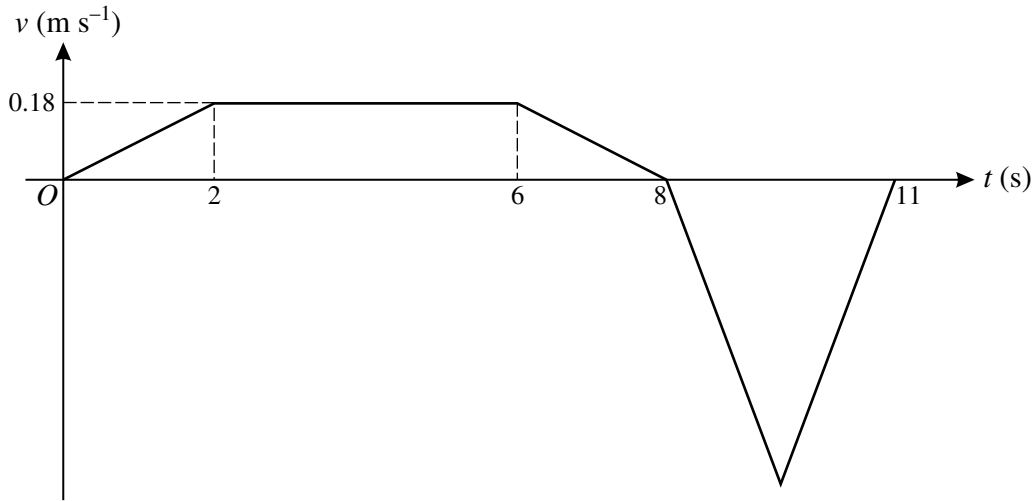


- 1 A car of mass 1150 kg travels up a straight hill inclined at 1.2° to the horizontal. The resistance to motion of the car is 975 N. Find the acceleration of the car at an instant when it is moving with speed 16 m s^{-1} and the engine is working at a power of 35 kW. [4]

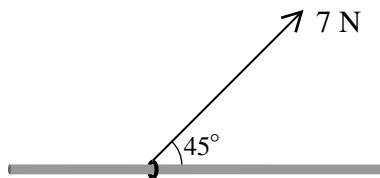
2



The diagram shows the velocity-time graph for the motion of a machine's cutting tool. The graph consists of five straight line segments. The tool moves forward for 8 s while cutting and then takes 3 s to return to its starting position. Find

- (i) the acceleration of the tool during the first 2 s of the motion, [1]
(ii) the distance the tool moves forward while cutting, [2]
(iii) the greatest speed of the tool during the return to its starting position. [2]

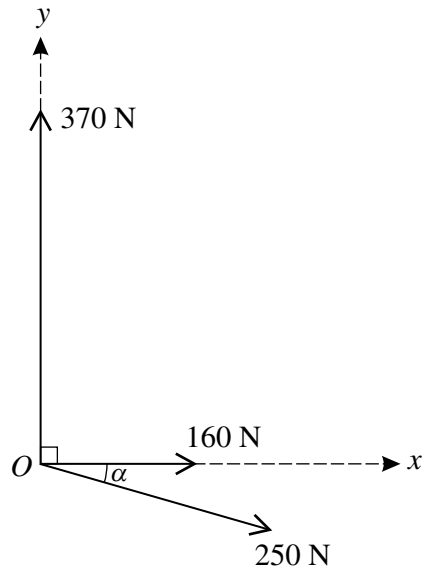
3



A small ring of mass 0.8 kg is threaded on a rough rod which is fixed horizontally. The ring is in equilibrium, acted on by a force of magnitude 7 N pulling upwards at 45° to the horizontal (see diagram).

- (i) Show that the normal component of the contact force acting on the ring has magnitude 3.05 N, correct to 3 significant figures. [2]
(ii) The ring is in limiting equilibrium. Find the coefficient of friction between the ring and the rod. [3]

4



Coplanar forces of magnitudes 250 N , 160 N and 370 N act at a point O in the directions shown in the diagram, where the angle α is such that $\sin \alpha = 0.28$ and $\cos \alpha = 0.96$. Calculate the magnitude of the resultant of the three forces. Calculate also the angle that the resultant makes with the x -direction.

[7]

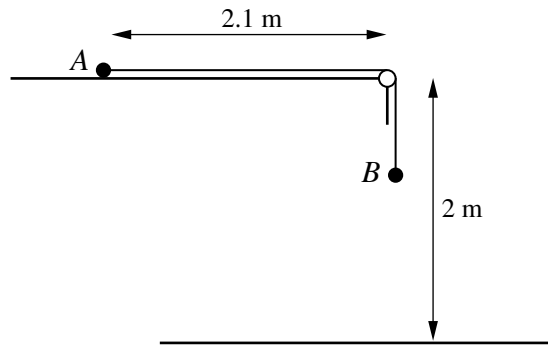
5 P and Q are fixed points on a line of greatest slope of an inclined plane. The point Q is at a height of 0.45 m above the level of P . A particle of mass 0.3 kg moves upwards along the line PQ .

(i) Given that the plane is smooth and that the particle just reaches Q , find the speed with which it passes through P . [3]

(ii) It is given instead that the plane is rough. The particle passes through P with the same speed as that found in part (i), and just reaches a point R which is between P and Q . The work done against the frictional force in moving from P to R is 0.39 J . Find the potential energy gained by the particle in moving from P to R and hence find the height of R above the level of P . [4]

[Questions 6 and 7 are printed on the next page.]

6



Particles A and B , of masses 0.2 kg and 0.45 kg respectively, are connected by a light inextensible string of length 2.8 m . The string passes over a small smooth pulley at the edge of a rough horizontal surface, which is 2 m above the floor. Particle A is held in contact with the surface at a distance of 2.1 m from the pulley and particle B hangs freely (see diagram). The coefficient of friction between A and the surface is 0.3 . Particle A is released and the system begins to move.

- (i) Find the acceleration of the particles and show that the speed of B immediately before it hits the floor is 3.95 m s^{-1} , correct to 3 significant figures. [7]
- (ii) Given that B remains on the floor, find the speed with which A reaches the pulley. [4]

7 A vehicle is moving in a straight line. The velocity $v \text{ m s}^{-1}$ at time $t \text{ s}$ after the vehicle starts is given by

$$v = A(t - 0.05t^2) \quad \text{for } 0 \leq t \leq 15,$$

$$v = \frac{B}{t^2} \quad \text{for } t \geq 15,$$

where A and B are constants. The distance travelled by the vehicle between $t = 0$ and $t = 15$ is 225 m .

- (i) Find the value of A and show that $B = 3375$. [5]
- (ii) Find an expression in terms of t for the total distance travelled by the vehicle when $t \geq 15$. [3]
- (iii) Find the speed of the vehicle when it has travelled a total distance of 315 m . [3]

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