| Question Number | Scheme | Marks |
|---|---|---|
| 7(a) | $r=\sqrt{\dfrac{12.8}{20}}=0.8*$ <br> or e.g. <br> $20\times0.8\times0.8=12.8$ <br> so $r=0.8*$ | B1* |
| | | **(1)** |
| (b) | $a=20\div0.8^2$ | M1 |
| | $=31.25$ | A1 |
| | | **(2)** |
| (c) | $\dfrac{31.25\left(1-0.8^n\right)}{1-0.8}>156$ | M1 |
| | Eg $1-0.8^n>0.9984$ <br> $\Rightarrow 0.8^n<0.0016$ | dM1 |
| | $0.8^n<0.0016\Rightarrow n>\dfrac{\log(0.0016)}{\log(0.8)}$ <br> or <br> $0.8^n<0.0016\Rightarrow n>\log_{0.8}0.0016$ | M1 |
| | $n=29$ | A1 |
| | | **(4)** |
| | | **Total 7** |

| Question Number | Scheme | Marks |
|---|---|---|
| **7 (a)** | States either $kn=-24$ (1) or $\dfrac{n(n-1)}{2}k^2=270$ (2) | M1 |
| | States both $kn=-24$ (1) and $\dfrac{n(n-1)}{2}k^2=270$ (2) | A1 |
| | Substitutes $k=-\dfrac{24}{n}$ in equation (2) $\Rightarrow\dfrac{n(n-1)}{2}\left(-\dfrac{24}{n}\right)^2=270\Rightarrow n=\ldots$ | M1 |
| | $n=16$ | A1 |
| | Uses their $n=16$ in $kn=-24\Rightarrow k=-\dfrac{24}{16}=-\dfrac{3}{2}$ | dM1, A1 |
| | | **(6)** |
| **(b)** | $p=\dfrac{n(n-1)(n-2)}{3!}k^3=\dfrac{16\times15\times14}{6}\times\left(-\dfrac{3}{2}\right)^3=\ldots$ | M1 |
| | $=-1890$ | A1 |
| | | **(2)** |
| | | **(8 marks)** |

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **3(a)** | $\left(2-\frac{kx}{4}\right)^8 = 2^8 + \binom{8}{1}2^7\left(-\frac{kx}{4}\right) + \binom{8}{2}2^6\left(-\frac{kx}{4}\right)^2 + \binom{8}{3}2^5\left(-\frac{kx}{4}\right)^3 + \ldots$ <br> Or $\left(1-\frac{kx}{8}\right)^8 = 1 + \binom{8}{1}\left(-\frac{kx}{8}\right) + \binom{8}{2}\left(-\frac{kx}{8}\right)^2 + \binom{8}{3}\left(-\frac{kx}{8}\right)^3 + \ldots$ | | M1 |
| | $= 256 - 256kx + 112k^2x^2 - 28k^3x^3 + \ldots$ | $256 - 256kx$ | B1 |
| | | $112k^2x^2$ **or** $-28k^3x^3$ (unsimplified) | A1 |
| | | $112k^2x^2$ **and** $-28k^3x^3$ (simplified) | A1 |
| | | | **(4)** |
| **(b)** | $f(x) = (5-3x)\left(2-\frac{kx}{4}\right)^8 = (5-3x)\left(256 - 256kx + 112k^2x^2 - 28k^3x^3 + \ldots\right)$ <br> Coefficient of $x$ is $5\times -256k - 3\times 256$ | | M1 |
| | $5\times 256 = 3(-1280k - 768) \Rightarrow k = \ldots$ | Sets $5\times$their constant term from (a) = $3\times$their coefficient of $x$ from $f(x)$ and solves for $k$ | M1 |
| | $k = -\frac{14}{15}$ | Correct value. | A1 |
| | | | **(3)** |
| | | | **Total 7** |

| Question Number | Scheme | Marks |
|---|---|---|
| **5** | $\log_2 16x + \log_2(x+1) = 3 + \log_2(x+6)$ | |
| | $\log_2 a = b \Rightarrow 2^b = a$ | B1 |
| | $\log_2 16x(x+1) = \log_2 8(x+6)$ | M1 |
| | $2x^2 + x - 6 = 0$ | A1 |
| | $(2x-3)(x+2) = 0$ | dM1 |
| | $x = \frac{3}{2}$ only | A1cso |
| | | **(5 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **2.(a)** | Attempts to substitute $u_2 = 6k+3$ in $u_3\left(=ku_2+3\right)$ | M1 |
| | $u_3 = k\left(6k+3\right)+3$ | A1 |
| | | **(2)** |
| **(b)** | Uses $\sum_{n=1}^{3} u_n = 117 \Rightarrow 6+6k+3+k(6k+3)+3=117$ | M1 |
| | $6k^2+9k-105=0 \Rightarrow k=...$ | dM1 |
| | $k=\frac{7}{2}$ | A1 |
| | | **(3)** |
| | | **(5 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **6(a)** | $(x\pm 3)^2+(y\pm 7)^2 \pm ... = ...$ | M1 |
| | Centre = $(3,7)$ | A1 |
| | | **(2)** |
| **(b)** | Attempts $(\pm 3)^2+(\pm 7)^2 \pm 32$ | M1 |
| | Radius = $3\sqrt{10}$ | A1 |
| | | **(2)** |
| **(c)** | Uses radius < 3 $\Rightarrow 9+49-k<9$ or uses radius > 0 $\Rightarrow 9+49-k>0$ | M1 |
| | $k>49$ or $k<58$ | A1 |
| | Uses radius < 3 $\Rightarrow 9+49-k<9$ and uses radius > 0 $\Rightarrow 9+49-k>0$ | dM1 |
| | $49<k<58$ oe (see notes) | A1 |
| | | **(4)** |
| | | **(8 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| 3. (a) | $\left(1+\frac{x}{4}\right)^{12} = 1+12\left(\frac{x}{4}\right)^{1}+\frac{12\times11}{2}\left(\frac{x}{4}\right)^{2}+\frac{12\times11\times10}{3!}\left(\frac{x}{4}\right)^{3}+\ldots$ | M1 |
| | $=1+3x,+\frac{33}{8}x^{2}+\frac{55}{16}x^{3}$ | B1, A1 |
| | | (3) |
| (b) | $\left(\frac{x^2+8}{x^5}\right)\left(1+\frac{x}{4}\right)^{12}=$ | |
| | Sight of a term independent of $x$ = "$\frac{55}{16}$" or $8\times {}^{12}C_5\left(\frac{1}{4}\right)^5 \left(=\frac{99}{16}\right)$ | B1ft, |
| | "$\frac{55}{16}$" $+8\times {}^{12}C_5\left(\frac{1}{4}\right)^5 = \frac{55}{16}+\frac{99}{16}=\frac{77}{8}$ | M1 A1 |
| | | (3) |
| | | (6 marks) |

| Question | Scheme | Marks |
|---|---|---|
| 9(a) | $V=hl^2 \Rightarrow 250000=hl^2$ or $l=\frac{500}{\sqrt{h}}$ oe (may use e.g. $hl=\sqrt{250\,000h}$ ) | B1 |
| | $S=l^2+4hl=\frac{"250000"}{h}+4h\times\frac{"500"}{\sqrt{h}}$ | M1 |
| | $S=\frac{250000}{h}+2000\sqrt{h}$ * | A1* |
| | | (3) |
| (b) | $\frac{\mathrm{d}S}{\mathrm{d}h}=-\frac{250000}{h^2}+2000\times\frac{1}{2}h^{-\frac{1}{2}}$ oe | M1A1 |
| | $\frac{\mathrm{d}S}{\mathrm{d}h}=0\Rightarrow -\frac{250000}{h^2}+2000\times\frac{1}{2}h^{-\frac{1}{2}}=0\Rightarrow h^k=\ldots$ | dM1 |
| | $\Rightarrow h^{\frac{3}{2}}=250\Rightarrow h=\ldots$ | ddM1 |
| | $h=250^{\frac{2}{3}}$ | A1 |
| | | (5) |
| (c) | $\frac{\mathrm{d}^2S}{\mathrm{d}h^2}=\frac{500000}{h^3}-500h^{-\frac{3}{2}}$ | M1 |
| | $\left.\frac{\mathrm{d}^2S}{\mathrm{d}h^2}\right\|_{h=39.7}=6>0$ hence gives the minimum value. | A1 |
| | | (2) |
| | | (10 marks) |

| Question Number | Scheme | Marks |
|---|---|---|
| 7. (i) | $\log_a\left(\frac{\sqrt{a}}{b}\right)=\frac{1}{2}\log_a a-\log_a b=\frac{1}{2}-k$ | M1 A1 |
| | | **(2)** |
| (ii) | $\frac{\log_a a^2b}{\log_a b^3}=\frac{2\log_a a+\log_a b}{3\log_a b}=\frac{2+k}{3k}$ | M1 A1 |
| | | **(2)** |
| (iii) | $\sum_{n=1}^{50}\left(k+\log_a b^n\right)=50k+\left(1k+2k+3k+...+50k\right)$ or $\left(2k+3k+4k+...+51k\right)$ | |
| | Uses the sum formula an AP with $n=50, d=k$ | M1 |
| | $S=50k+\frac{50}{2}\left(2k+49k\right)$ $\quad$ $S=\frac{50}{2}\left(2k+51k\right)$ | A1 |
| | $=1325k$ | A1 |
| | | **(3)** |
| | | **(7 marks)** |

| Question | Scheme | Marks |
| --- | --- | --- |
| 3(i) | E.g. $n=1:\ 2^3-1^3=7$, $n=2: 3^3-2^3=19$, $n=3:\ 4^3-3^3=\ldots$<br>Or identifies counterexample directly. | M1 |
| | e.g. $6^3-5^3=91=7\times13$ so not true for $n=5$, hence statement is not true. | A1 |
| | | (2) |
| | **Notes for part (i)**<br>**M1:** Shows evidence of trying to find a counter example for a positive integer (at least one attempt).<br>$2^3-1^3$ is prime is sufficient.<br>**A1:** Gives a correct counter example with reason (shows factorisation) and concludes e.g. "which is not prime". Ignore any previous "incorrect" attempts e.g. $6^3-5^3=91$ which is prime.<br>Note $n=7$ ($169=13\times13$) and $n=8$ ($217=7\times31$) and $n=12$ ($469=7\times67$) are the next few counter examples. (Bigger examples are not likely to be seen!)<br>Allow equivalent reasons for not being prime e.g. 169/13 = 13 or 169 is divisible by 13 (condone "can be divided by 13")<br>**Generally algebraic approaches score no marks unless they substitute numbers as indicated above.** | |
| 3(ii) | **The majority of methods here will follow ways 1, 2 or 3 below**<br>**In these cases the general guidance is as follows:**<br>M1: Attempts to find<br>• the gradient of any relevant line, e.g. $AC$ or $BC$ **or**<br>• the length of any relevant line, e.g. $AB/AB^2$ or $BC/BC^2$ or $AC/AC^2$ **or**<br>• the mid-point $M$ of line $AB$<br><br>A1: Correct **relevant** calculation of<br>• gradients $AC$ and $BC$<br>• lengths of lines $AB/AB^2$, $BC/BC^2$ and $AC/AC^2$<br>• mid-point of line $AB$<br><br>dM1: Full attempt at combining all **relevant** information required to solve the problem<br>• attempts product of gradients or equivalent<br>• attempts to show Pythagoras $AB^2=AC^2+BC^2$<br>• attempts to show $MA^2=MC^2$<br><br>A1: Correct calculations or equivalent providing required evidence for the above<br><br>A1: Provides correct reason and conclusion with all previous marks scored. | |

| Question Number | Scheme | Marks |
|---|---|---|
| **5. (i)** | $3^a = 70 \Rightarrow a\log 3 = \log 70$ | M1 |
| | $\Rightarrow a = \dfrac{\log 70}{\log 3} = 3.867$ | A1 |
| | | **(2)** |
| **(ii)** | $4 = \log_3 81$ or $3\log_3 b = \log_3 b^3$ or $\log_3 5b = \log_3 5 + \log_3 b$ | B1 |
| | $4 + 3\log_3 b = \log_3 5b \Rightarrow \log_3 81b^3 = \log_3 5b$ | M1 |
| | $\Rightarrow 81b^{\cancel{3}2} = 5\cancel{b} \Rightarrow b = \ldots$ | dM1 |
| | $\Rightarrow b = \sqrt{\dfrac{5}{81}}$ | A1 |
| | | **(4)** |
| | | **(6 marks)** |