# GATE Agricultural Engineering

## Sample Paper – 6

**Duration: 128 Minutes** **Maximum Marks: 72**

### Instructions

- This paper contains **46 questions** covering the core **Agricultural Engineering** subject of the GATE paper conducted by the IITs and IISc (General Aptitude and Engineering Mathematics are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Take $g = 9.81$ m/s$^2$, density of water $\rho_w = 1000$ kg/m$^3$ and unit weight of water $\gamma_w = 9.81$ kN/m$^3$ unless stated otherwise.

## Farm Machinery & Power

**Q1.** The indicated power developed inside the cylinders of a diesel engine is $20$ kW, and the mechanical efficiency of the engine is $80\%$. The brake power available at the crankshaft (flywheel) is: **[1 mark]**

(A) $25$ kW

(B) $16$ kW

(C) $4$ kW

(D) 20 kW

**Q2.** On a firm test track a tractor covers a certain distance in a fixed number of driving-wheel revolutions at a theoretical (no-slip) speed of 6 km/h, but under load in the field the same revolutions give an actual forward speed of only 4.8 km/h. The wheel slip of the tractor is: **[1 mark]**

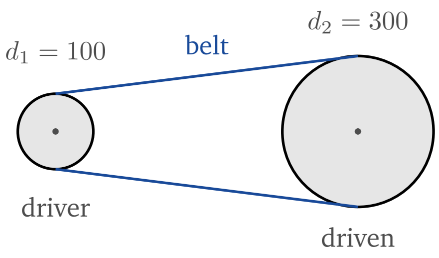
(A) 25%

(B) 80%

(C) 1.2%

(D) 20%

**Q3.** A flat-belt drive connects a small driver pulley to a larger driven pulley as shown. The driver pulley has a diameter of 100 mm and rotates at 1500 rpm, while the driven pulley has a diameter of 300 mm. Neglecting belt slip, the rotational speed of the driven pulley is: **[1 mark]**




(A) 4500 rpm

(B) 1500 rpm

(C) 500 rpm

(D) 250 rpm

**Q4.** A single-cylinder engine has a bore (cylinder diameter) of 100 mm and a stroke length of 120 mm. The swept (displacement) volume of the cylinder is nearest to: **[1 mark]**

(A) 942 $cm^3$

(B) 1885 $cm^3$

(C) 471 $cm^3$

(D) $120\ \text{cm}^3$

**Q5.** The property of a diesel fuel that indicates its ignition quality, i.e. the readiness with which it self-ignites under compression, is its: **[1 mark]**

(A) octane number

(B) flash point

(C) kinematic viscosity

(D) cetane number

**Q6.** Which one of the following is a *primary* tillage implement? **[1 mark]**

(A) Spike-tooth harrow

(B) Spring-tine cultivator

(C) Mouldboard plough

(D) Planker (float)

**Q7.** A tractor-drawn implement has an effective field capacity of $0.5$ ha/h. The time required for this implement to cover a field of area $4$ ha in one operation is: **[1 mark]**

(A) $8$ h

(B) $2$ h

(C) $0.125$ h

(D) $4$ h

**Q8.** An engine develops a brake power of $15$ kW while consuming $3$ kg of fuel per hour. The brake specific fuel consumption (BSFC) of the engine is: **[1 mark]**

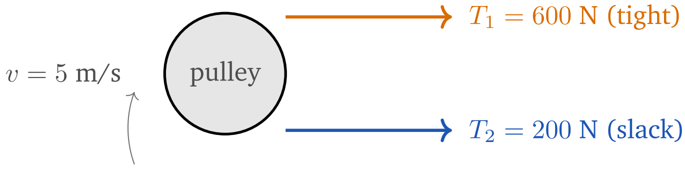
(A) $5.0$ kg/kWh

(B) $45$ kg/kWh

(C) $0.3$ kg/kWh

(D) $0.2$ kg/kWh

**Q9.** A flat belt runs over a driving pulley as shown. The tension on the tight side is 600 N and on the slack side is 200 N, and the belt travels at a linear speed of 5 m/s. The power transmitted by the belt is: **[1 mark]**




(A) 0.40 kW

(B) 80 kW

(C) 2.0 kW

(D) 10 kW

**Q10.** The hitch system in which the entire weight of the implement is carried by the tractor through three converging links, so that the implement is fully raised clear of the ground during transport, is the: **[1 mark]**

(A) mounted (integral three-point) hitch

(B) trailed (pull-type) hitch

(C) semi-mounted hitch

(D) single-point drawbar hitch

**Q11.** In a seed drill, the component that receives seed from the hopper and delivers a controlled, uniform quantity of seed to the seed tube is the: **[1 mark]**

(A) furrow opener

(B) fluted-roller feed (seed-metering mechanism)

(C) covering device (drag chain)

(D) boot

**Q12.** In a two-stroke-cycle internal-combustion engine, the number of power (expansion) strokes produced for every one revolution of the crankshaft is: **[1 mark]**

(A) 4

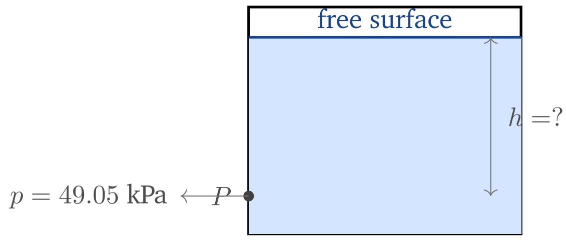
(B) 0.5

(C) 2

(D) 1

## Soil & Water Conservation Engineering

**Q13.** A pressure gauge tapped into the wall of a water tank at point $P$ reads a gauge pressure of $49.05$ kPa, as shown. The vertical height of the still-water column standing above point $P$ is (take $\gamma_w = 9.81$ kN/m$^3$): **[1 mark]**




(A) $50$ m

(B) $5$ m

(C) $0.2$ m

(D) $10$ m

**Q14.** Water flows full through a circular pipe of internal diameter $100$ mm at a mean velocity of $2$ m/s. The volumetric discharge carried by the pipe is nearest to: **[1 mark]**

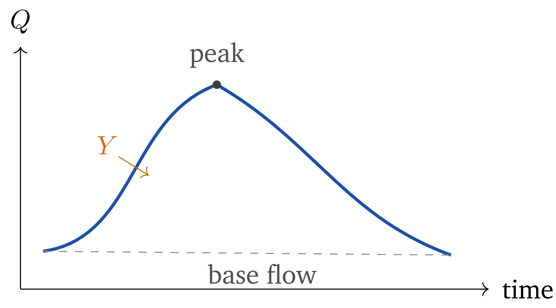
(A) $15.7$ L/s

(B) $0.0157$ L/s

(C) $157$ L/s

(D) $6.28$ L/s

**Q15.** In the single-peaked storm hydrograph shown, the portion marked $Y$ (the part of the curve that rises from the start of direct runoff up to the peak discharge) is called the: **[1 mark]**




(A) recession (falling) limb

(B) rising (concentration) limb

(C) base flow

(D) peak (crest)

**Q16.** In the rational formula for peak runoff, $Q = C\,i\,A$, the rainfall intensity $i$ used for design should correspond to a storm whose duration is taken equal to the: **[1 mark]**

(A) time of concentration of the catchment

(B) total duration of the annual rainfall

(C) time base of the flood hydrograph

(D) lag time between rainfall and peak

**Q17.** In the Universal Soil Loss Equation $A = R\,K\,LS\,C\,P$, the factor $R$ represents: **[1 mark]**

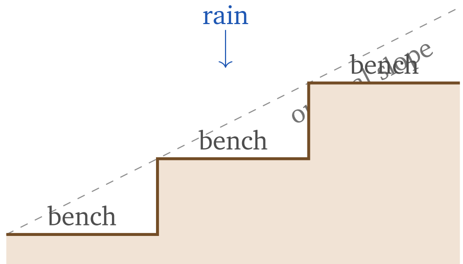
(A) the rainfall erosivity (energy–intensity) factor

(B) the soil erodibility factor

(C) the slope length and steepness factor

(D) the cover / crop-management factor

**Q18.** A bench terrace is constructed on steeply sloping cultivated land as shown, converting the hillside into a series of steps. The chief purpose of a bench terrace is to: **[1 mark]**




(A) lengthen the overland flow path and speed up runoff

(B) convert a steep slope into a series of nearly level steps that cut the effective slope and control erosion

(C) store irrigation water permanently on the hillside

(D) provide only a footpath across the field

**Q19.** A watershed of drainage area 15 km$^2$ contains a total of 30 streams of all orders. The stream frequency (drainage frequency) of the watershed is: **[1 mark]**

(A) 450 km$^{-2}$

(B) 0.5 km$^{-2}$

(C) 2 km$^{-2}$

(D) 45 km$^{-2}$

**Q20.** The ratio of the quantity of sediment retained (trapped) within a reservoir to the total quantity of sediment carried into it by the inflowing streams is called the: **[1 mark]**

(A) sediment delivery ratio

(B) soil erodibility index

(C) runoff coefficient

(D) trap efficiency

## Soil & Water Conservation Engineering (continued)

**Q21.** For an agricultural field the Universal Soil Loss Equation factors are $R = 300$, $K = 0.25$, $LS = 2.0$, $C = 0.20$ and $P = 0.80$ (in consistent units). The average annual soil loss $A$ from the field is: **[2 marks]**

(A) 48 t/ha/yr

(B) 12 t/ha/yr

(C) 24 t/ha/yr

(D) 60 t/ha/yr

**Q22.** A watershed of area $200$ ha has a runoff coefficient of $0.30$. For a design rainfall intensity of $5$ cm/h, the peak runoff estimated by the rational method $\left(Q = CiA/360,\ i \text{ in mm/h},\ A \text{ in ha}\right)$ is nearest to: **[2 marks]**

(A) $16.67\ \text{m}^3/\text{s}$

(B) $25.0\ \text{m}^3/\text{s}$

(C) $8.33\ \text{m}^3/\text{s}$

(D) $4.17\ \text{m}^3/\text{s}$

**Q23.** A storm of $40$ mm rainfall depth falls over a $25$ ha watershed whose runoff coefficient is $0.50$. The total volume of direct surface runoff produced is: **[2 marks]**

(A) $5000\ \text{m}^3$

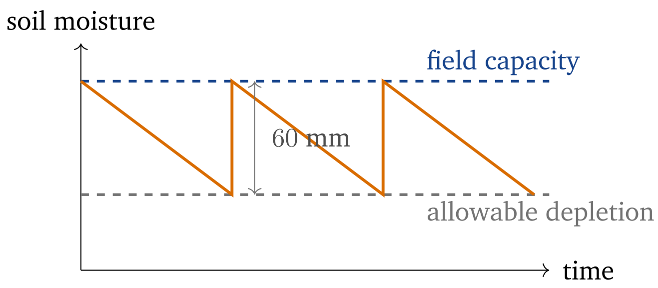
(B) $2500\ \text{m}^3$

(C) $10000\ \text{m}^3$

(D) $500\ \text{m}^3$

## Irrigation & Drainage Engineering

**Q24.** For a certain crop the net depth of irrigation water that can be stored in the root zone between two irrigations is $60$ mm, and the peak crop evapotranspiration rate is $5$ mm/day, as depicted by the soil-moisture depletion pattern shown. The irrigation interval (frequency) is: **[2 marks]**



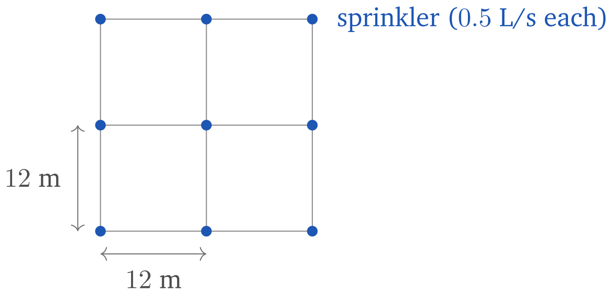
(A) 300 days

(B) 12 days

(C) 0.083 days

(D) 6 days

**Q25.** In a sprinkler irrigation system, each sprinkler discharges 0.5 L/s and the sprinklers are laid out on a square grid of spacing 12 m $\times$ 12 m, as shown. The application rate (rate at which water is applied to the ground) is: **[2 marks]**




(A) 25.0 mm/h

(B) 12.5 mm/h

(C) 6.25 mm/h

(D) 3.47 mm/h

**Q26.** The net depth of irrigation water to be stored in the crop root zone is 45 mm. If the water-application (on-farm) efficiency is 75%, the gross depth of water that must be applied at the field is: **[2 marks]**

(A) 33.75 mm

(B) 45 mm

(C) 90 mm

(D) 60 mm

**Q27.** The infiltration into a soil follows Horton's equation $f = f_c + (f_0 - f_c)\, e^{-kt}$, with initial infiltration capacity $f_0 = 25$ mm/h, final capacity $f_c = 5$ mm/h and decay constant $k = 1$ h$^{-1}$. The infiltration rate at $t = 2$ h is nearest to (take $e^{-2} = 0.135$): **[2 marks]**

(A) 5.0 mm/h

(B) 7.7 mm/h

(C) 25.0 mm/h

(D) 12.4 mm/h

**Q28.** During an irrigation the depth of water required to refill the crop root zone to field capacity is 80 mm, but the depth actually stored in the root zone after irrigation is only 72 mm (the remainder ran off before infiltrating). The water-storage efficiency of the irrigation is: **[2 marks]**

(A) 60%

(B) 111%

(C) 75%

(D) 90%

**Q29.** A centrifugal pump lifts 25 L/s of water against a total head of 18 m. The hydraulic (water) power delivered to the water by the pump is nearest to (take $\rho_w = 1000$ kg/m$^3$, $g = 9.81$ m/s$^2$): **[2 marks]**

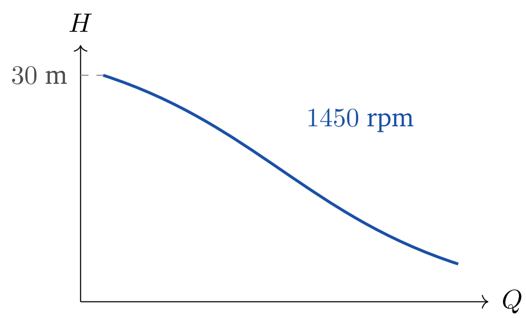
(A) 4.42 kW

(B) 5.89 kW

(C) 8.83 kW

(D) 2.21 kW

**Q30.** A centrifugal pump develops a head of 30 m when running at 1450 rpm, with its head–discharge characteristic shown. If the speed is reduced to 725 rpm, the head developed at the corresponding operating point, predicted by the pump affinity laws, becomes: **[2 marks]**



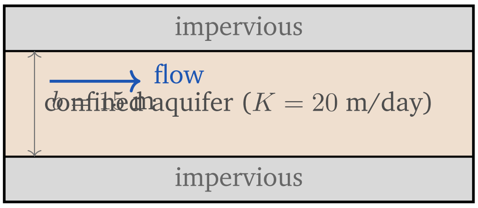
(A) 15 m

(B) 7.5 m

(C) 60 m

(D) 30 m

**Q31.** Water flows through a confined aquifer of hydraulic conductivity 20 m/day and saturated thickness 15 m, as sketched. The transmissivity of the aquifer is: **[2 marks]**




(A) 1.33 $m^2$/day

(B) 35 $m^2$/day

(C) 300 $m^2$/day

(D) 0.75 $m^2$/day

**Q32.** A drainage coefficient of 1.5 cm/day is to be provided for a low-lying agricultural area of 160 ha. The design discharge capacity of the drainage system is nearest to: **[2 marks]**

(A) 0.556 $m^3$/s

(B) 0.278 $m^3$/s

(C) 2.78 $m^3$/s

(D) 0.139 $m^3$/s

**Q33.** An irrigation project has a conveyance efficiency of 80% and a water-application efficiency of 75%. The overall (project) irrigation efficiency is: **[2 marks]**

(A) 80%

(B) 75%

(C) 60%

(D) 155%

**Q34.** The Darcy (discharge) velocity of groundwater through a sandy aquifer is 0.6 m/day, and the effective porosity of the sand is 0.40. The actual seepage (pore) velocity of the water through the aquifer is: **[2 marks]**

(A) 0.24 m/day

(B) 0.6 m/day

(C) 0.4 m/day

(D) 1.5 m/day

## Agricultural Processing & Food Engineering

**Q35.** A grain has a moisture content of 20% on a wet basis. The equivalent moisture content of the same grain expressed on a dry basis is: **[2 marks]**

(A) 20%

(B) 16.7%

(C) 80%

(D) 25%

**Q36.** A batch of 100 kg of paddy at a moisture content of 25% (wet basis) is dried to a moisture content of 15% (wet basis). The mass of water that must be removed during drying is nearest to: **[2 marks]**

(A) 10.0 kg

(B) 13.3 kg

(C) 11.76 kg

(D) 5.0 kg

**Q37.** In a grain dryer, 5 kg of water has to be evaporated from a wet product. Taking the latent heat of vaporisation of water as 2260 kJ/kg, the heat energy required just to evaporate this moisture is: **[2 marks]**

(A) $2260$ kJ

(B) $452$ kJ

(C) $11300$ kJ

(D) $1130$ kJ

**Q38.** During the drying of a moist solid, the moisture content at which the drying behaviour changes over from the constant-rate period to the falling-rate period is termed its: **[2 marks]**

(A) critical moisture content

(B) equilibrium moisture content

(C) bound moisture content

(D) free moisture content

**Q39.** According to Kick's law of size reduction, the energy required to reduce the size of a solid material is proportional to: **[2 marks]**

(A) the square of the size-reduction ratio

(B) the logarithm of the size-reduction ratio $\ln(d_1/d_2)$

(C) the new surface area created

(D) the volume of the feed particle

**Q40.** A spiral (inclined-chute) separator is used to clean a seed lot by allowing the seeds to roll or slide down a helical surface. The property on which this separator distinguishes the seeds is their difference in: **[2 marks]**

(A) shape and rolling ability (roundness)

(B) colour

(C) magnetic susceptibility

(D) length

**Q41.** A bucket elevator lifts grain such that each bucket discharges 2 kg of grain and 5 buckets are discharged every second. The conveying capacity of the elevator is: **[2 marks]**

(A) 36 t/h

(B) 10 t/h

(C) 72 t/h

(D) 18 t/h

**Q42.** In a milk pasteuriser, 10 kg of milk (specific heat 3.9 kJ/kg · K) is to be heated from 20°C to 70°C. The quantity of heat that must be supplied to the milk is: **[2 marks]**

(A) 390 kJ

(B) 500 kJ

(C) 3900 kJ

(D) 1950 kJ

**Q43.** Heat is conducted through a plane wall of thickness 0.1 m and thermal conductivity 0.4 W/m · K, having a face area of 5 $m^2$. The thermal (conductive) resistance of the wall is: **[2 marks]**

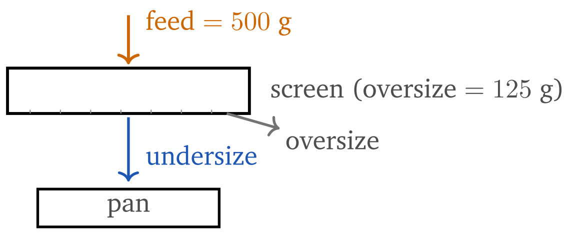
(A) 0.05 K/W

(B) 20 K/W

(C) 0.5 K/W

(D) 2.0 K/W

**Q44.** A 500 g sample of cleaned grain is fed onto a single test screen as shown; 125 g is retained on the screen as oversize and the remainder passes through as undersize. The fraction of the feed reporting as undersize (through-flow) is: **[2 marks]**




(A) 25%

(B) 133%

(C) 75%

(D) 43%

**Q45.** The unit operation in which fruits or vegetables are briefly heated (in hot water or steam) mainly to inactivate the enzymes that would otherwise cause spoilage, before canning, freezing or dehydration, is called: **[2 marks]**

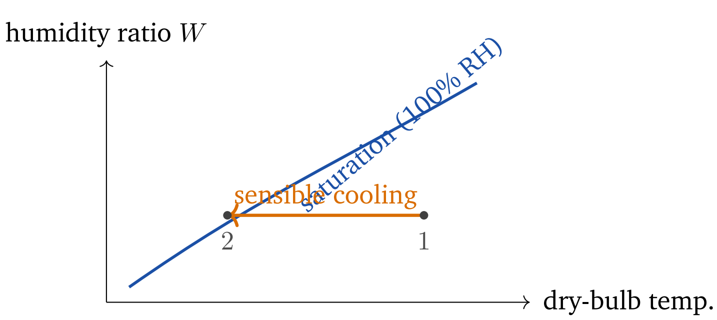
(A) pasteurization

(B) sterilization

(C) dehydration

(D) blanching

**Q46.** Moist air at a dry-bulb temperature of 30°C is cooled by a sensible cooling process (no moisture removed and no condensation, so the humidity ratio $W$ stays constant), shown as the horizontal line 1–2 on the psychrometric sketch. During this process the relative humidity of the air: **[2 marks]**




(A) decreases

(B) increases

(C) remains constant

(D) first decreases and then increases

# Detailed Solutions

## Q1.

**Solution**

**Concept – mechanical efficiency of an engine:** Mechanical efficiency is the ratio of brake power (delivered at the shaft) to indicated power (developed in the cylinders): $\eta_{mech} = \frac{\text{BP}}{\text{IP}}$.

**Step 1 – list the data:** IP $= 20$ kW, $\eta_{mech} = 80\% = 0.80$.

**Step 2 – rearrange for brake power:** BP $= \eta_{mech} \times$ IP

**Step 3 – substitute the values:** BP $= 0.80 \times 20$

**Step 4 – evaluate:** BP $= 16$ kW

**Final Answer:** BP $= 16$ kW $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

## Q2.

**Solution**

**Concept – travel-reduction (wheel slip):** Wheel slip is the fractional loss of forward travel relative to the theoretical no-slip travel: $s = \frac{V_t - V_a}{V_t} \times 100$.

**Step 1 – list the data:** Theoretical speed $V_t = 6$ km/h, actual speed $V_a = 4.8$ km/h.

**Step 2 – find the speed lost to slip:** $V_t - V_a = 6 - 4.8$

$V_t - V_a = 1.2$ km/h

**Step 3 – divide by the theoretical speed:** $s = \frac{1.2}{6}$

$s = 0.20$

**Step 4 – express as a percentage:** $s = 0.20 \times 100 = 20\%$

**Final Answer:** slip $= 20\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q2

## Q3.

**Solution**

**Concept – belt-drive speed ratio:** For a belt drive without slip the surface (belt) speed is the same on both pulleys, so $N_1 d_1 = N_2 d_2$, giving $N_2 = N_1 \dfrac{d_1}{d_2}$.

**Step 1 – list the data:** $d_1 = 100$ mm, $N_1 = 1500$ rpm, $d_2 = 300$ mm.

**Step 2 – write the speed ratio:** $N_2 = N_1 \times \dfrac{d_1}{d_2}$

**Step 3 – substitute the values:** $N_2 = 1500 \times \dfrac{100}{300}$

**Step 4 – simplify the diameter ratio:** $\dfrac{100}{300} = \dfrac{1}{3}$

**Step 5 – evaluate:** $N_2 = \dfrac{1500}{3} = 500$ rpm

**Final Answer:** $N_2 = 500$ rpm $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

## Q4.

**Solution**

**Concept – swept (displacement) volume of a cylinder:** The swept volume is the volume the piston sweeps in one stroke: $V_s = \dfrac{\pi}{4} D^2 L$.

**Step 1 – list the data:** Bore $D = 100$ mm $= 10$ cm, stroke $L = 120$ mm $= 12$ cm.

**Step 2 – square the bore:** $D^2 = 10^2 = 100$ cm$^2$

**Step 3 – multiply by the stroke:** $D^2 L = 100 \times 12 = 1200$ cm$^3$

**Step 4 – multiply by $\pi/4$:** $\dfrac{\pi}{4} = 0.7854$

$V_s = 0.7854 \times 1200$

**Step 5 – evaluate:** $V_s = 942.5$ cm$^3 \approx 942$ cm$^3$

**Final Answer:** $V_s \approx 942$ cm$^3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

## Q5.

**Solution**

**Concept – ignition quality of fuels:** The self-ignition tendency of a fuel under compression is rated by different numbers for the two engine types.

**Step 1 – recall the diesel rating:** The cetane number measures how readily a diesel (compression-ignition) fuel auto-ignites; a higher cetane number means a shorter ignition delay.

**Step 2 – separate it from the petrol rating:** The octane number rates the anti-knock (resistance to self-ignition) quality of petrol in spark-ignition engines, which is the opposite requirement.

**Why the other options are wrong:**

- A: octane number belongs to spark-ignition (petrol) fuels.
- B: flash point is a safety/handling property, not ignition quality in the cylinder.
- C: viscosity affects atomisation and flow, not the ignition delay directly.

**Final Answer:** ignition quality of diesel is the cetane number $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q5

## Q6.

### Solution

**Concept – primary versus secondary tillage:** Primary tillage cuts, inverts and loosens the soil at greater depth (ploughs); secondary tillage follows to pulverise clods and prepare the seedbed (harrows, cultivators, plankers).

**Step 1 – classify each option:** The spike-tooth harrow, the spring-tine cultivator and the planker all work the already-ploughed soil to refine the seedbed, so they are secondary-tillage tools.

**Step 2 – pick the primary implement:** The mouldboard plough cuts and inverts the soil deeply as the first (opening) operation, which is primary tillage.

**Final Answer:** the mouldboard plough is a primary-tillage implement $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q6

## Q7.

### Solution

**Concept – field capacity and time of operation:** Effective field capacity is the rate at which area is actually covered, so the time to cover a field is $t = \dfrac{\text{Area}}{\text{EFC}}$.

**Step 1 – list the data:** Area $= 4$ ha, effective field capacity EFC $= 0.5$ ha/h.

**Step 2 – write the time relation:** $t = \dfrac{\text{Area}}{\text{EFC}}$

**Step 3 – substitute the values:** $t = \dfrac{4}{0.5}$

**Step 4 – evaluate:** $t = 8$ h

**Final Answer:** $t = 8 \text{ h} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

**Q8.**

**Solution**

**Concept – brake specific fuel consumption:** BSFC is the fuel used per unit of brake power per hour: $\text{BSFC} = \dfrac{\dot{m}_f}{\text{BP}}$.

**Step 1 – list the data:** Brake power BP $= 15$ kW, fuel rate $\dot{m}_f = 3$ kg/h.

**Step 2 – write the formula:** $\text{BSFC} = \dfrac{\dot{m}_f}{\text{BP}}$

**Step 3 – substitute the values:** $\text{BSFC} = \dfrac{3}{15}$

**Step 4 – evaluate:** $\text{BSFC} = 0.2$ kg/kWh

**Final Answer:** $\text{BSFC} = 0.2 \text{ kg/kWh} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

**Q9.**

**Solution**

**Concept – power transmitted by a belt:** The power transmitted equals the effective (net) driving tension times the belt speed: $P = (T_1 - T_2)\, v$.

**Step 1 – list the data:** Tight-side tension $T_1 = 600$ N, slack-side tension $T_2 = 200$ N, belt speed $v = 5$ m/s.

**Step 2 – find the effective tension:** $T_1 - T_2 = 600 - 200$

$T_1 - T_2 = 400$ N

**Step 3 – multiply by the belt speed:** $P = 400 \times 5$

**Step 4 – evaluate:** $P = 2000$ W

**Step 5 – convert to kilowatts:** $P = 2.0$ kW

**Final Answer:** $P = 2.0 \text{ kW} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

## Q10.

**Solution**

**Concept – classification of hitch systems:** Implements are attached to a tractor as mounted, semi-mounted or trailed, depending on how much of the implement weight the tractor carries.

**Step 1 – identify the fully carried type:** In a mounted (integral) implement the three converging links of the three-point linkage carry the entire implement weight, so the implement can be lifted fully clear of the ground for transport.

**Step 2 – separate it from the others:** A trailed implement runs on its own wheels; a semi-mounted implement shares its weight between the tractor and its own rear wheel; a drawbar hitch simply pulls a trailed load.

**Final Answer:** the mounted (three-point) hitch carries the full implement weight $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

## Q11.

**Solution**

**Concept – functions of seed-drill components:** A seed drill meters seed, conveys it and places it in the opened furrow. The metering job belongs to a specific device.

**Step 1 – identify the metering element:** The fluted-roller feed rotates in the seed box and delivers a steady, adjustable quantity of seed into the seed tube, so it is the seed-metering mechanism.

**Step 2 – rule out the other parts:** The furrow opener cuts the slot in the soil, the seed tube (boot) guides seed down to the furrow, and the covering device closes the furrow over the seed.

**Final Answer:** the fluted-roller feed meters the seed $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q11

## Q12.

**Solution**

**Concept – power strokes in a two-stroke cycle:** In a two-stroke engine the working cycle (compression + power) is completed in one crankshaft revolution, so every revolution ends with a power stroke.

**Step 1 – count the strokes per revolution:** A two-stroke engine has two piston strokes per revolution: one up (compression) and one down (power).

**Step 2 – count the power strokes:** Of these, exactly one stroke, the downward expansion stroke, delivers work.

**Step 3 – state the result:** Hence there is $1$ power stroke for every one revolution of the crankshaft.

**Final Answer:** $1$ power stroke per revolution $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

## Q13.

### Solution

**Concept – pressure head of a liquid column:** The gauge pressure at a point equals the unit weight of water times the height of the water column above it: $p = \gamma_w\, h$, so $h = \dfrac{p}{\gamma_w}$.

**Step 1 – list the data:** $p = 49.05$ kPa $= 49.05$ kN/m$^2$, $\gamma_w = 9.81$ kN/m$^3$.

**Step 2 – rearrange for the height:** $h = \dfrac{p}{\gamma_w}$

**Step 3 – substitute the values:** $h = \dfrac{49.05}{9.81}$

**Step 4 – evaluate:** $h = 5$ m

**Final Answer:** $h = 5$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

## Q14.

### Solution

**Concept – continuity equation for pipe flow:** The discharge equals the cross-sectional area times the mean velocity: $Q = A\,v$, with $A = \dfrac{\pi}{4}D^2$.

**Step 1 – list the data:** $D = 100$ mm $= 0.1$ m, $v = 2$ m/s.

**Step 2 – find the pipe area:** $A = \dfrac{\pi}{4}(0.1)^2$

$A = 0.7854 \times 0.01$

$A = 0.007854\ \text{m}^2$

**Step 3 – multiply by the velocity:** $Q = 0.007854 \times 2$

$Q = 0.015708\ \text{m}^3/\text{s}$

**Step 4 – convert to litres per second:** $Q = 0.015708 \times 1000 = 15.7$ L/s

**Final Answer:** $Q \approx 15.7$ L/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

## Q15.

### Solution

**Concept – parts of a storm hydrograph:** A single-peaked hydrograph has a rising limb up to the peak and a falling (recession) limb after it.

**Step 1 – locate the marked part:** Segment $Y$ starts at the beginning of direct runoff and climbs up to the peak discharge.

**Step 2 – name that segment:** The ascending part before the peak is the rising (concentration) limb; its shape reflects how runoff builds up as more of the catchment starts contributing.

**Why the other options are wrong:**

- A: the recession limb is the falling part after the peak.
- C: base flow is the low, steady groundwater contribution.
- D: the peak (crest) is only the single highest point, not the whole rising segment.

**Final Answer:** $Y$ is the rising (concentration) limb $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

## Q16.

### Solution

**Concept – design intensity in the rational method:** The rational method assumes the peak runoff occurs when the whole catchment is contributing, which first happens after a time equal to the time of concentration.

**Step 1 – relate storm duration to $t_c$:** The design storm duration is set equal to the time of concentration $t_c$, and the design intensity $i$ is read for that duration.

**Step 2 – explain why:** For a shorter storm the whole area never contributes at once; for a longer storm the intensity is lower. The critical (peak-producing) case is duration $= t_c$.

**Why the other options are wrong:**

- B: the total annual duration is irrelevant to a single design storm.
- C: the time base is a hydrograph property, not the storm duration for $i$.
- D: the lag time is related but the intensity is taken for the time of concentra-

tion.

**Final Answer:** the storm duration equals the time of concentration $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q16

## Q17.

### Solution

**Concept – factors of the Universal Soil Loss Equation:** $A = R\,K\,LS\,C\,P$, where each capital letter is a distinct erosion factor.

**Step 1 – identify $R$:** $R$ is the rainfall erosivity factor; it measures the erosive power of rainfall, based on the storm energy and its maximum 30-minute intensity.

**Step 2 – separate it from the others:** $K$ is soil erodibility, $LS$ combines slope length and steepness, $C$ is the cover-management factor and $P$ is the support-practice factor.

**Why the other options are wrong:**

- B: soil erodibility is the factor $K$.
- C: slope length and steepness is the factor $LS$.
- D: cover / crop management is the factor $C$.

**Final Answer:** $R$ is the rainfall erosivity factor $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q17

## Q18.

### Solution

**Concept – purpose of a bench terrace:** A bench terrace cuts a steep hillside into a stair-step series of nearly level strips separated by risers.

**Step 1 – see the effect on slope:** Each level bench replaces a long steep slope with a short, almost flat one, so the effective slope over which runoff travels is drastically reduced.

**Step 2 – link to erosion control:** A reduced slope means lower runoff velocity and much less soil detachment and transport, so erosion is controlled and cultivation on steep land becomes possible.

**Why the other options are wrong:**

- A: terraces shorten the effective slope length, they do not lengthen the flow path.

- C: a bench terrace is for erosion control, not permanent water storage.
- D: it is a cultivable strip, not merely a footpath.

**Final Answer:** it converts a steep slope into level steps to control erosion $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q18

## Q19.

### Solution

**Concept – stream (drainage) frequency:** Stream frequency is the number of stream segments per unit drainage area: $F_s = \dfrac{N}{A}$.

**Step 1 – list the data:** Number of streams $N = 30$, drainage area $A = 15$ km$^2$.

**Step 2 – write the formula:** $F_s = \dfrac{N}{A}$

**Step 3 – substitute the values:** $F_s = \dfrac{30}{15}$

**Step 4 – evaluate:** $F_s = 2\ \text{km}^{-2}$

**Final Answer:** $F_s = 2\ \text{km}^{-2} \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q19

## Q20.

### Solution

**Concept – trap efficiency of a reservoir:** Trap efficiency is the fraction of the incoming sediment load that settles and is retained in the reservoir rather than passing out with the outflow.

**Step 1 – interpret the definition:** Trap efficiency $= \dfrac{\text{sediment retained in reservoir}}{\text{sediment inflow}}$, which is exactly the ratio described.

**Step 2 – separate it from the delivery ratio:** The sediment delivery ratio compares sediment leaving a watershed to gross erosion within it, which is a different quantity.

**Why the other options are wrong:**

- A: the sediment delivery ratio is a watershed-erosion quantity, not a reservoir-retention one.
- B: the erodibility index describes the soil, not sediment retention.
- C: the runoff coefficient concerns water, not sediment.

**Final Answer:** the ratio is the trap efficiency $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q20

## Q21.

**Solution**

**Concept – computing soil loss with the USLE:** $A = R \times K \times LS \times C \times P$; multiply all the factors together.

**Step 1 – list the data:** $R = 300$, $K = 0.25$, $LS = 2.0$, $C = 0.20$, $P = 0.80$.

**Step 2 – multiply $R$ and $K$:** $300 \times 0.25 = 75$

**Step 3 – multiply by $LS$:** $75 \times 2.0 = 150$

**Step 4 – multiply by $C$:** $150 \times 0.20 = 30$

**Step 5 – multiply by $P$:** $30 \times 0.80 = 24$

**Step 6 – state the soil loss:** $A = 24$ t/ha/yr

**Final Answer:** $A = 24$ t/ha/yr $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q21

## Q22.

**Solution**

**Concept – rational method for peak runoff:** With $i$ in mm/h and $A$ in ha, $Q = \dfrac{C\,i\,A}{360}$ gives $Q$ in m$^3$/s.

**Step 1 – list the data:** $C = 0.30$, $i = 5$ cm/h $= 50$ mm/h, $A = 200$ ha.

**Step 2 – multiply $C$ and $i$:** $0.30 \times 50 = 15$

**Step 3 – multiply by the area:** $15 \times 200 = 3000$

**Step 4 – divide by 360:** $Q = \dfrac{3000}{360}$

**Step 5 – evaluate:** $Q = 8.33$ m$^3$/s

**Final Answer:** $Q \approx 8.33$ m$^3$/s $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q22

## Q23.

**Solution**

**Concept – volume of direct runoff:** The runoff volume equals the runoff coefficient times the rainfall depth times the catchment area: $V = C \times P \times A$.

**Step 1 – list the data and convert units:** $C = 0.50$, rainfall depth $P = 40$ mm $= 0.04$ m, area $A = 25$ ha $= 25 \times 10^4 = 250000$ m$^2$.

**Step 2 – multiply $C$ and $P$:** $0.50 \times 0.04 = 0.02$ m

**Step 3 – multiply by the area:** $V = 0.02 \times 250000$

**Step 4 – evaluate:** $V = 5000$ m$^3$

**Final Answer:** $V = 5000$ m$^3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

## Q24.

**Solution**

**Concept – irrigation interval (frequency):** The interval between irrigations is the net depth that can be depleted divided by the daily consumptive use: $I = \dfrac{d_{net}}{\text{ET}}$.

**Step 1 – list the data:** Net (allowable) depth $d_{net} = 60$ mm, peak evapotranspiration ET $= 5$ mm/day.

**Step 2 – write the formula:** $I = \dfrac{d_{net}}{\text{ET}}$

**Step 3 – substitute the values:** $I = \dfrac{60}{5}$

**Step 4 – evaluate:** $I = 12$ days

**Final Answer:** irrigation interval $= 12$ days $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

## Q25.

**Solution**

**Concept – sprinkler application rate:** The application rate is the sprinkler discharge spread over the ground area served by one sprinkler: $\text{AR} = \dfrac{q}{S_l \times S_m}$.

**Step 1 – list the data:** $q = 0.5$ L/s $= 0.0005$ m$^3$/s, spacing $S_l \times S_m = 12 \times 12 = 144$ m$^2$.

**Step 2 – divide discharge by area:** $\text{AR} = \dfrac{0.0005}{144}$

$\text{AR} = 3.472 \times 10^{-6}$ m/s

**Step 3 – convert metres/second to mm/hour:** Multiply by $1000$ to get mm and by $3600$ to get per hour: $3.472 \times 10^{-6} \times 1000 \times 3600$

**Step 4 – evaluate:** $\text{AR} = 3.472 \times 10^{-6} \times 3.6 \times 10^{6}$

$\text{AR} = 12.5$ mm/h

**Final Answer:** application rate $= 12.5$ mm/h $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q25

## Q26.

### Solution

**Concept – gross depth from net depth and application efficiency:** Only a fraction of the applied water is stored in the root zone, so gross depth $= \dfrac{\text{net depth}}{\eta_a}$.

**Step 1 – list the data:** Net depth $d_{net} = 45$ mm, application efficiency $\eta_a = 75\% = 0.75$.

**Step 2 – write the formula:** $d_{gross} = \dfrac{d_{net}}{\eta_a}$

**Step 3 – substitute the values:** $d_{gross} = \dfrac{45}{0.75}$

**Step 4 – evaluate:** $d_{gross} = 60$ mm

**Final Answer:** gross depth $= 60$ mm $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q26

## Q27.

### Solution

**Concept – Horton's infiltration equation:** $f = f_c + (f_0 - f_c)\, e^{-kt}$, giving the infiltration capacity as it decays from $f_0$ towards $f_c$.

**Step 1 – list the data:** $f_0 = 25$ mm/h, $f_c = 5$ mm/h, $k = 1$ h$^{-1}$, $t = 2$ h, $e^{-2} = 0.135$.

**Step 2 – find the range $(f_0 - f_c)$:** $f_0 - f_c = 25 - 5 = 20$ mm/h

**Step 3 – form the exponent and its value:** $-kt = -1 \times 2 = -2$, so $e^{-kt} = e^{-2} = 0.135$

**Step 4 – multiply the range by the decay term:** $20 \times 0.135 = 2.7$ mm/h

**Step 5 – add the final capacity:** $f = 5 + 2.7$

$f = 7.7$ mm/h

**Final Answer:** $f \approx 7.7$ mm/h $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

## Q28.

### Solution

**Concept – water-storage efficiency:** Storage efficiency compares the water actually stored in the root zone with the water needed to refill it: $\eta_s = \dfrac{\text{water stored}}{\text{water needed}} \times 100$.

**Step 1 – list the data:** Water needed $= 80$ mm, water stored $= 72$ mm.

**Step 2 – form the ratio:** $\eta_s = \dfrac{72}{80}$

**Step 3 – evaluate the ratio:** $\eta_s = 0.90$

**Step 4 – express as a percentage:** $\eta_s = 90\%$

**Final Answer:** storage efficiency $= 90\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

## Q29.

### Solution

**Concept – hydraulic (water) power of a pump:** The power delivered to the water is $P = \rho_w \, g \, Q \, H$.

**Step 1 – list the data:** $\rho_w = 1000$ kg/m$^3$, $g = 9.81$ m/s$^2$, $Q = 25$ L/s $= 0.025$ m$^3$/s, $H = 18$ m.

**Step 2 – multiply $\rho_w$ and $g$:** $1000 \times 9.81 = 9810$

**Step 3 – multiply by the discharge:** $9810 \times 0.025 = 245.25$

**Step 4 – multiply by the head:** $P = 245.25 \times 18$

$P = 4414.5$ W

**Step 5 – convert to kilowatts:** $P = 4.41$ kW

**Final Answer:** $P \approx 4.41$ kW $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

## Q30.

**Solution**

**Concept – pump affinity law for head:** At a fixed impeller diameter, the head varies with the square of the speed: $\frac{H_2}{H_1} = \left(\frac{N_2}{N_1}\right)^2$.

**Step 1 – list the data:** $H_1 = 30$ m, $N_1 = 1450$ rpm, $N_2 = 725$ rpm.

**Step 2 – form the speed ratio:** $\frac{N_2}{N_1} = \frac{725}{1450} = 0.5$

**Step 3 – square the speed ratio:** $(0.5)^2 = 0.25$

**Step 4 – multiply the original head by this factor:** $H_2 = 30 \times 0.25$

**Step 5 – evaluate:** $H_2 = 7.5$ m

**Final Answer:** $H_2 = 7.5 \text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

## Q31.

**Solution**

**Concept – transmissivity of an aquifer:** Transmissivity is the rate at which water is transmitted through the full saturated thickness under a unit gradient: $T = K\,b$.

**Step 1 – list the data:** Hydraulic conductivity $K = 20$ m/day, saturated thickness $b = 15$ m.

**Step 2 – write the formula:** $T = K \times b$

**Step 3 – substitute the values:** $T = 20 \times 15$

**Step 4 – evaluate:** $T = 300 \text{ m}^2/\text{day}$

**Final Answer:** $T = 300 \text{ m}^2/\text{day} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

## Q32.

**Solution**

**Concept – design discharge from a drainage coefficient:** The drainage coefficient is the depth of excess water to be removed per day; the discharge is that depth spread over the area, converted to per second.

**Step 1 – list the data and convert units:** Drainage coefficient $= 1.5$ cm/day $= 0.015$ m/day, area $A = 160$ ha $= 160 \times 10^4 = 1.6 \times 10^6$ m$^2$.

**Step 2 – find the daily volume to be drained:** $V = 0.015 \times 1.6 \times 10^6$

$V = 24000 \text{ m}^3/\text{day}$

**Step 3 – convert one day to seconds:** $1 \text{ day} = 24 \times 3600 = 86400 \text{ s}$

**Step 4 – divide the volume by the seconds:** $Q = \dfrac{24000}{86400}$

**Step 5 – evaluate:** $Q = 0.278 \text{ m}^3/\text{s}$

**Final Answer:** $Q \approx 0.278 \text{ m}^3/\text{s} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q32

## Q33.

### Solution

**Concept – overall irrigation efficiency:** The overall efficiency is the product of the successive stage efficiencies: $\eta_o = \eta_c \times \eta_a$.

**Step 1 – list the data:** Conveyance efficiency $\eta_c = 80\% = 0.80$, application efficiency $\eta_a = 75\% = 0.75$.

**Step 2 – write the formula:** $\eta_o = \eta_c \times \eta_a$

**Step 3 – substitute the values:** $\eta_o = 0.80 \times 0.75$

**Step 4 – evaluate:** $\eta_o = 0.60$

**Step 5 – express as a percentage:** $\eta_o = 60\%$

**Final Answer:** overall efficiency $= 60\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

## Q34.

### Solution

**Concept – Darcy velocity versus seepage velocity:** The water actually moves only through the pore space, so the true pore (seepage) velocity is the Darcy velocity divided by the effective porosity: $v_s = \dfrac{v}{n}$.

**Step 1 – list the data:** Darcy velocity $v = 0.6$ m/day, effective porosity $n = 0.40$.

**Step 2 – write the formula:** $v_s = \dfrac{v}{n}$

**Step 3 – substitute the values:** $v_s = \dfrac{0.6}{0.40}$

**Step 4 – evaluate:** $v_s = 1.5 \text{ m/day}$

**Final Answer:** seepage velocity $= 1.5 \text{ m/day} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q34

## Q35.

### Solution

**Concept – converting wet-basis to dry-basis moisture:** The dry-basis content relates to the wet-basis content by $M_{db} = \dfrac{M_{wb}}{1 - M_{wb}}$.

**Step 1 – list the data:** $M_{wb} = 20\% = 0.20$.

**Step 2 – form the denominator** $(1 - M_{wb})$**:** $1 - 0.20 = 0.80$

**Step 3 – substitute into the formula:** $M_{db} = \dfrac{0.20}{0.80}$

**Step 4 – evaluate:** $M_{db} = 0.25$

**Step 5 – express as a percentage:** $M_{db} = 25\%$

**Final Answer:** $M_{db} = 25\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q35

## Q36.

### Solution

**Concept – water removed in drying (dry-matter balance):** The bone-dry matter stays constant during drying, so the final mass is found from $m_f = m_i \dfrac{1 - M_i}{1 - M_f}$ (moistures on wet basis), and water removed $= m_i - m_f$.

**Step 1 – list the data:** Initial mass $m_i = 100$ kg, $M_i = 25\% = 0.25$, $M_f = 15\% = 0.15$.

**Step 2 – find the dry matter (constant):** $m_i(1 - M_i) = 100 \times 0.75 = 75$ kg

**Step 3 – relate to the final mass:** $m_f(1 - M_f) = 75$, so $m_f = \dfrac{75}{1 - 0.15}$

**Step 4 – evaluate the final mass:** $m_f = \dfrac{75}{0.85} = 88.24$ kg

**Step 5 – find the water removed:** $\Delta m = m_i - m_f = 100 - 88.24$

$\Delta m = 11.76$ kg

**Final Answer:** water removed $\approx 11.76$ kg $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

## Q37.

**Solution**

**Concept – heat to evaporate water:** The heat needed to evaporate moisture at its boiling condition is the mass times the latent heat of vaporisation: $Q = m\,L$.

**Step 1 – list the data:** Mass of water $m = 5$ kg, latent heat $L = 2260$ kJ/kg.

**Step 2 – write the formula:** $Q = m \times L$

**Step 3 – substitute the values:** $Q = 5 \times 2260$

**Step 4 – evaluate:** $Q = 11300$ kJ

**Final Answer:** $Q = 11300$ kJ $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q37

## Q38.

**Solution**

**Concept – periods of a drying curve:** Drying proceeds first at a constant rate (free surface moisture) and then at a falling rate (moisture must diffuse from within).

**Step 1 – locate the changeover:** The moisture content at which drying switches from the constant-rate period to the falling-rate period is a characteristic value for the material.

**Step 2 – name that value:** This changeover value is called the critical moisture content.

**Why the other options are wrong:**

- B: the equilibrium moisture content is the final value reached in balance with the surrounding air.
- C: bound moisture is water held chemically/physically below its normal vapour pressure, not the changeover point.
- D: free moisture is the moisture above the equilibrium value, not the changeover point.

**Final Answer:** the changeover value is the critical moisture content $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q38

## Q39.

**Solution**

**Concept – laws of size reduction:** The three classical laws differ in what the size-reduction energy is proportional to: Rittinger (new surface), Kick (logarithm of the reduction ratio) and Bond (an intermediate law).

**Step 1 – recall Kick's law:** Kick's law states that the energy required is proportional to the logarithm of the size-reduction ratio, $E \propto \ln\left(\frac{d_1}{d_2}\right)$.

**Step 2 – interpret it:** It implies that the energy to reduce the size by a fixed ratio is the same, regardless of the starting size; it suits coarse crushing.

**Why the other options are wrong:**

- A: no law makes energy proportional to the square of the reduction ratio.
- C: proportionality to the new surface area created is Rittinger's law, not Kick's.
- D: proportionality to feed volume is not any of the standard laws.

**Final Answer:** Kick's law $\Rightarrow$ energy $\propto \ln(d_1/d_2) \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q39

## Q40.

**Solution**

**Concept – principle of a spiral separator:** A spiral separator lets seeds travel down a helical chute; round seeds roll fast and are thrown to the outer edge, while flat or irregular seeds slide slowly and stay to the inside.

**Step 1 – identify the distinguishing property:** The separation depends on the seeds' shape and their ability to roll (roundness/sphericity), since rolling and sliding differ with shape.

**Step 2 – rule out the other properties:** Colour, magnetic property and length are exploited by other machines (colour sorters, magnetic separators, length graders), not by the spiral separator.

**Final Answer:** the spiral separator works on shape / rolling ability $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q40

## Q41.

**Solution**

**Concept – conveying capacity of a bucket elevator:** The mass flow rate equals the mass per bucket times the number of buckets discharged per unit time: $\dot{m} = m_b \times n$.

**Step 1 – list the data:** Mass per bucket $m_b = 2$ kg, discharge rate $n = 5$ buckets/s.

**Step 2 – find the mass flow per second:** $\dot{m} = 2 \times 5 = 10$ kg/s

**Step 3 – convert to kg per hour:** $\dot{m} = 10 \times 3600 = 36000$ kg/h

**Step 4 – convert to tonnes per hour:** $\dot{m} = \frac{36000}{1000} = 36$ t/h

**Final Answer:** conveying capacity $= 36$ t/h $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q41

## Q42.

**Solution**

**Concept – sensible heat to warm a liquid:** The heat needed to raise the temperature of a mass without phase change is $Q = m\,c\,\Delta T$.

**Step 1 – list the data:** $m = 10$ kg, $c = 3.9$ kJ/kg · K, $\Delta T = 70 - 20 = 50$ K.

**Step 2 – multiply mass and specific heat:** $m\,c = 10 \times 3.9 = 39$ kJ/K

**Step 3 – multiply by the temperature rise:** $Q = 39 \times 50$

**Step 4 – evaluate:** $Q = 1950$ kJ

**Final Answer:** $Q = 1950$ kJ $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q42

## Q43.

**Solution**

**Concept – thermal (conductive) resistance of a plane wall:** The conduction resistance of a slab is $R = \frac{L}{k\,A}$, with $L$ the thickness, $k$ the conductivity and $A$ the area.

**Step 1 – list the data:** $L = 0.1$ m, $k = 0.4$ W/m · K, $A = 5$ m$^2$.

**Step 2 – form the denominator $kA$:** $k\,A = 0.4 \times 5 = 2.0$ W/K

**Step 3 – divide the thickness by $kA$:** $R = \frac{0.1}{2.0}$

**Step 4 – evaluate:** $R = 0.05$ K/W

**Final Answer:** $R = 0.05$ K/W $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q43

## Q44.

**Solution**

**Concept – mass split on a screen:** The feed divides into oversize (retained) and undersize (passing through); the undersize fraction is the undersize mass divided by the feed mass.

**Step 1 – list the data:** Feed $= 500$ g, oversize retained $= 125$ g.

**Step 2 – find the undersize mass by balance:** Undersize $= 500 - 125 = 375$ g

**Step 3 – form the undersize fraction:** Fraction $= \dfrac{375}{500}$

**Step 4 – evaluate the ratio:** Fraction $= 0.75$

**Step 5 – express as a percentage:** Fraction $= 75\%$

**Final Answer:** undersize fraction $= 75\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

## Q45.

**Solution**

**Concept – blanching as a pre-treatment:** Blanching is a mild, short heat treatment given to fruits and vegetables before further processing.

**Step 1 – state the purpose:** Its main aim is to inactivate the enzymes (such as peroxidase) that cause off-flavours, colour loss and spoilage during storage; it also expels intercellular air and softens the tissue.

**Step 2 – separate it from the others:** Pasteurization and sterilization target micro-organisms in liquids, and dehydration removes water; none of these is the brief enzyme-inactivating heat step.

**Why the other options are wrong:**

- A: pasteurization is a mild heat treatment of liquids (e.g. milk) to kill pathogens, not an enzyme pre-treatment of vegetables.
- B: sterilization is a severe heat treatment to destroy all micro-organisms and spores.
- C: dehydration is water removal for preservation, not a pre-treatment heating step.

**Final Answer:** the pre-treatment is blanching $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q45

## Q46.

### Solution

**Concept – sensible cooling on the psychrometric chart:** In sensible cooling no moisture is removed, so the humidity ratio $W$ stays constant while the dry-bulb temperature falls (a horizontal line to the left).

**Step 1 – track the humidity ratio:** $W$ is unchanged, so the actual amount of water vapour per kg of dry air is the same at states $1$ and $2$.

**Step 2 – track the saturation capacity:** As the temperature falls, the saturation vapour pressure of the air decreases, so the air can now hold much less moisture than before.

**Step 3 – combine the two effects:** Relative humidity is the ratio of the actual vapour present to the saturation amount. With the numerator fixed and the denominator shrinking, this ratio rises.

**Step 4 – state the conclusion:** Therefore the relative humidity increases during sensible cooling (until, if cooled far enough, it would reach the dew point at $100\%$).

**Why the other options are wrong:**

- A: RH would fall on heating, not cooling.
- C: RH is not constant, because the saturation capacity changes with temperature even though $W$ does not.
- D: the trend is monotonic for pure sensible cooling; there is no reversal.

**Final Answer:** the relative humidity increases $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q46

## Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | B | 2 | D | 3 | C | 4 | A | 5 | D |
| 6 | C | 7 | A | 8 | D | 9 | C | 10 | A |
| 11 | B | 12 | D | 13 | B | 14 | A | 15 | B |
| 16 | A | 17 | A | 18 | B | 19 | C | 20 | D |
| 21 | C | 22 | C | 23 | A | 24 | B | 25 | B |
| 26 | D | 27 | B | 28 | D | 29 | A | 30 | B |
| 31 | C | 32 | B | 33 | C | 34 | D | 35 | D |
| 36 | C | 37 | C | 38 | A | 39 | B | 40 | A |
| 41 | A | 42 | D | 43 | A | 44 | C | 45 | D |
| 46 | B | | | | | | | | |