Constant Acceleration in Two Dimensions (From Edexcel 6677)

Q1, (Jun 2010, Q1)

A particle P is moving with constant velocity $(-3\mathbf{i}+2\mathbf{j})$ m s^{-1}. At time $t=6$ s P is at the point with position vector $(-4\mathbf{i}-7\mathbf{j})$ m. Find the distance of P from the origin at time $t=2$ s.

(5)

Q2, (Jan 2009, Q1)

A particle P moves with constant acceleration $(2\mathbf{i} - 5\mathbf{j})$ m s^{-2}. At time $t = 0$, P has speed u m s^{-1}. At time $t = 3$ s, P has velocity $(-6\mathbf{i} + \mathbf{j})$ m s^{-1}.

Find the value of u.

(5)

Q3, (Jan 2005, Q7)

Two ships P and Q are travelling at night with constant velocities. At midnight, P is at the point with position vector $(20\mathbf{i} + 10\mathbf{j})$ km relative to a fixed origin O. At the same time, Q is at the point with position vector $(14\mathbf{i} - 6\mathbf{j})$ km. Three hours later, P is at the point with position vector $(29\mathbf{i} + 34\mathbf{j})$ km. The ship Q travels with velocity $12\mathbf{j}$ km h^{-1}. At time t hours after midnight, the position vectors of P and Q are $\mathbf{p}$ km and $\mathbf{q}$ km respectively. Find

(a) the velocity of P, in terms of $\mathbf{i}$ and $\mathbf{j}$,

(2)

(b) expressions for $\mathbf{p}$ and $\mathbf{q}$, in terms of t, $\mathbf{i}$ and $\mathbf{j}$.

(4)

At time t hours after midnight, the distance between P and Q is d km.

(c) By finding an expression for $\overrightarrow{PQ}$, show that

$$d^2 = 25t^2 - 92t + 292.$$

(5)

Weather conditions are such that an observer on P can only see the lights on Q when the distance between P and Q is 15 km or less. Given that when $t = 1$, the lights on Q move into sight of the observer,

(d) find the time, to the nearest minute, at which the lights on Q move out of sight of the observer.

(5)

Q4, (Jun 2006, Q7)

[*In this question the unit vectors* **i** *and* **j** *are due east and north respectively.*]

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

Q5, (Jan 2011, Q4)

A particle P of mass 2 kg is moving under the action of a constant force **F** newtons. The velocity of P is $(2\mathbf{i}-5\mathbf{j})$ m s^{-1} at time $t=0$, and $(7\mathbf{i}+10\mathbf{j})$ m s^{-1} at time $t=5$ s.

Find

(a) the speed of P at $t=0$,

(2)

(b) the vector **F** in the form $a\mathbf{i}+b\mathbf{j}$,

(5)

(c) the value of t when P is moving parallel to **i**.

(4)

Q6, (Jun 2007, Q7)

A boat B is moving with constant velocity. At noon, B is at the point with position vector $(3\mathbf{i}-4\mathbf{j})$ km with respect to a fixed origin O. At 1430 on the same day, B is at the point with position vector $(8\mathbf{i}+11\mathbf{j})$ km.

(a) Find the velocity of B, giving your answer in the form $p\mathbf{i}+q\mathbf{j}$.

(3)

At time t hours after noon, the position vector of B is **b** km.

(b) Find, in terms of t, an expression for **b**.

(3)

Another boat C is also moving with constant velocity. The position vector of C, **c** km, at time t hours after noon, is given by

$$\mathbf{c}=(-9\mathbf{i}+20\mathbf{j})+t(6\mathbf{i}+\lambda\mathbf{j}),$$

where λ is a constant. Given that C intercepts B,

(c) find the value of λ,

(5)

(d) show that, before C intercepts B, the boats are moving with the same speed.

(3)

Q7, (Jun 2013(R), Q6)

[In this question **i** *and* **j** *are horizontal unit vectors due east and due north respectively. Position vectors are given with respect to a fixed origin O.]*

A ship S is moving with constant velocity $(3\mathbf{i} + 3\mathbf{j})$ km h^{-1}. At time $t = 0$, the position vector of S is $(-4\mathbf{i} + 2\mathbf{j})$ km.

(a) Find the position vector of S at time t hours.

(2)

A ship T is moving with constant velocity $(-2\mathbf{i} + n\mathbf{j})$ km h^{-1}. At time $t = 0$, the position vector of T is $(6\mathbf{i} + \mathbf{j})$ km. The two ships meet at the point P.

(b) Find the value of n.

(5)

(c) Find the distance OP.

(4)

Q8, (Jun 2013, Q7)

[In this question, the horizontal unit vectors **i** *and* **j** *are directed due east and due north respectively.]*

The velocity, **v** m s^{-1}, of a particle P at time t seconds is given by

$$\mathbf{v} = (1 - 2t)\mathbf{i} + (3t - 3)\mathbf{j}$$

(a) Find the speed of P when $t = 0$

(3)

(b) Find the bearing on which P is moving when $t = 2$

(2)

(c) Find the value of t when P is moving

(i) parallel to **j**,

(ii) parallel to $(-\mathbf{i} - 3\mathbf{j})$.

(6)
