



- 1 (i) Express  $\frac{2}{3-x} + \frac{3}{1+x}$  as a single fraction in its simplest form. [2]
- (ii) Hence express  $\left(\frac{2}{3-x} + \frac{3}{1+x}\right) \times \frac{x^2+8x-33}{121-x^2}$  as a single fraction in its lowest terms. [3]
- 2 A triangle has vertices at  $A(1, 1, 3)$ ,  $B(5, 9, -5)$  and  $C(6, 5, -4)$ .  $P$  is the point on  $AB$  such that  $AP:PB = 3:1$ .
- (i) Show that  $\overrightarrow{CP}$  is perpendicular to  $\overrightarrow{AB}$ . [4]
- (ii) Find the area of the triangle  $ABC$ . [2]
- 3 The equation of a curve is  $y = e^{2x} \cos x$ . Find  $\frac{dy}{dx}$  and hence find the coordinates of any stationary points for which  $-\pi \leq x \leq \pi$ . Give your answers correct to 3 significant figures. [6]
- 4 (i) Find the first three terms in the binomial expansion of  $(8-9x)^{\frac{2}{3}}$  in ascending powers of  $x$ . [4]
- (ii) State the set of values of  $x$  for which this expansion is valid. [1]
- 5 By first using the substitution  $t = \sqrt{x+1}$ , find  $\int e^{2\sqrt{x+1}} dx$ . [6]
- 6 (i) Use the quotient rule to show that the derivative of  $\frac{\cos x}{\sin x}$  is  $\frac{-1}{\sin^2 x}$ . [2]
- (ii) Show that  $\int_{\frac{1}{6}\pi}^{\frac{1}{4}\pi} \frac{\sqrt{1+\cos 2x}}{\sin x \sin 2x} dx = \frac{1}{2}(\sqrt{6} - \sqrt{2})$ . [6]
- 7 A curve has equation  $(x+y)^2 = xy^2$ . Find the gradient of the curve at the point where  $x = 1$ . [7]
- 8 In the year 2000 the population density,  $P$ , of a village was 100 people per  $\text{km}^2$ , and was increasing at the rate of 1 person per  $\text{km}^2$  per year. The rate of increase of the population density is thought to be inversely proportional to the size of the population density. The time in years after the year 2000 is denoted by  $t$ .
- (i) Write down a differential equation to model this situation, and solve it to express  $P$  in terms of  $t$ . [6]
- (ii) In 2008 the population density of the village was 108 people per  $\text{km}^2$  and in 2013 it was 128 people per  $\text{km}^2$ . Determine how well the model fits these figures. [2]

9 Two lines have equations

$$\mathbf{r} = 3\mathbf{i} + 5\mathbf{j} - \mathbf{k} + \lambda(2\mathbf{i} + \mathbf{j} + \mathbf{k}) \text{ and } \mathbf{r} = 4\mathbf{i} + 10\mathbf{j} + 19\mathbf{k} + \mu(\mathbf{i} - \mathbf{j} + \alpha\mathbf{k}),$$

where  $\alpha$  is a constant.

Find the value of  $\alpha$  in each of the following cases.

(i) The lines intersect at the point  $(7, 7, 1)$ . [3]

(ii) The angle between their directions is  $60^\circ$ . [4]

10 (i) Express  $\frac{x+8}{x(x+2)}$  in partial fractions. [3]

(ii) By first using division, express  $\frac{7x^2 + 16x + 16}{x(x+2)}$  in the form  $P + \frac{Q}{x} + \frac{R}{x+2}$ . [3]

A curve has parametric equations  $x = \frac{2t}{1-t}$ ,  $y = 3t + \frac{4}{t}$ .

(iii) Show that the cartesian equation of the curve is  $y = \frac{7x^2 + 16x + 16}{x(x+2)}$ . [4]

(iv) Find the area of the region bounded by the curve, the  $x$ -axis and the lines  $x = 1$  and  $x = 2$ . Give your answer in the form  $L + M\ln 2 + N\ln 3$ . [4]

**END OF QUESTION PAPER**

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