2011
TRIAL
HIGHER SCHOOL CERTIFICATE

GIRRAWEEN HIGH SCHOOL

Mathematics Extension 1

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue 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

Girraween High School Trial Higher School Certificate 2011

Total marks-84
Attempt all 7 questions
All questions are of equal value
Answer each question on a separate piece of paper clearly marked Question 1, Question 2, etc.
Each piece of paper should show your name.

Question 1 (12 Marks) Use a separate piece of paper — Marks

(a) Factorise x^3+64 — **1**

(b) Find $\lim\limits_{x\to 0}\dfrac{\tan 3x}{2x}$ — **2**

(c) Differentiate $y = x\tan^{-1}x$. — **2**

(d) Solve the inequality $\dfrac{3}{x-1}\le 2$ — **2**

(e) Find the point $P\ (x\,,y)$ that divides the interval A (-2 , 3) and B (2 , -5) externally in the ratio 2 : 1 — **2**

(f) Use the table of standard integrals to find $\int \sec 3x \tan 3x\, dx$ — **1**

(g) Use the substitution $u = x^3 - 1$ to evaluate $\int_0^2 \dfrac{x^2}{(x^3-1)^2}\,dx$ — **3**

Marks

Question 2 (12 Marks) Use a separate piece of paper

(a) The population P of Happytown has been falling at a rate proportional to the current population. That is P satisfies the equation $\frac{dP}{dt} = -kP$

(i) Show that $P = P_0 e^{-kt}$ satisfies this equation **1**

(ii) In 1990 the population of Happytown was 25,000 by 2000 it had fallen to 20,000. Find the values of P_0 and k. **2**

(iii) Find the population of Happytown in 2010. **2**

(iv) At what rate is the population falling in 2010. (to the nearest person) **1**

(b) The polynomial $P(x)$ has a remainder of -2 when divided by $(x-2)$ and has a remainder of 4 when divided by $(x+1)$. Find the remainder when $P(x)$ is divided by $(x-2)(x+1)$. **2**

(c) A skydiver jumps from an aircraft at 4000m above the ground. The velocity V *m/s* at which he falls is given by $V = 60(1 - e^{-0.16t})$

(i) Find the acceleration 10 seconds after he jumps. (2 dec pl) **2**

(ii) Find the distance he has fallen in the first 10 seconds. (nearest metre) **2**

Marks

Question 3 (12 Marks) Use a separate piece of paper.

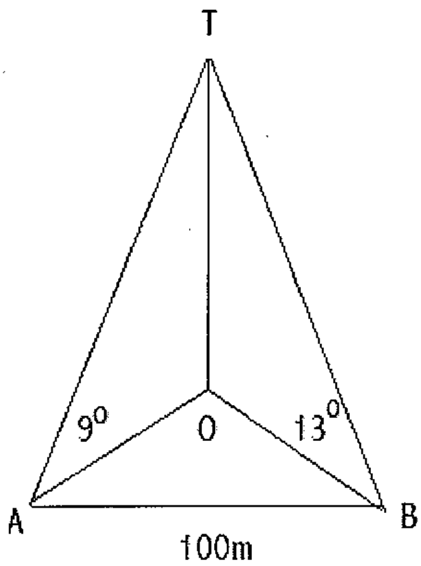
(a) A chess club has 7 male and 5 female members. A grade team of 4 players is selected at random.

(i) In how many ways can the team be chosen. **1**

(ii) What is the probability that the team contains a particular boy and particular girl. **2**

(b) Using the substitution $t = \tan\frac{\theta}{2}$ or otherwise , show that $\operatorname{cosec}\theta + \cot\theta = \cot\frac{\theta}{2}$ **2**

(c) From a point A due south of a tower OT the angle of elevation is 9^0
100m from A at B that is due east of the tower, the angle of elevation is 13^0.
As in the diagram below. Find the height of the tower. **3**



(d) The polynomial $x^3 - 2x^2 - 5x + 7 = 0$ has roots α, β and γ

(i) Find the value of $\alpha + \beta + \gamma$ **1**

(ii) Find the value of $\alpha\beta\gamma$ **1**

(iii) Find the cubic equation with roots $\alpha + 2, \beta + 2, \gamma + 2$ **2**

Marks

Question 4 (12 Marks) Use a separate piece of paper

(a) Two points $P(2ap, ap^2)$ and $Q(2aq, aq^2)$ lie on the parabola $x^2 = 4ay$

(i) Show that the equation of the tangent at P $y = px - ap^2$ **1**

(ii) Show that the point of intersection of the tangents from P and Q is $\{a(p+q), apq\}$ **2**

(iii) The tangents from P and Q intersect at 45^0. Show that $p - q = 1 + pq$ **1**

(b) The curve $y = tanx+secx$ is rotated about the X axis between $x = \frac{\pi}{6}$ and $\frac{\pi}{3}$.

Find the volume of the solid formed. **3**

(c) The 3rd and 5th term of a series are 10 and 4 respectively

(i) If the series is an A.P. find a the first term and d the common difference **2**

(ii) Find the least number of terms of the A.P. for the sum to be negative. **1**

(iii) If the series is a G.P. find a the first term and r the common ratio/s **2**

Question 5 (12 Marks) Use a separate piece of paper

(a) (i) Express $2\sin x - 3\cos x$ in the form $R\sin(x-\alpha)$ **2**

(ii) Hence or otherwise solve $2\sin x - 3\cos x = 2.5$. $0 \le x \le 360^0$ (nearest minute) **2**

(b) (i) Two fair six sided dice are rolled. Show that the probability of the total being 7 is $\frac{1}{6}$ **1**

(ii) If the dice are rolled seven times find the probability that the total is 7 exactly twice. **2**

(c) Find the greatest coefficient in the expansion of $(2x+3)^7$ **2**

(leave answer in unexpanded form)

(d) (i) Use the double angle expansion to express $\cos 2\theta$ in terms of $\cos\theta$ **1**

(ii) Using part (i) or otherwise find the exact value of cos 36^0 given cos $18^0 = \frac{\sqrt{5}+1}{4}$ **2**

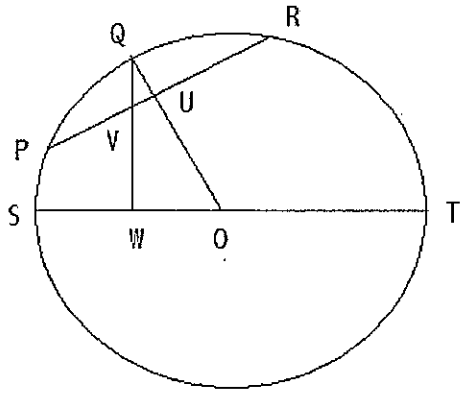
Marks

Question 6. (12 Marks) Use a separate piece of paper

(a) Use Mathematical Induction to show that for all integers $n \geq 1$ that

$$\frac{1}{2!}+\frac{2}{3!}+\frac{3}{4!}+\frac{4}{5!}+\ldots\ldots+\frac{n}{(n+1)!}=1-\frac{1}{(n+1)!}$$ **3**

(b) In the circle below Q is the mid point of the arc PR. The radius OQ meets the chord PR at U. From Q a perpendicular is dropped to W on the diameter ST meeting PR at V.



Prove that $OUVW$ is a cyclic quadrilateral. **3**

(c) For the function defined by $f(x)=\frac{2x^2}{x^2+1}$

(i) Show that $f(x)$ is an even function **1**

(ii) Show that $f(x)$ is monotonic increasing for $x \geq 0$ **2**

(iii) Find the inverse function $f^{-1}(x) \quad x \geq 0$ **2**

(iv) State the domain and range of $f^{-1}(x)$ **1**

Marks

Question 7 (12 Marks) Use a separate piece of paper

(a) The velocity v m/s of a particle moving along the x-axis is given by $v^2 = 24 + 8x - 2x^2$ where x is the displacement from the origin.

(i) Show that the motion is Simple Harmonic **2**

(ii) Find the centre of the motion **1**

(iii) Find the amplitude of the motion. **1**

(iv) Find the period of the motion. **1**

(v) Find the greatest velocity. **1**

(b) A cricketer at the centre of an oval strikes a cricket ball from the ground level producing a velocity of 30m/s. 60 meters from the batsman and in the same plane as the motion of the ball is a fence 1.2m high. The path of the ball is given by the parametric equations

$x = vt\cos\theta$ and $y = vt\sin\theta - \frac{1}{2}gt^2$ where g = $10ms^{-2}$ (there is no need to prove this)

(i) Show that the Cartesian equation of the path of the ball is given by

$$y = (\tan\theta)x - \frac{\sec^2\theta}{180}x^2$$ **2**

(ii) Show that the angle of projection can be found by solving

$$20\tan^2\theta - 60\tan\theta + 21.2 = 0$$ **2**

(iii) Find the range of angles for which the ball will clear the fence. **1**

(iv) Find the maximum distance the ball can land beyond the fence. **1**

END OF PAPER

HSC TRIAL EXTENSION 1

Question 1

a) $x^3+64 = (x+4)(x^2-4x+16)$ (1)

b) $\lim_{x\to 0} \frac{\tan 3x}{2x} = \lim_{x\to 0} \frac{\tan 3x}{3x}\cdot\frac{3}{2}$

$= 1\cdot 3/2$

$= 3/2$ (1)

c) $y = x\tan^{-1}x$

Let $u = x$ $\quad v = \tan^{-1}x$

$\frac{du}{dx} = 1$ $\quad \frac{dv}{dx} = \frac{1}{1+x^2}$

$\frac{du.v}{dx} = v\cdot\frac{du}{dx} + u\cdot\frac{dv}{dx}$

$= \tan^{-1}x + \frac{x}{1+x^2}$ (2)

d) $\frac{3}{x-1} \le 2$

$3(x-1) \le 2(x-1)^2$

$0 \le 2(x-1)^2 - 3(x-1)$

$0 \le (x-1)\{2x-2-3\}$

$0 \le (x-1)(2x-5)$

$x<1 \quad x \ge 5/2$ (2)

e) A $(-2,3)$ B $(2,-5)$

$2:-1$

$\left(\frac{2\times 2+(-2\times -1)}{2-1}, \frac{-5\times 2+3\times -1}{2-1}\right)$

$(6,-13)$ (2)

(f) $\int \sec 3x \tan 3x\, dx$

$= \frac{1}{3}\sec 3x + C$. (1)

(g) $I = \int_0^2 \frac{x^2}{(x^3+1)^2}\,dx$

let $u = x^3+1$

$\frac{du}{dx} = 3x^2$

$du = 3x^2 dx$

when $x=0$ $u=+1$

$x=2$ $u=9$

$= \frac{1}{3}\int_0^2 \frac{3x^2\,dx}{(x^3+1)^2}$

$= \frac{1}{3}\int_{+1}^{9} \frac{du}{u^2}$ (3)

$= \frac{1}{3}\left[\frac{-1}{u}\right]_{+1}^{9}$

$= \frac{1}{3}\left[\frac{-1}{9} + \frac{1}{+1}\right]$

$= +\frac{8}{27}$.

Question 2.

(a) (i) $P = P_0 e^{-kt}$

$\frac{dP}{dt} = -k(P_0 e^{-kt})$

$= -kP$. (1)

(ii) $t=0$ (1990) $P = 25{,}000$

$25000 = P_0 e^{-k(0)}$

$P_0 = 25000$ (1)

$t=10$ (2000) $P = 20{,}000$

$20000 = 25000\,e^{-10k}$

$0.8 = e^{-10k}$

$\ln 0.8 = -10k \ln e$

$k = 0.022314$ (1)

(iii) $t=20$ (2010)

$P = 25000\,e^{-20(0.022314)}$

$P = 16000$ (2)

(iv) $\frac{dP}{dt} = -kP$ (1)

$= -0.022314 \times 16000$

$= -357$ people/year

(b) $P(x) = Q(x)(x-2)(x+1) + ax+b$

$P(2) = -2$

$\therefore -2 = Q(2)(0)(3) + 2a+b$

$-2 = 2a+b$. (α)

$P(-1) = 4$

$4 = Q(-1)(-3)(0) - a+b$

$4 = -a+b$ (β)

$(\alpha)-(\beta)$ $\quad -6 = 3a$ $\quad \boxed{a=-2}$

$\therefore b = 2$

$\therefore$ Remainder $= -2x+2$. (2)

(c) (i) $V = 60(1-e^{-0.16t})$

$a = \frac{dV}{dt} = 60(0.16e^{-0.16t})$

$a_{(t=10)} = 60(0.16e^{-1.6})$

$= 1.9382$ m/s (2)

$= 1.94$ m/s 2 D.P.

(ii) $x = \int v\,dt$

$x = 60\int_0^{10} 1 - e^{-0.16t}\,dt$

$= 60\left[t + \frac{e^{-0.16t}}{0.16}\right]_0^{10}$

$= 60\left[(10+1.26185)-(0+6.25)\right]$

$= 300.711$ m

$= 301$ m (2)

Question 3.

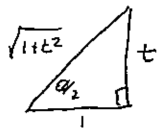
(a) (i) $^{12}C_4 = 495$ ways (1)

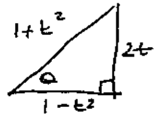
(ii) $P(B+G+***) = \frac{^{10}C_2}{^{12}C_4}$

$= \frac{45}{495}$

$= \frac{1}{11}$ (2)

(b)





$\therefore \operatorname{cosec}\theta + \cot\theta = \frac{1+t^2}{2t} + \frac{1-t^2}{2t}$

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

$= \frac{1}{t}$

$= \frac{1}{\tan\theta/2}$

$= \cot\theta/2$ (2)

(c) $\tan 9 = \frac{h}{AO}$ $\quad \tan 13 = \frac{h}{OB}$

$AO = \frac{h}{\tan 9}$ $\quad OB = \frac{h}{\tan 13}$

BY PYTHAGORAS IN $\triangle AOB$

$AO^2 + OB^2 = AB^2$

$\frac{h^2}{\tan^2 9} + \frac{h^2}{\tan^2 13} = 10000$

$h^2\left(\frac{1}{\tan^2 9} + \frac{1}{\tan^2 13}\right) = 10000$

$h^2 = \frac{10000}{58.6251614}$

$h^2 = 170.57528$

$h = 13.06$ m. (3)

(d) $x^3 - 2x^2 - 5x + 7 = 0$

α, β, γ

(i) $\alpha+\beta+\gamma = -b/a = 2.$ (1)

(ii) $\alpha\beta\gamma = -d/a = -7.$ (1)

(iii) WE REQUIRE $Y = x+2$

$\therefore x = Y-2$

$(Y-2)^3 - 2(Y-2)^2 - 5(Y-2) + 7 = 0$

$Y^3 - 6Y^2 + 12Y - 8 - 2Y^2 + 8Y - 8 - 5Y +$

$Y^3 - 8Y^2 + 15Y + 1 = 0$ (2)

CHECK WHEN USING SUM OF ROOT $= -b/a = 8$.

WHICH IS EQUAL TO $\alpha+\beta+\gamma+6$.

Question 4.

(a) (i) $x = 2ap$ $\quad y = ap^2$

$\frac{dx}{dp} = 2a$ $\quad \frac{dy}{dp} = 2ap$

$\frac{dy}{dx} = \frac{dy}{dp} \cdot \frac{dp}{2x} = p.$

EQN

$Y - ap^2 = p(x - 2ap)$

$Y - ap^2 = px - 2ap^2$

$Y = px - ap^2$ (1)

(ii) EQN OF TANG FROM Q

$Y = qx - aq^2$

$\therefore px - ap^2 = qx - aq^2$

$(p-q)x = a(p^2 - q^2)$

$x = \frac{a(p-q)(p+q)}{(p-q)}$

$x = a(p+q)$

$\therefore y = qa(p+q) - aq^2$

$y = apq + aq^2 - aq^2$

$y = apq$

Pt $(a(p+q), apq)$

(iii) grad from P, p

grad from Q, q

$\therefore \tan\theta = \frac{|p-q|}{1+pq}$

But $\theta = 45$, $\tan\theta = 1$

$1 = \frac{p-q}{1+pq}$

$1 + pq = p - q$ (1)

(b) $V = \pi \int_{\pi/6}^{\pi/3} (\tan x + \sec x)^2 dx$

$= \pi \int_{\pi/6}^{\pi/3} \tan^2 x + 2\tan x \sec x +$

$= \pi \int_{\pi/6}^{\pi/3} 2\tan x \sec x + 2\sec^2 x -$

$[\tan^2 x = \sec^2 x$

$= \pi\left[2\sec x + 2\tan x - x\right]$

$= \pi\left[(4 + 2\sqrt{3} - \pi/3) - \left(\frac{4}{\sqrt{3}} + \frac{2}{\sqrt{3}} -\right.\right.$

$= \pi\left[4 - \pi/6\right] u^3.$ (3)

(c) (i) $T_3 = 10 = a + 2d$ (A)

$T_5 = 4 = a + 4d$ (B)

(B)−(A) $2d = -6$ $\quad \boxed{d = -3}$

$\therefore 10 = a - 6$ $\quad \boxed{a = 16}$

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

$0 = \frac{n}{2}(32 + (n-1)-3)$

$0 = 16n - \frac{3n^2}{2} + \frac{3n}{2}$

Question 4 cont.

$3n^2 - 35n = 0$

$n(3n - 35) = 0$

$n = 0$ REJECT

or $n = 35/3$ ∴ $n = 12^{th}$ term

(iii) $T_3 = ar^2 = 10$ (A)

$T_5 = ar^4 = 4$ (B)

B/A $r^2 = 2/5$

$r = \pm\sqrt{2/5}$ (2)

$T_3 = a\left(\sqrt{2/5}\right)^2 = 10$

$a = 25$

Question 5.

a) i) $R\sin(x - \alpha) = R(\sin x\cos\alpha - \cos x\sin\alpha)$

$R\sin x\cos\alpha - R\cos x\sin\alpha = 2\sin x - 3\cos x$

equating $\sin x$, $\cos x$

$R\sin x\cos\alpha = 2\sin x$

$R\cos\alpha = 2$ (A)

$R\cos x\sin\alpha = 3\cos x$

$R\sin\alpha = 3$ (B)

B/A $\tan\alpha = 1.5$

$\alpha = 56.31^\circ$

$A^2 + B^2$ $R^2(\sin^2\alpha + \cos^2\alpha) = 2^2 + 3^2$

$R = \sqrt{13}$ (2)

$2\sin x - 3\cos x = 2.5$

$\sqrt{13}\sin(x - 56°31) = 2.5$

$\sin(x - 56.31) = \frac{2.5}{\sqrt{13}}$

$x - 56.31 = 43.8978, 136.1021$

$x = 100.2078, 192.4121$ (2)

$x = 100^\circ 12', 192^\circ 25'$

(b) (i) $n(7) = 6$ (WITH TWO DICE)

$n(S) = 36$ (36 OUTCOMES)

∴ $P(7) = 6/36 = 1/6$ (1)

(ii) $(\bar{7} + 7)^7 = {}^7C_0\left(\frac{5}{6}\right)^7 + {}^7C_1\left(\frac{5}{6}\right)^6\left(\frac{1}{6}\right)^1 + {}^7C_2\left(\frac{5}{6}\right)^5\left(\frac{1}{6}\right)^2$

= P(EXACTLY 2 "7"s) $= 21 \cdot \frac{5^5}{6^7}$

P(7's) = 0.2344 (2)

(c) Term $n = {}^7C_{n-1}\, 2^{8-n}\, 3^{n-1}$

Term $n+1 = {}^7C_n\, 2^{7-n}\, 3^n$

Require $\frac{T_{n+1}}{T_n} \geq 1$

$$\frac{\frac{7!}{(7-n)!\,n!}\, 2^{7-n}\, 3^n}{\frac{7!}{(8-n)!\,(n-1)!}\, 2^{8-n}\, 3^{n-1}} \geq 1$$

$\frac{(8-n)}{n} \cdot \frac{3}{2} \geq 1$

Question ... cont.

$24 - 3n \geq 2n$

$24 \geq 5n$

$n \leq 4.8$

Let $n = 4$

∴ $n+1^{th}$ term is the 5^{th} term

$= {}^7C_4\, 2^3\, 3^4$. (2)

(d) (i) $\cos 2\theta = \cos^2\theta - \sin^2\theta$

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

∴ (ii) $\cos 36 = 2(\cos 18)^2 - 1$

$= 2\left(\frac{\sqrt{5}+1}{4}\right)^2 - 1$

$= \frac{6 + 2\sqrt{5}}{8} - 1$

$= \frac{6 + 2\sqrt{5} - 8}{8}$

$= \frac{2\sqrt{5} - 1}{8}$

$= \frac{\sqrt{5} - 1}{4}$ (2)

Question 6

(a) $\frac{1}{2!} + \frac{2}{3!} + \frac{3}{4!} \cdots + \frac{n}{(n+1)!} = 1 - \frac{1}{(n+1)!}$

S.1 Prove true for $n = 1$

LHS $= \frac{1}{2!} = \frac{1}{2}$

RHS $= 1 - \frac{1}{2!} = 1 - \frac{1}{2} = 1/2$

LHS = RHS TRUE for $n = 1$

S.2. Assume true for $n = k$

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

PROVE TRUE FOR $n = k+1$

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

LHS $\frac{1}{2!} + \frac{2}{3!} + \cdots \frac{k}{(k+1)!} + \frac{k+1}{(k+2)!}$

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

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

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

S.3. Step 1 implies true for $n=1$ Step 2 implies if true for $n=1$ true for $n = 2, 3, 4 \ldots$ ∴ By the Principle of Mathematical Induction true for all $n \geq 1$.

(b) MUST PROVE △OPU ≡ △ORU

CONNECT O TO P and O TO R.

IN △OPU, △ORU

OP = OR (RADII)

∠POQ = ∠ROQ (STAND ON EQUAL ARCS)

OU IS COMMON

∴ △OPU ≡ △ORU (SAS)

∴ PU = RU (MATCHING SIDES IN ≡ △'s)

∴ U BISECTS CHORD PR

∴ OU ⊥ PR

IN QUADRILATERAL OUVW

$\angle OUV = 90°$ (above)

$\angle VWO = 90°$ (data) (3)

$\therefore$ OUVW IS CYCLIC QUAD

OPPOSITE ANGLES SUPPLEMENTARY.

(c) (i) $f(x) = \frac{2x^2}{x^2+1}$

$f(a) = \frac{2a^2}{a^2+1}$

$f(-a) = \frac{2(-a)^2}{(-a)^2+1}$

$= \frac{2a^2}{a^2+1}$

$f(a) = f(-a) \therefore$ EVEN (1)

(ii) $f'(x) = \frac{(x^2+1)(4x)-(2x^2)2x}{(x^2+1)^2}$

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

$f'(x) \geq 0 \quad x \geq 0$ (2)

$\therefore$ MONOTONIC INCREASING

(iii) let $y = \frac{2x^2}{x^2+1}$

$\therefore$ INVERSE $x = \frac{2y^2}{y^2+1}$

$y^2x + x = 2y^2$

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

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

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

(iv) Domain $0 \leq x < 2$

Range $y \geq 0$ (1)

Question 7

(a) $v^2 = 24 + 8x - 2x^2$

(i) $a = \frac{d\frac{1}{2}v^2}{dx} = \frac{d}{dx} 12 + 4x - x^2$

$= 4 - 2x$

$a = -2(x-2)$

$\therefore \ddot{x} = -n^2(x-\alpha)$

$\therefore$ SIMPLE HARMONIC (2)

(ii) $x = 2$ (1)

(iii) FOR MAX AMPLITUDE $v=0$

$0 = 24 + 8x - 2x^2$

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

$0 = (x-6)(x+2)$

$x = 6 \quad x = -2$

AMP $= 4$. (1)

(iv) PERIOD $T = \frac{2\pi}{n}$

$= \frac{2\pi}{\sqrt{2}}$

$= \sqrt{2}\pi$ sec (1)

(v) MAX VEL $x = 2$

$v^2 = 24 + 8(2) - 2(2^2)$

$v^2 = 32$

$v = 4\sqrt{2}$ m/s (1)

(b) (i) $x = vt\cos\theta$ 1.

$y = vt\sin\theta - \frac{1}{2}gt^2$ 2.

From 1. $t = \frac{x}{v\cos\theta}$

SUBST 2. $y = \frac{v\,x\sin\theta}{v\cos\theta} - \frac{g}{2}\frac{x^2}{v^2\cos^2\theta}$

$y = \tan\theta\, x - \frac{10}{2}\frac{x^2\sec^2\theta}{30^2}$

$y = (\tan\theta)x - \frac{\sec^2\theta}{180}x^2$ (2)

(ii) when $x = 60 \quad y = 1.2$

$1.2 = 60\tan\theta - \frac{(\tan^2\theta+1)\cdot 3600}{180}$

$1.2 = 60\tan\theta - 20\tan^2\theta - 20$

$20\tan^2\theta - 60\tan\theta + 21.2 = 0$ (2)

(iii) $\tan\theta = \frac{60 \pm \sqrt{3600 - 4(20)(21.2)}}{40}$

$\tan\theta = \frac{60 \pm \sqrt{1904}}{40}$

$22°15' < \theta < 68°54'$ (1)

(iv) $x_{MAX} = \frac{v^2}{g}$

$= \frac{30^2}{10}$

$= 90$ m

$\therefore$ 30 metres beyond fence.

END OF SOLUTIONS.

X_{MAX} when $\theta = 45$

$R = \frac{v^2 \sin 2\theta}{g}$ *.