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

Two particles, A and B, are moving on a smooth horizontal surface.
Each particle is moving with constant velocity.

At time t seconds, the position vector of A is given by $\mathbf{r}$ metres.

- When $t = 2$, $\mathbf{r} = (-5\mathbf{i} + 16\mathbf{j})$
- When $t = 5$, $\mathbf{r} = (10\mathbf{i} + 4\mathbf{j})$

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

(2)

(b) Find an expression for $\mathbf{r}$ at time t seconds.
Give your answer in the form $p\mathbf{i} + q\mathbf{j}$, where p and q are functions of t

(2)

At time t seconds, the position vector of B is given by $\mathbf{s}$ metres where

$$\mathbf{s} = -5\mathbf{i} + 7\mathbf{j} + t(2\mathbf{i} - 3\mathbf{j})$$

(c) Find, to the nearest degree, the bearing of B from A when $t = 5$

(3)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

Leave blank

5. [*In this question* **i** *and* **j** *are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O.*]

A particle P is moving in a straight line with constant velocity. At 9 am, the position vector of P is $(7\mathbf{i} + 5\mathbf{j})$ km and at 9.20 am, the position vector of P is $6\mathbf{i}$ km. At time t hours after 9 am, the position vector of P is $\mathbf{r}_P$ km.

(a) Find, in km h^{-1}, the speed of P.

(4)

(b) Show that $\mathbf{r}_P = (7 - 3t)\,\mathbf{i} + (5 - 15t)\,\mathbf{j}$.

(2)

(c) Find the value of t when $\mathbf{r}_P$ is parallel to $16\mathbf{i} + 5\mathbf{j}$.

(4)

The position vector of another particle Q, at time t hours after 9 am, is $\mathbf{r}_Q$ km, where $\mathbf{r}_Q = (5 + 2t)\,\mathbf{i} + (-3 + 5t)\,\mathbf{j}$

(d) Show that P and Q will collide and find the position vector of the point of collision.

(5)

Leave blank

7. A particle P moves from point A to point B with constant acceleration $(c\mathbf{i} + d\mathbf{j})$ m s^{-2}, where c and d are positive constants. The velocity of P at A is $(-3\mathbf{i} - 3\mathbf{j})$ m s^{-1} and the velocity of P at B is $(2\mathbf{i} + 9\mathbf{j})$ m s^{-1}. The magnitude of the acceleration of P is 2.6 m s^{-2}.

Find the value of c and the value of d.

(5)

Leave blank

7. A force **F** is given by **F** = (9**i** + 13**j**) N.

(a) Find the size of the angle between the direction of **F** and the vector **j**.

(3)

The force **F** is the resultant of two forces **P** and **Q**. The line of action of **P** is parallel to the vector (2**i** – **j**). The line of action of **Q** is parallel to the vector (**i** + 3**j**).

(b) Find, in terms of **i** and **j**,

(i) the force **P**,

(ii) the force **Q**.

(9)

[*In this question* **i** *and* **j** *are horizontal perpendicular unit vectors.*]

2. A particle P rests in equilibrium on a smooth horizontal plane.

A system of **three** forces, $\mathbf{F}_1$ N, $\mathbf{F}_2$ N and $\mathbf{F}_3$ N where

$$\mathbf{F}_1 = (3c\mathbf{i} + 4c\mathbf{j})$$
$$\mathbf{F}_2 = (-14\mathbf{i} + 7\mathbf{j})$$

is applied to P.

Given that P remains in equilibrium,

(a) find $\mathbf{F}_3$ in terms of c, **i** and **j**.

(2)

The force $\mathbf{F}_3$ is **removed** from the system.

Given that $c = 2$

(b) find the size of the angle between the direction of **i** and the direction of the resultant force acting on P.

(4)

The mass of P is m kg.

Given that the magnitude of the acceleration of P is $8.5\,\text{m s}^{-2}$

(c) find the value of m.

(4)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA