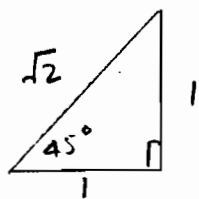


1)

By Pythagoras hypotenuse = $\sqrt{2}$

$$\therefore \cos 45 = \frac{1}{\sqrt{2}}$$

$$\theta = \frac{s}{r} = \frac{43.2}{18.0} = 2.4 \text{ radians}$$

4 ii)

$$2.4 \times \frac{180}{\pi} = 137.50987^\circ$$

$$= 138^\circ \text{ to nearest degree}$$

2)

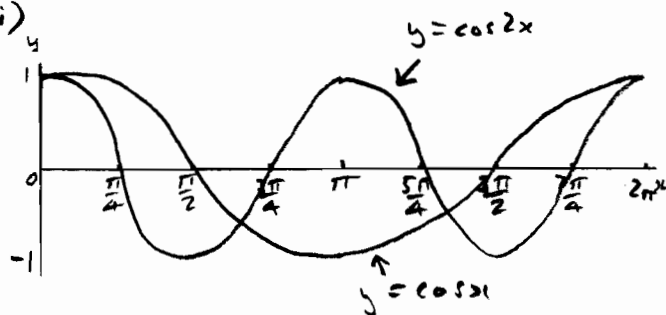
$$\int_1^2 (12x^5 + 5) dx$$

$$= [2x^6 + 5x]_1^2$$

$$= (2 \times 64 + 5 \times 2) - (2 + 5)$$

$$= 138 - 7 = 131$$

5 i)



5 ii)

$y = \cos x$ is mapped to $y = 3 \cos x$ by a stretch scale factor 3 parallel to the y-axis.

3) i)

$$\sum_{k=3}^8 (k^2 - 1)$$

$$= (3^2 - 1) + (4^2 - 1) + (5^2 - 1)$$

$$+ (6^2 - 1) + (7^2 - 1) + (8^2 - 1)$$

$$= 8 + 15 + 24 + 35 + 48 + 63$$

$$= 193$$

6)

$$y = x^3 - 6x^2 - 15x$$

$$\frac{dy}{dx} = 3x^2 - 12x - 15$$

At t.p. $\frac{dy}{dx} = 0$

$$\Rightarrow 3x^2 - 12x - 15 = 0$$

$$3(x^2 - 4x - 5) = 0$$

$$3(x - 5)(x + 1) = 0$$

$$\Rightarrow x = 5 \text{ or } x = -1$$

Sketch



3) ii)

n^{th} term is divergent because successive terms get ever further apart.

4) i)

$$r = 18.0 \text{ cm} \quad s = 43.2 \text{ cm}$$

Arc length $s = r\theta$

Increasing function when $x < -1$ and also when $x > 5$

7)

$$4 \cos^2 \theta = 4 - \sin \theta$$

$$\Rightarrow 4(1 - \sin^2 \theta) = 4 - \sin \theta$$

$$\Rightarrow 4 - 4 \sin^2 \theta = 4 - \sin \theta$$

$$\Rightarrow 0 = 4 \sin^2 \theta - \sin \theta$$

$$\Rightarrow \sin \theta (4 \sin \theta - 1) = 0$$

$$\Rightarrow \sin \theta = 0 \text{ or } \sin \theta = \frac{1}{4}$$

When $\sin \theta = 0$ $\theta = 0, 180^\circ$

When $\sin \theta = \frac{1}{4}$ $\theta = 14.5^\circ, 165.5^\circ$

Solution $\theta = 0, 14.5^\circ, 165.5^\circ, 180^\circ$

8)

$$\frac{dy}{dx} = 3\sqrt{x} - 5$$

$$\frac{dy}{dx} = 3x^{\frac{1}{2}} - 5$$

$$\Rightarrow y = \frac{3x^{\frac{3}{2}}}{\frac{3}{2}} - 5x + c$$

$$y = 2x^{\frac{3}{2}} - 5x + c$$

Passes through (4,6) so

$$6 = 2 \times 4^{\frac{3}{2}} - 5(4) + c$$

$$6 = 2 \times 8 - 20 + c$$

$$10 = c$$

Curve is given by:

$$y = 2x^{\frac{3}{2}} - 5x + 10$$

9)

$$10 - 3 \log_a a$$

i)

$$= 10 - 3 = 7$$

9ii)

$$\frac{\log_{10} a^5 + \log_{10} \sqrt{a}}{\log_{10} a}$$

$$= \frac{5 \log_{10} a + \log_{10} a^{\frac{1}{2}}}{\log_{10} a}$$

$$= \frac{5 \log_{10} a + \frac{1}{2} \log_{10} a}{\log_{10} a}$$

$$= \frac{\frac{11}{2} \log_{10} a}{\log_{10} a} = \frac{11}{2}$$

10 i) See insert

ii) $h = a \log_{10} t + b$

From graph $b = h$ intercept = -9

$$a = \text{gradient} = \frac{26 - (-9)}{1.6 - 0} = \frac{35}{1.6}$$

$$a = 21.875$$

Eqn $h = 21.9 \log_{10} t - 9$

iii)

When $t = 100$ $h = 21.9 \log_{10} 100 - 9$

$$h = 34.8 \text{ m}$$

iv)

$$29 = 21.9 \log_{10} t - 9$$

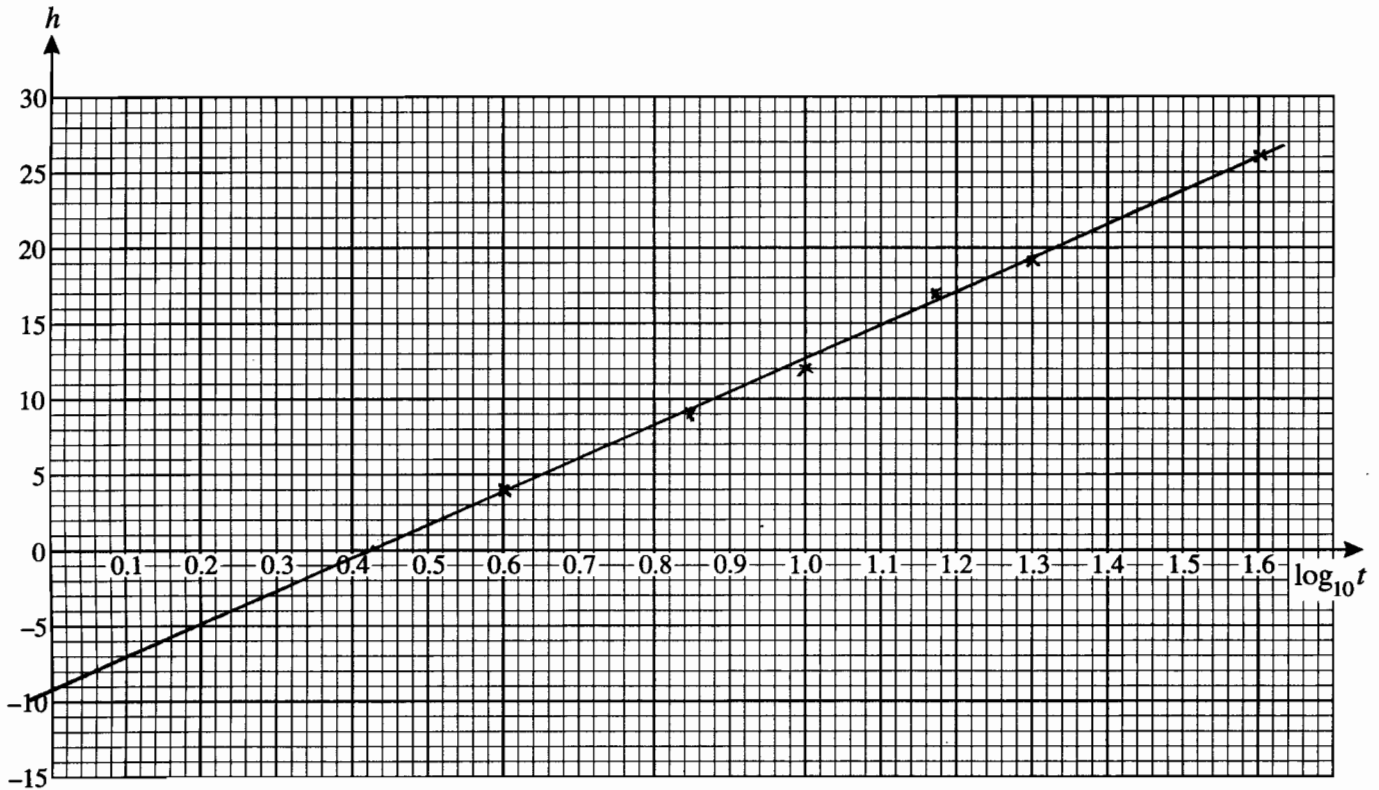
$$38 = 21.9 \log_{10} t$$

$$\frac{38}{21.9} = \log_{10} t$$

$$t = 10^{\left(\frac{38}{21.9}\right)} = 54.3 \text{ years}$$

10 (i)

Age (t years)	4	7	10	15	20	40
$\log_{10} t$	0.602	0.845	1	1.176	1.301	1.602
Height (h m)	4	9	12	17	19	26



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10v) Model is unsuitable for very young trees which will be predicted to have negative heights.

eg When $t = 2$ years model predicts

$$h = 21.9 \log_{10} 2 - 9 = -2.4 \text{ m}$$

11 i)

A) $10 + 20 + 30 + 40 + 50 + 60 = \pounds 210$

B) AP $a = 10, d = 10$

$$S_n = \frac{n}{2} (2a + (n-1)d)$$

$$S_n = \frac{n}{2} (20 + 10(n-1))$$

$$S_n = \frac{n}{2} (10n + 10)$$

$$S_n = 5n(n+1)$$

$$10,350 = 5n^2 + 5n$$

$$2070 = n^2 + n$$

$$n^2 + n - 2070 = 0$$

$$n = \frac{-1 \pm \sqrt{1^2 + 4 \times 2070}}{2}$$

$$n = \frac{-1 \pm 91}{2}$$

$$n = -46 \text{ or } n = 45$$

In this context

$$n = 45$$

11 ii)

A) $5 + 10 + 20 + 40 = \pounds 75$

4 questions correct

B) GP $a = 5, r = 2$

$$S_n = \frac{a(r^n - 1)}{r - 1}$$

$$S_9 = \frac{5(2^9 - 1)}{2 - 1} = \pounds 2555$$

C)

$$S_n = 5(2^n - 1)$$

$$2,621,435 = 5(2^n - 1)$$

$$524,287 = 2^n - 1$$

$$2^n = 524,288$$

$$n \log_{10} 2 = \log_{10} 524,288$$

$$n = \frac{\log_{10} 524,288}{\log_{10} 2}$$

$$n = 19$$

12)

i) $y = x^2 - 7$

When $x = 3.1, y = 3.1^2 - 7 = 2.61$

When $x = 3, y = 3^2 - 7 = 2$

Points are $(3, 2)$ and $(3.1, 2.61)$

$$\text{Gradient} = \frac{2.61 - 2}{3.1 - 3} = 6.1$$

$$\begin{aligned}
 12\text{ii)} \quad f(x) &= x^2 - 7 \\
 \frac{f(3+h) - f(3)}{h} & \\
 &= \frac{(3+h)^2 - 7 - (3^2 - 7)}{h} \\
 &= \frac{9 + 6h + h^2 - 7 - 2}{h} \\
 &= \frac{6h + h^2}{h} \\
 &= \frac{h(6+h)}{h} \\
 &= 6 + h
 \end{aligned}$$

12iii) Letting $h \rightarrow 0$ gives the gradient of the tangent and therefore the function at $x = 3$

$$\therefore \text{gradient} = 6 + 0 = 6$$

12iv) When $x = 3$, $y = 2$
gradient = 6

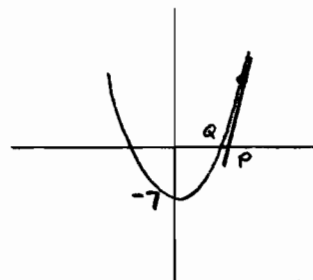
$$y - y_1 = m(x - x_1)$$

$$y - 2 = 6(x - 3)$$

$$y - 2 = 6x - 18$$

$$y = 6x - 16$$

12v)



$$y = 6x - 16$$

$$\text{At } P \quad y = 0 \quad \therefore 0 = 6x - 16$$

$$6x = 16$$

$$x = \frac{16}{6}$$

$$\begin{aligned}
 \text{At } Q \quad y = 0 \quad \therefore x^2 - 7 = 0 \\
 x^2 = 7 \\
 x = +\sqrt{7}
 \end{aligned}$$

$$PQ = \frac{16}{6} - \sqrt{7} = 0.0209$$

$$PQ = 0.021 \text{ to 3 d.p.}$$