

- 1 A stone is released from rest on a bridge and falls vertically into a lake. The stone has velocity 14 m s^{-1} when it enters the lake.

(i) Calculate the distance the stone falls before it enters the lake, and the time after its release when it enters the lake. [4]

The lake is 15 m deep and the stone has velocity 20 m s^{-1} immediately before it reaches the bed of the lake.

(ii) Given that there is no sudden change in the velocity of the stone when it enters the lake, find the acceleration of the stone while it is falling through the lake. [3]

- 2 A particle P is projected down a line of greatest slope on a smooth inclined plane. P has velocity 5 m s^{-1} at the instant when it has been in motion for 1.6 s and travelled a distance of 6.4 m. Calculate

(i) the initial speed and the acceleration of P , [5]

(ii) the inclination of the plane to the vertical. [3]

- 3 Two forces each of magnitude 4 N have a resultant of magnitude 6 N.

(i) Calculate the angle between the two 4 N forces. [4]

The two given forces of magnitude 4 N act on a particle of mass m kg which remains at rest on a smooth horizontal surface. The surface exerts a force of magnitude 3 N on the particle.

(ii) Find m , and give the acute angle between the surface and one of the 4 N forces. [3]

4



Four particles A , B , C and D are on the same straight line on a smooth horizontal table. A has speed 6 m s^{-1} and is moving towards B . The speed of B is 2 m s^{-1} and B is moving towards A . The particle C is moving with speed 5 m s^{-1} away from B and towards D , which is stationary (see diagram). The first collision is between A and B which have masses 0.8 kg and 0.2 kg respectively.

(i) After the particles collide A has speed 4 m s^{-1} in its original direction of motion. Calculate the speed of B after the collision. [4]

The second collision is between C and D which have masses 0.3 kg and 0.1 kg respectively.

(ii) The particles coalesce when they collide. Find the speed of the combined particle after this collision. [3]

The third collision is between B and the combined particle, after which no further collisions occur.

(iii) Calculate the greatest possible speed of the combined particle after the third collision. [4]

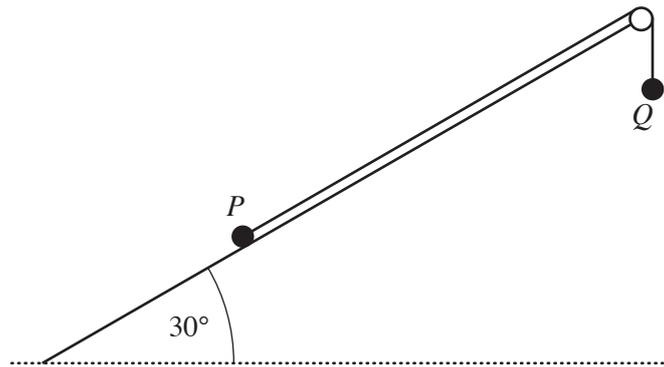
- 5 Three forces act on a particle. The first force has magnitude P N and acts horizontally due east. The second force has magnitude 5 N and acts horizontally due west. The third force has magnitude $2P$ N and acts vertically upwards. The resultant of these three forces has magnitude 25 N.

(i) Calculate P and the angle between the resultant and the vertical. [7]

The particle has mass 3 kg and rests on a rough horizontal table. The coefficient of friction between the particle and the table is 0.15.

(ii) Find the acceleration of the particle, and state the direction in which it moves. [5]

6



Two particles P and Q are attached to opposite ends of a light inextensible string which passes over a small smooth pulley at the top of a rough plane inclined at 30° to the horizontal. P has mass 0.2 kg and is held at rest on the plane. Q has mass 0.2 kg and hangs freely. The string is taut (see diagram). The coefficient of friction between P and the plane is 0.4. The particle P is released.

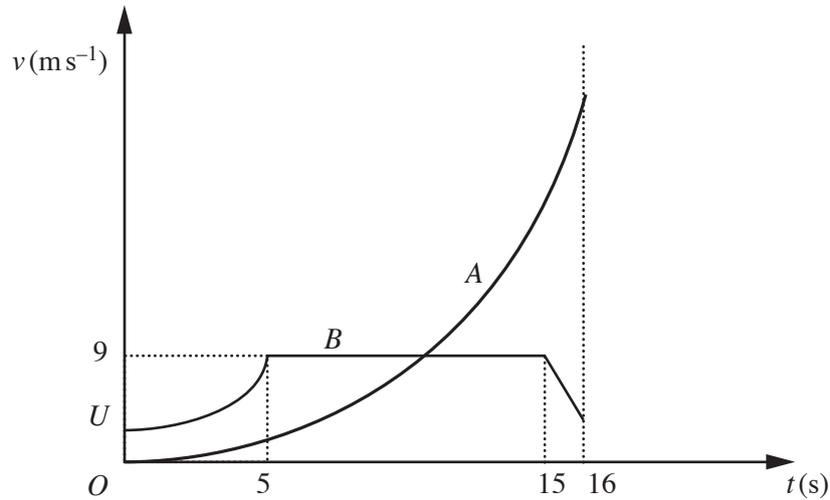
(i) State the tension in the string before P is released, and find the tension in the string after P is released. [6]

Q strikes the floor and remains at rest. P continues to move up the plane for a further distance of 0.8 m before it comes to rest. P does not reach the pulley.

(ii) Find the speed of the particles immediately before Q strikes the floor. [5]

(iii) Calculate the magnitude of the contact force exerted on P by the plane while P is in motion. [3]

Question 7 begins on page 4.



The diagram shows the (t, v) graphs for two particles A and B which move on the same straight line. The units of v and t are ms^{-1} and s respectively. Both particles are at the point S on the line when $t = 0$. The particle A is initially at rest, and moves with acceleration $0.18t \text{ms}^{-2}$ until the two particles collide when $t = 16$. The initial velocity of B is $U \text{ms}^{-1}$ and B has variable acceleration for the first five seconds of its motion. For the next ten seconds of its motion B has a constant velocity of 9ms^{-1} ; finally B moves with constant deceleration for one second before it collides with A .

- (i) Calculate the value of t at which the two particles have the same velocity. [4]

For $0 \leq t \leq 5$ the distance of B from S is $(Ut + 0.08t^3) \text{m}$.

- (ii) Calculate U and verify that when $t = 5$, B is 25m from S . [4]
- (iii) Calculate the velocity of B when $t = 16$. [5]

END OF QUESTION PAPER

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