9. (a) The 125 kg concrete block A is released from rest in the position shown in Fig. 11 and pulls the 200 kg log up the 300 ramp. If the coefficient of the log and the ramp is 0.5, determine the velocity of the block as it hits the ground at B.

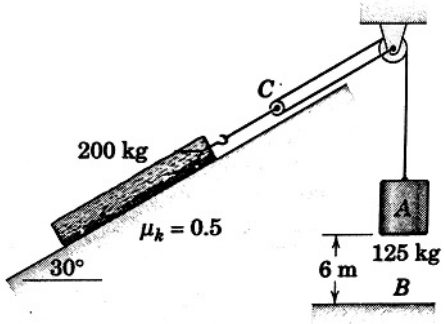


Fig. 11

(b) The 0.5 kg collar *C* starts from rest at *A* and slides with negligible friction on the fixed rod in the vertical plane as shown in Fig. 12. Determine the velocity v with which the collar strikes end B when acted upon by the 5 N force, which is constant in direction. Neglect the small dimensions of the collar.

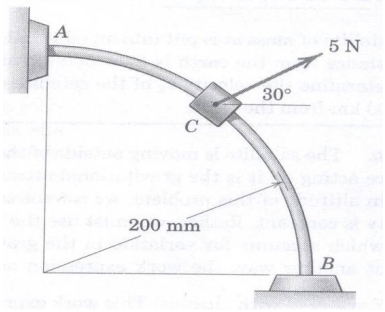


Fig. 12

6 + 6 =12

MECHANICS FOR ENGINEERS
(MECH 2106)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) According to the principle of transmissibility of forces, the effect of a force upon a body is
(a) maximum when it acts at the centre of gravity of a body
(b) same at every point in its line of action
(c) minimum when it acts at the centre of gravity of a body
(d) different at different points in its line of action.

(ii) The resultant of three concurrent and coplanar vectors having same magnitude each, is zero. Angle between any two vector is
(a) 90^0 (b) 45^0 (c) 120^0 (d) 0^0.

(iii) "If three coplanar concurrent forces are in equilibrium, then ratio of each force and the sine of the angle included between the other two forces is constant". This statement is called
(a) Lami's theorem (b) Law of Transmissibility
(c) Varignon's theorem (d) Parallelogram law of vector .

(iv) If ϕ is the angle of repose, then coefficient of friction μ is given by
(a) $\mu = \tan\phi$ (b) $\mu = \cot\phi$
(c) $\mu = \sin\phi$ (d) $\mu = \sec\phi$.

(v) The dot product of two orthogonal vector is
(a) 0 (b) 1
(c) cosine of the angle between two vectors (d) no definite value.

(vi) A semi-circular sector or area of radius r is situated horizontally and the centre of the sector coincides with the origin of normal rectangular co-ordinate system. The y coordinate of the centroid of the sector is
(a) 0 (b) $(2r/\pi)$ (c) $(4r/3\pi)$ (d) 3r/8.

(vii) Poisson's ratio is defined as
(a) (Lateral Stress)/ (Linear Stress)
(b) (Linear Stress)/(Lateral Stress)
(c) (Lateral Strain)/ (Linear Strain)
(d) (Linear Strain)/ (Lateral Strain).

(viii) The relationship among elastic constants E,G,K is
(a) E = 2G (1+ μ) = 3K(1-μ) (b) E= 3G(1+μ)= 2K(1-2μ)
(c) E = 2G(1-μ) = 3K(1+μ) (d) E= 3G(1-μ) = 2K(1-2μ).

(ix) A particle is moving by maintaining the displacement equation $s= 2t^3 -9t^2+4t-6$ m where 't' is time in 's'. The acceleration in (m/s^2) at t= 4 s is
(a) 30 (b) 35 (c) 21 (d) 78.

(x) For maximum range of projection, the angle of projection is
(a) 75° (b) 60° (c) 45° (d) 30°

Group – B

2. (a) A force F acts from B (8m, -3m, 0m) to D (0 m, 0 m, 6 m) and produces a moment of 875 Nm about an axis directed from A (12 m, 0 m, 0 m) to E (0 m, 4 m, -6 m). Compute the magnitude of F.

(b) The 10 N force is applied to the handle of the hydraulic control valve as shown in Fig. 1. Calculate the moment of this force about point O.

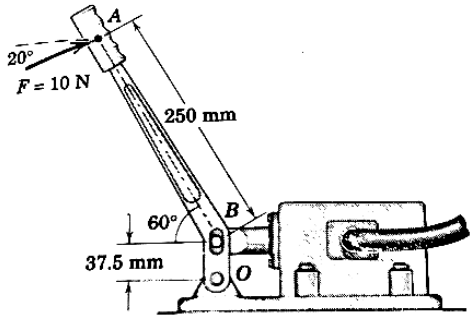


Fig. 1

7 + 5 = 12

7. (a) Find the Centroid of the shaded area as shown in Fig. 8.

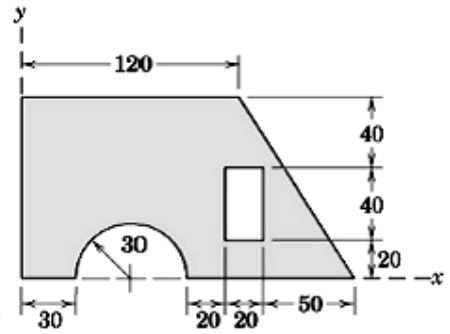


Fig. 8

(b) A steel circular bar has three segments as shown in Fig. 9.

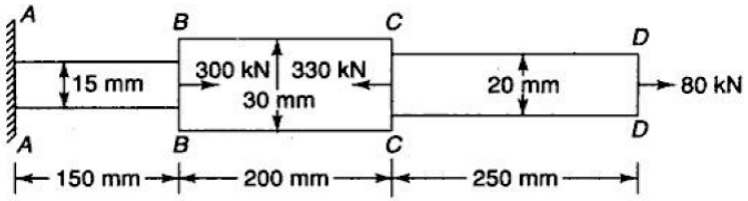


Fig. 9

Determine the total elongation of the bar .Take E=205GPa.

6 + 6 =12

Group – E

8. (a) A projectile is launched from point *A* with the initial conditions shown in the Fig. 10. Determine the slant distance s which locates the point *B* of impact. Calculate the time of flight t.

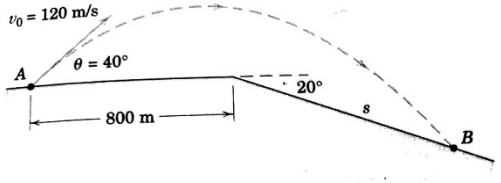


Fig. 10

(b) The acceleration of a particle is given by $a = 2t - 10$, where, a is in meters per second squared and t is in seconds. Determine the velocity and displacement as functions of time. The initial displacement at $t = 0$ is $s_0 = -4$ m, and the initial velocity is $v_0 = 3$ m/s.

(7 + 5) =12

3. (a) Determine the displacement vector AB, given that A (3,4,5) B (3,5,4) in meter units. Determine the vector form of AB, its direction cosines and the direction w.r.t the x, y, z axis.

(b) A (50, 30, 40) and B (30, 20, 80) are the two points on the line of action of 500N force which is acting in the direction A to B. Express the force in vector format and find the moment of this force about the point C(20, 20, 20). The mm units are used for the co-ordinate system in space.

6 + 6 =12

Group – C

4. (a) A 561.5 N man stands on the middle rung of a 334.5 N ladder, as shown in Fig. 2. Assuming a smooth wall at B and a stop at A to prevent slipping, find the reactions at A and B. Draw the necessary free body diagram.

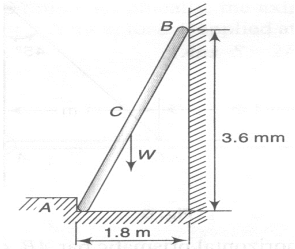


Fig. 2

(b) Two blocks connected by a horizontal link AB are supported on two rough planes as shown in Fig.3. The coefficient of friction for block A on the horizontal plane is μ = 0.45. The angle of friction for block B on the inclined plane is ϕ = 25°. What is the smallest weight W of block A for which equilibrium of the system can exist?

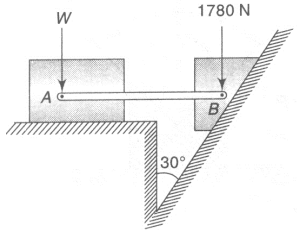
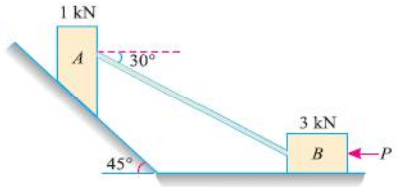


Fig. 3

6 + 6 =12

5. (a) A block (A) weighing 1 kN rests on a rough inclined plane whose inclination to the horizontal is 45°. This block is connected by a weightless rigid bar inclined at 30 ° to the horizontal to another block (B) weighing 3 kN and it rests on a rough horizontal plane as shown in Fig. 4.



ig. 4

Find the horizontal force (P) required to be applied to the block(B) just to move the block (A) in the upward direction. Assume angle of limiting friction as 12° at all surface where there is sliding.

(b) An electric light fixture weighing 15 N hangs from a point C, by two strings AC and BC. The string AC is inclined at 60° to the horizontal and BC at 45° to the horizontal as shown in Fig. 5 below.

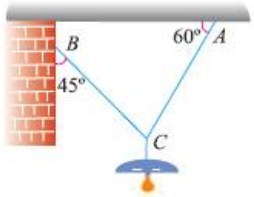


Fig. 5

Using Lami's theorem, or otherwise, determine the forces in the strings AC and BC.

6 + 6 =12

Group – D

6. (a) Find the centroid of the parabolic Spandrel as shown in Fig. 6.

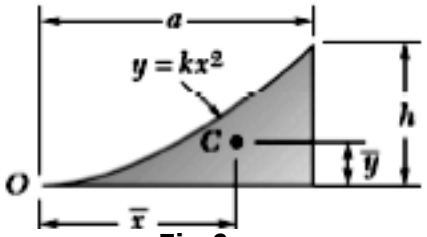


Fig. 6

(b) Three pillars, two of Alluminium of identical length and one of steel, placed at mid way between the Aluminium pillars support a rigid platform of 250 KN as shown in Fig. 7. If area of each Aluminium pillar is 1200 mm² and that of steel pillar is 1000 mm², find the stress developed in each pillar. Take $E_s = 2.08 \times 10^5$ N/mm² and $E_a = 1.2 \times 105$ N/mm².

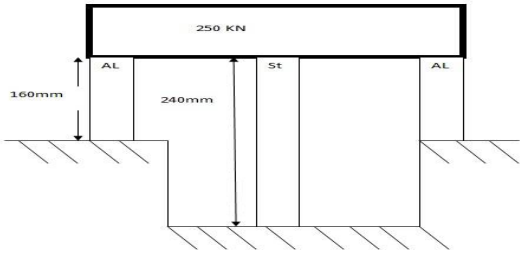


Fig. 7

6 + 6 =12