

3. A particle P is moving with constant acceleration $(-4\mathbf{i} + \mathbf{j})\text{ms}^{-2}$

At time $t = 0$, P has velocity $(14\mathbf{i} - 5\mathbf{j})\text{ms}^{-1}$

(a) Find the speed of P at time $t = 2$ seconds.

(3)

(b) Find the size of the angle between the direction of \mathbf{i} and the direction of motion of P at time $t = 2$ seconds.

(3)

At time $t = T$ seconds, P is moving in the direction of vector $(2\mathbf{i} - 3\mathbf{j})$

(c) Find the value of T

(4)



6. [In this question \mathbf{i} and \mathbf{j} are horizontal unit vectors directed due east and due north respectively and position vectors are given relative to a fixed origin O .]

At 12:00, a ship P sets sail from a harbour with position vector $(15\mathbf{i} + 36\mathbf{j})$ km.
At 12:30, P is at the point with position vector $(20\mathbf{i} + 34\mathbf{j})$ km.

Given that P moves with constant velocity,

- (a) show that the velocity of P is $(10\mathbf{i} - 4\mathbf{j})$ km h⁻¹ (2)

At time t hours after 12:00, the position vector of P is \mathbf{p} km.

- (b) Find an expression for \mathbf{p} in terms of \mathbf{i} , \mathbf{j} and t . (2)

A second ship Q is also travelling at a constant velocity.

At time t hours after 12:00, the position vector of Q is given by \mathbf{q} km, where

$$\mathbf{q} = (42 - 8t)\mathbf{i} + (9 + 14t)\mathbf{j}$$

Ships P and Q are modelled as particles.

If both ships maintained their course,

- (c) (i) verify that they would collide at 13:30
(ii) find the position vector of the point at which the collision would occur. (4)

At 12:30 Q changes speed and direction to avoid the collision.

Ship Q now travels due north with a constant speed of 15 km h⁻¹

Ship P maintains the same constant velocity throughout.

- (d) Find the exact distance between P and Q at 14:30 (7)

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

A particle P moves with constant acceleration $(-\lambda\mathbf{i} + 2\lambda\mathbf{j})\text{ m s}^{-2}$, where λ is a positive constant.

At time $t = 0$, the velocity of P is $(5\mathbf{i} - 8\mathbf{j})\text{ m s}^{-1}$

- (a) Find the velocity of P when $t = 5$ s, giving your answer in terms of \mathbf{i} , \mathbf{j} and λ .

(2)

The speed of P when $t = 5$ s is 13 m s^{-1}

- (b) Show that

$$25\lambda^2 - 42\lambda - 16 = 0$$

(3)

- (c) Find the direction of motion of P when $t = 4$ s, giving your answer as a bearing to the nearest degree.

(5)

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