Randwick Girls' High School

2006
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Extension 1

General Instructions

- Reading Time- 5 minutes
- Working Time – 2 hours
- Write using a black or blue pen
- Approved calculators may be used
- A table of standard integrals is provided at the back of this paper.
- All necessary working should be shown for every question.
- Begin each question on a fresh sheet of paper.

Total marks (84)

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

Question	Marks
1	/12
2	/12
3	/12
4	/12
5	/12
6	/12
7	/12
Total	/84

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

Total Marks – 84
Attempt Questions 1-7
All Questions are of equal value

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

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

a) Divide the interval A (-2, 7) B (12, 0) internally in the ratio 4:3 **2**

b) Find $\int_{-2}^{2} \frac{dx}{4+x^2}$ **2**

c) Factorise $27x^6 + \frac{1}{8}$ **2**

d) Solve $3^{2x} - (1+\sqrt{3}) \times 3^x + \sqrt{3} = 0$ **2**

e) On the separate page provided you are given y = f(x)
Sketch y = f '(x) immediately below. **2**

f) For what values of x is $|2x-5| < -1$ **2**

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

(a) A point P (x, y) moves so that its distance from A(8, -2) is equal to twice its distance from B (-1, 4). **3**
Find its locus in algebraic form and describe the locus geometrically.

(b) (i) Show that $\frac{d}{dx}\left(\operatorname{cosec}(x^2)\right) = -2x\operatorname{cosec}(x^2)\cot(x^2)$ **2**

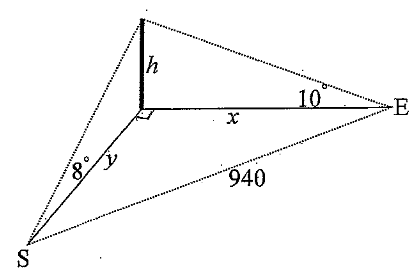
(ii) Hence evaluate $-\int_{\frac{\sqrt{\pi}}{2}}^{\frac{\sqrt{\pi}}{\sqrt{2}}} x\operatorname{cosec}(x^2)\cot(x^2)\,dx$ **2**

(c) A surveyor who is y metres south of a tower sees the top of it with an angle of elevation 8°. A second surveyor is x metres east of the tower. From his position the angle of elevation is 10° to the top of the tower.

The two surveyors are 940m apart.

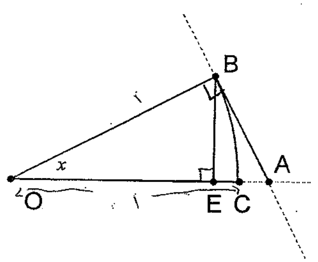
(i) Show that $y = h\cot 8^\circ$ **1**

(ii) Find the height of the tower to the nearest metre. **4**



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

(a)



The diagram shows a part of a unit circle

i.e. OB = OC = 1. $BE \perp OE$ $\angle OBA = 90^0$

O, E, C, A are collinear.

(i) Define x, $\tan x$ and $\sin x$ in terms of lengths shown on the diagram. **1**

(ii) Use the diagram to show that $\sin x < x < \tan x$ **1**

(b) (i) Two lines with gradients m_1 and m_2 intersect on the Cartesian Plane. If the acute angle between the lines is θ, write the formula for $\tan\theta$. **1**

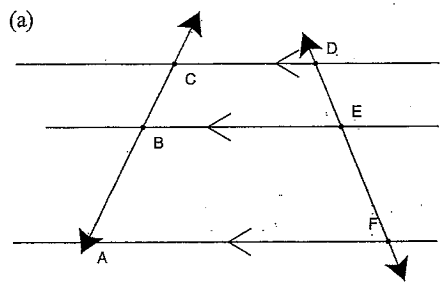
(ii) If $m_1 = 2$, find the exact value(s) of m_2 if $\theta = 60^0$ **2**

(c) Evaluate $\int_0^3 x\sqrt{9-x^2}\,dx$ using the substitution $u = 9 - x^2$ **4**

(d) Use the principal of Mathematical Induction to prove that $7^n - 3^n$ is a multiple of 4 for all positive whole numbers. **3**

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

(a)



The diagram shows 3 parallel lines; CD || BE || AF and 2 transversals AC and DF

(i) Copy the diagram onto your answers and **draw the parallel to AC through E.** **1**

(ii) Prove $\frac{BC}{BA} = \frac{DE}{EF}$ **2**

(You may assume that the opposite sides of a parallelogram are equal)

(b) The polynomial $px^3 - qx + r = 0$ has a double root at $x = \alpha$. **3**

Show that $\alpha = \sqrt[3]{\frac{r}{2p}}$

(c) Find the domain and range for the function $y = 5\sin^{-1}\left(\frac{x}{\pi}\right)$. **2**

(d) Evaluate $\int_0^{\frac{\pi}{8}} \cos^2 2x\,dx$ **3**

(e) Write the sum $5 + 9 + 13 + \ldots + 4n - 3$ in Sigma Notation **1**

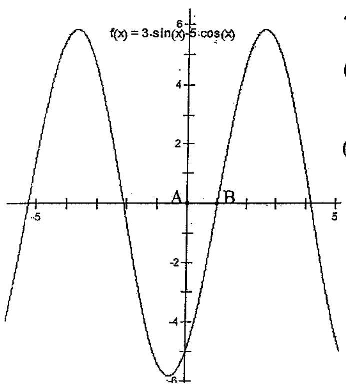
QUESTION 5 (12 MARKS) Begin a NEW sheet of writing paper. **Marks**

(a) P $(2ap, ap^2)$ and Q $(2aq, aq^2)$ are distinct points on the parabola $x^2 = 4ay$ such that $\angle PSQ = 90°$ and S is the focus.

i) Show that $(pq + 1)^2 = (p - q)^2$. **4**

ii) The tangents at P and Q intersect at T.
Show that the figure PSQT cannot be a cyclic quadrilateral. **2**

(b)



The curve $y = 3\sin x - 5\cos x$ is shown

(i) State the amplitude of the function in exact terms. **1**

(ii) Calculate the distance AB correct to 3 decimal places. **2**

(c) Consider the equation $x^2 + 2x + 4y^2 - 16y + 13 = 0$ which represents an ellipse. **3**

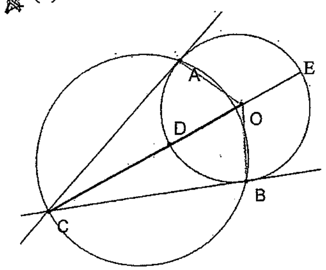
The line $y = mx$ meets the ellipse.

Show that $3m^2 - 4m - 3 \geq 0$. What value(s) of m make the line a tangent to the ellipse?

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

(a) 250ml of coffee at 60° is poured into each of 2 containers. **5**
The surrounding temperature is 24°. The temperature of the coffee after 5 minutes is 50° in the normal cup and 58° in the insulated cup.
Find the temperature difference after a further 25 minutes have elapsed.
You may use $T = A + Ce^{kt}$ to model this situation.

(b)



Not to Scale

O is the centre of the small circle. CA and CB are tangents to this circle.
The large circle is drawn through A, B and C.
CO is produced to E and intersects the small circle at D.

Note: $\overline{CD}$ means the length of CD

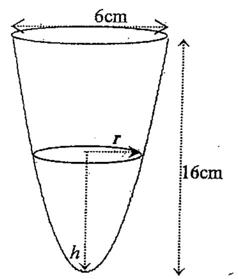
(i) Show that O lies on the large circle **2**

(ii) Show that $\overline{CD} = \dfrac{\overline{CB} \times \overline{CA}}{\overline{CD} + 2\overline{DO}}$ **2**

(c) Prove that the equation of motion $x = 10\cos(2t - \frac{\pi}{3}) + 1$ specifies Simple Harmonic Motion and find the initial position of the particle. **3**

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

(a) A wine glass is formed by rotating $y = ax^2$ around the y axis.



The depth of liquid in the glass is h and the radius at the top of the liquid is r.

(i) Find the value of a **1**

(ii) Write an expression for h in terms of r. **1**

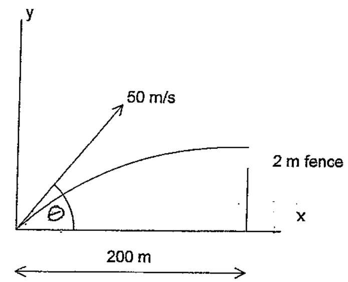
(iii) Show that the volume of liquid in the glass when the depth is h cm is $\frac{8\pi r^4}{9}$ **1**

(iv) Liquid is being added to the glass at the at a rate $3(15-h)$ ml per second. Find the rate at which the radius of the surface is increasing when $h = 10$cm. **3**

Question 7 is continued on page 9

QUESTION 7 CONTINUED **Marks**

(b) A method to score a home run in baseball is to hit the ball over the boundary fence on the field.



A ball is hit at $50\ m\ s^{-1}$. The fence 200 metres away is 2 metres high. You may neglect air resistance and acceleration due to gravity can be taken as $10\ m\ s^{-2}$ and you may assume the following equations of motion

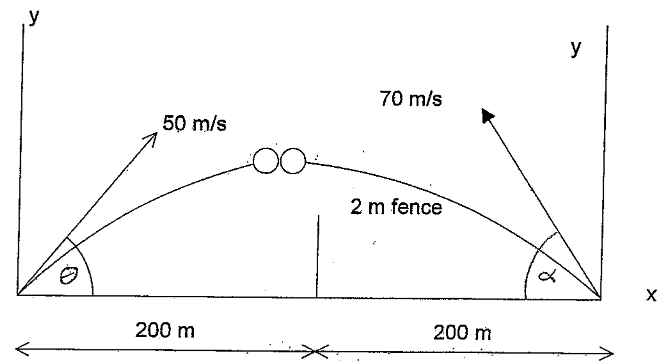
$x = 50\,t\cos\theta$ and $y = 50\,t\sin\theta - 5\,t^2$

(i) Show that if the ball just clears the 2 m boundary fence then

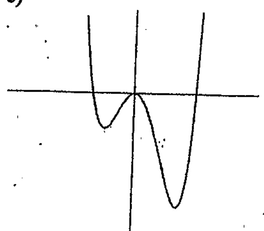
$80\tan^2\theta - 200\tan\theta + 82 = 0$ **2**

(ii) In what range of values must θ lie to score a home run by this method? **2**

(iii) In an adjacent field another ball is hit at the same instant at $70\ m\ s^{-1}$ and the balls collide. Assume that $\theta = 30^\circ$. Find the angle of projection α of the second ball and the time and position where the balls collide. **2**



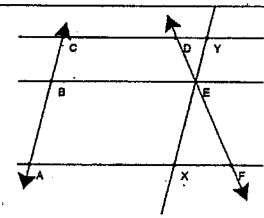
End of Examination

Solutions	Marks/Comments
1 a) $\left(\frac{mx_2+nx_1}{m+n},\frac{my_2+ny_1}{m+n}\right)=\left(\frac{4\times12+3\times-2}{4+3},\frac{4\times0+3\times7}{4+3}\right)$	1
$\left(\frac{42}{7},\frac{21}{7}\right)=(6,3)$	1
b) Using the standard integrals $I=\frac{1}{2}\left[\tan^{-1}\left(\frac{x}{2}\right)\right]_{-2}^{2}$	1
$=\frac{1}{2}[\tan^{-1}1-\tan^{-1}(-1)]=\frac{1}{2}\left(\frac{\pi}{4}-\left(-\frac{\pi}{4}\right)\right)=\frac{\pi}{4}$	1
c) Of the form $(a+b)(a^2-ab+b^2)$ $\left(3x^2+\frac{1}{2}\right)\left(9x^4-\frac{3}{2}x^2+\frac{1}{4}\right)$	1 for significant progress 1 for completion
d) $(3^x-1)(3^x-\sqrt{3})=0$	1
so $3^x=1, x=0$ or $3^x=\sqrt{3}, x=½$	1
e) 	1 min in correct location 1 max in correct location
f) Solving $2x-5=-1, x=2$ and $5-2x=-1, 3=x$ gives critical points. Testing $x=0$ $5<-1$ false . $x=2{\cdot}5$ $0<-1$ false, $x=4$ $3<-1$ false No solution	1 1 Allow 1 for $x<2$ OR $x>3$
	/12

Randwick Girls' High School Trial HSC Exam SOLUTIONS Extension 1 Mathematics 2006

Solutions	Marks/Comments
2 a) $\sqrt{(x-8)^2+(y+2)^2}=2\times\sqrt{(x+1)^2+(y-4)^2}$	1
$x^2-16x+64+y^2+4y+4=4(x^2+2x+1+y^2-8y+16)$	
$x^2-16x+64+y^2+4y+4=4x^2+8x+4+4y^2-32y+64$	
$0=3x^2+24x-60+3y^2-36y+60$	
$0=x^2+8x-20+y^2-12y+20$	1
$36+16=x^2+8x+16+y^2-12y+36$	
$52=(x+4)^2+(y-6)^2$	
Which is a circle centre (-4, 6) radius $2\sqrt{13}$	1
b) let $u=x^2$ $\frac{du}{dx}=2x$ $y=\operatorname{cosec}u=(\sin u)^{-1}$	
i) $\frac{dy}{du}=-1\cos u.(\sin u)^{-2}$	1
$\frac{dy}{du}\times\frac{du}{dx}=-2x\frac{\cos(x^2)}{(\sin(x^2))^2}=-2x.\operatorname{cosec}(x^2)\cot(x^2)$ as req^d	1
ii) $I=\frac{1}{2}\left[\operatorname{cosec}(x^2)\right]_{\frac{\sqrt{\pi}}{2}}^{\sqrt{\frac{\pi}{2}}}=\frac{1}{2}\left(\operatorname{cosec}\frac{\pi}{2}-\operatorname{cosec}\frac{\pi}{4}\right)=\frac{1-\sqrt{2}}{2}$	2 (1 for substantial progress)
c) i) $\frac{h}{y}=\tan 8$ so $\frac{y}{h}=\cot 8^\circ$ ie $y=h\cot 8^\circ$	1
ii) likewise $x=h\cot 10^\circ$	1
By Pythagoras $x^2+y^2=940^2$ i.e.	
$h^2\cot^2 8^\circ+h^2\cot^2 10^\circ=883600$	1
$h^2(\cot^2 8^\circ+\cot^2 10^\circ)=883600$	1
$h^2=\frac{883600}{\cot^2 8^\circ+\cot^2 10^\circ}=\frac{883600}{82.7919}=10672.54$	1 /12
= 103 metres (to nearest metre)	

Solutions	Marks/Comments
3 a) i) x = arc length BC $\sin x = BE$ $\tan x = BA$	1
ii) $\overline{BE} < \overline{BC} < \overline{BA}$ so $\sin x < x < \tan x$	1
b) i) $\tan\theta = \left\lvert\dfrac{m_1 - m_2}{1+m_1m_2}\right\rvert$	1
ii) $\left\lvert\dfrac{2-m_2}{1+2m_2}\right\rvert = \sqrt{3}$	
Then $\dfrac{2-m_2}{1+2m_2} = \sqrt{3}$ OR $\dfrac{2-m_2}{1+2m_2} = -\sqrt{3}$	1
$2 - m_2 = \sqrt{3} + 2\sqrt{3}m_2$ $2 - m_2 = -\sqrt{3} - 2\sqrt{3}m_2$ $2-\sqrt{3} = m_2(1+2\sqrt{3})$ $2+\sqrt{3} = (1-2\sqrt{3})m_2$ $m_2 = \dfrac{2-\sqrt{3}}{1+2\sqrt{3}}$ OR $m_2 = \dfrac{2+\sqrt{3}}{1-2\sqrt{3}}$	1
c) let $u = 9 - x^2$ $\dfrac{du}{dx} = -2x$ $x = 0, u = 9$ $x = 3, u = 0$	1
$I = -\frac{1}{2}\int_0^3 -2x(9-x)^{\frac{1}{2}}dx = -\frac{1}{2}\int_9^0 \frac{du}{dx}u^{\frac{1}{2}}dx = \frac{1}{2}\left[\frac{2}{3}u^{\frac{3}{2}}\right]_0^9$	2
$= 9$	1
c) If $n = 1$ $7^1 - 3^1 = 7 - 3 = 4$ (Which is a multiple of 4) Assume true for $n = k$ i.e $7^k - 3^k = 4p$	1
Show that $7^{k+1} - 3^{k+1} = 4q$ LHS $= 7^k - 3^k = 7^k \times 7 - 3^k \times 3$ $= 4 \times 7^k + 3 \times 7^k - 3 \times 3^k$ $= 4 \times 7^k + 3(7^k - 3^k)$	1
$= 4 \times 7^k + 3(4p)$ $= 4(7^k + 3p)$ $= 4q$	1
∴ if true for $n = k$ also true for $n = k + 1$ but since true for $n = 1$, by induction also true for all positive whole numbers.	/12

Solutions	Marks/Comments
4 a) i) 	1
ii) $\Delta DEY \parallel\!\mid \Delta FEX$ since $\angle DEY = \angle FEX$ vertically opposite & $\angle EDY = \angle EFX$ z angles parallel lines	1
$\dfrac{EY}{EX} = \dfrac{ED}{EF}$ corresponding sides in similar triangles but EY = BC and EX = AB Opposite sides in parallelogram so $\dfrac{BC}{BA} = \dfrac{DE}{EF}$ as required	1
4 b) $px^3 - qx + r = 0$ has roots α, α and β	
Sum of the roots= $2\alpha + \beta = -\dfrac{b}{a} = 0$	1 for sum
$\therefore \beta = -2\alpha$	
Product of the roots $= \alpha^2\beta = -\dfrac{d}{a} = -\dfrac{r}{p}$	1 for product
Substituting $\alpha^2\beta = \alpha^2(-2\alpha) = -\dfrac{r}{p}$	
$-2\alpha^3 = -\dfrac{r}{p} \Rightarrow \alpha^3 = \dfrac{r}{2p} \Rightarrow \alpha = \sqrt[3]{\dfrac{r}{2p}}$	1 for result
c) $5\sin^{-1}\left(\frac{x}{\pi}\right)$ Domain $-1 \le \frac{x}{\pi} \le 1$ so $\pi \le x \le \pi$	1 for each of domain and range
Range $-\dfrac{5\pi}{2} \le y \le \dfrac{5\pi}{2}$	1
$\cos^2 x = \frac{1}{2}(1 + \cos 2x)$ $\therefore$ $\cos^2 2x = \frac{1}{2}(1 + \cos 4x)$	1
$\int_0^{\frac{\pi}{8}} \cos^2 2x\,dx = \frac{1}{2}\left[x + \frac{1}{4}\sin 4x\right]_0^{\frac{\pi}{8}} = \dfrac{\pi+2}{16}$	1 + 1
d) $\sum_{r=2}^{n} 4r - 3$	1 /12

Solutions	Marks/Comments
5 a) i) $m_{ps} = \frac{ap^2 - a^2}{2ap}$	
$= \frac{p^2-1}{2p}$ *similarly* $m_{qs} = \frac{q^2-1}{2q}$	1 for gradients
Note $(pq+1)^2 = p^2q^2 + 2pq + 1$	
$m_1 \times m_2 = -1$	1 for product = -1
$\frac{p^2-1}{2p} \times \frac{q^2-1}{2q} = -1$	
$p^2q^2 - p^2 - q^2 + 1 = -4pq$	1 for simplifying
Re arranging and adding 2pq to both sides $p^2q^2 + 2pq + 1 = p^2 + q^2 - 2pq$	1 for result
$(pq+1)^2 = (p-q)^2$	
ii) For cyclic quadrilateral opposite angles are supplementary thus <PTQ must equal 90° so pq must equal −1. From (i) (pq+1)2 = (p-q)2 this is impossible as p and q are distinct points (they would need to be equal for this condition to apply).	1 for property 1 for correct conclusion
(b)) i) $R = \sqrt{3^2+5^2} = \sqrt{34}$	1
ii) $\frac{3}{\sqrt{34}}\sin x - \frac{5}{\sqrt{34}}\cos x$ is of the form $\sin x\cos\alpha - \cos x \sin\alpha$ i.e. $y = 3\sin x - 5\cos x = \sqrt{34}\sin(x - \tan^{-1}\frac{5}{3})$ $= \sqrt{34}\sin(x - 1.030)$	1
AB = 1.030 units correct to 3 d.p.	1
c) $x^2 + 2x + 4y^2 - 16y + 13 = 0$ $(x+1)^2 + 4(y-2)^2 - 4 = 0$ $(x+1)^2 + 4(mx-2)^2 + 13 = 0$ $x^2 + 2x + 4m^2x^2 - 16mx + 13 = 0$	1
$(4m^2+1)x^2 + (2-16m)x + 13 = 0$ $\Delta = b^2 - 4ac = 4 - 64m + 256m^2 - 52(4m^2+1)$ $= 48m^2 - 64m - 48$ Line intersects if this expression ≥ 0 ie if $3m^2 - 4m - 3 \geq 0$	1
For the line to be tangent $3m^2 - 4m - 3 = 0$ $\frac{-b \pm \sqrt{b2-4ac}}{2a} = \frac{4 \pm \sqrt{16+36}}{6} \approx 1\cdot868...or - 0\cdot535...$	1
	/12

Solutions	Marks/Comments
6 a) The equation for the two cups is $T = A + Ce^{kt}$ observe that A = 24 and C = 36 since T = 60 when t = 0	1
In the first cup $50 = 24 + 36e^{5k}$ so $\frac{26}{36} = e^{5k}$	
$k_1 = \ln\left(\frac{26}{36}\right) \div 5 = -0\cdot06508448$ and likewise...	1
$k_2 = \ln\left(\frac{34}{36}\right) \div 5 = -0\cdot01143168277$	1
When $t = 30$ $T_1 = 24 + 36e^{30\times -0.06508448} \approx 29\cdot1^\circ$	1
$T_2 = 24 + 36e^{30\times -0.01143168277} \approx 49\cdot5^\circ$ and so the difference is $20\cdot4^\circ$	1
b) i) $\angle OAC = \angle OBC = 90^\circ$ radius meets tangent at right angles.	1
Now OACB is a cyclic quadrilateral since two opposite angles are supplementary. So O is on the circle.	1
ii) Produce CO till it meets the circle again at E. The square on the tangent equals the product of the intercepts of the secant i.e. $CA^2 = CD \times CE = CD(CD + 2DO)$	1 reasons req[d] in full
Also $CA = CB$ tangents from an external point are equal so $CD(CD + 2OD) = CA \times CB$ i.e. $CD = \frac{CA \times CB}{CD + 2OD}$ as req[d]	1
c) $x = 10\cos(2t - \frac{\pi}{3}) + 1$ $\quad \dot{x} - 20\sin\left(2t - \frac{\pi}{3}\right)$	
$\ddot{x} = -40\cos\left(2t - \frac{\pi}{3}\right)$	1
Now $-4x = -40\cos\left(2t - \frac{\pi}{3}\right) + 4$	
$-4x - 4 = -40\cos\left(2t - \frac{\pi}{3}\right)$	
$-4(x-1) = \ddot{x}$	1 not req[d] (x = 1)
∴ Motion can be expressed in the form $\ddot{x} = -n^2x$ so motion is simple harmonic	
$\ddot{x} = -2^2(x-1)$	
SHM with centre of $x = 1$	
Initially $x = 10\cos(\frac{-\pi}{3}) + 1 = 6$	1 /12

Solutions	Marks/Comments
7 a) i) $y=ax^2 \quad 16=a\times 3^2 \quad a=\frac{16}{9}$	1
ii) Substituting (r, h) into $y=ax^2$ gives $h=\frac{16}{9}r^2$	1
iii) $V=\pi\int r^2.dh=\pi\int\frac{9}{16}h.dh=\frac{9\pi}{32}h^2=\frac{9\pi}{32}\left(\frac{16r^2}{9}\right)^2=\frac{8\pi r^4}{9}$	1
iv) $\frac{dr}{dt}=\frac{dV}{dt}\times\frac{dr}{dV}$ and	1
$r=\frac{3}{4}\sqrt{h}=\frac{3}{4}\sqrt{10}$ when h = 10	1
$\frac{dr}{dt}=3(15-h)\times\frac{9}{32\pi r^3}=\frac{135}{32\times\pi\frac{270\sqrt{10}}{64}}=0\cdot100658cms^{-1}$	1
	continued

Randwick Girls' High School Trial HSC Exam SOLUTIONS Extension 1 Mathematics 2006

7b)i) (200,2) satisfies $x=50t\cos\theta$ *and* $y=50t\sin\theta-5t^2$

Marks /Coments

$x=50t\cos\theta$

$200=50t\cos\theta$

$\therefore t=\frac{4}{\cos\theta}$

$y=50t\sin\theta-5t^2$

$2=50t\sin\theta-5t^2$

$50t\sin\theta-5t^2-2=0$ — 1 for t

Substituting I into II gives

$50\left(\frac{4}{\cos\theta}\right)\sin\theta-5\left(\frac{4}{\cos\theta}\right)^2-2=0$

$200\tan\theta-80\sec^2\theta-2=0$

$200\tan\theta-80(1+\tan^2\theta)-2=0$

$80\tan^2\theta-200\tan\theta+82=0$

1 for simplifying

ii)

$\tan\theta=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$\tan\theta=\frac{200\pm\sqrt{13760}}{160}$ — 1 for substitution

$\theta=63^\circ14'$ *or* $27^\circ20'$

$\therefore$ *Range is* $27^\circ20'\le\theta\le63^\circ14'$ — 1 for range

iii)

For ball 1

$x_1=50t\cos30^\circ$

$=25\sqrt{3}\,t$

$y_1=50t\sin30^\circ-5t^2$

$=25t-5t^2$

For ball 2

$x_2=70t\cos\alpha$

$y_2=70t\sin\alpha-5t^2$

Now $x_1+x_2=400$

$\therefore x_1=400-x_2$

$=400-70t\cos\alpha$

For the balls to collide $y_1=y_2$

$25t-5t^2=70t\sin\alpha-5t^2$

$\sin\alpha=\frac{25}{70}$

$\alpha=20^\circ55'$

Sub $\alpha=25^\circ55'$ *into* $x_1=400-70t\cos\alpha$

$25\sqrt{3}\,t=400-70t\cos20^\circ55'$

$\therefore t=\frac{400}{25\sqrt{3}+70\cos^{20}{}^\circ55'}=3.68\,seconds$ — 1 for time

Position

$x_1=25\sqrt{3}\,t$ $\quad y_1=25t-5t^2$

$x_1=25\sqrt{3}\times3.68=159.36m$ $\quad y_1=25\times3.68-5(3.68)^2=24.28m$ — 1 for position

/12