AN ROINN OIDEACHAIS M.51

LEAVING CERTIFICATE EXAMINATION, 1973

APPLIED MATHEMATICS - ORDINARY LEVEL

(400 marks)

TUESDAY, 26 JUNE - Morning, 9.30 to 12

Not more than six questions may be answered
All questions are of equal value
Mathematics Tables may be obtained from the Superintendent
Take the value of g to be 9·8 metres/second^2
$\vec{i}$ and $\vec{j}$ are perpendicular unit vectors.

1. A sprinter runs a 100 metre race in 10 seconds. He starts with a speed of 7 m/s, but immediately accelerates uniformly for t seconds to a constant speed of 12 m/s and maintains this speed to the finish. Write down in terms of t the distances covered:

(i) while accelerating,
(ii) while travelling with constant speed.

Deduce that $t = 8$ and find the acceleration.

2. Three players A, B, C are running with velocities v_1 m/s, v_2 m/s, v_3 m/s, respectively, where $\vec{v}_1 = 2\vec{i} - 3\vec{j}$, $\vec{v}_2 = 5\vec{i} + \vec{j}$, $\vec{v}_3 = 13\vec{j}$.

Calculate the magnitudes and directions of the relative velocities of A with respect to B and of C with respect to B.

3. Particles of weights W_1 and W_2 are situated at the points with coordinates $(x_1, y_1,)$, and (x_2, y_2), respectively. Write down the coordinates of their centre of gravity.

Particles of weights 1, 2, 3, 4 are placed at the vertices a, b, c, d, respectively, of a square, the letters a, b, c, d being in a clockwise sense. By taking moments about ab and ad, find the position of the centre of gravity of the system.

4. A particle of weight W is at rest on a rough plane inclined at angle 45° to the horizontal under the action of a horizontal force P. Calculate the least value of P which will just move the particle up the plane given that $\mu = \frac{1}{2}$ is the coefficient of friction between the particle and the plane.

5. Write down expressions for the displacement $\vec{r}$ from the origin o of a projectile and for its velocity $\vec{v}$, t units of time after it is fired from the point o with initial velocity $(u_1\vec{i} + u_2\vec{j})$, where $\vec{i}$, $\vec{j}$ are along the horizontal and upward drawn vertical, respectively.

A particle is projected from o with velocity u m/s, where $\vec{u} = 10\vec{i} + u_2\vec{j}$ so as to pass through a point p with displacement s metres, where $\vec{s} = 100\vec{i} + 110\vec{j}$. Find the time taken for the particle to reach p and show that $u_2 = 60$.

6. A man of mass 80 kg, and hence of weight 784 N, is standing on a lift. Show in a diagram the forces acting on him when the lift is in motion. Calculate the reaction between the floor and the man when the lift

(i) ascends with an acceleration of 0·2 m/s^2,
(ii) ascends with constant speed of 10 m/s,
(iii) descends with an acceleration of 1 m/s^2.

7. State the law of the conservation of linear momentum. A bullet of mass 0·1 kg is fired horizontally with speed 300 m/s into a stationary block of wood of mass 5 kg which is free to move on a smooth horizontal table. The bullet penetrates the block and emerges with a speed of 100 m/s. Find the speed of the block as the bullet emerges.

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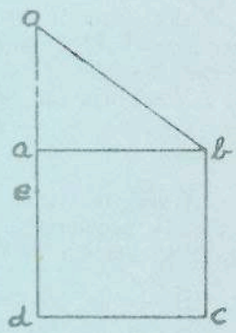
8. When can the principle of the conservation of mechanical energy be applied to a moving system ? Particles of masses 0·9 kg and 1·1 kg hang at the ends of a light inelastic string which passes over a small fixed smooth peg p. The parts of the string are vertical. The lighter particle is held 1 m from p and the system is then released from rest. Find the speed of the particles when the lighter one reaches p.

9. The diagram shows the central cross section $abcd$ of a uniform solid cube of weight 200 N and edge 0·4 m, suspended from a point o by a light inelastic string of length 0·5 m tied to the mid point b of an upper edge of the cube. It rests in limiting equilibrium against a rough vertical wall. The resultant reaction of the wall on the cube acts at the point e where $|ae| = 0·1$ m. Show in a diagram the forces acting on the cube and calculate the tension in the string and the coefficient of friction at e.



10. Show that if three coplanar forces are in equilibrium they must be either concurrent or parallel.

A uniform cylinder of weight W and radius a with its axis horizontal is to be dragged over an obstacle of height $a/5$ above the horizontal ground by the application of a horizontal force p applied to the axis. Show in a diagram the forces acting on the cylinder as it is just about to move over the obstacle. Calculate the value of p and show that the reaction at the obstacle is 5 W/4.