1. (a) y-intercept is -6, $(0,-6)$, $y=-6$ ***A1*** ***N1***

[1 mark]

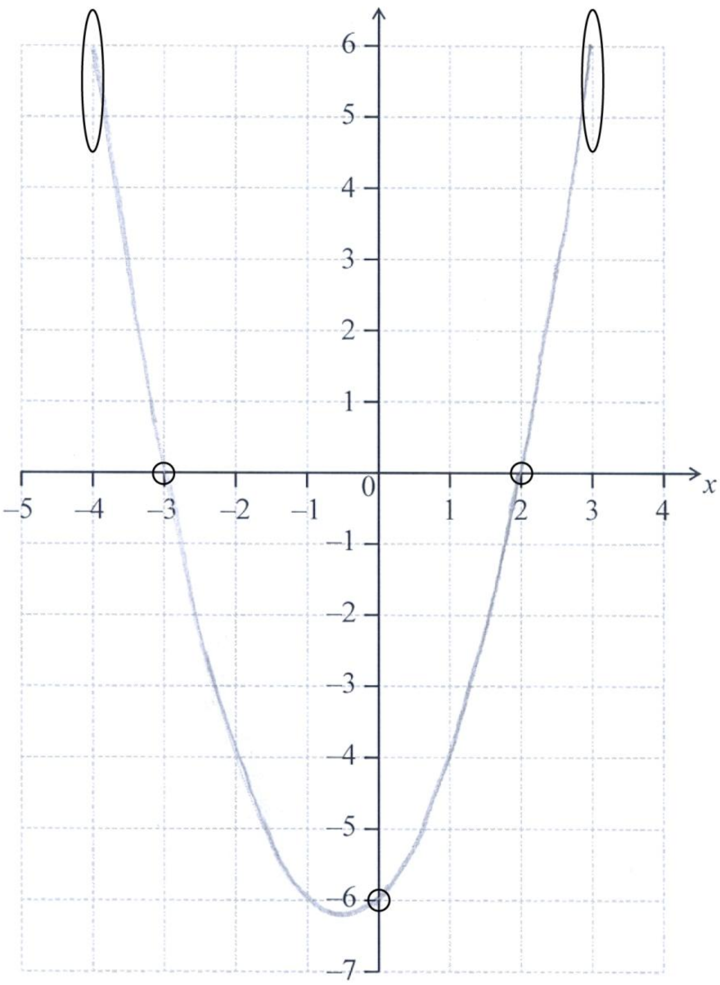
(b) valid attempt to solve ***(M1)***

eg $(x-2)(x+3)=0$, $x=\frac{-1\pm\sqrt{1+24}}{2}$, one correct answer

$x=2$, $x=-3$ ***A1A1*** ***N3***

[3 marks]

(c)



A1A1A1 ***N3***

Note:	The shape must be an approximately correct concave up parabola. Only if the shape is correct, award the following: ***A1*** for the y-intercept in circle **and** the vertex approximately on $x=-\frac{1}{2}$, below $y=-6$, ***A1*** for **both** the x-intercepts in circles, ***A1*** for **both** end points in ovals.

[3 marks]

Total [7 marks]

2. (a) correct approach *(A1)*

eg $d = u_2 - u_1$, $5-2$

$d = 3$ ***A1*** ***N2***

[2 marks]

(b) correct approach *(A1)*

eg $u_8 = 2 + 7 \times 3$, listing terms

$u_8 = 23$ ***A1*** ***N2***

[2 marks]

(c) correct approach *(A1)*

eg $S_8 = \frac{8}{2}(2+23)$, listing terms, $\frac{8}{2}\left(2(2)+7(3)\right)$

$S_8 = 100$ ***A1*** ***N2***

[2 marks]

Total [6 marks]

3. (a) substituting for $\left(f(x)\right)^2$ (may be seen in integral) ***A1***

eg $\left(x^2\right)^2$, x^4

correct integration, $\int x^4 \, \mathrm{d}x = \frac{1}{5}x^5$ *(A1)*

substituting limits into **their integrated** function and subtracting (in any order) *(M1)*

eg $\frac{2^5}{5} - \frac{1}{5}$, $\frac{1}{5}(1-4)$

$\int_1^2 \left(f(x)\right)^2 \mathrm{d}x = \frac{31}{5}$ $(= 6.2)$ ***A1*** ***N2***

[4 marks]

(b) attempt to substitute limits or function into formula involving f^2 *(M1)*

eg $\int_1^2 \left(f(x)\right)^2 \mathrm{d}x$, $\pi \int x^4 \mathrm{d}x$

$\frac{31}{5}\pi$ $(= 6.2\pi)$ ***A1*** ***N2***

[2 marks]

Total [6 marks]

4. (a) (i) $\log_3 27 = 3$ *A1* *N1*

(ii) $\log_8 \frac{1}{8} = -1$ *A1* *N1*

(iii) $\log_{16} 4 = \frac{1}{2}$ *A1* *N1*

[3 marks]

(b) correct equation with **their** three values *(A1)*

eg $\frac{3}{2} = \log_4 x$, $3 + (-1) - \frac{1}{2} = \log_4 x$

correct working involving powers *(A1)*

eg $x = 4^{\frac{3}{2}}$, $4^{\frac{3}{2}} = 4^{\log_4 x}$

$x = 8$ *A1* *N2*

[3 marks]

Total [6 marks]

5

(a) (i) $f(-3) = -1$ *A1* *N1*

(ii) $f^{-1}(1) = 0$ (accept $y = 0$) *A1* *N1*

[2 marks]

(b) domain of f^{-1} is range of f *(R1)*

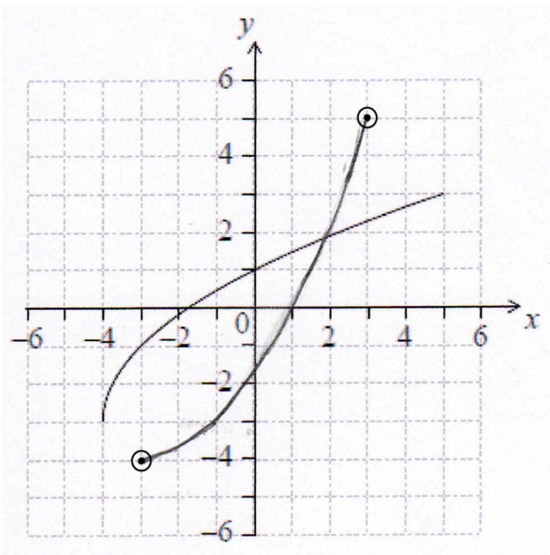
eg $\mathrm{R}f = \mathrm{D}f^{-1}$

correct answer *A1* *N2*

eg $-3 \le x \le 3$, $x \in [-3, 3]$ (accept $-3 < x < 3$, $-3 \le y \le 3$)

[2 marks]

(c)



A1A1 *N2*

Note:	Graph must be approximately correct reflection in $y = x$. **Only** if the shape is approximately correct, award the following: ***A1*** for x-intercept at 1, and ***A1*** for endpoints within circles.

[2 marks]

Total [6 marks]

6) (a) **METHOD 1**

approach involving Pythagoras' theorem *(M1)*

eg $5^2 + x^2 = 13^2$, labelling correct sides on triangle

finding third side is 12 (may be seen on diagram) ***A1***

$\cos A = \frac{12}{13}$ ***AG*** ***N0***

METHOD 2

approach involving $\sin^2\theta + \cos^2\theta = 1$ *(M1)*

eg $\left(\frac{5}{13}\right)^2 + \cos^2\theta = 1$, $x^2 + \frac{25}{169} = 1$

correct working ***A1***

eg $\cos^2\theta = \frac{144}{169}$

$\cos A = \frac{12}{13}$ ***AG*** ***N0***

[2 marks]

(b) correct substitution into $\cos 2\theta$ *(A1)*

eg $1 - 2\left(\frac{5}{13}\right)^2$, $2\left(\frac{12}{13}\right)^2 - 1$, $\left(\frac{12}{13}\right)^2 - \left(\frac{5}{13}\right)^2$

correct working *(A1)*

eg $1 - \frac{50}{169}$, $\frac{288}{169} - 1$, $\frac{144}{169} - \frac{25}{169}$

$\cos 2A = \frac{119}{169}$ ***A1*** ***N2***

[3 marks]

Total [5 marks]

7) (a) summing probabilities to 1 ***(M1)***

eg $\sum = 1$, $3 + 4 + 2 + x = 10$

36

correct working ***(A1)***

$\frac{3}{10} + \frac{4}{10} + \frac{2}{10} + p = 1$, $p = 1 - \frac{9}{10}$

$p = \frac{1}{10}$ ***A1*** ***N3***

[3 marks]

(b) correct substitution into formula for $\mathrm{E}(X)$ ***(A1)***

eg $0\left(\frac{3}{10}\right) + \ldots + 3(p)$

correct working ***(A1)***

eg $\frac{4}{10} + \frac{4}{10} + \frac{3}{10}$

$\mathrm{E}(X) = \frac{11}{10}$ (1.1) ***A1*** ***N2***

[3 marks]

Total [6 marks]

8)

(a) correct working *(A1)*

eg $1-\frac{1}{6}$

$p=\frac{5}{6}$ ***A1*** ***N2***

[2 marks]

(b) multiplying along correct branches *(A1)*

eg $\frac{1}{2}\times\frac{1}{6}$

$\mathrm{P}(C\cap L)=\frac{1}{12}$ ***A1*** ***N2***

[2 marks]

(c) multiplying along the other branch *(M1)*

eg $\frac{1}{2}\times\frac{1}{3}$

adding probabilities of their 2 mutually exclusive paths *(M1)*

eg $\frac{1}{2}\times\frac{1}{6}+\frac{1}{2}\times\frac{1}{3}$

correct working *(A1)*

eg $\frac{1}{12}+\frac{1}{6}$

$\mathrm{P}(L)=\frac{3}{12}\ \left(=\frac{1}{4}\right)$ ***A1*** ***N3***

[4 marks]

continued ...

(d) recognizing conditional probability (seen anywhere) *(M1)*
eg $\mathrm{P}(C \mid L)$

correct substitution of **their** values into formula *(A1)*

eg $\dfrac{\frac{1}{12}}{\frac{3}{12}}$

$\mathrm{P}(C \mid L) = \dfrac{1}{3}$ ***A1*** ***N2***

[3 marks]

(e) valid approach *(M1)*

eg $X \sim \mathrm{B}\left(3, \dfrac{1}{4}\right), \left(\dfrac{1}{4}\right)\left(\dfrac{3}{4}\right)^2, \dbinom{3}{1}$, three ways it could happen

correct substitution *(A1)*

eg $\dbinom{3}{1}\left(\dfrac{1}{4}\right)^1\left(\dfrac{3}{4}\right)^2, \dfrac{1}{4}\times\dfrac{3}{4}\times\dfrac{3}{4} + \dfrac{3}{4}\times\dfrac{1}{4}\times\dfrac{3}{4} + \dfrac{3}{4}\times\dfrac{3}{4}\times\dfrac{1}{4}$

correct working *(A1)*

eg $3\left(\dfrac{1}{4}\right)\left(\dfrac{9}{16}\right), \dfrac{9}{64}+\dfrac{9}{64}+\dfrac{9}{64}$

$\dfrac{27}{64}$ ***A1*** ***N2***

[4 marks]

Total [15 marks]

9.

8. (a) (i) correct value 0, or $36-12p$ *A2* *N2*

(ii) correct equation which clearly leads to $p=3$ *A1*

eg $36-12p=0$, $36=12p$

$p=3$ *AG* *N0*

[3 marks]

(b) **METHOD 1**

valid approach *(M1)*

eg $x=-\frac{b}{2a}$

correct working *A1*

eg $-\frac{(-6)}{2(3)}$, $x=\frac{6}{6}$

correct answers *A1A1* *N2*

eg $x=1$, $y=0$; $(1, 0)$

METHOD 2

valid approach *(M1)*

eg $f(x)=0$, factorisation, completing the square

correct working *A1*

eg $x^2-2x+1=0$, $(3x-3)(x-1)$, $f(x)=3(x-1)^2$

correct answers *A1A1* *N2*

eg $x=1$, $y=0$; $(1, 0)$

METHOD 3

valid approach using derivative *(M1)*

eg $f'(x)=0$, $6x-6$

correct equation *A1*

eg $6x-6=0$

correct answers *A1A1* *N2*

eg $x=1$, $y=0$; $(1, 0)$

[4 marks]

(c) $x=1$ *A1* *N1*

[1 mark]

(d) (i) $a=3$ *A1* *N1*

(ii) $h=1$ *A1* *N1*

(iii) $k=0$ *A1* *N1*

[3 marks]

10.

9. (a) derivative of $2x$ is 2 (must be seen in quotient rule) *(A1)*

derivative of x^2+5 is $2x$ (must be seen in quotient rule) *(A1)*

correct substitution into quotient rule ***A1***

eg $\dfrac{(x^2+5)(2)-(2x)(2x)}{(x^2+5)^2}$, $\dfrac{2(x^2+5)-4x^2}{(x^2+5)^2}$

correct working which clearly leads to given answer ***A1***

eg $\dfrac{2x^2+10-4x^2}{(x^2+5)^2}$, $\dfrac{2x^2+10-4x^2}{x^4+10x^2+25}$

$f'(x)=\dfrac{10-2x^2}{(x^2+5)^2}$ ***AG*** ***N0***

[4 marks]

(b) valid approach using substitution or inspection *(M1)*

eg $u=x^2+5$, $\mathrm{d}u=2x\mathrm{d}x$, $\dfrac{1}{2}\ln(x^2+5)$

$\int\dfrac{2x}{x^2+5}\mathrm{d}x=\int\dfrac{1}{u}\mathrm{d}u$ *(A1)*

$\int\dfrac{1}{u}\mathrm{d}u=\ln u+c$ *(A1)*

$\ln(x^2+5)+c$ ***A1*** ***N4***

[4 marks]

(c) correct expression for area *(A1)*

eg $\left[\ln\left(x^2+5\right)\right]_{\sqrt{5}}^{q}$, $\int_{\sqrt{5}}^{q} \frac{2x}{x^2+5}dx$

substituting limits into **their** integrated function and subtracting (in either order) *(M1)*

eg $\ln(q^2+5)-\ln\left(\sqrt{5}^2+5\right)$

correct working *(A1)*

eg $\ln(q^2+5)-\ln 10$, $\ln\frac{q^2+5}{10}$

equating **their** expression to $\ln 7$ (seen anywhere) *(M1)*

eg $\ln(q^2+5)-\ln 10=\ln 7$, $\ln\frac{q^2+5}{10}=\ln 7$, $\ln(q^2+5)=\ln 7+\ln 10$

correct equation without logs *(A1)*

eg $\frac{q^2+5}{10}=7$, $q^2+5=70$

$q^2=65$ *(A1)*

$q=\sqrt{65}$ ***A1*** ***N3***

Note: Award ***A0*** for $q=\pm\sqrt{65}$.

[7 marks]

Total [15 marks]