Student Number: ______________

OLSH COLLEGE

DN

REGNET CHRISTUS

OUR LADY OF THE SACRED HEART COLLEGE

MATHEMATICS

H.S.C. ASSESSMENT TASK 2 (HALF – YEARLY)

Monday April 2, 2012.

Time allowed:	**3 hours plus 5 minutes reading time**
Weighting:	**30%**
Topics covered	**Preliminary Work, Series and Sequences, Locus and Parabola, Calculus, Integration, The Quadratic Polynomial.**

Section I:	10 multiple choice questions. (1 mark each) Answer all questions on the answer sheet provided
Section II:	6 questions (15 marks each) Answer all questions in the answer booklets provided Start each question in a new booklet Show all necessary working

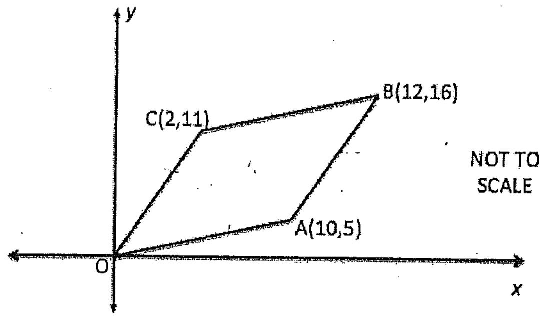
- Board approved calculators may be used in this test
- A standard integrals page has been attached to the back of the question paper.
-

SECTION B – QUESTION ONE (15 marks)

(a) What is the value of $\sqrt[3]{2a-b}$ if a = 7.3 and b = 1.6. Answer to 2 decimal places **1**

(b) Rationalise and simplify $\dfrac{6}{\sqrt{3}-1}$ **2**

(c)



In the diagram, A, B and C are the points (10,5) , (12,16) and (2,11) respectively.

Copy or trace the diagram into your writing booklet.

(i) Find the distance AC **1**

(ii) Find the midpoint of AC **1**

(iii) Show that $OB \perp AC$ **2**

(iv) Find the midpoint of OB and hence explain why OABC is a rhombus. **2**

(v) Hence, or otherwise, find the area of OABC. **1**

(d) Find the derivative of the function $f(x) = 2x^2 - 3x$ using first principles **3**

(e) Simplify $(4e^2f^3)^4$ **1**

(f) Solve the equation : $\dfrac{x+2}{3} + 7 = 10$ **1**

SECTION B – QUESTION TWO (15 marks)

(a) In an isosceles triangle ΔPQR, PQ = QR and S is a point on QR such that $PS \perp QR$.

If $\angle PQR = 74°53'$ and PQ = 85 mm,

(i) Draw a diagram representing this information **1**

(ii) Find the length of SR correct to 1 decimal place. **2**

(b) Differentiate the following expressions

(i) $f(x) = (3x^2 + 7)^5$ **1**

(ii) $f(x) = \dfrac{1}{x^2}$ **2**

(iii) $f(x) = \dfrac{3x+5}{2x-7}$ **2**

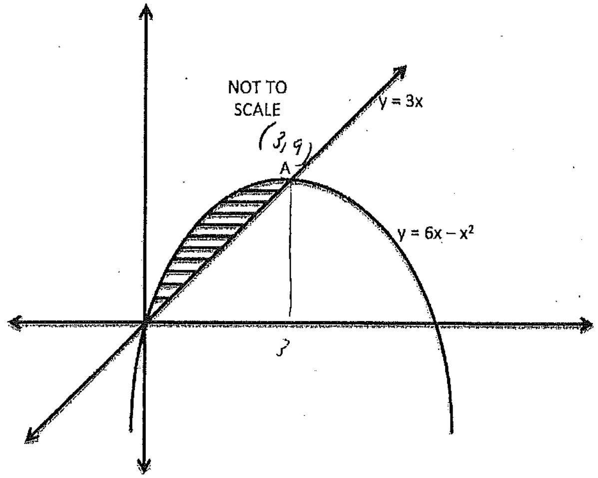
(c) Find the primitive function of

(i) $\int \dfrac{1}{x^3}\,dx$ **1**

(ii) $\int \dfrac{4+3x^5}{x^2}\,dx$ **2**

Question 2 continued overleaf

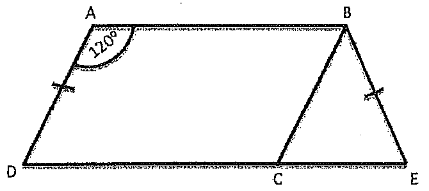
(d) The graphs of $y = 6x - x^2$ and $y = 3x$ intersect at (0,0) and the point A, as shown in the diagram.



(i) Find the co-ordinates of A **1**

(ii) Find the area of the shaded region bounded by $y = 6x - x^2$ and $y = 3x$ **2**

SECTION B – QUESTION THREE (15 marks)

(a) 

This diagram shows a parallelogram ABCD with $\angle DAB = 120^\circ$. The line DC is produced to E so that AD = BE.

Copy or trace the diagram into your writing booklet.
Prove that ΔBCE is equilateral. **2**

(b) For the function $y = \frac{3}{\sqrt[3]{x^5}}$, find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$, writing both answers in surd form. **3**

(c) If α and β are the roots of $2x^2 + 3x - 4 = 0$, find,

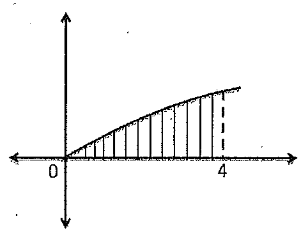
(i) $\alpha+\beta$ **1**

(ii) $\alpha\beta$ **1**

(iii) $(\alpha-1)(\beta-1)$ **2**

(d) The point P moves in such a way so that its distance from the point A (2,4) is always twice the distance from the point B (1,0). Show that the equation of this locus is $3x^2 + 3y^2 - 4x + 8y - 16 = 0$. **3**

(e) This graph shows the curve $y = \sqrt{x}$ between the values of x = 0 and x = 4.



Show that the shaded area is equal to $5\frac{1}{3}$ units^2. **3**

SECTION B – QUESTION FOUR (15 marks)

(a) Consider the graph $y = x^3 - 3x^2$.

(i) Find the co-ordinates of the stationary points of the curve and determine their nature. **3**

(ii) Sketch the curve showing stationary points, points of inflexion and intercepts with both axes. **3**

(b) For the quadratic equation $4x^2 + 3kx + k^2 = 0$,

(i) Find the discriminant in terms of k **1**

(ii) Hence, or otherwise, state whether the roots of the quadratic are real or unreal whatever the value of k, giving reasons for your answer. **2**

(c) Sketch the parabola $2y = x^2 + 6x + 5$, showing the vertex, focus and directrix. **3**

(d) Given that $\frac{d^2y}{dx^2} = 12x - 2$ and that $\frac{dy}{dx} = 0$ at the point (1,4), find the expression for y in terms of x. **3**

SECTION B – QUESTION FIVE (15 marks)

(a) A store has cans of tomatoes stacked in a display which has 40 cans on the bottom row. Each row has two cans less than the row below it. The top row has 6 cans.

(i) How many cans are in the 6^{th} row from the bottom. **1**

(ii) Find an expression for the number of cans in the n^{th} row. **2**

(iii) Using the formula for the sum of an arithmetic progression, find the total number of cans in the display. **2**

(b) Solve the equation $x^4 - 13x^2 + 36 = 0$. **3**

(c) On a number plane, a circle has its centre O at the point (-4,2).
The line $y = 3x + 4$ is a tangent to the circle.

(i) Find the radius of the circle. **2**

(ii) Find the equation of the circle. **1**

(d) (i) For the function $y = \dfrac{1}{10 + x^2}$, copy and complete the following table. **1**

x	1	1.5	2	2.5	3
y					

(ii) Use Simpson's Rule and 5 function values to approximate the area under the curve $y = \dfrac{1}{10 + x^2}$ between the values $x = 1$ and $x = 3$.

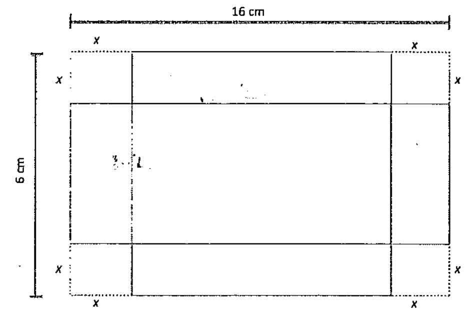
Use 2 decimal places throughout the working. **2**

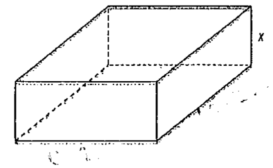
(e) Find the limiting sum of the Geometric Progression which begins

18, 12, 8, ... **1**

SECTION B – QUESTION SIX (15 marks)

(a) A box is formed from a rectangular piece of cardboard 16 cm long and 6 cm wide. A square of side x will be cut and removed from each corner so that the sides can be folded to form a box.





(i) If x is the height of the finished box, what are the length and breadth of the finished box. **1**

(ii) Show that the volume V cm^3 of the box is given by

$$V = 4x^3 - 44x^2 + 96x$$ **1**

(iii) Show that the maximum volume of the box is achieved when $x = \frac{4}{3}$ cm **3**

(iv) Find the maximum volume of the box correct to 2 decimal places **1**

Question Six continued overleaf

(b) A man borrows \$ 15000 to buy a car. He has to pay off the loan over 5 years in equal monthly repayments. If the interest is 15% p.a. and the interest is compounded monthly, and M is the size of each monthly repayment,

(i) Show that the amount owing after 1 month (A_1) is given by

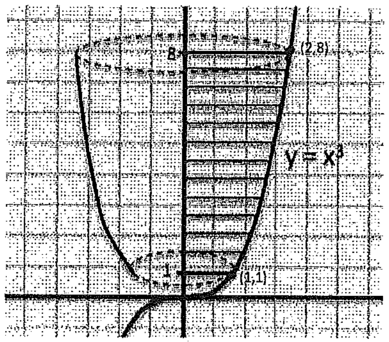
$$A_1 = 15000 \times 1.0125 - M$$ **1**

(ii) Show that $A_3 = 15000\,(1.0125)^3 - M\,(1.0125^2 + 1.0125 + 1)$ **1**

(iii) Calculate the size of each monthly repayment **3**

(iv) How much interest does the man pay over the life of the loan ? **1**

(c) Here is a diagram of the curve $y = x^3$.



Find the volume of the solid generated when the area between $y = 1$ and $y = 8$ is rotated about the y-axis.

Answer in terms of π **3**

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Q1 a) $\sqrt[3]{2(7.3)-1.6}$

$= \sqrt[3]{13}$

$= 2.35$

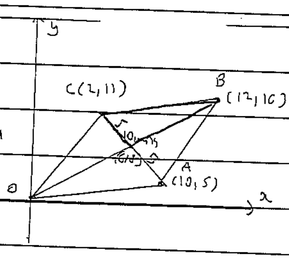
b) $\dfrac{6}{\sqrt{3}-1} \times \dfrac{(\sqrt{3}+1)}{(\sqrt{3}+1)}$

$= \dfrac{6\sqrt{3}+6}{3-1}$

$= \dfrac{\cancel{6}^{3}(\sqrt{3}+1)}{\cancel{2}}$

$= 3(\sqrt{3}+1)$ OR $3\sqrt{3}+3$

c)



i) $D = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$

$= \sqrt{(10-2)^2+(5-11)^2}$

$= \sqrt{64+36}$

$= 10$ units

Q1. ii) mid-pt of AC

$\dfrac{x_1+x_2}{2}, \dfrac{y_1+y_2}{2}$

$\dfrac{10+2}{2}, \dfrac{5+11}{2}$

$(6, 8)$

iii) for $OB \perp AC$, $m_1 \times m_2 = -1$

$m_1 = \dfrac{y_2-y_1}{x_2-x_1}$ $\qquad m_2 = \dfrac{y_2-y_1}{x_2-x_1}$

$= \dfrac{11-5}{2-10}$ $\qquad = \dfrac{16-0}{12-0}$

$= \dfrac{6}{-8} = \dfrac{3}{-4}$ $\qquad = \dfrac{16}{12} = \dfrac{4}{3}$

$m_1 \times m_2 = -1$

$\cancel{\dfrac{8}{-4} \times \dfrac{16}{12} = -1}$ $\qquad \dfrac{-3}{4} \times \dfrac{4}{-3} = -1$

$\therefore OB \perp AC$

iv) mid-pt of OB

$\left(\dfrac{x_1+x_2}{2}, \dfrac{y_1+y_2}{2}\right)$

$\left(\dfrac{12}{2}, \dfrac{16}{2}\right)$

$(6, 8)$

Q1: OABC is a rhombus as diagonals meet at one point at right angles.

(v) Missing ~~point~~ part (v) is on a different pa..

(vi) $D_{OB} = \sqrt{12^2+16^2}$

$= 20$ units

$A_{total} = 4 \times$ ~~sm~~ $\triangle$ area

$= 4 \times 10 \times 5$

$= 200$ units^2

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d) $\lim_{h \to 0} \dfrac{f(x+h) - f(x)}{h}$

$f(x+h) = 2(x+h)^2 - 3(x+h)$

$= 2(x^2+2xh+h^2) - 3x - 3h$

$= 2x^2+4xh+2h^2-3x-3h$

$\lim_{h \to 0} \dfrac{\cancel{2x^2}+4xh+2h^2\cancel{-3x}-3h\cancel{-2x^2}\cancel{+3x}}{h}$

$= \lim_{h \to 0} \dfrac{4xh+2h^2-3h}{h}$

$= \lim_{h \to 0} \dfrac{\cancel{h}(4x+2h-3)}{\cancel{h}}$

$= \lim_{h \to 0} 4x+2h-3$

~~$= 2x - 3$~~

$= 4x - 3$

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e) $256e^3f^{12}$ 1

f) $\frac{x+2}{3} + 7 = 10$

$x + 2 + 21 = 30$ 1

$x = 7$

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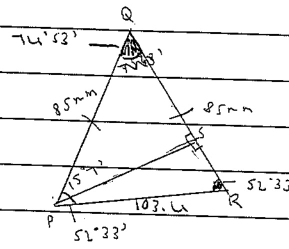
Q2 a)



1

$\frac{\sin 74°53'}{PR} = \frac{\sin 52°33'}{85}$

$PR = \frac{85 \sin 74°53'}{\sin 52°33'}$

$= 103.4 \text{ mm}$

$\cos 52°33' = \frac{SR}{103.4}$

$SR = 103.4 \cos 52°33'$

$= 62.94 \text{ mm}$ 2

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b) i) $f'(x) = 5(3x^2+7)^4 \times 6x$

$= 30x(3x^2+7)^4$ 2

ii) $f(x) = x^{-2}$

$f'(x) = -2x^{-3}$

$= \frac{-2}{x^3}$ 2

iii) $f'(x) = \frac{u'v - uv'}{v^2}$ $u = 3x+5$ $v = 2x-7$, $u' = 3$ $v' = 2$

$= \frac{3(2x-7) - 2(3x+5)}{(2x-7)^2}$

$= \frac{6x - 21 - 6x - 10}{(2x-7)^2}$

$= \frac{-31}{(2x-7)^2}$ 2

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c) i) $\int x^{-3}\, dx$

$= \frac{x^{-2}}{-2} + c$

$= \frac{1}{-2x^2} + c$ 1

ii) $\int 4x^{-2} + 3x^3\, dx$

$= \frac{4x^{-1}}{-1} + \frac{3x^4}{4} + c$

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

a) i) $3x = 6x - x^2$

$-3x = -x^2$

$x^2 - 3x = 0$

$x(x-3) = 0$

$x = 0, 3$

$\therefore x = 3$

$y = 3(3)$

$= 9$

$A(3, 9)$

ii) $A = \int_0^3 6x - x^2 - 3x \, dx$

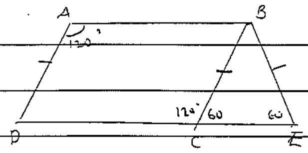
$= \int_0^3 3x - x^2 \, dx$

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

$= \left[\frac{27}{2} - 9 - 0\right]$

$= 4.5u^2$

Q3 a)



$AD = BC$ (opposite sides are equal in parallelograms)

$\angle DCB = 120°$ (opposite angles are equal in parallelograms)

$\angle BCE = 60°$ (angles on a straight line)

$\triangle BCE$ is isosceles, (base sides are equal in isosceles triangle) $BC = BE$

$\therefore \angle BEC = 60°$ (base angles are equal in isosceles triangle)

$120° = \angle CBE + \angle BEC$ (exterior angle of triangles equals sum of interior opposite angles)

$120° = \angle CBE + 60°$

$\angle CBE = 60°$

$\therefore \triangle BCE$ is equilateral (all angles are 60° is equilateral triangle)

(3) b) $y = 3x^{-5/3}$

$\frac{dy}{dx} = -5x^{-8/3}$

$= \frac{-5}{\sqrt[3]{x^8}}$

$\frac{d^2y}{dx^2} = -5 \cdot -\frac{8}{3} x^{-11/3}$

$= \frac{40}{3} x^{-11/3}$

$= \frac{40}{3\sqrt[3]{x^{11}}} = \frac{40}{3x^3\sqrt[3]{x^2}}$

c) $2x^2 + 3x - 4 = 0$

i) $\alpha + \beta = \frac{-b}{a}$

$= \frac{-3}{2}$

ii) $\alpha\beta = \frac{c}{a}$

$= \frac{-4}{2}$

$= -2$

iii) $(\alpha - 1)(\beta - 1)$

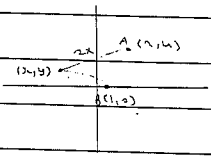
$= \alpha\beta - (\alpha + \beta) + 1$

$= -2 - (-\frac{3}{2}) + 1$

$= 1/2$

d) $A(2, 4)$

$B(1, 0)$



$4PB^2 = PA^2$

$2 \times \sqrt{(x_2 - x_1)^2 + (y_2 - x_1)}^2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$4[(x_2 - x_1)^2 + (y_2 - y_1)^2] = (x_2 - x_1)^2 + (y_2 - y_1)^2$

$4((x-1)^2 + (y-0)^2] = (x-2)^2 + (y-4)^2$

$4[x^2 - 2x + 1 + y^2] = x^2 - 4x + 4 + y^2 - 8y + 16$

$4x^2 - 8x + \cancel{4} + 4y^2 = \cancel{x^2} - \cancel{4x} + \cancel{4} + \cancel{y^2} - 8y + 16$

$3x^2 + 3y^2 - 4x + 8y - 16 = 0$

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c) $A = \int_0^4 x^{1/2}\,dx$

$= \left[\dfrac{x^{3/2}}{3/2}\right]_0^4$

$= \dfrac{4^{3/2}}{3/2} - \dfrac{0^{3/2}}{3/2}$

$= 5\tfrac{1}{3} - 0$

$= 5\tfrac{1}{3}$ units^2

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$y = x^3 - 3x^2$

Q4 a) i) $y' = 3x^2 - 6x$

$y'' = 6x - 6$

For stationary, $y' = 0$

$3x^2 - 6x = 0$ $\rightarrow 3x(x-2)$ $x = 0, 2$.

$3x^2 = 6x$

$x^2 = 2x$

$x = 2$

$x = 2$

test $x = 2$ into y''

$6(2) - 6$

$= 6$

> 0

$\therefore$ minimum

$\underline{x=2}$ $y = 2^3 - 3(2)^2$

$= -4$

~~(2, -4)~~ $(2, -4)$

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ii) ~~For turning pain~~

For points of inflexion, $y'' = 0$

$6x - 6 = 0$

$6x = 6$

$x = 1$

test $x = 1$

$y = 1^3 - 3(1)^2$

$= -2$

$(1, -2)$

x	0	1	2
y''	-6 <0	0	6 >0

x intercepts, $y = 0$

$0 = x^2(x-3)$

$= 0, 3$

y intercept, $x = 0$

~~$0 = x^3 - 3x^2$~~

$y = 0$

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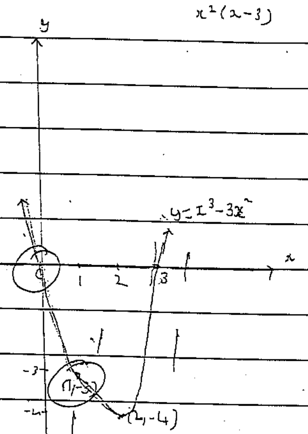
$x^2(x-3)$



Transcription Error
Be careful.

b) $4x^2 + 3kx + k^2 = 0$

i) $\Delta = b^2 - 4ac$

$= (3k)^2 - 4(4)(k^2)$

$= 9k^2 - 16k^2$

$= -7k^2$

ii) if $k > 0$, $\Delta < 0$

$\therefore$ the roots are unreal

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c) $2y = x^2 + 6x + 5$

$2y + 4 = (x+3)^2$

$2(y+2) = (x+3)^2$

$4(\frac{1}{2})(y+2) = (x+3)^2$

$V(-3, -2)$

$F(-3, -3/2)$

Directrix $y = -5/2$

when $y=0$

$4 = (x+3)^2$

$4 = x^2 + 6x + 9$

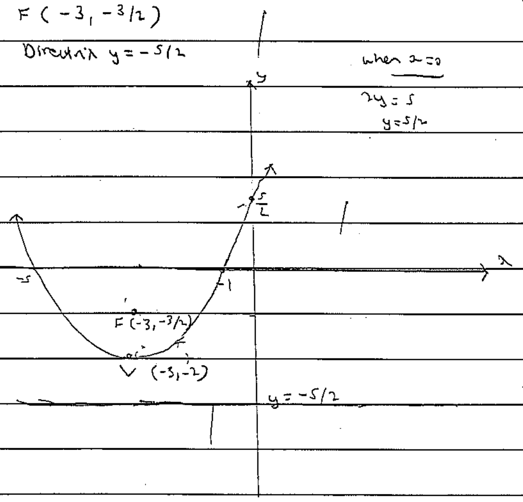
$x^2 + 6x + 5 = 0$

$(x+1)(x+5) = 0$

when $x = 0$

$2y = 5$

$y = 5/2$



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

$\frac{dy}{dx} = 0$, $(1, 4)$

$\frac{dy}{dx} = \int 12x - 2 \, dx$

$= \frac{\cancel{12}^{6} x^2}{2} - 2x + c$

$4 = 6(1)^2 - 2(1) + c$

$c = 0$

$\frac{dy}{dx} = 6x^2 - 2x$ → Failed to find c.

$y = \int 6x^2 - 2x \, dx$

$= \frac{\cancel{6}^{2} x^3}{3} - \frac{2x^2}{2} + c$

$= 2x^3 - x^2 + c$

$4 = 2(1)^3 - 1^2 + c$

$3 = c$

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

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Q5 a) i) ~~$T_6 = 6 + (6-1)2$~~

~~$= 6 + 10$~~

~~$= 16$~~

~~i) $T_{28} = 6 + 27(2)$~~

~~$= 60$~~

i) 30

~~ii) $T_n = 6 + (n-1)2$~~

iii) $S_n = \frac{n}{2}[2a + (n-1)d]$

$= \frac{18}{2}[2(6) + 17(2)]$

$= 9[12 + 34]$

$= 414$ cans

ii) $T_n = 6 + (n-1)2$

$6 + 2n - 2$

$4 + 2n$

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b) $x^4 - 13x^2 + 36 = 0$

let $x^2 = k$

$k^2 - 13k + 36 = 0$

$(k-4)(k-9) = 0$

$k = 4, 9$

$4 = x^2$ $\quad$ $9 = x^2$

$x = \pm 2$ $\quad$ $x = \pm 3$

$x = -2, 2, -3, 3$

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d) i) $y = \dfrac{1}{10 + x^2}$

i)

x	1	1.5	2	2.5	3
y	$1/11$	$4/49$	$1/14$	$4/65$	$1/19$

ii) $\frac{h}{3}\left[\text{first} + \text{last} + 4(\text{odd}) + 2(\text{even})\right]$

$= \frac{1/2}{3}\left[1/11 + 1/19 + 4(4/49 + 4/65) + 2(1/14)\right]$

$0.09 + 0.05 + 4(0.08 + 0.06) + 2(0.07)$

$= \frac{1}{6}\left[30/209 + 1824/3185 + 1/7\right]$

$= 0.1433180378$

$= 0.14$

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e) $S_\infty = \dfrac{a}{1-r}$

$= \dfrac{18}{1 - (3/2)}$ $2/3$ $= \dfrac{18}{1/3}$

$= 54$

$\cancel{ 36}$

(c) (i) Using pep. distance formula $d = \dfrac{|ax_1 + by_1 + c|}{\sqrt{a^2+b^2}}$

$\therefore$ rad $= \dfrac{|3(-4) - (2) + 4|}{\sqrt{3^2 + (-1)^2}}$

$= \dfrac{10}{\sqrt{10}} = \sqrt{10}$ units

(ii) Eq^n. of the circle is $(x+4)^2 + (y-2)^2 = (\sqrt{10})^2$

$(x+4)^2 + (y-2)^2 = 10.$

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Q6 a) i) $16 - 2x,\ 6 - 2x$

ii) $V = x(6-2x)(16-2x)$

$= x\left[96 - 12x - 32x + 4x^2\right]$

$= 96x - 12x^2 - 32x + 4x^3$

$= 4x^3 - 44x^2 + 96x$

iii) $V' = 12x^2 - 88x + 96$

$V'' = 24x - 88$

for maximum, $V' = 0$

$12x^2 - 88x + 96 = 0$

$4(3x^2 - 22x + 24) = 0$

$\cancel{(3x \quad x \quad) = 0}$

$3x^2 - 22x + 24 = 0$

$x = \dfrac{22 \pm \sqrt{484 - 4(3)(24)}}{6}$

$= \dfrac{22 \pm 14}{6}$

$= 6,\ 4/3$

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test $x = 6$ into V'' | test $x = 4/3$ into V''

$24(6) - 88$ | $24(4/3) - 88$

$= 56$ | $= -56$

> 0 | < 0

$\therefore$ minimum | $\therefore$ maximum

iii) $x = 4/3$

$V = 4(4/3)^3 - 44(4/3)^2 + 96(4/3) = 59\frac{7}{27}$

$= 9\ 13/27 - 78\ 2/9 + 128$ $\doteqdot 59.26$ (to 2dp).

$= 40\ 8/27$

$= 40.30$ cm^3

b) i) $A_1 = PR^1 - M$

$= 15000(1 + \frac{0.15}{12}) - M$

$= 15000 \times 1.0125 - M$

ii) $A_2 = (15000 \times 1.0125 - M)1.0125 - M$

$= 15000 \times 1.0125^2 - M \times 1.0125 - M$

$A_3 = (15000 \times 1.0125^2 - M \times 1.0125 - M) \times 1.0125 - M$

$= 15000(1.0125)^3 - M(1.0125^2) - M(1.0125) - M$

$= 15000(1.0125)^3 - M(1.0125^2 + 1.0125 + 1)$

iii) $0 = 15000 \times (1.0125)^{60} - M(1 + 1.0125 + 1.0125^2 + \dots + 1.0125^{59})$

$M\left[\frac{1.0125^{60} - 1}{0.0125}\right] = 15000 \times 1.0125^{60}$

$M = \frac{15000 \times 1.0125^{60} \times 0.0125}{1.0125^{60} - 1}$

$= \frac{395.097}{1.107}$

Don't round off until the end!

$= 356.908$

$= \$356.91$

iv) $356.91 \times 60 = \$21414.6$

~~Ein~~ $21414.6 - 15000$

c) $y = x^3$

$y^{1/3} = x$

$y^{2/3} = x^2$

$V = \pi \int_1^8 y^{2/3}\, dy$

$= \pi \left[\frac{y^{5/3}}{5/3}\right]_1^8 = \frac{3\pi}{5}\left[8^{5/3} - 1\right] = \frac{3\pi}{5}[32 - 1] = \frac{3\pi}{5} \times 31$

$= \frac{3\pi}{5}\left[10922^{2}/3 - 1/3\right] = \frac{93\pi}{5}$ units^3

$= \frac{3\pi}{5}\left[10922^{1}/3\right]$

$= 6553.4\pi$ units^3