Student Name/ Number: ....

2006

YEAR 12

TRIAL HIGHERSCHOOL CERTIFICATE EXAMINATION

MATHEMATICS EXTENSION 1

General Instructions

- Reading Time – 5 minutes
- Working Time – 2 hours
- Write using blue or black pen
- Board-approved calculators may be used
- A table of standard integrals is provided at the back of this paper.
- All necessary working should be shown in every question

Total marks - 84

- Attempt Questions 1-7
- All questions are of equal value.

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Begin each question on a NEW SHEET of paper, writing your name and question number at the top of the page.

QUESTION 1 (12 MARKS) Begin a NEW sheet of writing paper. **Marks**

a) Solve $\dfrac{x}{x^2-4} < 0$ **2**

b) For what values of x is $3^{2x} - (1+\sqrt{3}) \times 3^x + \sqrt{3} = 0$? **2**

c) Write the general solution to $\sqrt{3}\tan\theta - 1 = 0$ in exact radian form **2**

d) Find $\int \sec^2 x.\tan^2 x dx$ using the substitution $u = \tan x$ **2**

e) Calculate the acute angle between the lines $2x\text{-}y\text{-}1 = 0$ and $x\text{-}2y + 1 = 0$ Give your answer to the nearest degree. **2**

f) A parabola has the parametric equation $x = \sin\theta, y = \cos 2\theta$
What is the cartesian equation of this parabola? **2**

QUESTION 2 (12 MARKS) Begin a NEW sheet of writing paper. **Marks**

a) With reference to the table of standard integrals find **2**

$$\int \frac{\tan 2x}{\cos 2x} dx$$

b) A particle is moving along the x axis. Its velocity V at position x is given by $V = \sqrt{8x - x^2}$. Find the acceleration when $x = 3$ **2**

c) On the same axes sketch the graphs of $y - 2x = 0$ and $y = -\cos x$ for $-\pi \le x \le \pi$. Use the graph to deduce the number of solutions to $2x + \cos x = 0$ **2**

d) Find the coordinates of the point which divides the interval joining (3, -2) and (-5, 4) *externally* in the ratio 5:2 **2**

e) $(x - k)$ is a factor of $x^2 - 5x + (2k + 2)$. Find the value(s) of k. **2**

f) The equation $2x^3 + 12x^2 + 6x - 20 = 0$ has roots $\alpha - d, \alpha$ and $\alpha + d$.

i) Find the value of α **1**

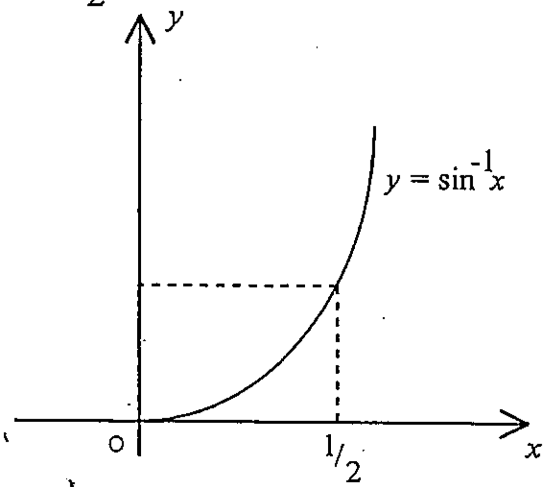
ii) Find a value of d. **1**

QUESTION 3 **(12 MARKS)** Begin a NEW sheet of writing paper. **Marks**

a) i) Show that $x^3 + x^2 + x - 8 = 0$ has a root between $x = 1$ and $x = 2$. **1**

ii) Starting with $x = 2$ as the first approximation to the root of $x^3 + x^2 + x - 8 = 0$, use one application of Newton's method to find a better approximation to the root. **2**

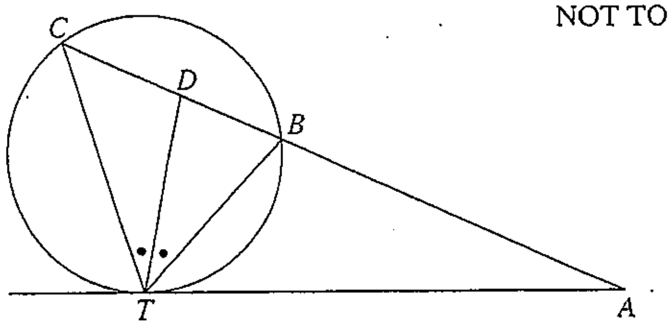
b) Find the exact area bounded by the curve $y = \sin^{-1} x$, the x axis and the ordinate $x = \frac{1}{2}$, as shown in the diagram **3**



c) Differentiate $(x^2 + 2x + 2)e^{-x}$ and hence evaluate $\int_1^2 x^2 e^{-x}\,dx$ to 3 decimal places. **3**

d) TA is a tangent to a circle. Line ABCD intersects the circle at B and C. Line TD bisects < BTC. Prove AT=AD **3**

NOT TO SCALE



QUESTION 4 (12 MARKS) Begin a NEW sheet of writing paper. **Marks**

a) $P(2ap, ap^2)$ is a point on the parabola $x^2 = 4ay$

i. Show the equation of the normal at P is $x + py = 2ap + ap^3$ **2**

ii. This normal cuts the y-axis at R. State the coordinates of R. **1**

iii. From P, a line PT is drawn perpendicular to the directrix, meeting it at T. State the coordinates of T. **1**

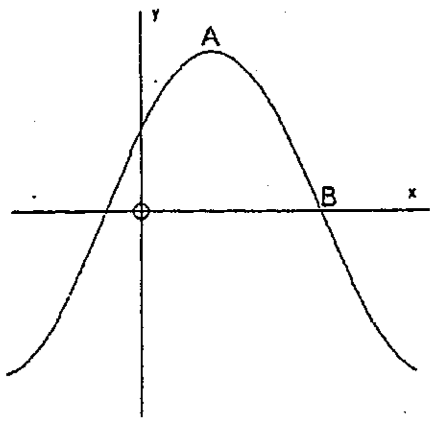
iv. If M is the midpoint of RT, find the coordinates of M. **1**

v. Find the locus of M and show that it is a parabola with vertex at the focus of the original parabola. **2**

b)

i) Express $\sqrt{3}\sin x + \cos x$ in the form $R\sin(x + \alpha)$, R>0 , $0<\alpha<\frac{\pi}{2}$ **2**

ii) The graph of $y = \sqrt{3}\sin x + \cos x$ is shown here. Find the coordinates of A and B if A is a maximum turning point and B is where the curve cuts the x axis **3**



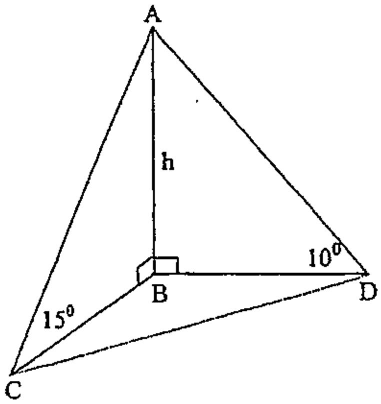
QUESTION 5 **(12 MARKS)** Begin a NEW sheet of writing paper **Marks**

a) A B represents Kincumber mountain, height h metres. From points C and D in the same plane as the base of the mountain, the angles of elevation of the top of the mountain (A) are 15° and 10° respectively. From the base of the mountain, the bearings of the points C and D are 230° and 100° respectively.

i) Find the size of angle CBD **1**

ii) Show $BD = h\cot 10^\circ$ **1**

iii) If CD is 450 metres find the height of the mountain **3**



b) i) Prove that $\dfrac{d}{dx}\left(\dfrac{x}{\sqrt{1-x^2}}\right) = \dfrac{1}{\left(1-x^2\right)^{\frac{3}{2}}}$ **2**

ii) Hence find the derivative of $\tan^{-1}\left(\dfrac{x}{\sqrt{1-x^2}}\right)$ **2**

iii) What restrictions are there on x **1**

iv) By considering a right angled triangle with a 1 unit hypotenuse show that $\tan^{-1}\left(\dfrac{x}{\sqrt{1-x^2}}\right) = \sin^{-1} x$ for the domain $0 < x < 1$ **2**

Marks

QUESTION 6 (12 MARKS) Begin a NEW sheet of writing paper.

a) i) If $f(x)=2-\sqrt{x}, x \geq 0$ and $g(x)=(x-2)^2$ for all x find the values of x for which $f[g(x)]=x=g[f(x)]$ **2**

ii) Find $f^{-1}(x)$ giving its domain. **1**

b) Use mathematical induction to prove that for all positive integers $n \geq 1$ **4**

$$1^2+3^2+5^2+\ldots.+(2n-1)^2=\frac{1}{3}n(2n-1)(2n+1)$$

c) A particle is moving in a straight line with Simple Harmonic Motion. At time t seconds it has displacement x metres from a fixed point O, velocity v *m/s* and its acceleration a ms^{-2} is given by $a=-4x+4$
Initially the particle is 2m to the right of O and moving away from O with speed $2\sqrt{3}ms^{-1}$

i) Use integration to show $v^2=-4x^2+8x+12$ **2**

ii) Hence find the centre of the motion **1**

iii) If $x=1+2\cos(2t+\alpha)$ for $0<\alpha<2\pi$ find the exact value of α. **2**

QUESTION 7 (12 MARKS) Begin a NEW sheet of writing paper. Marks

a) Whilst playing in the US Open Tennis Andre Agassi can serve a ball from the height of 1.8 metres. He hits the ball in a horizontal direction at a speed of 35m/s.

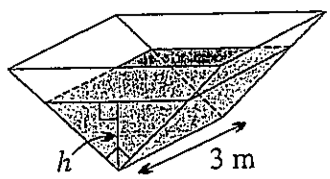
i) Using $g = 10ms^{-2}$, derive expressions for the horizontal displacement x metres and the vertical displacement y metres, of the tennis ball after time t seconds of being hit. **2**

ii) Find how long before the ball hits the ground. **1**

iii) Find how far the ball will travel before bouncing. **1**

iv) By how much will the ball clear the net which is 0.95 metres high and 14 metres away from the service line. **2**

b) Due to council water restrictions a new tank in the shape of an isosceles triangular prism was installed. The tank was 3 metres long. A hose was used to fill the tank at a constant rate of 2 *litres* /second. The depth of water was h cm at time t seconds



i) Find an expression for the volume of water in the tank (in cm^3 /second.) The depth of water is h cm **1**

ii) Find the rate at which the depth of the water is changing when h =20 cm **2**

QUESTION 7 CONTINUED

c) A can of soft drink has an initial temperature of $18°C$. To chill it Kim places it in her freezer that has a constant temperature of $-19^{\circ}C$. The cooling rate of the soft drink is proportional to the difference between the temperature of the freezer and the temperature of the soft drink, T. that is $T = -19 + Ae^{-kt}$

i) Find the value of A. **1**

ii) After 5 minutes in the freezer the temperature of the drink is $3°C$. Find the time it will take for the drink to reach a freezing temperature of 0° **2**

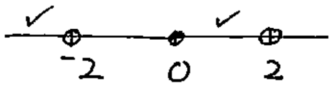
END OF EXAMINATION

EXT 1 2006 TRIAL. GHS.

QUESTION 1.

a) $\dfrac{x}{x^2-4} < 0$ c.p $x \neq \pm 2$.

solve $x = 0$



test $x=1$

$\dfrac{1}{-3} \leq 0$ true

test $x=-3$

$\dfrac{-3}{5} \leq 0$ true

$\underline{\underline{x < -2}}$ $\underline{\underline{0 < x < 2}}$

b) let $m = 3^x$

$m^2 - (1+\sqrt{3})m + \sqrt{3} = 0$

$(m - \sqrt{3})(m-1) = 0$

$m = \sqrt{3}$ $m = 1$

but $3^x = m$

$3^x = \sqrt{3}$ $3^x = 1$

$\underline{\underline{x = \frac{1}{2}}}$ $\underline{\underline{x = 0}}$

c) $\sqrt{3} \tan\theta = 1$

$\tan\theta = \dfrac{1}{\sqrt{3}}$

$\theta = n\pi + \alpha$ in radians

$\theta = n\pi + \dfrac{\pi}{6}$

d) $\int u^2 \, du$

$= \dfrac{u^3}{3} + c$

$= \dfrac{1}{3}\tan^3 x + c$

$u = \tan x$

$\dfrac{du}{dx} = \sec^2 x$.

$du = \sec^2 x \, dx$.

e) $2x - 1 = y$

$m_1 = 2$

$x + 1 = 2y$

$\frac{1}{2}x + \frac{1}{2} = y$

$m_2 = \frac{1}{2}$

$\tan\theta = \left| \dfrac{m_1 - m_2}{1 + m_1 m_2} \right|$

$= \left| \dfrac{2 - \frac{1}{2}}{1 + 2 \times \frac{1}{2}} \right|$

$= \left| \dfrac{1\frac{1}{2}}{2} \right|$

$\theta = 37°$

f) $x = \sin\theta$

$y = \cos 2\theta$

$= 1 - 2\sin^2\theta$

$= 1 - 2x^2$

answer $y = 1 - 2x^2$.

QUESTION 2.

a)
$$\int \frac{\tan 2x}{\cos 2x}\,dx = \int \sec 2x \tan 2x$$
$$= \frac{1}{2}\sec 2x + c$$

b) $v^2 = 8x - x^2$

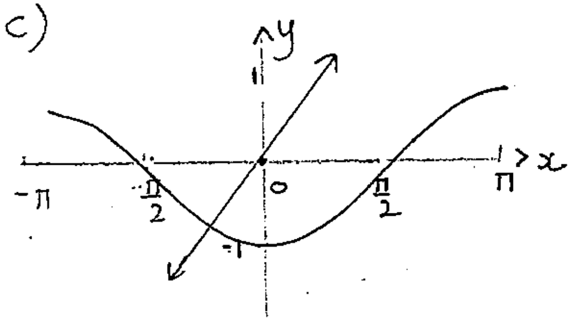
$\frac{1}{2}v^2 = 4x - \frac{x^2}{2}$

$\frac{d}{dx}\left(\frac{1}{2}v^2\right) = 4 - x$

at $x = 3$ $\quad \ddot{x} = 4 - 3$

$= 1\ m/s^2$

c)



$y = 2x$

from graph <u>one</u> solution

d) $(3,-2)$ $(-5,4)$

$5 : -2$

$x = \frac{6-25}{3}$ $\quad y = \frac{4-20}{3}$ $\quad \Rightarrow x = \frac{-19}{3}$ $\quad y = \frac{-16}{3}$

e) $f(x) = x^2 - 5x + (2k+2)$

$f(k) = k^2 - 5k + 2k + 2 = 0$

$k^2 - 3k + 2 = 0$

$(k-2)(k-1) = 0$ $\quad k = 2$ or $k = 1$.

f) $\alpha + \beta + \gamma = -\frac{b}{a}$ $\qquad \alpha\beta\gamma = \frac{-d}{a}$

$a - d + a + a + d = -6$ $\qquad (a-d)(a)(a+d) = 10$

$3a = -6$ $\qquad (-2-d)\times -2(-2+d) = 10$

$a = -2.$ $\qquad -8 + 2d^2 = 10$

$2d^2 = 18$

$d^2 = 9$

$d = \pm 3$

QUESTION 3.

a) $f(x) = x^3 + x^2 + x - 8$

$f(1) = -5$

$f(2) = 8 + 4 + 2 - 8$
$= 6$

$f(1)$ and $f(2)$ have opposite signs and $f(x)$ is continuous

$\therefore$ a root exists between 1 & 2

ii) approx $= x_1 - \dfrac{f(x_1)}{f'(x_1)}$

$f'(x) = 3x^2 + 2x + 1$

$f'(2) = 12 + 4 + 1$
$= 17$

$= 2 - \dfrac{6}{17}$

$= \underline{1 \cdot 647}$

b) $y = \sin^{-1} x$ $\quad x = \frac{1}{2}$, $y = \frac{\pi}{6}$ $\quad x = 0$, $y = 0$

Area = rectangle − area to y axis

$= \frac{1}{2} \times \frac{\pi}{6} - \int_0^{\frac{\pi}{6}} \sin y \, dy$

$= \frac{\pi}{12} - \left[-\cos y \right]_0^{\frac{\pi}{6}}$

$= \frac{\pi}{12} + \cos \frac{\pi}{6} - \cos 0$

$= \frac{\pi}{12} + \frac{\sqrt{3}}{2} - 1$

c)) $\frac{d}{dx}\left[\left(x^2 + 2x + 2 \right) e^{-x} \right]$

$= (2x+2) \cdot e^{-x} - e^{-x}(x^2 + 2x + 2)$

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

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

$\int_1^2 x^2 e^{-x} \, dx = \left[-\left(x^2 + 2x + 2 \right) e^{-x} \right]_1^2$

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

$= -10e^{-2} + 5e^{-1}$

$= 0 \cdot 486$

d) Let $\angle DTB = \beta$

$\angle BTA = \angle TCB$ ($\angle$ in alternate segment) $=$

$\angle TDA$ is exterior $\angle$ of $\triangle TCD$

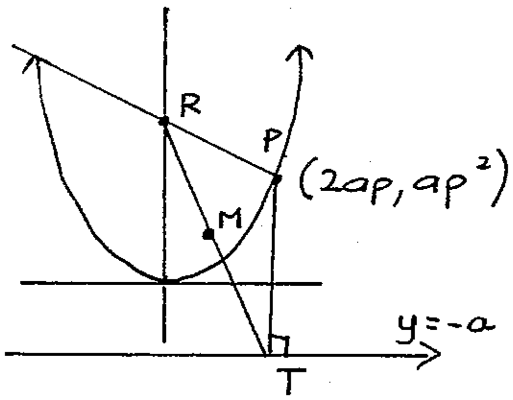
$\therefore \angle TDA = \alpha + \beta$

similarly $\angle DTA = \alpha + \beta$

$\therefore \triangle ADT$ is isosceles $\triangle$ (equal base $\angle$'s

$\therefore AT = AD$

QUESTION . 4



i) $y = \frac{x^2}{4a}$

$\frac{dy}{dx} = \frac{2x}{4a}$ at $x = 2ap$

$m = p$

normal $m = \frac{-1}{p}$

$y - ap^2 = \frac{-1}{p}(x - 2ap)$

$py - ap^3 = -x + 2ap$

$x + py = 2ap + ap^3$

ii) y axis $x=0$ $py = 2ap + ap^3$

$(0, 2a + ap^2) = R.$

iii) T directrix $y = -a$

$T(2ap, -a)$

iv) $R(0, 2a+ap^2)$ $T(2ap, -a)$

$M = \left(ap, \frac{a+ap^2}{2}\right)$

v) $x = ap$ $y = \frac{a}{2} + \frac{ap^2}{2}$

$p = \frac{x}{a}$

$y = \frac{a}{2} + \left(\frac{x}{a}\right)^2 \cdot \frac{a}{2}$

$y = \frac{a^2 + x^2}{2a}$

$2ay - a^2 = x^2$

$2a\left(y - \frac{a}{2}\right) = x^2 \Rightarrow$ vertex $\left(0, \frac{a}{2}\right)$.

b) $\sqrt{3}\sin x + \cos x = R\sin(x + \alpha)$

(1 mark R)

$R = 2$

$\frac{\sqrt{3}}{2}\sin x + \frac{1}{2}\cos x = \sin x \cos\alpha + \cos x \sin\alpha$

$\cos\alpha = \frac{\sqrt{3}}{2} \Rightarrow \alpha = \frac{\pi}{6}$ (1 mark α,

$\therefore \sqrt{3}\sin x + \cos x = 2\sin\left(x + \frac{\pi}{6}\right)$

ii) $A = \left(\frac{\pi}{2} - \frac{\pi}{6}, 2\right)$ (1 mark each for x and y

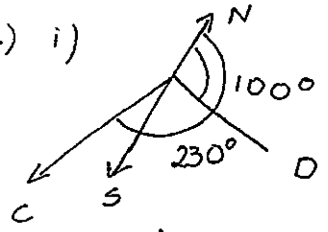
$= \left(\frac{\pi}{3}, 2\right)$

$B = \pi - \frac{\pi}{6}$ (1 mark for $B = \frac{5\pi}{6}$

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

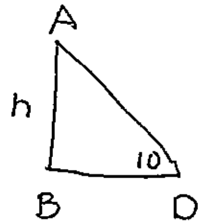
QUESTION 5

a) i)



$\angle CBD = 130°$ (1)

ii)

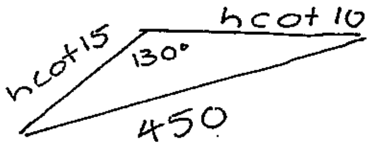


$\tan 10° = \dfrac{h}{BD}$

$BD = \dfrac{h}{\tan 10°}$

$= h \cdot \cot 10°$

iii) $BC = h \cot 15°$



$450^2 = h^2 \cot^2 15 + h^2 \cot^2 10 - 2h^2 \cot 10 \cot 15 \cos 130°$ ✓

$450^2 = h^2 [\cot^2 15 + \cot^2 10 - 2 \cot 10 \cot 15 \cos 130]$

$450^2 = h^2 \times 73.3 \ldots$ ✓

$h^2 = 2762.589$

$h = 52.56 \text{ m}$ ✓

b) $\dfrac{d}{dx}\left(\dfrac{x}{\sqrt{1-x^2}}\right) = \dfrac{\sqrt{1-x^2} \cdot 1 - x \cdot \frac{1}{2}(1-x^2)^{-1/2} \cdot -2x}{(1-x^2)}$

$$= \dfrac{(1-x^2)^{1/2} + \dfrac{x^2}{(1-x^2)^{1/2}}}{(1-x^2)}$$

$$= \dfrac{(1-x^2) + x^2}{(1-x^2)^{3/2}}$$

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

ii) Note $\dfrac{d}{dx} \tan^{-1} x = \dfrac{1}{1+x^2}$

$\dfrac{d}{dx} \tan^{-1}\left(\dfrac{x}{\sqrt{1-x^2}}\right)$

$$= \dfrac{1}{1 + \dfrac{x^2}{1-x^2}} \times \dfrac{1}{(1-x^2)^{3/2}}$$

$$= \dfrac{1-x^2}{1-x^2+x^2} \times \dfrac{1}{(1-x^2)^{3/2}}$$

$$= (1-x^2) \times \dfrac{1}{(1-x^2)^{3/2}}$$

$$= \dfrac{1}{\sqrt{1-x^2}}$$

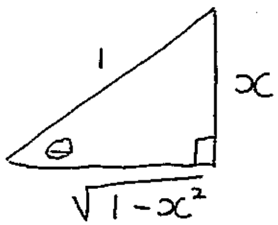
QUESTION 5ctd.

b iii) $\tan^{-1}x$ exists for all real x

$\therefore \dfrac{x}{\sqrt{1-x^2}}$ must be real

$\therefore -1 < x < 1$

iv)



$\sin\theta = \dfrac{x}{1}$

$\sin^{-1}x = \theta$

and $\tan^{-1}\left(\dfrac{x}{\sqrt{1-x^2}}\right) = \theta$

for $0 < x < 1$

so $\tan^{-1}\left(\dfrac{x}{\sqrt{1-x^2}}\right) = \theta = \sin^{-1}x$

QUESTION 6

a). $f(x) = 2 - \sqrt{x} \quad x \geq 0$

$g(x) = (x-2)^2$

$f[g(x)] = 2 - \sqrt{(x-2)^2}$

$= 2 - |x-2|$ for $x \leq 2$

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

$= 2 + (x-2)$

$= x$

NOTE

$\sqrt{(x-2)^2} = \pm(x-2)$

If $x > 2$

$2 - (x-2) = 4 - x$

This is not needed as told $f[g(x)] = x$

If $x \leq 2$

$2 - {}^{-}(x-2)$

which is required.

$g[f(x)] = (2 - \sqrt{x} - 2)^2$

$= (-\sqrt{x})^2$

$= x$

$\therefore f[g(x)] = g[f(x)] = x$

for $x \geq 0$ and $x \leq 2$. or $0 \leq x \leq 2$

ii) $y = 2 - \sqrt{x}$.

$x = 2 - \sqrt{y}$

$\sqrt{y} = (2-x)$

$y = (2-x)^2$

$f^{-1}(x) = (2-x)^2$

Domain $x \leq 2 \quad y \geq 0$

b) $1^2 + 3^2 + 5^2 + \dots (2n-1)^2 = \frac{1}{3}n(2n-1)(2n+1)$

• prove true for $n=1$

$LHS = 1^2$
$= 1$

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

hence true for $n=1$

• assume true for $n=k$

$1^2 + 3^2 + 5^2 + \dots + (2k-1)^2 = \frac{1}{3}k(2k-1)(2k+1)$

• prove true for $n=k+1$ if true for $n=k$

$\underbrace{1^2 + 3^2 + 5^2 + \dots + (2k-1)^2} + (2k+1)^2$

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

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

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

$= \frac{1}{3}(2k+1)\{2k^2 + 5k + 3\}$

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

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

$= RHS.$

since it is true for $n=1$, true for $n=1+1$ i.e $n=2$, If it is true for $n=k$, then true for, $n=k+1$ and so on for all positive integers $n \geq 1$

QUESTION 6 (c)

$\ddot{x} = -4x + 4$

$\frac{1}{2}v^2 = \int -4x + 4 \, dx$

$\frac{1}{2}v^2 = -2x^2 + 4x + c$

at $x = 2$ $v = 2\sqrt{3}$

$6 = -8 + 8 + c$

$c = 6$

$\frac{1}{2}v^2 = -2x^2 + 4x + 6$

$v^2 = -4x^2 + 8x + 12.$

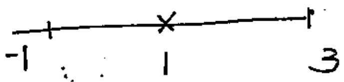
ii) at $v = 0$

$4x^2 - 8x - 12 = 0$

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

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

$x = 3$ $x = -1$



centre = 1

amplitude

$\underline{\underline{a = 2}}$

iii) when $t = 0$ $x = 2$

$x = 1 + 2\cos(\alpha)$

$\therefore$ $2 = 1 + 2\cos(\alpha)$

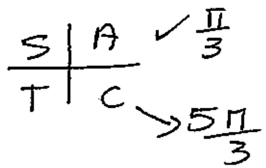
$1 = 2\cos(\alpha)$

$\frac{1}{2} = \cos\alpha$

$\alpha = \frac{\pi}{3}$ or $\alpha = \frac{5\pi}{3}$

check which one?

$v = -4\sin(2t + \alpha)$

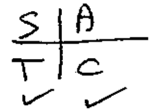


when $t = 0$ $v = 2\sqrt{3}$

$2\sqrt{3} = -4\sin\alpha$

$\therefore \sin\alpha = \frac{-\sqrt{3}}{2}$

$\alpha = \frac{5\pi}{3}$ to satisfy both x and v



QUESTION 7

a) $\ddot{y} = -10$

$\dot{y} = -10t + c$

when $t = 0$ $\dot{y} = v\sin\theta$

$\therefore$ $c = v\sin\theta$

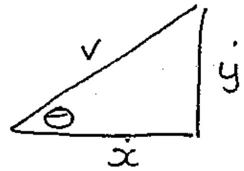
$c = 35\sin 0$

$= 0$

$\dot{y} = -10t$

$y = -5t^2 + c_1$

at $t = 0$ $y = 1{\cdot}8$ $\therefore$ $c_1 = 1{\cdot}8$



$v\sin\theta = \dot{y}$

$\cos\theta = \frac{\dot{x}}{v}$

$v\cos\theta = \dot{x}$

$y = -5t^2 + 1{\cdot}8$

Horizontal

$\dot{x} = v\cos\theta$

$= 35\cos 0$

$= 35$

$x = 35t$

ii) when $y = 0$

$0 = -5t^2 + 1{\cdot}8$

$t = 0{\cdot}6$ sec.

iii) find x at $t = 0{\cdot}6$

$x = 35 \times 0{\cdot}6$

$= 21$ metres.

iv) Find y when

$x = 14$ find t fi

$14 = 35 \times t$

$t = 0{\cdot}4$ sec.

at $t = 0.4$

$y = -5(0.4)^2 + 1.8$

$= 1$ metre.

$\therefore$ Ball clears net by

$1 - 0.95 = .05$ metre

or 5 cm.

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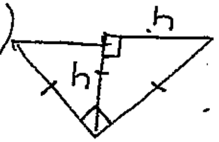
b) 

$\tan 45 = 1$

$\therefore$ base is also h.

Area $= \frac{1}{2} \times 2h \times h$

$= h^2$

Volume $= h^2 \times 300$

$= 300h^2$ cm/sec^3

NOTE UNITS h is cm

need 3m as 300 cm

ii) $\frac{dV}{dt} = \frac{dV}{dh} \times \frac{dh}{dt}$ $\quad \frac{dV}{dt} = 2000 \text{ cm}^3$

$2000 = 600h \times \frac{dh}{dt}$

$\frac{2000}{600h} = \frac{dh}{dt}$

$\frac{20}{6 \times 20} = \frac{dh}{dt} \Rightarrow \frac{1}{6}$ cm/sec.

c) $T = -19 + Ae^{-kt}$

i) at $t = 0$ $\quad T = 18$

$18 = -19 + Ae^0$ $\quad$ 1

$37 = A$

ii) $T = -19 + 37e^{-kt}$

$t = 5 \quad T = 3$

$3 = -19 + 37e^{-5k}$

$e^{-5k} = \frac{22}{37}$

$k = -\frac{1}{5} \log_e \frac{22}{37}$

$\doteqdot 0.10397509$

$0 = -19 + 37e^{-kt}$

$\frac{19}{37} = e^{-kt}$

$\log_e\left(\frac{19}{37}\right) = -0.103975091t$

$t \doteqdot 6.4$ mins $\quad$ or 6 min 25 sec