

APPLIED MATHEMATICS - ORDINARY LEVEL

FRIDAY 25 JUNE - MORNING 9.30 to 12.00

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

Mathematics Tables may be obtained from the Superintendent.

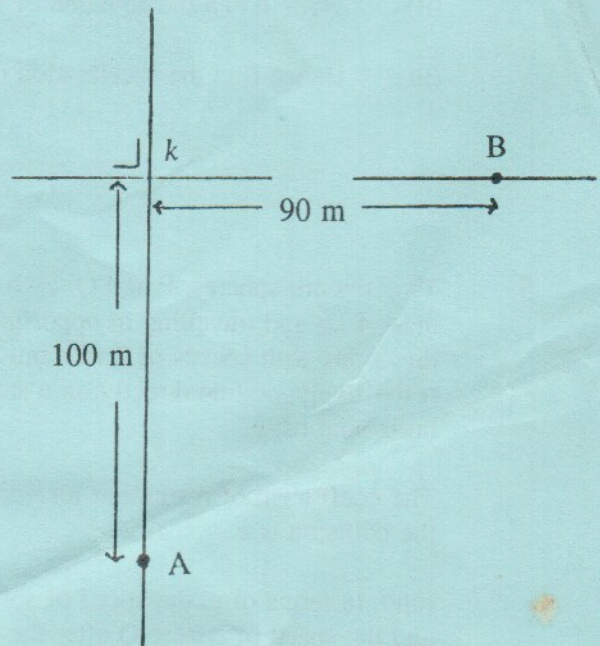
Take the value of g to be 10 m/s^2 .

\vec{i} and \vec{j} are unit perpendicular vectors in the horizontal and vertical directions, respectively.

**Marks may be lost if all your work is not shown
or you do not indicate where a calculator has been used.**

1. Stations C and D are a certain distance apart on a straight level track. A train starts from rest at station C and takes 30 s to accelerate uniformly to its maximum speed of 20 m/s. It maintains this maximum speed for 75 s. It then decelerates uniformly to rest at station D in a time of 90 s.
- Find the acceleration of the train.
 - Find the deceleration of the train.
 - Draw an accurate velocity-time graph of the motion of the train from C to D.
 - Find the distance between C and D.

2. Two cars, A and B, travel towards a junction, k , on roads which are at right angles to one another. Car A is travelling due North with a speed of 4 m/s. Car B is travelling due West with a speed of 3 m/s. At a particular time A is 100 m from k and B is 90 m from k .



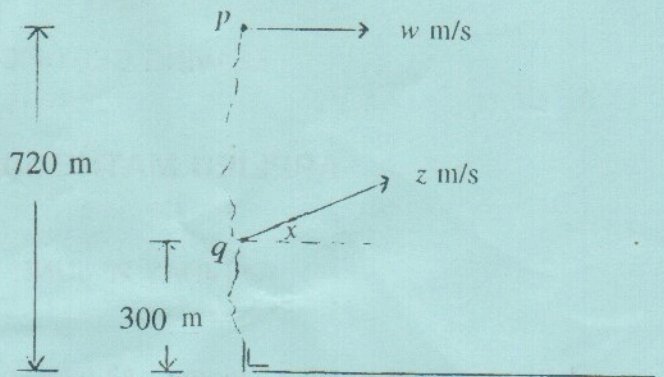
How long does it take A to reach k ?
How far from k is B at this time ?

Find the velocity of A relative to B.
Calculate the shortest distance between the cars.

3. On a cliff face, p is a point 720 m above sea level and q is another point 300 m above sea level and is vertically below p .

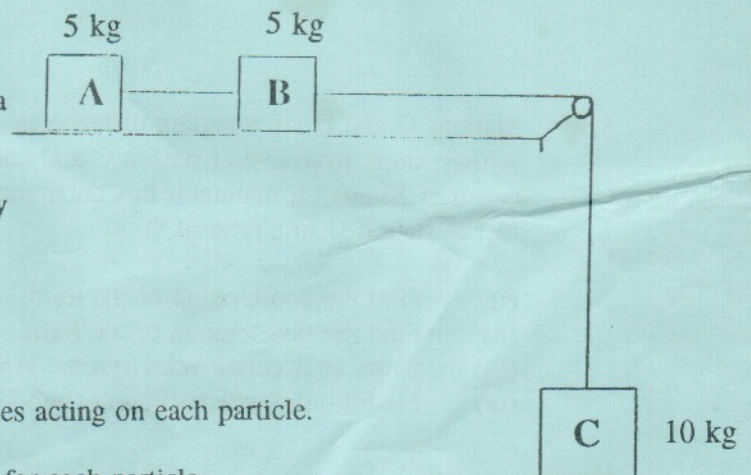
A particle is projected horizontally out to sea from p with an initial speed of w m/s.

At the same instant a second particle is projected out to sea from q with an initial speed of z m/s inclined at an angle x to the horizontal, where $\tan x = \frac{5}{12}$.



- Show that it takes 12 s for the particle projected from p to strike the sea.
- Find the value of z so that the two particles strike the sea at the same time.
- How far from the base of the cliff does the second particle strike the sea?
- If the two particles strike the sea at the same point, find the value of w .

4. Two particles, A and B, each of mass 5 kg, are connected by a light inelastic string on a smooth horizontal table. The particle B is connected by means of a second light inelastic string passing over a smooth pulley at the edge of the table to a third particle C, of mass 10 kg, hanging freely.



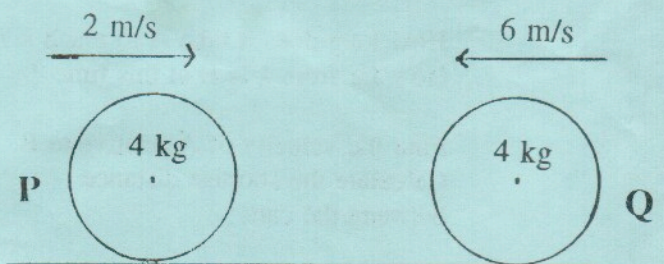
The system is released from rest.

- Show on separate diagrams the forces acting on each particle.
- Write down the equation of motion for each particle.
- Hence find the acceleration of the particle and the tensions in the two strings.

5. Two smooth spheres, P and Q, each of mass 4 kg and travelling in opposite directions with speeds of 2 m/s and 6 m/s, respectively, collide directly on a smooth horizontal table.

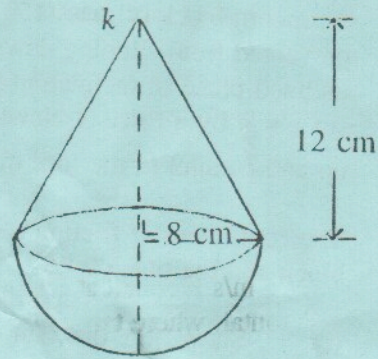
The coefficient of restitution for the collision is e .

Find, in terms of e , the speed of sphere P and the speed of sphere Q after the collision.



If the loss in kinetic energy due to the collision is 28 Joules, find the value of e .

6. (a) A toy consists of a solid hemisphere surmounted by a solid, right cone. The mass of the hemisphere is ten times the mass of the cone. The cone is of height 12 cm and the base radius of the cone is 8 cm.

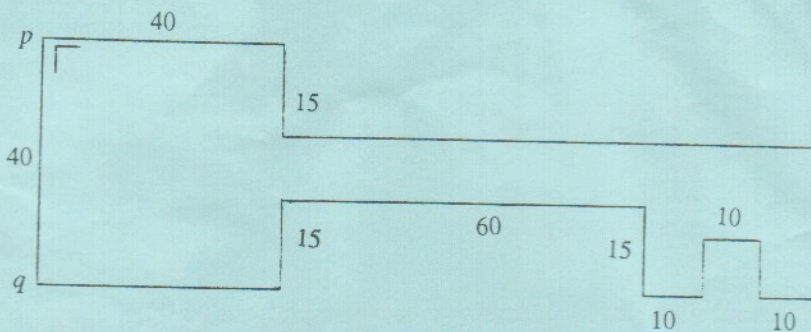


Find the distance of the centre of gravity of the toy from the apex, k of the cone.

Refer to Tables, page 40.

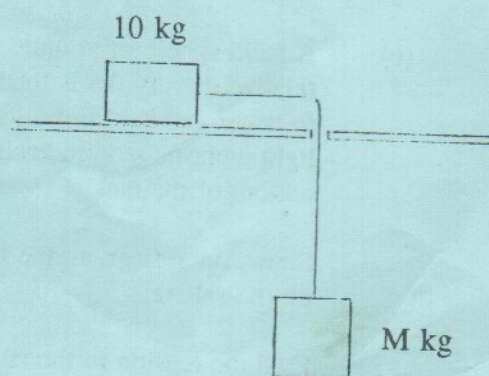
- (b) A locksmith has an advertising sign, made of uniform sheet metal in the shape of a key, with dimensions in cm as shown. Angles in the diagram are right angles.

Find, to the nearest cm, the distance of gravity of the sign from $[pq]$.



7. A particle of mass 10 kg is connected by a light inextensible string which passes through a hole in a table to another particle of mass M kg which hangs freely and remains at rest.

The first particle describes a circle of constant radius 0.4 m on the smooth horizontal table at a constant angular velocity of 1.5 rad/s, the hole being in the centre of the circle.



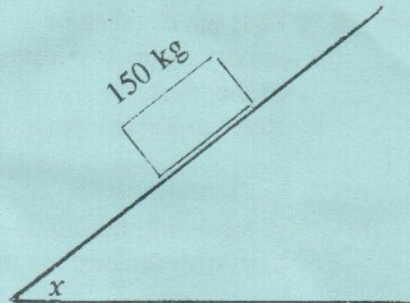
- Draw separate diagrams showing the forces acting on each mass.
- Calculate the tension in the string.
- Find the value of M .
- Find the speed of the particle on the table.

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8. A smooth block of mass 150 kg is just prevented from slipping down a rough inclined plane of inclination x , where $\sin x = \frac{3}{5}$, by a force X Newtons acting up and parallel to the face of the plane.

The coefficient of friction between the block and the plane is $\frac{1}{3}$

- (i) Show on a diagram, the forces acting on the block.
- (ii) Find the normal reaction between the plane and the block.
- (iii) Find the force of friction.
- (iv) Calculate the value of X .



9. (a) Brass of mass 10 kg is made of 8 kg of copper 2 kg of zinc. The relative density of copper is 8.9 and the relative density of zinc is 6.8.

Find the relative density of the brass, correct to one decimal place.

- (b) A solid sphere of volume 0.5 m^3 and relative density 0.6 is totally immersed in water and held in position by a light inelastic string attached to the bottom of the tank.

Show, on a diagram, the forces acting on the sphere.

Find the tension in the string.
(Density of water = 1000 kg/m^3).

