Exam Questions – Set 2 - Answers

1.

i		State range of f is $f(x) \geq 3a$ or $y \geq 3a$	B1	Allow $f \geq 3a$ or equiv expression in words but $3a$ to be included
		State range of g is all real numbers or equiv such as $y \in \mathbb{R}$ (real numbers)	B1 [2]	
ii		State function is not 1 – 1 or different x-values give same y-value or equiv	B1	no credit for 'no inverse due to modulus' nor for 'cannot be reflected across $y = x$'
		Obtain form $k(y+4a)$ or $k(x+4a)$	M1	for non-zero constant k
		Obtain $\frac{1}{5}(x+4a)$ or $\frac{1}{5}x+\frac{4}{5}a$	A1 [3]	Must finally be in terms of x
iii		<u>Either</u> Attempt composition of functions the right way round	M1	Earned for 5(what they think f(x) is) – $4a$
		Obtain $5\|2x+a\|+11a=31a$ or equiv	A1	
		<u>Or</u> Apply their g^{-1} to $31a$	M1	
		Obtain $\|2x+a\|+3a=7a$ or equiv	A1	
		<u>Either</u> Solve $2x+a=4a$ and obtain $\frac{3}{2}a$	B1 FT	Following their $\|2x+a\|=ka$
		Solve linear equation in which signs of (their) $2x$ and (their) $4a$ are different	M1	Condone other sign slips
		Obtain $-\frac{5}{2}a$	A1	And no others; obtaining $-\frac{5}{2}a$ and then concluding $\frac{5}{2}a$ is A0
		<u>Or</u> Square both sides and obtain $4x^2+4ax-15a^2=0$	B1 FT	Following their $\|2x+a\|=ka$
		Solve 3-term quadratic equation to obtain two values	M1	Allow M1 if factorisation wrong but expansion gives correct first and third terms; allow M1 if incorrect use of formula involves only one error
		Obtain $-\frac{5}{2}a$, $\frac{3}{2}a$	A1 [5]	And no others; continuing from two correct answers to conclude $\frac{5}{2}a$, $\frac{3}{2}a$ is A0

2.

(i)	Use at least one identity correctly	B1		angle-sum or angle-difference identity
	Attempt use of relevant identities in single rational expression	M1		not earned if identities used in expression where step equiv to $\frac{A+B+C}{D+E+F}=\frac{A}{D}+\frac{B}{E}+\frac{C}{F}$ or similar has been carried out; condone (for M1A1) if signs of identities apparently switched (so that, for example, denominator appears as $\cos\theta\cos\alpha-\sin\theta\sin\alpha+$ $3\cos\theta+\cos\theta\cos\alpha+\sin\theta\sin\alpha$)
	Obtain $\frac{2\sin\theta\cos\alpha+3\sin\theta}{2\cos\theta\cos\alpha+3\cos\theta}$	A1		or equiv but with the other two terms from each of num'r and den'r absent
	Attempt factorisation of num'r and den'r	M1		
	Obtain $\frac{\sin\theta}{\cos\theta}$ and hence $\tan\theta$	A1	5	AG; necessary detail needed
(ii)	State or imply form $k\tan 150°$	M1		obtained without any wrong method seen
	State or imply $\frac{4}{3}\tan 150°$	A1		or equiv such as $\frac{12\sin 150°}{9\cos 150°}$
	Obtain $-\frac{4}{9}\sqrt{3}$	A1	3	or exact equiv (such as $-\frac{4}{3\sqrt{3}}$); correct answer only earns 3/3
(iii)	State or imply $\tan 6\theta = k$	B1		
	State $\frac{1}{6}\tan^{-1}k$	B1		
	Attempt second value of θ	M1		using $6\theta = \tan^{-1}k +$ (multiple of 180)
	Obtain $\frac{1}{6}\tan^{-1}k + 30°$	A1	4	and no other value

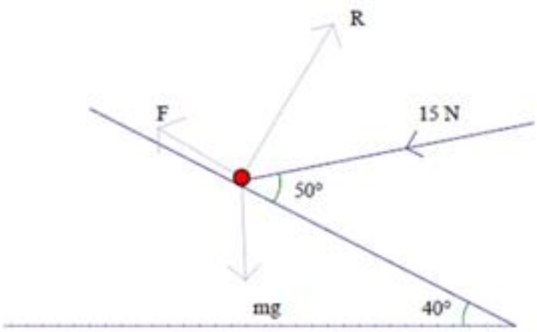
3.

(i)	Attempt to connect dx and du	M1		Including $\frac{du}{dx}=$ or $du = ...dx$; not $dx = du$
	$5-x=4-u^2$	B1		perhaps in conjunction with next line
	Show $\int \frac{4-u^2}{2+u}.2u\,du$ reduced to $\int 4u-2u^2\,du$ **AG**	A1		In a fully satisfactory & acceptable manner
	Clear explanation of why limits change	B1		e.g. when $x = 2$, $u = 1$ and when $x = 5$, $u = 2$
	$\frac{4}{3}$	B1	5	not dependent on any of first 4 marks
(ii)(a)	$5-x$	*B1	1	Accept $4-x-1=5-x$ (this is not **AG**)
(b)	Show reduction to $2-\sqrt{x-1}$	dep*B1		
	$\int\sqrt{x-1}\,dx=\frac{2}{3}(x-1)^{\frac{3}{2}}$	B1		Indep of other marks, seen anywhere in (b)
	$\left(10-\frac{2}{3}.8\right)-\left(4-\frac{2}{3}\right)=\frac{4}{3}$ or $4\frac{2}{3}-3\frac{1}{3}=\frac{4}{3}$	B1	3	Working must be shown

4.

(a) (i) ii)	For A : $T - F = 2ma$ For B : $mg - T = ma$	M1 A1 M1 A1 (4)
b)	$R = 2mg$ $mg(1-2\mu) = 3ma$ $\frac{g}{3}(1-2\mu) = a$	B1 M1 A1 (3)
(c)	$v^2 = \frac{2gh}{3}(1-2\mu)$ $v = \sqrt{\frac{2gh}{3}(1-2\mu)}$	M1 A1 (2)
d)	$-\mu R = 2ma'$ $0^2 = \text{their } u^2 - 2a's$ $0 = \frac{2gh}{3}(1-\frac{2}{3}) - 2(\frac{1}{3}g)s$ (or $s = (d-h)$) $s = \frac{1}{3}h$ $d = \frac{1}{3}h + h = \frac{4}{3}h$	M1 M1 A1 (A1) A1 A1 (5)
(e)	A (or B) would not move; **OR** A (or B) would remain in (limiting) equilibrium; **OR** the system would remain in (limiting) equilibrium	B1 (1) **15**

5.

a	 Perpendicular to the slope: $R = 2.7g\cos 40 + 15\cos 40$ $= 31.8$ (N) or 32 (N)	M1A2 A1 (4)
b	Parallel to the slope: $F = 2.7g\sin 40 - 15\cos 50$ $(F = 7.366..)$ Use of $F = \mu R$ $\mu = \frac{2.7g\sin 40 - 15\cos 50}{R} = 0.23$ or 0.232	M1A2 M1 A1 (5)
c	Component of wt parallel to slope = $2.7g\sin 40° \ (= 17.0)$ $F_{max} = 0.232 \times 2.7 \times g \times \cos 40° = 4.7...$ (N) $17.0 > 4.70$so the particle moves	B1 M1A1 A1 (4)

6.

(a)	The random variable $H \sim$ height of females		
	$\text{P}(H > 170) = \text{P}\left(Z > \frac{170-160}{8}\right)$ $[= \text{P}(Z > 1.25)]$	M1	
	$= 1 - 0.8944$	M1	
	$= 0.1056$ (calc 0.1056498…) **awrt 0.106** (accept 10.6%)	A1	**(3)**
(b)	$\text{P}(H > 180) = \text{P}\left(Z > \frac{180-160}{8}\right)$ $[= 1 - 0.9938]$	M1	
	$= 0.0062$ (calc 0.006209…) awrt 0.0062 or $\frac{31}{5000}$	A1	
	$[\text{P}(H > 180 \mid H > 170)] = \frac{0.0062}{0.1056}$	M1	
	$= 0.0587$ (calc 0.0587760…) **awrt 0.0587 or 0.0588**	A1	**(4)**
(c)	$\text{P}(H > h \mid H > 170)$ $(= 0.5)$ <u>or</u> $\frac{\text{P}(H > h)}{\text{P}(H > 170)}(= 0.5)$	M1	
	$[\text{P}(H > h)] = 0.5 \times "0.1056" = 0.0528$ (calc 0.0528249…) <u>or</u> $[\text{P}(H < h)] = 0.9472$	A1ft	
	$\frac{h-160}{8} = 1.62$ (calc 1.6180592…)	M1 B1	
	$h =$ awrt 173 cm **awrt 173**	A1	(5)