

Question Number	Scheme	Marks
<p><b>1(a)</b></p> <p><b>(b)</b></p>	$\frac{3(x+1)}{(x+2)(x-1)} \equiv \frac{A}{x+2} + \frac{B}{x-1}, \text{ and correct method for finding } A \text{ or } B$ <p><math>A = 1, B = 2</math></p> $f'(x) = -\frac{1}{(x+2)^2} - \frac{2}{(x-1)^2}$ <p>Argument for negative, including statement that square terms are positive for all values of <math>x</math>. (f.t. on wrong values of <math>A</math> and <math>B</math>)</p>	<p>M1</p> <p>A1, A1 (3)</p> <p>M1 A1</p> <p>A1ft✓ (3)</p>
<p><b>2</b></p> <p><b>(a)</b></p> <p><b>(b)</b></p> <p><b>(c)</b></p>	<p><math>a = 4, b = 5</math> (both are required)</p> <p><math>(x-4)^2 + (y-5)^2 = 25</math></p> <p>Finding the distance between centre and <math>(8, 17), \sqrt{[(8-a)^2 + (17-b)^2]}</math></p> <p>Complete method to find <math>PT</math>, i.e. use Pythagoras theorem and subtraction,</p> <p><math>PT = 11.6</math></p>	<p>B1 (1)</p> <p>M1A1ft (2)</p> <p>M1</p> <p>M1</p> <p>A1 (3)</p>

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<p><b>3(a)</b></p> <p><b>(b)</b></p> <p><b>(c)</b></p>	<p>Using <math>f(\pm 2) = 3</math></p> <p>Showing that <math>p = 6</math> ★, with no wrong working seen.</p> <p><b>S.C.</b> If <math>p = 6</math> used and the remainder is shown to be 3 award B1</p> <p>Attempt to find quotient when dividing <math>(n + 2)</math> into <math>f(n)</math> or attempting to equate coefficients.</p> <p>Quotient = <math>n^2 + 4n + 3</math>, or finding either <math>q = 1</math> or <math>r = 3</math></p> <p>Finding both <math>q = 1</math> and <math>r = 3</math></p> <p>The product of three consecutive numbers must be divisible by 3</p> <p>Complete argument</p>	<p>M1</p> <p>A1 (2)</p> <p>M1</p> <p>A1</p> <p>A1 (3)</p> <p>M1</p> <p>A1 (2)</p>
<p><b>4. (a)</b></p> <p><b>(b)</b></p>	<p><math>(1 + 3x)^{-2} = 1 + (-2)(3x) + \frac{(-2)(-3)}{2!}(3x)^2 + \frac{(-2)(-3)(-4)}{3!}(3x)^3 + \dots</math></p> <p><math>= 1, -6x, +27x^2 \dots (-108x^3)</math></p> <p>Using (a) to expand <math>(x + 4)(1 + 3x)^{-2}</math> or complete method to find coefficients [e.g. Maclaurin or <math>\frac{1}{3}(1 + 3x)^{-1} + \frac{11}{3}(1 + 3x)^{-2}</math>].</p> <p><math>= 4 - 23x, +102x^2, -405x^3 = 4, -23x, +102x^2 \dots (-405x^3)</math></p>	<p>M1</p> <p>B1, A1, A1 (4)</p> <p>M1</p> <p>A1, A1ft, A1ft (4)</p>

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<b>6(a)</b>	$\mathbf{r} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k} \pm \lambda(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k})$ or $\mathbf{r} = 5\mathbf{i} - 3\mathbf{j} \pm \lambda(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k})$ (or any equivalent vector equation)	M1A1 (2)
<b>(b)</b>	Show that $\mu = -3$	B1 (1)
<b>(c)</b>	Using $\cos \theta = \frac{(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}) \cdot (\mathbf{i} - 2\mathbf{j} + 2\mathbf{k})}{\sqrt{(4^2 + 5^2 + 3^2)}\sqrt{(1^2 + 2^2 + 2^2)}}$ $= \frac{20}{15\sqrt{2}} = \frac{4}{3\sqrt{2}}$ (ft on $4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}$ ) num, denom. $\theta = 19.5^\circ$ (allow 19 or 20 if no wrong working is seen)	M1 A1ft A1ft A1 (4)
<b>(d)</b>	Shortest distance = $AC \sin \theta$ $AC = \sqrt{((a-1)^2 + 2^2 + (b+3)^2)}$ (= 3) Shortest distance = 1 unit <i>Alternatives</i> Since $X = (1+4\lambda, 2-5\lambda, -3+3\lambda)$ $\mathbf{CX} = (-1+4\lambda)\mathbf{i} + (2-5\lambda)\mathbf{j} + (-2+3\lambda)\mathbf{k}$ Use Scalar product $\mathbf{CX} \cdot (4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}) = 0$ , OR differentiate $ \mathbf{CX} $ or $ \mathbf{CX} ^2$ and equate to zero, to obtain $\lambda = 0.4$ and thus $ \mathbf{CX}  = 1$	M1 M1A1 A1 (4) M1 M1 A1 A1 (4)

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<b>5. (a)</b>	$\frac{dV}{dt} = 30 - \frac{2}{15}V$ $\Rightarrow -15 \frac{dV}{dt} = -450 + 2V, \quad \text{no wrong working seen}$	M1A1 A1* (3)
<b>(b)</b>	Separating the variables $\Rightarrow -\frac{15}{2V-450}dV = dt$ Integrating to obtain $-\frac{15}{2}\ln 2V-450 =t$ OR $-\frac{15}{2}\ln V-225 =t$ Using limits correctly or finding $c$ ( $-\frac{15}{2}\ln 1550$ OR $-\frac{15}{2}\ln 775$ ) $\ln \frac{2V-450}{1550} = -\frac{2}{15}t$ , or equivalent Rearranging to give $V = 225 + 775e^{-\frac{2}{15}t}$ .	M1 dM1 A1 M1 A1 dM1A1 (7)
<b>(c)</b>	$V = 225$	B1 (1)

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<b>7(a)</b>	$\frac{dy}{dx} = -2e^{-2x}\sqrt{x} + \frac{e^{-2x}}{2\sqrt{x}}$ <p>Putting <math>\frac{dy}{dx} = 0</math> and attempting to solve</p> $x = \frac{1}{4}$	<p>M1 A1 A1</p> <p>dM1</p> <p>A1 (5)</p>
<b>(b)</b>	$\text{Volume} = \pi \int_0^1 (\sqrt{x}e^{-2x})^2 dx = \pi \int_0^1 xe^{-4x} dx$ $\int xe^{-4x} dx = -\frac{1}{4}xe^{-4x} + \int \frac{1}{4}e^{-4x} dx$ $= -\frac{1}{4}xe^{-4x} - \frac{1}{16}e^{-4x}$ $\text{Volume} = \pi \left[ -\frac{1}{4}e^{-4} - \frac{1}{16}e^{-4} \right] - \left[ -\frac{1}{16} \right] = \frac{\pi}{16} [1 - 5e^{-4}]$	<p>M1 A1</p> <p>M1 A1</p> <p>A1 ft</p> <p>M1 A1 (7)</p>

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<b>8 (a)</b>	$\cos(A + A) = \cos^2 A - \sin^2 A$ $= \cos^2 A - (1 - \cos^2 A) = 2\cos^2 A - 1$	M1 A1 (2)
<b>(b)</b>	$[x = 2, \theta = \frac{\pi}{4}; x = \sqrt{6}, \theta = \frac{\pi}{3}]$ $x = 2\sqrt{2} \sin \theta, \frac{dx}{d\theta} = 2\sqrt{2} \cos \theta$ $\int \sqrt{8 - x^2} dx = \int 2\sqrt{2} \cos \theta \cdot 2\sqrt{2} \cos \theta d\theta = \int 8 \cos^2 \theta d\theta$ <p>Using <math>\cos 2\theta = 2\cos^2 \theta - 1</math> to give <math>\int 4(1 + \cos 2\theta) d\theta</math>  <math>= 4\theta + 2 \sin 2\theta</math></p> <p>Substituting limits to give <math>\frac{1}{3}\pi + \sqrt{3} - 2</math> or given result</p>	B1 B1 M1A1 dM1 A1ft A1 (7)
<b>(c)</b>	$\frac{dy}{d\theta} = \frac{-2 \sin 2\theta}{1 + \cos 2\theta}$ <p>Using the chain rule, with <math>\frac{dx}{d\theta} = \sec \theta \tan \theta</math> to give <math>\frac{dy}{dx} (= -2 \cos \theta)</math></p> <p>Gradient at the point where <math>\theta = \frac{\pi}{3}</math> is <math>-1</math>.</p> <p>Equation of tangent is <math>y + \ln 2 = -(x - 2)</math> (o.a.e.)</p>	B1 M1 A1ft M1A1 (5)