Question Number	Scheme	Marks	Notes
5a	Correct equation for $\mathbf{v}_P$ or find displacement	M1	Use of $\mathbf{r}_P = \mathbf{r}_0 + \mathbf{v}_P t$ to find $\mathbf{v}$. Allow for $\lambda(-\mathbf{i}-5\mathbf{j})$
	$\mathbf{v}_P = 3(6\mathbf{i}-(7\mathbf{i}+5\mathbf{j})) = -3\mathbf{i}-15\mathbf{j}$	A1	
	$\sqrt{(-3)^2+(-15)^2}$	M1	Use of Pythagoras to find magnitude of their $\mathbf{v}$
	$=\sqrt{234}=15.3\ \left(\text{km h}^{-1}\right)$ (or better)	A1	CSO $\left(3\sqrt{26}\right)$ A0 if it comes from $3\mathbf{i}+15\mathbf{j}$
			NB Could score the M marks in reverse order - find displacement in 20 minutes and then multiply by 3
		(4)	
5b	Use of $\mathbf{r}_P = \mathbf{r}_0 + \mathbf{v}_P t$: $\mathbf{r}_P = 7\mathbf{i}+5\mathbf{j}+t(-3\mathbf{i}-15\mathbf{j})$	M1	For their $\mathbf{v}_P$
	$\Rightarrow \mathbf{r}_P = (7-3t)\mathbf{i}+(5-15t)\mathbf{j}$	A1	Obtain **given answer** from correct working
		(2)	
5c	$\dfrac{(7-3t)}{(5-15t)}=\dfrac{16}{5}$	M1	Use given answer and direction to form equation in t
		A1	Correct unsimplified equation
	$35-15t=80-240t$	DM1	Solve for t. Dependent on the previous M1
	$t=0.2$	A1	
		(4)	
5d	P and Q in the same place at the same time	M1	Equate **i** or **j** components of position vectors and solve for t
	$\Rightarrow\ 7-3t=5+2t$ or $5-15t=-3+5t$	A1	Either
	$t=0.4$	A1	
	Check that the same value of t gives equal values for the other component	DM1	Dependent on the previous M mark
	$\mathbf{r}=(5.8\mathbf{i}-\mathbf{j})$ km	A1	Must be a vector
		(5)	
		[15]	

3.(a)	$\tan\alpha = 1/3 \Rightarrow \alpha = 18.4^{o}$	M1 A1
	Bearing is 288° (nearest degree)	A1 (3)
(b)	$\mathbf{r} = (21\mathbf{i} + 5\mathbf{j}) + t(-6\mathbf{i} + 2\mathbf{j})$	B1 (1)
(c)	$21 - 6t = -(5 + 2t)$	M1 A1
	$t = 6.5$	A1 (3)
		7

NOTES

Question 3(a)

First M1 for $\arctan(\frac{\pm 2}{\pm 6})$

First A1 for a correct value from their expression, usually 18.4^{o} or 71.6^{o}

Second A1 for 288 (nearest degree)

Question 3(b)

B1 for $(21\mathbf{i} + 5\mathbf{j}) + t(-6\mathbf{i} + 2\mathbf{j})$

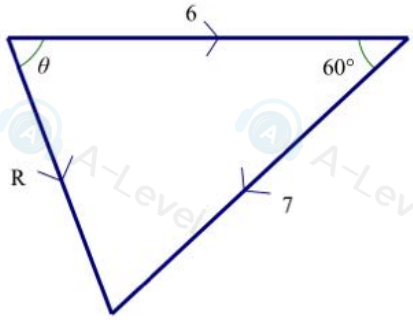
Question 3(c)

M1 for equating the negative of their **i**-component to their **j**-component oe

Allow equating the components for the M mark.

First A1 for a correct equation.

Second A1 for $t = 6.5$

Question Number	Scheme	Marks
3		
Method 1	Horizontal component $= 6 - 7\cos 60$ (N)	M1A1
	Vertical component (N) $= 7\cos 30$	M1A1
	Use Pythagoras: $\sqrt{2.5^2 + 6.06^2} = \sqrt{43} = 6.6$(N) or better	M1A1
	Use trig: angle = $\tan^{-1}\left(\frac{7\cos 30}{2.5}\right) = 68^o$(below **P**) or better Also allow 112^0, 292^0 or 248^0	M1A1
		(8)
Alt		
	Cosine rule to find $\lvert\mathbf{R}\rvert$: $R^2 = 36 + 49 - 2\times 6\times 7\times\cos 60 \left(= 43\right)$	M2 A2
	R = 6.6 (N) or better	M1 A1
	Solve Sine rule for θ: $\sin^{-1}\left(\frac{7\sin 60}{R}\right)$	M1
	$= 68^o$ or better Also allow 112^0 or 292^0 or 248^0	A1
		[8]
	Notes	
Method 1	First M1 for attempt, allow sin/cos confusion, to find component parallel to **P**	
	First A1 for a correct expression	
	Second M1 for attempt, allow sin/cos confusion to find component perp to **P**	
	First A1 for a correct expression	
	Third M1 for using Pythag to find magnitude of **R**	
	Third A1 for $\sqrt{43}$, 6.6 (N) or better	
	Fourth M1 for complete method to find angle (M0 if 6 used for 'horiz' cpt) Fourth A1 for 68^o or better (67.589089…) 112^0 or 292^0 or 248^0	

1

Question Number	Scheme	Marks
	Notes	
Alt	First M2 for use of cosine rule with correct structure but allow $\cos 120^o$ and allow R^2 First A2 for a correct equation. (A0 if 120^o used) Third M1 for solving for R Third A1 for $\sqrt{43}$, 6.6 (N) or better Fourth M1 for complete method (e.g. sine rule) to find angle between their **R** and **P** Fourth A1 for 68^o or better	

1

Question Number	Scheme	Marks
2(a)	$\tan\theta = \frac{6}{7}$ $\theta = 40.60°...$ **Bearing is $360° - 40.60° = 319°$ nearest degree**	M1 A1 A1 (3)
(b)	$\mathbf{r}_A = (20\mathbf{i} - 17\mathbf{j}) + 4(-6\mathbf{i} + 7\mathbf{j}) = (-4\mathbf{i} + 11\mathbf{j})$ $\mathbf{r}_B = (-8\mathbf{i} + 9\mathbf{j}) + 4(p\mathbf{i} + 2p\mathbf{j}) = (-8 + 4p)\mathbf{i} + (9 + 8p)\mathbf{j}$ $\mathbf{r}_A - \mathbf{r}_B = (4 - 4p)\mathbf{i} + (2 - 8p)\mathbf{j}$ $-8 + 4p - -4 = 9 + 8p - 11$ $p = -0.5$ $\mathbf{v}_B = (-0.5\mathbf{i} - \mathbf{j})$ $\lvert\mathbf{v}_B\rvert = \sqrt{(-0.5)^2 + (-1)^2}$ $= \frac{\sqrt{5}}{2} = 1.1 \text{ ms}^{-1}$ **or better**	M1 A1 A1 **DM1** M1 A1 A1 M1 M1 A1 (10) **13**
	Notes	
2(a)	M1 for any trig ratio using 6 and 7: $\tan\theta = \pm\frac{6}{7}$ or $\pm\frac{7}{6}$: $\sin\theta$ or $\cos\theta = \pm\frac{6}{\sqrt{6^2+7^2}}$ or $\pm\frac{7}{\sqrt{6^2+7^2}}$	
	A1 for a correct angle from their *correct* equation e.g. 49°, 41°, 139°, 131°,....	
	A1 for 319° cao	
2(b)	First M1 for attempt at use of $\mathbf{r}_4 = \mathbf{r}_0 + 4\mathbf{v}$ for either *A* or *B*	
	First A1 for $(-4\mathbf{i} + 11\mathbf{j})$ **i**'s and **j**'s must be collected at some stage	
	Second A1 for $(-8 + 4p)\mathbf{i} + (9 + 8p)\mathbf{j}$ **i**'s and **j**'s must be collected at some stage	
	Second **DM**1, dependent on first M1, for finding the difference between their two $\mathbf{r}_4$ vectors (must be an attempt to subtract both **i** and **j** components)	
	Third M1 for equating the **i** cpt and **j** cpt of their difference (M0 if no difference) to give an equation in *p only*. oe e.g. $\frac{(4-4p)}{(2-8p)} = \frac{(-)1}{(-)1}$	
	Third A1 for a correct equation in *p* only	
	Fourth A1 for a correct value of *p*	
	Fourth M1 for using their *p* value to obtain a velocity vector for *B*	
	Fifth M1 for finding the magnitude of their $\mathbf{v}_B$ (**N.B.** This M mark is available, even if their $\mathbf{v}_B$ does not have the correct form)	
	Fifth A1 for $\frac{\sqrt{5}}{2}$ oe or 1.1 or better	

Question Number	Scheme	Marks
2. (a)	$v = \sqrt{2^2 + (-3)^2} = \sqrt{13} = 3.61 \text{ ms}^{-1}$	M1 A1 (2)
(b)	$\mathbf{a} + 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ $\mathbf{a} = (-7\mathbf{i} + 8\mathbf{j})$ m	M1 A1 DM1 A1 (4) **6**

Notes	
2. (a)	M1 for $\sqrt{}$ (sum of squares of cpt.s) allow $\sqrt{(2^2+3^2)}$ A1 for $\sqrt{13}$, 3.6 or better
(b)	First M1 for $\mathbf{a} \pm 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ oe A1 for $\mathbf{a} + 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ oe Second DM1, dependent, for solving for a A1 for $(-7\mathbf{i} + 8\mathbf{j})$ A0 for $\begin{pmatrix} -7\mathbf{i} \\ 8\mathbf{j} \end{pmatrix}$ or $(-7\mathbf{i}, 8\mathbf{j})$