| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(a) | Equation of $BC$ is $\{y=\}\{2\}\{-3x\}$ | **B2, 1, 0** | OE forms $y+4=-3(x-2)$ or $y-2=-3(x-0)$. |
| | | **2** | |
| 7(b) | $(x-2)^2+(2-3x+4)^2=20$ | ***M1** | OE<br>Sub line equation into equation of circle to eliminate $y$. |
| | $10(x-2)^2=20$ or $[10](x^2-4x+2)[=0]$ | **A1** | OE Accept $(10x^2-40x+20)$. |
| | $x-2=[\pm]\sqrt{2}$ or $x=\dfrac{4[\pm]\sqrt{16-8}}{2}$ | **DM1** | Correctly solving *their* quadratic. |
| | $x=2-\sqrt{2}$ | **A1** | OE only solution. Answer only **SC B1** If DM1 not scored. |
| | $y=3\sqrt{2}-4$ | **A1** | OE only solution. Answer only **SC B1** If DM1 not scored. |
| | | **5** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 9(a) | $ar=\dfrac{24}{100}\times\dfrac{a}{1-r}$ | **M1** | Form an equation using a numerical form of the percentage and correct formula for $u_2$ and $S_\infty$ |
| | $100r^2-100r+24[=0]$ | **A1** | OE. All 3 terms on one side of an equation. |
| | $(20r-8)(5r-3)[=0]\rightarrow\ r=\dfrac{2}{5},\dfrac{3}{5}$ | **A1** | Dependent on factors or formula seen from their quadratic. |
| | | **3** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 9(b) | $3\times\{(a+4d)\}=\{(2(a+1)+11(d+1))\}$ | ***M1** | SOI Attempt to cross multiply with contents of at least one { } correct |
| | Simplifies to $a+d=13$ | **A1** | |
| | $\left[\dfrac{5}{2}\right]\times3\{(2a+4d)\}=\left[\dfrac{5}{2}\right]\times2\{(4(a+1)+4(d+1))\}$ | ***M1** | SOI Attempt to cross multiply with contents of at least one { } correct |
| | Simplifies to $-a+2d=8$ | **A1** | |
| | Solve 2 linear equations simultaneously | **DM1** | Elimination or substitution expected |
| | $d=7,\ \ a=6$ | **A1** | **SC B1** for $a$=6, $d$=7 without complete working |
| | | **6** | |

| Question Number | Scheme | Marks |
|---|---|---|
| **7ai** | $\mathrm{f}'(4)=\dfrac{4(4)^2+10-7(4)^{\frac{1}{2}}}{4(4)^{\frac{1}{2}}}=\dfrac{15}{2}$ | B1 |
| **ii** | $"\dfrac{15}{2}"\rightarrow-\dfrac{2}{15}$ | M1 |
| | $y+1="-\dfrac{2}{15}"(x-4)$ | M1 |
| | $2x+15y+7=0$ | A1 |
| | | **(4)** |
| **b** | $\dfrac{4x^2+10-7x^{\frac{1}{2}}}{4x^{\frac{1}{2}}}=\pm\ldots x^{\frac{3}{2}}\pm\ldots x^{-\frac{1}{2}}\pm\ldots$ | M1 |
| | Two of the terms of $x^{\frac{3}{2}}+\dfrac{5}{2}x^{-\frac{1}{2}}-\dfrac{7}{4}$ | A1 |
| | $\displaystyle\int\left(x^{\frac{3}{2}}+\frac{5}{2}x^{-\frac{1}{2}}-\frac{7}{4}\right)\mathrm{d}x=\frac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\frac{7}{4}x\ \ (+c)$ | dM1A1ft |
| | $\dfrac{2}{5}(4)^{\frac{5}{2}}+5(4)^{\frac{1}{2}}-\dfrac{7}{4}(4)+c=-1\Rightarrow c=\ldots$ | ddM1 |
| | $(\mathrm{f}(x)=)\ \dfrac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\dfrac{7}{4}x-\dfrac{84}{5}$ | A1 |
| | | **(6)** |
| | | **(10 marks)** |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(c) | $\mathrm{gf}(x)=2\left(\dfrac{3}{x-2}+1\right)-2$ or $2\left(\dfrac{x+1}{x-2}\right)-2$ | **M1** | Substitute f(*x*) into g(*x*). |
| | $\dfrac{6}{x-2}$ | **A1** | |
| | | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6 | $\dfrac{\frac{10(1-r^8)}{1-r}}{\frac{10(1-r^4)}{1-r}}=\dfrac{17}{16}$ $\left[a\dfrac{(1-r^8)}{(1-r)}=\dfrac{17}{16}\times a\dfrac{(1-r^4)}{(1-r)}\right]$ | **M1*** | OE, i.e. substituting *p* and *q* expressions into ratio $\frac{17}{16}$. $16=a\dfrac{(1-r^4)}{(1-r)}$, $17=a\dfrac{(1-r^8)}{(1-r)}$ gets M0 unless recovered later. |
| | Simplifying to $16r^8-17r^4+1\ [=0]$ (or equivalent form) | **DM1** | Or $\dfrac{(1-r^8)}{(1-r^4)}=(1+r^4)=\dfrac{17}{16}$. |
| | $\left[(16r^4-1)(r^4-1)=0\right]\Rightarrow r=\pm\dfrac{1}{2}$ | **A1** | Or $r^4=\dfrac{1}{16}\ \Rightarrow\ r=\pm\dfrac{1}{2}$ (condone extra $r=\pm1$ solution). |
| | $S_\infty=\dfrac{10}{1-\left([\pm]\frac{1}{2}\right)}$ | **DM1** | Use of correct sum to infinity formula with either of *their r* values providing $\lvert r\rvert<1$. |
| | $S_\infty=20$ and $\dfrac{20}{3}$ | **A1** | Allow 6.67 or better. A0 if there is only one or more than two $S_\infty$ values. |
| | | **5** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3 | $x^2-4x+3=mx-6$ leading to $x^2-x(4+m)+9$ | *M1 | Equating and gathering terms. May be implied on the next line. |
| | $b^2-4ac$ leading to $(4+m)^2-4\times 9$ | DM1 | SOI. Use of the discriminant with *their* $a$, $b$ and $c$ |
| | $4+m=\pm 6$ or $(m-2)(m+10)=0$ leading to $m=2$ or $-10$ | A1 | Must come from $b^2-4ac=0$ SOI |
| | Substitute both *their* $m$ values into *their* equation in line 1 | DM1 | |
| | $m=2$ leading to $x=3$ ; $m=-10$ leading to $x=-3$ | A1 | |
| | (3, 0), (–3, 24) | A1 | Accept 'when $x=3$, $y=0$; when $x=-3$, $y=24$' If final A0A0 scored, **SC B1** for one point correct WWW |
| | **Alternative method for Question 3** | | |
| | $\frac{dy}{dx}=2x-4 \rightarrow 2x-4=m$ | *M1 | |
| | $x^2-4x+3=(2x-4)x-6$ | DM1 | |
| | $x^2-4x+3=2x^2-4x-6 \rightarrow 9=x^2 \rightarrow x=\pm 3$ | A1 | |
| | $y=0$, 24 or (3, 0), (–3, 24) | A1 | |
| | Substitute both *their* $x$ values into *their* equation in line 1 | DM1 | Or substitute both *their* $(x,y)$ into $y=mx-6$ |
| | When $x=3$, $m=2$; when $x=-3$, $m=-10$ | A1 | If A0, DM1, A0 scored, **SC B1** for one point correct WWW |
| | | **6** | |

| Question | Scheme | Marks |
|---|---|---|
| **11(a)** | $x=\frac{5\pi}{2}$ **or** $y=12$ | B1 |
| | $x=\frac{5\pi}{2}$ **and** $y=12$ | B1 |
| | | **(2)** |
| **(b)** | $x=\frac{3\pi}{2}$ **or** $y=-21$ | B1 |
| | $x=\frac{3\pi}{2}$ **and** $y=-21$ | B1 |
| | | **(2)** |
| **(c)(i)** | $(A=)-12$ | B1 |
| **(ii)** | $(B=)\frac{5\pi}{4}$ | B1 |
| | | **(2)** |
| | | **Total 6** |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 11(b) | $g^{-1}(x)=\frac{1}{4}(x-k)$ | B1 | |
| | $g^{-1}f(x)=\frac{1}{4}(10+6x-x^2-k)=4x+k$ | M1 | OE<br>May use *their* completed square form for $f(x)$. |
| | Simplify the quadratic equation obtained from $g^{-1}f(x)=g(x)$ provided $k$ is present and apply $b^2-4ac=0$ to this quadratic equation | *M1 | Expect $x^2+10x-10+5k=0$. |
| | Obtain $100-4(5k-10)=0$ and hence $k=7$ | A1 | |
| | Use *their* $k$ to form and solve a quadratic in $x$ | DM1 | Allow if *their* quadratic has two solutions. |
| | $(-5,-13)$ only | A1 | **SC B1** if no method seen. |
| | **Alternative Method for first 4 marks** | | |
| | State $f(x)=gg(x)$ | (B1) | |
| | $gg(x)=16x+5k$ | (M1) | |
| | Apply $b^2-4ac=0$ to quadratic equation obtained from $f(x)=gg(x)$ | (*M1) | Provided $k$ is present. |
| | $100-4(5k-10)=0$ and hence $k=7$ | (A1) | |
| | | 6 | |

| Question | Answer | Marks |
|---|---|---|
| 3(a) | $(y)=f(-x)$ | B1 |
| | | 1 |
| 3(b) | $(y)=2f(x)$ | B1 |
| | | 1 |
| 3(c) | $(y)=f(x+4)-3$ | B1 B1 |
| | | 2 |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 | {Reflection} {[in the] $x$-axis}<br>or<br>{Stretch of scale factor -1} {parallel to y-axis} | *B1 DB1 | { } indicate how the B1 marks should be awarded throughout. |
| | Then {Translation} $\left\{\begin{pmatrix}0\\3\end{pmatrix}\right\}$ | B1 B1 | Or Translation 3 units in the positive $y$-direction.<br>**N.B.** If order reversed a maximum of 3 out of 4 marks awarded. |
| | **Alternative method for question 1** | | |
| | {Translation} $\left\{\begin{pmatrix}0\\-3\end{pmatrix}\right\}$ | B1 B1 | Or Translation 3 units in the negative $y$-direction. |
| | Then {Reflection} {in the $x$-axis}<br>or {Stretch of scale factor -1} {parallel to $y$-axis} | *B1 DB1 | **N.B.** If order reversed a maximum of 3 out of 4 marks awarded. |
| | | 4 | |

| Question Number | Scheme | Marks |
|---|---|---|
| **8 (a) (i)** | $x=4, f'(x)=10,\ f'(x)=3\sqrt{x}+kx^2 \Rightarrow 10=3\sqrt{4}+4^2k \Rightarrow k=...$ | M1 |
| | $10=3\times2+k\times16 \Rightarrow k=\frac{1}{4}$ * | A1* |
| **(ii)** | $x=4, y=12$ on $y=10x+c \Rightarrow 12=10\times4+c$ | M1 |
| | $\Rightarrow c=-28$ | A1 |
| | | **(4)** |
| **(b)** | $f''(x)=\frac{3}{2}x^{-\frac{1}{2}}+\frac{1}{2}x$ | M1 A1ft |
| | $\{\Rightarrow f''(4)\}=\frac{11}{4}$ | A1 |
| | | **(3)** |
| **(c)** | $f(x)=2x^{\frac{3}{2}}+\frac{1}{12}x^3+d$ | M1, A1ft |
| | Uses $P(4,12) \Rightarrow 12=2\times8+\frac{1}{12}\times4^3+d \Rightarrow d=...$ | dM1 |
| | $\{f(x)=\}\,2x^{\frac{3}{2}}+\frac{1}{12}x^3-\frac{28}{3}$ | A1 |
| | | **(4)** |
| | | **(11 marks)** |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 8(b) | [$AE$ or $AF$ =] $\sqrt{160}$ or $\frac{4}{\sin E\hat{A}B}$ | B1 | OE<br>Expect AWRT 12.65. |
| | $[r\theta=]$ $(\textit{their}\ 12.65)\times0.9273$ | M1 | Use of $r\theta$ with $(\textit{their}\ \sqrt{160})$.<br>Note: using $r$ = 12 scores M0. |
| | $[11.729...+8+8=]$ 27.7 AWRT | A1 | |
| | | 3 | |
| 8(c) | $\frac{1}{2}(\textit{their}\ 12.65)^2\times0.9273$ [= 74.184] | M1 | Use $\frac{1}{2}r^2\theta$ for area of sector with $(\textit{their}\ 12.65)$.<br>Note: using $r$ = 12 scores M0. |
| | $144-24-24-\left\{\frac{1}{2}(\textit{their}\,12.65)^2\times0.9273\right\}$ | M1 | Attempt a complete method for finding area of shaded region. Condone use of $r$ = 12. |
| | [Area =] 21.8 | A1 | AWRT |
| | **Alternative Method for Question 8(c)** | | |
| | $\frac{1}{2}(\textit{their}\ 12.65)^2(0.9273-\sin0.9273)$ [=10.183] | M1 | Area of the segment with $(\textit{their}\ 12.65)$.<br>Note: using $r$ =12 scores M0. |
| | $32-\frac{1}{2}(\textit{their}\,12.65)^2(0.9273-\sin0.9273)$ | M1 | Attempt a complete method for finding area of shaded region, condone use of $r$ = 12. |
| | [Area =] 21.8 | A1 | AWRT |
| | | 3 | |