1989 Q1

Two cars A and B, each 5m in length, travel with constant velocity 20m/s along a straight level road. The front of car A is 15m directly behind the rear of car B. Immediately on reaching a point P each car decelerates at 4 m/s^2.

(i) Show that A collides with B. **(Collision occurs @ t = 4.25)**

(ii) At what distance from P does the collision occur? **(43.875m)**

(iii) Show the motion of both cars on the same speed-time graph.

1989 Q2

A man travelling North at 20m/s finds that the wind appears to blow from the West. When he travels due West at 8.45 m/s the wind appears to blow from the South West.

(i) Calculate the velocity of the wind.

(ii) If the man travelled in a direction 300 North of West at 8m/s from what direction would the wind appear to blow?

1989 Q3

A particle is projected with speed u at an angle α to the horizontal. The range of the particle of the horizontal plane through the point of projection is R.

(i) Show that R is a maximum when $\alpha = 45^0$.

(ii) If $R = \frac{u^2}{2g}$, find the two possible values of α.

(iii) If the ratio of the greatest height to the range is 2:5, find α.

1989 Q4

State the laws governing the oblique collision of elastic spheres.

A smooth sphere A, of mass m, moving with speed 0.6m/s, impinges obliquely on a smooth sphere B, of mass $2m$, which is at rest. After the collision A is found to move with speed 0.2 m/s in a direction at right angles to its original direction.

(i) Find the direction of A before impact.

(ii) Find the coefficient of restitution.

(iii) Show that the loss of kinetic energy, as a result of the impact , is $0.06m$.

1989 Q5

A wedge of mass 8kg can slide freely on a smooth horizontal table. On one face inclined at an angle of 30^0 to the horizontal, is placed a particle of mass 4kg and on the other face, inclined at an angle 60^0 to the horizontal, is placed a particle of mass 6kg. If both faces of the wedge are smooth.

(i) Show on separate diagrams the forces acting on each mass.

(ii) Show that when the particles are released from rest, the acceleration of the wedge is $\frac{g}{9\sqrt{3}}$.

1989 Q6

Define Simple Harmonic Motion.

A mass of 4kg suspended by a light spiral extends it 8 cm when in equilibrium. A second mass of 2kg is attached to the first without moving it and the combined mass is then released from rest.

(i) Prove that the motion is simple harmonic.

(ii) Find the periodic time of the ensuing motion.

(iii) Find the maximum velocity of the resulting motion.

1989 Q7

A particle of mass 10kg is placed on a rough inclined plane. The least force acting up along the plane which will prevent the particle slipping down the plane is 19.6 N. The least force acting up along the plane which will make the particle slip upwards is 98N.

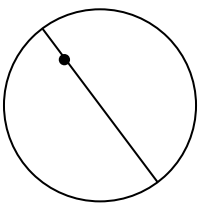
(i) Find the inclination of the plane.

(ii) Show that the coefficient of friction is ½.

(iii) Find the least force required to move the particle up the plane. The least force need not necessarily be parallel to the plane.

1989 Q8

Prove that the moment of inertia of a uniform circular lamina of mass M and radius r about an axis through its centre, perpendicular to the plane of the lamina , is $\frac{1}{2}Mr^2$.

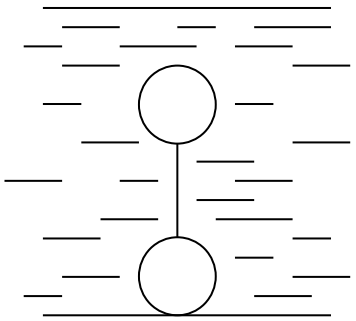


A circular sheet of cardboard of radius r rotates freely in its own plane, which is vertical, about a horizontal pin. At what distance from the centre should the pin be stuck to make the period of small oscillation a minimum?

1989 Q9

(a) A cube of side 1m is filled to a height x m with water and a second liquid of relative density 0.8, which does not mix with water, occupies the remainder of the cube. The thrust on each vertical side due to the water is equal to the thrust due to the other liquid. Find x.

(b) Two solid uniform spheres each of radius 6cm are connected by a light string and are completely immersed in a tank of water. The heavier sphere lies on the bottom of the tank. The relative densities of the spheres are 0.75 and 2.25 respectively. Find the tension in the string and the reaction between the bottom of the tank and the heavier sphere.



1989 Q10

(a) Find the solution of the differential equation $x\dfrac{dy}{dx} = y + xy$ if $y = 1$ when $x = 1$.

(b) A cyclist, free-wheeling on a straight level road, experiences a retardation which is proportional to the square of his speed. His speed is reduced from 6m/s to 3m/s in a distance of 35m. Show that the average speed during this period is $6ln2$.