

**Constant Acceleration in Two Dimensions (From Edexcel 6677)**

**Q1, (Jun 2010, Q1)**

$$(-4\mathbf{i} - 7\mathbf{j}) = \mathbf{r} + 4(-3\mathbf{i} + 2\mathbf{j})$$

$$\mathbf{r} = (8\mathbf{i} - 15\mathbf{j})$$

$$|\mathbf{r}| = \sqrt{8^2 + (-15)^2} = 17 \text{ m}$$

M1 A1

A1

M1 A1 ft

[5]

**Q2, (Jan 2009, Q1)**

$$-6\mathbf{i} + \mathbf{j} = \mathbf{u} + 3(2\mathbf{i} - 5\mathbf{j})$$

$$\Rightarrow \mathbf{u} = -12\mathbf{i} + 16\mathbf{j}$$

$$\Rightarrow u = \sqrt{(-12)^2 + 16^2} = 20$$

M1 A1

A1 cso

M1 A1

[5]

**Q3, (Jan 2005, Q7)**

(a)  $\mathbf{v}_P = \{(29\mathbf{i} + 34\mathbf{j}) - (20\mathbf{i} + 10\mathbf{j})\}/3 = \underline{(3\mathbf{i} + 8\mathbf{j}) \text{ km h}^{-1}}$

M1 A1

(2)

(b)  $\mathbf{p} = (20\mathbf{i} + 10\mathbf{j}) + (3\mathbf{i} + 8\mathbf{j})t$

M1 A1√

$\mathbf{q} = (14\mathbf{i} - 6\mathbf{j}) + 12t\mathbf{j}$

M1 A1

(4)

(c)  $\mathbf{q} - \mathbf{p} = (-6 - 3t)\mathbf{i} + (-16 + 4t)\mathbf{j}$

M1 A1

$$d^2 = (-6 - 3t)^2 + (-16 + 4t)^2$$

↓

M1

↓

M1

$$= 36 + 36t + 9t^2 + 16t^2 - 128t + 256$$

$$= 25t^2 - 92t + 292 \quad (*)$$

A1 (cso)

(5)

(d)  $25t^2 - 92t + 292 = 225$

M1

$$25t^2 - 92t + 67 = 0$$

A1

↓

M1

$$(t - 1)(25t - 67) = 0$$

$$t = 67/25 \text{ or } 2.68$$

A1

time  $\approx$  161 mins, or 2 hrs 41 mins, or 2.41 am, or 0241

A1

(5)

**Q4, (Jun 2006, Q7)**

(a) Speed =  $\sqrt{(2.5^2 + 6^2)} = \underline{6.5 \text{ km h}^{-1}}$

(b) Bearing =  $360 - \arctan(2.5/6) \approx \underline{337}$

(c)  $\mathbf{R} = (16 - 3 \times 2.5)\mathbf{i} + (5 + 3 \times 6)\mathbf{j}$   
 $= \underline{8.5\mathbf{i} + 23\mathbf{j}}$

(d) At 1400  $\mathbf{s} = 11\mathbf{i} + 17\mathbf{j}$

At time  $t$ ,  $\mathbf{s} = \underline{11\mathbf{i} + (17 + 5t)\mathbf{j}}$

(e) East of  $R \Rightarrow 17 + 5t = 23$

$\Rightarrow t = 6/5 \Rightarrow \underline{1512 \text{ hours}}$

(f) At 1600  $\mathbf{s} = 11\mathbf{i} + 27\mathbf{j}$

$\mathbf{s} - \mathbf{r} = 2.5\mathbf{i} + 4\mathbf{j}$

Distance =  $\sqrt{(2.5^2 + 4^2)} \approx \underline{4.72 \text{ km}}$

(a) M1 needs square, add and  $\sqrt$  correct components

(b) M1 for finding acute angle =  $\arctan(2.5/6)$  or  $\arctan(6/2.5)$  (i.e.  $67^\circ/23^\circ$ ).  
 Accept answer as AWRT 337.

(c) M1 needs non-zero initial p.v. used + 'their 3' x velocity vector

(d) Allow 1<sup>st</sup> M1 even if non-zero initial p.v. not used here

(e) A1 is for answer as a time of the day

(f) 1<sup>st</sup> M1 for using  $t = 2$  or  $4$  (but *not* 200, 400, 6, 16 etc) and forming  $\mathbf{s} - \mathbf{r}$  or  $\mathbf{r} - \mathbf{s}$

M1 A1  
(2)

M1 A1  
(2)

M1  
A1  
(2)

M1 A1  
↓  
M1 A1  
(4)

M1  
A1  
(2)

M1  
↓  
M1 A1  
(3)

**Q5, (Jan 2011, Q4)**

<b>(a)</b>	$\text{speed} = \sqrt{2^2 + (-5)^2}$ $= \sqrt{29} = 5.4 \text{ or better}$	M1 A1 <b>(2)</b>
<b>(b)</b>	$((7\mathbf{i} + 10\mathbf{j}) - (2\mathbf{i} - 5\mathbf{j})) / 5$ $= (5\mathbf{i} + 15\mathbf{j}) / 5 = \mathbf{i} + 3\mathbf{j}$ $\mathbf{F} = m\mathbf{a} = 2(\mathbf{i} + 3\mathbf{j}) = 2\mathbf{i} + 6\mathbf{j}$	M1 A1 A1 DM1 A1ft <b>(5)</b>
<b>(c)</b>	$\mathbf{v} = \mathbf{u} + \mathbf{a}t = (2\mathbf{i} - 5\mathbf{j}) + (\mathbf{i} + 3\mathbf{j})t$ $(-5 + 3t)\mathbf{j}$ <p>Parallel to <math>\mathbf{i} \Rightarrow -5 + 3t = 0</math></p> $t = 5/3$	M1 A1 M1 A1 <b>(4)</b> <b>[11]</b>

**Q6, (Jun 2007, Q7)**

<b>(a)</b>	$\mathbf{v} = \frac{8\mathbf{i} + 11\mathbf{j} - (3\mathbf{i} - 4\mathbf{j})}{2.5} \text{ or any equivalent}$ $\mathbf{v} = 2\mathbf{i} + 6\mathbf{j}$	M1 A1 A1 <b>(3)</b>
<b>(b)</b>	$\mathbf{b} = 3\mathbf{i} - 4\mathbf{j} + \mathbf{v}t \text{ ft their } \mathbf{v}$ $= 3\mathbf{i} - 4\mathbf{j} + (2\mathbf{i} + 6\mathbf{j})t$	M1 A1 ft A1cao <b>(3)</b>
<b>(c)</b>	<p><b>i</b> component: <math>-9 + 6t = 3 + 2t</math></p> $t = 3$ <p><b>j</b> component: <math>20 + 3\lambda = -4 + 18</math></p> $\lambda = -2$	M1 M1 A1  M1 A1 <b>(5)</b>
<b>(d)</b>	$v_B = \sqrt{(2^2 + 6^2)} \text{ or } v_C = \sqrt{(6^2 + (-2)^2)}$ <p style="text-align: center;">Both correct</p> <p style="text-align: center;">The speeds of <math>B</math> and <math>C</math> are the same</p>	M1  A1 cs0 A1 <b>(3)</b> <b>[14]</b>

**Q7, (Jun 2013(R), Q6)**

<b>(a)</b>	Use of $r = r_0 + vt$ $(-4i + 2j) + (3i + 3j)t = (-4 + 3t)i + (2 + 3t)j$	M1 A1	<b>(2)</b>	
<b>(b)</b>	$(6i + j) + (-2i + nj)t = (6 - 2t)i + (1 + nt)j$ Position vectors identical $\Rightarrow -4 + 3t = 6 - 2t$ <b>AND</b> $5t = 10$ , Either equation $2 + 3 \times 2 = 1 + 2n$ , $n = 3.5$	B1 M1 A1 <b>DM1</b> A1		<b>(5)</b>
<b>(c)</b>	Position vector of P is $(-4 + 6)i + (2 + 6)j = 2i + 8j$ Distance OP = $\sqrt{2^2 + 8^2} = \sqrt{68} = 8.25$ (km)	M1A1 M1A1		

**Q8, (Jun 2013, Q7)**

<b>(a)</b>	$t = 0$ gives $v = i - 3j$	B1
	speed = $\sqrt{1^2 + (-3)^2}$	M1
	= $\sqrt{10} = 3.2$ or better	A1
		<b>(3)</b>
<b>(b)</b>	$t = 2$ gives $v = (-3i + 3j)$	M1
	Bearing is $315^\circ$	A1
		<b>(2)</b>
<b>(c)(i)</b>	$1 - 2t = 0 \Rightarrow t = 0.5$	M1 A1
<b>(ii)</b>	$-(3t - 3) = -3(1 - 2t)$	M1 A1
	Solving for $t$	<b>DM1</b>
	$t = 2/3, 0.67$ or better	A1
		<b>(6)</b>
		<b>[11]</b>

**Notes for Question 7**

<b>Q7(a)</b>	B1 for $i - 3j$ . M1 for $\sqrt{\text{(sum of squares of cpt.s)}}$ A1 for $\sqrt{10}, 3.2$ or better
<b>Q7(b)</b>	M1 for clear attempt to sub $t = 2$ into given expression. A1 for $315$ .
<b>Q7(c)</b>	<b>(i)</b> First M1 for $1 - 2t = 0$ . First A1 for $t = 0.5$ . N.B. If they offer two solutions, by equating both the <b>i</b> and <b>j</b> components to zero, give M0. <b>(ii)</b> First M1 for $\frac{1 - 2t}{3t - 3} = \pm \left(\frac{-1}{-3}\right)$ o.e. (Must be an equation in $t$ only) First A1 for a correct equation (the + sign) Second M1, dependent on first M1, for solving for $t$ . Second A1 for $2/3, 0.67$ or better.