1 Use law of the logarithm of a product, power or quotient **M1***
Obtain a correct linear equation, e.g. $(3x-1)\ln 4 = \ln 3 + x\ln 5$ **A1**
Solve a linear equation for x **DM1***
Obtain answer $x = 0.975$ **A1** [4]

2 State a correct un-simplified version of the x or x^2 or x^3 term **M1**
State correct first two terms $1 + x$ **A1**
Obtain the next two terms $\frac{3}{2}x^2 + \frac{5}{2}x^3$ **A1 A1** [4]
[Symbolic binomial coefficients, e.g. $\binom{-\frac{1}{2}}{3}$ are not sufficient for the M mark.]

3 Integrate by parts and reach $ax^2\cos 2x + b\int x\cos 2x\ \mathrm{d}x$ **M1***
Obtain $-\frac{1}{2}x^2\cos 2x + \int x\cos 2x$, or equivalent **A1**
Complete the integration and obtain $-\frac{1}{2}x^2\cos 2x + \frac{1}{2}x\sin 2x + \frac{1}{4}\cos 2x$, or equivalent **A1**
Use limits correctly having integrated twice **DM1***
Obtain answer $\frac{1}{8}(\pi^2 - 4)$, or exact equivalent, with no errors seen **A1** [5]

4 State or imply derivative of $(\ln x)^2$ is $\dfrac{2\ln x}{x}$ **B1**
Use correct quotient or product rule **M1**
Obtain correct derivative in any form, e.g. $\dfrac{2\ln x}{x^2} - \dfrac{(\ln x)^2}{x^2}$ **A1**
Equate derivative (or its numerator) to zero and solve for $\ln x$ **M1**
Obtain the point (1, 0) with no errors seen **A1**
Obtain the point $(e^2,\ 4e^{-2})$ **A1** [6]

5 **(i)** *EITHER*: Express $\cos 4\theta$ in terms of $\cos 2\theta$ and/or $\sin 2\theta$ **B1**
Use correct double angle formulae to express LHS in terms of $\sin\theta$ and/or $\cos\theta$ **M1**
Obtain a correct expression in terms of $\sin\theta$ alone **A1**
Reduce correctly to the given form **A1**

OR: Use correct double angle formula to express RHS in terms of $\cos 2\theta$ **M1**
Express $\cos^2 2\theta$ in terms of $\cos 4\theta$ **B1**
Obtain a correct expression in terms of $\cos 4\theta$ and $\cos 2\theta$ **A1**
Reduce correctly to the given form **A1** [4]

(ii) Use the identity and carry out a method for finding a root **M1**
Obtain answer 68.5° **A1**
Obtain a second answer, e.g. 291.5° **A1**√
Obtain the remaining answers, e.g. 111.5° and 248.5°, and no others in the given interval **A1**√ [4]
[Ignore answers outside the given interval. Treat answers in radians as a misread.]

6 **(i)** Separate variables correctly and attempt integration of at least one side **B1**
Obtain term $\ln x$ **B1**
Obtain term of the form $k\ln(3+\cos 2\theta)$, or equivalent **M1**
Obtain term $-\frac{1}{2}\ln(3+\cos 2\theta)$, or equivalent **A1**
Use $x = 3$, $\theta = \frac{1}{4}\pi$ to evaluate a constant or as limits in a solution with terms $a\ln x$ and $b\ln(3+\cos 2\theta)$, where $ab \neq 0$ **M1**
State correct solution in any form, e.g. $\ln x = -\frac{1}{2}\ln(3+\cos 2\theta) + \frac{3}{2}\ln 3$ **A1**
Rearrange in a correct form, e.g. $x = \sqrt{\left(\frac{27}{3+\cos 2\theta}\right)}$ **A1** [7]

(ii) State answer $x = 3\sqrt{3}/2$, or exact equivalent (accept decimal answer in [2.59, 2.60]) **B1** [1]

7 **(i)** State or imply the form $A + \frac{B}{2x+1} + \frac{C}{x+2}$ **B1**
State or obtain $A = 2$ **B1**
Use a correct method for finding a constant **M1**
Obtain one of $B = 1$, $C = -2$ **A1**
Obtain the other value **A1** [5]

(ii) Integrate and obtain terms $2x + \frac{1}{2}\ln(2x+1) - 2\ln(x+2)$ **B3**
Substitute correct limits correctly in an integral with terms $a\ln(2x+1)$ and $b\ln(x+2)$, where $ab \neq 0$ **M1**
Obtain the given answer after full and correct working **A1** [5]

8 **(i)** Use correct quotient or chain rule **M1**
Obtain correct derivative in any form **A1**
Obtain the given answer correctly **A1** [3]

(ii) State a correct equation, e.g. $-e^{-a} = -\operatorname{cosec} a \cot a$ **B1**
Rearrange it correctly in the given form **B1** [2]

(iii) Calculate values of a relevant expression or pair of expressions at $x = 1$ and $x = 1.5$ **M1**
Complete the argument correctly with correct calculated values **A1** [2]

(iv) Use the iterative formula correctly at least once **M1**
Obtain final answer 1.317 **A1**
Show sufficient iterations to 5 d.p. to justify 1.317 to 3 d.p., or show there is a sign change in the interval (1.3165, 1,3175) **A1** [3]

9 **(i)** *Either* state or imply $\overrightarrow{AB}$ or $\overrightarrow{BC}$ in component form, *or* state position vector of midpoint of $\overrightarrow{AC}$ **B1**

Use a correct method for finding the position vector of D **M1**
Obtain answer $3\mathbf{i}+3\mathbf{j}+\mathbf{k}$, or equivalent **A1**

EITHER: Using the correct process for the moduli, compare lengths of a pair of adjacent sides,
e.g. AB and BC **M1**
Show that $ABCD$ has a pair of adjacent sides that are equal **A1**

OR: Calculate scalar product $\overrightarrow{AC}.\overrightarrow{BD}$ or equivalent **M1**
Show that $ABCD$ has perpendicular diagonals **A1** [5]

(ii) *EITHER*: State $a+2b+3c=0$ or $2a+b-2c=0$ **B1**
Obtain two relevant equations and solve for one ratio, e.g. $a : b$ **M1**
Obtain $a : b : c = -7 : 8 : -3$, or equivalent **A1**
Substitute coordinates of a relevant point in $-7x + 8y - 3z = d$, and evaluate **M1**
Obtain answer $-7x + 8y - 3z = 29$, or equivalent **A1**

*OR*1:Attempt to calculate vector product of relevant vectors,
e.g. $(\mathbf{i}+2\mathbf{j}+3\mathbf{k})\times(2\mathbf{i}+\mathbf{j}-2\mathbf{k})$ **M1**
Obtain two correct components of the product **A1**
Obtain correct product, e.g. $-7\mathbf{i}+8\mathbf{j}-3\mathbf{k}$ **A1**
Substitute coordinates of a relevant point in $-7x+8y-3z=d$ and evaluate d **M1**
Obtain answer $-7x+8y-3z=29$ or equivalent **A1**

*OR*2:Attempt to form a 2-parameter equation with relevant vectors **M1**
State a correct equation, e.g. $\mathbf{r}=2\mathbf{i}+5\mathbf{j}-\mathbf{k}+\lambda(\mathbf{i}+2\mathbf{j}+3\mathbf{k})+\mu(2\mathbf{i}+\mathbf{j}-2\mathbf{k})$ **A1**
State 3 equations in x, y, z, λ and μ **A1**
Eliminate λ and μ **M1**
Obtain answer $-7x+8y-3z=29$, or equivalent **A1**

*OR*3:Using a relevant point and relevant direction vectors, form a determinant equation for the plane **M1**
State a correct equation, e.g. $\begin{vmatrix} x-2 & y-5 & z+1 \\ 1 & 2 & 3 \\ 2 & 1 & -2 \end{vmatrix}=0$ **A1**
Attempt to expand the determinant **M1**
Obtain correct values of two cofactors **A1**
Obtain answer $-7x+8y-3z=29$, or equivalent **A1** [5]

10 (a) *EITHER*: Use quadratic formula to solve for z **M1**
Use $i^2 = -1$ **M1**
Obtain a correct answer in any form, simplified as far as $(-2 \pm i\sqrt{8}) / 2i$ **A1**
Multiply numerator and denominator by i, or equivalent **M1**
Obtain final answers $\sqrt{2} + i$ and $-\sqrt{2} + i$ **A1**

OR: Substitute $x + iy$ and equate real and imaginary parts to zero **M1**
Use $i^2 = -1$ **M1**
Obtain $-2xy + 2x = 0$ and $x^2 - y^2 + 2y - 3 = 0$, or equivalent **A1**
Solve for x and y **M1**
Obtain final answers $\sqrt{2} + i$ and $-\sqrt{2} + i$ **A1** [5]

(b) (i) *EITHER*: Show the point representing 4 + 3i in relatively correct position **B1**
Show the perpendicular bisector of the line segment joining this point to the origin **B1√** [2]

OR: Obtain correct Cartesian equation of the locus in any form, e.g. $8x + 6y = 25$ **B1**
Show this line **B1√**
[This f.t. is dependent on using a correct method to determine the equation.]

(ii) State or imply the relevant point is represented by 2 + 1.5i or is at (2, 1.5) **B1**
Obtain modulus 2.5 **B1√**
Obtain argument 0.64 (or 36.9°) (allow decimals in [0.64, 0.65] or [36.8, 36.9]) **B1√** [3]