Worked Solutions

OCR C3 Paper D

1. **(i)** $\dfrac{(x+3)(x+4)}{x(x+3)} = \dfrac{x+4}{x}$ **(3)**

(ii) $\log_3\left(\dfrac{x^2+7x+12}{x^2+3x}\right) = 2$

$$\frac{x+4}{x} = 3^2$$

$$x+4 = 9x$$

$$x = \frac{1}{2}$$ **(4)**

2. **(i)** $\mathrm{f}(x) > 0$ **(2)**

(ii) $\mathrm{f}\left(1\frac{1}{2}\right) = 2$

$\mathrm{g}(2) = 9 + k$

$9 + k = 14 \Rightarrow k = 5$ **(4)**

3. **(i)** $\cos 4x = \cos 2(2x)$

$= 2\cos^2 2x - 1$

$= 2\left(2\cos^2 x - 1\right)^2 - 1$

$= 8\cos^4 x - 8\cos^2 x + 1$ **(4)**

(ii) $8\cos^2 \times - 8\cos^4 x - 1 = 0 \Rightarrow \cos 4x = 0$

$4x = 90,\ 270,\ 450,\ 630$

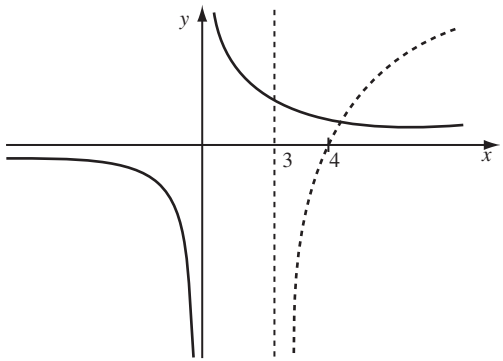
$\therefore x = 22\frac{1}{2},\ 67\frac{1}{2},\ 112\frac{1}{2},\ 157\frac{1}{2}$ **(3)**

4. **(i)** (*a*) $x^3 \cdot 3\mathrm{e}^{3x} + 3x^2 \cdot \mathrm{e}^{3x}$ **(3)**

(*b*) $\dfrac{\cos x \cdot 2 + 2x \cdot \sin x}{\cos^2 x}$ **(3)**

(ii) $\dfrac{\mathrm{d}x}{\mathrm{d}y} = -\sin y^2 \cdot 2y \qquad \dfrac{\mathrm{d}y}{\mathrm{d}x} = -\dfrac{1}{2y\sin y^2}$ **(4)**

5. **(i)**



(3)

(ii) curves cross once **(1)**

(iii) $\mathrm{f}(4) = \ln 1 - \dfrac{2}{4} = -\dfrac{1}{2}$

$\mathrm{f}(5) = \ln 2 - \dfrac{2}{5} = 0.293$

} change in sign $\Rightarrow$ root in interval

(2)

(iv) $x_1 = 4.4918$

$x_2 = 4.5609$

$x_3 = 4.5504$

$x_4 = 4.5520$

$x = 4.55$ (2 d.p.) **(3)**

6. **(i)** $\cot x = \frac{4}{3}$:

$$\operatorname{cosec}^2 x = 1 + \cot^2 x$$
$$= 1 + \frac{16}{9} = \frac{25}{9}$$
$$\operatorname{cosec} x = \pm\frac{5}{3};$$

x is reflex, $\quad \therefore \operatorname{cosec} x = \frac{-5}{3}$ **(4)**

$$\left[\begin{array}{l} \text{or } \tan x = \frac{3}{4} \\ \quad \sin x = -\frac{3}{5}, \quad x \text{ is reflex} \end{array}\right]$$

(ii) $\sin x = \frac{-3}{5}$

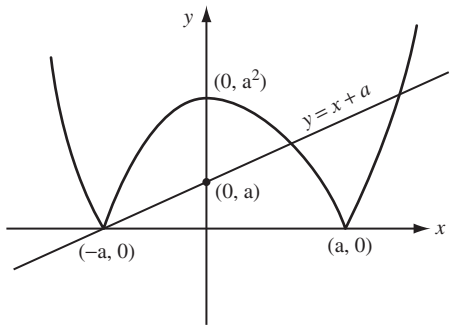
so $\cos 2x = 1 - 2\sin^2 x$

$$\Rightarrow \cos 2x = 1 - 2 \times \frac{9}{25}$$
$$= \frac{7}{25}$$ **(4)**

(iii) $\tan x = \frac{3}{4}$

$$\left.\begin{aligned} \tan 2x &= \frac{2\tan x}{1 - \tan^2 x} \\ &= \frac{2 \cdot \frac{3}{4}}{1 - \frac{9}{16}} \end{aligned}\right\} = \frac{\frac{3}{2}}{\frac{7}{16}} = \frac{24}{7}$$ **(3)**

7. **(i)**



(4)

(ii) see graph, $\quad y = 0, \quad x^2 = a^2 \quad \therefore x = \pm a$ **(1)**

(iii) $x^2 - a^2 = x + a$

$$x^2 - x - a^2 - a = 0$$ **(2)**

(iv) $-\left(x^2 - a^2\right) = x + a$

$$x^2 + x + a - a^2 = 0$$ **(2)**

(v) $x^2 - x - 12 = 0 \qquad (a = 3)$

$(x - 4)(x + 3) = 0 \qquad$ 2nd pt. (4, 7)

$$x^2 + x - 6 = 0$$

$(x + 3)(x - 2) = 0 \qquad$ 3rd pt. (2, 5) **(2)**

8. $\dfrac{dx}{dt} = e^{-t}(-\sin t + \cos t) + \left(-e^{-t}\right)(\cos t + \sin t) = -2e^{-t}\sin t$

$\dfrac{d^2x}{dt^2} = 2e^{-t}\sin t - 2e^{-t}\cos t$

$2e^{-t}\sin t - 2e^{-t}\cos t - 4e^{-t}\sin t + 2e^{-t}(\cos t + \sin t) = 0$ **(6)**

(i) $x = e^0(\cos 0 + \sin 0) = 1$

$\dfrac{dx}{dt} = -2e^{-0} \cdot \sin 0 = 0$ **(2)**

(ii) $\sin t = 0 \Rightarrow t = 0, \pi, 2\pi$ etc. $t = \pi$ **(2)**

(iii) $x = 1, x = e^{-x}(-1) = -e^{-\pi}$ **(2)**

(iv) $\dfrac{d^2x}{dt^2} = -2x - 2\dfrac{dx}{dt} = -2x$

$x = 1, \dfrac{d^2x}{dt^2} < 0 \quad \therefore$ max.

$x = -e^{-\pi}, \dfrac{d^2x}{dt^2} > 0 \quad \therefore$ min. **(2)**