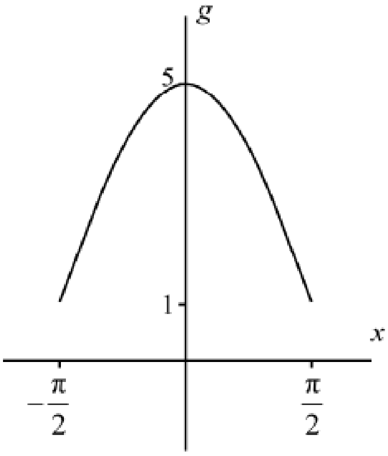
1

(a)



concave down and symmetrical over correct domain ***A1***
indication of maximum and minimum values of the function (correct range) ***A1A1***

[3 marks]

(b) $a = 0$ ***A1***

Note: Award ***A1*** for $a = 0$ only if consistent with their graph.

[1 mark]

(c) (i) $1 \le x \le 5$ ***A1***

Note: Allow FT from their graph.

(ii) $y = 4\cos x + 1$

$x = 4\cos y + 1$

$\frac{x-1}{4} = \cos y$ ***(M1)***

$\Rightarrow y = \arccos\left(\frac{x-1}{4}\right)$

$\Rightarrow g^{-1}(x) = \arccos\left(\frac{x-1}{4}\right)$ ***A1***

[3 marks]

Total [7 marks]

2

. **METHOD 1**

$$\left(x+\frac{3}{x^2}\right)^5 = \ldots + \binom{5}{2}x^2\left(\frac{3}{x^2}\right)^3 + \ldots$$ ***(M1)(A1)(A1)***

Note: Award ***M1*** for a product of a binomial coefficient, a power of x, and a power of $\frac{3}{x^2}$, ***A1*** for correct binomial coefficient, ***A1*** for correct powers.

$$= \ldots + 10\times\frac{27}{x^4} + \ldots\left(= \ldots + \frac{270}{x^4} + \ldots\right)$$ ***(A1)***

constant term is $x^4\left(\frac{270}{x^4}\right)$

$= 270$ ***A1***

METHOD 2

EITHER

the general term is $x^4\binom{5}{r}x^r\left(\frac{3}{x^2}\right)^{5-r}$ ***(M1)(A1)***

Note: Award ***M1*** for a product of a binomial coefficient, power(s) of x, and a power of $\frac{3}{x^2}$.

$$= \binom{5}{r}\times 3^{5-r}\times\frac{x^{r+4}}{x^{10-2r}}\left(= \binom{5}{r}\times 3^{5-r}x^{3r-6}\right)$$

constant term occurs when $r = 2$ ***(A1)***

OR

the general term is $x^4\binom{5}{5-r}x^{5-r}\left(\frac{3}{x^2}\right)^{r}$ ***(M1)(A1)***

Note: Award ***M1*** for a product of a binomial coefficient, power(s) of x, and a power of $\frac{3}{x^2}$.

$$= \binom{5}{5-r}\times 3^{r}\times\frac{x^{9-r}}{x^{2r}}\left(= \binom{5}{5-r}\times 3^{r}x^{9-3r}\right)$$

constant term occurs when $r = 3$ ***(A1)***

THEN

$\binom{5}{2}(3)^3$ ***(A1)***

$= 270$ ***A1***

[5 marks]

3

$\log_2 x - \log_2 5 = 2 + \log_2 3$

collecting at least two log terms **(M1)**

eg $\log_2 \frac{x}{5} = 2 + \log_2 3$ or $\log_2 \frac{x}{15} = 2$

obtaining a correct equation without logs **(M1)**

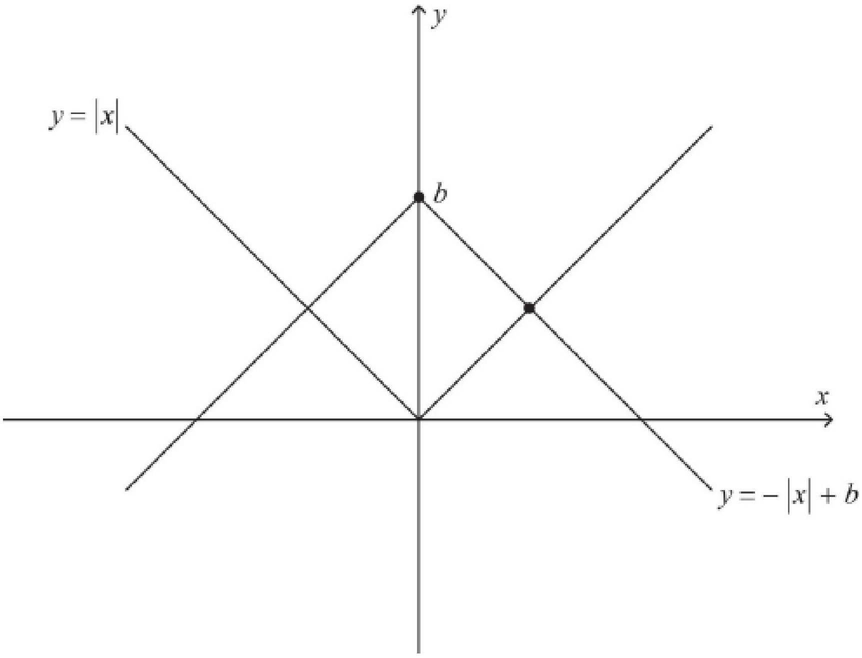
eg $\frac{x}{5} = 12$ **OR** $\frac{x}{15} = 2^2$ **(A1)**

$x = 60$ **A1**

[4 marks]

4

(a)



graphs sketched correctly (condone missing b) **A1A1**

[2 marks]

(b) $\frac{b^2}{2} = 18$ **(M1)A1**

$b = 6$ **A1**

[3 marks]

Total [5 marks]

5

(a) sum = 0 *A1*

product = 6 *A1*

[2 marks]

(b) $P(1) = 1 - 10 + 15 - 6 = 0$ *M1A1*

$\Rightarrow (z - 1)$ is a factor of $P(z)$ *AG*

Note: Accept use of division to show remainder is zero.

[2 marks]

(c) **METHOD 1**

$(z-1)^3\left(z^2 + bz + c\right) = z^5 - 10z^2 + 15z - 6$ *(M1)*

by inspection $c = 6$ *A1*

$\left(z^3 - 3z^2 + 3z - 1\right)\left(z^2 + bz + 6\right) = z^5 - 10z^2 + 15z - 6$ *(M1)(A1)*

$b = 3$ *A1*

METHOD 2

α, β are two roots of the quadratic

$b = -(\alpha + \beta),\ c = \alpha\beta$ *(A1)*

from part (a) $1 + 1 + 1 + \alpha + \beta = 0$ *(M1)*

$\Rightarrow b = 3$ *A1*

$1 \times 1 \times 1 \times \alpha\beta = 6$ *(M1)*

$\Rightarrow c = 6$ *A1*

Note: Award ***FT*** if $b = -7$ following through from their sum = 10.

METHOD 3

$\left(z^5 - 10z^2 + 15z - 6\right) \div (z-1) = z^4 + z^3 + z^2 - 9z + 6$ *(M1)A1*

Note: This may have been seen in part (b).

$z^4 + z^3 + z^2 - 9z + 6 \div (z-1) = z^3 + 2z^2 + 3z - 6$ *(M1)*

$z^3 + 2z^2 + 3z - 6 \div (z-1) = z^2 + 3z + 6$ *A1A1*

[5 marks]

(d) $z^2 + 3z + 6 = 0$ *M1*

$z = \dfrac{-3 \pm \sqrt{9 - 4 \cdot 6}}{2}$ *M1*

$= \dfrac{-3 \pm \sqrt{-15}}{2}$

$z = -\dfrac{3}{2} \pm \dfrac{i\sqrt{15}}{2}$ *A1*

(or $z = 1$)

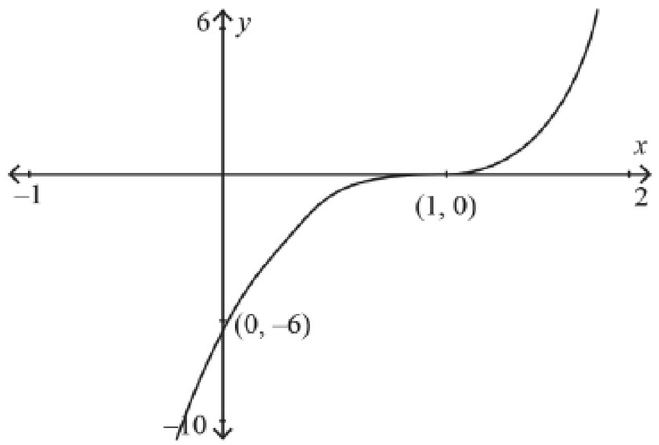
Notes:	Award the second ***M1*** for an attempt to use the quadratic formula or to complete the square. Do not award ***FT*** from (c).

[3 marks]

(e) (i) $\dfrac{d^2y}{dx^2} = 20x^3 - 20$ *M1A1*

for $x > 1$, $20x^3 - 20 > 0 \Rightarrow$ concave up *R1AG*

(ii)



x-intercept at $(1, 0)$ *A1*

y-intercept at $(0, -6)$ *A1*

stationary point of inflexion at $(1, 0)$ with correct curvature either side *A1*

[6 marks]

Total [18 marks]