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1.

Figure 1

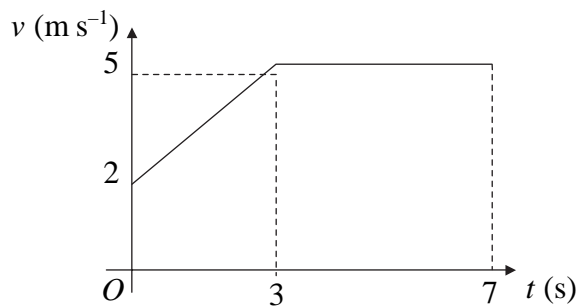


Figure 1 shows the speed-time graph of a cyclist moving on a straight road over a 7 s period. The sections of the graph from $t = 0$ to $t = 3$, and from $t = 3$ to $t = 7$, are straight lines. The section from $t = 3$ to $t = 7$ is parallel to the t -axis.

State what can be deduced about the motion of the cyclist from the fact that

- (a) the graph from $t = 0$ to $t = 3$ is a straight line, (1)
- (b) the graph from $t = 3$ to $t = 7$ is parallel to the t -axis. (1)
- (c) Find the distance travelled by the cyclist during this 7 s period. (4)



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2. Two particles A and B have mass 0.4 kg and 0.3 kg respectively. They are moving in opposite directions on a smooth horizontal table and collide directly. Immediately before the collision, the speed of A is 6 m s^{-1} and the speed of B is 2 m s^{-1} . As a result of the collision, the direction of motion of B is reversed and its speed immediately after the collision is 3 m s^{-1} . Find

(a) the speed of A immediately after the collision, stating clearly whether the direction of motion of A is changed by the collision, (4)

(b) the magnitude of the impulse exerted on B in the collision, stating clearly the units in which your answer is given. (3)



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3. A train moves along a straight track with constant acceleration. Three telegraph poles are set at equal intervals beside the track at points *A*, *B* and *C*, where $AB = 50$ m and $BC = 50$ m. The front of the train passes *A* with speed 22.5 m s^{-1} , and 2 s later it passes *B*. Find

(a) the acceleration of the train, (3)

(b) the speed of the front of the train when it passes *C*, (3)

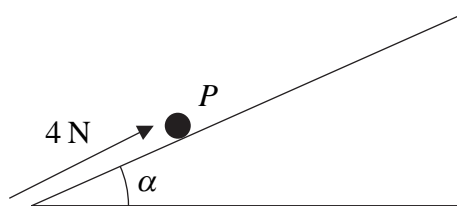
(c) the time that elapses from the instant the front of the train passes *B* to the instant it passes *C*. (4)



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4.

Figure 2



A particle P of mass 0.5 kg is on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The particle is held at rest on the plane by the action of a force of magnitude 4 N acting up the plane in a direction parallel to a line of greatest slope of the plane, as shown in Figure 2. The particle is on the point of slipping up the plane.

- (a) Find the coefficient of friction between P and the plane. (7)

The force of magnitude 4 N is removed.

- (b) Find the acceleration of P down the plane. (4)



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Question 4 continued

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Q4

(Total 11 marks)

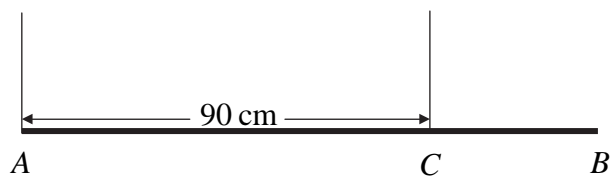
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5.

Figure 3



A steel girder AB has weight 210 N . It is held in equilibrium in a horizontal position by two vertical cables. One cable is attached to the end A . The other cable is attached to the point C on the girder, where $AC = 90\text{ cm}$, as shown in Figure 3. The girder is modelled as a uniform rod, and the cables as light inextensible strings.

Given that the tension in the cable at C is twice the tension in the cable at A , find

(a) the tension in the cable at A , (2)

(b) show that $AB = 120\text{ cm}$. (4)

A small load of weight W newtons is attached to the girder at B . The load is modelled as a particle. The girder remains in equilibrium in a horizontal position. The tension in the cable at C is now three times the tension in the cable at A .

(c) Find the value of W . (7)



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Question 5 continued

[Lined area for writing answers to Question 5 continued]

(Total 13 marks)

Q5

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N 2 2 3 3 1 A 0 1 1 1 6

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6. A car is towing a trailer along a straight horizontal road by means of a horizontal tow-rope. The mass of the car is 1400 kg. The mass of the trailer is 700 kg. The car and the trailer are modelled as particles and the tow-rope as a light inextensible string. The resistances to motion of the car and the trailer are assumed to be constant and of magnitude 630 N and 280 N respectively. The driving force on the car, due to its engine, is 2380 N. Find

(a) the acceleration of the car, (3)

(b) the tension in the tow-rope. (3)

When the car and trailer are moving at 12 m s⁻¹, the tow-rope breaks. Assuming that the driving force on the car and the resistances to motion are unchanged,

(c) find the distance moved by the car in the first 4 s after the tow-rope breaks. (6)

(d) State how you have used the modelling assumption that the tow-rope is inextensible. (1)

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Question 6 continued

Lined area for writing the answer to Question 6 continued.

Q6

(Total 13 marks)



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7. [In this question the unit vectors \mathbf{i} and \mathbf{j} are due east and north respectively.]

A ship S is moving with constant velocity $(-2.5\mathbf{i} + 6\mathbf{j}) \text{ km h}^{-1}$. At time 1200, the position vector of S relative to a fixed origin O is $(16\mathbf{i} + 5\mathbf{j}) \text{ km}$. Find

- (a) the speed of S , (2)

- (b) the bearing on which S is moving. (2)

The ship is heading directly towards a submerged rock R . A radar tracking station calculates that, if S continues on the same course with the same speed, it will hit R at the time 1500.

- (c) Find the position vector of R . (2)

The tracking station warns the ship's captain of the situation. The captain maintains S on its course with the same speed until the time is 1400. He then changes course so that S moves due north at a constant speed of 5 km h^{-1} . Assuming that S continues to move with this new constant velocity, find

- (d) an expression for the position vector of the ship t hours after 1400, (4)

- (e) the time when S will be due east of R , (2)

- (f) the distance of S from R at the time 1600. (3)



