6. [*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.*]

Two ships, P and Q, are moving with constant velocities. The velocity of P is $(3\mathbf{i} - 2\mathbf{j})\,\text{km h}^{-1}$ and the velocity of Q is $(5\mathbf{i} + 6\mathbf{j})\,\text{km h}^{-1}$.

At 9 am, the position vector of P is $(\mathbf{i} + 4\mathbf{j})\,\text{km}$ and the position vector of Q is $(7\mathbf{i} + 8\mathbf{j})\,\text{km}$.

(a) (i) Write down the position vector of P at time t hours after 9 am.

(ii) Write down the position vector of Q at time t hours after 9 am.

(3)

At time t hours after 9 am, $\overrightarrow{QP} = \mathbf{r}\,\text{km}$.

(b) Show that $\mathbf{r} = (-6 - 2t)\mathbf{i} + (-4 - 8t)\mathbf{j}$

(2)

(c) Hence find the distance between the ships when P is south west of Q.

(5)

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

Two forces $\mathbf{F}_1$ and $\mathbf{F}_2$ act on a particle P of mass 0.5 kg.

$\mathbf{F}_1 = (4\mathbf{i} - 6\mathbf{j})$ N and $\mathbf{F}_2 = (p\mathbf{i} + q\mathbf{j})$ N.

Given that the resultant force of $\mathbf{F}_1$ and $\mathbf{F}_2$ is in the same direction as $-2\mathbf{i} - \mathbf{j}$,

(a) show that $p - 2q = -16$

(5)

Given that $q = 3$

(b) find the magnitude of the acceleration of P,

(5)

(c) find the direction of the acceleration of P, giving your answer as a bearing to the nearest degree.

(3)

6(a)	(i) $\mathbf{r}_P = (\mathbf{i} + 4\mathbf{j}) + t(3\mathbf{i} - 2\mathbf{j})$ (ii) $\mathbf{r}_Q = (7\mathbf{i} + 8\mathbf{j}) + t(5\mathbf{i} + 6\mathbf{j})$	M1 A1 A1 (3)
(b)	$\mathbf{QP} = (\mathbf{i} + 4\mathbf{j}) + t(3\mathbf{i} - 2\mathbf{j}) - [(7\mathbf{i} + 8\mathbf{j}) + t(5\mathbf{i} + 6\mathbf{j})]$ $= (-6 - 2t)\mathbf{i} + (-4 - 8t)\mathbf{j}$ Given Answer	M1 A1 (2)
(c)	$(-6 - 2t) = (-4 - 8t)$ $t = \frac{1}{3}$ $\mathbf{QP} = (-6 - \frac{2}{3})\mathbf{i} + (-4 - \frac{8}{3})\mathbf{j}$ $QP = \sqrt{\left(-\frac{20}{3}\right)^2 + \left(-\frac{20}{3}\right)^2}$ $= \frac{20\sqrt{2}}{3} = 9.4$ km (or better)	M1 A1 M1 M1 A1 (5)

6.(a)	$(4\mathbf{i} - 6\mathbf{j}) + (p\mathbf{i} + q\mathbf{j}) = (4 + p)\mathbf{i} + (q - 6)\mathbf{j}$	M1
	$\frac{(4+p)}{(q-6)} = \frac{2}{1}$ or $-\frac{2}{1}$ **(or** $\frac{1}{2}$ or $-\frac{1}{2}$)	**DM**1 A1
	$2q - 12 = 4 + p$	
	$p - 2q = -16$ GIVEN ANSWER	**DM**1 A1 (5)
(b)	$q = 3 \Rightarrow p = -10$	B1
	EITHER $0.5\mathbf{a} = -6\mathbf{i} - 3\mathbf{j}$ **OR** $\lvert\mathbf{R}\rvert = \sqrt{(-6)^2 + (-3)^2}$	M1
	$\mathbf{a} = -12\mathbf{i} - 6\mathbf{j}$ $= \sqrt{45}$ oe	A1
	$\lvert\mathbf{a}\rvert = \sqrt{(-12)^2 + (-6)^2}$ $0.5a = \sqrt{45}$	M1
	$a = \sqrt{180} = 13.4\text{ms}^{-2}$ $a = \sqrt{180} = 13.4\text{ms}^{-2}$	A1 (5)
(c)	e.g. $\tan\theta = \frac{12}{6} \Rightarrow \theta = 63.4°$	M1A1
	Bearing $= 180° + 63.4° = 243°$ (nearest degree)	A1cao (3)

7. [*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.*]

Two ships, P and Q, are moving with constant velocities.
The velocity of P is $(9\mathbf{i} - 2\mathbf{j})$ km h^{-1} and the velocity of Q is $(4\mathbf{i} + 8\mathbf{j})$ km h^{-1}

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

(3)

When $t = 0$, the position vector of P is $(9\mathbf{i} + 10\mathbf{j})$ km and the position vector of Q is $(\mathbf{i} + 4\mathbf{j})$ km. At time t hours, the position vectors of P and Q are $\mathbf{p}$ km and $\mathbf{q}$ km respectively.

(b) Find an expression for

(i) $\mathbf{p}$ in terms of t,

(ii) $\mathbf{q}$ in terms of t.

(3)

(c) Hence show that, at time t hours,

$$\overrightarrow{QP} = (8 + 5t)\mathbf{i} + (6 - 10t)\mathbf{j}$$

(2)

(d) Find the values of t when the ships are 10 km apart.

(6)

6. A particle P is moving with constant velocity. The position vector of P at time t seconds $(t \geqslant 0)$ is $\mathbf{r}$ metres, relative to a fixed origin O, and is given by

$$\mathbf{r} = (2t - 3)\mathbf{i} + (4 - 5t)\mathbf{j}$$

(a) Find the initial position vector of P.

(1)

The particle P passes through the point with position vector $(3.4\mathbf{i} - 12\mathbf{j})$ m at time T seconds.

(b) Find the value of T.

(3)

(c) Find the speed of P.

(4)

7(a)	$\tan\theta = \frac{2}{9}$ $\theta = 12.5°$ bearing $103°$	M1 A1 A1 (3)
(b) (i) (ii)	$\mathbf{p} = (9\mathbf{i} + 10\mathbf{j}) + t(9\mathbf{i} - 2\mathbf{j})$ $\mathbf{q} = (\mathbf{i} + 4\mathbf{j}) + t(4\mathbf{i} + 8\mathbf{j})$	M1 A1 A1 (3)
(c)	$\overrightarrow{QP} = (8 + 5t)\mathbf{i} + (6 - 10t)\mathbf{j}$	M1 A1 (2)
(d)	$D^2 = (8 + 5t)^2 + (6 - 10t)^2$ $= 125t^2 - 40t + 100$ $100 = 125t^2 - 40t + 100$ $0 = 5t(25t - 8)$ $t = 0$ or 0.32	M1 A1 M1 M1 A1 A1 (6) **14**

6(a)	$\mathbf{r} = (-3\mathbf{i} + 4\mathbf{j})$ m	B1 (1)
(b)	$3.4 = 2T - 3$ or $-12 = 4 - 5T$ $T = 3.2$	M1 A1 A1 (3)
(c)	$\mathbf{r} = (-3\mathbf{i} + 4\mathbf{j}) + t(2\mathbf{i} - 5\mathbf{j})$ $\mathbf{v} = (2\mathbf{i} - 5\mathbf{j})$ speed $= \sqrt{\left(2^2 + (-5)^2\right)} = \sqrt{29} = 5.4\text{m s}^{-1}$ or better	M1 A1 M1 A1 (4) **8**

1. [*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.*]

Two cars P and Q are moving on straight horizontal roads with constant velocities. The velocity of P is $(15\mathbf{i} + 20\mathbf{j})\ \text{m s}^{-1}$ and the velocity of Q is $(20\mathbf{i} - 5\mathbf{j})\ \text{m s}^{-1}$

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

(3)

At time $t = 0$, the position vector of P is $400\mathbf{i}$ metres and the position vector of Q is $800\mathbf{j}$ metres. At time t seconds, the position vectors of P and Q are $\mathbf{p}$ metres and $\mathbf{q}$ metres respectively.

(b) Find an expression for

(i) $\mathbf{p}$ in terms of t,

(ii) $\mathbf{q}$ in terms of t.

(3)

(c) Find the position vector of Q when Q is due west of P.

(4)

4 An aeroplane flies in air that is moving due east at a speed of $V\ \text{m s}^{-1}$

The velocity of the aeroplane relative to the air is $180\ \text{m s}^{-1}$ due north.

The aeroplane actually travels on a bearing of $020°$

(a) Find V

[2 marks]

(b) Find the magnitude of the resultant velocity of the aeroplane.

[3 marks]

1(a)	$\tan\theta = \frac{5}{20}$ $\theta = 14.036..^0$ $\theta = 104^0$ nearest degree	M1 A1 A1 (3)
(b)	$\mathbf{p} = 400\mathbf{i} + t(15\mathbf{i} + 20\mathbf{j})$ $\mathbf{q} = 800\mathbf{j} + t(20\mathbf{i} - 5\mathbf{j})$	M1 A1 A1 (3)
(c)	Equate their **j** components: $20t(\mathbf{j}) = (800 - 5t)(\mathbf{j})$ $t = 32$ $\mathbf{s} = 800\mathbf{j} + 32(20\mathbf{i} - 5\mathbf{j})$ $= 640\mathbf{i} + 640\mathbf{j}$	M1 A1 M1 A1 (4) **10**

4 (a)	$V = 180\tan 20°$ $= 65.5$ OR $\frac{V}{\sin 20°} = \frac{180}{\sin 70°}$ $V = 65.5$	**M1** **A1**	**2**	M1: Using trigonometry (usually tan or sine rule) to find *V* A1: Correct answer from correct working (Division by 2 only acceptable if sin20° or cos70° seen.)
(b)	$\frac{180}{v} = \cos 20°$ $v = \frac{180}{\cos 20°} = 192$	**M1A1** **A1**	**3**	M1: Using trigonometry or Pythagoras to find *v* A1: Correct expression A1: Correct answer

5 The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively. A boat moves horizontally with a constant acceleration of $(-0.2\mathbf{i} + 0.4\mathbf{j})\,\mathrm{m\,s^{-2}}$.

At time $t = 0$, the boat is at the origin and has velocity $2\mathbf{i}\,\mathrm{m\,s^{-1}}$

(a) Write down an expression for the velocity of the boat at time t seconds.

[2 marks]

(b) Find the time when the boat is travelling due north.

[3 marks]

(c) Find an expression for the position vector of the boat at time t seconds.

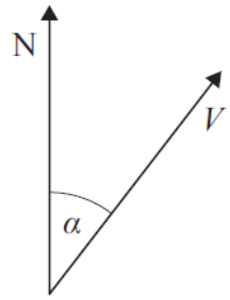
[2 marks]

(d) Find the speed of the boat when it is due north of the origin.

[6 marks]

5 (a)	$\mathbf{v} = 2\mathbf{i} + (-0.2\mathbf{i} + 0.4\mathbf{j})t$	**M1** **A1**	 **2**	M1: Use of constant acceleration equation to find expression for **v**. A1: Correct expression.
(b)	$\mathbf{v} = (2 - 0.2t)\mathbf{i} + 0.4t\mathbf{j}$ $2 - 0.2t = 0$ $t = \dfrac{2}{0.2} = 10 \text{ seconds}$	**M1** **dM1** **A1**	 **3**	M1: Simplifying **v**. dM1: Putting **i** component equal to zero. A1: Correct time.
(c)	$\mathbf{r} = 2\mathbf{i} \times t + \dfrac{1}{2}(-0.2\mathbf{i} + 0.4\mathbf{j}) \times t^2$	**M1** **A1**	 **2**	M1: Use of constant acceleration equation to find expression for **r**. A1: Correct expression.
(d)	$2t - 0.1t^2 = 0$ $t = \dfrac{2}{0.1} = 20$ $\mathbf{v} = (2 - 0.2 \times 20)\mathbf{i} + 0.4 \times 20\mathbf{j}$ $= -2\mathbf{i} + 8\mathbf{j}$ $v = \sqrt{2^2 + 8^2} = 8.25 \text{ m s}^{-1}$	**M1** **A1** **A1** **M1** **A1** **A1**	 **6**	M1: Putting **i** component equal to zero. A1: Correct equation. A1: Correct time. M1: Substituting their time into their expression for **v**. A1: Correct simplified velocity. A1: Correct speed.

4 Relative to the air, an aeroplane flies with velocity V on a bearing α, as shown in the diagram.



The air is moving due east at $20\,\mathrm{m\,s^{-1}}$. The aeroplane travels at $120\,\mathrm{m\,s^{-1}}$ on a bearing of $040°$.

(a) Find V.

[3 marks]

(b) Find α, giving your answer to the nearest degree.

[4 marks]

4 (a)	$V^2 = 120^2 + 20^2 - 2\times 20\times 120\cos 50°$ $V = \sqrt{11715} = 108\ \text{m s}^{-1}$ OR $\begin{pmatrix}120\sin 40° - 20\\ 120\cos 40°\end{pmatrix}$ $V^2 = (120\sin 40° - 20)^2 + (120\cos 40°)^2$ $V = 108\ \text{m s}^{-1}$	**M1A1** **A1** **(M1)** **(A1)** **(A1)**	**3**	M1: Use of cosine rule to find *V*. A1: Correct equation. A1: Correct *V*. M1: Velocity vector with sin40/50 or cos40/50 and ±20. A1: Correct expression for *V* or . V^2. A1: Correct *V*.
(b)	$\frac{\sin\beta}{20} = \frac{\sin 50°}{\sqrt{11715}}$ $\beta = 8.1$ $\alpha = 40 - 8.1 = 032°$ OR $\tan\theta = \frac{120\cos 40°}{120\sin 40° - 20}$ $\theta = 58.1377..$ $\alpha = 90 - 58.1 = 032°$	**M1** **A1** **M1A1** **(M1)** **(A1)** **(M1A1)**	**4**	M1: Use of sine rule to find angle in the velocity triangle. A1: Correct angle. M1: Finding *α* having used the sine rule. Only award if their *α* is less than 40° A1: Correct value for α. M1: Use of appropriate trig to find angle in the velocity triangle. A1: Correct angle. M1: Finding *α* having used appropriate trig. Only award if their *α* is less than 40° A1: Correct value for α.

8 Two particles, A and B, move on a horizontal surface with constant accelerations of $(8\mathbf{i} + 4\mathbf{j})\,\mathrm{m\,s^{-2}}$ and $(6\mathbf{i} + 10\mathbf{j})\,\mathrm{m\,s^{-2}}$ respectively. The unit vectors **i** and **j** are perpendicular.

At time $t = 0$, A has position $(7\mathbf{i} + 8\mathbf{j})\,\mathrm{m}$ and velocity $(4\mathbf{i} + 3\mathbf{j})\,\mathrm{m\,s^{-1}}$.

At time $t = 0$, B has position $(70\mathbf{i} + k\mathbf{j})\,\mathrm{m}$ and velocity $(2\mathbf{i} - 1\mathbf{j})\,\mathrm{m\,s^{-1}}$, where k is a constant.

The particles collide.

(a) Find the time when the particles collide.

[5 marks]

(b) Find k.

[3 marks]

8 (a)	$\mathbf{r}_A = (7\mathbf{i}+8\mathbf{j})+(4\mathbf{i}+3\mathbf{j})t+\frac{1}{2}(8\mathbf{i}+4\mathbf{j})t^2$ $\mathbf{r}_B = (70\mathbf{i}+k\mathbf{j})+(2\mathbf{i}-\mathbf{j})t+\frac{1}{2}(6\mathbf{i}+10\mathbf{j})t^2$ $7+4t+4t^2 = 70+2t+3t^2$ $t^2+2t-63=0$ $t = 7$ or -9 $t = 7$	**B1** **B1** **M1A1** **A1**	**5**	B1: Correct position vector for *A*. B1: Correct position vector for *B*. Both B1 marks can be awarded if the correct quadratic is obtained. M1: Equates **i** components. A1: Forms correct simplified quadratic. A1: Final answer as 7.
(b)	$8+3\times 7+2\times 49=127$ $k-7+5\times 49=127$ $k=-111$	**M1A1** **A1**	**3**	Forms equation from **j** components to find *k*. A1: Correct equation. A1: Correct value for *k*.
	Total		**8**	

7 A jet ski moves on a lake, with an acceleration of $(0.25\mathbf{i} + 1.2\mathbf{j})\ \text{m s}^{-2}$. At the point A, the jet ski has velocity $(4\mathbf{i} - 1.6\mathbf{j})\ \text{m s}^{-1}$.

The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.

(a) Find the speed of the jet ski 2 seconds after it leaves A.

[4 marks]

(b) At the point B, the jet ski has speed $10\ \text{m s}^{-1}$. Find the average velocity of the jet ski as it travels from A to B.

[9 marks]

4 An aeroplane is flying in air that is moving due east at $V\ \text{m s}^{-1}$. Relative to the air, the aeroplane has a velocity of $90\ \text{m s}^{-1}$ due north. During a 20 second period, the motion of the air causes the aeroplane to move 240 metres to the east.

(a) Find V.

[2 marks]

(b) Find the magnitude of the resultant velocity of the aeroplane.

[2 marks]

(c) Find the direction of the resultant velocity, giving your answer as a three-figure bearing, correct to the nearest degree.

[3 marks]

7 (a)	$\mathbf{v} = (4 + 0.25 \times 2)\mathbf{i} + (1.2 \times 2 - 1.6)\mathbf{j}$	M1		M1: Correct expression for the velocity when $t = 2$.
	$= 4.5\mathbf{i} + 0.8\mathbf{j}$	A1		A1: Correct simplified velocity.
	$v = \sqrt{4.5^2 + 0.8^2}$	dM1		dM1: Finding magnitude of the velocity.
	$= 4.57 \text{ m s}^{-1}$	A1	4	A1: Correct magnitude. AWRT 4.57.
(b)	$\mathbf{v} = (4 + 0.25t)\mathbf{i} + (1.2t - 1.6)\mathbf{j}$	M1		M1: Correct expression for velocity in any form, eg $(4\mathbf{i} - 1.6\mathbf{j}) + (0.25\mathbf{i} + 1.2\mathbf{j})t$
		A1		A1: Correct velocity as the sum of two components. PI.
	$10^2 = (4 + 0.25t)^2 + (1.2t - 1.6)^2$	M1		M1: Quadratic equation to find time when speed is 10, including both their velocity components.
	$0 = 1.5025t^2 - 1.84t - 81.44$	A1		A1: Correct expanded quadratic, that is equal to zero. (Allow any multiple of the equation.)
	$t = 8 \quad \text{or} \quad t = -6.77....$	dM1		dM1: One or two times obtained from their quadratic.
	$t = 8$	A1		A1: Concludes that $t = 8$.
	$\mathbf{r} = \left(4 \times 8 + \frac{1}{2} \times 0.25 \times 8^2\right)\mathbf{i} + \left(-1.6 \times 8 + \frac{1}{2} \times 1.2 \times 8^2\right)\mathbf{j}$	dM1		dM1: Finding the position vector at their time.
	$= 40\mathbf{i} + 25.6\mathbf{j}$	A1		A1: Correct position vector. AWRT 40.0**i** + 25.6**j**
	$\text{Average Velocity} = \frac{40\mathbf{i} + 25.6\mathbf{j}}{8}$ $= 5\mathbf{i} + 3.2\mathbf{j}$	A1		A1: Correct average velocity.
	OR			

4. (a)	$240 = 20V$ $V = \frac{240}{20} = 12$	**M1** **A1**	**2**	M1: Correct equation. A1: Correct V.
4. (b)	$v = \sqrt{90^2 + 12^2} = 90.8 \text{ m s}^{-1}$	**M1A1**	**2**	M1: Equation or expression to find v or v^2 based on the use of Pythagoras. Must have a +. Allow their value of V from part (a). A1: Correct velocity. AWRT 90.8 OR (If finding the angle first.) M1: Using 12 or 90 with the sin or cos of their angle. Allow their value of V from part (a). A1: Correct velocity. AWRT 90.8
4. (c)	$\tan \alpha = \frac{12}{90}$ $\alpha = 008°$ Or	**M1A1** **A1**	**3**	M1: seeing tan with 12 or their V from (a) and 90, either way round. A1: Seeing AWRT 8 or 82. A1: Final answer of 008°. CAO

8 The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.

Two helicopters, A and B, are taking part in an air display. Both helicopters move in the same horizontal plane which is well above ground level. At the start of the display, A is at the origin, which is located in this horizontal plane, and B has position vector $(40\mathbf{i} + 50\mathbf{j})$ metres relative to this origin. The velocities of A and B at the start of the display are $(8\mathbf{i} + 4\mathbf{j})\,\mathrm{m\,s^{-1}}$ and $(6\mathbf{i} + 9\mathbf{j})\,\mathrm{m\,s^{-1}}$ respectively. Both helicopters move with constant acceleration. The acceleration of A is $(-0.2\mathbf{i} + 0.1\mathbf{j})\,\mathrm{m\,s^{-2}}$ and the acceleration of B is $(0.2\mathbf{i} - 0.1\mathbf{j})\,\mathrm{m\,s^{-2}}$.

Find the distance between A and B at the instant when their velocities are parallel.

[10 marks]

4 A particle moves with constant acceleration between the points A and B. At A, it has velocity $(4\mathbf{i} + 2\mathbf{j})\,\mathrm{m\,s^{-1}}$. At B, it has velocity $(7\mathbf{i} + 6\mathbf{j})\,\mathrm{m\,s^{-1}}$. It takes 10 seconds to move from A to B.

(a) Find the acceleration of the particle.

[3 marks]

(b) Find the distance between A and B.

[5 marks]

(c) Find the average velocity as the particle moves from A to B.

[2 marks]

Q	Solution	Mark	Total	Comment
8	$\mathbf{v}_A = (8-0.2t)\mathbf{i} + (4+0.1t)\mathbf{j}$	B1		B1: Correct velocity for A. May be implied.
	$\mathbf{v}_B = (6+0.2t)\mathbf{i} + (9-0.1t)\mathbf{j}$	B1		B1: Correct velocity for B. May be implied.
	$k(8-0.2t) = 6+0.2t$ $k(4+0.1t) = 9-0.1t$ $\frac{6+0.2t}{8-0.2t} = \frac{9-0.1t}{4+0.1t}$	M1A1		M1: Forming an equation based on the ratio of **i** and **j** components of both velocity vectors. Allow $\frac{6+0.2t}{8-0.2t} = \frac{4+0.1t}{9-0.1t}$ oe.
	$(6+0.2t)(4+0.1t) = (9-0.1t)(8-0.2t)$ $24+1.4t+0.02t^2 = 72-2.6t+0.02t^2$ $4t = 48$ $t = 12$	A1		A1: Correct value of t. SC3 For obtaining $t = 12$ by trial and improvement. Replaces M1A1A1 above. Also award B1B1.
	$\mathbf{r}_A = (8\times12 - 0.1\times12^2)\mathbf{i} + (4\times12 + 0.05\times12^2)\mathbf{j}$	dM1		dM1: Finding position vectors of A and B at the time found by candidate provided that they have previous M1 or 12 from the SC.
	$= 81.6\mathbf{i} + 55.2\mathbf{j}$	A1		A1: Correct position vector for A.
	$\mathbf{r}_B = (40 + 6\times12 + 0.1\times12^2)\mathbf{i} + (50 + 9\times12 - 0.05\times12^2)\mathbf{j}$ $= 126.4\mathbf{i} + 150.8\mathbf{j}$	A1		A1: Correct position vector for B.
	$d = \sqrt{44.8^2 + 95.6^2} = 106$ m	dM1 A1	10	dM1: Finding the difference between the position vectors. A1: Correct distance. Accept AWRT 106
	Total		**10**	

Q	Solution	Mark	Total	Comment
4. (a)	$7\mathbf{i} + 6\mathbf{j} = 4\mathbf{i} + 2\mathbf{j} + 10\mathbf{a}$	M1A1		M1: Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$. Allow if **u** substituted for **v** and **v** substituted for **u** after a correct statement of the constant acceleration equation. A1: Correct expression.
	$\mathbf{a} = \frac{3\mathbf{i} + 4\mathbf{j}}{10} = (0.3\mathbf{i} + 0.4\mathbf{j})\ \text{m s}^{-2}$	A1	3	A1: Correct acceleration.
4. (b)	$\mathbf{r} = \frac{1}{2}((4\mathbf{i}+2\mathbf{j}) + (7\mathbf{i}+6\mathbf{j}))\times10$	M1A1		M1: Using $\mathbf{r} = \frac{1}{2}(\mathbf{u}+\mathbf{v})t$.
	$= 5(11\mathbf{i} + 8\mathbf{j})$ $= 55\mathbf{i} + 40\mathbf{j}$ OR	A1		A1: Correct expression. A1: Correct position vector.
	$d = \sqrt{55^2 + 40^2} = 68.0\ \text{m}$	dM1A1		68.0 or $5\sqrt{185}$.
4. (c)	$\text{Ave. Velocity} = \frac{55\mathbf{i} + 40\mathbf{j}}{10}$	M1		M1: Their displacement from part (b) divided by 10.
	$= (5.5\mathbf{i} + 4\mathbf{j})\ \text{m s}^{-1}$	A1	2	A1: Correct average velocity. Condone taking means!
	Total		**10**	

2 A yacht is sailing through water that is flowing due west at $2\,\mathrm{m\,s^{-1}}$. The velocity of the yacht relative to the water is $6\,\mathrm{m\,s^{-1}}$ due south. The yacht has a resultant velocity of $V\,\mathrm{m\,s^{-1}}$ on a bearing of θ.

(a) Find V.

[2 marks]

(b) Find θ, giving your answer to the nearest degree.

[3 marks]

2. (a)	$V=\sqrt{2^2+6^2}=\sqrt{40}=6.32\text{ m s}^{-1}$	M1A1	**2**	M1: Equation or expression to find V or V^2 based on Pythagoras. Must have a +. A1: Correct V. Accept AWRT 6.32. Accept $2\sqrt{10}$ or $\sqrt{40}$. Note that just $V^2=2^2+6^2$ Scores M1A0. OR (if angle found first) M1:Using 2 or 6 with the sin or cos of their angle. A1: Correct V.
2. (b)	$\tan^{-1}\left(\frac{6}{2}\right)=71.6°$ **or** $\sin^{-1}\left(\frac{6}{2\sqrt{10}}\right)=71.6°$	M1A1 (M1A1)	**3**	M1: Seeing tan with 6 and 2. (Can be either way round.) A1: Seeing AWRT 72° or 18°. A1: Final answer of 198°. CAO