2016 PAPER SET-II

Q.1-Q.5 carry one mark each

Q1 The volume of a sphere of diameter 1 unit is _____ than the volume of a cube of side 1 unit.
(A) least
(B) less
(C) lesser
(D) low

S1 Correct option is (C)
'Lesser than' is apt because the sentence should be in comparative degree.

Q2 The unruly crowd demanded that the accused be _____ without trial.
(A) hanged
(B) hanging
(C) hankering
(D) hung

S1 Correct option is (A)
'hanged' means death by hanging 'hung' is used only with things and not with people.

Q3 Choose the statement(s) where the underlined word is used correctly.
(i) A prone is a dried plum.
(ii) He was lying prone on the floor.
(iii) People who eat a lot of fat are prone to heart disease.
(A) (i) and (iii) only
(B) (iii) only
(C) (i) and (ii) only
(D) (ii) and (iii) only

S1 Correct option is (D)
'lying prone' means lie down flat. 'Prone to' means vulnerable to.

Q4 Fact: If it rains, then the field is wet.
Read the following statements:
(i) It rains
(ii) The field is not wet
(iii) The field is wet
(iv) It did not rain
Which one of the options given below in NOT logically possible, based on the given fact?
(A) If (iii), then (iv)
(B) If (i), then (iii)
(C) If (i), then (ii)
(D) If (ii), then (iv)

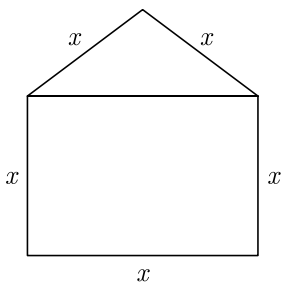
S1 Correct option is (C)
Statements (i) and (ii) are not logically possible based on the given fact.

Q5 A window is made up of a square portion and an equilateral triangle portion above it. The base of the triangular portion coincides with the upper side of the square. If the perimeter of the window is 6 m, the area of the window in m^2 is _____
(A) 1.43
(B) 2.06
(C) 2.68
(D) 2.88

S1 Correct option is (B)
From the given data, the following window is possible
The perimeter of the window

$$= 5x$$
$$= 6 \text{ m}$$
$$x = \frac{6}{5}$$
$$= 1.20 \text{ m}$$

$$\text{Area of the window} = \text{Area of square} + \text{Area of } \Delta^{l} e$$
$$= 1.2 \times 1.2 + \frac{\sqrt{3}}{4} \times (1.2)^2$$
$$= 1.44 + 0.623$$
$$= 2.06 \text{ m}^2$$



Q.6-Q.10 carry two marks each

Q6 Students taking an exam are divided into two groups, P and Q such that each group has the same number of students. The performance of each of the students in a test was evaluated out of 200 marks. It was observed that the mean of group P was 105, while that of group Q was 85. The standard deviation of group P was 25, while that of group, Q was 5. Assuming that the marks were distributed on a normal distribution which of the following statements will have the highest probability of being TRUE?
(A) No students in group Q scored less marks than any student in group P.
(B) No student in group P scored less marks than any student in group Q.

(C) Most students of group Q scored marks in a narrower range than students in group P.

(D) The median of the marks of group P is 100.

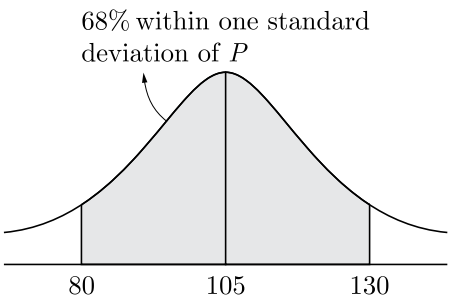
S1 Correct option is (C)

$$\text{Mean } (\mu) = 105$$
$$\text{Standard deviation, } (\sigma_1) = 25$$

$\therefore$ 68% within one standard deviation

$$\mu_1 = \sigma_1$$
$$= 105 - 25$$
$$= 80$$
$$\mu_1 + \sigma_1 = 105 + 25$$
$$= 130$$

Distribution of P



Group Q

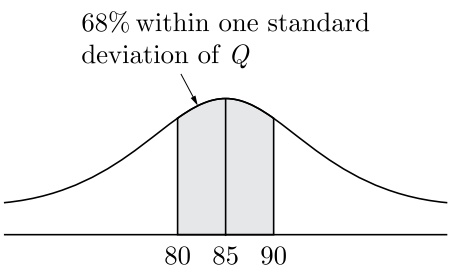
$$\text{Mean } (\mu_2) = 85$$
$$\text{Standard deviation, } (\sigma_2) = 5$$
$$\Pr(\mu - \sigma \leq x \leq \mu + \sigma) \simeq 0.6827$$

$\therefore$ 68% within one standard deviation

$$\mu_2 - \sigma_2 = 85 - 5$$
$$= 80$$
$$\mu_2 + \sigma_2 = 85 + 5$$
$$= 90$$

$\therefore$ range of Q in one standard deviation is 80 to 90

68% within one standard deviation of Q is narrower



$\therefore$ 68% within one standard deviation of Q means most students of group Q.

$\therefore$ Most students of group 'Q' scored marks in a narrower range than students in group 'P'.

Q7 A smart city integrates all modes of transport, uses clean energy and promotes sustainable use of resources. It also uses technology to ensure safety and security of the city, something which critics argue, will lead to a surveillance state.

Which of the following can be logically inferred from the above paragraph?

(i) All smart cities encourage the formation of surveillances states.

(ii) Surveillances is an integral part of a smart city.

(iii) Sustainability and surveillance go hand in hand in a smart city.

(iv) There is a perception that smart cities promote surveillance.

(A) (i) and (iv) only

(B) (ii) and (iii) only

(C) (iv) only

(D) (i) only

S1 Correct option is (B)

Q8 Find the missing sequence in the letter series.

B, FH, LNP, _____

(A) SUWY

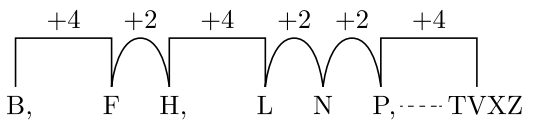
(B) TUVW

(C) TVXZ

(D) TWXZ

S1 Correct option is (C)

The following letter series is in the order of even letters series.



Q9 The binary operation $\square$ is defined as $a \square b = ab + (a + b)$, where a and b are any two real number. The value of the identity element of this operation, defined as the number x such that $a \square x = a$, for any a, is.

(A) 0

(B) 1

(C) 2

(D) 10

S1 Correct option is (A)

The binary operation $\square$ is defined

$\Rightarrow$
$$a \square b = ab + (a + b)$$
$$a \square x = a$$

$\therefore$ From the equation 'b' is the variable

Option A: $x = 0$

$$a \square o = a \times 0 + (a + 0)$$
$$= 0 + a = a$$

Option B: $x = 1$

$$a \square 1 = a \times 1 + (a + 1)$$
$$= a + a + 1$$
$$= 2a + 1$$

Option C: $x = 2$

$$a \square 2 \Rightarrow a \times 2 + (a + 2)$$
$$= 2a + a + 2$$
$$= 3a + 2$$

Option D: $x = 10$

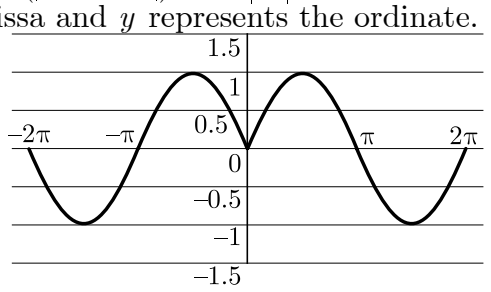
$$a \square 10 \Rightarrow a \times 10 + (a + 10)$$

$$= 10a + a + 10$$
$$= 11a + 10$$

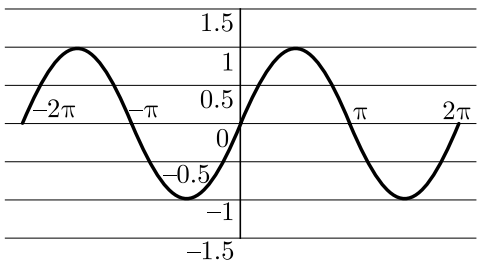
$\therefore$ Option A only True.

Q10 Which of the following curves represents the function $y = \ln\left(\left| e^{(|\sin(|x|)|)} \right|\right)$ for $|x| < 2\pi$? Here, x represents the abscissa and y represents the ordinate.

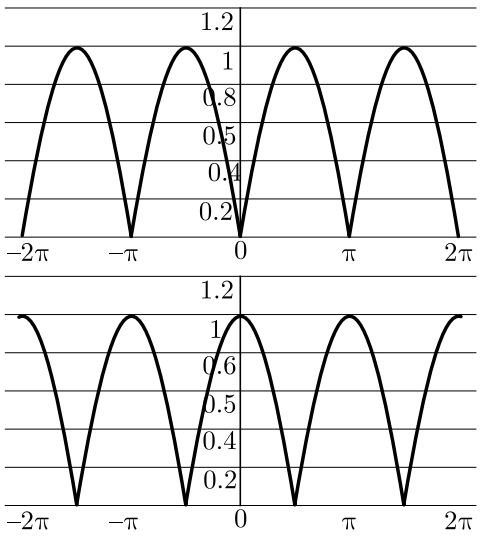
(A)



(B)



(C)



(C)

S1 Correct option is (C)

Q.11-Q.35 carry one mark each.

Q11 The condition for which the eigen values of the matrix $A = \begin{bmatrix} 2 & 1 \\ 1 & k \end{bmatrix}$ are positive, is

(A) $k > 1/2$

(B) $k > -2$

(C) $k > 0$

(D) $k < -1/2$

S1 Correct option is (A)

$$A = \begin{bmatrix} 2 & 1 \\ 1 & k \end{bmatrix}$$

If λ_1, λ_2 are eigen values of A_{2x2} then

$$|A| = \lambda_1 \lambda_2$$
$$|A| = 2k - 1$$
$$\lambda_1, \lambda_2 > 0$$
$$2k - 1 > 0$$
$$\therefore \quad k > \frac{1}{2}$$

Q12 The values of x for which the function $f(x) = \frac{x^2-3x-4}{x^2+3x-4}$ is NOT continuous are

(A) 4 and -1

(B) 4 and 1

(C) -4 and 1

(D) -4 and -1

S1 Correct option is (C) -4 and 1

The function, $f(x) = \dfrac{x^2 - 3x - 4}{x^2 + 3x - 4}$ is not defined at $x = 1$ and $x = -4$

$\therefore$ The function $f(x)$ is not continuous at $x = -4, 1$.

Q13 Laplace transform of $\cos(\omega t)$ is

(A) $\frac{s}{s^2 + \omega^2}$

(B) $\frac{\omega}{s^2 + \omega^2}$

(C) $\frac{s}{s^2 - \omega^2}$

(D) $\frac{\omega}{s^2 - \omega^2}$

S1 Correct option is (A)

$$L\{\cos(\omega t)\} = \frac{s}{s^2 + \omega^2}$$

$$\left(\therefore\ L\{\cos(at)\} = \frac{s}{s^2 + a^2}\right)$$

Q14 A function f of the complex variable $z = x + iy$, is given as $f(x, y) = u(x, y) + (x, y)$ where $u(x, y) = 2kxy$ and $v(x, y) = x^2 - y^2$. The value of k, for which the function is analytic, is _____

S1 Correct answer is -1

Given, $u = 2kxy$ & $v = x^2 - y^2$

$$u_x = v_y$$
$$\Rightarrow \quad 2ky = -2y$$
$$\therefore \quad k = -1$$

Q15 Numerical integration using trapezoidal rule gives the best result for a single variable function, which is

(A) linear

(B) parabolic

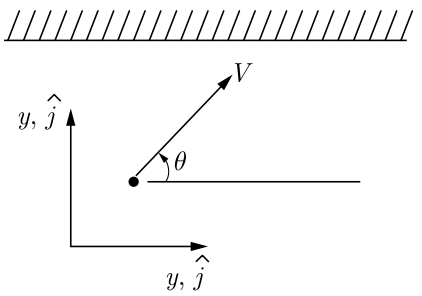
(C) logarithmic

(D) hyperbolic

S1 Correct option is (A)

$f(x)$ is a linear function.

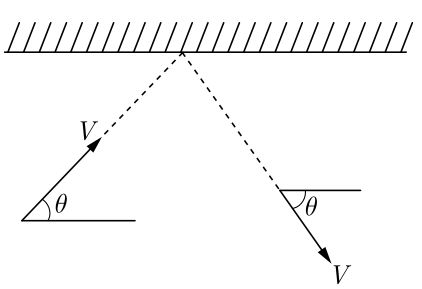
Q16 A point mass having mass M is moving with a velocity V at an angle θ to the wall as shown in the figure. The mass undergoes a perfectly elastic collision with the smooth walls and rebounds. The total change (final minus initial) in the momentum of the mass is



(A) $-2MV\cos\theta\hat{j}$
(B) $2MV\sin\theta\hat{j}$
(C) $2MV\cos\theta\hat{j}$
(D) $-2MV\sin\theta\hat{j}$

S1 Correct option is (D)

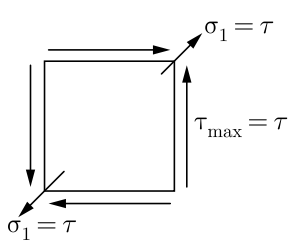
$$\vec{U} = V\cos\theta i + V\sin\theta j$$
$$\vec{V} = V\cos\theta i - V\sin\theta j$$
$$\Delta\,\overline{mv} = m(\overline{V} - \overline{U})$$
$$= -2mV\sin\theta j$$



Q17 A shaft with a circular cross-section is subjected to pure twisting moment. The ratio of the maximum shear stress to the largest principal stress is
(A) 2.0
(B) 1.0
(C) 0.5
(D) 0

S1 Correct option is (B)

$$\frac{\tau_{\max}}{\sigma_1} = 1$$

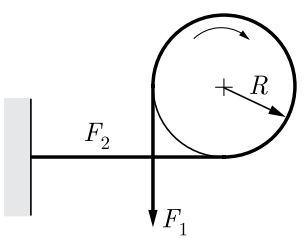


Q18 A thin cylindrical pressure vessel with closed-ends is subjected to internal pressure. The ratio of circumferential (hoop) stress to the longitudinal stress is
(A) 0.25
(B) 0.50
(C) 1.0
(D) 2.0

S1 Correct option is (D)

$$\frac{\sigma_h}{\sigma_l} = \frac{\left(\frac{pd}{2t}\right)}{\left(\frac{pd}{4t}\right)}$$
$$= 2$$

Q19 The forces F_1 and F_2 in a brake band and the direction of rotation of the drum are as shown in the figure. The coefficient of friction is 0.25. The angle of wrap is $\frac{3\pi}{2}$ radians. It is given that $R = 1$ m and $F2 = 1$ N. The torque (in N-m) exerted on the drum is _____



S1 Correct answer is 2.248

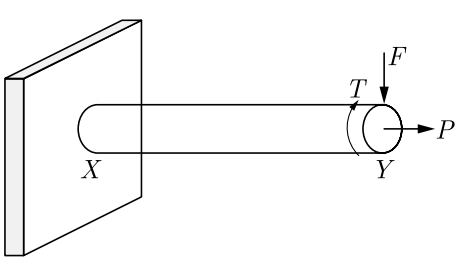
$$\frac{F_1}{F_2} = e^{\mu\theta}$$
$$= e^{0.25\times 3\pi/2}$$
$$= 3.248$$
$$\therefore \quad F_1 = 3.248 \text{ N}$$
Torque, $$T = (F_1 - F_2)\times r$$
$$= (3.248 - 1)\times 1$$
$$= 2.248 \text{ N-m}$$

Q20 A single degree of freedom mass-spring-viscous damper system with mass m, spring constant k and viscous damping coefficient q is critically damped. The correct relation among m, k and q is
(A) $q = \sqrt{2km}$
(B) $q = \sqrt{2km}$
(C) $q = \sqrt{\frac{2k}{m}}$
(D) $q = 2\sqrt{\frac{k}{m}}$

S1 Correct option is (B)

Critical damping constant $= 2\sqrt{km}$
$$q = 2\sqrt{km}$$

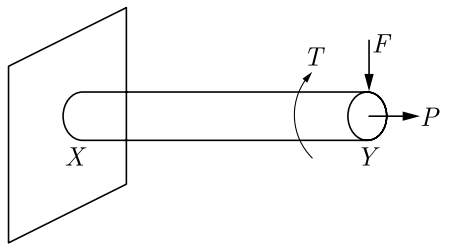
Q21 A machine element XY, fixed at end X, is subjected to and axial load P, transverse load F, and a twisting moment T at its free and Y. The most critical point from the strength point of view is

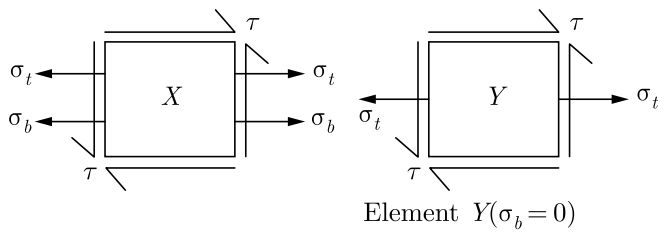


(A) a point on the circumference at location Y
(B) a point at the center at location Y
(C) a point on the circumference at location X

(D) a point at the center at location X

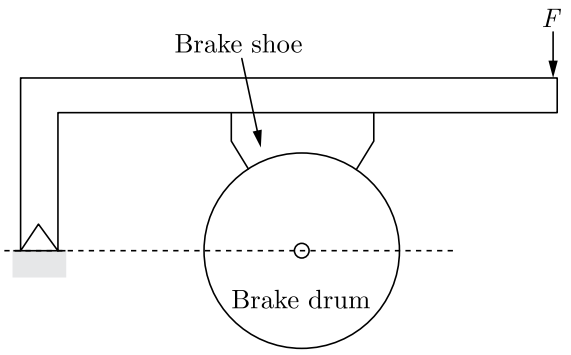
S1 Correct option is (C)





At centre $\sigma_b = 0$ and torsional shear stress are zero.

Q22 For the brake shown in the figure, which one of the following is TRUE?



(A) Self energizing for clockwise rotation of the drum

(B) Self energizing for anti-clockwise rotation of the drum

(C) Self energizing for rotation in either direction of the drum

(D) Not of the self energizing type

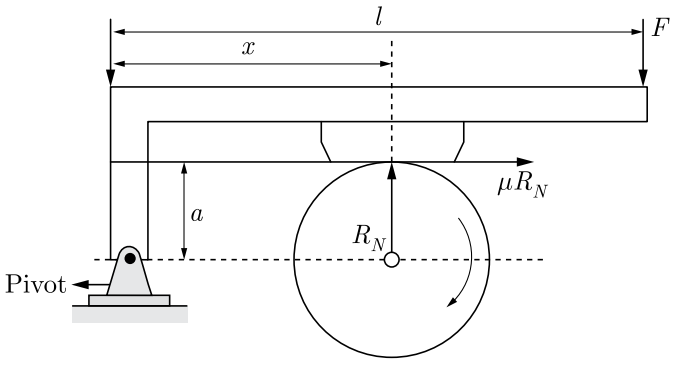
S1 Correct option is (A)

For clockwise rotation

$$\sum M_{\text{pivot}} = 0$$

$$+F \times l - R_N \times x + \mu R_N \times a = 0$$

When applied moment and frictional moment are in same direction is called self energizing brake.



Q23 The volumetric flow rate (per unit depth) between two streamlines having stream functions ψ_1 and ψ_2 is

(A) $\left|\psi_1\psi_2\right|$

(B) $\psi_1\psi_2$

(C) $\dfrac{\psi_1}{\psi_2}$

(D) $\left|\psi_1 - \psi_2\right|$

S1 Correct option is (D)

Q24 Assuming constant temperature condition and air to be an ideal gas, the variation in atmospheric pressure with height calculated from fluid statics is

(A) linear

(B) exponential

(C) quadratic

(D) cubic

S1 Correct option is (A)

Q25 A hollow cylinder has length L, inner radius r_1, outer radius r_2, and thermal conductivity k. The thermal resistance of the cylinder for radial conduction is

(A) $\dfrac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi kL}$

(B) $\dfrac{\ln\left(\frac{r_1}{r_2}\right)}{2\pi kL}$

(C) $\dfrac{2\pi kL}{\ln\left(\frac{r_2}{r_1}\right)}$

(D) $\dfrac{2\pi kL}{\ln\left(\frac{r_1}{r_2}\right)}$

S1 Correct option is (A)

Q26 Consider the radiation heat exchange inside a annulus between two very long concentric cylinders. The radius of the outer cylinder is R_o and that of the inner cylinder is R_i. The radiation view factor of the outer cylinder onto itself is

(A) $1 - \sqrt{\dfrac{R_i}{R_o}}$

(B) $\sqrt{1 - \dfrac{R_i}{R_o}}$

(C) $1 - \left(\dfrac{R_i}{R_o}\right)^{1/3}$

(D) $1 - \dfrac{R_i}{R_o}$

S1 Correct option is (D)

$$F_{11} = 0$$

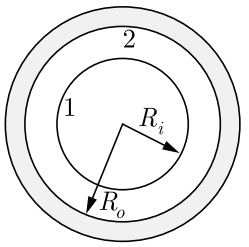
$$F_{12} = 1$$

$$F_{21} = \frac{A_1}{A_2} \times F_{12}$$

$$= \frac{2\pi R_i L}{2\pi R_o L} \times 1$$

$$= \frac{R_i}{R_o}$$

$$F_{22} = 1 - F_{21}$$
$$= 1 - \frac{R_i}{R_o}$$



Q27 The thermal energy of an ideal gas is a function of
(A) temperature and pressure
(B) volume and pressure
(C) entropy and pressure
(D) temperature only

S1 Correct option is (D)

Q28 The heat removal rate from a refrigerated space and the power input to the compressor are 7.2 kW and 1.8 kW, respectively. The coefficient of performance (COP) of the refrigerator is _____

S1 Correct answer is 4

$$\text{NRE} = 7.2 \text{ kW}$$
$$W = 1.8 \text{ kW}$$
$$\text{COP} = \frac{\text{NPF}}{W}$$
$$= \frac{7.2}{1.8}$$
$$= 4$$

Q29 Consider a simple gas turbine (Brayton) cycle and a gas turbine cycle with perfect regeneration. In both the cycle, the pressure ratio is 6 and the ratio of the specific heats of the working medium is 1.4. The ratio of minimum to maximum temperatures is 0.3 (with temperatures expressed in K) in the regenerative cycle. The ratio of the thermal efficiency of the simple cycle to that of the regenerative cycle is _____

S1 Correct answer is 0.803

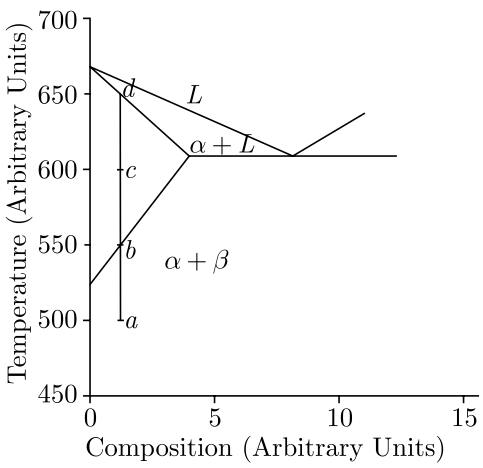
$$\frac{T_{\min}}{T_{\max}} = 0.3$$
$$\text{Pressure ratio} = r_p$$
$$= 6$$
$$\gamma = 1.4$$
$$(\eta_{\text{th}})_B = 1 - \left(\frac{1}{r_p}\right)^{\frac{\gamma-1}{\gamma}} 1 - \left(\frac{1}{6}\right)^{\frac{0.4}{1.4}}$$
$$= 0.4$$
$$(\eta_{\text{th}})_{\text{ideal region}} = 1 - \frac{T_{\min}}{T_{\max}} \cdot (r_p)^{\gamma - 1/\gamma}$$
$$= 1 - 0.3(6)^{1.4-1/1.4}$$
$$= 0.49816$$
$$\frac{(\eta_{\text{th}})_B}{(\eta_{\text{th}})_{IR}} = \frac{0.4}{0.498}$$
$$= 0.803$$

Q30 In a single-channel queuing model, the customer arrival rate is 12 per hour and the serving rate is 24 per hour. The expected time that a customer is in queue is _____ minutes.

S1 Correct answer is 2.5

$$\lambda = 12 \text{ hr}^{-1}$$
$$\mu = 24 \text{ hr}^{-1}$$
$$W_w = \frac{\lambda}{\mu(\mu - \lambda)}$$
$$= \frac{12}{24(24-12)}$$
$$= \frac{1}{24} \times 60$$
$$= 2.5 \text{ minutes}$$

Q31 In the phase diagram shown in the figure, four sample of the same composition are heated to temperatures marked by a, b, c and d.



At which temperature will a simple get solutionized the fastest?
(A) a
(B) b
(C) c
(D) d

S1 Correct option is (C)
For aluminium alloy solution hardening process will be used to increase strength and hardness. In this process component will be heated to 550°C above temperature so that solute particles can penetrate into the lattice easily.

Q32 The welding process which uses a blanket of fusible granular flux is
(A) tungsten inert gas welding
(B) submerged are welding
(C) electroslag welding
(D) thermit welding

S1 Correct option is (B)

In submerged arc welding, the arc is completely submerged inside the granular flux powder and forming as blanket.

Q33 The value of true strain produced in compressing a cylinder to half its original length is
(A) 0.69
(B) -0.69
(C) 0.5
(D) -0.5

S1 Correct option is (B)

$$\text{Engg. strain} = \frac{\text{Change in length}}{\text{Original length}}$$
$$= \frac{\left(\frac{L}{2} - L\right)}{L}$$
$$= 0.5$$
$$\text{True strain} = \ln(1+e)$$
$$= \ln(1-0.5)$$
$$= -0.69$$

Q34 The following data is applicable for a turning operation. The length of job is 900 mm, diameter of job is 200 mm; feed rate is 0.25 mm/rev and optimum cutting speed is 300 m/min. The machining time (in min) is

——————

S1 Correct answer is 7.53

$$N = \text{Rpm of job}$$
$$= \frac{1000\,V}{\pi D}$$
$$= \frac{1000 \times 300}{\pi \times 200}$$
$$= 477.7 \text{ rpm}$$
$$\text{Time for machining} = \frac{L}{f.N}$$
$$= \frac{900}{0.25 \times 477.7}$$
$$= 7.53 \text{ min}$$

Q35 In an ultrasonic machining (USM) process, the material removal rate (MRR) is plotted as a function of the feed force of the USM tool. With increasing feed force, the MRR exhibits the following behavior:
(A) increases linearly
(B) decrease linearly
(C) does not change
(D) first increases and then decreases

S1 Correct option is (D)
With increase of feed force, the material removal rate MRR is first increase and then decreases.

Q.36-Q.65 carry two marks each.

Q36 A scalar potential φ has the following gradient: $\nabla\varphi = yz\hat{i} + xz\hat{j} + xy\hat{k}$. Consider the integral $\int_C \nabla\varphi \cdot \overrightarrow{dr}$ on the curve $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. The curve C is parameterized as follows:

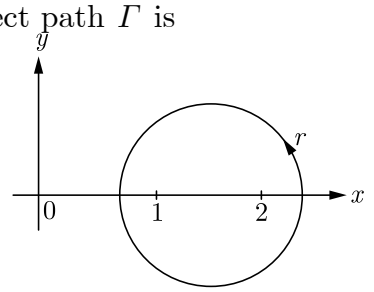
$$\begin{cases} x = t \\ y = t^2 \text{ and } 1 \le t \le 3 \\ z = 3t^2 \end{cases}$$

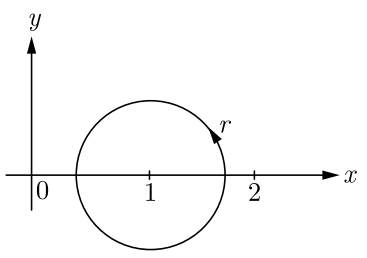
The value of the integral is

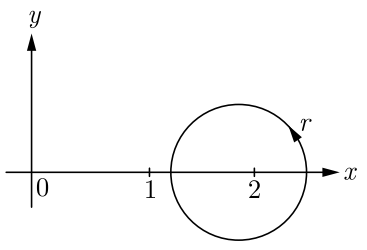
S1 Correct answer is 726
line integral

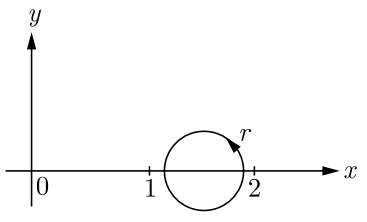
$$\text{L.I.} = \int_C \overline{f}\, d\overline{r}$$
$$= \int_{t=1}^{3} [yzdx + xzdy + xydz]$$
$$\int_{t=1}^{3} d(xyz) = (xyz)_{t=1}^{3}$$
$$= (3t^5)_{t=1}^{3}$$
$$= 726$$

Q37 The value of $\oint_\Gamma \frac{3z-5}{(z-1)(z-2)}dz$ along a closed path Γ is equal to $(4\pi i)$, where $z = x + iy$ and $i = \sqrt{-1}$. The correct path Γ is

(A)


(B)


(C)


(D)


S1 Correct option is (B)
Γ The correct path is given in option (B)

$$\int_c \frac{\left(\frac{3z-5}{z-2}\right)}{z-1}dz = 2\pi i\left[\frac{3z-5}{z-2}\right]_{z=1}$$
$$= 4\pi i$$

Q38 The probability that a screw manufactures by a company is defective is 0.1. The company sells screw in packets containing 5 screws and gives a guarantee of

replacement if one or more screw in the packet are found to be defective. The probability that a packet would have to be replaced is _____

S1 Correct answer is 0.41

We require $P(x \geq 1) = 1 - P(x = 0)$

$$= 1 - 5C_0(0.1)^0(0.9)^5$$
$$= 0.4095 \approx 0.41$$

Q39 The error is numerically computing the integral $\int_0^{\pi}(\sin x + \cos x)\,dx$ using the trapezoidal rule with three intervals of equal length between 0 and π is _____

S1 Correct answer is 0.1862

$$I = \int_0^{\pi}(\sin x + \cos x)\,dx$$

x	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π
$f(x)$	1	$\sqrt{\frac{3}{2}}$	$\sqrt{\frac{3}{2}}$	-1

$$h = \frac{b-a}{n} = \frac{\pi - 0}{3} = \frac{\pi}{3}$$

By trapezoida, rule we have

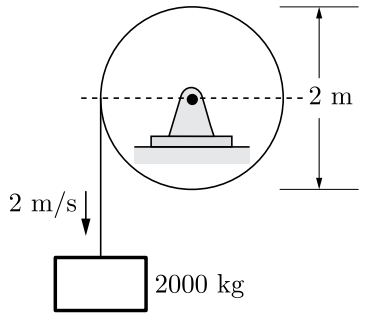
$$\int_0^{\pi} f(x)\,dx = \frac{h}{2}[(y_0 + y_3) + 2(y_1 + y_2)]$$
$$= \frac{\pi}{6}\left[(1-1) + 2\left(\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right)\right]$$
$$= 1.813799364 \text{ (approximate value)}$$

By exact method

$$I = \int_0^{\pi}(\sin(x) + \cos(x))\,dx$$
$$= [-\cos(x) + \sin x]_0^{\pi}$$
$$= \cos(0) - \cos(\pi) + \sin(\pi) - \sin 0$$
$$= 1 - (-1)$$
$$= 2 \text{ (Exact value)}$$

$\therefore$ Error = Exact value − approximate value
$$= 2 - 1.813799364$$
$$= 0.1862$$

Q40 A mass of 2000 kg is currently being lowered at a velocity of 2 m/s from the drum as shown in the figure. The mass moment of inertia of the drum is 150 kg - m^2. On applying the brake, the mass is brought to rest in a distance of 0.5 m. The energy absorbed by the brake (in kJ) is _____

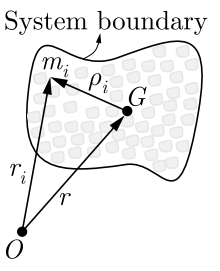


S1 Correct answer is 14.11 kJ

$$\text{K.E}_T = \frac{1}{2}m(V_1^2 - V_2^2)$$
$$= \frac{1}{2} \times 2000 \times (2^2 - 0)$$
$$= 4000 \text{ J}$$
$$\text{K.E}_R = \frac{1}{2}I(\omega_1^2 - \omega_2^2)$$
$$= \frac{1}{2} \times 150 \times (2^2 - 0)$$
$$= 300 \text{ J}$$
$$\text{P.E.} = mgh$$
$$= 2000 \times 9.81 \times 0.5$$
$$= 9810 \text{ J}$$
$$\text{Totel E} = 4000 + 300 + 9810$$
$$= 14110 \text{ J}$$
$$= 14.11 \text{ kJ}$$

Q41 A system of particles in motion has mass center G as shown in the figure. The particle i has mass m_i and its position with respect to t fixed point O is given by the position vector r_i. The position of the particle with respect to G is given by the vector ρ_i. The time rate of change of the angular momentum of the system of particles about G is

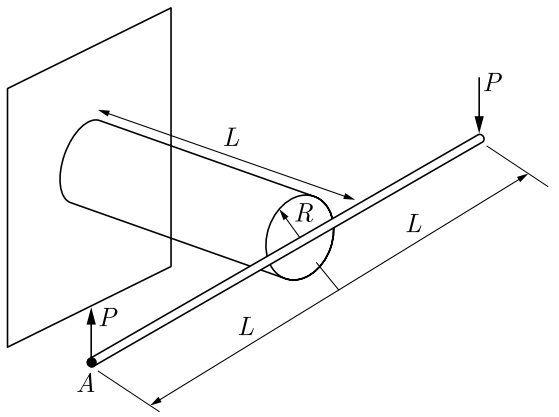
(The quantity $\ddot{\rho}_i$ indicates second derivatives of ρ_i with respect to time and likewise for r_i)



(A) $\sum_i r_i \times m_i \ddot{\rho}_i$
(B) $\sum_i \rho_i \times m_i \ddot{r}_i$
(C) $\sum_i r_i \times m_i \ddot{r}_i$
(D) $\sum_i \rho_i \times m_i \ddot{\rho}_i$

S1 Correct option is (B)

Q42 A rigid rod of length $2L$ is fixed to a circular cylinder of radius R as shown in the figure. Vertical forces of magnitude P are applied at the two ends as shown in the figure. The shear modulus for the cylinder is G and the Young's modulus is E.



The vertical deflection at point A is

(A) $\dfrac{PL^3}{(\pi R^4 G)}$

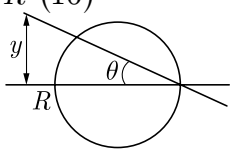
(B) $\dfrac{PL^3}{(\pi R^4 E)}$

(C) $\dfrac{2PL^3}{(\pi R^4 E)}$

(D) $\dfrac{4PL^3}{(\pi R^4 G)}$

S1 Correct option is (D)

$$T = P(2L)$$
$$= 2PL$$
$$\theta = \frac{TL}{GJ}$$
$$= \frac{(2PL)(L)}{(G)\frac{\pi}{32}(2R)^4}$$
$$= \frac{32 \times 2PL^2}{\pi GR^4(16)}$$

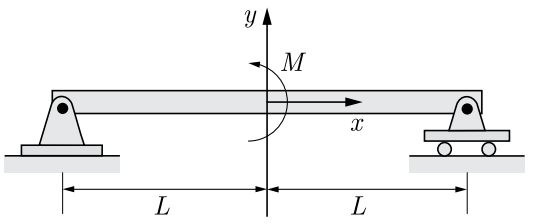


$$Q = \frac{4PL^2}{\pi GR^4}$$
$$y = R\theta$$
$$= \frac{4PL^3}{\pi GR^4}$$

Q43 A simply supported beam of length $2L$ is subjected to a moment M at the mid-point $x = 0$ as shown in the figure. The deflection in the domain $0 \le x \le L$ is given by

$$W = \frac{-Mx}{12EIL}(L - x)(x + c)$$

where E is the Young's modulus, I is the area moment of inertia and c is a constant (to be determined).



The slope at the center $x = 0$ is

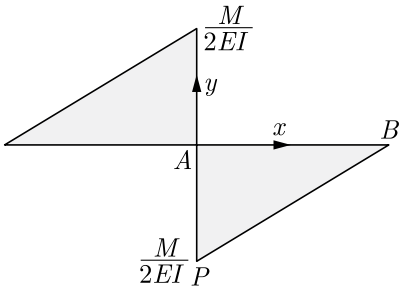
(A) $\dfrac{ML}{(2EI)}$

(B) $\dfrac{ML}{(3EI)}$

(C) $\dfrac{ML}{(6EI)}$

(D) $\dfrac{ML}{(12EI)}$

S1 Correct option is (C)



$$\Delta_{BA} = -\frac{1}{EI}$$

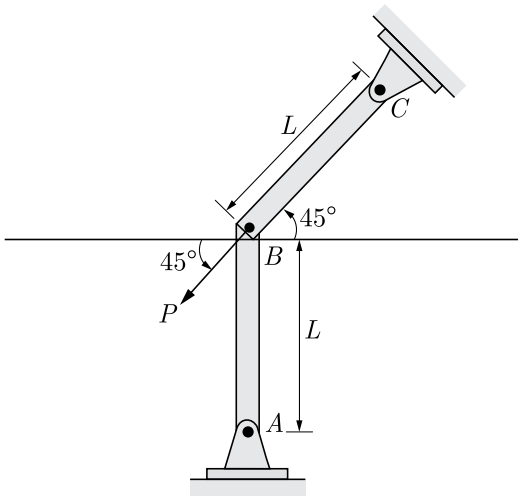
(First moment of area APB about B)

$$-\frac{1}{EI}\left(\frac{M}{2} \times \frac{1}{2} \times L \times \frac{2L}{3}\right) = \frac{ML^2}{6EI}$$

$$\text{Sloper at `}A\text{'} = \frac{\Delta_{BA}}{L}$$
$$= \frac{ML}{6EI}$$

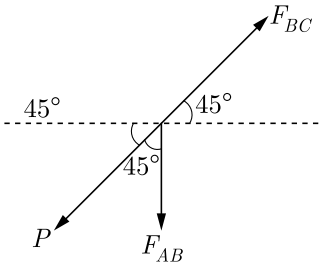
$\therefore$ (at `A'$x = 0$, $W = 0$ so slope$= \dfrac{\Delta_{BA}}{L}$)

Q44 In the figure, the load $P = 1$ N, length $L = 1$ m, Young's modulus $E = 70$ GPa, and the cross-section of the links is a square with dimension 10 mm×10 mm. All joints are pin joints.



The stress (in Pa) in the link AB is _____
(Indicate compressive stress by a negative sign and tensile stress by a positive sign.)

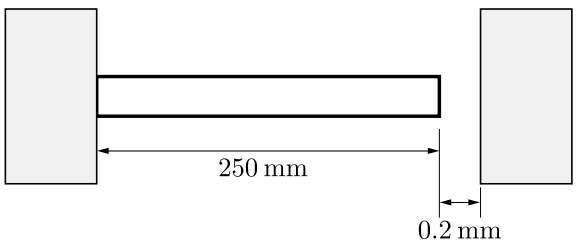
S1 Correct answer is 0.



$$P\cos 45^\circ = F_B \cos 45^\circ$$
$$F_{BC}\ P$$

$$\sum F_y = F_{BC}\sin 45^\circ$$
$$= P\cos 45 + F_{AB}$$
$$\Rightarrow \quad P\left(\frac{1}{\sqrt{2}}\right) = \frac{P}{\sqrt{2}} + F_{AB}$$
$$F_{AB} = 0$$
$$\therefore \quad \sigma_{AB} = 0$$

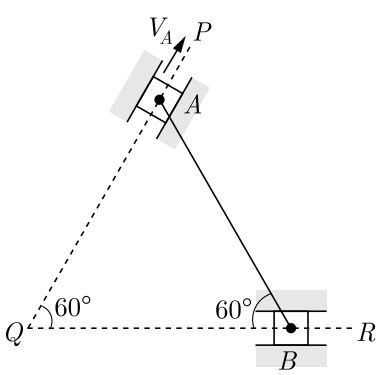
Q45 A circular metallic rod of length 250 mm is placed between two rigid immovable walls as shown in the figure. The rod is in perfect contact with the wall on the left side and there is a gap of 0.2 mm between the rod and the wall on the right side. If the temperature of the rod is increased by 200°C, the axial stress developed in the rod is _____ MPa.
Young's modulus of the material of the rod is 200 Gpa and the coefficient of thermal expansion is 10^{-5}per°C.



S1 Correct answer is 239.8 MPa

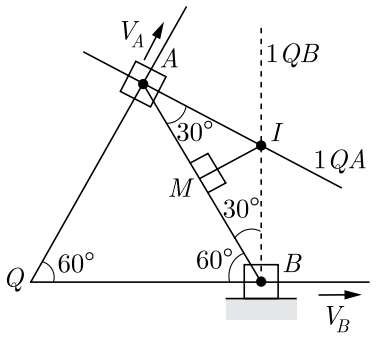
$$1\alpha t = 250 \times (10^{-5})(200)$$
$$= \frac{1}{2}$$
$$= 0.5 \text{ mm} > \text{gap}$$
$$\text{Deformation prevented} = 0.5 - 0.2$$
$$= 0.3$$
$$= \frac{pl}{AE}$$
$$\Rightarrow \quad 0.3 = \frac{\sigma(250 + 0.2)}{200 \times 10^3}$$
$$\sigma = 239.8 \text{ MPa}$$

Q46 The rod AB, of length 1 m, shown in the figure is connected to two sliders at each end through pins. The sliders can slide along QP and QR. If the velocity V_A of the slider at A is 2 m/s, the velocity of the midpoint of the rod at this instant is _____ m/s.



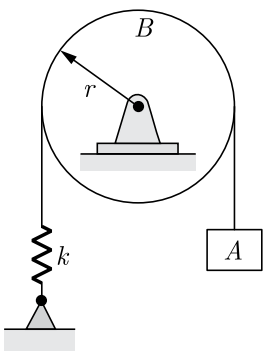
S1 Correct answer is 1 m/sec
Locate the I-center for the link AB as shown in the fig. M is the mid point of AB

Given, $V_A = 2$ m/sec



$$V_A = IA \cdot \omega \Rightarrow \omega$$
$$= \frac{V_A}{IA}$$
$$V_A = IM \cdot \omega$$
$$= IM$$
$$= \frac{V_A}{IA}$$
$$= \frac{IM}{IA} \cdot V_A$$
$$= \sin 30^\circ \cdot V_A$$
$$= \frac{1}{2} \cdot 2$$
$$= 1 \text{ m/sec.}$$

Q47 The system shown in the figure consists of block A of mass 5 kg connected to a spring through a massless rope passing over pulley B of radius r and mass 20 kg. The spring constant k is 1500 N/m. If there is no slipping of the rope over the pulley, the natural frequency of the system is _____ rad/s.



S1 Correct answer is 10 rad/sec

$$KE = \frac{1}{2}mx^2 + \frac{1}{2}I\theta^2$$
$$m = 5 \text{ kg}$$
$$\theta = \frac{x}{r}$$
$$I = \frac{20 \times r^2}{2}$$
$$= 10r^2$$
$$KE = \frac{1}{2}5x^2 + \frac{1}{2}10r^2 \cdot \frac{X^2}{r^2}$$
$$= \frac{1}{2}(15)x^2$$
$$\therefore \quad m_{eq} = 15$$
$$PE = \frac{1}{2}kx^2$$
$$\therefore \quad K_{eq} = k$$
$$= 1500 \text{ N/m}$$

$$\text{Natural frequency},\omega_n = \sqrt{\frac{k_{eq}}{m_{eq}}}$$
$$= \sqrt{\frac{1500}{15}}$$
$$= 10 \text{ rad/sec}$$

Q48 In a structural member under fatigue loading, the minimum and maximum stresses developed at the critical point are 50 MPa and 150 MPa, respectively. The endurance, yield, and the ultimate strengths of the material are 200 MPa, 300 MPa and 400 MPa, respectively. The factor of safety using modified goodman criterion is

(A) $\frac{3}{2}$

(B) $\frac{8}{5}$

(C) $\frac{12}{7}$

(D) 2

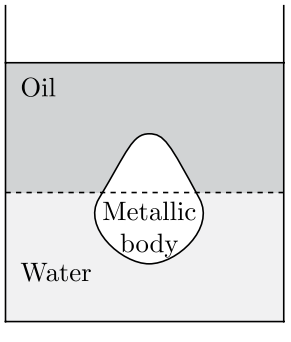
S1 Correct option is (D) 2

$$\sigma_{\max} = 150 \text{ MPa},$$
$$\sigma_{\min} = 50 \text{ MPa}$$
$$S_e = 200 \text{ MPa}$$
$$S_{yt} = 300 \text{ MPa}$$
$$S_{ut} = 400 \text{ MPa}$$
$$\sigma_a = \frac{\sigma_{\max} - \sigma_{\min}}{2}$$
$$= \frac{150 - 50}{2}$$
$$= 50 \text{ MPa}$$
$$\sigma_m = \frac{\sigma_{\max} + \sigma_{\min}}{2}$$
$$= \frac{150 + 50}{2}$$
$$= 100 \text{ MPa Goodman sequation}$$
$$\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}} = \frac{1}{FS}$$
$$\frac{50}{200} + \frac{100}{400} = \frac{1}{FS} \Rightarrow FS$$
$$= 2$$

Q49 The large vessel shown in the figure contains oil and water. A body is submerged at the interface of oil and water such that 45 percent of its volume is in oil while the rest is in water. The density of the body is _____ kg/m^3.

The specific gravity of oil is 0.7 and density of water is 1000 kg/m^3.

Acceleration due to gravity $g = 10 \text{ m/s}^2$.



S1 Correct answer is 865

$$\rho_b \times g \cdot V = \rho_{\text{oil}} \times g \times 0.45 \text{ V} + \rho_{\text{water}} \times g \times 0.55 \text{ V}$$
$$\Rightarrow \quad \rho_b = 865 \text{ kg/m}^3$$

Q50 Consider fluid flow between two infinite horizontal plates which are parallel (the gap between them being 50 mm). The top plate is sliding parallel to the stationary bottom plate at a speed of 3 m/s. The flow between the plates is solely due to the motion of the top plate. The force per unit area (magnitude) required to maintain the bottom plate stationary is _____ N/m^2.

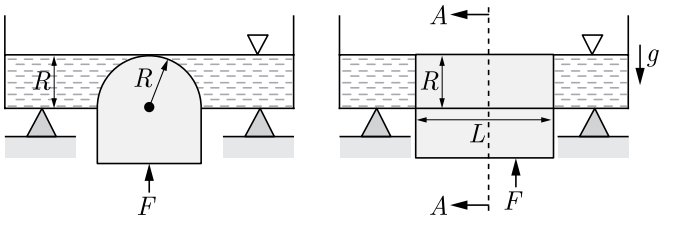
Viscosity of the fluid $\mu = 0.44$ kg/m-s and

Density $\sigma = 888 \text{ kg/m}^3$

S1 Correct answer is 26.4 N/m^2

$$\frac{F}{A} = \tau$$
$$= \frac{\mu V}{y}$$
$$= \frac{0.44 \times 3}{50 \times 10^{-3}}$$
$$= 26.4 \text{ N/m}^2$$

Q51 Consider a frictionless, massless and leak-proof plug blocking a rectangular hole of dimensions $2R \times L$ at the bottom of an open tank as shown in the figure. The head of the plug has the shape of a semi-cylinder or radius R. The tank is filled with a liquid of density ρ up to the tip of the plug. The gravitational acceleration is g. Neglect the effect of the atmospheric pressure.



Sectional view A-A

The force F required to hold the plug in its position is

(A) $2\rho R^2 gL\left(1 - \frac{\pi}{4}\right)$

(B) $2\rho R^2 gL\left(1 + \frac{\pi}{4}\right)$

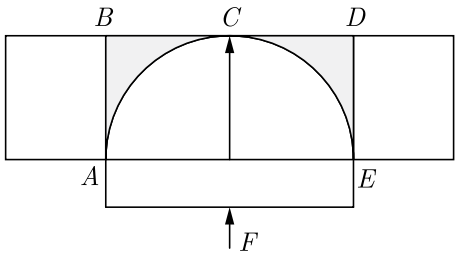
(C) $\pi R^2 \rho g L$

(D) $\frac{\pi}{2}\rho R^2 gL$

S1 Correct option is (A)

Force required to balance hydrostatic force

$$F_v = \left[(\text{Volume})_{\text{Rectngle}} - (\text{Volume})_{\text{semicircle}}\right] \times \rho g$$
$$F_v = \left[2R \times R \times L - \frac{\pi R^2}{2} \cdot L\right] \times \rho g$$



$$= 2\rho R^2 gL\left[1 - \frac{\pi}{4}\right]$$

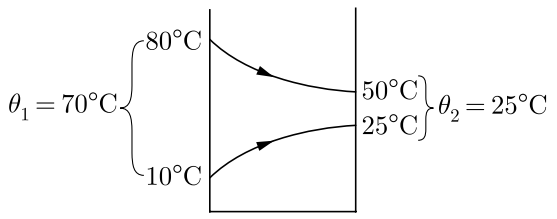
Q52 Consider a parallel-flow heat exchanger with are A_p and a counter-flow heat exchanger with area A_c. In both the heat exchangers, the hot stream flowing at 1 kg/s cools from 80°C to 50°C. For the cold stream in both the heat exchangers, the flow rate and the inlet temperature are 2 kg/s and 10°C, respectively. The hot and cold streams in both the heat exchangers are of the same fluid. Also, both the heat exchangers have the same overall heat transfer coefficient. The ration $\frac{A_c}{A_p}$ is _____

S1 Correct answer is 0.9278

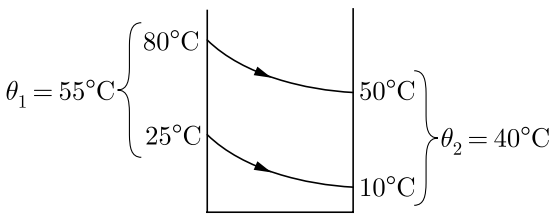
$$m_h = 1 \text{ kg/s}$$
$$m_c = 2 \text{ kg/s}$$
$$T_{h_1} = 80^\circ\text{C}$$
$$T_{h_2} = 50^\circ\text{C}$$
$$T_{c_1} = 10^\circ\text{C}$$
$$T_{c_2} = ?$$

Heat lost by hot fluid = Heat gained by cold fluid

$$m_h c_p \times (T_{h_1} - T_{h_2}) = m_c \times c_p (T_{c_2} - T_{c_1})$$
$$\Rightarrow \quad 1 \times (80 - 50) = 2 \times (T_{c_2} - 10)$$
$$\Rightarrow \quad T_{c_2} = 25^\circ\text{C}$$



Parallel flow Heat exchanger



Counter flow Heat exchanger

$$(\text{LMTD})_{\text{P.F}} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)}$$
$$= \frac{(80-10)-(50-25)}{\ln\left(\frac{80-10}{50-25}\right)}$$
$$= 43.7054$$
$$(\text{LMTD})_{\text{C.F.}} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)}$$
$$= \frac{(80-25)-(50-10)}{\ln\left(\frac{80-25}{50-10}\right)}$$
$$= 47.1026$$
$$(Q)_{\text{C.F.}} = (Q)_{\text{P.F.}}$$
$$U(A)_{\text{C.F.}} \times (\text{LMTD})_{\text{C.F.}} = U \times (A)_{\text{P.F.}} \times (\text{LMTD})_{\text{P.F.}}$$
$$\frac{(A)_{\text{C.F.}}}{(A)_{\text{P.F.}}} = \frac{43.7054}{47.1026}$$
$$= 0.9278$$

Q53 Two cylindrical shafts A and B at the same initial temperature are simultaneously placed in a furnace. The surface of the shaft remains at the furnace gas temperature at all times after they are introduced into the furnace. The temperature variation in the axial direction of the shaft can be assumed to be negligible. The data related to shafts A and B is given in the following Table.

Quantity	Shaft A	Shaft B
Diameter (m)	0.4	0.1
Thermal conductivity (W/m-K)	40	20
Volumetric heat capacity ($\text{J/m}^3\text{-K}$)	2×10^6	2×10^7

The temperature at the centerline of the shaft A reaches 400°C after two hours. The time required (in hours) for the centerline of the shaft B to attain the temperature of 400°C is _____

S1 Correct answer is 5 hrs

$$\frac{T - T_\infty}{T_1 - T_\infty} = e^{-hA_s t/\rho VCp}$$
$$(\rho C_p)_A = 2 \times \frac{10^6 \text{J}}{\text{m}^3\text{K}},$$
$$(\rho C_p)_B = 2 \times 10^7 \text{ j/m}^3\text{K}$$
$$d_A = 0.4 \text{ m}$$
$$d_B = 0.1 \text{ m}$$
$$t_A = 2 \text{ hrs}$$
$$= 2 \times 3600$$
$$= 7200 \text{ sec}$$
$$h_A = h_B$$
$$\left(\frac{hA_s}{\rho VC_p} \times t\right)_A = \left(\frac{hA_s}{\rho VC_p} \times t\right)_B$$
$$\Rightarrow \left(\frac{\pi \times 0.4 \times L \times 7200}{2 \times 10^6 \frac{\pi}{4} \times (0.4)^2 \times L}\right)_A = \left(\frac{\pi \times 0.1 \times L \times t}{2 \times 10^7 \times \frac{\pi}{4} \times (0.1)^2 \times L}\right)_B$$
$$\Rightarrow \quad t_B = 18000 \text{ secs}$$
$$= 5 \text{ hrs}$$

Q54 A piston-cylinder device initially contains 0.4 m^3 of air (to be treated as an ideal gas) at 100 kPa and 80°C . The air is now isothermally compressed to 0.1 m^3. The work done during this process is _____ kJ.
(Take the sign convention such that work done on the system is negative)

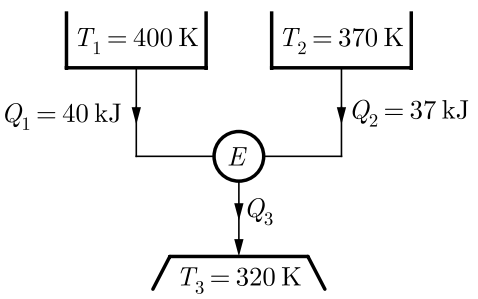
S1 Correct answer is -55.45 kJ

$$W_2 = P_1 V_1 \ln\left(\frac{V_2}{V_1}\right)$$

$$= 100 \times 0.4 \times \ln\left(\frac{0.1}{0.4}\right)$$
$$= -5.45 \text{ kJ}$$

Q55 A reversible cycle receives 40 kJ of heat from one heat source at a temperature of 127°C and 37 kJ from another heat source at 97°C. The heat rejected (in kJ) to the heat sink at 47°C is _____

S1 Correct answer is 64 kJ



Applying classius inequality

$$\oint \frac{\delta Q}{T} = 0$$
$$\frac{Q_1}{T_1} + \frac{Q_2}{T_2} - \frac{Q_3}{T_3} = 0$$
$$\frac{40}{400} + \frac{37}{370} - \frac{Q_3}{320} = 0$$
$$0.1 + 0.1 - \frac{Q_3}{320} = 0$$
$$Q_3 = 0.2 \times 320$$
$$= 64 \text{ kJ}$$

Q56 A refrigerator user R-134a as its refrigerant and operators on an ideal vapour-compression refrigeration cycle between 0.14 MPa and 0.8 MPa. If the mass flow rate of the refrigerant is 0.05 kg/s the rate of heat rejection to the environment is _____ kW.

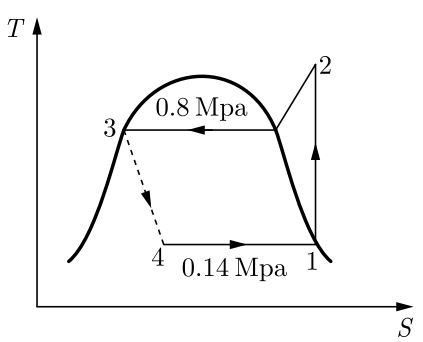
Given data:

At $P = 0.14$ MPa,
$h = 236.04$ kJ/kg
$s = 0.9322$ kJ/kg-K

At $P = 0.8$ MPa
$h = 272.05$ kJ/kg (superheated vapour)

At $P = 0.8$ MPa,
$h = 93.42$ kJ/kg (saturated liquid)

S1 Correct answer is 8.9315 kW



$$h_2 = 272.05 \text{ kJ/kg}$$
$$h_3 = h_4$$
$$= 93.42 \text{ kJ/kg}$$
$$h_1 = 236.04 \text{ kJ/kg}$$
$$M_r = 0.05 \text{ kg/sec}$$
$$\text{Heat rejected} = m_r\left(\frac{\text{kg}}{\text{sec}}\right)(h_2 - h_3) \text{ kJ/kg}$$
$$= 0.05(272.05 - 93.42)$$
$$= 8.9315 \text{ kW}$$

Q57 The partial pressure of water vapour in a moist air sample of relative humidity 70% is 1.6 kPa, the total pressure being 101.325 kPa. Moist air may be treated as an ideal gas mixture of water vapour and dry air. The relation between saturation temperature (T_s in K) and saturation pressure (p_s in kPa) for water is given by $\ln\left(\frac{p_s}{p_o}\right) = 14.317 - 5304/T_s$, where $p_o = 101.325$ kPa. The dry bulb temperature of the moist air sample (in °C) is _____.

S1 Correct answer is 19.89°

$$\phi = 0.7$$
$$P_o = 101.325$$
$$\phi = \frac{P_v}{P_{sat}} \Rightarrow P_{sat}$$
$$= \frac{P_v}{\phi}$$
$$P_{sat} = \frac{1.6}{0.7}$$
$$= 2.28571 \text{ kpa}$$

Corresponding to saturation pressure whatever is the temperature is the DBT

$$\ln\left(\frac{p_s}{p_o}\right) = 14.317 - \frac{5304}{T_{sat}}$$
$$\ln\left(\frac{2.28571}{101.325}\right) = 14.317 - \frac{5304}{T_{sat}}$$
$$-3.7916\ 14.317 - \frac{5304}{T_{sat}}$$
$$T_{sat} = \frac{5304}{18.1086}$$
$$= 292.898 \text{ K}$$
$$= 19.89^\circ\text{C}$$

Q58 In a binary system of A and B, a liquid of 20% A (80% B) is coexisting with a solid of 70% A (30% B). For an overall composition having 40% A, the fraction of solid is

(A) 0.40
(B) 0.50
(C) 0.60
(D) 0.75

S1 Correct option is (A)

Weight of the liquid $A = W_{LA}$
$= l_a \times W_l$
$= 0.2 \times W_l$
(where W_l is Weight of total liquid)

Weight of solid of $A = W_{SA}$
$= S_a(W_T - W_l)$
$= 0.7 \times (W_T - W_l)$

$$W_A = 0.2\,W_l + 0.7(W_T - W_l)$$

$$
\begin{aligned}
W_A &= 0.7\,W_T - 0.5\,W_l \\
\frac{W_A}{W_T} &= 0.7 - 0.5\frac{W_l}{W_T} \\
0.4 &= 0.7 - 0.5(\%\,W_l) \\
(0.5)(\%\,W_l) &= 0.3 \\
(\%\,W_l) &= \frac{3}{5} \\
(\%\,W_l) &= 1 - \frac{3}{5} \\
&= 0.4
\end{aligned}
$$

Q59 Gray cast iron blocks of size 100 mm × 50 mm × 10 mm with a central spherical cavity of diameter 4 mm are sand cast. The shrinkage allowance for the pattern is 3%. The ratio of the volume of the pattern to volume of the casting is _____

S1 Correct answer is 0.913

Ratio of volume of pattern to casting

$$
\begin{aligned}
&= \frac{\big[(0.97\times 100)(0.97\times 50)(0.97\times 10)\big]}{(100\times 50\times 10)} \\
&= 0.913
\end{aligned}
$$

Volume of cavity is assumed to be small and negligible.

Q60 The voltage-length characteristic of a direct current are in an arc welding process is $V = (100 + 40l)$, where l is the length of the arc in mm and V is arc voltages in volts. During a welding operation, the arc length varies between 1 and 2 mm and the welding current is in the range 200-250 A. Assuming a linear power source, the short circuit current is _____ A.

S1 Correct answer is 425

$$
\begin{aligned}
V &= 100 + 40L \\
L &= 1 \text{ to } 2 \text{ mm} \\
I &= 200 \text{ to } 250 \text{ A} \\
L &= 1,\ I = 250 \\
V &= 100 + 40\times 1 \\
&= 140 \\
&= V_0 - \frac{V_0}{I_s}\times 250 \\
L &= 2 \\
I &= 200 \\
V &= 100 + 40\times 2 \\
&= 180 \\
&= V_0 - \frac{V_0}{I_s}\times 200 \\
\Rightarrow \quad 40 &= 50\times\frac{V_0}{I_s} \\
\frac{V_0}{I_s} &= \frac{40}{50} \\
&= \frac{4}{5} \\
V_0 &= 140 + \frac{4}{5}\times 250 \\
&= 140 + 200 \\
&= 340 \\
\frac{V_0}{I_s} &= \frac{4}{5} \Rightarrow I_s \\
&= \frac{V_0\times 5}{4} \\
&= \frac{340\times 5}{4} \\
&= 425 \text{ A}
\end{aligned}
$$

Q61 For a certain job, the cost of metal cutting is $18\,C/V$ and the cost of tooling is Rs. $270\,C/(TV)$, where C is a constant, V is the cutting speed in m/min and T is the tool life in minutes. The Taylor's tool life equation is $VT^{0.25} = 150$. The cutting speed (in m/min) for the minimum total cost is _____

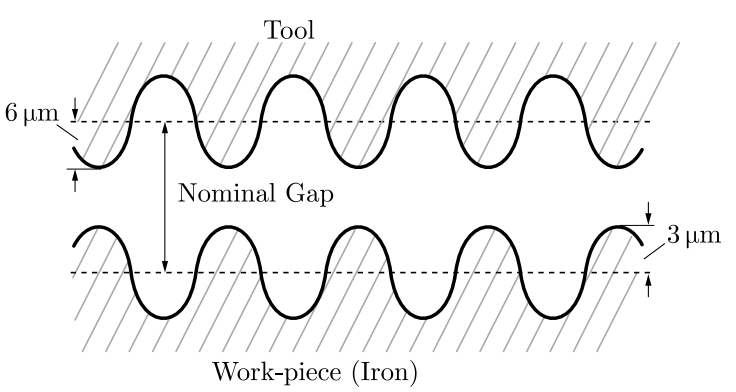
S1 Correct answer is 93.2

$$
\begin{aligned}
L_m &= \frac{18C}{V} \\
C_g &= \frac{270C}{TV} \\
VT^{0.25} &= 150 \\
V_{opt} &= V = C\left[\frac{n}{1-n}\frac{L_m}{C_g}\right]^n \\
&= 150\left[\frac{0.25}{1-0.25}\times\frac{\frac{18C}{V}}{\frac{270C}{TV}}\right]^{0.25} \\
&= 150\left[\frac{0.25}{1-0.25}\times\frac{18}{270}\,T\right]^{-0.25} \\
&= 150\left[\frac{1}{3}\times\frac{18}{270}\times\frac{150^4}{V^4}\right]^{0.25} \\
&= 150(57.914)\times\left(\frac{1}{V^4}\right)^{0.25} \\
V &= 150\times 57.914\times\frac{1}{V} \\
V^2 &= 150\times 57.914 \\
V &= 93.2 \text{ m/min.}
\end{aligned}
$$

Q62 The surface irregular of electrodes used in an electrochemical machining (ECM) process are 3 μm and 6 μm as shown in the figure. If the work-piece is of pure iron and 12 V DC is applied between the electrodes, the largest feed rate is _____ mm/min.

Conductivity of the electrolyte	0.02 $\text{ohm}^{-1}\text{mm}^{-1}$
Over-potential voltage	1.5 V
Density of iron	7860 kg/m^3
Atomic weight of iron	55.85 gm

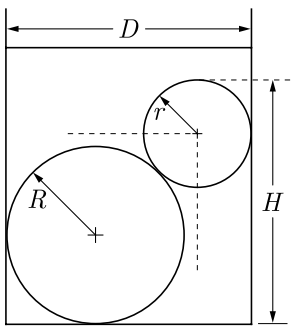
Assume the iron to be dissolved as Fe^{+2} and the Farady constant to be 96500 Coulomb.



S1 Correct answer is 51.542

$$\begin{aligned} R &= \frac{\rho L}{\text{Area}} \\ &= \frac{\frac{1}{0.02} \times 0.009}{\text{Area}} \\ &= \frac{50 \times 0.009}{\text{Area}} \\ I &= \frac{V}{R} \\ &= \frac{(12 - 1.5) \times \text{Area}}{50 \times 0.009} \\ &= \frac{23}{333} \times \text{Area} \\ L &= 3 + 6 \\ &= 9\,\mu\text{m} \\ &= 0.009 \\ \text{MRR} &= \frac{AI}{\rho ZF} \\ &= \frac{55.85 \times 23.333 \times \text{Area}}{7860 \times 10^{-6} \times 2 \times 96500} \\ &= 0.98189 \times \text{Area} \\ \frac{\text{MRR}}{\text{Area}} &= 0.8590 \text{ mm/sec} \\ &= 0.8590 \times 60 \text{ mm/min} \\ &= 51.542 \text{ mm/min.} \end{aligned}$$

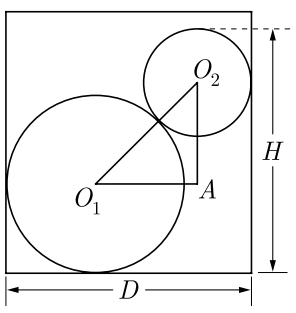
Q63 For the situation shown in the figure below the expression for H in terms of r, R and D is



(A) $H = D + \sqrt{r^2 + R^2}$
(B) $H = (R + r) + (D + r)$
(C) $H = (R + r) + \sqrt{D^2 - r^2}$
(D) $H = (R + r) + \sqrt{2D(R + r) - D^2}$

S1 Correct option is (D)

$$\begin{aligned} H &= (R + r) + O_2A \\ O_2A &= \sqrt{O_1O_2^2 - O_1A^2} \\ &= \sqrt{(R + r)^2 - \left(D - (R + r)\right)^2} \\ &= \sqrt{2D\big((R + r) - D^2} \\ H &= (R + r) + \sqrt{2D(R + r) - D^2} \end{aligned}$$



Q64 A food processing company uses 25,000 kg of corn flour every year. The quantity-discount price of corn flour is provided in the table below;

Quantity (kg)	Unit price (Rs/kg)
1-749	70
750-1499	65
1500 and above	60

The order processing charges are Rs. 500/order. The handling plus carry-over charge on an annual basis is 20% of the purchase price of the corn flour per kg. The optimal order quantity (in kg) is

S1 Correct answer is 1500

$$\begin{aligned} A &= 25{,}000 \\ S &= 500 \\ I &= 0.2 \\ C_1 &= 60 \\ EDQ &= \sqrt{\frac{2AS}{C_1 I}} \\ &= \sqrt{\frac{2 \times 25000 \times 500}{60 \times 0.2}} \\ &= 1443 < 1500 \text{ units} \end{aligned}$$

Hence no the best order
EOQ is falling in the $750 - 1499$ prime range

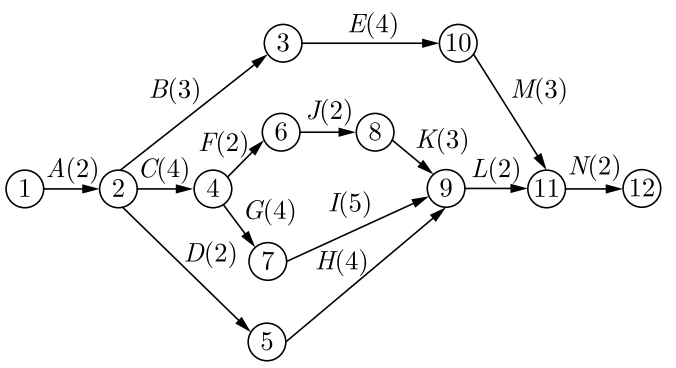
$$\begin{aligned} (TAC)_{EDQ} &= AC + \sqrt{2ACSI} \\ &= 25000 \times 65 + \sqrt{2 \times 25000 \times 65 \times 500 \times 0.2} \\ &= 1625000 + 18027.75 \\ &= 16{,}43{,}027.75 \end{aligned}$$

If 1500 kgs are ordered we get it at 60/-

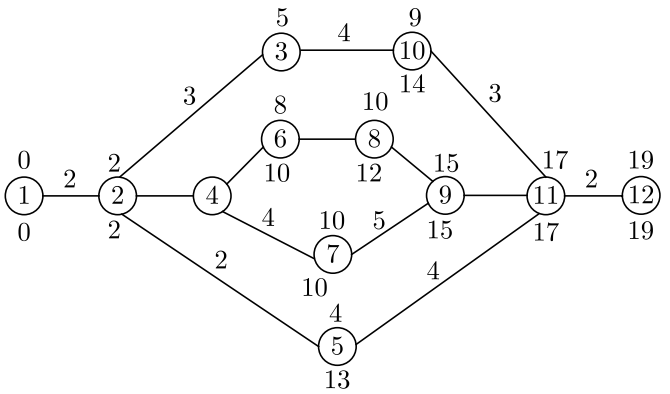
$$\begin{aligned} (TCQ)_Q &= AC + \frac{A}{Q}S + \frac{Q}{2}CI \\ (TAC)_{1500} &= 25000 \times 60 + \frac{25000}{1500} \times 500 + \frac{1500}{2} \times 60 \times 0.2 \\ &= 15{,}00{,}000 + 8333.33 + 9000 \\ &= 15{,}17{,}333.33 \end{aligned}$$

$(TAC)_{1500} < (TAC)_{EOQ}$
Hence order 1500 units.

Q65 A project consists of 14 activities. The duration of these activities (in days) are shown in brackets on the network diagram. The latest finish time (in days) for node 10 is _____



S1 Correct answer is 14



(LFT) for node 10 = 14 days