A), (B) and (D) only

Quick Tip: Think about the basic assumptions of unit hydrograph theory and which listed statements actually violate them versus which ones reverse the correct logic.

• • •

106. A 12-h unit hydrograph of a catchment is triangular in shape with a base width of 144h and a peak discharge of 23 cumec. This unit hydrograph refers to a catchment area of

(A) 786 km^2

(B) 596 km^2

(C) 900 km^2

(D) 1200 km^2

Correct Answer: (B) 596 km^2

SOLUTION:

Step 1: A neat way to solve this without converting hours to seconds right away is to work in the unit "cumec-hours," since 1 cumec flowing for 1 hour equals $3600\ m^3$ of water, and this shortcuts the arithmetic.
Step 2: The triangle's area, in flow times time, is $\frac{1}{2} \times 144\ h \times 23\ m^3/s$ $= 1656$ cumec-hours.
Step 3: Convert cumec-hours to cubic metres using 1 cumec-hour $= 3600\ m^3$:

$$1656 \times 3600 = 5961600\ m^3$$

which is the same runoff volume as before, just reached through a different bookkeeping path.
Step 4: This entire volume is what 1 cm of effective rain would produce over the catchment, so divide by the depth in metres, $0.01\ m$, to isolate the plan area:

$$A = \frac{5961600}{0.01}\ m^2 = 596160000\ m^2$$

Step 5: Since 1 square kilometre holds 10^6 square metres, divide once more:

$$A = 596.16\ km^2$$

Step 6: Rounding to match the answer choices given, this lands on 596 km^2.

$$\boxed{596\ km^2}$$

Quick Tip: Remember that the area under a unit hydrograph must equal 1 cm of runoff depth spread over the whole catchment.

• • •

107. (A) Floods are exceedingly complex natural events. They are resultant of a number of component parameters and are therefore very difficult to model them analytically.
(B) In the regions having same climatological characteristics, if the available flood data are quite insufficient, the enveloping curve technique can be used to develop a relationship between the minimum flood flow and drainage area.
(C) For design purposes, extreme rainfall situations are used to obtain the design storm.
(D) The rational formula is found to be suitable for a peak flow prediction in small catchments upto 75 km^2 in an area.
(E) The rational formula assumes a homogeneous catchment surface.

Choose the *correct* answer from the options given below:

(A) (A), (C) and (E) only.

(B) (A), (B) and (C) only.

(C) (B), (C) and (D) only.

(D) (C), (D) and (E) only.

Correct Answer: (A) (A), (C) and (E) only.

SOLUTION:

Step 1: A faster route here is to spot the two statements that contain a specific number or a swapped word, since those are the easiest to check first and usually decide the answer.
Step 2: Look at (B): the phrase is "minimum flood flow." Envelope curves exist precisely because engineers want an upper bound, the biggest flood a catchment of a given size could throw up, when they do not have enough local data. A curve of minimum flows would not help with flood safety design at all, so this statement does not fit real practice and must be false.
Step 3: Look at (D): the number quoted is 75 square kilometres. Standard reference values used in irrigation and drainage courses put the ceiling for the rational method nearer 50 square kilometres, since the method assumes the whole catchment responds together almost instantly, which stops holding as the catchment grows. So (D) is also false.
Step 4: With (B) and (D) both eliminated, only the answer choice keeping (A), (C) and (E) survives among the four given, which is choice 1.
Step 5: Confirm the three survivors make sense together: floods are indeed hard to model exactly (A), design storms are indeed chosen from extreme rainfall records (C), and the rational method does

indeed assume the catchment surface behaves uniformly everywhere (E). All three hold up under scrutiny.

Option 1: (A), (C) and (E) only

Quick Tip: Check statement (B) for which extreme (maximum or minimum) envelope curves actually represent, and check the numeric limit quoted in (D) against the standard rational method range.

• • •

108. Given below are two statements:

Statement (I): Chute spillways carry the flow down the steep slopes through a lined channel rather than by dropping the water in a free overfall.

Statement (II): On steep slopes, chutes are more economical than series of drop structures to take the flow down the slope.

In light of the above statements, choose the *most appropriate* answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Step 1: Picture the two options physically side by side on the same steep hillside to judge these statements by common sense engineering rather than by memorised definitions.
Step 2: A chute is basically a paved or lined trough that lets the water slide continuously downhill in contact with the lining the whole way, rather than jumping off a ledge into open air the way a free overfall spillway does. That is exactly what Statement (I) describes, so it checks out as accurate.
Step 3: Now think about cost. A single chute needs one lined channel plus one energy dissipator at the bottom. A staircase of drop structures needs a new small structure, its own footing, and its own stilling arrangement at each step down the slope. Building and maintaining many small structures on steep ground usually costs more than one continuous lined channel, so the claim in Statement (II) that chutes are more economical lines up with normal design practice.
Step 4: Since neither statement contradicts standard spillway design logic, both must be treated as correct together.

Both Statement (I) and Statement (II) are correct

Quick Tip: Compare how a chute channels water down a slope versus how a stepped series of drop structures would, and weigh the construction cost of each.

109. (A) The plan inspection method of land levelling design is adapted for moderate to flat land slopes.
(B) The profile method of land levelling design consists of plotting the profiles of the grid lines and then laying the desired grade on the profiles.
(C) The contour adjustment method of land levelling design consists of a trial and error adjustment of the contour lines on a plan map.
(D) The contour adjustment method is especially adapted to the smoothening of flat lands that are to be irrigated.
(E) The plane method is rarely used for land levelling design.

Choose the *correct* answer from the options given below:

(A) (C), (D) and (E) only.

(B) (B), (C) and (D) only.

(C) (A), (B) and (C) only.

(D) (A), (B) and (E) only.

Correct Answer: (B) (B), (C) and (D) only.

SOLUTION:

Step 1: Rather than judging all five statements equally, first ask which of them name a technique that does not exist in the standard land grading syllabus, since that quickly flags a false statement.
Step 2: "Plan inspection method" in (A) is not one of the recognised categories, profile, contour adjustment, or plane. Because it is not a real named method, (A) cannot be validated and is rejected.
Step 3: Next, ask whether the plane method, mentioned in (E), is actually rare in field use. Fitting a single sloping plane, or a pair of planes, to a field's elevation data is one of the most commonly taught and applied approaches for reasonably uniform land, so calling it "rarely used" does not match reality, and (E) is rejected too.

Step 4: With (A) and (E) both out, only the choice keeping (B), (C) and (D) remains among the four given, which is option 2.
Step 5: Sanity check the three survivors: the profile method genuinely works by plotting grid-line profiles and overlaying the target grade (B), the contour adjustment method genuinely works by nudging contour lines on the map until cut equals fill (C), and this same contour method is genuinely the natural choice for smoothing flat land destined for irrigation (D). All three are internally consistent with standard land grading theory.

Option 2: (B), (C) and (D) only

Quick Tip: Match each statement to one of the three standard land levelling design methods (profile, contour adjustment, plane) and see which method names or descriptions do not really exist or do not fit.

• • •

110. Given below are two statements:

Statement (I): Water storage efficiency becomes important when water supplies are limited or when excessive time is required to secure adequate penetration of water into the soil.

Statement (II): Water application efficiency decreases as the amount of water applied during each irrigation increases.

In light of the above statements, choose the *most appropriate* answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Step 1: Think of these two statements in terms of a simple water balance at the field rather than by quoting definitions.
Step 2: When water is scarce, or the soil takes a long time to let water soak all the way into the root zone, every drop that gets properly stored in the root zone matters a lot, which is exactly why storage efficiency becomes a critical number to track in those conditions. Statement (I) is simply restating this practical concern, so it holds up.
Step 3: Now imagine gradually turning up how much water is applied in a single irrigation. At first the extra water helps fill the root zone, but past a certain point any additional water has nowhere useful to go, it either sinks below the roots or runs off the field. So the ratio of useful water stored to total water applied, which is the application efficiency, keeps shrinking the more water is put in per irrigation. Statement (II) describes exactly this diminishing returns pattern, so it also holds up.
Step 4: Since both descriptions match how these efficiencies actually behave in the field, neither statement can be dismissed.

Both Statement (I) and Statement (II) are correct

Quick Tip: Think about what happens to the wasted water (deep percolation and runoff) as the applied depth per irrigation grows larger.

• • •

111. Given below are two statements:

Statement (I): Isotropic and homogeneous aquifers seldom occur in nature.

Statement (II): Water level measurements during pumping test are made in observation wells installed close to the well or at some distance away from it.

In light of the above statements, choose the *most appropriate* answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (A) Both Statement (I) and Statement (II) are correct.

SOLUTION:

Step 1: Approach Statement (I) by asking whether any natural aquifer material is ever perfectly uniform in every direction. Sand, gravel, clay layers, and fractured rock all form through processes like sedimentation and weathering that naturally produce layering and directional differences in how easily water moves through them. A truly isotropic and homogeneous aquifer would need the material to be identical everywhere and in every direction, which almost never happens in nature, so calling such aquifers rare is a fair and standard observation.

Step 2: Approach Statement (II) by picturing an actual pumping test

in the field. Engineers cannot read the aquifer properties directly, so they pump one well steadily and watch how the water table drops in nearby wells set up beforehand at different distances, some very close and some further out, over the course of the test. That is precisely the setup Statement (II) is describing, so it lines up with real field procedure.

Step 3: Neither statement runs into a contradiction with standard groundwater theory or practice, so both stand as valid together.

Both Statement (I) and Statement (II) are correct

Quick Tip: Think about whether real geological materials are ever perfectly uniform and directionless, and recall the standard layout of observation wells around a pumping test.

• • •

112. (A) In levelling, datum surface is an arbitrary surface with reference to which the elevations of the points are measured and compared.
(B) The line of collimation or the line of sight is the line joining the intersection of the cross-hairs to the optical centre of the object glass and its continuation.
(C) A foresight is the first staff reading taken after setting up the instrument in any position.
(D) The height of instrument is the elevation of the plane of collimation when the instrument is levelled.
(E) A change point indicates the shifting of the instrument, both back sight and intermediate sight are taken on this change point.

Choose the *correct* answer from the options given below:

(A) (A), (B) and (D) only.

(B) (A), (B) and (C) only.

(C) (C), (D) and (E) only.

(D) (B), (C) and (D) only.

Correct Answer: (A) (A), (B) and (D) only.

SOLUTION:

Step 1: A quick way through this question is to look specifically for any statement that swaps two related surveying terms, since that is a common trick in these definition questions.
Step 2: Look at (C): it talks about "the first staff reading taken after setting up the instrument." Think about what actually happens on site: the very first reading after setting up over a new instrument position is always taken on a point of known elevation to fix the height of the instrument, and that reading is called a backsight, not a foresight. The statement has the two terms swapped, so (C) fails.
Step 3: Look at (E): a change point is where the surveyor closes one instrument setup and opens the next. The last reading before moving is a foresight, and the first reading after moving is a backsight. There is no intermediate sight involved at a change point at all, since intermediate sights are only the readings taken on points between the backsight and foresight within a single setup. The statement's use of "intermediate sight" is the wrong term, so (E) fails too.
Step 4: With (C) and (E) eliminated, only (A), (B) and (D) remain, and checking them against ordinary levelling vocabulary, the datum in (A), the line of collimation in (B), and the height of instrument in (D) are all textbook-accurate as written.
Step 5: That combination of surviving statements matches only one listed choice.

Option 1: (A), (B) and (D) only

Quick Tip: Watch for two statements that quietly swap the standard meanings of backsight, foresight and intermediate sight.

• • •

113. Match List-I with List-II.

List-I	List-II
(A) Close contour lines	(I) Foot hill
(B) Wider contour lines	(II) Higher contour values outside
(C) Depression	(III) At right angles
(D) Crossing of ridge lines	(IV) Top of hill

Choose the correct answer from the options given below:

(A) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

(B) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

(C) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)

(D) (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

Correct Answer: (A) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

SOLUTION:

A quicker way to solve this match-the-following is to fix the pairs you are most sure of first and then eliminate wrong options.
The safest fact in surveying is that contours always cross a ridge or a valley line at a right angle, since the direction of steepest slope (the ridge/valley line) is always perpendicular to the lines of constant elevation (the contours). So (D) must go with (III). Checking the four

options, only option 1 and option 4 keep (D) - (III); options 2 and 3 can be dropped right away.
Next, look at depression. A depression is a closed contour loop, and by convention the innermost contour of a depression carries the lowest value, so elevation values increase as you move away from the centre, that is, higher contour values lie outside the loop. So (C) must go with (II), not with (I) or with the foot hill idea. Between the two remaining options, option 1 pairs (C) - (II), while option 4 wrongly pairs (C) with (I) (foot hill). This rules out option 4.
That leaves option 1 as the only surviving choice, giving (A) - (IV), (B) - (I), (C) - (II), (D) - (III). This also matches the general slope rule: closely packed contours near the summit (top of hill) and widely spaced contours near the base (foot hill).

Option 1: (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Quick Tip: Think about what close versus wide contour spacing tells you about slope, and what a closed loop with rising values around it represents.

• • •

114. Which points should be kept in mind while selecting the stations?

(A) The survey lines should be as few as possible.
(B) If possible, a base line should be run roughly through the middle of the area on which the framework of triangles covering the major portions of area may be built up.
(C) Offsets should be long particularly for locating the important features.
(D) All the triangles should be well conditioned.
(E) The main principle of surveying is to work from the part to the whole.
Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (A), (B) and (D) only.

(D) (C), (D) and (E) only.

Correct Answer: (C) (A), (B) and (D) only.

SOLUTION:

Another way to handle this question is to recall the standard list of rules for selecting survey stations and tick off each statement against it.

The textbook rules are: use as few lines as possible, run one base line through the middle of the plot and build the triangle framework on it, keep every triangle well conditioned, avoid obtuse or very thin triangles, and keep offsets short, especially to important features, since short offsets are quicker and more accurate to lay out at right angles.

Matching this list against the five given statements: (A) matches as few lines as possible, true. (B) matches base line through the middle with the framework built on it, true. (D) matches well conditioned triangles, true. (C) says offsets should be long, the reverse of keep offsets short, so false. (E) says work from part to whole, the reverse of the actual principle work from whole to part, so false.

Only three statements survive the check, (A), (B) and (D), and this combination is listed as option 3.

Option 3: (A), (B) and (D) only

Quick Tip: Two of the five statements reverse well known surveying rules about offset length and about whether you work whole-to-part or part-to-

whole.

• • •

115. The design of bench terraces consists in determining the

(A) type of bench terraces
(B) terrace spacing
(C) terrace cross section
(D) terrace length
(E) terrace alignment
Choose the correct answer from the options given below:

(A) (A), (B) and (C) only.

(B) (B), (C) and (D) only.

(C) (C), (D) and (E) only.

(D) (A), (B) and (E) only.

Correct Answer: (A) (A), (B) and (C) only.

SOLUTION:

Think of bench terrace design the way an engineer would draw it on paper before construction starts. Three choices must be fixed before touching the ground: what type of terrace to build, how far apart (vertically) the terraces should be, and what cross sectional shape and size each terrace strip and riser will have.
Type of terrace decides the overall strategy (level terrace, graded terrace, or narrow orchard terrace). Spacing decides how many terraces are needed down the slope and how wide each strip will be. Cross section decides the actual earthwork, the cut, the fill, and the riser slope, which is what makes the terrace stand safely.

Length and alignment come next, but they are adjusted to match the shape of the field and the property boundary on site, they are not computed the same way spacing and cross section are, so they sit outside the strict design step described in the question.
That leaves type, spacing and cross section, statements (A), (B) and (C), as the answer.

Option 1: (A), (B) and (C) only

Quick Tip: Focus on which of the five items are actually computed as design quantities, versus which are simply fitted to the field afterwards.

• • •

116. Which land capability classes are suitable for pastures?

(A) class I and class II

(B) class II and class III

(C) class III and class IV

(D) class V and class VI

Correct Answer: (D) class V and class VI

SOLUTION:

A simple way to remember the eight land capability classes is to split them into two groups. Classes I, II, III and IV can grow regular field crops, with class I needing almost no special care and class IV needing very careful management with conservation practices. Classes V, VI, VII and VIII cannot be safely cultivated with ordinary crops at all. Within that second group, class V land is often nearly flat but blocked from cultivation by some other permanent problem, so it is kept as

permanent pasture, range or woodland. Class VI carries a real slope or erosion hazard and is described in the classification tables as land suited to grazing and forestry rather than cultivation. Class VII needs even more caution and supports only light grazing or forestry, and class VIII is fit for nothing beyond wildlife habitat or recreation. Since the question asks specifically which classes are described as suited for pasture, and class III and class IV are still cultivable classes, the cultivable options can be ruled out. Class V and class VI are the pair the classification system actually names for pasture and grazing use.

Option 4: class V and class VI

Quick Tip: Remember that classes I to IV are for cultivation, while classes V to VIII are reserved for grazing, forestry, wildlife or recreation.

• • •

117. Orchard benched terraces has a width of about

(A) 2m

(B) 3m

(C) 0.5m

(D) 1m

Correct Answer: (A) 2m

SOLUTION:

Look at this from the purpose of the terrace rather than trying to memorise a number in isolation. A level (table top) bench terrace is used for irrigated field crops planted across the whole strip, so it

needs a wide flat top, typically 3 to 6 metres, to fit multiple crop rows and allow machinery to move.

An orchard terrace exists purely to hold one line of fruit trees running along the contour. Since only a single tree row sits on each bench, the strip does not need to be nearly as wide as a crop terrace. Soil conservation design guidance for deep soils gives about 2 metres as the practical top width for such an orchard bench, wide enough for the tree's root zone and a safe working margin, but no wider than necessary.

Checking the alternatives, 3 metres suits a field crop terrace rather than an orchard row, and 0.5 metre or 1 metre would be too tight for a mature tree's base and root spread on a stable terrace edge. So 2 metres is the width that fits the actual function of an orchard bench terrace.

$\boxed{2\ \text{m}}$

Quick Tip: Orchard terraces only need to carry one row of trees, so think about what strip width is enough for that, without copying the wider field-crop terrace dimensions.

• • •

118. A quantity of 100ml gypsum solution having 36 meq/l concentration as calcium, on reacting with 5gm of an alkali soil showed 32 meq/l of Ca+Mg concentration in the filtrate. Estimate the gypsum requirement in meq/100gm of soil.

(A) 6

(B) 8

(C) 12

(D) 16

Correct Answer: (B) 8

SOLUTION:

Set this up with a direct formula instead of working step by step through the meq totals. Gypsum requirement, in meq per 100 gm of soil, can be written as:

$$GR = \frac{(C_1 - C_2) \times V}{W} \times 100$$

where C_1 is the starting calcium concentration of the gypsum solution in meq/l, C_2 is the Ca+Mg concentration found in the filtrate in meq/l, V is the volume of solution used in litres, and W is the weight of soil in grams.

Substitute the given numbers: $C_1 = 36$, $C_2 = 32$, $V = 0.1$ litre, $W = 5$ gm.

$$GR = \frac{(36 - 32) \times 0.1}{5} \times 100 = \frac{4 \times 0.1}{5} \times 100 = \frac{0.4}{5} \times 100 = 8$$

The formula gives the same result as the step by step method, 8 meq of gypsum needed per 100 gm of this alkali soil.

$$\boxed{8 \text{ meq/100gm soil}}$$

Quick Tip: Find how much calcium disappeared from the solution after reacting with the soil, then scale that loss up to a 100 gm soil basis.

119. Convert 1300 ppm sodium chloride salt concentration into meq/l

(A) 22.22

(B) 20.22

(C) 18.75

(D) 23.25

Correct Answer: (A) 22.22

SOLUTION:

Work this out by first finding how many milligrams sit in each litre, then converting that mass into milliequivalents using the definition of an equivalent.

An equivalent weight is the molecular weight divided by the valence involved in the reaction. For NaCl, the molecular weight is 23 (Na) + 35.5 (Cl) = 58.5, and the ion exchange valence is 1, so one equivalent of NaCl weighs 58.5 g, and one milliequivalent weighs 58.5 mg.

Since the concentration is 1300 ppm, that is the same as 1300 mg of NaCl in every litre of solution. Convert that mass into milliequivalents by dividing by the weight of one milliequivalent:

$$\frac{1300 \text{ mg/l}}{58.5 \text{ mg/meq}} = 22.22 \text{ meq/l}$$

This confirms the same figure as the direct ppm-over-equivalent-weight method, 22.22 meq/l.

$$\boxed{22.22 \text{ meq/l}}$$

Quick Tip: Divide the ppm value by the equivalent weight of sodium chloride, which comes from its molecular weight and its valence of one.

• • •

120. Given below are two statements:

Statement (I): The axis of the bubble tube should be perpendicular to the vertical axis in dumpy level.
Statement (II): The line of collimation of the telescope of the dumpy level should be perpendicular to the axis of the bubble tube.
In light of the above statements, choose the most appropriate answer from the options given below.

(A) Both Statement (I) and Statement (II) are correct.

(B) Both Statement (I) and Statement (II) are incorrect.

(C) Statement (I) is correct but Statement (II) is incorrect.

(D) Statement (I) is incorrect but Statement (II) is correct.

Correct Answer: (C) Statement (I) is correct but Statement (II) is incorrect.

SOLUTION:

Picture what a dumpy level actually needs to do: when you centre the bubble, the telescope's line of sight must come out perfectly horizontal, whichever direction you point it.
For the vertical axis to stand truly vertical whenever the bubble is centred, the bubble tube's own axis has to sit at a right angle to that vertical axis. That is exactly what keeps the instrument level all around as you rotate it, so Statement (I), which says the bubble tube axis should be perpendicular to the vertical axis, matches the real design requirement.
Now think about the telescope's line of sight. If this line of sight were perpendicular to the bubble tube axis, then centring the bubble would point the telescope straight up or down instead of horizontally,

making the instrument useless for levelling. The correct requirement is that the line of collimation must run parallel to the bubble tube axis, so centring the bubble automatically makes the line of sight horizontal. Statement (II) claims perpendicular where it should say parallel, so it is wrong.

Putting the two findings together, Statement (I) holds up and Statement (II) does not.

Option 3: Statement (I) correct, Statement (II) incorrect

Quick Tip: Recall that the bubble tube axis relates to the vertical axis one way, and to the line of sight a different way, in the two permanent adjustments of a dumpy level.