International Grammar School

Year 12
Mathematics
Trial HSC Examination
2014

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Board-approved calculators may be used
- A table of standard integrals is provided on the back page of this question paper
- In Questions 11 - 16, show relevant mathematical reasoning and/or calculations

Total marks – 100

Section I

10 marks

- Attempt Questions 1 – 10
- Allow about 15 minutes for this section.

Section II

90 marks

- Attempt Questions 11-16
- Start each question in a new writing booklet
- Write your name on the front cover of each booklet to be handed in
- If you do not attempt a question, submit a blank booklet marked with your name and "N/A" on the front cover
- Allow about 2 hours 45 minutes for this section

DO NOT REMOVE THIS PAPER FROM THE EXAMINATION ROOM

STUDENT NUMBER/NAME: ....

STANDARD INTEGRALS

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

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

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

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

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

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

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

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

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

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

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

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

Section I

10 marks
Attempt Questions 1–10
Allow about 15 minutes for this section

Use the multiple-choice answer sheet for Questions 1–10.

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1 What is the primitive of $\frac{2}{x} - \cos x$?

(A) $-\frac{2}{x^2} + \sin x + C$

(B) $-\frac{2}{x^2} - \sin x + C$

(C) $2\ln x + \sin x + C$

(D) $2\ln x - \sin x + C$

2 What are the values of x for which $|4-3x| < 13$?

(A) $x < -3$ and $x < \frac{17}{3}$

(B) $x > -3$ and $x > \frac{17}{3}$

(C) $x > -3$ and $x < \frac{17}{3}$

(D) $x < -3$ and $x > \frac{17}{3}$

3 What is the simultaneous solution to the equations $2x + y = 7$ and $x - 2y = 1$?

(A) $x = 3$ and $y = 1$

(B) $x = -1$ and $y = 9$

(C) $x = 2$ and $y = 3$

(D) $x = 5$ and $y = 1$

4 Factorise $2x^2 - 7x - 15$

(A) $(2x-3)(x-5)$

(B) $(2x+3)(x-5)$

(C) $(2x-5)(x-3)$

(D) $(2x+5)(x-3)$

5 The value of $\frac{5.79+0.55}{\sqrt{4.32-3.28}}$ is closest to:

(A) 4

(B) 6

(C) 9

(D) 10

6 What are the values of p and q given $(3\sqrt{12}+\sqrt{75})(2+\sqrt{48}) = p + q\sqrt{3}$?

(A) $p = 132$ and $q = 15$

(B) $p = 396$ and $q = 15$

(C) $p = 132$ and $q = 22$

(D) $p = 396$ and $q = 22$

7 The line $6x - ky = 8$ passes through the point $(3,2)$. What is the value of k?

(A) -13

(B) -5

(C) 5

(D) 15

8 The semi-circle $y=\sqrt{4-x^2}$ is rotated about the x-axis. Which of the following expressions is correct for the volume of the solid of revolution?

(A) $V=\pi\int_0^2\left(4-x^2\right)dx$

(B) $V=2\pi\int_0^2\left(4-x^2\right)dx$

(C) $V=\pi\int_0^2\left(4-y^2\right)dy$

(D) $V=2\pi\int_0^2\left(4-y^2\right)dy$

9 A circle has the equation $4x^2-4x+4y^2+24y+21=0$. What is the radius and centre?

(A) Centre $\left(\frac{1}{2},-3\right)$ and radius of 2.

(B) Centre $\left(\frac{1}{2},3\right)$ and radius of 2.

(C) Centre $\left(\frac{1}{2},-3\right)$ and radius of 4.

(D) Centre $\left(\frac{1}{2},3\right)$ and radius of 4.

10 An infinite geometric series has a first term of 12 and a limiting sum of 15. What is the common ratio?

(A) $\frac{1}{5}$

(B) $\frac{1}{4}$

(C) $\frac{1}{3}$

(D) $\frac{1}{2}$

Section II

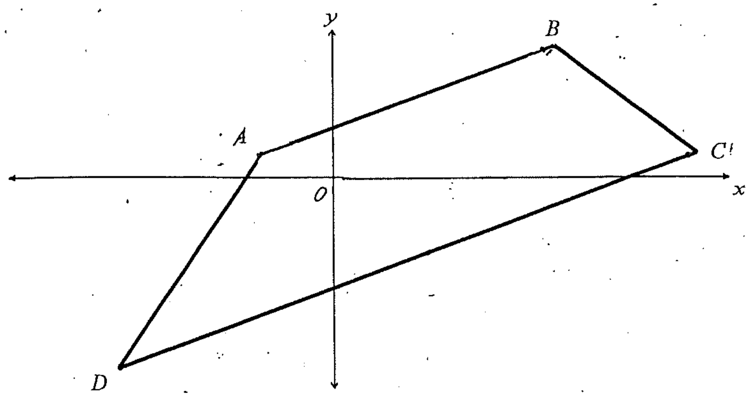
90 marks
Attempt Questions 11–16
Allow about 2 hours 45 minutes for this section

Answer each question in the appropriate writing booklet. Extra writing booklets are available.

In Questions 11–16, your responses should include relevant mathematical reasoning and/or calculations.

Question 11 (15 marks) **Marks**

(a) The diagram shows the points $A(-1,1)$, $B(3,6)$, $C(5,1)$ and $D(-3,-9)$.



(i) Find the coordinates of E, the midpoint of DC. 1

(ii) Show that the equation of BE is $5x-y-9=0$. 2

(iii) Find the perpendicular distance from A to the line BE. 2

(iv) Show that $ABED$ is a parallelogram. 2

(v) Find the area of $ABED$. 1

Question 11 continues over the page

(b) Find the equation of the tangent to the curve $y=\log_e x-1$ at the point $(e,0)$. 2

(c) The equation of a parabola is given by $y=x^2-2x+5$.

(i) Find the coordinates of its vertex. 2

(ii) State the focal length of the parabola. 1

(iii) Find the equation of the normal at the point $P(2,5)$. 2

End of Question 11

Marks

Question 12 (15 marks) Use a SEPARATE writing booklet

(a) There are 200 tickets sold in a raffle with only two prizes. These tickets are placed in a bag and two are drawn, one at a time. Once a ticket is drawn it is not placed back in the bag. One boy bought 3 tickets. calculate the probability the boy wins:

(i) First prize. 1

(ii) Both prizes. 1

(iii) The second prize only. 1

(iv) No prize at all. 1

(b) Differentiate with respect to x.

(i) $e^{3x}\tan x$ 2

(ii) $\dfrac{\sin x}{5-x}$ 2

(c) Evaluate

(i) $\displaystyle\int \frac{1}{1-2x}dx$ 2

(ii) $\displaystyle\int_0^{\pi} \sec^2\frac{x}{3}dx$ 2

(d) The roots of the equation $2x^2-x-15=0$ are α and β. Find the value of:

(i) $\alpha+\beta$ 1

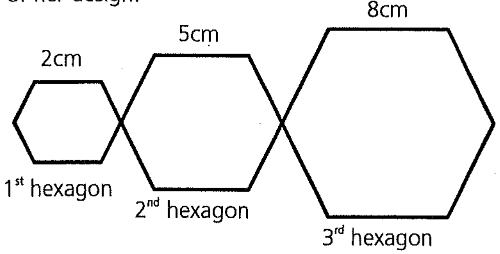
(ii) $\alpha\beta$ 1

(iii) $\dfrac{1}{\alpha}+\dfrac{1}{\beta}$

End of Question 12

Question 13 (15 marks) Use a SEPARATE writing booklet **Marks**

(a) Melanie is using wire to construct a geometrical design which consists of n regular hexagons with sides 2cm, 5cm, 8cm and so on going up by the same amount each hexagon. The diagram below shows the first 3 hexagons of her design.



(i) Find the perimeter of the nth hexagon. 1

(ii) Show that the total length of the wire is $L = 9n^2 + 3n$. 2

(iii) If the total length of the wire is 6 metres, find the number of hexagons that Melanie has constructed. 2

(b) Let $f(x) = x^3 - 3x^2 - 9x + 22$

(i) Show that $f''(x) = 6x - 6$ 1

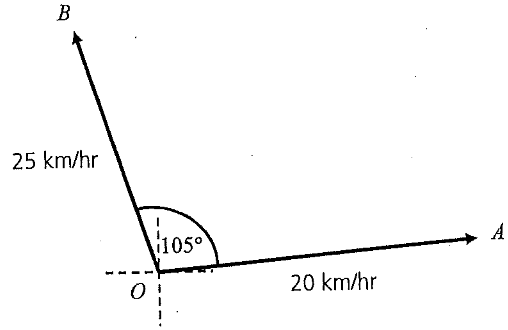
(ii) Find the coordinates of the stationary points on $y = f(x)$ and determine their nature. 2

(iii) Find the coordinates of the point(s) of inflexion. 2

(iv) Sketch the graph of $y = f(x)$, indicating where the curve meets the y-axis, stationary points and the point(s) of inflexion. 2

(v) For what values of x is the graph of $y = f(x)$ concave down? 1

(c) Alex and Bella leave from point O at the same time. Alex travels at 20km/h along a straight road in the direction 085°. Bella travels at 25km/h along another straight road in the direction 340°.

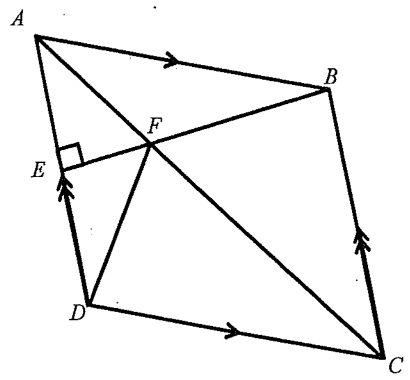


Find the distance Alex and Bella are apart to the nearest kilometre after two hours. 2

End of Question 13

Question 14 (15 marks) Use a SEPARATE writing booklet **Marks**

(a)



$ABCD$ is a rhombus, BE is perpendicular to AD and intersects AC at F.
Copy or trace the diagram into your writing booklet.

(i) Explain why $\angle BCA = \angle DCA$. 1

(ii) Prove that the triangles BFC and DFC are congruent. 3

(iii) Show that $\angle FBC$ is a right angle. 1

(iv) Hence, or otherwise, find the size of $\angle FDC$. 1

(b) A scientist grows the number of bacteria according to the equation

$$N(t) = Ae^{0.15t}$$

Where t is measured in days and A is a constant.

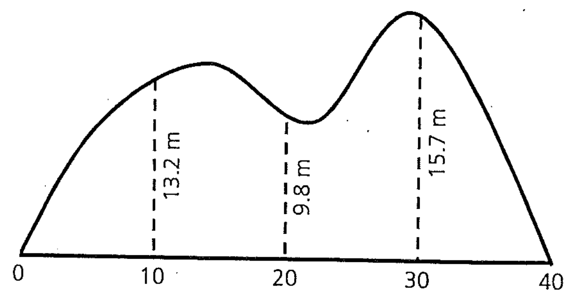
(i) Show that the number of bacteria increases at a rate proportional to the number present. 2

(ii) When $t = 3$ the number of bacteria was estimated at 1.5×10^8. Evaluate A. Answer correct to 2 significant figures. 1

(iii) [redacted] 2

Question 14 continues over the page

(c) During a survey the area of an irregular headland was to be found. Measurements of the area were noted on the diagram below.



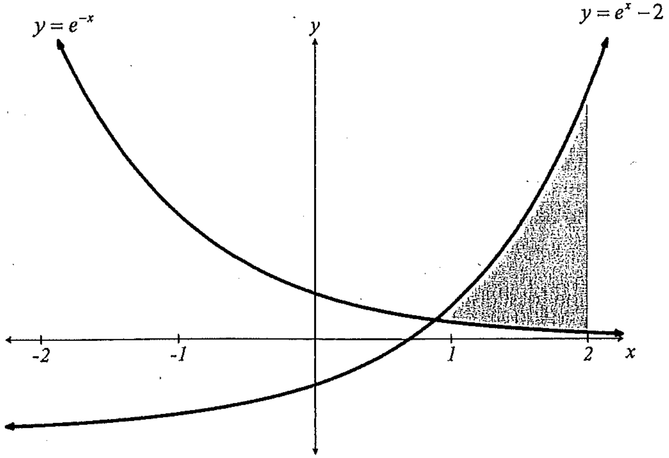
Use Simpson's rule with 5 function values to estimate the area of the headland. Answer correct to the nearest square metre. 2

(d) Solve the equation $(\cos x + 2)(2\cos x + 1) = 0$ in the domain $0 \le x \le 2\pi$. 2

End of Question 14

Question 15 (15 marks) Use a SEPARATE writing booklet **Marks**

(a)



The diagram shows the graphs of $y = e^x - 2$ and $y = e^{-x}$.

(i) Find the area between the curves from $x = 1$ to $x = 2$. Leave your answer in terms of e. 3

(ii) Show that the curves intersect when $e^{2x} - 2e^x - 1 = 0$. 2

(iii) Hence, using the substitution $u = e^x$, or otherwise, find the point of intersection of the curves. 2

(b) Velocity of an object moving along the x-axis is given by

$$v = 2\sin t + 1 \text{ for } 0 \le t \le 2\pi$$

Where v is measured in metres per second and t in seconds.

(i) When is the object at rest? 2

(ii) Sketch the graph of v as a function of t for $0 \le t \le 2\pi$ 2

(iii) Find the maximum velocity of the object for this period. 1

(iv) When is the object travelling in the negative direction during this period? 1

(v) Calculate the total distance travelled by the object in the period $0 \le t \le \pi$ 2

End of Question 15

Question 16 (15 marks) Use a SEPARATE writing booklet

Marks

(a) George is saving for a holiday. He opens a savings account with an interest rate of 0.4% per month compounded monthly at the end of each month. George decides to deposit \$450 into the account on the first day of each month. He makes his first deposit on the 1st of January 2012 and his last on the 1st of December 2014. George withdraws the entire amount, plus interest, immediately after his final interest payment on the 31st December 2014.

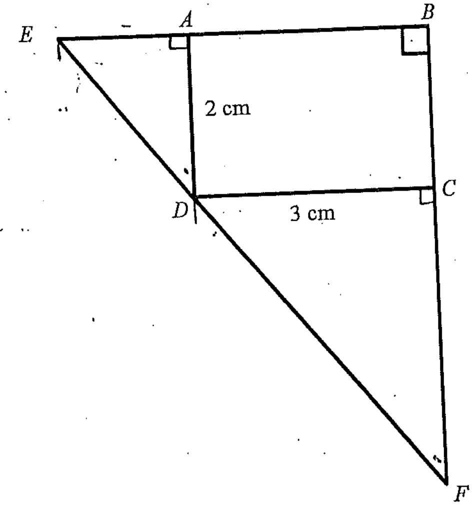
(i) How much in total did George deposit into his savings account over this period? **1**

(ii) How much did George withdraw from his account on the 31st December 2014? Answer correct to the nearest dollar. **3**

(iii) George's holiday is postponed due to family illness. He decides to deposit \$12 000 into a different account with an interest rate of 5% p.a. compounded quarterly for 2 years. How much will George receive at the end of the investment period from this \$12000 investment? Answer correct to the nearest dollar. **2**

Question 16 continues over the page

(b)



$ABCD$ is a rectangle with $CD = 3$ cm and $AD = 2$ cm. F and E lie on the lines BC and BA, so that, F, D and E are collinear. Let $CF = x$ cm and $AE = y$ cm.

(i) Show that ΔFCD and ΔDAE are similar.

(ii) Show that $xy = 6$

(iii) Show that the area (A) of ΔFBE is given by $A = 6 + \frac{3}{2}x + \frac{6}{x}$.

(iv) Find the height and base of ΔFBE with minimum area. Justify your answer.

End of Examination

2014 Year 12 Trial HSC Examination **Student Name:** ..Sols.......

Mathematics

Section I Multiple-Choice Answer Sheet

1	A ○	B ○	C ○	D ●
2	A ○	B ○	C ●	D ○
3	A ●	B ○	C ○	D ○
4	A ○	B ●	C ○	D ○
5	A ○	B ●	C ○	D ○
6	A ○	B ○	C ●	D ○
7	A ○	B ○	C ●	D ○
8	A ○	B ●	C ○	D ○
9	A ●	B ○	C ○	D ○
10	A ●	B ○	C ○	D ○

Year 12 2U Trial HSC 2014

1) $\int \frac{2}{x} - \cos x \, dx = 2\ln x - \sin x + c$. $\boxed{D}$

2) $|4-3x| < 13$

$4-3x < 13$
$-9 < 3x$
$x > -3$

$4-3x > -13$
$17 > 3x$
$x < \frac{17}{3}$

$\boxed{C}$

3) $2x+y=7$ ... (1)
$x-2y=1$ ... (2)

(1) $4x+2y=14$
$x-2y=1$

$5x = 15$
$x=3$
$y=1$

$\boxed{A}$

4) $2x^2-7x-15 = (2x+3)(x-5)$ $\boxed{B}$

5) $\boxed{B}$

6) $(3\sqrt{12}+\sqrt{75})(2+\sqrt{48}) = (6\sqrt{3}+5\sqrt{3})(2+4\sqrt{3})$
$= 11\sqrt{3}(2+4\sqrt{3})$
$= 22\sqrt{3}+132$.

$p=132$
$q=22$.

$\boxed{C}$

7) $6(3) - 2k = 8$

$2k = 10$
$k = 5$ $\boxed{C}$

8) $V = 2\pi \int_0^2 4 - x^2 \, dx$ $\boxed{B}$

9) $4x^2 - 4x + 4y^2 + 24y = -21$

$x^2 - x + y^2 + 6y = -\frac{21}{4}$

$x^2 - x + \frac{1}{4} + y^2 + 6y + 9 = -\frac{21}{4} + \frac{1}{4} + 9$

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

$(\frac{1}{2}, -3)$ $R = 2$ $\boxed{A}$

10) $a = 12$
$S_n = 15$

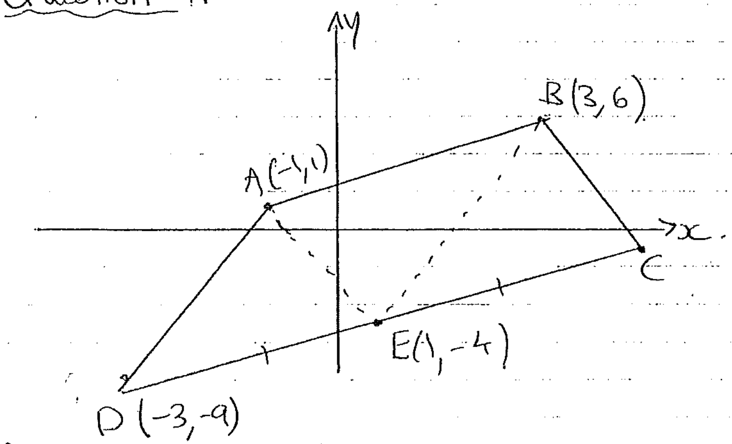
$15 = \frac{12}{1-r}$

$1 - r = \frac{12}{15}$

$r = 1 - \frac{4}{5}$

$= \frac{1}{5}$ $\boxed{A}$

Question 11



i) $E\left(\frac{5-3}{2}, \frac{1-9}{2}\right)$

$E(1, -4)$

ii) $m_{BE} = \frac{6+4}{3-1}$
$= 5$

$y + 4 = 5(x - 1)$

$y + 4 = 5x - 5$

$5x - y - 9 = 0$

iii) $M_{AE}\left(\frac{-1+1}{2}, \frac{1-4}{2}\right)$ $M_{BD}\left(\frac{3-3}{2}, \frac{6-9}{2}\right)$

$M_{AE}\left(0, \frac{-3}{2}\right)$ $M_{BD}\left(0, \frac{-3}{2}\right)$

$\therefore$ ABED is a parallelogram (Diagonals bisect each other)

ii) $A(-1,1)$

$d = \frac{|5(-1) - (1) - 9|}{\sqrt{5^2 + 1^2}}$

$= \frac{15}{\sqrt{26}}$

) $BE = \sqrt{(3-1)^2 + (6+4)^2}$

$= \sqrt{104}$

$= 2\sqrt{26}$

$A = 2\sqrt{26} \times \frac{15}{\sqrt{26}}$

$= 30 \ u^2$

) $y = \ln x - 1$

$y' = \frac{1}{x}$

@ $x = e$, $y' = ?$

$y' = \frac{1}{e}$

~~$m_N = -e$~~

$y - 0 = \frac{1}{e}(x - e)$

$y = \frac{x}{e} - 1$ OR $x - ey - e = 0$

c i) $y - 5 = x^2 - 2x$

$y - 5 + 1 = x^2 - 2x + 1$

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

V: $(1, 4)$

ii) $a = \frac{1}{4}$

iii) $y' = 2x - 2$

@ $x = 2$,

$y' = 2$

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

$y - 5 = -\frac{1}{2}(x - 2)$

$2y - 10 = -x + 2$

$x + 2y - 12 = 0$

or $y = 6 - \frac{x}{2}$

(6)

Question 12

ii) $P(1st) = \frac{3}{200}$ ✓

i) $P(1st + 2nd) = \frac{3}{200} \times \frac{2}{199}$ ✓

$= \frac{3}{19900}$

i) $P(2nd) = \frac{197}{200} \times \frac{3}{199}$ ✓

$= \frac{591}{39800}$

i) $P(none) = \frac{197}{200} \times \frac{196}{199}$ ✓

$= \frac{9653}{9950}$

bi) $\frac{d}{dx}(e^{3x}\tan x) = 3e^{3x}\tan x + e^{3x}.\sec^2 x$ ✓✓

$= e^{3x}(3\tan x + \sec^2 x)$

i) $\frac{d}{dx}\left(\frac{\sin x}{5-x}\right) = \frac{\cos x(5-x) - \sin x.(-1)}{(5-x)^2}$

$= \frac{5\cos x - x\cos x + \sin x}{(5-x)^2}$ ✓✓

(7)

ci) $\int \frac{1}{1-2x}\,dx = -\frac{1}{2}\ln(1-2x) + C$ ✓✓

ii) $\int_0^{\pi} \sec^2 \frac{x}{3}\,dx = \left[3\tan\frac{x}{3}\right]_0^{\pi}$ ✓

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

$= 3\sqrt{3}$ ✓

di) $\alpha + \beta = \frac{1}{2}$ ✓

ii) $\alpha\beta = -\frac{15}{2}$ ✓

iii) $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha+\beta}{\alpha\beta}$

$= \frac{\frac{1}{2}}{\frac{-15}{2}}$

$= -\frac{1}{15}$

8

Question 13

i) $P = 6(2+(n-1)\times 3)$

$= 6(2+3n-3)$

$= 18n-6$ ✓

ii) $S_n = \frac{n}{2}(18n-6+2\times 6)$ ✓

$= \frac{n}{2}(18n+6)$

$= 9n^2+3n$ ✓

iii) $600 = 9n^2+3n$

$3n^2+n-200=0$

$(3n+25)(n-8)=0$

$n = -\frac{25}{3}, 8$

$n=8$

i) $f'(x) = 3x^2-6x-9$ ✓

$f''(x) = 6x-6$

ii) Stat pts @ $f'(x)=0$

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

$(x-3)(x+1)=0$

$x = 3, -1$

9

@ $x=-1$, $y=27$

$y'' = -6-6$

$= -12$

$\therefore (-1, 27)$ is a max t.p. ✓

@ $x=3$, $y=-5$

$y'' = 18-6$

$=12$

$\therefore (3,-5)$ is a min t.p. $(3,-12)$ ✓

iii) POI @ $y''=0$

$0 = 6x-6$

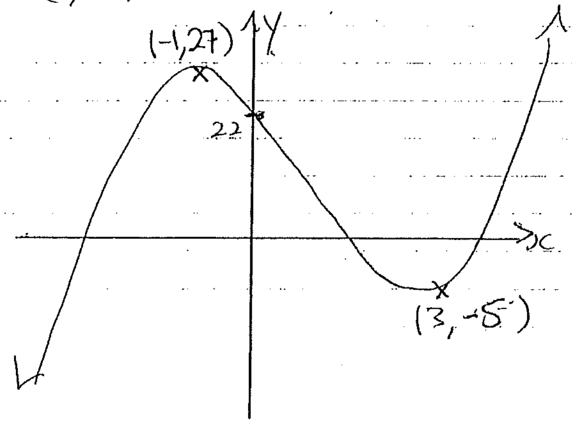
$x=1$ ✓

Check

x	0	1	2
y''	$-$	0	$+$

$\therefore (1, 11)$ is a POI ✓

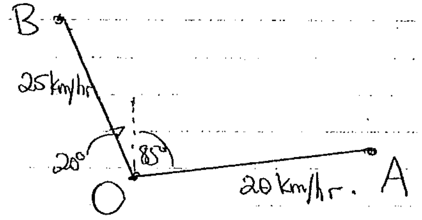
iv)



✓✓

) $x < 1$ ✓

3)



$\angle AOB = 20 + 85$
$= 105°$

AO = 40 km
BO = 50 km

$AB^2 = 40^2 + 50^2 - 2 \times 40 \times 50 \times \cos 105°$ ✓

$= 5135.28\ldots$

$AB = \underline{72 \text{ km}}$ ✓

Question 14

ai) Diagonals in a rhombus bisect the angles they pass through. ✓

ii) FC is common.

$\angle BCA = \angle DCA$ (given (i)) ✓

$BC = DC$ (equal sides in a rhombus) ✓

$\therefore \Delta BFC \equiv \Delta DFC$ (SAS) ✓

iii) $\angle FBC = 90°$ (alt $\angle$'s on $\parallel$ lines) ✓

v) $\angle FDC = 90°$ (corres $\angle$'s in Congruent Δ's) ✓

bi) $N(t) = Ae^{0.15t}$

$\frac{dN}{dt} = 0.15 . Ae^{0.15t}$ ✓

$= 0.15N$

$\therefore \frac{dN}{dt} \propto N$ ✓

ii) @ $t=3$, $N = 1.5 \times 10^8$

$1.5 \times 10^8 = Ae^{0.45}$

$A = \frac{1.5 \times 10^8}{e^{0.45}}$

$= \underline{9.6 \times 10^7}$ bacteria ✓

OR 96,000000

ii) $N = 2$.

$2 = e^{0.15t}$ ✓

$\ln 2 = 0.15t$

$t = \frac{\ln 2}{0.15}$

$= 4.62$

$= 4.6$ days ✓

i)

x	0	10	20	30	40
y	0	13.2	9.8	15.7	0
w	1	4	2	4	1
yw	0	52.8	19.6	62.8	0

$A \doteqdot \frac{10}{3}(52.8 + 19.6 + 62.8)$ ✓

$\doteqdot 450.7$

$\doteqdot 451 \text{ m}^2$ ✓

i) $(\cos x + 2)(2\cos x + 1) = 0$

$\cos x = -2, -\frac{1}{2}$ ✓ $\cos x \neq -2$

$\therefore x = \frac{2\pi}{3}, \frac{4\pi}{3}$

✓

Question 15

a i) $A = \int_1^2 e^x - 2 - e^{-x}\,dx$ ✓

$= \left[e^x - 2x + e^{-x}\right]_1^2$ ✓

$= (e^2 - 4 + e^{-2}) - (e - 2 + e^{-1})$

$= e^2 - e - 2 - e^{-1} + e^{-2}$ ✓

ii) $y = e^x - 2$

$y = e^{-x}$

$e^x - 2 = e^{-x}$

$e^x - 2 = \frac{1}{e^x}$ ✓

$e^{2x} - 2e^x = 1$

$e^{2x} - 2e^x - 1 = 0$ ✓

iii)

$u^2 - 2u - 1 = 0$

$u = \frac{2 \pm \sqrt{4+4}}{2}$

$= 1 \pm \sqrt{2}$

$e^x = 1 + \sqrt{2}$ ✓

$x = \ln(1+\sqrt{2})$ or $\doteqdot 0.881$ ✓ $\therefore y = 0.414$

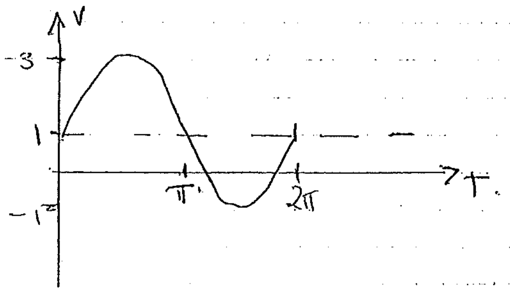
i) @ $v=0, t=?$

$0 = 2\sin t + 1$

$\sin t = -\frac{1}{2}$

$t = \frac{7\pi}{6}, \frac{11\pi}{6}$ s. ✓✓

)



ii) $v = 3$ ✓

i) $\frac{7\pi}{6} < t < \frac{11\pi}{6}$

) $d = \int_0^{\pi} 2\sin t + 1 \, dt$ ✓

$= \left[t - 2\cos t\right]_0^{\pi}$

$= (\pi - 2\cos\pi) - (0 - 2\cos 0)$

$= \pi + 2 + 2$

$= \underline{\underline{\pi + 4}}$ ✓

Question 16

ai) $r = 0.004$

$A = 450 \times 36$

$= \cancel{\$10800}\ \$16\,200$ ✓

ii) $A_1 = 450 \times 1.004^{36}$

$A_2 = 450 \times 1.004^{35}$

⋮

$A_{36} = 450 \times 1.004$

✓

$\text{Total} = 450(1.004 + 1.004^2 + \ldots + 1.004^{36})$

$= 450 \times \frac{1.004(1.004^{36} - 1)}{0.004}$ ✓

$= \$17\,456.70$

$= \$17\,\underline{\underline{457}}$ ✓

iii) $r = 0.05 \div 4$

$= 0.0125$

$A = 12000(1.0125)^8$ ✓ ?

$= 13253.83$

$= \underline{\underline{\$13254}}$ ✓

16

ii) $\angle FCD = \angle DAE = 90^\circ$ ($\angle$'s on a straight line)

Let $\angle FDC = x$

$\angle ADE = 180 - 90 - x$
$= 90 - x$ ($\angle$'s ") ✓

$\angle AED = 180 - 90 - (90 - x)$
$= x$ ($\angle$ sum of Δ) ✓

$\therefore \angle FDC = \angle AED$

$\therefore \Delta FCD \,|||\, \Delta DAE$ (equiangular) ✓

) $\frac{CE}{AD} = \frac{CD}{AE}$

$\frac{x}{2} = \frac{3}{y}$

$\therefore xy = 6$ ✓ $y = \frac{6}{x}$ ✓

i) $A = \frac{1}{2}(BF) \times (BE)$

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

$= \frac{1}{2}(xy + 3x + 2y + 6)$ ✓

$= \frac{1}{2}\left(x \cdot \frac{6}{x} + 3x + 2 \cdot \frac{6}{x} + 6\right)$

$= \frac{1}{2}\left(6 + 3x + \frac{12}{x} + 6\right)$ ✓

$= \frac{1}{2}\left(12 + 3x + \frac{12}{x}\right)$

$A = 6 + \frac{3}{2}x + \frac{6}{x}$

iv) $\frac{dA}{dx} = \frac{3}{2} - \frac{6}{x^2}$

Stat pts @ $\frac{dA}{dx} = 0$

$0 = \frac{3}{2} - \frac{6}{x^2}$

$\frac{6}{x^2} = \frac{3}{2}$

$12 = 3x^2$

$x^2 = 4$

$x = 2$ ✓ $x > 0$

$\therefore y = 3$

$\boxed{\text{Height is 4 cm} \quad \text{Base is 6 cm}}$ ✓

$\frac{d^2A}{dx^2} = \frac{12}{x^3}$

$x = 2 \quad \frac{d^2A}{dx^2} > 0 \therefore \text{min}$ ✓