



Coimisiún na Scrúduithe Stáit State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2014

APPLIED MATHEMATICS – ORDINARY LEVEL

FRIDAY, 20 JUNE – MORNING, 9.30 to 12.00

Six questions to be answered. All questions carry equal marks.

A *Formulae and Tables* booklet may be obtained from the Superintendent.

Take the value of g to be 10 m s^{-2} .

\vec{i} and \vec{j} are unit perpendicular vectors in the horizontal and vertical directions, respectively, or eastwards and northwards, respectively, as appropriate to the question.

Marks may be lost if necessary work is not clearly shown.

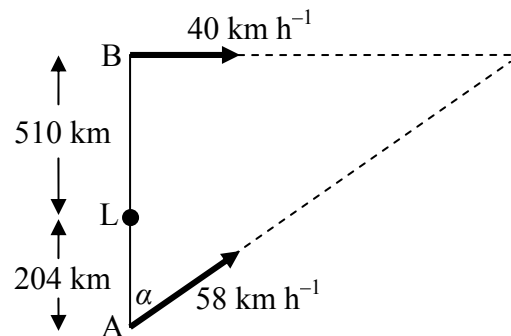
1. The points P and Q lie on a straight level road.
 A car passes point P with a constant speed of 13 m s^{-1} and continues at this speed for 9 seconds.
 The car then accelerates uniformly for 5 seconds to a speed of 28 m s^{-1} .
 Finally the car decelerates uniformly from 28 m s^{-1} to rest at point Q .
 The car travels 98 metres while decelerating.
- (a) Draw a speed-time graph of the motion of the car from P to Q .
- (b) Find
- (i) the acceleration
 - (ii) the deceleration
 - (iii) $|PQ|$, the distance from P to Q
 - (iv) the average speed of the car as it travels from P to Q , correct to two decimal places.

2. Ship A is positioned 204 km due south of lighthouse L.

A is moving at an angle α east of north at a constant speed of 58 km h^{-1} , where $\tan \alpha = \frac{20}{21}$.

Ship B is positioned 510 km due north of lighthouse L.

B is moving due east at a constant speed of 40 km h^{-1} .



- Find
- (i) the velocity of A in terms of \vec{i} and \vec{j}
 - (ii) the velocity of B in terms of \vec{i} and \vec{j}
 - (iii) the velocity of A relative to B in terms of \vec{i} and \vec{j} .

Ship A intercepts ship B after t hours.

- Find
- (iv) the value of t
 - (v) the distance from lighthouse L to the meeting point.

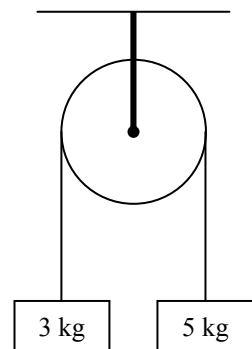
3. A particle is projected from a point on horizontal ground with an initial speed of 82 m s^{-1} at an angle β to the horizontal, where $\tan \beta = \frac{40}{9}$.

- Find
- (i) the initial velocity of the particle in terms of \vec{i} and \vec{j}
 - (ii) the time taken to reach the maximum height
 - (iii) the maximum height of the particle above ground level
 - (iv) the range
 - (v) the two times at which the height of the particle is 275 m.

4. (a) Two particles of masses 3 kg and 5 kg are connected by a taut, light, inextensible string which passes over a smooth light fixed pulley.

The system is released from rest.

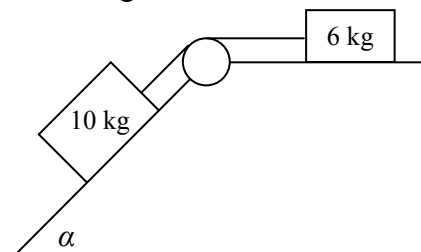
- Find
- (i) the common acceleration of the particles
 - (ii) the tension in the string.



- (b) Masses of 6 kg and 10 kg are connected by a taut, light, inextensible string which passes over a smooth light fixed pulley as shown in the diagram.

The 6 kg mass lies on a rough horizontal plane and the coefficient of friction between the 6 kg mass and the plane is $\frac{2}{3}$.

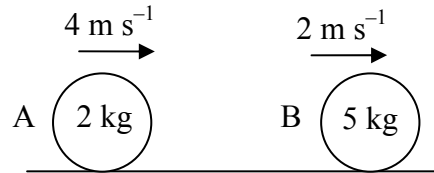
The 10 kg mass lies on a smooth plane which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{4}{3}$.



The system is released from rest.

- (i) Show on separate diagrams the forces acting on each particle.
- (ii) Find the common acceleration of the masses.
- (iii) Find the tension in the string.

5. A smooth sphere A, of mass 2 kg, collides directly with another smooth sphere B, of mass 5 kg, on a smooth horizontal table.



A and B are moving in the same direction with speeds of 4 m s^{-1} and 2 m s^{-1} respectively.

The impulse imparted to B due to the collision is 5 N s .

- Find
- (i) the speed of B after the collision
 - (ii) the speed of A after the collision
 - (iii) the coefficient of restitution for the collision
 - (iv) the loss in kinetic energy due to the collision.

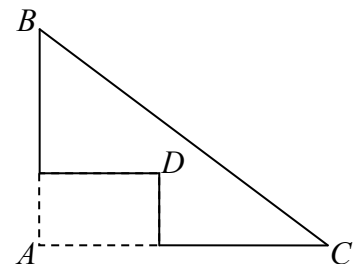
6. (a) Particles of weight 8 N, 2 N, 7 N and 3 N are placed at the points $(6, p)$, $(-4, q)$, $(p, 4)$ and $(11, 6)$ respectively.

The co-ordinates of the centre of gravity of the system are $(4, q)$.

- Find
- (i) the value of p
 - (ii) the value of q .

- (b) A triangular lamina with vertices A , B and C has the rectangle with diagonal $[AD]$ removed.

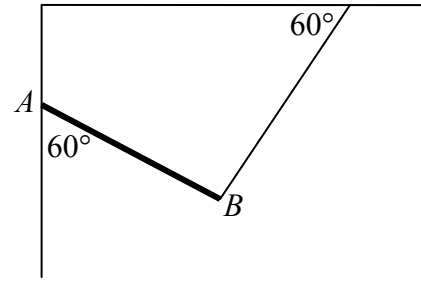
The co-ordinates of the points are $A(0, 0)$, $B(0, 18)$, $C(24, 0)$ and $D(10, 6)$.



Find the co-ordinates of the centre of gravity of the remaining lamina.

7. A uniform rod, $[AB]$, of length 2 m and weight 120 N is smoothly hinged at end A to a vertical wall.

One end of a light inelastic string is attached to B and the other end of the string is attached to a horizontal ceiling.



The string makes an angle of 60° with the ceiling and the rod makes an angle of 60° with the wall, as shown in the diagram.

The rod is in equilibrium.

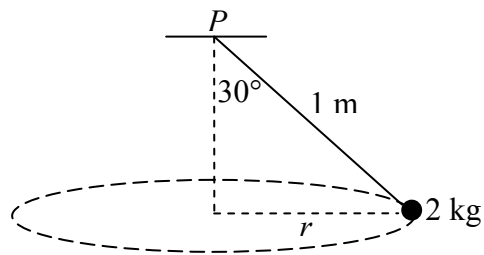
- (i) Show on a diagram all the forces acting on the rod $[AB]$.
- (ii) Write down the two equations that arise from resolving the forces horizontally and vertically.
- (iii) Write down the equation that arises from taking moments about the point A .
- (iv) Find the tension in the string.
- (v) Find the magnitude of the reaction at the point A .

8. (a) A particle describes a horizontal circle of radius 2 metres with uniform angular velocity ω radians per second.
The period T (the time to travel one complete circle) is 0.4π seconds.

Find (i) the value of ω
(ii) the speed of the particle
(iii) the acceleration of the particle.

- (b) A conical pendulum consists of a particle of mass 2 kg attached by a light inelastic string of length 1 metre to a fixed point P .
The string makes an angle of 30° with the vertical.

The particle describes a horizontal circle of radius r and the centre of the circle is vertically below P .



Find (i) the value of r
(ii) the tension in the string
(iii) the angular velocity of the particle.

9. (a) State the principle of Archimedes.

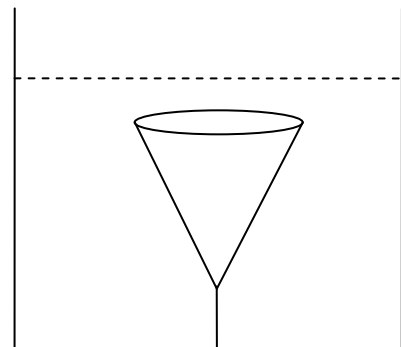
A solid piece of metal has a weight of 35 N.
When it is completely immersed in water, the metal appears to weigh 27 N.

Find (i) the volume of the metal
(ii) the density of the metal.

- (b) A right circular solid cone has a base of radius 4 cm and a height of 12 cm.

The relative density of the cone is 0.9 and it is completely immersed in a tank of liquid of relative density 1.3.

The cone is held at rest by a light, inextensible, vertical string which is attached to the base of the tank. The upper surface of the cone is horizontal.



Find the tension in the string.

[Density of water = 1000 kg m^{-3}]

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