

## C2 summer 2014

$$1 \quad \int 7x^{5/2} dx = \frac{2}{7} \times 7x^{7/2}$$

$$= \underline{\underline{2x^{7/2} + C}}$$

$$2 \quad (i) \quad \sum_{r=1}^5 \frac{21}{r+2} = \frac{21}{3} + \frac{21}{4} + \frac{21}{5} + \frac{21}{6} + \frac{21}{7} = \frac{1}{4} + \frac{1}{5} + \frac{1}{2}$$

$$= 7 + 5\frac{1}{4} + 4\frac{1}{5} + 3\frac{1}{2} + 3 = \frac{5}{20} + \frac{4}{20} + \frac{10}{20}$$

$$= \underline{\underline{22\frac{19}{20}}}$$

$$(ii) \quad u_1 = a$$

$$u_2 = a+5$$

$$u_3 = a+5+5$$

$$u_r = a + (r-1)d \quad \therefore u_{10} = a + 9d \quad S_{10} = \frac{1}{2}(10)(2a + 9(5))$$

$$S_n = \frac{1}{2}n(2a + (n-1)d) \quad = \underline{\underline{a + 45}}$$

$$= \underline{\underline{10a + 225d}}$$

$$3. \quad f'(2) \approx \frac{3.6 - 2.4}{2 - 2.2}$$

$$= \frac{-1.2}{0.2}$$

$$= \underline{\underline{-6}}$$

$$4. \quad R(6, -3) \quad (i) \quad \text{stretch s.f. } \frac{1}{2} \parallel \text{to } y\text{-axis} \quad \therefore \text{image } \underline{\underline{(6, -1.5)}}$$

$$(ii) \quad \text{stretch s.f. } \frac{1}{3} \parallel \text{to } x\text{-axis} \quad \therefore \text{image } \underline{\underline{(2, -3)}}$$

$$5. \quad \text{cosine rule: } |AC| = \sqrt{(5.9)^2 + (8.5)^2 - 2(5.9)(8.5) \cos 72^\circ}$$

$$= \underline{\underline{8.72 \text{ cm}}} \quad (3 \text{ s.f.})$$

$$6 \text{ AREA} = \frac{1}{2} r^2 \theta - \frac{1}{2} r^2 \sin \theta$$

$$= \frac{1}{2} (12 \cdot 4)^2 (2 \cdot 1 - \sin 2 \cdot 1^\circ)$$

$$= \underline{\underline{95.1 \text{ cm}^2}} \quad (3 \text{ s.f.})$$

$$7 \text{ G.P. } a_n = ar^{n-1} \quad S_\infty = \frac{a}{1-r}$$

$$a_2 = \underline{\underline{24}} = ar \quad ① \quad S_\infty = 150 = \frac{a}{1-r} \quad ②$$

$$\frac{①}{②} : \frac{24}{150} = \frac{ar}{\frac{a}{1-r}}$$

$$\frac{4}{25} = ar \times \frac{(1-r)}{r}$$

$$\frac{4}{25} = r - r^2$$

rearrange ①:

$$a = \frac{24}{r}$$

$$r^2 - r + \frac{4}{25} = 0$$

$$25r^2 - 25r + 4 = 0$$

$$25r^2 - 20r - 5r + 4 = 0$$

$$5r(5r-4) - (5r-4) = 0$$

$$(5r-1)(5r-4) = 0$$

$$r = \frac{1}{5}, r = \frac{4}{5}$$

$$r = \frac{1}{5} \Rightarrow a = \frac{24}{1/5}$$

$$= 24(5)$$

$$= \underline{\underline{120}}$$

$$r = \frac{4}{5} \Rightarrow a = \frac{24}{4/5}$$

$$= 24(\frac{5}{4})$$

$$= \underline{\underline{30}}$$

$$8 \cos^2 \theta + \sin^2 \theta = 1$$

$$\frac{\sin \theta}{\cos \theta} = \tan \theta$$

$$\Rightarrow \sin^2 \theta = 1 - \cos^2 \theta$$

$$\frac{\sqrt{1 - \cos^2 \theta}}{\tan \theta} = \frac{\sqrt{\sin^2 \theta}}{\frac{\sin \theta}{\cos \theta}}$$

$$= \cancel{\sin \theta} \times \frac{\cos \theta}{\cancel{\sin \theta}}$$

$$= \underline{\underline{\cos \theta}}$$

9

$$\tan 2\theta = 3$$

$$0^\circ < \theta < 360^\circ$$

$$\text{let } 2\theta = x$$

$$\tan x = 3$$

$$\begin{aligned} x &= \arctan 3 \\ &= 71.6^\circ \end{aligned}$$

$\tan$  has period  $180^\circ$

$$\begin{aligned} 2\theta &= 71.6^\circ, 71.6^\circ + 180^\circ, 71.6^\circ + 360^\circ, 71.6^\circ + 540^\circ \\ \theta &= 35.8^\circ, 126^\circ, 216^\circ, 306^\circ \quad (\text{3 s.f.}) \end{aligned}$$

10

$$3^{x+1} = 5^{2x}$$

$$\log 3^{x+1} = \log 5^{2x}$$

$$(x+1) \log 3 = 2x \log 5$$

$$x \log 3 + \log 3 = 2x \log 5$$

$$\log 3 = 2x \log 5 - x \log 3$$

$$\log 3 = x(2 \log 5 - \log 3)$$

$$\frac{\log 3}{2 \log 5 - \log 3} = x$$

$$\frac{\log 3}{2 \log 5 - \log 3}$$

$$x = \frac{\log 3}{\log \left(\frac{25}{3}\right)}$$

$$= 0.518 \quad (\text{3 d.p.})$$

$$\begin{aligned} 11 \text{ (i)} \quad y &= x - \frac{4}{x^2} \\ &= x - 4x^{-2} \end{aligned}$$

$$\frac{dy}{dx} = 1 + 8x^{-3} = 1 + \frac{8}{x^3}$$

$$\frac{d^2y}{dx^2} = -24x^{-4}$$

$$= -\frac{24}{x^4}$$

QED

$$\text{(ii) At stat. pt. } \frac{dy}{dx} = 0 \Rightarrow 1 + \frac{8}{x^3} = 0$$

$$\begin{aligned} \frac{8}{x^3} &= -1 \\ -8 &= x^3 \end{aligned}$$

$$x = -2$$

(ii)  $y = -2 - \frac{4}{(-2)^2}$   $\therefore$  stat. pt. at  $(-2, -3)$   
 cont'd

$$= -2 - 1 \quad \text{at max. pt. } \frac{d^2y}{dx^2} < 0$$

$$= -3$$

$$\text{at } x = -2, \frac{d^2y}{dx^2} = -\frac{24}{(-2)^4}$$

$$= -\frac{24}{16}$$

$< 0 \therefore$  max. pt.

(ii) When  $x = -1, y = -1 - \frac{4}{(-1)^2}, \text{ grad. } \frac{dy}{dx} = 1 + \frac{8}{(-1)^3}$

$$= -5 \qquad \qquad \qquad = -7$$

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

$$y - (-5) = \frac{1}{7}(x + 1)$$

$\therefore$  grad. of normal is  $\frac{1}{7}$

$$7(y + 5) = x + 1$$

$$0 = x - 7y - 34$$

12(i) AREA  $\approx \frac{1}{2}(3)(9 + 9.1 + 2(10.7 + 11.7 + 11.9 + 11.0))$

$$= \frac{3261}{20}$$

$$= \underline{\underline{163 \text{ m}^2}} \text{ (3.s.f.)}$$

(ii)(A) subst.  $x = 12: y = -0.001(12)^3 - 0.025(12)^2 + 0.6(12) + 9$   
 $= 10.872$

data gives  $y = 11 \text{ m}$  when  $x = 12 \therefore$  height difference  $11 - 10.872$   
 (cubic model is slightly lower)  $= \underline{\underline{0.128 \text{ m}}}$

(B) AREA is  $\int_0^{15} -0.001x^3 - 0.025x^2 + 0.6x + 9 \, dx$

$$= \left[ -\frac{0.001}{4}x^4 - \frac{0.025}{3}x^3 + \frac{0.6}{2}x^2 + 9x \right]_0^{15}$$

$$= \left( -\frac{0.001}{4}(15)^4 - \frac{0.025}{3}(15)^3 + 0.3(15)^2 + 9(15) \right) - (0)$$

$$= \underline{\underline{162 \text{ m}^2}} \text{ (3.s.f.)}$$

13 (i)  $h = a \times 10^{bt}$  take logs (base 10)

$$\log_{10} h = \log_{10}(a \times 10^{bt})$$

$$= \log_{10} a + \log_{10} 10^{bt}$$

$$= bt \log_{10} 10 + \log_{10} a$$

$$= bt + \log_{10} a$$

$$= mt + c$$

$$\log_{10} 10 = 1$$

$$\text{where } m = b, \log_{10} a = c$$

$$\downarrow \\ a = 10^c$$

(ii) on separate sheet

(iii)  $\text{grad} = \frac{1.16 - 0.22}{48 - 2}$   $y\text{-int} = -0.25$

$$\therefore b = 0.03$$

$$\therefore a = 10^{-0.25}$$

$$= 0.56$$

$$h = a \times 10^{bt} \Rightarrow h = 0.56 \times 10^{0.03t}$$

(iv) in 2020  $t = 60$   $\therefore$  between 2010 and 2010 reduction is

$$a \times 10^{60b} - a \times 10^{50b} = 0.56 (10^{60(0.03)} - 10^{50(0.03)})$$

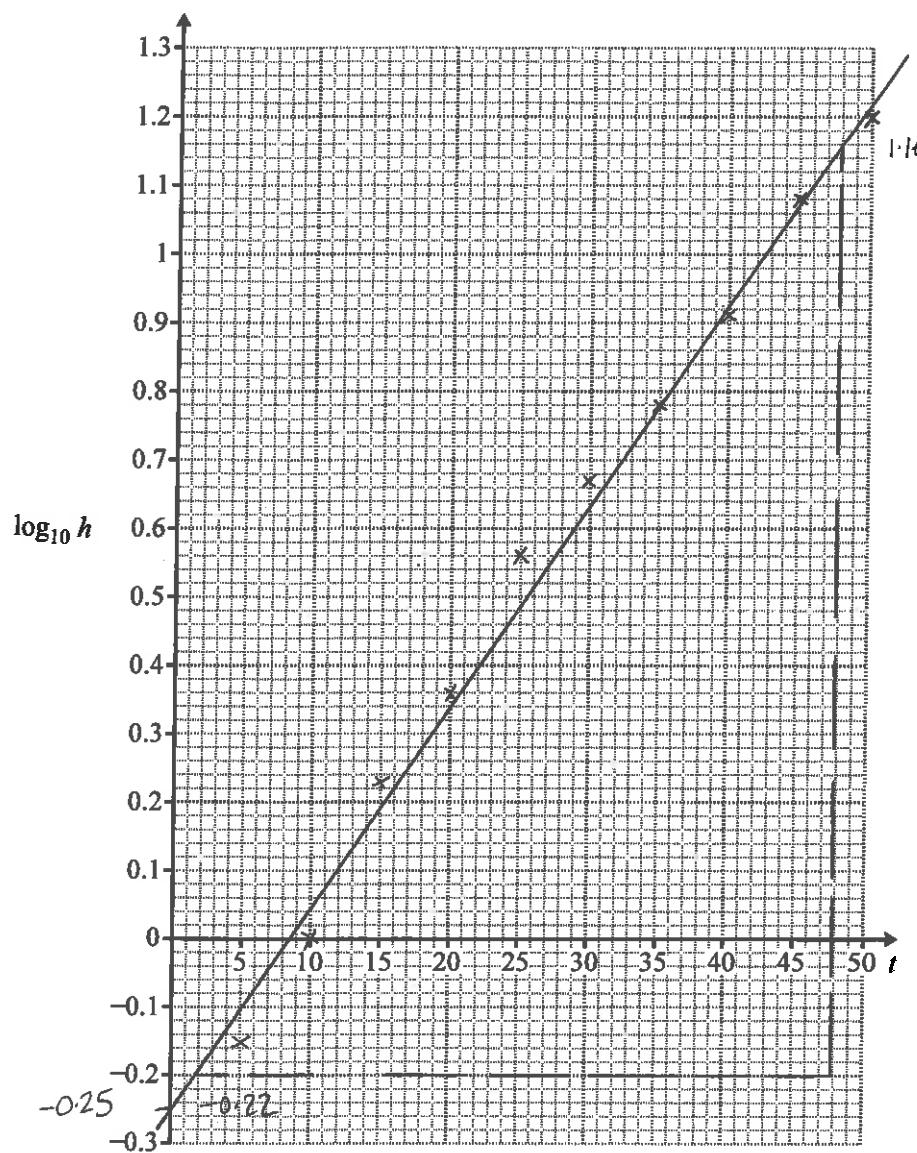
$$= 17.6 \text{ m (3 s.f.)}$$

(v) In the long term, according to this model,  $h$  would continue to increase, until the reduction in thickness is greater than the original thickness of the glacier, which does not make sense. Once the glacier has totally melted (thickness of zero) it cannot continue to reduce in thickness.

13(ii)

## Spare copy of table and graph for question 13(ii)

$t$	5	10	15	20	25	30	35	40	45	50
$h$	0.7	1.0	1.7	2.3	3.6	4.7	6.0	8.2	12	15.9
$\log_{10} h$	-0.15	0	0.23	0.36	0.56	0.67	0.78	0.91	1.08	1.20



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