Leave blank

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

A particle P is moving with constant velocity $(-6\mathbf{i} + 2\mathbf{j})$ m s^{-1}. At time $t = 0$, P passes through the point with position vector $(21\mathbf{i} + 5\mathbf{j})$ m, relative to a fixed origin O.

(a) Find the direction of motion of P, giving your answer as a bearing to the nearest degree.

(3)

(b) Write down the position vector of P at time t seconds.

(1)

(c) Find the time at which P is north-west of O.

(3)

Leave blank

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

A particle P is moving with velocity $(\mathbf{i} - 2\mathbf{j})$ km h^{-1}. At time $t = 0$ hours, the position vector of P is $(-5\mathbf{i} + 9\mathbf{j})$ km. At time t hours, the position vector of P is $\mathbf{p}$ km.

(a) Find an expression for $\mathbf{p}$ in terms of t.

(2)

The point A has position vector $(3\mathbf{i} + 2\mathbf{j})$ km.

(b) Find the position vector of P when P is due west of A.

(4)

Another particle Q is moving with velocity $\left[(2b - 1)\mathbf{i} + (5 - 2b)\mathbf{j}\right]$ km h^{-1} where b is a constant.

Given that the particles are moving along parallel lines,

(c) find the value of b.

(4)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

7. [*In this question, the horizontal unit vectors* **i** *and* **j** *are directed due east and due north respectively and position vectors are given relative to a fixed origin O.*]

Two speedboats, A and B, are each moving with constant velocity.

- the velocity of A is $40\,\text{km h}^{-1}$ due east
- the velocity of B is $20\,\text{km h}^{-1}$ on a bearing of angle α $(0° < \alpha < 90°)$, where $\tan\alpha = \frac{4}{3}$

The boats are modelled as particles.

(a) Find, in terms of **i** and **j**, the velocity of B in km h^{-1}

(2)

At noon

- the position vector of A is $20\mathbf{j}\,\text{km}$
- the position vector of B is $(10\mathbf{i} + 5\mathbf{j})\,\text{km}$

At time t hours after noon

- the position vector of A is $\mathbf{r}\,\text{km}$, where $\mathbf{r} = 20\mathbf{j} + 40t\mathbf{i}$
- the position vector of B is $\mathbf{s}\,\text{km}$

(b) Find an expression for $\mathbf{s}$ in terms of t, **i** and **j**.

(2)

(c) Show that at time t hours after noon,

$$\overrightarrow{AB} = [(10 - 24t)\mathbf{i} + (12t - 15)\mathbf{j}]\,\text{km}$$

(2)

(d) Show that the boats will never collide.

(3)

(e) Find the distance between the boats when the bearing of B from A is 225°

(4)

Leave blank

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

A particle P of mass 2 kg moves under the action of two forces, $(2\mathbf{i} + 3\mathbf{j})$ N and $(4\mathbf{i} - 5\mathbf{j})$ N.

(a) Find the magnitude of the acceleration of P.

(4)

At time $t = 0$, P has velocity $(-u\mathbf{i} + u\mathbf{j})$ m s^{-1}, where u is a positive constant.

At time $t = T$ seconds, P has velocity $(10\mathbf{i} + 2\mathbf{j})$ m s^{-1}.

(b) Find

(i) the value of T,

(ii) the value of u.

(5)

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 horizontal unit vectors due east and due north respectively. Position vectors are given relative to a fixed origin O.*]

A boy B is running in a field with constant velocity $(3\mathbf{i} - 2\mathbf{j})$ m s^{-1}. At time $t = 0$, B is at the point with position vector $10\mathbf{j}$ m.

Find

(a) the speed of B,

(2)

(b) the direction in which B is running, giving your answer as a bearing.

(3)

At time $t = 0$, a girl G is at the point with position vector $(4\mathbf{i} - 2\mathbf{j})$ m. The girl is running with constant velocity $\left(\frac{5}{3}\mathbf{i} + 2\mathbf{j}\right)$ m s^{-1} and meets B at the point P.

(c) Find

(i) the value of t when they meet,

(ii) the position vector of P.

(6)