ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2008

MECHANICAL SCIENCES

SEMESTER – 1

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) Free body diagram can be applied only in

a) dynamic equilibrium problem

b) static equilibrium problem

c) both dynamic and static equilibrium problems

d) none of these. ☐

ii) The conditions of equilibrium for coplanar non-concurrent forces are

a) $\Sigma F_X = 0 ; \Sigma F_Y = 0$ b) $\Sigma F_X = 0 ; \Sigma M = 0$

c) $\Sigma F_Y = 0 ; \Sigma M = 0$ d) $\Sigma F_X = 0 ; \Sigma F_Y = 0 ; \Sigma M = 0.$

☐

iii) The centre of gravity of solid hemisphere of radius R is

a) $3R / 8$ b) $R / 2$

c) $3R / 4$ d) none of these. ☐

iv) Equation of motion of a particle is $s = 2t^3 - t^2 - 2$ where s is displacement in metre and t is time in second. Acceleration of the particle after 1 second will be

a) 8 m/sec^2 b) 9 m/sec^2

c) 10 m/sec^2 d) 5 m/sec^2 . ☐

v) When a body slides down an inclined surface of inclination θ, the acceleration of the body is given by

a) $f = g$ b) $f = g \sin \theta$

c) $f = g \cos \theta$ d) $f = g/\sin \theta$. ☐

vi) The maximum strain energy that can be stored in a body is known as

a) impact energy b) resilience

c) proof resilience d) modulus of resilience. ☐

vii) When two ships are moving along inclined directions, then the time when the two ships will be closest together depends upon

a) velocity of one of the ships

b) velocity of both the ships

c) angle between the two directions

d) all of these. ☐

viii) The maximum height of a projectile on a horizontal range is

a) $\frac{(u^2 \sin 2\alpha)}{2g}$ b) $\frac{(u^2 \sin \alpha)}{2g}$

c) $\frac{(u^2 \sin^2 2\alpha)}{2g}$ d) $\frac{(u^2 \sin^2 \alpha)}{2g}$. ☐

ix) The differential equation of falling body under gravity is

a) $\ddot{x} = 0, \quad \ddot{y} = 0$ b) $\ddot{x} = 0, \quad \ddot{y} = -g$

c) $\ddot{x} = c, \quad \ddot{y} = -g$ d) $\ddot{x} = 0, \quad \ddot{y} = 0$

e) none of these. ☐

x) If a momentum of a body is doubled, its kinetic energy will

a) increase by two times b) increase by four times

c) remain same d) get halved

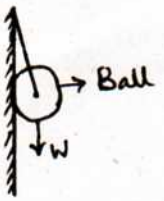
e) reduce to four times. ☐

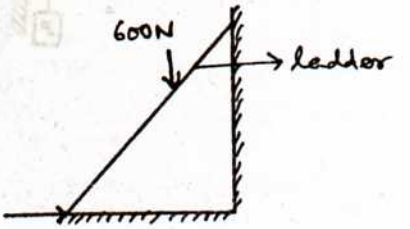
GROUP – B

(Short Answer Type Questions)

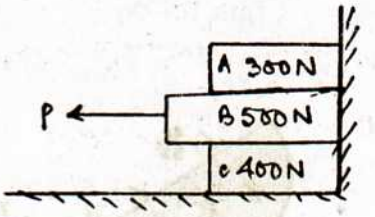
Answer any *three* of the following. $3 \times 5 = 15$

2. What do you mean by a Free Body Diagram ? Draw the Free Body Diagrams of the following as shown below : 1 + 2 + 2





3. Determine the force *P* required to intend the motion of the block *B* shown in the figure below. Take $\mu = 0{\cdot}3$ for all surfaces of contact, where μ = coefficient of friction 5

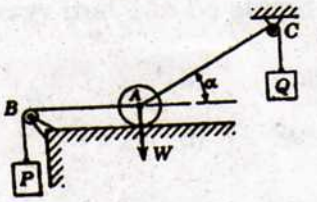


4. A force $\vec{F} = 3i - 4j + 12k$ acts at a point *A* whose coordinates are (1, – 2, 3) m. Compute,

   a) moment of force about origin 3

   b) moment of force about the point *B* (2, 1, 2) m. 2

5. If the string AB is horizontal, find the angle that the string AC makes with the horizontal when the ball is in a position of equilibrium. Also find the pressure R between the ball and the plane.

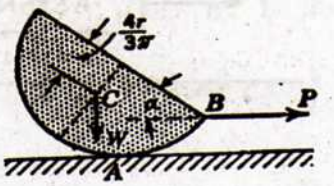


GROUP – C

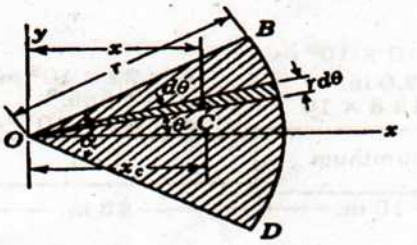
(Long Answer Type Questions)

Answer any *three* of the following questions. $3 \times 15 = 45$

6. a) A short semi-circular right cylinder of radius r and weight W rests on a horizontal surface and is pulled at right angles to its geometric axis by a horizontal force P applied at the middle B of the front edge as shown. Find the angle α that the flat face will make with the horizontal plane just before sliding begins if the coefficient of friction at the line of contact A is μ. The gravity force W must be considered as acting at the centre of gravity C as shown in the figure.



b) Determine the coordinates of the centroid C of the area of the circular sector OBD of radius r and central angle α.

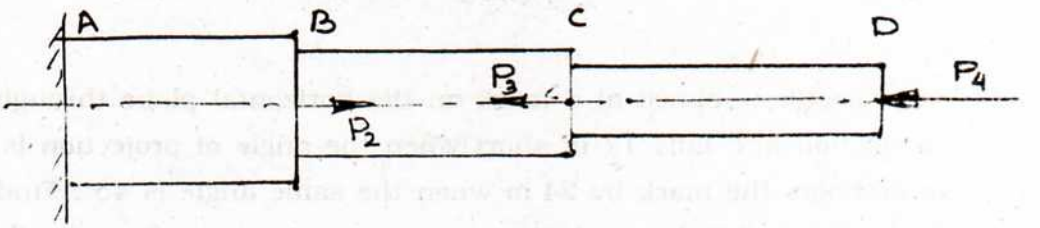


8 + 7

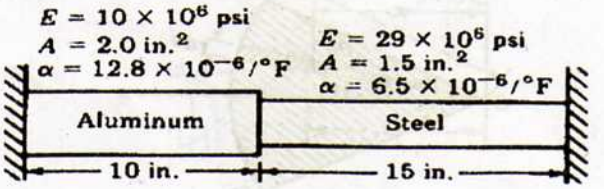
7. a) The following details refer to the bar as shown :

Portion	*Lenngth*	*Cross-Section*
AB	600 mm	40 × 40 mm
BC	800 mm	30 × 30 mm
CD	1000 mm	20 × 20 mm

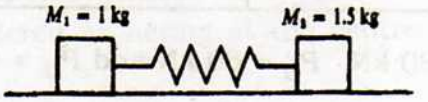
If the load $P_4 = 80$ kN, $P_2 = 60$ kN and $P_3 = 40$ kN, find the extension of the bar, where $E = 2 \times 10^5$ N/mm^2. 7



b) Calculate the increase in stress for each segment of the compound bar shown i figure, if the temperature increases by 100°F. Assume that the supports are unyielding and that the bar is suitably braced against buckling. 8

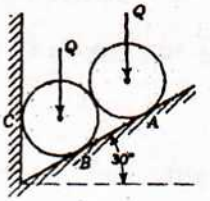


8. a) A spring normally 150 mm long is connected to the two masses as shown in figure and compressed 50 mm. If the system is released on a smooth horizontal plane, what will be the speed of each block when the spring is again in is normal length ? The spring constant is 2100 N/m. 8

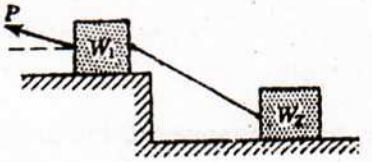


b) A projectile is aimed at a mark on the horizontal plane through the point of projection and falls 12 m short when the angle of projection is 15°, while it overshoots the mark by 24 m when the same angle is 45°. Find the angle of projection to hit the mark. Assume no air resistance. Consider the velocities of projections are constant in all cases. 7

9. a) Two inclined rollers, each of weight Q = 100 kgf are supported by an inclined plane and a vertical wall as shown below. Assuming smooth surfaces, find the reactions induced at the points A, B and C. 7



b) Two blocks of weight W_1 and W_2 rest as shown. If the angle of friction of each block is φ, find the magnitude and direction of the least force P applied to the upper block that will induce sliding. 8



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