| Question | Answer | Marks |
|---|---|---|
| 1(i) | State or imply ordinates 0.915929…, 1, 1.112485… | **B1** |
| | Use correct formula, or equivalent, with $h = 1.2$ and three ordinates | **M1** |
| | Obtain answer 2.42 only | **A1** |
| | | **3** |
| 1(ii) | Justify the given statement | **B1** |
| | | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2 | Use law for the logarithm of a power or a quotient on the given equation | **M1** |
| | Use $\log_2 8 = 3$ or $2^3 = 8$ | **M1** |
| | Obtain $x^2 - 8x - 8 = 0$, or horizontal equivalent | **A1** |
| | Solve a 3-term quadratic equation | **M1** |
| | Obtain final answer $x = 8.90$ only | **A1** |
| | | **5** |

| Question | Answer | Marks |
|---|---|---|
| 3 | Use correct $\tan(A \pm B)$ formula and express LHS in terms of $\tan\theta$ | **M1** |
| | Using $\tan 60° = \sqrt{3}$ and $\cot\theta = 1/\tan\theta$, obtain a correct equation in $\tan\theta$ in any form | **A1** |
| | Reduce the equation to one in $\tan^2\theta$ only | **M1** |
| | Obtain $11\tan^2\theta = 1$, or equivalent | **A1** |
| | Obtain answer 16.8° | **A1** |
| | | **5** |

| Question | Answer | Marks |
|---|---|---|
| 4(i) | Use correct product or quotient rule or rewrite as $2\sec x - \tan x$ and differentiate | **M1** |
| | Obtain correct derivative in any form | **A1** |
| | Equate the derivative to zero and solve for $x$ | **M1** |
| | Obtain $x = \frac{1}{6}\pi$ | **A1** |
| | Obtain $y = \sqrt{3}$ | **A1** |
| | | **5** |
| 4(ii) | Carry out an appropriate method for determining the nature of a stationary point | **M1** |
| | Show the point is a minimum point with no errors seen | **A1** |
| | | **2** |

| Question | Answer | Marks |
|---|---|---|
| 5 | Separate variables and obtain $\int \frac{1}{y}\mathrm{d}y = \int \frac{x+2}{x+1}\mathrm{d}x$ | **B1** |
| | Obtain term $\ln y$ | **B1** |
| | Use an appropriate method to integrate $(x+2)/(x+1)$ | ***M1** |
| | Obtain integral $x + \ln(x+1)$, or equivalent, e.g. $\ln(x+1) + x + 1$ | **A1** |
| | Use $x = 1$ and $y = 2$ to evaluate a constant, or as limits | **DM1** |
| | Obtain correct solution in $x$ and $y$ in any form e.g. $\ln y = x + \ln(x+1) - 1$ | **A1** |
| | Obtain answer $y = (x+1)\mathrm{e}^{x-1}$ | **A1** |
| | | **7** |

| Question | Answer | Marks |
|---|---|---|
| 6(i) | State or imply $3x^2y + x^3\frac{dy}{dx}$ as derivative of $x^3y$ | **B1** |
| | State or imply $9xy^2\frac{dy}{dx} + 3y^3$ as derivative of $3xy^3$ | **B1** |
| | Equate derivative of the LHS to zero and solve for $\frac{dy}{dx}$ | **M1** |
| | Obtain the given answer AG | **A1** |
| | | **4** |
| 6(ii) | Equate numerator to zero and use $x = -y$ to obtain an equation in $x$ or in $y$ | **M1** |
| | Obtain answer $x = a$ and $y = -a$ | **A1** |
| | Obtain answer $x = -a$ and $y = a$ | **A1** |
| | Consider and reject $y = 0$ and $x = y$ as possibilities | **B1** |
| | | **4** |

| Question | Answer | Marks |
|---|---|---|
| 7(i) | State modulus 2 | **B1** |
| | State argument $-\frac{1}{3}\pi$ or $-60°$ ($\frac{5}{3}\pi$ or $300°$) | **B1** |
| | | **2** |
| 7(ii) | *EITHER:* Expand $(1-(\sqrt{3})\mathrm{i})^3$ completely and process $\mathrm{i}^2$ and $\mathrm{i}^3$ | **(M1** |
| | Verify that the given relation is satisfied | **A1)** |
| | *OR:* $u^3 = 2^3\left(\cos(-\pi) + i\sin(-\pi)\right)$ or equivalent: follow their answers to **(i)** | **(M1** |
| | Verify that the given relation is satisfied | **A1)** |
| | | **2** |

| Question | Answer | Marks |
|---|---|---|
| 7(iii) | Show a circle with centre $1-(\sqrt{3})\mathrm{i}$ in a relatively correct position | **B1** |
| | Show a circle with radius 2 passing through the origin | **B1** |
| | Show the line Re $z = 2$ | **B1** |
| | Shade the correct region | **B1** |
| | | **4** |

| Question | Answer | Marks |
|---|---|---|
| 8(i) | State or imply the form $\frac{A}{1-x}+\frac{B}{2x+3}+\frac{C}{(2x+3)^2}$ | **B1** |
| | Use a relevant method to determine a constant | **M1** |
| | Obtain one of the values $A = 1$, $B = -2$, $C = 5$ | **A1** |
| | Obtain a second value | **A1** |
| | Obtain the third value | **A1** |
| | | **5** |
| | [Mark the form $\frac{A}{1-x}+\frac{Dx+E}{(2x+3)^2}$, where $A = 1$, $D = -4$, $E = -1$, **B1M1A1A1A1** as above.] | |
| 8(ii) | Use a correct method to find the first two terms of the expansion of $(1-x)^{-1}$, $(1+\frac{2}{3}x)^{-1}$, $(2x+3)^{-1}$, $(1+\frac{2}{3}x)^{-2}$ or $(2x+3)^{-2}$ | **M1** |
| | Obtain correct unsimplified expansions up to the term in $x^2$ of each partial fraction | **A3 FT** |
| | Obtain final answer $\frac{8}{9}+\frac{19}{27}x+\frac{13}{9}x^2$, or equivalent | **A1** |
| | | **5** |

| Question | Answer | Marks |
|---|---|---|
| 9(i) | Integrate by parts and reach $ax^{\frac{3}{2}} \ln x + b\int x^{\frac{3}{2}}.\frac{1}{x}\,\mathrm{d}x$ | ***M1** |
| | Obtain $\frac{2}{3}x^{\frac{3}{2}} \ln x - \frac{2}{3}\int x^{\frac{1}{2}}\,\mathrm{d}x$ | **A1** |
| | Obtain integral $\frac{2}{3}x^{\frac{3}{2}} \ln x - \frac{4}{9}x^{\frac{3}{2}}$, or equivalent | **A1** |
| | Substitute limits correctly and equate to 2 | **DM1** |
| | Obtain the given answer correctly AG | **A1** |
| | | **5** |
| 9(ii) | Evaluate a relevant expression or pair of expressions at $x = 2$ and $x = 4$ | **M1** |
| | Complete the argument correctly with correct calculated values | **A1** |
| | | **2** |
| 9(iii) | Use the iterative formula correctly at least once | **M1** |
| | Obtain final answer 3.031 | **A1** |
| | Show sufficient iterations to 5 d.p. to justify 3.031 to 3 d.p., or show there is a sign change in the interval (3.0305, 3.0315) | **A1** |
| | | **3** |

| Question | Answer | Marks |
|---|---|---|
| 10(i) | State or imply a correct normal vector to either plane, e.g. $\mathbf{i}+\mathbf{j}+3\mathbf{k}$ or $2\mathbf{i}-2\mathbf{j}+\mathbf{k}$ | **B1** |
| | Carry out correct process for evaluating the scalar product of two normal vectors | **M1** |
| | Using the correct process for the moduli, divide the scalar product of the two normals by the product of their moduli and evaluate the inverse cosine of the result | **M1** |
| | Obtain final answer 72.5° or 1.26 radians | **A1** |
| | | **4** |
| 10(ii) | *EITHER*: Substitute $y = 2$ in both plane equations and solve for $x$ or for $z$ | **(M1** |
| | Obtain $x = 3$ and $z = 1$ | **A1)** |
| | *OR*: Find the equation of the line of intersection of the planes | |
| | Substitute $y = 2$ in line equation and solve for $x$ or for $z$ | **(M1** |
| | Obtain $x = 3$ and $z = 1$ | **A1)** |

| Question | Answer | Marks |
|---|---|---|
| | *EITHER*: Use scalar product to obtain an equation in $a$, $b$ and $c$, e.g. $a + b + 3c = 0$ | **(B1** |
| | Form a second relevant equation, e.g. $2a - 2b + c = 0$, and solve for one ratio, e.g. $a : b$ | ***M1** |
| | Obtain final answer $a : b : c = 7 : 5 : -4$ | **A1** |
| | Use coordinates of $A$ and values of $a$, $b$ and $c$ in general equation and find $d$ | **DM1** |
| | Obtain answer $7x + 5y - 4z = 27$, or equivalent | **A1 FT)** |
| | *OR*1: Calculate the vector product of relevant vectors, e.g. $(\mathbf{i} + \mathbf{j} + 3\mathbf{k}) \times (2\mathbf{i} - 2\mathbf{j} + \mathbf{k})$ | **(*M1** |
| | Obtain two correct components | **A1** |
| | Obtain correct answer, e.g. $7\mathbf{i} + 5\mathbf{j} - 4\mathbf{k}$ | **A1** |
| | Substitute coordinates of $A$ in plane equation with their normal and find $d$ | **DM1** |
| | Obtain answer $7x + 5y - 4z = 27$, or equivalent | **A1 FT)** |
| | *OR*2: Using relevant vectors, form a two-parameter equation for the plane | **(*M1** |
| | State a correct equation, e.g. $\mathbf{r} = 3\mathbf{i} + 2\mathbf{j} + \mathbf{k} + \lambda(\mathbf{i} + \mathbf{j} + 3\mathbf{k}) + \mu(2\mathbf{i} - 2\mathbf{j} + \mathbf{k})$ | **A1 FT** |
| | State 3 correct equations in $x$, $y$, $z$, $\lambda$ and $\mu$ | **A1 FT** |
| | Eliminate $\lambda$ and $\mu$ | **DM1** |
| | Obtain answer $7x + 5y - 4z = 27$, or equivalent | **A1 FT)** |
| | *OR*3: Use the direction vector of the line of intersection of the two planes as normal vector to the plane | **(*M1** |
| | Two correct components | **A1** |
| | Three correct components | **A1** |
| | Substitute coordinates of $A$ in plane equation with their normal and find $d$ | **DM1** |
| | Obtain answer $7x + 5y - 4z = 27$, or equivalent | **A1 FT)** |
| | | **7** |