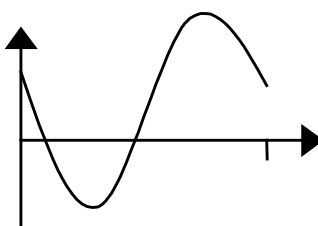


Question number	Scheme	Marks
<p><b>1.</b> (a)</p> <p>(b)</p>	<p><math>f(-2) = (-2)^3 - (19 \times -2) - 30</math>      M: Evaluate <math>f(-2)</math> or <math>f(2)</math></p> <p><math>f(-2) = 0</math>,      so <math>(x + 2)</math> is a factor</p> <p><math>(x^3 - 19x - 30) = (x + 2)(x^2 - 2x - 15)</math></p> <p><math>= (x + 2)(x + 3)(x - 5)</math></p>	<p>M1</p> <p>A1      (2)</p> <p>M1 A1</p> <p>M1 A1      (4)</p> <p><b>(6 marks)</b></p>
<p><b>2.</b> (a)</p> <p>(b)</p>	<p><math>(x^3)^{12}; \dots + \binom{12}{1}(x^3)^{11}\left(-\frac{1}{2x}\right) + \binom{12}{2}(x^3)^{10}\left(-\frac{1}{2x}\right)^2 + \dots</math></p> <p>[For M1, needs binomial coefficients, <math>{}^nC_r</math> form OK, at least as far as shown]</p> <p>Correct values for <math>{}^nC_r</math> s: 12, 66, 220 used (may be implied)</p> <p><math>(x^3)^{12} + 12(x^3)^{11}\left(-\frac{1}{2x}\right) + 66(x^3)^{10}\left(-\frac{1}{2x}\right)^2 + 220(x^3)^9\left(-\frac{1}{2x}\right)^3 \dots</math></p> <p><math>x^{36} - 6x^{32} + \frac{33}{2}x^{28} - \frac{55}{2}x^{24}</math></p> <p>Term involving <math>(x^3)^3\left(-\frac{1}{2x}\right)^9</math>;</p> <p>coeff = <math>\frac{12 \cdot 11 \cdot 10}{3 \cdot 2 \cdot 1}\left(-\frac{1}{2}\right)^9</math></p> <p><math>= -\frac{55}{128}</math>      (or <math>-0.4296875</math>)</p>	<p>B1; M1</p> <p>B1</p> <p>A2(1,0)      (5)</p> <p>M1</p> <p>A1</p> <p>A1      (3)</p> <p><b>(8 marks)</b></p>

Question number	Scheme	Marks
<p>3. (a)</p> <div style="text-align: center;">  </div> <p>(b) <math>\left(0, \frac{1}{\sqrt{2}}\right), \left(\frac{\pi}{4}, 0\right), \left(\frac{5\pi}{4}, 0\right)</math></p> <p>(c) <math>\left(x + \frac{\pi}{4} = \right) \frac{\pi}{3}</math>                      Other value <math>\left(2\pi - \frac{\pi}{3} = \right) \frac{5\pi}{3}</math>                      Subtract <math>\frac{\pi}{4}</math> <math>x = \frac{\pi}{12}, x = \frac{17\pi}{12}</math></p>	<p style="text-align: right;">Shape</p> <p style="text-align: right;">Position</p>	<p>B1</p> <p>B1 (2)</p> <p>B1, B1, B1 (3)</p> <p>B1</p> <p>M1</p> <p>M1 A1 (4)</p> <p style="text-align: right;"><b>(9 marks)</b></p>
<p>4. (a)</p> <p>(b)</p> <p>(c)</p>	<p><math>\log_2(16x) = \log_2 16 + \log_2 x</math>  <math>= 4 + a</math></p> <p><math>\log_2\left(\frac{x^4}{2}\right) = \log_2 x^4 - \log_2 2</math>  <math>= 4 \log_2 x - \log_2 2</math>  <math>= 4a - 1</math> (accept <math>4 \log_2 x - 1</math>)</p> <p><math>\frac{1}{2} = 4 + a - (4a - 1)</math>  <math>a = \frac{3}{2}</math></p> <p><math>\log_2 x = \frac{3}{2} \Rightarrow x = 2^{\frac{3}{2}}</math>  <math>\underline{\underline{x = \sqrt{8} \text{ or } 2\sqrt{2}}}</math> or <math>\sqrt{2^3}</math> or <math>(\sqrt{2})^3</math></p>	<p>M1</p> <p>A1 c.a.o (2)</p> <p>M1</p> <p>M1</p> <p>A1 (3)</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 (4)</p> <p style="text-align: right;"><b>(9 marks)</b></p>

Question number	Scheme	Marks
<p><b>5.</b> (a)</p> <p>(b)</p> <p>(c)</p>	<p><math>\tan x = \frac{8}{3}</math> (or exact equivalent, or 3 s.f. or better)</p> <p><math>\tan x = \frac{8}{3}</math> <math>x = 69.4^\circ (\alpha)</math>, <math>x = 249.4^\circ (180 + \alpha)</math></p> <p><math>3(1 - \cos^2 y) - 8\cos y = 0</math>    <math>3\cos^2 y + 8\cos y - 3 = 0</math></p> <p><math>(3\cos y - 1)(\cos y + 3) = 0</math>    <math>\cos y = \dots</math>,    <math>\frac{1}{3}</math> (or -3)</p> <p><math>y = 70.5^\circ (\beta)</math>, <math>x = 289.5^\circ (360 - \beta)</math></p>	<p>B1 (1)</p> <p>M1 A1, A1ft (3)</p> <p>M1 A1</p> <p>M1 A1</p> <p>A1 A1ft (6)</p> <p><b>(10 marks)</b></p>
<p><b>6.</b> (a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p>	<p><math>(x^4 - 6x^2 + 9)</math></p> <p><math>(x^4 - 6x^2 + 9) \div x^3 = x - 6x^{-1} + 9x^{-3}</math> (*)</p> <p><math>f'(x) = 1 + 6x^{-2} - 27x^{-4}</math>    First A1: 2 terms correct (unsimplified)</p> <p>Second A1: all 3 correct (simplified)</p> <p>When <math>x = \pm\sqrt{3}</math>, <math>f'(x) = 1 + \frac{6}{(\sqrt{3})^2} - \frac{27}{(\sqrt{3})^4}</math></p> <p><math>\left(= 1 + \frac{6}{3} - \frac{27}{9}\right) = 0</math>, <math>\therefore</math> Stationary</p> <p><math>f''(x) = -12x^{-3} + 108x^{-5}</math>    M: Attempt to diff. <math>f'(x)</math>, <u>not</u> <math>g(x)f'(x)</math></p> <p><math>f''(\sqrt{3}) = -\frac{12}{(\sqrt{3})^3} + \frac{108}{(\sqrt{3})^5}</math>    <math>(\approx -2.309 + 6.928 = 4.619)</math> <math>\left(= \frac{8}{\sqrt{3}}\right)</math></p> <p><math>&gt; 0</math>, <math>\therefore</math> Minimum (not dependent on a numerical version of <math>f''(x)</math>)</p>	<p>M1</p> <p>A1 (2)</p> <p>M1 A1 A1</p> <p>A1 (3)</p> <p>M1</p> <p>A1 (2)</p> <p>M1</p> <p>A1</p> <p>A1ft (3)</p> <p><b>(10 marks)</b></p>

Question number	Scheme	Marks
<p><b>7.</b> (a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p>	<p>Solve <math>\frac{3}{2}x^2 - \frac{1}{4}x^3 = 0</math> to find <math>p = 6</math>, or verify: <math>\frac{3}{2} \times 6^2 - \frac{1}{4} \times 6^3 = 0</math> (*)</p> <p><math>\frac{dy}{dx} = 3x - \frac{3x^2}{4}</math></p> <p><math>m = -9,</math>      <math>y - 0 = -9(x - 6)</math>      (Any correct form)</p> <p><math>3x - \frac{3x^2}{4} = 0,</math>      <math>x = 4</math></p> <p><math>\int \left( \frac{3x^2}{2} - \frac{x^3}{4} \right) dx = \frac{x^3}{2} - \frac{x^4}{16}</math>      (Allow unsimplified versions)</p> <p><math>[\dots\dots\dots]_0^6 = \frac{6^3}{2} - \frac{6^4}{16} = 27</math>      M: Need 6 and 0 as limits.</p>	<p>B1      (1)</p> <p>M1 A1</p> <p>M1 A1      (4)</p> <p>M1, A1ft      (2)</p> <p>M1 A1</p> <p>M1 A1      (4)</p> <p style="text-align: right;"><b>(11 marks)</b></p>
<p><b>8.</b> (a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p>	<p><math>(S =) a + ar + \dots + ar^{n-1}</math>      “S =” not required.      Addition required.</p> <p><math>(rS =) ar + ar^2 + \dots + ar^n</math>      “rS =” not required      (M: Multiply by r)</p> <p><math>S(1 - r) = a(1 - r^n)</math>      <math>S = \frac{a(1 - r^n)}{1 - r}</math>      (M: Subtract and factorise each side)      (*)</p> <p><math>r = 0.9</math></p> <p><math>S_{20} = \frac{10(1 - 0.9^{20})}{1 - 0.9} = 87.8</math></p> <p>Sum to infinity = <math>\frac{a}{1 - r} = \frac{10}{1 - 0.9} = 100</math>      (ft only for <math> r  &lt; 1</math>)</p> <p><math>\frac{a}{1 - r} = \frac{r}{1 - r} = 10</math>      (Put <math>a = r</math> in the formula from (c), and equate to 10)</p> <p><math>r = 10(1 - r)</math>      <math>r = \dots,</math>      <math>\frac{10}{11}</math> (or exact equivalent)</p>	<p>B1</p> <p>M1</p> <p>M1 A1      (4)</p> <p>B1</p> <p>M1 A1      (3)</p> <p>M1 A1ft      (2)</p> <p>M1</p> <p>M1, A1      (3)</p> <p style="text-align: right;"><b>(12 marks)</b></p>