GATE Agricultural Engineering

Sample Paper – 3

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. An internal-combustion engine develops an indicated power of 25 kW while delivering a brake power of 20 kW at the flywheel. The mechanical efficiency of the engine is: **[1 mark]**

(A) 125%

(B) 25%

(C) 80%

(D) 20%

Q2. A tractor carries a dynamic weight of 20 kN on its driving wheels and develops a maximum drawbar pull of 8 kN on a field surface. The coefficient of traction of the wheels on this surface is: **[1 mark]**

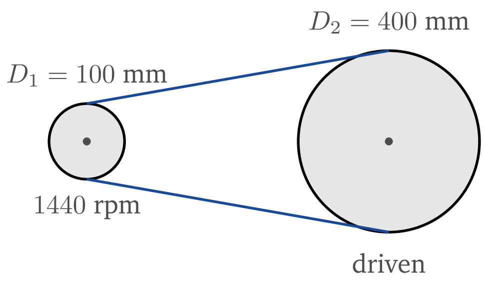
(A) 2.5

(B) 0.20

(C) 0.40

(D) 0.60

Q3. A flat belt connects a driver pulley of 100 mm diameter rotating at 1440 rpm to a driven pulley of 400 mm diameter, as shown. Neglecting belt slip, the rotational speed of the driven pulley is: **[1 mark]**



(A) 5760 rpm

(B) 360 rpm

(C) 1440 rpm

(D) 144 rpm

Q4. A diesel engine develops a brake power of 15 kW while consuming 3.6 kg of fuel per hour. The calorific value of the fuel is 42000 kJ/kg. The brake thermal efficiency of the engine is nearest to: **[1 mark]**

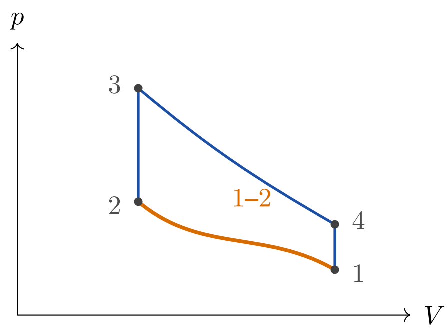
(A) 15%

(B) 42%

(C) 35.7%

(D) 25%

Q5. The pressure–volume (p–V) diagram shown is the air-standard Otto cycle of a spark-ignition engine, with the states numbered 1–2–3–4. The process 1–2 highlighted on the diagram represents: **[1 mark]**



(A) constant-volume heat addition

(B) isentropic (reversible adiabatic) compression

(C) constant-pressure heat addition

(D) isentropic (reversible adiabatic) expansion

Q6. Which one of the following implements is used specifically to break a hard pan and loosen the soil at a depth below the normal ploughing depth, *without inverting* the soil? **[1 mark]**

(A) Disc harrow

(B) Cultivator

(C) Planker

(D) Subsoiler (chisel plough)

Q7. During the calibration of a seed drill, the drill was operated over a measured area of 0.1 ha and delivered 20 kg of seed. The seed rate of the drill is: **[1 mark]**

(A) 2 kg/ha

(B) 20 kg/ha

(C) 100 kg/ha

(D) 200 kg/ha

Q8. A tractor-drawn implement has an effective field capacity of 0.5 ha/h. The time required by this implement to cover a field of 4 ha is: **[1 mark]**

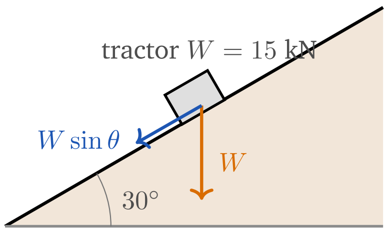
(A) 8 h

(B) 2 h

(C) 0.125 h

(D) 4 h

Q9. A tractor of weight 15 kN stands on a field slope inclined at 30° to the horizontal, as shown. The component of the tractor's weight acting parallel to (down) the slope is (take $\sin 30° = 0.5$): **[1 mark]**



(A) 13.0 kN

(B) 7.5 kN

(C) 15.0 kN

(D) 3.75 kN

Q10. According to the Bureau of Indian Standards, the two standard rated speeds of a tractor power take-off (PTO) shaft are: **[1 mark]**

(A) 340 and 800 rpm

(B) 540 and 1000 rpm

(C) 720 and 1440 rpm

(D) 1000 and 2000 rpm

Q11. In a self-propelled grain combine harvester, the unit that removes the chaff and light impurities from the threshed grain using oscillating sieves together with a blast of air is the: **[1 mark]**

(A) cleaning shoe (sieve-and-fan unit)

(B) cutter bar

(C) threshing cylinder

(D) pick-up reel

Q12. The device fitted on a tractor engine that keeps the engine speed nearly constant under a varying load by automatically adjusting the fuel supplied to the cylinders is the: **[1 mark]**

(A) governor

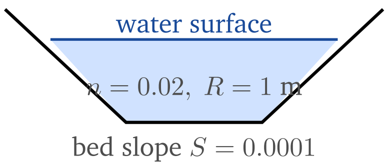
(B) carburettor

(C) camshaft

(D) flywheel

Soil & Water Conservation Engineering

Q13. Water flows uniformly through the open channel whose cross-section is shown, with Manning's roughness coefficient $n = 0.02$, hydraulic radius $R = 1$ m and bed slope $S = 0.0001$. Using Manning's formula $V = \frac{1}{n}R^{2/3}S^{1/2}$, the mean velocity of flow is: **[1 mark]**



(A) 5.0 m/s

(B) 0.05 m/s

(C) 2.5 m/s

(D) 0.5 m/s

Q14. A rectangular open channel 4 m wide carries water at a uniform depth of 1 m. The hydraulic radius (hydraulic mean depth) of the flow section is: **[1 mark]**

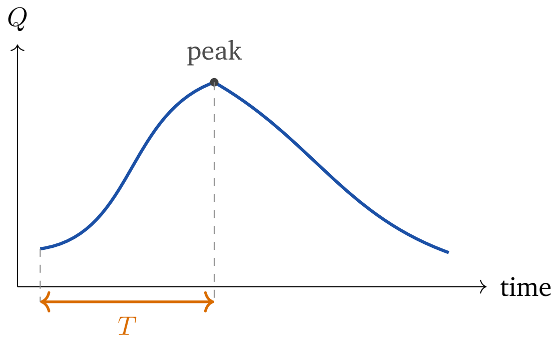
(A) 4.0 m

(B) 1.0 m

(C) 0.25 m

(D) 0.667 m

Q15. In the single-peaked storm hydrograph shown, the time interval marked T, measured from the beginning of the direct-runoff rise up to the instant of peak discharge, is called the: **[1 mark]**



(A) time base

(B) time to peak

(C) recession time

(D) basin lag time

Q16. In the Universal Soil Loss Equation $A = R\,K\,LS\,C\,P$, the combined factor LS accounts for the effect of: **[1 mark]**

(A) the rainfall erosivity

(B) the soil erodibility

(C) the slope length and the slope steepness of the land

(D) the crop cover and management practice

Q17. The more or less uniform removal of a thin layer of surface soil over a whole field, caused by the beating action of raindrops and by shallow overland flow, is called: **[1 mark]**

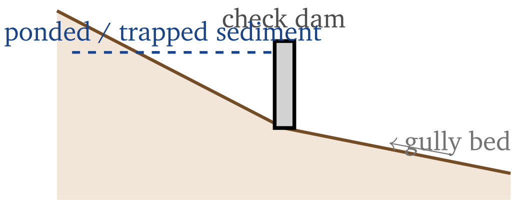
(A) sheet erosion

(B) gully erosion

(C) stream-bank erosion

(D) wind erosion

Q18. The soil-conservation structure shown in longitudinal section, built across a gully to reduce the bed gradient of the flowing water and to trap the sediment being carried down, is a: **[1 mark]**



(A) bench terrace

(B) grassed waterway

(C) check dam (gully-control structure)

(D) contour bund

Q19. The maximum rate at which a given soil in a given condition can absorb water from its surface, which is high at the start of a storm and decreases with time to a nearly constant final value, is the soil's: **[1 mark]**

(A) infiltration capacity

(B) percolation rate

(C) field capacity

(D) saturated hydraulic conductivity

Q20. The ratio of the mass of sediment retained (deposited) within a reservoir to the total mass of sediment that flows into it is called the: **[1 mark]**

(A) sediment delivery ratio

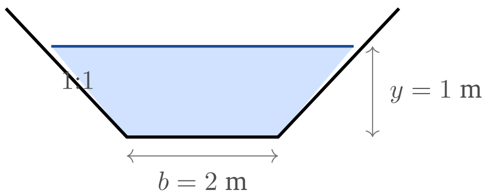
(B) trap efficiency

(C) drainage density

(D) runoff coefficient

Soil & Water Conservation Engineering (continued)

Q21. A trapezoidal field channel has a bed width $b = 2$ m and side slopes of $1 : 1$ (horizontal : vertical), and carries water at a depth $y = 1$ m, as shown. The cross-sectional area of flow, given by $A = (b + zy)\,y$ with side-slope ratio $z = 1$, is: **[2 marks]**



(A) 2.0 m^2

(B) 3.0 m^2

(C) 4.0 m^2

(D) 6.0 m^2

Q22. For an agricultural field the Universal Soil Loss Equation factors are $R = 400$, $K = 0.30$, $LS = 1.0$, $C = 0.25$ 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) 30 t/ha/yr

(C) 12 t/ha/yr

(D) 24 t/ha/yr

Q23. A catchment of area 200 ha has a runoff coefficient of 0.45. 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) $12.5\ \text{m}^3/\text{s}$

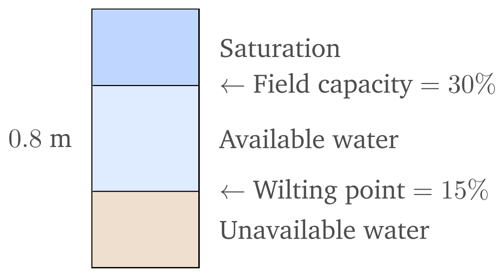
(B) $25.0\ \text{m}^3/\text{s}$

(C) $6.25\ \text{m}^3/\text{s}$

(D) $3.6\ \text{m}^3/\text{s}$

Irrigation & Drainage Engineering

Q24. For the root-zone soil profile shown, the field capacity is 30% and the permanent wilting point is 15%, both expressed on a volume basis. For a crop root-zone depth of 0.8 m, the total available water depth stored in the root zone is: **[2 marks]**



(A) 240 mm

(B) 120 mm

(C) 60 mm

(D) 360 mm

Q25. A net irrigation depth of 50 mm is to be applied uniformly over a field of 4 ha. The volume of water required for one irrigation is: **[2 marks]**

(A) $200\ \text{m}^3$

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

(C) $20000\ \text{m}^3$

(D) $2000\ \text{m}^3$

Q26. A single rotating sprinkler discharges 0.5 L/s of water and wets a rectangular area set by a spacing of $12\ \text{m} \times 15\ \text{m}$. The average application rate of the sprinkler over this area is: **[2 marks]**

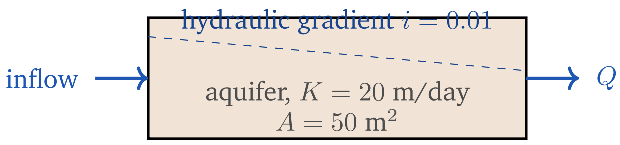
(A) 10 mm/h

(B) 5 mm/h

(C) 20 mm/h

(D) 2.78 mm/h

Q27. Groundwater flows through the soil block shown under Darcy's law $Q = K\,i\,A$. The hydraulic conductivity is $K = 20$ m/day, the hydraulic gradient is $i = 0.01$, and the cross-sectional area normal to flow is $A = 50$ m^2. The discharge through the block is: **[2 marks]**



(A) 1000 m^3/day

(B) 0.1 m^3/day

(C) 100 m^3/day

(D) 10 m^3/day

Q28. To keep the salts in the root zone within safe limits, irrigation water of electrical conductivity $EC_{iw} = 1.5$ dS/m is applied, and the drainage water is allowed to reach an electrical conductivity of $EC_{dw} = 6$ dS/m. The leaching requirement, $LR = \dfrac{EC_{iw}}{EC_{dw}}$, is: **[2 marks]**

(A) 400%

(B) 75%

(C) 25%

(D) 6%

Q29. A centrifugal pump absorbs a shaft power of 5 kW while running at 1450 rpm. Using the pump affinity (similarity) laws, if the pump speed is increased to 2900 rpm, the shaft power it will absorb becomes nearest to: **[2 marks]**

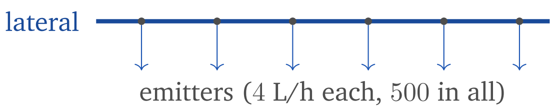
(A) 5 kW

(B) 10 kW

(C) 20 kW

(D) 40 kW

Q30. A drip (trickle) irrigation system has 500 point-source emitters, each discharging 4 L/h, connected on the lateral network shown. The total system discharge is: **[2 marks]**



(A) 0.5 m^3/h

(B) 2 m^3/h

(C) 2000 m^3/h

(D) 0.56 m^3/h

Q31. A subsurface drainage system is designed to remove excess water at a drainage coefficient of 10 mm/day from a low-lying area of 50 ha. The volume of water the system must remove per day is: **[2 marks]**

(A) 500 m^3/day

(B) 50000 m^3/day

(C) 2500 m^3/day

(D) 5000 m^3/day

Q32. A crop has a seasonal consumptive use (water requirement) of 600 mm. The effective rainfall received during the growing season is 250 mm. The net irrigation requirement of the crop for the season is: **[2 marks]**

(A) 850 mm

(B) 350 mm

(C) 250 mm

(D) 600 mm

Q33. An irrigation canal carries a steady discharge of 2 cumec ($2\ \text{m}^3/\text{s}$). If the duty of the water at the field is 900 hectares per cumec, the area that can be irrigated by this canal is: **[2 marks]**

(A) 450 ha

(B) 1800 ha

(C) 900 ha

(D) 3600 ha

Q34. An unconfined aquifer covers a plan area of 10 ha and has a specific yield (drainable porosity) of 0.15. If pumping lowers the water table uniformly by 2 m over this area, the volume of water released from storage is: **[2 marks]**

(A) $200000\ \text{m}^3$

(B) $3000\ \text{m}^3$

(C) $30000\ \text{m}^3$

(D) $15000\ \text{m}^3$

Agricultural Processing & Food Engineering

Q35. A 50 kg sample of paddy has a moisture content of 24% on a wet basis. The mass of bone-dry matter (dry solids) contained in this sample is: **[2 marks]**

(A) 38 kg

(B) 12 kg

(C) 62 kg

(D) 24 kg

Q36. A grain has a moisture content of 30% on a wet basis. The equivalent moisture content of the grain on a dry basis is nearest to: **[2 marks]**

(A) 30%

(B) 23%

(C) 42.9%

(D) 70%

Q37. A rice mill processes 200 kg of clean paddy. The milled output contains 104 kg of whole (head) rice along with some brokens. The head rice yield of the mill is: **[2 marks]**

(A) 80%

(B) 65%

(C) 26%

(D) 52%

Q38. According to Bond's law of size reduction, the energy required to reduce the size of a solid is proportional to: **[2 marks]**

(A) the new crack length created, i.e. to $\left(\frac{1}{\sqrt{d_2}} - \frac{1}{\sqrt{d_1}}\right)$

(B) the reduction in the volume of the feed

(C) the logarithm of the size-reduction ratio

(D) the square of the feed particle size

Q39. During the constant-rate period of the drying of a wet solid, the moisture being removed is the: **[2 marks]**

(A) free (unbound) moisture at a saturated surface, whose surface temperature stays near the wet-bulb temperature of the drying air

(B) tightly bound moisture held inside the solid only

(C) moisture removed at a rate that keeps increasing with time

(D) moisture whose removal rate is controlled by slow diffusion from the interior

Q40. An indented-cylinder (disc) separator is used to separate a mixture of grains and weed seeds. The separation is achieved mainly on the basis of the difference in the particles': **[2 marks]**

(A) colour

(B) length

(C) terminal velocity in air

(D) electrical charge

Q41. A screw conveyor moves cleaned grain steadily at a mass flow rate of 5 kg/s. The conveying capacity of the screw conveyor expressed in tonnes per hour is: **[2 marks]**

(A) 5 t/h

(B) 300 t/h

(C) 18 t/h

(D) 9 t/h

Q42. In a food-processing plate heat exchanger the overall heat-transfer coefficient is $U = 500$ W/m$^2 \cdot$ K, the heat-transfer area is $A = 2$ m^2 and the log-mean temperature difference is $\Delta T_{lm} = 20$ K. The rate of heat transfer, $Q = UA\,\Delta T_{lm}$, is: **[2 marks]**

(A) 20 kW

(B) 10 kW

(C) 40 kW

(D) 5 kW

Q43. A cold-storage refrigeration plant removes heat from the store (the refrigeration effect) at a rate of 12 kW while its compressor consumes 4 kW of work. The coefficient of performance (COP) of the plant is: **[2 marks]**

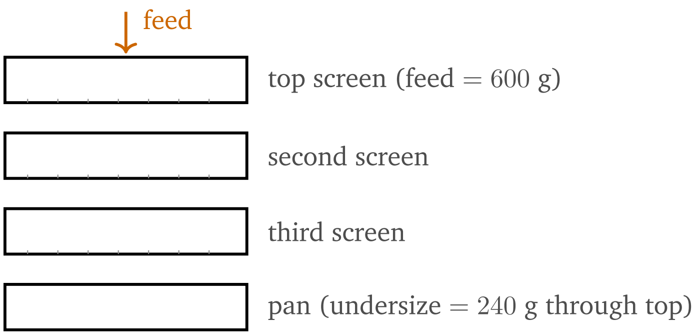
(A) 0.33

(B) 16

(C) 3

(D) 4

Q44. A 600 g feed sample of ground material is placed on the top screen of the test-sieve stack shown. Of this feed, 240 g passes through the top screen (undersize) and the remainder is retained on it as oversize. The fraction of the feed reporting as oversize on the top screen is: **[2 marks]**



(A) 40%

(B) 167%

(C) 60%

(D) 240%

Q45. The low-temperature long-time (LTLT), or holder, method of pasteurizing milk is normally carried out at a temperature and holding time of: **[2 marks]**

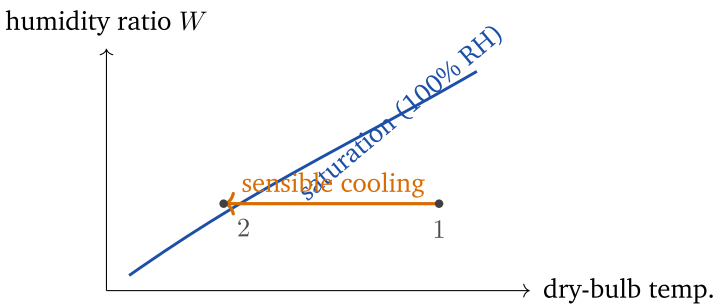
(A) 72°C for 15 seconds

(B) 135°C for 3 seconds

(C) 100°C for 30 minutes

(D) 63°C for 30 minutes

Q46. Moist air is cooled at a constant humidity ratio (no moisture removed) along the horizontal line 1–2 shown, until it just reaches the saturation curve at state 2. The dry-bulb temperature at state 2, where the relative humidity first becomes 100%, is the air's: **[2 marks]**



(A) dew-point temperature

(B) wet-bulb temperature

(C) dry-bulb temperature

(D) adiabatic saturation temperature

Detailed Solutions

Q1.

Solution

Concept – mechanical efficiency of an engine: Mechanical efficiency is the fraction of the indicated power that survives friction to appear as brake power: $\eta_{mech} = \dfrac{\text{Brake power}}{\text{Indicated power}}$.

Step 1 – list the data: Indicated power IP $= 25$ kW, brake power BP $= 20$ kW.

Step 2 – write the formula: $\eta_{mech} = \dfrac{\text{BP}}{\text{IP}}$

Step 3 – substitute the values: $\eta_{mech} = \dfrac{20}{25}$

Step 4 – simplify the ratio: $\eta_{mech} = 0.80$

Step 5 – express as a percentage: $\eta_{mech} = 80\%$

Final Answer: $\eta_{mech} = 80\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept – coefficient of traction: The coefficient of traction is the ratio of the pull a wheel can develop to the dynamic weight carried on that driving wheel: $C_t = \dfrac{\text{drawbar pull}}{\text{weight on driving wheels}}$.

Step 1 – list the data: Weight on driving wheels $W = 20$ kN, drawbar pull $P = 8$ kN.

Step 2 – write the formula: $C_t = \dfrac{P}{W}$

Step 3 – substitute the values: $C_t = \dfrac{8}{20}$

Step 4 – simplify: $C_t = 0.40$

Final Answer: $C_t = 0.40 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept – belt (pulley) speed ratio: For a belt drive without slip the product of pulley diameter and speed is the same on both pulleys: $N_1 D_1 = N_2 D_2$.

Step 1 – list the data: Driver $D_1 = 100$ mm at $N_1 = 1440$ rpm; driven $D_2 = 400$ mm.

Step 2 – rearrange for the driven speed: $N_2 = N_1 \times \dfrac{D_1}{D_2}$

Step 3 – substitute the values: $N_2 = 1440 \times \dfrac{100}{400}$

Step 4 – simplify the diameter ratio: $\dfrac{100}{400} = 0.25$

Step 5 – multiply: $N_2 = 1440 \times 0.25$

$N_2 = 360 \text{ rpm}$

Final Answer: $N_2 = 360 \text{ rpm} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept – brake thermal efficiency: Brake thermal efficiency compares the useful brake power with the chemical energy supplied by the fuel: $\eta_{bth} = \dfrac{\text{BP}}{\dot{m}_f \times \text{CV}}$.

Step 1 – list the data: BP $= 15$ kW, fuel rate $\dot{m}_f = 3.6$ kg/h, calorific value CV $= 42000$ kJ/kg.

Step 2 – find the rate of heat supplied by the fuel: $\dot{Q}_{in} = \dot{m}_f \times \text{CV}$

$\dot{Q}_{in} = 3.6 \times 42000$

$\dot{Q}_{in} = 151200$ kJ/h

Step 3 – convert this heat rate to kilowatts: $\dot{Q}_{in} = \dfrac{151200}{3600}$ kJ/s

$\dot{Q}_{in} = 42$ kW

Step 4 – form the efficiency ratio: $\eta_{bth} = \dfrac{15}{42}$

Step 5 – evaluate: $\eta_{bth} = 0.357$

Step 6 – express as a percentage: $\eta_{bth} = 35.7\%$

Final Answer: $\eta_{bth} \approx 35.7\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q4

Q5.

Solution

Concept – the four processes of the Otto cycle: The air-standard Otto cycle is made up of isentropic compression (1–2), constant-volume heat addition (2–3), isentropic expansion (3–4) and constant-volume heat rejection (4–1).

Step 1 – read the highlighted process: On the diagram the process 1–2 runs from the large-volume state 1 to the small-volume state 2, so the volume decreases and the pressure rises steeply along a curve.

Step 2 – identify that curve: A steep p–V curve with no heat exchange (the piston compressing the charge quickly) is the isentropic (reversible adiabatic) compression.

Why the other options are wrong:

- A: constant-volume heat addition is the vertical line 2–3, not 1–2.
- C: the Otto cycle adds heat at constant volume, not constant pressure.
- D: isentropic expansion is the power stroke 3–4, in which the volume increases.

Final Answer: 1–2 is isentropic compression $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept – deep tillage without soil inversion: A subsoiler (chisel) is a primary-tillage tool that runs a narrow shank deep into the profile to shatter a compacted hard pan and improve water movement, while leaving the surface layers essentially unturned.

Step 1 – match the description to the tool: The requirement is deep loosening below the normal plough depth with no inversion, which is exactly what a subsoiler does.

Step 2 – rule out the other options: The disc harrow and the planker are secondary, shallow tools; the cultivator works only the tilled surface layer and does not reach the hard pan.

Final Answer: the subsoiler (chisel plough) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q6

Q7.

Solution

Concept – seed rate from a calibration run: The seed rate is the mass of seed sown per unit area: Seed rate $= \dfrac{\text{seed dropped}}{\text{area covered}}$.

Step 1 – list the data: Seed dropped $= 20$ kg, area covered $= 0.1$ ha.

Step 2 – write the formula: Seed rate $= \dfrac{20}{0.1}$

Step 3 – evaluate: Seed rate $= 200$ kg/ha

Final Answer: 200 kg/ha $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept – time to cover a field: The time required equals the area to be covered divided by the effective field capacity: $t = \dfrac{\text{area}}{\text{EFC}}$.

Step 1 – list the data: Effective field capacity EFC $= 0.5$ ha/h, area $= 4$ ha.

Step 2 – write the formula: $t = \dfrac{\text{area}}{\text{EFC}}$

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

Step 4 – evaluate: $t = 8$ h

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

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – weight component along a slope: On an incline of angle θ, the component of the weight acting parallel to (down) the slope is $W_{\parallel} = W \sin\theta$.

Step 1 – list the data: $W = 15$ kN, $\theta = 30°$, with $\sin 30° = 0.5$.

Step 2 – write the formula: $W_{\parallel} = W \sin\theta$

Step 3 – substitute the values: $W_{\parallel} = 15 \times 0.5$

Step 4 – evaluate: $W_{\parallel} = 7.5$ kN

Final Answer: $W_{\parallel} = 7.5$ kN $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept – standard PTO speeds: The tractor power take-off shaft is standardised so that PTO-driven implements can be matched to it. The two BIS standard rated speeds are 540 rpm and 1000 rpm.

Step 1 – recall the standard values: Lighter implements use the 540 rpm setting; higher-power implements use the 1000 rpm setting.

Step 2 – pick the matching option: Only the pair 540 and 1000 rpm is correct.

Final Answer: 540 and 1000 rpm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept – cleaning in a grain combine: After threshing and separation, the grain still carries chaff and dust. The cleaning shoe uses oscillating sieves and a fan-driven air blast to blow away the light material while the clean grain drops through.

Step 1 – match the function: Removing chaff and light impurities with sieves plus an air blast is exactly the job of the cleaning shoe.

Step 2 – rule out the other parts: The cutter bar only cuts the crop, the threshing cylinder detaches the grain, and the pick-up reel gathers the standing crop.

Final Answer: the cleaning shoe (sieve-and-fan unit) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept – the engine governor: A governor senses the engine speed and automatically increases or decreases the fuel delivered so that the speed stays nearly constant as the load changes.

Step 1 – match the function: Holding speed constant under varying load by regulating fuel is the defining role of the governor.

Step 2 – rule out the other parts: The carburettor prepares the air–fuel mixture in petrol engines, the camshaft times the valves, and the flywheel only smooths the cyclic speed within one cycle.

Final Answer: the governor $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept – Manning's velocity formula: $V = \frac{1}{n}R^{2/3}S^{1/2}$, with n the roughness, R the hydraulic radius and S the bed slope.

Step 1 – list the data: $n = 0.02$, $R = 1$ m, $S = 0.0001$.

Step 2 – evaluate $R^{2/3}$: $R^{2/3} = 1^{2/3} = 1$

Step 3 – evaluate $S^{1/2}$: $S^{1/2} = \sqrt{0.0001} = 0.01$

Step 4 – evaluate $\frac{1}{n}$: $\frac{1}{0.02} = 50$

Step 5 – multiply the three factors: $V = 50 \times 1 \times 0.01$

Step 6 – evaluate: $V = 0.5$ m/s

Final Answer: $V = 0.5$ m/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept – hydraulic radius: The hydraulic radius is the flow area divided by the wetted perimeter: $R = \frac{A}{P}$.

Step 1 – list the data: Width $B = 4$ m, depth $y = 1$ m (rectangular section).

Step 2 – compute the flow area: $A = B \times y = 4 \times 1 = 4$ m^2

Step 3 – compute the wetted perimeter: $P = B + 2y = 4 + 2 \times 1 = 6$ m

Step 4 – form the ratio: $R = \frac{4}{6}$

Step 5 – evaluate: $R = 0.667$ m

Final Answer: $R = 0.667$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q14

Q15.

Solution

Concept – time to peak on a hydrograph: The interval from the start of the direct-runoff rise to the instant of peak discharge is the time to peak.

Step 1 – read the marked interval: T starts where the discharge begins to rise and ends at the peak, so it measures how long the catchment takes to build to its maximum flow.

Step 2 – name it: This interval is the time to peak of the hydrograph.

Why the other options are wrong:

- A: the time base is the whole duration of direct runoff, from start to end.
- C: the recession time is measured after the peak, not up to it.
- D: the basin lag is measured from the centroid of rainfall, not from the start of runoff.

Final Answer: T is the time to peak $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept – the LS factor of the USLE: In $A = R\,K\,LS\,C\,P$, the topographic factor LS combines the slope-length effect L and the slope-steepness effect S.

Step 1 – identify LS: A longer and steeper slope gives the runoff more energy, so LS scales the soil loss up as slope length and steepness increase.

Step 2 – separate it from the others: R is rainfall erosivity, K is soil erodibility, C is cover management and P is the support practice.

Final Answer: LS is the slope length and steepness factor $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – forms of water erosion: Sheet erosion is the fairly uniform removal of a thin surface layer of soil from a whole field, driven by raindrop splash and shallow overland flow.

Step 1 – match the description: A uniform thin layer lost over the whole surface fits sheet erosion.

Step 2 – rule out the others: Gully erosion cuts deep incised channels, stream-bank erosion attacks channel sides, and wind erosion is driven by air, not raindrops and overland flow.

Final Answer: sheet erosion $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept – gully-control structure: A check dam is a small barrier built across a gully. It flattens the effective bed slope of the flowing water and ponds it so that the sediment being carried settles out upstream.

Step 1 – match the sketch: The wall across the gully with sediment stored behind it is a check dam.

Step 2 – rule out the others: A bench terrace reshapes a hill slope into steps, a grassed waterway is a vegetated channel that resists erosion, and a contour bund runs along the contour of cultivated land, not across a gully.

Final Answer: a check dam (gully-control structure) $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept – infiltration capacity: Infiltration capacity is the maximum rate at which a soil can take in water at its surface. It is highest when the storm begins and falls off with time to a steady final rate as the soil wets up.

Step 1 – match the definition: A maximum absorption rate that decreases with time to a constant value is the infiltration capacity.

Step 2 – rule out the others: Percolation is the downward movement below the root zone, field capacity is a moisture content, and hydraulic conductivity is a soil property, not the surface intake rate itself.

Final Answer: infiltration capacity $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept – reservoir trap efficiency: Trap efficiency is the fraction of the incoming sediment that is caught and deposited within a reservoir: $\eta_{trap} = \frac{\text{sediment deposited}}{\text{sediment inflow}}$.

Step 1 – match the definition: Sediment retained divided by sediment inflow is the trap efficiency.

Step 2 – separate it from the delivery ratio: The sediment delivery ratio compares sediment leaving a watershed with the gross erosion in it; that is a different ratio.

Final Answer: trap efficiency $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Concept – flow area of a trapezoidal channel: For a trapezoidal section of bed width b, water depth y and side-slope ratio z (horizontal per unit vertical), the flow area is $A = (b + zy)\,y$.

Step 1 – list the data: $b = 2$ m, $y = 1$ m, side slope $1 : 1$ so $z = 1$.

Step 2 – form the bracket $(b + zy)$**:** $b + zy = 2 + 1 \times 1$

$b + zy = 3$

Step 3 – multiply by the depth: $A = 3 \times 1$

Step 4 – evaluate: $A = 3\ \text{m}^2$

Final Answer: $A = 3\ \text{m}^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept – the Universal Soil Loss Equation: $A = R\,K\,LS\,C\,P$, the product of the five factors.

Step 1 – list the data: $R = 400$, $K = 0.30$, $LS = 1.0$, $C = 0.25$, $P = 0.80$.

Step 2 – multiply R **and** K**:** $400 \times 0.30 = 120$

Step 3 – multiply by LS**:** $120 \times 1.0 = 120$

Step 4 – multiply by C: $120 \times 0.25 = 30$

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

Step 6 – state the result: $A = 24$ t/ha/yr

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

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – the rational method for peak runoff: $Q = \dfrac{C\,i\,A}{360}$, with C dimensionless, i in mm/h and A in hectares, giving Q in m^3/s.

Step 1 – list the data: $C = 0.45$, $i = 5$ cm/h $= 50$ mm/h, $A = 200$ ha.

Step 2 – multiply C and i: $C \times i = 0.45 \times 50 = 22.5$

Step 3 – multiply by the area: $22.5 \times 200 = 4500$

Step 4 – divide by 360**:** $Q = \dfrac{4500}{360}$

Step 5 – evaluate: $Q = 12.5$ m^3/s

Final Answer: $Q = 12.5$ m^3/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept – available water depth in the root zone (volume basis): When field capacity and wilting point are given as volume fractions, the available water depth is $d = (\theta_{FC} - \theta_{PWP}) \times D$, where D is the root-zone depth.

Step 1 – list the data: $\theta_{FC} = 30\% = 0.30$, $\theta_{PWP} = 15\% = 0.15$, $D = 0.8$ m.

Step 2 – find the available moisture fraction: $\theta_{FC} - \theta_{PWP} = 0.30 - 0.15 = 0.15$

Step 3 – multiply by the root-zone depth: $d = 0.15 \times 0.8$

Step 4 – evaluate in metres: $d = 0.12$ m

Step 5 – convert to millimetres: $d = 0.12 \times 1000 = 120$ mm

Final Answer: $d = 120$ mm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

Q25.

Solution

Concept – volume of water for a given depth over an area: Volume = depth × area, once both are in consistent units.

Step 1 – list the data: Net depth $d = 50$ mm $= 0.05$ m, area $A = 4$ ha.

Step 2 – convert the area to square metres: $A = 4 \times 10000 = 40000\ \text{m}^2$

Step 3 – multiply depth by area: $V = 0.05 \times 40000$

Step 4 – evaluate: $V = 2000\ \text{m}^3$

Final Answer: $V = 2000\ \text{m}^3 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept – sprinkler application rate: The application rate is the volume of water applied per unit time spread over the wetted area: rate $= \dfrac{\text{discharge}}{\text{spacing area}}$.

Step 1 – list the data: Discharge $q = 0.5$ L/s, spacing $= 12$ m $\times$ 15 m.

Step 2 – find the wetted area: $A = 12 \times 15 = 180\ \text{m}^2$

Step 3 – convert the discharge to per hour: $q = 0.5\ \text{L/s} \times 3600 = 1800\ \text{L/h}$

Step 4 – convert litres to cubic metres: $1800\ \text{L/h} = 1.8\ \text{m}^3/\text{h}$

Step 5 – divide by the area to get the depth per hour: rate $= \dfrac{1.8}{180} = 0.01\ \text{m/h}$

Step 6 – convert to millimetres per hour: rate $= 0.01 \times 1000 = 10\ \text{mm/h}$

Final Answer: application rate $= 10\ \text{mm/h} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

Concept – Darcy's law for groundwater discharge: $Q = K\,i\,A$, with K the hydraulic conductivity, i the hydraulic gradient and A the cross-sectional area of flow.

Step 1 – list the data: $K = 20$ m/day, $i = 0.01$, $A = 50\ \text{m}^2$.

Step 2 – multiply K and i: $K \times i = 20 \times 0.01 = 0.2$ m/day

Step 3 – multiply by the area: $Q = 0.2 \times 50$

Step 4 – evaluate: $Q = 10\ \text{m}^3/\text{day}$

Final Answer: $Q = 10\ \text{m}^3/\text{day} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept – leaching requirement: The leaching requirement is the fraction of applied water that must pass through the root zone to keep salts in check, estimated by $LR = \dfrac{EC_{iw}}{EC_{dw}}$.

Step 1 – list the data: $EC_{iw} = 1.5$ dS/m, $EC_{dw} = 6$ dS/m.

Step 2 – form the ratio: $LR = \dfrac{1.5}{6}$

Step 3 – simplify: $LR = 0.25$

Step 4 – express as a percentage: $LR = 25\%$

Final Answer: $LR = 25\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept – pump affinity law for power: For a given pump the absorbed power varies as the cube of the speed: $\dfrac{P_2}{P_1} = \left(\dfrac{N_2}{N_1}\right)^3$.

Step 1 – list the data: $P_1 = 5$ kW at $N_1 = 1450$ rpm; new speed $N_2 = 2900$ rpm.

Step 2 – form the speed ratio: $\dfrac{N_2}{N_1} = \dfrac{2900}{1450} = 2$

Step 3 – cube the speed ratio: $\left(\dfrac{N_2}{N_1}\right)^3 = 2^3 = 8$

Step 4 – multiply the original power: $P_2 = 5 \times 8$

Step 5 – evaluate: $P_2 = 40$ kW

Final Answer: $P_2 = 40\ \text{kW} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q29

Q30.

Solution

Concept – total discharge of a drip system: The system discharge is the number of emitters times the discharge of each emitter: $Q = n \times q$.

Step 1 – list the data: Number of emitters $n = 500$, each discharging $q = 4$ L/h.

Step 2 – multiply: $Q = 500 \times 4$

Step 3 – evaluate in litres per hour: $Q = 2000$ L/h

Step 4 – convert to cubic metres per hour: $Q = \dfrac{2000}{1000} = 2\ \text{m}^3/\text{h}$

Final Answer: $Q = 2\ \text{m}^3/\text{h} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – volume from a drainage coefficient: The drainage coefficient is a depth of water removed per day; the volume removed per day is that depth times the area.

Step 1 – list the data: Drainage coefficient $= 10$ mm/day $= 0.010$ m/day, area $= 50$ ha.

Step 2 – convert the area to square metres: $A = 50 \times 10000 = 500000\ \text{m}^2$

Step 3 – multiply depth by area: $V = 0.010 \times 500000$

Step 4 – evaluate: $V = 5000\ \text{m}^3/\text{day}$

Final Answer: $V = 5000\ \text{m}^3/\text{day} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept – net irrigation requirement: The net irrigation requirement is the crop water need not met by rainfall: NIR $=$ CU $-$ effective rainfall.

Step 1 – list the data: Consumptive use CU $= 600$ mm, effective rainfall $= 250$ mm.

Step 2 – write the formula: NIR $=$ CU $-$ effective rainfall

Step 3 – substitute the values: NIR $= 600 - 250$

Step 4 – evaluate: $\text{NIR} = 350$ mm

Final Answer: $\text{NIR} = 350 \text{ mm} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q32

Q33.

Solution

Concept – area irrigated from duty and discharge: Duty D is the area a unit discharge can irrigate, so the area served is $\text{Area} = D \times Q$.

Step 1 – list the data: $Q = 2$ cumec, duty $D = 900$ ha/cumec.

Step 2 – write the formula: $\text{Area} = D \times Q$

Step 3 – substitute the values: $\text{Area} = 900 \times 2$

Step 4 – evaluate: $\text{Area} = 1800$ ha

Final Answer: $\text{Area} = 1800 \text{ ha} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept – water released from an unconfined aquifer: The volume released equals the plan area times the drop in water table times the specific yield: $V = A \times \Delta h \times S_y$.

Step 1 – list the data: $A = 10$ ha, $\Delta h = 2$ m, $S_y = 0.15$.

Step 2 – convert the area to square metres: $A = 10 \times 10000 = 100000 \text{ m}^2$

Step 3 – multiply area by the drop: $A \times \Delta h = 100000 \times 2 = 200000 \text{ m}^3$

Step 4 – multiply by the specific yield: $V = 200000 \times 0.15$

Step 5 – evaluate: $V = 30000 \text{ m}^3$

Final Answer: $V = 30000 \text{ m}^3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q34

Q35.

Solution

Concept – dry-matter mass from wet-basis moisture: On a wet basis the dry-matter fraction is $(1 - \text{MC}_{wb})$, so the dry matter mass is $m_{dry} = m \times (1 - \text{MC}_{wb})$.

Step 1 – list the data: Sample mass $m = 50$ kg, $\text{MC}_{wb} = 24\% = 0.24$.

Step 2 – find the dry-matter fraction: $1 - 0.24 = 0.76$

Step 3 – multiply by the sample mass: $m_{dry} = 50 \times 0.76$

Step 4 – evaluate: $m_{dry} = 38$ kg

Final Answer: $m_{dry} = 38 \text{ kg} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q35

Q36.

Solution

Concept – converting wet-basis moisture to dry basis: $\text{MC}_{db} = \dfrac{\text{MC}_{wb}}{1 - \text{MC}_{wb}}$.

Step 1 – list the data: $\text{MC}_{wb} = 30\% = 0.30$.

Step 2 – find the denominator: $1 - 0.30 = 0.70$

Step 3 – form the ratio: $\text{MC}_{db} = \dfrac{0.30}{0.70}$

Step 4 – evaluate: $\text{MC}_{db} = 0.4286$

Step 5 – express as a percentage: $\text{MC}_{db} = 42.9\%$

Final Answer: $\text{MC}_{db} \approx 42.9\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – head rice yield: Head rice yield is the mass of whole (unbroken) milled rice expressed as a fraction of the paddy fed: $\text{HRY} = \dfrac{\text{head rice}}{\text{paddy fed}}$.

Step 1 – list the data: Paddy fed $= 200$ kg, head (whole) rice $= 104$ kg.

Step 2 – form the ratio: $\text{HRY} = \dfrac{104}{200}$

Step 3 – simplify: $\text{HRY} = 0.52$

Step 4 – express as a percentage: $\text{HRY} = 52\%$

Final Answer: $\text{HRY} = 52\% \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q37

Q38.

Solution

Concept – Bond's law of size reduction: Bond's law says the work needed for size reduction is proportional to the new crack length generated, which scales with the reciprocal of the square root of the particle size, giving $W \propto \left(\frac{1}{\sqrt{d_2}} - \frac{1}{\sqrt{d_1}}\right)$.

Step 1 – recall the three grinding laws: Rittinger's law uses the new surface area $\left(\frac{1}{d_2} - \frac{1}{d_1}\right)$; Kick's law uses $\ln\left(\frac{d_1}{d_2}\right)$; Bond's law uses the crack length $\left(\frac{1}{\sqrt{d_2}} - \frac{1}{\sqrt{d_1}}\right)$.

Step 2 – pick the Bond form: The reciprocal-square-root expression is Bond's law.

Final Answer: $W \propto \left(\frac{1}{\sqrt{d_2}} - \frac{1}{\sqrt{d_1}}\right) \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q38

Q39.

Solution

Concept – the constant-rate drying period: While a continuous film of free water covers the surface of the solid, evaporation proceeds at a steady (constant) rate and the wet surface stays near the wet-bulb temperature of the drying air.

Step 1 – identify what is being removed: During the constant-rate period the moisture leaving is the free (unbound) surface water, not the tightly held internal moisture.

Step 2 – note the surface temperature: Because the latent heat of evaporation is drawn from the air, the saturated surface holds at about the wet-bulb temperature.

Why the other options are wrong:

- B: bound moisture is removed later, in the falling-rate period.
- C: the rate is constant, not increasing, during this period.
- D: internal diffusion controls the falling-rate period, not the constant-rate period.

Final Answer: free surface moisture at the wet-bulb temperature $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept – the indented-cylinder (disc) separator: The pockets or indents of a disc separator lift and reject short particles while long particles ride over, so the machine grades a mixture chiefly by particle length.

Step 1 – match the mechanism: Separation set by which particles fit into the indents is a length-based separation.

Step 2 – rule out the others: Colour is used by optical sorters, terminal velocity by aspiration/air screens, and electrical charge by electrostatic separators.

Final Answer: the difference in length $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – capacity from mass flow rate: Conveying capacity in tonnes per hour follows from the mass flow rate in kg/s by converting seconds to hours and kilograms to tonnes.

Step 1 – list the data: Mass flow rate $= 5$ kg/s.

Step 2 – convert per second to per hour: $5\ \text{kg/s} \times 3600 = 18000\ \text{kg/h}$

Step 3 – convert kilograms to tonnes: $18000\ \text{kg/h} = \dfrac{18000}{1000} = 18\ \text{t/h}$

Final Answer: capacity $= 18$ t/h $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q41

Q42.

Solution

Concept – heat duty of a heat exchanger: $Q = U\,A\,\Delta T_{lm}$, with U the overall coefficient, A the area and ΔT_{lm} the log-mean temperature difference.

Step 1 – list the data: $U = 500\ \text{W/m}^2\cdot\text{K}$, $A = 2\ \text{m}^2$, $\Delta T_{lm} = 20$ K.

Step 2 – multiply U and A: $U \times A = 500 \times 2 = 1000$ W/K

Step 3 – multiply by the temperature difference: $Q = 1000 \times 20$

Step 4 – evaluate in watts: $Q = 20000$ W

Step 5 – convert to kilowatts: $Q = 20$ kW

Final Answer: $Q = 20\ \text{kW} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept – coefficient of performance of a refrigerator: The COP of a refrigeration plant is the refrigeration effect divided by the work input: $\text{COP} = \dfrac{Q_{ref}}{W}$.

Step 1 – list the data: Refrigeration effect $Q_{ref} = 12$ kW, compressor work $W = 4$ kW.

Step 2 – form the ratio: $\text{COP} = \dfrac{12}{4}$

Step 3 – evaluate: $\text{COP} = 3$

Final Answer: $\text{COP} = 3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q43

Q44.

Solution

Concept – oversize fraction on a screen: The oversize retained equals the feed minus the undersize that passes through, and the oversize fraction is that retained mass divided by the feed.

Step 1 – list the data: Feed $= 600$ g, undersize (passing through) $= 240$ g.

Step 2 – find the oversize retained: $600 - 240 = 360$ g

Step 3 – form the oversize fraction: $\text{fraction} = \dfrac{360}{600}$

Step 4 – simplify: $\text{fraction} = 0.60$

Step 5 – express as a percentage: $\text{fraction} = 60\%$

Final Answer: oversize fraction $= 60\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept – LTLT (holder) pasteurization: The low-temperature long-time process holds milk at a mild temperature for a long time to achieve the required lethality: about 63°C for 30 minutes.

Step 1 – recall the LTLT condition: 63°C held for 30 minutes is the holder (LTLT) method.

Why the other options are wrong:

- A: $72°$C for 15 s is the HTST (high-temperature short-time) process.
- B: $135°$C for a few seconds is UHT sterilization.
- C: $100°$C for 30 min is not a standard milk-pasteurization setting.

Final Answer: LTLT is $63°$C for 30 minutes $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept – dew-point temperature: If moist air is cooled at constant humidity ratio, its relative humidity rises until, at a certain temperature, the air becomes just saturated (RH $= 100\%$). That temperature is the dew point.

Step 1 – track the process: Moving left along the horizontal line 1–2, the humidity ratio W is fixed while the temperature falls, so the state approaches the saturation curve.

Step 2 – name the saturation point: The temperature at which the constant-W line first touches the saturation curve is the dew-point temperature.

Why the other options are wrong:

- B: the wet-bulb temperature is reached along a constant wet-bulb (adiabatic saturation) line, not a horizontal constant-W line.
- C: the dry-bulb temperature is the actual air temperature at state 1, before cooling.
- D: the adiabatic saturation temperature is defined for an adiabatic saturation process, not this constant-W cooling.

Final Answer: the dew-point temperature $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q46

Answer Key

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