

QUESTION 1:

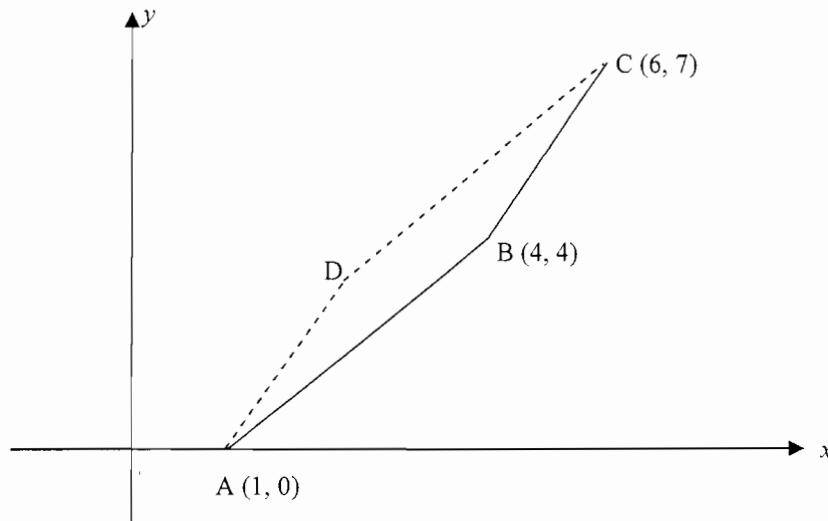
- (a) Completely factorise $2 - 8x^2$ 2
- (b) Solve for x : $1 - 2(3x - 5) = 4$ 2
- (c) Solve the following inequality and plot the solution on a number line. 3
- $$|1 - 3x| > 4$$
- (d) Find the value of $e^{\frac{3\pi}{4}}$ correct to 4 decimal places 1
- (e) Find the value of a if $\sqrt[3]{75} + \sqrt[3]{a} = 8\sqrt[3]{3}$ 2
- (f) Simplify $e^{4\ln x}$ 1
- (g) Simplify $\frac{\frac{1}{m} + \frac{1}{n}}{m + n}$ 1

QUESTION 2: (Begin on a new page)

- (a) Differentiate with respect to x : (i) $\frac{1}{\sqrt{x}}$ 1
- (ii) $2\cos^3 x$ 1
- (iii) $\log\left(\frac{x}{x-1}\right)$ 2
- (b) Find indefinite integrals of: (i) $\frac{x^2 + 2}{x}$ 1
- (ii) $\sin\frac{2x}{3}$ 2
- (iii) e^{1-4x} 2
- (c) Find the exact value of $\int_0^{\frac{\pi}{2}} 3\cos\frac{3x}{2} dx$ 3

QUESTION 3: (Begin on a new page)

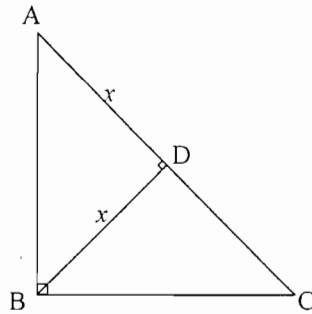
(a) The points $A(1, 0)$, $B(4, 4)$ and $C(6, 7)$ are shown below:



- (i) Find the co-ordinates of the point D if ABCD is a parallelogram 1
- (ii) Find the equation of the line AB 2
- (iii) Find the length of the perpendicular from D to AB 2
- (iv) Find the length of AB 1
- (v) Find the area of the quadrilateral ABCD 1
- (b) If $y = x \ln x - x$, (i) find $\frac{dy}{dx}$ 1
- (ii) using part (i) find $\int_1^2 \ln x dx$ 2
- (c) For a certain base, a , $\log_a 3 = 0.683$ and $\log_a 2 = 0.431$ 2
- Use these values to find $\log_a 1.5$.

QUESTION 4: (Begin on a new page)

(a) Copy the following diagram neatly onto your answer sheet:



$\triangle ABC$ is right-angled at B.

$AD = BD = x$ units

$BD \perp AC$

- | | | |
|-------|--|---|
| (i) | Find the size of $\angle BAD$ and $\angle DCB$ | 1 |
| (ii) | Prove that $\triangle ABD$ is congruent to $\triangle CBD$ | 2 |
| (iii) | Hence prove that D is the midpoint of AC. | 1 |
| (iv) | Show that $\triangle ABD$ is similar to $\triangle ACB$ | 2 |
| (v) | Show that $AB^2 = AD \cdot AC$ | 1 |
| (vi) | Hence, or otherwise, find the length of BC | 1 |

(b) The function $y=f(x)$ passes through the point (1, 1) and is defined by

$$f'(x) = \frac{1}{2x-1}$$

- | | | |
|------|---|---|
| (i) | Show that $y = \frac{1}{2} \ln(2x-1) + 1$ | 2 |
| (ii) | Hence show that $x = \frac{1}{2}(e^{2y-2} + 1)$ | 2 |

QUESTION 5 : (Begin on a new page)

(a) A function is defined by the following conditions:

$$f(0) = f(2) = 2$$

$$f'(1) = f'(2) = 0$$

$$f'(x) > 0 \quad \text{for } 0 \leq x < 1$$

$$f'(x) > 0 \quad \text{for } 2 < x \leq 4$$

$$f''(2) > 0$$

4

On your answer page, draw a possible graph of $y = f(x)$ for $0 \leq x \leq 4$ which incorporates all you may deduce about the function $f(x)$.

(b) Given that $y = 2x^3 - 21x^2 + 72x$,

(i) find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ 1

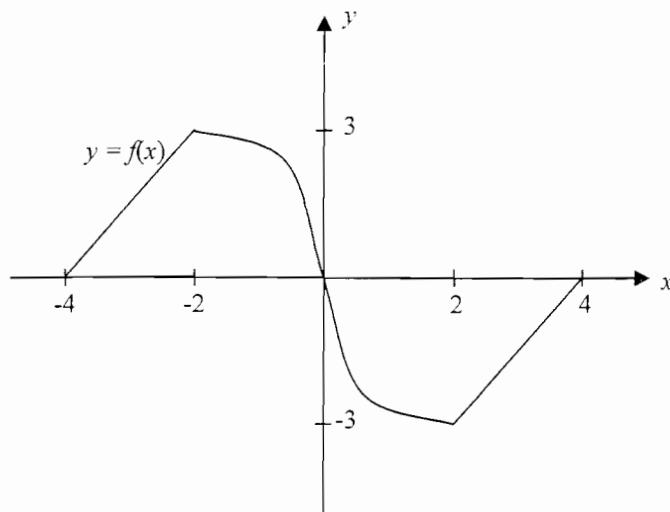
(ii) find all stationary points and determine their nature 4

(iii) find the x-value of the point of inflexion 1

(iv) sketch the curve, showing all important features 2
(DO NOT DRAW TO SCALE)

QUESTION 6: (Begin on a new page)

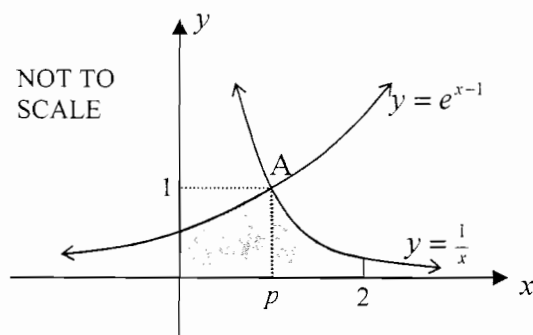
- (a) The function drawn below is an
- odd
- function.



Find $\int_{-4}^2 f(x) dx$

2

- (b) The curves
- $y = \frac{1}{x}$
- and
- $y = e^{x-1}$
- are shown below and intersect at the point A (
- $p, 1$
-)



- (i) Find p , the x -coordinate of the point A. 1
- (ii) Find the shaded area, correct to 2 decimal places. 4

- (c) Find,
- by calculus
- , the volume of the solid formed when the curve
- $y = \sqrt{r^2 - x^2}$
- is revolved about the
- x
- axis. Leave your answer in
- exact
- form. 5

QUESTION 7: (Begin on a new page)

- (a) Find the value(s) of k for which the equation 2

$$x^2 - (k + 2)x + \frac{k}{2} + 7 = 0 \quad \text{has real roots.}$$

- (b) (i) You are given that the roots of $2x^2 - 4x + 5 = 0$ are α and β .

Find the value of (I) $\alpha + \beta$ 1

(II) $\alpha\beta$ 1

(III) $\alpha^2 + \beta^2$ 1

(IV) $\frac{1}{\alpha} + \frac{1}{\beta}$ 1

- (ii) Form another quadratic equation with roots α^2 and β^2 where α and β are the roots referred to in part (i) above. 2

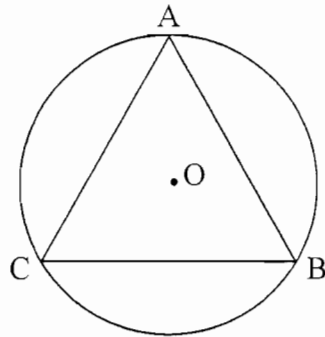
- (c) (i) If A is the point (2, 1) and B is the point (-2, 1), find the algebraic equation giving the locus of a point P(x, y) which moves so that $\angle APB = 90^\circ$. 3

- (ii) What geometric shape is this locus? 1

QUESTION 8: (Begin on a new page)

- (a) Find the value of $\frac{1}{2} - \frac{1}{4} + \frac{1}{8} - \dots$ 1

- (b) An equilateral triangle ABC is inscribed in a circle of radius 2 cm.
Find the exact value of the area shaded. 4

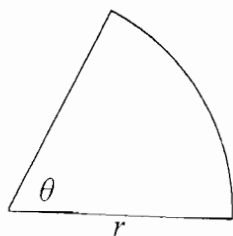


- (c) A tower is formed by laying 1 metre cubes. The layers are in the form of a square and the first layer has 99 cubes in each side. The second layer has 97 cubes in each side while the third layer has 95 cubes, and so on. The final layer has only 1 cube.
- (i) How many layers are there? 2
- (ii) How many cubes make up the 18th layer? 1
- (d) Solve the equation $2 \cos^2 \theta - 5 \sin \theta + 1 = 0$ for $0 \leq \theta \leq 2\pi$. 4

QUESTION 9: (Begin on a new page)

- (a) Prove that $(1 + \tan^2 A) \cos A = \sec A$. 2

- (b) A landscape gardener wants to build a garden bed in the form of a sector as follows:



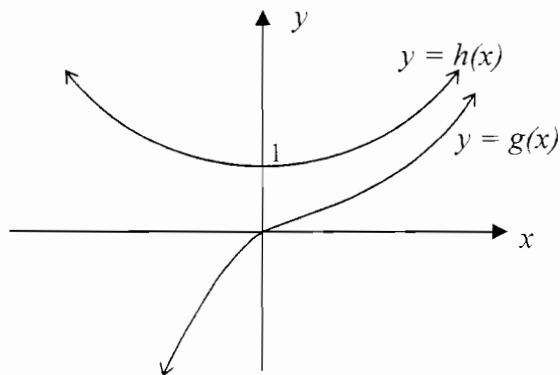
He wants the area of the garden to be exactly 16 m^2 , but wants to use as little concrete as possible to build the edge around the garden.

- (i) Show that the perimeter, P , of the garden is given by 3

$$P = 2r + \frac{32}{r}$$

- (ii) Find the value of r which will give the minimum perimeter and the angle, θ , needed to give this minimum. 3
- (iii) What is this minimum perimeter? 1

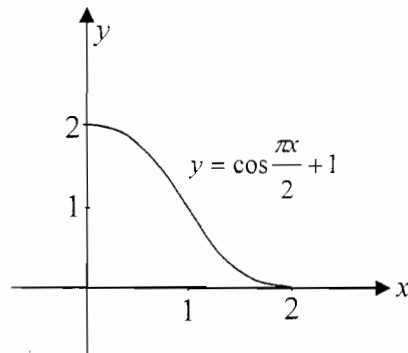
- (c) The graphs of $h(x) = \frac{e^x + e^{-x}}{2}$ and $g(x) = \frac{e^x - e^{-x}}{2}$ are shown below:



- (i) Prove algebraically that the two curves do not intersect. 1
- (ii) Hence, or otherwise, find the value of $\lim_{x \rightarrow 0} [h(x) - g(x)]$. 2

QUESTION 10: (Begin on a new page)

- (a) The curve $y = \cos \frac{\pi x}{2} + 1$ is shown below for $0 \leq x \leq 2$.



- (i) By using two applications of the Trapezoidal Rule (ie. 3 function values) find an approximation for the area between the curve $y = \cos \frac{\pi x}{2} + 1$, the x -axis, and the lines $x = 0$ and $x = 1$. (LEAVE YOUR ANSWER AS A SURD) 3
- (ii) By using integration, find an expression for the exact area in part (i) above. 2
- (iii) Using your answers to parts (i) and (ii) above, find an approximation for π correct to 3 decimal places. 2
- (b) A function $f(x)$ is defined in such a way that $\sin f(x) = x$, for $0 \leq f(x) \leq \frac{\pi}{2}$
- (i) By differentiating both sides of $\sin f(x) = x$ with respect to x , show that 2
- $$f'(x) = \frac{1}{\cos f(x)} = \frac{1}{\sqrt{1-x^2}}$$
- (ii) A second function $g(x)$, is defined similarly, so that $\cos g(x) = x$,
for $0 \leq g(x) \leq \frac{\pi}{2}$
leading to the fact that $g'(x) = \frac{-1}{\sqrt{1-x^2}}$. 2
- Show by integration, or otherwise, that $f(x) + g(x)$ is a constant.
- (iii) Hence find the value of $f(x) + g(x)$. 1

STANDARD INTEGRALS

$$\int x^n dx = \frac{1}{n+1} x^{n+1}, \quad n \neq -1; \quad x \neq 0, \text{ if } n < 0$$

$$\int \frac{1}{x} dx = \ln x, \quad x > 0$$

$$\int e^{ax} dx = \frac{1}{a} e^{ax}, \quad a \neq 0$$

$$\int \cos ax dx = \frac{1}{a} \sin ax, \quad a \neq 0$$

$$\int \sin ax dx = -\frac{1}{a} \cos ax, \quad a \neq 0$$

$$\int \sec^2 ax dx = \frac{1}{a} \tan ax, \quad a \neq 0$$

$$\int \sec ax \tan ax dx = \frac{1}{a} \sec ax, \quad a \neq 0$$

$$\int \frac{1}{a^2 + x^2} dx = \frac{1}{a} \tan^{-1} \frac{x}{a}, \quad a \neq 0$$

$$\int \frac{1}{\sqrt{a^2 - x^2}} dx = \sin^{-1} \frac{x}{a}, \quad a > 0, \quad -a < x < a$$

$$\int \frac{1}{\sqrt{x^2 - a^2}} dx = \ln \left(x + \sqrt{x^2 - a^2} \right), \quad x > a > 0$$

$$\int \frac{1}{\sqrt{x^2 + a^2}} dx = \ln \left(x + \sqrt{x^2 + a^2} \right)$$

NOTE : $\ln x = \log_e x, \quad x > 0$

Teacher's Name: _____

Student's Name/N^o: _____

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SOLUTIONS

① (a) $2(1-4x^2)$ ① MARK ② (a)(i) $-\frac{1}{2}x^{-\frac{1}{2}} =$ ① MARK

$= 2(1-2x)(1+2x)$ ① MARK $= -\frac{1}{2}\sqrt{x}$ (not necessary)

(b) $1-6x+10 = 4$ ②

$6x = 7$ } 100%
 $x = \frac{7}{6}$ } Exact

$x = \frac{7}{6}$ } Error

(ii) $6 \cos^2 x (\sin x)$ ① MARK

$= 6 \sin x \cos^3 x$ } for

(c) $1-3x > 4$ OR $1-3x < 4$ (iii) $\int \frac{1}{x} [\log x - \log(x-1)] dx$ ①

$x < -1$ OR $x > \frac{5}{3}$ ②

$= \frac{1}{x} - \frac{1}{x-1}$ ①



(d) ① MARK (b) (i) $\int (x + 2x dx = \frac{1}{2}x^2 + 2ln|x +$

(e) $5\sqrt{3} + \sqrt{a} = 8\sqrt{3}$ for this line.

$\sqrt{a} = 3\sqrt{3}$

$\sqrt{a} = \sqrt{137}$

(f) $e^{\ln x^4} = x^4$ ① (ii) $-\frac{3}{2} \cos \frac{2x}{3} + k$ ①

(g) $\frac{n+m}{m+n} = \frac{m+n}{m+n}$ ① (iii) $-\frac{1}{4}e^{-4x} + k$ ②

$= \frac{1}{m+n}$ ①

(c) $\int_0^{\pi/2} [3 \sin 3x] dx$ ①

$= 2 \sin 3x - 2 \sin 0$

$= 2 \sin 3x$ ②

③ (a) D(3,3) ①

(ii) $m_{AG} = \frac{4}{3}$ ①

$y - 3 = \frac{4}{3}(x-1)$

$4x - 3y - 4 = 0$ } for

$4x - 3y - 4 = 0$ } like

(iii) $P = \frac{4(3-3) - 4}{\sqrt{4^2 + 3^2}}$

$= \frac{-4}{5}$

$= \frac{4}{5}$ ② } part marks

$= \frac{4}{5}$ ② } for first

(iv) $d_{AG} = \sqrt{(4-1)^2 + (4-0)^2}$

$= \sqrt{9+16}$

$= 5$ ①

(v) $A = \frac{1}{2} \times 5 \times \frac{4}{5}$

$= \frac{1}{2} \times 4 = 2$ ①

(b) (i)

$y = x \ln x - x$

$\frac{dy}{dx} = \ln x + x - 1$

$= \ln x$ ①

(ii) $\int \ln x dx = [x \ln x - x]$

$= (2 \ln x)$

$= 2 \ln x$

(c) $\log_a 1.5 = \log_a 3$

$= 0.683$

$= 0.252$

④ (a) (i) $\angle BAD = 45^\circ$, $\angle DCB = 45^\circ$ ①

(ii) $\triangle ADB$ and $\triangle CBD$

$\angle ADB = \angle CBD = 90^\circ$ (given) ①

$\angle BAD = \angle DCB = 45^\circ$ (proven) ①

BD is common ①

$\triangle ABD \cong \triangle CBD$ (AAS) ②

AD = DC (corresponding sides) ①

D is midpoint ①

(iv) $\triangle ADB$ and $\triangle DCB$

$\angle ADB = \angle DCB = 90^\circ$ (given) ②

$\angle BAD = \angle DCB = 45^\circ$ (proven) ②

BD is common (equilateral) ②

$\triangle ADB \cong \triangle DCB$ (ASA) ②

AD = DC (corresponding sides) ②

(ii) $y = 2x - 2$

$2x - 1 = 2x$

$2x - 1 = 2x$

$x = 2$

$x = 2$

$x = 2$

$x = 2$

$x = 2$

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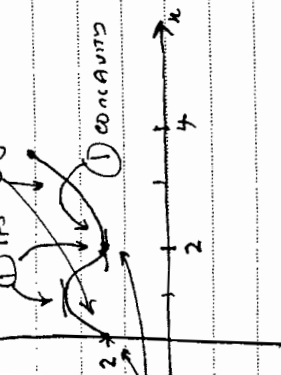
$x = 2$

$x = 2$

Teacher's Name: _____

Student's Name/N^o: _____

1) TP's for m.s.



6) (a) The area is the curved section since each other (because of odd function)

THEY MUST MENTION SOMETHING LIKE THIS FOR MARK

∴ Area under triangle

$$= \frac{1}{2} \times 2 \times 3$$

$$> 3 \text{ m}^2$$

$$\therefore \int_0^3 f(x) dx = 3 \text{ (1)}$$

$$y = 2x^3 - 21x^2 + 72x$$

$$\frac{dy}{dx} = 6x^2 - 42x + 72$$

$$\frac{d^2y}{dx^2} = 12x - 42$$

(b) (i) At (1,1) ∴ p = 1 (1)

At s.p.'s $\frac{dy}{dx} = 0$

$$x^2 - 7x + 12 = 0 \text{ (1)}$$

$$(x-4)(x-3) = 0$$

$$x = 4 \text{ or } x = 3$$

$$y = 80 \text{ (at } x=4)$$

$$y = 670 \text{ (at } x=3)$$

$$\text{max at } (3, 80)$$

$$\therefore A = 1 - \frac{1}{e} + \ln 2$$

$$V = \pi \int_0^2 y^2 dx$$

$$= \pi \int_0^2 (x^2 - 2x) dx$$

$$= \pi \left[\frac{x^3}{3} - x^2 \right]_0^2$$

$$= \pi \left[\frac{8}{3} - 4 \right] = -\frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

$$= \pi \left[\left(\frac{8}{3} - 4 \right) \right] = -\frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

$$= \frac{4\pi}{3}$$

7) (a) Real roots means $\Delta \geq 0$

$$\therefore (k+2)^2 - 4 \left(\frac{k}{2} + 7 \right) \geq 0 \text{ (1)}$$

$$k^2 + 4k + 4 - 2k - 28 \geq 0$$

$$\therefore k^2 + 2k - 24 \geq 0$$

$$(k+6)(k-4) \geq 0$$

$$\therefore k \geq 6 \text{ or } k \leq 4 \text{ (1)}$$

(subtract 1 if no equal sign)

$$\therefore \frac{y-1}{x-2} \cdot \frac{y-1}{x+2} = -1 \text{ (1)}$$

$$\therefore -1(x^2 - 4) = (y-1)^2$$

$$\therefore x^2 + (y-1)^2 = 4 \text{ EITHER}$$

$$x^2 + y^2 - 2y - 3 = 0 \text{ (1)}$$

$$\therefore -1(x^2 - 4) = (y-1)^2$$

$$\therefore x^2 + (y-1)^2 = 4 \text{ EITHER}$$

$$x^2 + y^2 - 2y - 3 = 0 \text{ (1)}$$

$$\therefore -1(x^2 - 4) = (y-1)^2$$

$$\therefore x^2 + (y-1)^2 = 4 \text{ EITHER}$$

$$x^2 + y^2 - 2y - 3 = 0 \text{ (1)}$$

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$$x^2 + y^2 - 2y - 3 = 0 \text{ (1)}$$

$$\therefore -1(x^2 - 4) = (y-1)^2$$

$$\therefore x^2 + (y-1)^2 = 4 \text{ EITHER}$$

$$x^2 + y^2 - 2y - 3 = 0 \text{ (1)}$$

$$\therefore -1(x^2 - 4) = (y-1)^2$$

$$\therefore x^2 + (y-1)^2 = 4 \text{ EITHER}$$

Remember standard errors

$$(ii) (x - \alpha^2)(x - \beta^2) = 0$$

$$\therefore x^2 - (\alpha^2 + \beta^2)x + \alpha^2\beta^2 = 0 \text{ (1)}$$

$$\therefore x^2 + 2x + 25/4 = 0 \text{ (1)}$$

$$4x^2 + 4x + 25 = 0 \text{ neither}$$

(ii) CIRCLE (1)

(nothing more required)

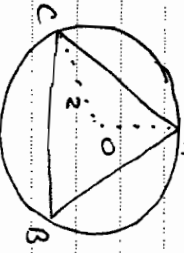
8 (a) G.P. $a = \frac{1}{2}$

$r = -\frac{1}{2}$

$S_0 = \frac{\frac{1}{2}}{1 + \frac{1}{2}}$

$= \frac{1}{3}$ (1) RIGHT OR WRONG ONLY

(b) METHOD 1:



$\angle COB = 120^\circ \left(\frac{2\pi}{3} \right)$ (1)

Area sector AOB = $\frac{1}{2} r^2 \theta$

$= \frac{1}{2} (4) \left(\frac{2\pi}{3} \right)$

$= \frac{4\pi}{3}$ (1)

Area $\Delta AOC = \frac{1}{2} (r)(r) \sin \theta$

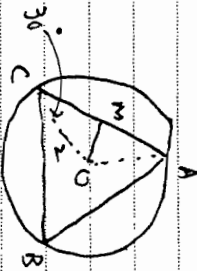
$= 2 \sin 120^\circ$

$= \sqrt{3}$ (1)

Shaded area = $3 \left(\frac{4\pi}{3} - \sqrt{3} \right)$

$= 4\pi - 3\sqrt{3}$ (1)

OR



$\angle ACO = 30^\circ$ (angle cm of ΔAOC)

$OM = 1 \left(\sin 30^\circ = \frac{OM}{2} \right)$

$CM = \sqrt{3}$ (Pythogoras)

Area (AOC) = $\frac{1}{2} \times 1 \times 2\sqrt{3}$

$= \sqrt{3}$ (1)

Area $\Delta AOB = 3\sqrt{3}$

Area circle = $\pi (a)^2$ (1)

\therefore Shaded area = $4\pi - 3\sqrt{3}$ (1)

(c) (i) 99, 97, 95, ...

$a = 99, d = -2, T_n = 1$

$99 + (n-1)(-2) = 1$ (1)

$99 - 2n + 2 = 1$

$2n = 100$

$n = 50$ (1)

(ii) $T_{18} = a + 17d$

$= 99 - 34$

$= 65$

\therefore cube = $(65)^3$ (1)

$= 4225$

(d) $2 \cos^2 \theta - 5 \sin \theta + 1 = 0$

$2(1 - \sin^2 \theta) - 5 \sin \theta + 1 = 0$ (1)

$2 - 2 \sin^2 \theta - 5 \sin \theta + 1 = 0$

$2 \sin^2 \theta + 5 \sin \theta - 3 = 0$

$(2 \sin \theta - 1)(\sin \theta + 3) = 0$ (1)

$\therefore \sin \theta = \frac{1}{2}$

$\theta = \frac{\pi}{6}, \frac{5\pi}{6}$

$\sin \theta = -3$

NO SOLUTION

(give only 1 mark for $30^\circ, 150^\circ$)

9 (a) $(1 + \tan^2 A) \cos A$

$= \sec^2 A \cos A$ (1)

$= \sec A \cdot \frac{1}{\cos A} \cdot \cos A$ (1)

$= \sec A$

(b) (i) $l = r\theta, A = \frac{1}{2} r^2 \theta = 16$

$\therefore \theta = \frac{32}{r^2}$ (1)

$\therefore P = r\theta + 2r$

$= \frac{32}{r} + 2r$ (1)

(ii) $\frac{dP}{dr} = -\frac{32}{r^2} + 2$ (1)

$\frac{d^2P}{dr^2} = +\frac{64}{r^3}$ (1)

$\frac{dP}{dr}$

At min. $\frac{dP}{dr} = 0$

$-\frac{32}{r^2} + 2 = 0$

$r^2 = 16$

(1) $\rightarrow r = 4$ or $r = -4$

(1) $\rightarrow r = +1$ NOT A SOLUTION

\therefore min at $r = 4$

(1) $\rightarrow \theta = 2$

(iii) $P = 16$ (1)

(c) (i) $\frac{e^x + e^{-x}}{2} = \frac{e^x - e^{-x}}{2}$

$2e^{-x} = 0$ (1)

$e^{-x} = 0$ has no solution

(ii) $\lim_{x \rightarrow 0} [h(x) - g(x)]$

$= \lim_{x \rightarrow 0} \frac{2e^{-x}}{2}$

$= \lim_{x \rightarrow 0} e^{-x}$

$= \lim_{x \rightarrow 0} e^{-x} = 1$ (1)

$$\begin{aligned} a) (i) \quad A_1 &= \frac{1}{2} \cdot \frac{1}{2} [2 + \cos \frac{\pi}{2} \cdot \frac{1}{2}] \\ &= \frac{1}{4} [3 + \cos \frac{\pi}{4}] \\ &= \frac{3 + \frac{1}{\sqrt{2}}}{4} \quad \textcircled{1} = \frac{3\sqrt{2} + 1}{4\sqrt{2}} \quad (\text{not necessary}) \end{aligned}$$

$$A_2 = \frac{1}{2} \times \frac{1}{2} \left[\frac{1}{\sqrt{2}} + 1 + \cos \frac{\pi}{2} + 1 \right]$$

$$= \frac{1}{4} \left[\frac{1}{\sqrt{2}} + 2 \right]$$

$$= \frac{2 + \frac{1}{\sqrt{2}}}{4} \quad \textcircled{1} = \frac{2\sqrt{2} + 1}{4\sqrt{2}} \quad (\text{not necessary})$$

$$\therefore A = \frac{5 + \frac{2}{\sqrt{2}}}{4} \quad \textcircled{1} = \frac{5\sqrt{2} + 2}{4\sqrt{2}} \quad (\text{not necessary})$$

$$i) \quad A = \int \left(\cos \frac{\pi x}{2} + 1 \right) dx$$

$$= \frac{2}{\pi} \sin \frac{\pi x}{2} + x \Big|_0^1 \quad \textcircled{1}$$

$$= \frac{2}{\pi} \sin \frac{\pi}{2} + 1 - \sin 0 + 0$$

$$= \frac{2}{\pi} + 1$$

$$\begin{aligned} \frac{4}{\pi} \pi &= \frac{5 + \frac{2}{\sqrt{2}}}{4} \quad \textcircled{1} \quad \text{or} \quad \left\{ \begin{array}{l} \frac{5\sqrt{2} + 2}{4\sqrt{2}} \Rightarrow \frac{4}{\pi} \\ \frac{16\sqrt{2}}{5\sqrt{2} + 2} \Rightarrow \pi \end{array} \right. \end{aligned}$$

$$\pi \approx 3.14159$$

$$\pi \approx 3.14159$$

(don't practice for not correct to 3 dec. pl.)

$$(i) \quad \sin f(x) = x$$

$$f'(x) \cos f(x) = 1$$

$$\therefore f'(x) = \frac{1}{\cos f(x)}$$

$$= \frac{1}{\sqrt{1 - \sin^2 f(x)}} \quad \textcircled{1}$$

① for complete one use

$$ii) \quad f'(x) + g'(x) = 0$$

$$\int (f'(x) + g'(x)) dx = k \quad \textcircled{2}$$

$$\begin{aligned} \frac{d}{dx} = 0 & \quad f(0) + g(0) = k \\ \sin f(0) + \cos g(0) = 0 & \Rightarrow f(0) = 0 \\ \frac{d}{dx} = 0 & \Rightarrow g(0) = \frac{\pi}{2} \end{aligned}$$