

- (h) $x < -\frac{1}{3}\sqrt{21}$ or $x > \frac{1}{3}\sqrt{21}$
 (i) True for no x
 (j) True for all x
 (k) $x < -\frac{3}{4}$ or $x > \frac{1}{3}$
 (l) $\frac{1}{6}(7 - \sqrt{37}) \leq x \leq \frac{1}{6}(7 + \sqrt{37})$

Miscellaneous exercise 5 (page 72)

- 1 $-6 \leq x \leq 7$
 2 $-4 < x < 2$
 3 $-4 < x < 3$
 4 $-1 < x < 0$ or $x > 1$
 5 $-3 \leq x \leq 0$ or $x \geq 2$
 6 (a) $k < 0$ or $k > 8$
 (b) $-1\frac{1}{2} < k < 1\frac{1}{2}$ provided $k \neq 0$ (if $k = 0$ the equation is linear, and has just one root)
 (c) $k < -2$ or $k > 2$
 7 (a) $0 \leq k < 5$ (b) $k = 0$
 (c) $-\frac{8}{25} < k < 0$
 8 $k \leq 0$ or $k \geq \frac{4}{9}$
 9 $x < -2$ or $x > \frac{2}{3}$
 10 $-\frac{1}{2} < x < 0$ or $x > 2$
 11 (a) $x < 2$ or $x > 2\frac{1}{2}$ (b) $1 - \sqrt{6} < x < 1 + \sqrt{6}$

Revision exercise 1 (page 73)

- 1 $(-4, -16)$
 3 $(x+5)^2 + 13$;
 (a) 13, -5 (b) $x \leq -8$ or $x \geq -2$
 4 $8x^2$
 5 (a) $\frac{1}{2} \leq x \leq 2$ (b) $-\frac{1}{2} < x < \frac{7}{2}$ (c) $x > 6.3$
 6 6
 7 $\pm\sqrt{65}$
 8 $(0,0), (-1,-1), (1,1)$
 9 $\$(12(x+y) + 15xy); 5z^2 + 8z - 4 = 0, 0.4$
 10 $x + y = 5; 7$
 11 (a) $x > \frac{4}{3}$ (b) $x > \frac{3}{2}$ (c) $x \leq 0$ or $x \geq 5$
 12 0, 5
 13 $x = 1, y = 1$ or $x = 4, y = -1$
 14 25
 15 $(2,1)$; the line is a tangent to the curve.
 16 $2x + 3y = 7, 3x - 2y = 4; (4,4)$
 17 (a) $(3,-1)$ (b) 5 (c) $2\sqrt{6} - 1$
 18 (a) $x < -1$ or $x > 2$ (b) $-1 < x < 2$ or $x > 3$
 19 $2\sqrt{19}$ cm
 20 $x = 7, 3y + x = 10; (7,1)$; all $5\sqrt{2}; 30; 2\sqrt{5}$

- 21 $5, y = 1; 2\sqrt{2}, y = x + 1$
 22 $3, -18, 35; 3(x-3)^2 + 8; 8$
 23 $-2, 0$
 24 $1.52, -8.52$
 25 (a) $\left(\frac{c}{a}\right)^{\frac{5}{2}}$ (b) $\frac{c^2}{a^2}\sqrt{\frac{c}{a}}$

6 Differentiation**Exercise 6A (page 77)**

- 1 $y = 3x - 2$
 2 (a) 2.001 (b) 1.9999
 (c) 4.002 (d) 3.999
 (e) 6.000 001 (f) 5.999 99

Exercise 6B (page 79)

- 1 (a) 2 (b) 8 (c) 0 (d) -4
 (e) -0.4 (f) -7 (g) $2p$ (h) $4p$
 2 (a) 2 (b) 8 (c) 0 (d) -4
 (e) -0.4 (f) -7 (g) $2p$ (h) $4p$
 3 4 and -4
 4 (a) $y = 4x - 4$ (b) $y = -2x + 1$
 (c) $y = 2x - 3$ and $y = -2x - 3$
 (d) $y = -2$
 5 (a) $2y = -x + 3$ (b) $4y = x + 22$
 (c) $x = 0$
 (d) $2y\sqrt{c} = -x + \sqrt{c}(4c + 1)$
 6 $12y = -4x + 33$
 7 $4y = 4x + 3$
 8 $(-2\frac{1}{4}, 5\frac{1}{16})$

Exercise 6C (page 82)

- 1 (a) $2x$ (b) $2x - 1$ (c) $8x$
 (d) $6x - 2$ (e) -3 (f) $1 - 4x$
 (g) $4 - 6x$ (h) $\sqrt{2} - 2\sqrt{3}x$
 2 (a) 3 (b) $-6x$ (c) 0
 (d) $2 + 6x$ (e) $-2x$ (f) $6 - 6x$
 (g) $2 - 4x$ (h) $4x + 1$
 3 (a) 6 (b) 3 (c) -3 (d) 8
 (e) -8 (f) -6 (g) 4 (h) -17
 4 (a) $\frac{3}{4}$ (b) $\frac{1}{2}$ (c) $-\frac{3}{2}$
 (d) -1 (e) $\frac{3}{2}$ (f) $\frac{1}{2}$
 5 (a) $y = -2x - 1$ (b) $y = -x$
 (c) $y = 2x - 1$ (d) $y = 6x + 10$
 (e) $y = 1$ (f) $y = 0$
 6 (a) $2y = x - 3$ (b) $4y = -x + 1$
 (c) $8y = -x - 58$ (d) $x = 0$
 (e) $2y = x + 9$ (f) $x = \frac{1}{2}$
 7 $4y = 4x - 1$

- 8 $y = 0$
 9 $y = -2x$
 10 $12y = 12x - 17$
 11 $x = 1$
 12 $7y = -x + 64$
 14 (a) 0.499 875... (b) 0.500 012...
 (c) 0.249 968... (d) 0.250 015...
 (e) 0.999 999... (f) 1.000 001...

Exercise 6D (page 86)

- 1 (a) $3x^2 + 4x$ (b) $-6x^2 + 6x$
 (c) $3x^2 - 12x + 11$ (d) $6x^2 - 6x + 1$
 (e) $4x - 24x^3$ (f) $-3x^2$
 2 (a) -10 (b) 6 (c) 58
 (d) -1 (e) 8 (f) 12
 3 (a) -2, 2 (b) $-\frac{4}{3}, 2$ (c) -5, 7
 (d) 1 (e) $-1, -\frac{1}{3}$ (f) No values
 4 (a) $\frac{1}{\sqrt{x}}$ (b) $\frac{1}{\sqrt{x}} + 1$ (c) $1 - \frac{1}{4\sqrt{x}}$
 (d) $1 - \frac{1}{\sqrt{x}}$ (e) $1 + \frac{1}{x^2}$ (f) $2x + 1 - \frac{1}{x^2}$
 (g) $1 - \frac{2}{x^2}$ (h) $1 + \frac{1}{\sqrt{x}}$
 5 $y = 4x + 2$
 6 $y = x + 2$
 7 $4y = x + 4$
 8 $4y = -x + 4$
 9 $x = 1$
 11 $y = -2x - 6$
 12 $y = -a^2x, y = 2a^2x + 2a^3, y = 2a^2x - 2a^3$
 13 $(\frac{1}{2}, -2)$
 14 (a) $-\frac{1}{4x^2}$ (b) $-\frac{6}{x^3}$ (c) 0
 (d) $\frac{3}{4\sqrt{x}}$ (e) $\frac{2}{\sqrt[3]{x^2}}$ (f) $-\frac{2}{\sqrt{x^3}}$
 (g) $-\frac{3}{x^2} - \frac{1}{x^4}$ (h) $10\sqrt{x^3}$ (i) $\frac{3}{2}\sqrt{x}$
 (j) $-\frac{1}{6\sqrt[3]{x^4}}$ (k) $\frac{4-x}{x^3}$ (l) $\frac{3x-1}{4\sqrt[4]{x^5}}$
 15 $3y - x = 4, y + 3x = 28$
 16 $(0, 12), (\frac{3}{4}, 0)$

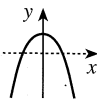
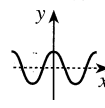
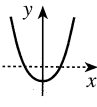
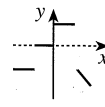
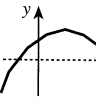
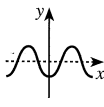
Exercise 6E (page 93)

- 1 $f'(p) = 3p^2$
 2 $f'(p) = 8p^7$
 3 $f'(p) = -\frac{2}{p^3}$

Miscellaneous exercise 6 (page 94)

- 1 $y = 13x - 16$
 2 (a) -9 (b) $-\frac{19}{3}, 3$
 3 $80y = 32x - 51$
 4 $(-3, -\frac{1}{3})$
 5 2
 6 $(-\frac{1}{3}, -4\frac{17}{27}), (2, 13)$
 7 $x + 19y - 153 = 0$
 8 13
 9 (2, 12)
 10 2
 11 Both curves have gradient 12.
 12 -183
 13 $mn = -1$
 14 $(\frac{11}{20}, \frac{4}{5})$
 15 $(\frac{67}{32}, \frac{5}{8})$

7 Applications of differentiation**Exercise 7A (page 96)**

- 3 (a)  (b) 
 (c)  (d) 
 4 (a)  (b) 

Exercise 7B (page 103)

- 1 (a) $2x - 5, x \geq \frac{5}{2}$ (b) $2x + 6, x \geq -3$
 (c) $-3 - 2x, x \leq -\frac{3}{2}$ (d) $6x - 5, x \geq \frac{5}{6}$
 (e) $10x + 3, x \geq -\frac{3}{10}$ (f) $-4 - 6x, x \leq -\frac{2}{3}$
 2 (a) $2x + 4, x \leq -2$ (b) $2x - 3, x \leq \frac{3}{2}$
 (c) $-3 + 2x, x \leq \frac{3}{2}$ (d) $4x - 8, x \leq 2$
 (e) $7 - 4x, x \geq \frac{7}{4}$ (f) $-5 - 14x, x \geq -\frac{5}{14}$
 3 (a) $3x^2 - 12, x \leq -2$ and $x \geq 2$
 (b) $6x^2 - 18, x \leq -\sqrt{3}$ and $x \geq \sqrt{3}$
 (c) $6x^2 - 18x - 24, x \leq -1$ and $x \geq 4$
 (d) $3x^2 - 6x + 3, \text{all } x$
 (e) $4x^3 - 4x, -1 \leq x \leq 0$ and $x \geq 1$
 (f) $4x^3 + 12x^2, x \geq -3$
 (g) $3 - 3x^2, -1 \leq x \leq 1$
 (h) $10x^4 - 20x^3, x \leq 0$ and $x \geq 2$
 (i) $3(1 + x^2), \text{all } x$

- 4 (a) $3x^2 - 27, -3 \leq x \leq 3$
 (b) $4x^3 + 8x, x \leq 0$
 (c) $3x^2 - 6x + 3$, none
 (d) $12 - 6x^2, x \leq -\sqrt{2}$ and $x \geq \sqrt{2}$
 (e) $6x^2 + 6x - 36, -3 \leq x \leq 2$
 (f) $12x^3 - 60x^2, x \leq 5$
 (g) $72x - 8x^3, -3 \leq x \leq 0$ and $x \geq 3$
 (h) $5x^4 - 5, -1 \leq x \leq 1$
 (i) $nx^{n-1} - n; x \leq 1$ if n is even,
 $-1 \leq x \leq 1$ if n is odd
- 5 (a) $\frac{1}{2}x^{1/2}(5x-3); 0 < x < \frac{3}{5}; x \geq \frac{3}{5}$
 (b) $\frac{1}{4}x^{-1/4}(3-14x); x \geq \frac{3}{14}; 0 \leq x \leq \frac{3}{14}$
 (c) $\frac{1}{3}x^{-1/3}(5x+4); -\frac{4}{5} \leq x \leq 0;$
 $x \leq -\frac{4}{5}$ and $x \geq 0$
 (d) $\frac{13}{5}x^{-2/5}(x^2-3); -\sqrt{3} \leq x \leq \sqrt{3};$
 $x \leq -\sqrt{3}$ and $x \geq \sqrt{3}$
 (e) $1 - \frac{3}{x^2}; -\sqrt{3} \leq x < 0$ and $0 < x \leq \sqrt{3};$
 $x \leq -\sqrt{3}$ and $x \geq \sqrt{3}$
 (f) $\frac{x-1}{2x\sqrt{x}}; 0 < x \leq 1; x \geq 1$
- 6 (a) (i) $(4, -12)$ (ii) minimum (iv) $f(x) \geq -12$
 (b) (i) $(-2, -7)$ (ii) minimum (iv) $f(x) \geq -7$
 (c) (i) $(-\frac{3}{5}, \frac{1}{5})$ (ii) minimum (iv) $f(x) \geq \frac{1}{5}$
 (d) (i) $(-3, 13)$ (ii) maximum (iv) $f(x) \leq 13$
 (e) (i) $(-3, 0)$ (ii) minimum (iv) $f(x) \geq 0$
 (f) (i) $(-\frac{1}{2}, 2)$ (ii) maximum (iv) $f(x) \leq 2$
- 7 (a) $(-4, 213)$, maximum; $(3, -130)$, minimum
 (b) $(-3, 88)$, maximum; $(5, -168)$, minimum
 (c) $(0, 0)$, minimum; $(1, 1)$, neither
 (d) $(-2, 65)$, maximum; $(0, 1)$, neither;
 $(2, -63)$, minimum
 (e) $(-\frac{1}{3}, -\frac{11}{27})$, minimum; $(\frac{1}{2}, \frac{3}{4})$, maximum
 (f) $(-1, 0)$, neither
 (g) $(-1, -2)$, maximum; $(1, 2)$, minimum
 (h) $(3, 27)$, minimum
 (i) none
 (j) $(\frac{1}{4}, -\frac{1}{4})$, minimum
 (k) $(6, \frac{1}{12})$, maximum
 (l) $(-2, 17)$, minimum
 (m) $(1, 3)$, maximum
 (n) $(-1, -5)$, minimum
 (o) $(0, 0)$, minimum; $(\frac{4}{5}, \frac{256}{3125})$, maximum
- 8 (a) $f(x) \geq \frac{3}{4}$
 (b) $f(x) \geq -16$
 (c) $f(x) \leq -2, f(x) \geq 2$

Exercise 7C (page 109)

- 1 (a) Gradient of road
 (b) Rate of increase of crowd
 (c) Rate of increase (or decrease if negative) of magnetic force with respect to distance
 (d) Acceleration of particle
 (e) Rate of increase of petrol consumption with respect to speed
- 2 (a) $\frac{dp}{dh}$, p in millibars, h in metres
 (b) $\frac{d\theta}{dt}$, θ in degrees C, t in hours
 (c) $\frac{dh}{dt}$, h in metres, t in hours
 (d) $\frac{dW}{dt}$, W in kilograms, t in weeks
- 3 (a) $6t+7$ (b) $1 - \frac{1}{2\sqrt{x}}$
 (c) $1 - \frac{6}{y^3}$ (d) $2t - \frac{1}{2t\sqrt{t}}$
 (e) $2t+6$ (f) $12s^5 - 6s$
 (g) 5 (h) $-\frac{2}{r^3} - 1$
- 4 (a) Velocity
 (b) (i) Increasing (ii) Decreasing
 (c) 9, occurs when velocity is zero and direction of motion changes
- 5 (a) $\frac{dx}{dt} = c$
 (b) $\frac{dA}{dt} = kA$; A stands for the amount deposited
 (c) $\frac{dx}{dt} = f(\theta)$; x stands for diameter, θ for air temperature
- 6 80 km h^{-1}
 7 20 m
 8 36
 9 $4\sqrt{5}$
 10 Greatest $V = 32\pi$ when $r = 4$,
 least $V = 0$ when $r = 0$ or $h = 0$
 11 25
 12 (b) 1800 m^2
 13 $0 < x < 20$, 7.36 cm
 14 20 cm
 15 (b) $38\,400 \text{ cm}^3$ (to 3 s.f.)
 16 2420 cm^3 (to 3 s.f.)

Miscellaneous exercise 7 (page 110)

- 1 Maximum at $(-2, -4)$; minimum at $(2, 4)$;
y increases with x for $x \leq -2$ and $x \geq 2$
- 2 (a) $\frac{dn}{dt} = kn$ (b) $\frac{d\theta}{dt} = -k\theta$
(c) $\frac{d\theta}{dt} = -k(\theta - \beta)$
- 4 $(20 - 4t) \text{ m s}^{-1}$, -4 m s^{-2} ; for $0 \leq t \leq 5$
- 5 (a) 20 m (b) 6 s (c) 40 m s^{-1}
- 6 50
- 7 (a) $9\sqrt{2} \text{ cm}$ (b) $40\frac{1}{2} \text{ cm}^2$
- 8 (a) $(-1, -7), (2, 20)$
(b) Graph crosses the x -axis three times.
(c) $y = -5$ has three intersections with graph.
(d) (i) $-20 < k < 7$ (ii) $k < -20$ and $k > 7$
- 9 $(-2, 4), (2, -28)$; $-28 \leq k \leq 4$
- 10 $(-\frac{2}{3}, \frac{4}{27}), (0, 0)$; $0 < k < \frac{4}{27}$
- 11 $(-1, 5), (2, -22), (0, 10)$;
(a) $5 < k < 10$ (b) $-22 < k < 5$ and $k > 10$
- 12 $(\frac{1}{3}, \frac{4}{27}), (1, 0)$; $k < -\frac{2}{3\sqrt{3}}$ and $k > \frac{2}{3\sqrt{3}}$
- 13 (a) $P = 2x + 2r + \frac{1}{2}\pi r$, $A = \frac{1}{4}\pi r^2 + rx$
(b) $x = \frac{1}{4}r(4 - \pi)$
- 14 Maximum at $(2, \frac{1}{4})$
(a) $(2, 5\frac{1}{4})$
(b) $(3, \frac{1}{2})$; that is, when $x - 1 = 2$
- 16 (a) $1100 - 20x$ (b) $\pounds x(1100 - 20x)$
(c) $\pounds(24\,000 - 400x)$;
 $\pounds 37.50$
- 17 (a) The gradient at P' is the negative of the gradient at P . So $f'(-p) = -f'(p)$. The derivative of an even function is odd.

8 Sequences**Exercise 8A (page 115)**

- 1 (a) 7, 14, 21, 28, 35 (b) 13, 8, 3, -2, -7
(c) 4, 12, 36, 108, 324 (d) 6, 3, 1.5, 0.75, 0.375
(e) 2, 7, 22, 67, 202 (f) 1, 4, 19, 364, 132499
- 2 (a) $u_1 = 2, u_{r+1} = u_r + 2$
(b) $u_1 = 11, u_{r+1} = u_r - 2$
(c) $u_1 = 2, u_{r+1} = u + 4$
(d) $u_1 = 2, u_{r+1} = 3u_r$
(e) $u_1 = \frac{1}{3}, u_{r+1} = \frac{1}{3}u_r$
(f) $u_1 = \frac{1}{2}a, u_{r+1} = \frac{1}{2}u_r$
(g) $u_1 = b - 2c, u_{r+1} = u_r + c$
(h) $u_1 = 1, u_{r+1} = -u_r$

(i) $u_1 = \frac{p}{q^3}, u_{r+1} = qu_r$

(j) $u_1 = \frac{a^3}{b^2}, u_{r+1} = \frac{bu_r}{a}$

(k) $u_1 = x^3, u_{r+1} = \frac{5u_r}{x}$

(l) $u_1 = 1, u_{r+1} = (1+x)u_r$

- 3 (a) 5, 7, 9, 11, 13; $u_1 = 5, u_{r+1} = u_r + 2$
(b) 1, 4, 9, 16, 25; $u_1 = 1, u_{r+1} = u_r + 2r + 1$
(c) 1, 3, 6, 10, 15; $u_1 = 1, u_{n+1} = u_r + r + 1$
(d) 1, 5, 14, 30, 55; $u_1 = 1, u_{n+1} = u_r + (r+1)^2$
(e) 6, 18, 54, 162, 486; $u_1 = 6, u_{r+1} = 3u_r$
(f) 3, 15, 75, 375, 1875; $u_1 = 3, u_{r+1} = 5u_r$

- 4 (a) $u_r = 10 - r$ (b) $u_r = 2 \times 3^r$
(c) $u_r = r^2 + 3$ (d) $u_r = 2r(r+1)$
(e) $u_r = \frac{2r-1}{r+3}$ (f) $u_n = \frac{r^2+1}{2^r}$

Exercise 8B (page 119)

- 2 (a) r (c) $1^3 = t_1^2 - t_0^2, 2^3 = t_2^2 - t_1^2,$
 $3^3 = t_3^2 - t_2^2, \dots, n^3 = t_n^2 - t_{n-1}^2$
- 3 (a) 5040 (b) 6720 (c) 35
- 4 (a) $\frac{8!}{4!}$ (b) $\frac{12!}{8!}$ (c) $\frac{n!}{(n-3)!}$
(d) $\frac{(n+1)!}{(n-2)!}$ (e) $\frac{(n+3)!}{(n-1)!}$ (f) $\frac{(n+6)!}{(n+3)!}$
(g) $8!$ (h) $n!$
- 5 (a) 12 (b) $22 \times 22!$
(c) $n+1$ (d) $n \times n!$
- 7 (a) 1, 5, 10, 10, 5, 1, 0, 0, ...
(b) 1, 6, 15, 20, 15, 6, 1, 0, 0, ...
(c) 1, 8, 28, 56, 70, 56, 28, 8, 1, 0, 0, ...
- 8 (a) $\frac{11!}{4! \times 7!}$ (b) $\frac{11!}{7! \times 4!}$ (c) $\frac{10!}{5! \times 5!}$
(d) $\frac{12!}{3! \times 9!}$ (e) $\frac{12!}{9! \times 3!}$

10 $\binom{n}{r} + \binom{n}{r+1} = \binom{n+1}{r+1}$

- 11 The sum of the terms in the sequence is
- 2^n
- .

Exercise 8C (page 124)

- 1 (a), (d), (f), (h); 3, -2, q , x respectively
- 2 (a) 12, 2r (b) 32, 14 + 3r
(c) -10, 8 - 3r (d) 3.3, 0.9 + 0.4r
(e) $3\frac{1}{2}, \frac{1}{2} + \frac{1}{2}r$ (f) 43, 79 - 6r
(g) $x + 10, x - 2 + 2r$ (h) $1 + 4x, 1 - 2x + xr$
- 3 (a) 14 (b) 88 (c) 36
(d) 11 (e) 11 (f) 11
(g) 16 (h) 28

4 60

5 $(-6, 125)$

6 $y = -\frac{3}{4}x - \frac{5}{4}$

7 $y = -3x + 48$

Exercise 12C (page 179)

1 (a) $30(5x+3)^5$ (b) $\frac{5}{2}(5x+3)^{-\frac{1}{2}}$

(c) $\frac{-5}{(5x+3)^2}$

2 (a) $-20(1-4x)^4$ (b) $12(1-4x)^{-4}$

(c) $\frac{-2}{\sqrt{1-4x}}$

3 (a) $15x^2(1+x^3)^4$ (b) $-12x^2(1+x^3)^{-5}$

(c) $\frac{x^2}{(1+x^3)^{\frac{5}{3}}}$

4 (a) $24x(2x^2+3)^5$ (b) $\frac{-4x}{(2x^2+3)^2}$

(c) $\frac{2}{\sqrt{(2x^2+3)^3}}$

5 $24x^3(3x^4+2)$

6 (a) $72x^8+72x^5+18x^2$ (b) $18x^2(2x^3+1)^2$

7 (a) $20x^4(x^5+1)^3$ (b) $48x^2(2x^3-1)^7$

(c) $\frac{5}{2\sqrt{x}}(\sqrt{x}-1)^4$

8 (a) $8x(x^2+6)^3$ (b) $45x^2(5x^3+4)^2$

(c) $28x^3(x^4-8)^6$ (d) $-45x^8(2-x^9)^4$

9 (a) $\frac{2}{\sqrt{(4x+3)}}$ (b) $12x(x^2+4)^5$

(c) $-36x^2(6x^3-5)^{-3}$ (d) $3x^2(5-x^3)^{-2}$

10 (a) $-\frac{4}{25}$ (b) 0

11 $\frac{3}{8}$

12 (a) $6(x^2+3x+1)^5(2x+3)$ (b) $\frac{-3(2x+5)}{(x^2+5x)^4}$

13 $y = 12x - 25$

14 $x + 4y = 8$

15 $x + 6y = 23$

16 $6x(x^2-1)^{-\frac{1}{2}}(\sqrt{x^2-1}+1)^5$

17 $\frac{1}{\sqrt{(4x+3)(1+\sqrt{4x+3})}}$

18 $(0, 3)$; minimum

Exercise 12D (page 182)

1 4500 per hour

2 0.622°C per minute

3 (a) 4.8 cm s^{-1} (b) $24\text{ cm}^2\text{ s}^{-1}$

4 (a) $240\text{ mm}^2\text{ s}^{-1}$ (b) $2400\text{ mm}^3\text{ s}^{-1}$

5 $942\text{ mm}^2\text{ s}^{-1}$

6 0.25 m min^{-1}

7 0.0076 m s^{-1}

8 0.011 m s^{-1}

9 0.0040 cm s^{-1}

Miscellaneous exercise 12 (page 184)

1 $80(4x-1)^{19}$

2 $\frac{8}{(3-4x)^3}$

3 $40x^3(x^4+3)^4$

4 $24x + y = 49$

6 $-\frac{10}{27}$

7 $y = 20x + 11$

8 $(0, \frac{1}{4})$

9 $3x + 4y = 18$

10 $0.377\text{ cm}^2\text{ s}^{-1}$

11 (a) $\frac{10}{\sqrt{\pi}}\text{ cm}$ (b) $\frac{1}{4\sqrt{\pi}}\text{ cm s}^{-1}$

12 $8x + 5y - 34 = 0$

13 $(2, -4); (0, 0), (4, 0)$

$(0, 16), (4, -16); (2, 0), (2 \pm 2\sqrt{3}, 0), (0, 16)$

14 $\frac{(1-1/x^2)}{2\sqrt{(x+1/x)}}$

15 $4\text{ m}^2\text{ s}^{-1}$

16 $y = 2x - 3$

17 $\frac{-12t}{(3t^2+5)^3}$

18 (a) $\frac{2-x}{\sqrt{4x-x^2}}, (2, 2)$

19 (a) Minimum (b) 20

20 $\frac{3}{20\pi}\text{ cm s}^{-1}$

21 0.052 m s^{-1}

22 $(-\sqrt{3}, -4)$, minimum; $(-1, 0)$, maximum;
 $(0, -4)$, minimum; $(1, 0)$, maximum;
 $(\sqrt{3}, -4)$, minimum