

1.

Figure 1

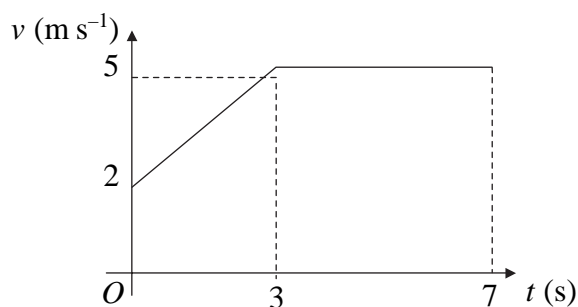


Figure 1 shows the speed-time graph of a cyclist moving on a straight road over a 7 s period. The sections of the graph from $t = 0$ to $t = 3$, and from $t = 3$ to $t = 7$, are straight lines. The section from $t = 3$ to $t = 7$ is parallel to the t -axis.

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)



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

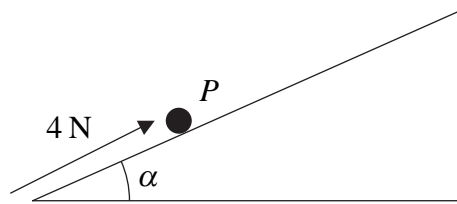
(a) the speed of *A* immediately after the collision, stating clearly whether the direction of motion of *A* is changed by the collision, (4)

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



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)



Question 5 continued

Lined writing area for the question.

(Total 13 marks)

Q5	
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N 2 2 3 3 1 A 0 1 1 1 6

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)



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)



