LEAVING CERTIFICATE EXAMINATION, 1984

APPLIED MATHEMATICS-ORDINARY LEVEL

WEDNESDAY, 27 JUNE - AFTERNOON, 2.00 - 4.30

Six questions to be answered. All questions carry equal marks.
Mathematics Tables may be obtained from the Superintendent.
Take the value of g to be $9{\cdot}8$ m/s^2.

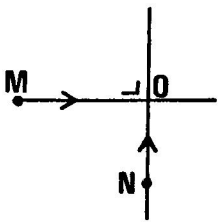
1. Define velocity and speed.

   Show that a speed of 1 km/h is equivalent to $\frac{5}{18}$ m/s.

   The speed of a car is reduced from 72 km/h to 54 km/h over a distance of 35 m. Find the retardation, assuming it is uniform throughout. If the retardation continues, how much farther will the car travel before coming to rest ?

2. Two straight road cross at rightangles at O. M and N jog towards O at 4 m/s and $1\frac{2}{3}$ m/s, respectively. Calculate the magnitude and direction of the velocity of M with respect to N.

   When M was at O, N was 50 m beyond O. Calculate the shortest distance they were apart.



3. State (i) Newtons Law of Restitution (for collisions);
(ii) the Law of Conservation of Momentum.

(a) An elastic sphere, initially at rest 19·6 m above the ground, falls and bounces off the ground. If the coefficient of restitution is 0·8, find the greatest height attained after the first bounce.

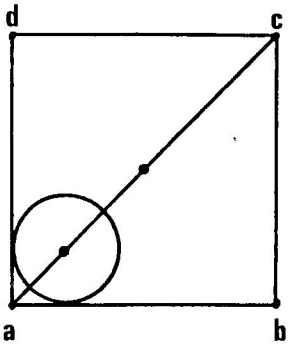
(b) A gun, of mass 2 kg, fires a bullet of mass 10 g with a muzzle velocity of 300 m/s. Find the velocity of recoil of the gun and the constant force required to stop the recoil in a distance of 50 mm.

4. (a) Particles of 5, 8, 3, 2 units of mass are placed at points the coordinates of which are (3, −1), (4, 2), (−1, 5), (2, −6), respectively. Calculate the coordinates of the centre of gravity of the system.

(b) A uniform lamina is in the shap of a square $abcd$, $|ab| = 100$ mm. A circular portion of radius 20 mm is removed

Find, correct to the nearest mm, the x-coordinates of the centre of gravity of the remainder, if ab and ad are taken as the x and y axes, respectively.

(Assume $\pi = \frac{22}{7}$)



5. A projectile is fired from a point p on the horizontal plane with initial velocity 98 m/s at an angle of 30° to the horizontal.
(i) Calculate the greatest height.
(ii) At a horizontal distance of $49\sqrt{3}$ m from p there is a tower of vertical height 40 m. Show that the projectile clears the tower and calculate by how must it does so.

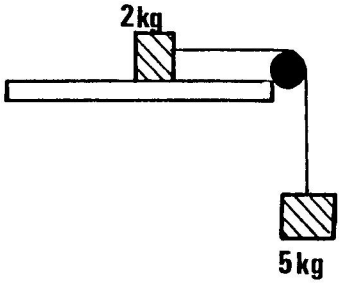
6. Fill in the missing word/phrase in each of the following

(i) "_____ is the force between two rough surfaces in contact which tends to oppose sliding".

(ii) "The _____ is a measure of the turning effect of the force".

A uniform ladder of mass 25 kg rests with one end against a smooth vertical wall and the other end on rough horizontal ground, the coefficient of friction being 0·8. The ladder is just on the point of slipping when inclined at an angle α to the horizontal. Find value of $\tan \alpha$.

7. A particle of mass 2 kg lies on a horizontal table. It is connected by a light inextensible string passing over a smooth pulley to a second particle of mass 5 kg which hangs freely. The system is released from rest.

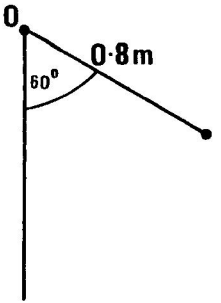


Use separate diagrams to show the forces acting on the two masses:

(i) when the contact between the 2 kg mass and the table is smooth;
(ii) when the coefficient of friction is 0·4.

Find, in m/s^2, the acceleration of the system in (i) and (ii).

8. A small particle is attached to the end of an inextensible string of length 0·8 m. The other end of the string is fixed at 0. The particle is drawn aside through an angle of 60° with the vertical as shown.



(i) If it is then released from rest, find in m/s the velocity with which it passes through the vertical position.

(ii) If, instead, it is made to move in a horizontal circle, so that string and circle form a conical pendulum, find the angular velocity, if the angle 60° remains unchanged.

9. (a) Define relative density.

Assuming the relative density of ice is 0·9 and that of sea-water is 1·03, find what percentage of the volume of a block of ice floats under sea-water, correct to the nearest percent.

(b) A uniform rectangular block of metal 0·8m X 0·6m X 0·4m rests on the bottom of a tank of water so that it is completely submerged. If the relative density of the metal is 2·5, find the reaction of the bottom of the tank on the block in newtons.