Mixed Exam Questions – Set 12 - Answers

1.

(a)	$H_0: \rho = 0 \quad H_1: \rho < 0$	B1	2.5
	Critical value: -0.6215 (Allow any cv in range $0.5 < \lvert cv \rvert < 0.75$)	M1	1.1a
	$r < -0.6215$ so significant result and there is evidence of a negative correlation between w and t	A1	2.2b
		(3)	
(b)	e.g. As temperature increases people spend more time on the beach and less time shopping (o.e.)	B1	2.4
		(1)	
(c)	Since r is close to -1, it is consistent with the suggestion	B1	2.4
		(1)	
(d)	t will be the explanatory variable since sales are likely to depend on the temperature	B1	2.4
		(1)	
(e)	Every degree rise in temperature leads to a drop in weekly earnings of £171	B1	3.4
		(1)	
		(7 marks)	

2.

(a)

Use of $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$: $(7\mathbf{i} - 10\mathbf{j}) = 2(2\mathbf{i} - 3\mathbf{j}) + \frac{1}{2}\mathbf{a}2^2$	M1	3.1b
$\mathbf{a} = (1.5\mathbf{i} - 2\mathbf{j})$	A1	1.1b
$\lvert\mathbf{a}\rvert = \sqrt{1.5^2 + (-2)^2}$	M1	1.1b
$= 2.5 \text{ m s}^{-2}$ * GIVEN ANSWER	A1*	2.1
	(4)	

(b)

Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t = (2\mathbf{i} - 3\mathbf{j}) + 2(1.5\mathbf{i} - 2\mathbf{j})$	M1	3.1b
$= (5\mathbf{i} - 7\mathbf{j})$	A1	1.1b
$\mathbf{v} = (5\mathbf{i} - 7\mathbf{j}) + t(4\mathbf{i} + 8.8\mathbf{j}) = (5 + 4t)\mathbf{i} + (8.8t - 7)\mathbf{j}$ and $(5 + 4t) = (8.8t - 7)$	M1	3.1b
$t = 2.5$ (s)	A1	1.1b
	(4)	

3.

(a)	Moments about A (or any other complete method)	M1	3.3
	$T2a\sin\alpha = Mga + 3Mgx$	A1	1.1b
	$T = \dfrac{Mg(a+3x)}{2a \times \frac{3}{5}} = \dfrac{5Mg(3x+a)}{6a}$ * GIVEN ANSWER	A1*	2.1
		(3)	
(b)	$\dfrac{5Mg(3x+a)}{6a}\cos\alpha = 2Mg$ **OR** $2Mg.2a\tan\alpha = Mga + 3Mgx$	M1	3.1b
	$x = \dfrac{2a}{3}$	A1	2.2a
		(2)	
(c)	Resolve vertically **OR** Moments about B	M1	3.1b
	$Y = 3Mg + Mg - \dfrac{5Mg(3.\frac{2a}{3}+a)}{6a}\sin\alpha$ $2aY = Mga + 3Mg(2a - \frac{2a}{3})$ **Or**: $Y = 3Mg + Mg - \left(\dfrac{2Mg}{\cos\alpha}\right)\sin\alpha$	A1ft	1.1b
	$Y = \dfrac{5Mg}{2}$ N.B. May use $R\sin\beta$ for Y and/or $R\cos\beta$ for X throughout	A1	1.1b
	$\tan\beta = \dfrac{Y}{X}$ or $\dfrac{R\sin\beta}{R\cos\beta}$ $= \dfrac{\frac{5Mg}{2}}{2Mg}$	M1	3.4
	$= \dfrac{5}{4}$	A1	2.2a
		(5)	
(d)	$\dfrac{5Mg(3x+a)}{6a} \le 5Mg$ and solve for x	M1	2.4
	$x \le \dfrac{5a}{3}$	A1	2.4
	For rope not to break, block can't be more than $\dfrac{5a}{3}$ from A oe Or just: $x \le \dfrac{5a}{3}$, if no incorrect statement seen. **N.B. If the correct inequality is not found,** their comment must mention 'distance from A'.	B1 A1	2.4
		(3)	

4.

(a)	Differentiate **v**	M1	1.1a
	$(\mathbf{a} =)6\mathbf{i} - \frac{15}{2}t^{\frac{1}{2}}\mathbf{j}$	A1	1.1b
	$= 6\mathbf{i} - 15\mathbf{j}$ (m s^{-2})	A1	1.1b
		(3)	
(b)	Integrate **v**	M1	1.1a
	$(\mathbf{r} =)(\mathbf{r}_0) + 3t^2\mathbf{i} - 2t^{\frac{5}{2}}\mathbf{j}$	A1	1.1b
	$= (-20\mathbf{i} + 20\mathbf{j}) + (48\mathbf{i} - 64\mathbf{j}) = 28\mathbf{i} - 44\mathbf{j}$ (m)	A1	2.2a
		(3)	
		(6)	

5.

	In this question mark parts (a) and (b) together.		
(a)	Horizontal speed $= 20\cos 30°$	B1	3.4
	Vertical velocity <u>at $t = 2$</u>	M1	3.4
	$= 20\sin 30° - 2g$	A1	1.1b
	$\theta = \tan^{-1}\left(\pm\frac{9.6}{10\sqrt{3}}\right)$	M1	1.1b
	Speed $= \sqrt{100 \times 3 + 9.6^2}$ or e.g. speed $= \frac{9.6}{\sin\theta}$	M1	1.1b
	19.8 or 20 $\left(\text{m s}^{-1}\right)$ at 29.0° or 29° to the horizontal oe	A1	2.2a
		(6)	

(b)	Using sum of horizontal distances $=50$ at $t=2$	M1	3.3
	$(u\cos\theta)\times 2 + (20\cos 30°)\times 2 = 50$ $(u\cos\theta = 25 - 20\cos 30°)$	A1	1.1b
	Vertical distances equal	M1	3.4
	$\Rightarrow (20\sin 30°)\times 2 - \frac{g}{2}\times 4 = (u\sin\theta)\times 2 - \frac{g}{2}\times 4$ $(20\sin 30° = u\sin\theta)$	A1	1.1b
	Solving for both θ and u	M1	3.1b
	$\theta = 52°$ or better $(52.47756849....°)$ $u = 13$ or better $(12.6085128...)$	A1	2.2a
		(6)	
(c)	It does not take account of the fact that they are not particles (moving freely under gravity) It does not take account of the size(s) of the balls It does not take account of the spin of the balls It does not take account of the wind g is not exactly 9.8 m s^{-2} **N.B.** If they refer to the mass or weight of the balls give B0	B1	3.5b
		(1)	
		(13)	

6.

(a)			**M1***	**3.1b**	At least two terms differentiated correctly (but not for e.g. $\mathbf{a} = (pt-3)\mathbf{i} + (8+qt^{-1})\mathbf{j}$ which is just dividing each term in t by t)
		$\mathbf{a} = (2pt-3)\mathbf{i} + 8\mathbf{j}$	**A1**	**1.1**	Allow stated as a column vector
		$(\lvert\mathbf{F}\rvert =) m\sqrt{(2pt-3)^2 + 8^2}$ Or $(\lvert\mathbf{F}\rvert^2 =) m^2\{(2pt-3)^2 + 8^2\}$	**M1dep***	**3.3**	Correct use of $\lvert\mathbf{F}\rvert = m\lvert\mathbf{a}\rvert$ with their $\mathbf{a}$ – allow in terms of m (and with or without $t = 0.5$ substituted) – must multiply both terms by m
		$(p-3)^2 + 64 = 100$ or $(2p-6)^2 + 16^2 = 400$	**A1**	**1.1**	A correct equation in p only eg $20 = 2\sqrt{(2p(0.5)-3)^2 + 64}$
			M1dep*	**1.1**	Attempt to solve their 3TQ in p (see 5(b) for awarding this M mark if working shown). If no method seen this mark can be implied by either the correct value of p or both 9 and –3 seen. As this part is not DR then the correct real roots of their 3TQ (with or without working) or their negative root of their 3TQ (with or without working) can score this mark
		$p = -3$ only	**A1**	**2.2a**	Do not award this mark if $p = 9$ is also stated without being rejected
			[6]		

(b)			**M1***	**3.1b**	At least two terms integrated correctly
		$\mathbf{s}=\left(\frac{1}{3}pt^3-\frac{3}{2}t^2\right)\mathbf{i}+\left(4t^2+qt\right)\mathbf{j}+\mathbf{c}$	**A1ft**	**1.1**	Condone lack of + **c** and allow in terms of p or their value for p found/stated in **(a)**
		$t=0,\ \mathbf{s}=2\mathbf{i}-3\mathbf{j}\Rightarrow\mathbf{c}=2\mathbf{i}-3\mathbf{j}$	**M1dep***	**3.4**	Using correct initial conditions to find **c**
		$\mathbf{s}=\left(-t^3-\frac{3}{2}t^2+2\right)\mathbf{i}+\left(4t^2+qt-3\right)\mathbf{j}$	**A1**	**1.1**	cao (oe)
			[4]		

(c)		$t=1,\ \mathbf{s}=-\frac{1}{2}\mathbf{i}+(1+q)\mathbf{j}$	**M1***	**3.4**	Substitute $t=1$ into their **s**
		$k\left(-\frac{1}{2}\mathbf{i}+(1+q)\mathbf{j}\right)=2\mathbf{i}-8\mathbf{j}\Rightarrow k=\ldots$	**M1dep***	**3.1b**	Correct method in an attempt to find q (e.g. equating a scalar multiple of their **s** (evaluated at $t=1$) to $2\mathbf{i}-3\mathbf{j}$ and solving for the scalar)
		$k=-4\Rightarrow q=1$	**A1**	**2.2a**	www
			[3]		