

## Exercise 2E

$$\begin{aligned} 1 \text{ a } f(1) &= 5(1) + 3 \\ &= 5 + 3 \\ &= 8 \end{aligned}$$

$$\begin{aligned} \text{b } g(3) &= 3^2 - 2 \\ &= 9 - 2 \\ &= 7 \end{aligned}$$

$$\begin{aligned} \text{c } h(8) &= \sqrt{8+1} \\ &= \sqrt{9} \\ &= 3 \end{aligned}$$

$$\begin{aligned} \text{d } f(1.5) &= 5(1.5) + 3 \\ &= 7.5 + 3 \\ &= 10.5 \end{aligned}$$

$$\begin{aligned} \text{e } g(\sqrt{2}) &= (\sqrt{2})^2 - 2 \\ &= 2 - 2 \\ &= 0 \end{aligned}$$

$$\begin{aligned} \text{f } h(-1) &= \sqrt{-1+1} \\ &= 0 \end{aligned}$$

$$\begin{aligned} \text{g } f(4) + g(2) &= 5(4) + 3 + 2^2 - 2 \\ &= 20 + 3 + 4 - 2 \\ &= 25 \end{aligned}$$

$$\begin{aligned} \text{h } f(0) + g(0) + h(0) &= 5(0) + 3 \\ &\quad + 0^2 - 2 + \sqrt{0+1} \\ &= 0 + 3 + 0 - 2 + 1 \\ &= 2 \end{aligned}$$

$$\begin{aligned} \text{i } \frac{g(4)}{h(3)} &= \frac{4^2 - 2}{\sqrt{3+1}} \\ &= \frac{16-2}{\sqrt{4}} \\ &= \frac{14}{2} \\ &= 7 \end{aligned}$$

$$\begin{aligned} 2 \quad f(a) &= a^2 - 2a = 8 \\ a^2 - 2a - 8 &= 0 \\ (a - 4)(a + 2) &= 0 \\ \text{So } a &= 4 \text{ or } a = -2 \end{aligned}$$

$$\begin{aligned} 3 \text{ a } \quad f(x) &= 0 \\ 10 - 15x &= 0 \\ 5(2 - 3x) &= 0 \\ x &= \frac{2}{3} \\ \text{The root of } f(x) &\text{ is } \frac{2}{3}. \end{aligned}$$

$$\begin{aligned} \text{b } \quad g(x) &= 0 \\ (x + 9)(x - 2) &= 0 \\ x = -9 \text{ or } x &= 2 \\ \text{The roots of } g(x) &\text{ are } -9 \text{ and } 2. \end{aligned}$$

$$\begin{aligned} \text{c } \quad h(x) &= 0 \\ x^2 + 6x - 40 &= 0 \\ (x + 10)(x - 4) &= 0 \\ x = -10 \text{ or } x &= 4 \\ \text{The roots of } h(x) &\text{ are } -10 \text{ and } 4. \end{aligned}$$

$$\begin{aligned} \text{d } \quad j(x) &= 0 \\ 144 - x^2 &= 0 \\ (12 + x)(12 - x) &= 0 \\ x = -12 \text{ or } 12 \\ \text{The roots of } j(x) &\text{ are } 12 \text{ and } -12. \end{aligned}$$

$$\begin{aligned} \text{e } \quad k(x) &= 0 \\ x(x + 5)(x + 7) &= 0 \\ x = 0, x = -5 \text{ or } x &= -7 \\ \text{The roots of } k(x) &\text{ are } 0, -5 \text{ and } -7. \end{aligned}$$

$$\begin{aligned} \text{f } \quad m(x) &= 0 \\ x^3 + 5x^2 - 24x &= 0 \\ x(x^2 + 5x - 24) &= 0 \\ x(x + 8)(x - 3) &= 0 \\ x = 0, x = -8 \text{ or } x &= 3 \\ \text{The roots of } m(x) &\text{ are } 0, -8 \text{ and } 3. \end{aligned}$$

$$\begin{aligned} 4 \quad p(x) &= q(x) \\ x^2 - 3x &= 2x - 6 \\ x^2 - 5x + 6 &= 0 \\ (x - 3)(x - 2) &= 0 \\ \text{So } x &= 3 \text{ or } x = 2 \end{aligned}$$

$$\begin{aligned} 5 \quad f(x) &= g(x) \\ 2x^3 + 30x &= 17x^2 \\ 2x^3 - 17x^2 + 30x &= 0 \\ x(2x^2 - 17x + 30) &= 0 \\ x(2x - 5)(x - 6) &= 0 \\ \text{So } x &= 0, x = \frac{5}{2} \text{ or } x = 6 \end{aligned}$$

$$\begin{aligned}
 6 \text{ a } f(x) &= x^2 - 2x + 2 \\
 &= (x-1)^2 - 1^2 + 2 \\
 &= (x-1)^2 + 1 \\
 p &= -1 \text{ and } q = 1
 \end{aligned}$$

**b**  $(x-1)^2$  is a squared term so is always  $\geq 0$ .  
Therefore, the minimum value of  
 $f(x) = 0 + 1 = 1$ , so  $f(x) > 0$ .

$$\begin{aligned}
 7 \text{ a } f(x) &= 0 \\
 x^6 + 9x^3 + 8 &= 0 \\
 (x^3)^2 + 9(x^3) + 8 &= 0 \\
 (x^3 + 1)(x^3 + 8) &= 0 \\
 \text{So } x^3 &= -1 \text{ or } x^3 = -8 \\
 x^3 = -1 &\Rightarrow x = -1 \\
 x^3 = -8 &\Rightarrow x = -2
 \end{aligned}$$

The roots of  $f(x)$  are  $-1$  and  $-2$ .

$$\begin{aligned}
 \text{b } g(x) &= 0 \\
 x^4 - 12x^2 + 32 &= 0 \\
 (x^2)^2 - 12(x^2) + 32 &= 0 \\
 (x^2 - 4)(x^2 - 8) &= 0 \\
 \text{So } x^2 &= 4 \text{ or } x^2 = 8 \\
 x^2 = 4 &\Rightarrow x = \pm 2 \\
 x^2 = 8 &\Rightarrow x = \pm\sqrt{8} = \pm\sqrt{4 \times 2} = \pm 2\sqrt{2}
 \end{aligned}$$

The roots of  $g(x)$  are  $-2, 2, -2\sqrt{2}$  and  $2\sqrt{2}$ .

$$\begin{aligned}
 \text{c } h(x) &= 0 \\
 27x^6 + 26x^3 - 1 &= 0 \\
 27(x^3)^2 + 26(x^3) - 1 &= 0 \\
 (27x^3 - 1)(x^3 + 1) &= 0 \\
 x^3 = \frac{1}{27} &\Rightarrow x = \frac{1}{3} \\
 x^3 = -1 &\Rightarrow x = -1
 \end{aligned}$$

The roots of  $h(x)$  are  $-1$  and  $\frac{1}{3}$ .

$$\begin{aligned}
 \text{d } j(x) &= 0 \\
 32x^{10} - 33x^5 + 1 &= 0 \\
 32(x^5)^2 - 33(x^5) + 1 &= 0 \\
 (32x^5 - 1)(x^5 - 1) &= 0 \\
 \text{So } x^5 &= \frac{1}{32} \text{ or } x^5 = 1 \\
 x^5 = \frac{1}{32} &\Rightarrow x = \frac{1}{2} \\
 x^5 = 1 &\Rightarrow x = 1
 \end{aligned}$$

The roots of  $j(x)$  are  $\frac{1}{2}$  and  $1$ .

$$\begin{aligned}
 7 \text{ e } k(x) &= 0 \\
 x - 7\sqrt{x} + 10 &= 0
 \end{aligned}$$

$$\left(x^{\frac{1}{2}}\right)^2 - 7\left(x^{\frac{1}{2}}\right) + 10 = 0$$

$$\left(x^{\frac{1}{2}} - 2\right)\left(x^{\frac{1}{2}} - 5\right) = 0$$

$$\text{So } x^{\frac{1}{2}} = 2 \text{ or } x^{\frac{1}{2}} = 5$$

$$x^{\frac{1}{2}} = 2 \Rightarrow x = 4 \frac{n!}{r!(n-r)!}$$

$$x^{\frac{1}{2}} = 5 \Rightarrow x = 25$$

The roots of  $k(x)$  are  $4$  and  $25$ .

$$\begin{aligned}
 \text{f } m(x) &= 0 \\
 2x^{\frac{2}{3}} + 2x^{\frac{1}{3}} - 12 &= 0
 \end{aligned}$$

$$\left(x^{\frac{1}{3}}\right)^2 + \left(x^{\frac{1}{3}}\right) - 6 = 0$$

$$\left(x^{\frac{1}{3}} - 2\right)\left(x^{\frac{1}{3}} + 3\right) = 0$$

$$\text{So } x^{\frac{1}{3}} = 2 \text{ or } x^{\frac{1}{3}} = -3$$

$$x^{\frac{1}{3}} = 2 \Rightarrow x = 8$$

$$x^{\frac{1}{3}} = -3 \Rightarrow x = -27$$

The roots of  $m(x)$  are  $8$  and  $-27$ .

$$\begin{aligned}
 8 \text{ a } 3^{2x} - 28(3^x) + 27 &= (3^x)^2 - 28(3^x) + 27 \\
 &= (3^x - 27)(3^x - 1)
 \end{aligned}$$

$$\begin{aligned}
 \text{b } f(x) &= 0 \\
 (3^x - 27)(3^x - 1) &= 0 \\
 3^x = 27 &\Rightarrow x = 3
 \end{aligned}$$

$$3^x = 1 \Rightarrow x = 0$$

The roots of  $f(x)$  are  $0$  and  $3$ .