Forces in Two Dimensions Exam Questions MS

Q1, (OCR 4728, Jan 2008, Q1)

i	$\sqrt{(12^2 + 15^2)}$	M1	Applies Pythagoras, requires +.
	19.2 N	A1	
		A1	
	$\tan\theta = 12/15$, $\tan\theta = 15/12$, $\sin\theta = 12/19.2$, $\cos\theta = 15/19.2$	M1	trig and R included between X and Y
	Bearing = 038.7°	A1	Accept cv 19.2
		A1	Accept 039 or 39 or art 39 from below (not given if X and Y transposed)
		[6]	
ii	$E = 19.2$	B1ft	ft cv 19.2
	Bearing = 180 + 38.7 = 219°	B1ft	180+cv 38.7(-360) or correct answer
		[2]	

Q2, (OCR 4728, Jun 2009, Q1)

1 i	$x^2 + (3x)^2 = 6^2$	M1	Using Pythagoras, 2 squared terms
	$10x^2 = 36$	A1	May be implied
	$x = 1.9(0)$ (1.8973..)	A1	Not surd form unless rationalised $(3\sqrt{10})/5$, $(6\sqrt{10})/10$
		[3]	
ii	$\tan\theta = 3x/x$ (= 3×1.9/1.9) = 3	M1	Must target correct angle.
	$\theta = 71.6°$ (71.565..)	A2	Accept $\sin\theta = 3\times1.9/6$ or $\cos\theta = 1.9/6$ which give θ=71.8°, θ=71.5° respectively, A1. **SR** $\theta = 71.6°$ from $\tan\theta = 3x/x$ if x is incorrect; x used A1, no evidence of x used A2
		[3]	

Q3, (OCR 4728, Jun 2012, Q1)

(i)	$F^2 = 17^2 - 8^2$	M1
	$F = 15$	A1
	$\cos\alpha = 8/17$	M1
	$\alpha = 61.9°$	A1
		[4]

Q4, (OCR 4761, Jun 2005, Q3)

(i)	$\mathbf{R} + \begin{pmatrix}-3\\4\end{pmatrix} + \begin{pmatrix}21\\-7\end{pmatrix} = \begin{pmatrix}0\\0\end{pmatrix}$	M1	Sum to zero	
	$\mathbf{R} = \begin{pmatrix}-18\\3\end{pmatrix}$	A1	Award if seen here or in (ii) or used in (ii).	
			[SC1 for $\begin{pmatrix}18\\-3\end{pmatrix}$]	2
(ii)	$\lvert\mathbf{R}\rvert = \sqrt{18^2 + 3^2}$	M1	Use of Pythagoras	
	= 18.248… so 18.2 N (3 s. f.)	A1	Any reasonable accuracy. FT **R** (with 2 non-zero cpts)	
	angle is $180 - \arctan\left(\frac{3}{18}\right) = 170.53…°$	M1	Allow $\arctan\left(\frac{\pm3}{\pm18}\right)$ or $\arctan\left(\frac{\pm18}{\pm3}\right)$	
	so 171° (3 s. f.)	A1	Any reasonable accuracy. FT **R** provided their angle is obtuse but not 180°	4
	total	6		

Q5, (OCR 4761, Jan 2006, Q3)

(i)	$\lvert\mathbf{F}\rvert = 12.5$ so 12.5 N	B1		
	bearing is $90 - \arctan\frac{12}{3.5}$	M1	Use of arctan with 3.5 and 12 or equiv	
	$= (0)16.260\ldots$ so $(0)16.3°$ (3 s. f.)	A1	May be obtained directly as $\arctan\frac{3.5}{12}$	3
(ii)	24/7 = 12/3.5 or ….	E1	Accept **statement** following **G** = 2**F** shown.	
	$\mathbf{G} = 2\mathbf{F}$ so $\lvert\mathbf{G}\rvert = 2\lvert\mathbf{F}\rvert$	B1	Accept equivalent in words.	2
(iii)	$\frac{9+12}{3.5} = \frac{-18+q}{12}$	M1	Or equivalent or in scalar equations. Accept $\frac{21}{q-18}$ or $\frac{q-18}{21}$ = tan (i) or tan(90 - (i))	
	so $q = 6\times12+18 = 90$	A1	Accept 90**j**	2
				7

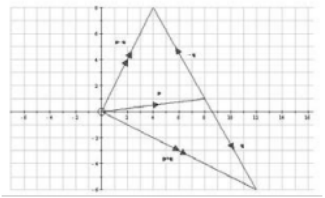
Q6, (OCR 4761, Jan 2008, Q2i,ii) [Modified]

2 (i)	$\begin{pmatrix}6\\9\end{pmatrix} = 1.5\mathbf{a}$ giving $\mathbf{a} = \begin{pmatrix}4\\6\end{pmatrix}$ so $\begin{pmatrix}4\\6\end{pmatrix}$ m s^{-2}	M1 A1	Use of N2L with an attempt to find **a**. Condone spurious notation. Must be a vector in proper form. Penalise only once in paper.	2
(ii)	Angle is $\arctan\left(\frac{6}{4}\right)$ = 56.309… so 56.3° (3 s. f.)	M1 F1	Use of arctan with **their** $\frac{6}{4}$ or $\frac{4}{6}$ or equiv. May use **F**. FT **their a** provided both cpts are +ve and non-zero.	2

Q7, (OCR 4761, Jun 2008, Q2)

(i)		B1	Sketch. O, **i**, **j** and **r** (only require correct quadrant.) Vectors must have arrows. Need not label **r**.	1
(ii)	$\sqrt{4^2+(-5)^2}$ = $\sqrt{41}$ or 6.4031… so 6.40 (3 s. f.)	M1 A1	Accept $\sqrt{4^2-5^2}$	
	Need $180-\arctan\left(\frac{4}{5}\right)$	M1	Or equivalent. Award for $\arctan\left(\pm\frac{4}{5}\right)$ or $\arctan\left(\pm\frac{5}{4}\right)$ or equivalent seen without 180 or 90.	
	141.340 so 141°	A1	cao	4
(iii)	12**i** – 15**j** or $\begin{pmatrix}12\\-15\end{pmatrix}$	B1	Do not award for magnitude given as the answer. Penalise spurious notation by 1 mark at most once in paper	1
		6		

Q8, (OCR 4761, Jan 2012, Q5)

(i)	$\lvert\mathbf{p}\rvert=\sqrt{8^2+1^2}$	M1	For applying Pythagoras theorem	
	$\lvert\mathbf{p}\rvert=\sqrt{65}$	A1		
	$\lvert\mathbf{q}\rvert=\sqrt{4^2+(-7)^2}=\sqrt{65}$ They are equal	A1 **[3]**	Condone no explicit statement that they are equal	
(ii)	$\mathbf{p}+\mathbf{q}=12\mathbf{i}-6\mathbf{j}$ $\mathbf{p}+\mathbf{q}=6(2\mathbf{i}-\mathbf{j})$ so $\mathbf{p}+\mathbf{q}$ is parallel to $2\mathbf{i}-\mathbf{j}$	M1 E1 **[2]**	Accept argument based on gradients being equal. "Parallel" may be implied	
(iii)		B1 B1	One mark for each of $\mathbf{p}+\mathbf{q}$ and $\mathbf{p}-\mathbf{q}$ drawn correctly SC1 if arrows missing or incorrect from otherwise correct vectors	
	The angle is 90°	B1 **[3]**	Cao	

Q9, (OCR 4761, Jun 2014, Q2)

(i)		$\mathbf{p} + \mathbf{q} = 28\mathbf{i} - 3.5\mathbf{j}$	B1	
		$28\mathbf{i} - 3.5\mathbf{j} = k(8\mathbf{i} - \mathbf{j})$	M1	Or equivalent. k may be implied by going straight to 3.5
		$k = 3.5$	A1	
		(So they are parallel)		
		Alternative		
		$\mathbf{p} + \mathbf{q} = 28\mathbf{i} - 3.5\mathbf{j}$	B1	
		$\mathbf{p} + \mathbf{q}$: $\tan\theta = \frac{-3.5}{28} \Rightarrow \theta = -7.13°$		
		$8\mathbf{i} - \mathbf{j}$: $\tan\theta = \frac{-1}{8} \Rightarrow \theta = -7.13°$	M1	Comparing the ratio of the components in each of the two vectors is sufficient, using any consistent sign convention. The angle does not need to be worked out, nor does tan have to be seen.
		So they are parallel	A1	Both ratios the same and correct
			[3]	
(ii)		$3\mathbf{p} + 10\mathbf{q} = (36+160)\mathbf{i} + (-15 + 15)\mathbf{j}$		
		$= 196\mathbf{i}$	B1	
		Zero **j** component so horizontal	B1	Or equivalent explanation. May be shown on a diagram
			[2]	
(iii)		The horizontal component must be zero		
		So $12k + 3\times 16 = 0 \Rightarrow k = -4$	B1	Substituting k = -4 and showing **i** component is zero is acceptable
		$\mathbf{w}$ = -24.5**j**	B1	Award for 24.5 seen
		$mg = 24.5 \Rightarrow m = 2.5$ The mass is 2.5 kg	B1	Award for 2.5 seen. FT from their weight.
			[3]	