6 It is given that $\int_1^a \ln(2x)\,dx = 1$, where $a > 1$.

   (i) Show that $a = \frac{1}{2}\exp\left(1 + \frac{\ln 2}{a}\right)$, where $\exp(x)$ denotes e^x. [6]

   (ii) Use the iterative formula

$$a_{n+1} = \frac{1}{2}\exp\left(1 + \frac{\ln 2}{a_n}\right)$$

   to determine the value of a correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

7 In a certain country the government charges tax on each litre of petrol sold to motorists. The revenue per year is R million dollars when the rate of tax is x dollars per litre. The variation of R with x is modelled by the differential equation

$$\frac{dR}{dx} = R\left(\frac{1}{x} - 0.57\right),$$

where R and x are taken to be continuous variables. When $x = 0.5$, $R = 16.8$.

   (i) Solve the differential equation and obtain an expression for R in terms of x. [6]

   (ii) This model predicts that R cannot exceed a certain amount. Find this maximum value of R. [3]

8   **(i)** By first expanding $\sin(2\theta + \theta)$, show that

$$\sin 3\theta = 3\sin\theta - 4\sin^3\theta.$$ [4]

   (ii) Show that, after making the substitution $x = \frac{2\sin\theta}{\sqrt{3}}$, the equation $x^3 - x + \frac{1}{6}\sqrt{3} = 0$ can be written in the form $\sin 3\theta = \frac{3}{4}$. [1]

   (iii) Hence solve the equation

$$x^3 - x + \frac{1}{6}\sqrt{3} = 0,$$

   giving your answers correct to 3 significant figures. [4]

9 Let $f(x) = \dfrac{x^2 - 8x + 9}{(1 - x)(2 - x)^2}$.

   (i) Express $f(x)$ in partial fractions. [5]

   (ii) Hence obtain the expansion of $f(x)$ in ascending powers of x, up to and including the term in x^2. [5]

10 The line l has equation $\mathbf{r} = 4\mathbf{i} - 9\mathbf{j} + 9\mathbf{k} + \lambda(-2\mathbf{i} + \mathbf{j} - 2\mathbf{k})$. The point A has position vector $3\mathbf{i} + 8\mathbf{j} + 5\mathbf{k}$.

   (i) Show that the length of the perpendicular from A to l is 15. [5]

   (ii) The line l lies in the plane with equation $ax + by - 3z + 1 = 0$, where a and b are constants. Find the values of a and b. [5]

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Miles Abdel Keasey,George Alfred Kline,David Allison McIlhatten

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