Number:	
Class:	

YEAR 12

ASSESSMENT TEST 3
TERM 2, 2013

MATHEMATICS
EXTENSION 1

***Time Allowed** – 90 Minutes*
(Plus 5 minutes Reading Time)

- *All* questions may be attempted
- *All* questions are of equal value
- Department of Education approved calculators are permitted
- In every Question, show all relevant mathematical reasoning and/or calculations.
- Marks may not be awarded for careless or badly arranged work
- No grid paper is to be used unless provided with the examination paper
- This is an open book test, any printed or hand written materials are allowed must be placed on desk

The answers to all questions are to be returned in separate bundles clearly labeled Question 1, Question 2, etc. Each question must show your Candidate Number.

Question 1 (9 marks)

(a) A particle vibrates in Simple Harmonic Motion, making 100 oscillations in 2 seconds.

(i) Find the period of the oscillations and hence show that the acceleration is given by:

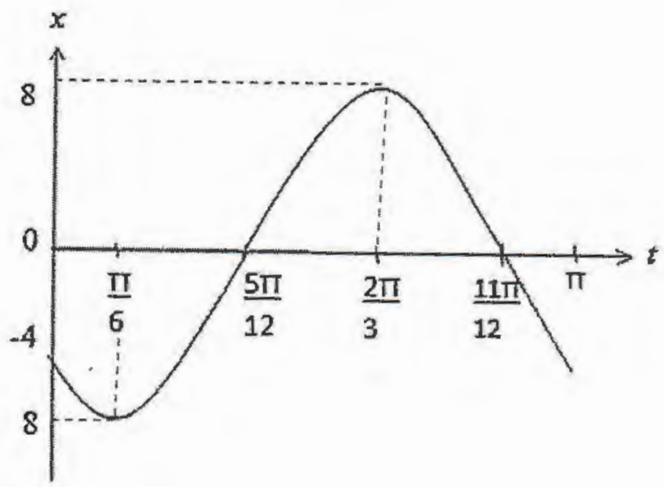
$$\ddot{x} = -10000\pi^2 x$$ 3

If the amplitude of the motion is 40cm, calculate the speed, in m/s, of the particle at:

(ii) the centre of its motion $(x = 0)$. 2

(iii) a distance 20cm from the centre of the motion. 2

(b) Consider the following graph for $0 \le t \le \pi$. The graph illustrates Simple Harmonic Motion (SHM).



Determine the time in seconds, when:

(i) the particle is moving to the left (namely the negative direction). 1

(ii) the absolute value of acceleration is greatest. 1

Question 2 (9 marks)Start a new page

In a colony of bees it is found that the number, N infected by a virus at any time t, in months, is given by:

$$N = \frac{600}{4 + Ae^{-0.05t}}$$

(a) If initially there are 50 infected bees find the value of A. 1

(b) Find the time taken before there are 100 infected bees.(Give your answer to the nearest month) 2

(c) Show that $\dfrac{dN}{dt} = \dfrac{N(150 - N)}{3000}$. 3

(d) Find the rate at which the infection is spreading when there are 100 infected bees. 1

(e) Sketch a graph of $N(t)$ against t. 2

Question 3 (9 marks) Start a new page

(a) Tidal flow in a harbour is assumed to be in Simple Harmonic Motion and water depth x metres at time t hours is given by

$$x = 20 + A\cos(nt + \alpha)$$

where A, n and α are positive constants.

The depth of the water is 12m at low tide and 28m at high tide which occurs 7 hours later.

(i) Evaluate A and n 2

(ii) On a day when low tide occurs at 2:00am, find the first period of time during which the water level is greater than 22m. 3

(b) A particle moves in a straight line from a fixed point, O, along the x-axis. Its velocity, $v\ m/s$ is given by:

$$v^2 = 4x^2 - 9.$$

Initially the particle is located $\sqrt{3}$ m to the right of O and is moving towards the origin.

(i) Find the set of possible values for x. 1

(ii) Find an expression for the acceleration, a. 1

(iii) Describe the motion of the particle. 2

Question 4 (9 marks) Start a new page

(a) The rate at which the population $P(t)$ of birds on an island increases is proportional to the amount that the population is less than M, the maximum number of birds which the island will support. Given that $P(t) = M + Ae^{kt}$, where A and k are constants, find when the population of the island will exceed 650 given that the bird population was 500 in 1970 and 600 in 1980. The island can support a maximum of 800 birds. 4

(b) A missile is fired from ground level into the air at a velocity of $40m/s$ and at an angle α with the horizontal. A short time later another missile is fired from the same point and with the same speed but at a different angle β. Both missiles hit the same target at the same time. The target is 55 m above the ground and 80 m from the point of firing. The value of g is taken as 10 m/s^2, and air resistance is neglected.

The equations for the horizontal and vertical components of the position of the first missile t seconds after it is fired are given by

$$x = 40t\cos\alpha \quad \text{and} \quad y = 40t\sin\alpha - 5t^2$$

Also the path of the first missile is given by

$$y = x\tan\alpha - x^2\left(\frac{\sec^2\alpha}{320}\right).$$

(i) Find the value of $\tan\alpha$ and the value of $\tan\beta$. 3

(ii) Determine the time difference between the firing time of the two missiles. Leave your answer in the exact form. 2

Question 5 (9 marks) Start a new page

The acceleration of a body moving along a straight line is given by:

$$a = -24e^{-4x}$$

Where x is the displacement from the origin after t seconds.

Initially the particle is at the origin with velocity of $2\sqrt{3}\ m/s$.

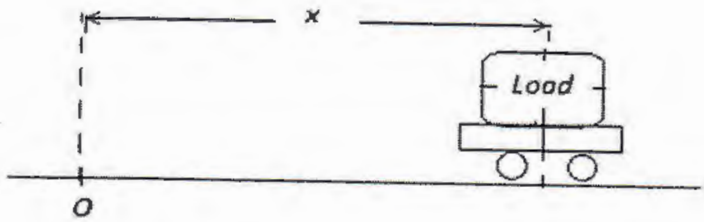
(a) Prove that the velocity, v, of the body in terms of x is given by $v = 2\sqrt{3}e^{-2x}$ 2

(b) Find an expression for t in terms of x. 3

(c) Hence show that $x = \frac{1}{2}\ln\left(1+4\sqrt{3}t\right)$. 2

(d) How long does it take for the body to reach a point 5 m to the right of the origin? Leave your answer in exact form. 2

Question 6 (9 marks) Start a new page

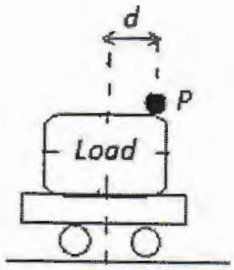


A load moves in such a way that its displacement x m from the origin O after a time t seconds is given by:

$$x = 8\sin\left(3t + \frac{\pi}{3}\right)\text{m}$$

(a) Find the velocity of the load when $t = 0$. 2

(b) Find the first time the centre of the load is at $x = 4$. 2



A particle P, placed on top of the load, is moving about the centre of the load. Its displacement, d metres, from the centre of the load at time t seconds, is given by:

$$d = \sin 3t$$

The displacement, y metres, of P from the origin is the sum of the two displacements x and d, so that:

$$y = 8\sin\left(3t + \frac{\pi}{3}\right) + \sin 3t$$

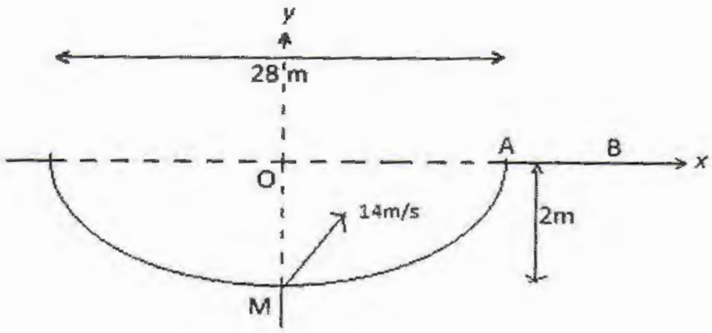
(c) Show that P, is moving in Simple Harmonic Motion. 2

(d) Find the amplitude of this motion. 3

Question 7 (9 marks) Start a new page

A golf ball is lying at point *M*, at the middle of a sand bunker, which is surrounded by level ground. The point A is at the edge of the bunker, and line *AB* lies on level ground. The bunker is 28 metres wide and 2 metres deep.

The ball is hit towards *A* with an initial speed of 14 metres per second, and the angle of elevation α. You may assume that the acceleration due to gravity is $10\,m/s^2$.



(a) Write down expressions for x and y, the horizontal and vertical displacements respectively, in metres, of the ball as functions of t. 2

(b) Given that α = 30°, will the golfer clear the sand bunker? Justify your answer. 2

(c) Find the maximum height above the ground reached by the ball if α = 30°. 2

(d) Find the range of values of α, to the nearest degree, at which the ball must be hit so that the golfer will clear the sand bunker and the ball will land to the right of A. 3

END OF THE PAPER

Y12 TERM 2, 2013

MATHEMATICS Extension 1 : Question 1

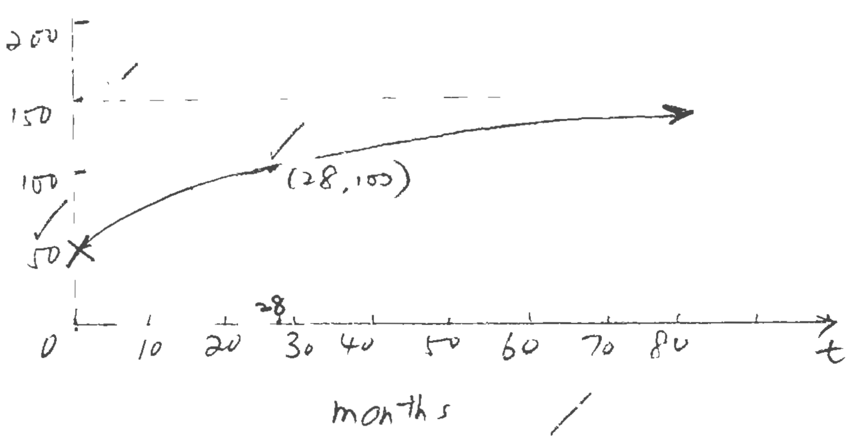
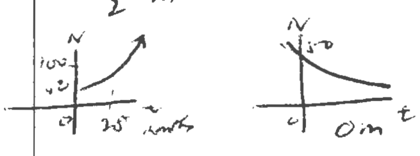
Suggested Solutions	Marks	Marker's Comments
(a) (i) 100 oscillations in 2 seconds		
$f = \frac{1}{T}$, $50 = \frac{1}{T}$, $T = \frac{1}{50}$ 1 mk; $n = \frac{2\pi}{T} = \frac{2\pi}{1/50}$, $n = 100\pi$	1 mk	
now $\ddot{x} = -n^2 x$ (as given its SHM) $= -(100\pi)^2 x$ $= -10\,000\pi^2 x$	1 mk	* lost ½ mk if second last line not given
(ii) centre of motion is $x = 0$, $a = 0.4$ m	½	
$v^2 = n^2(a^2 - x^2)$ $= (100\pi)^2(0.4^2 - 0^2)$	½	
$v = 100\pi \times 0.4$	½	
$v = 40\pi$		
∴ speed is 40π m/s	½	
(iii) when $x = 0.2$, $v = ??$		
$v^2 = n^2(a^2 - x^2)$ $= (100\pi)^2(0.16 - 0.2^2)$	½	* lost ½ a mk if you didn't simplify the surd
$= (100\pi)^2 \times 0.12$	½	
$= 1200\pi^2$		
∴ $v = \sqrt{1200\pi^2}$	½	
speed $= 20\sqrt{3}\,\pi$ m/s	½	
(b) (i) $0 \le t < \pi/6$, $2\pi/3 < t \le \pi$	½ for each	
(ii) $t = \pi/6$ or $t = 2\pi/3$	½ for each	

2013 Yr 12 T2 Q2

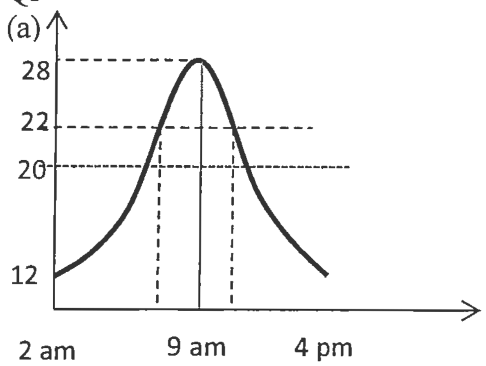
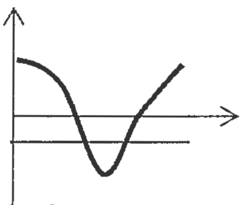
MATHEMATICS Extension 1 : Question 2 P. 1/2

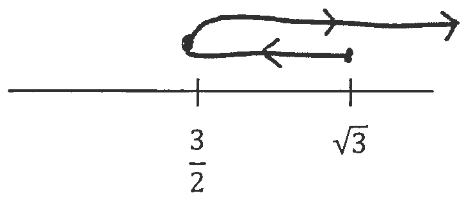
Suggested Solutions	Marks	Marker's Comments
a) $t=0 \quad 50 = \dfrac{600}{4+A}$ $4+A=12$ $\therefore A = 8$ #	1	well done
b) $100 = \dfrac{600}{4+8e^{-0.05t}}$ $4+8e^{-0.05t}=6$ $e^{-0.05t} = \frac{2}{8} = \frac{1}{4}$ $0.05t = \ln 4$ $t = 27.7259$	1	must show d.p.
$\therefore$ 28 months (nearest month)	1	well done
c) $N = \dfrac{600}{4+8e^{-0.05t}}$ $\dfrac{dN}{dt} = -600\left[\dfrac{-0.05\times 8e^{-0.05t}}{(4+8e^{-0.05t})^2}\right]$	1	must show double minus and $-600(-0.05)\times 8$ most got this right.
$= \left(\dfrac{600}{4+8e^{-0.05t}}\right)\cdot\dfrac{0.4e^{-0.05t}}{4+8e^{-0.05t}}$ $= N \times \dfrac{1200e^{-0.05t}}{3000(4+8e^{-0.05t})}$ $= \dfrac{N}{3000}\left[\dfrac{600+1200e^{-0.05t}-600}{(4+8e^{-0.05t})}\right]$ $= \dfrac{N}{3000}\left[\dfrac{150(4+\cancel{8e^{-0.05t}})}{(4+\cancel{8e^{-0.05t}})} - \dfrac{600}{(4+8e^{-0.05t})}\right]$	1	This is a show 'Q' must give details since answer is given in Q.

2013 T2 Yr12 Q2

MATHEMATICS Extension 1 : Question........		P 7/2
Suggested Solutions	**Marks**	**Marker's Comments**
$= \dfrac{N\left[150-N\right]}{3000}$	1	many fudging.
d) $N=100$, $\dfrac{dN}{dt}=\dfrac{N(150-N)}{3000}$ $=\dfrac{100(150-100)}{3000}$ $=\dfrac{100\times 50}{3000}=5/3$ ∴ Rate is 5/3 bees infected per month	1	many forget per month $-\frac{1}{2}$m
e) $N=\dfrac{600}{4+8e^{-0.05t}}$ as $t\to\infty$ $N\to\dfrac{600}{4+8}$ ∴ $N\to 150$ 	2	each ✓ ½ @. many forget to mark 150 on N-axis many forget months in t-axis. change of concavity $-\frac{1}{2}$ m  max 1m

Mathematics Extension 1 **Task 3 Term 2 2013** **Question 3**

Expected answers	Marks	Comments
Q3 (a)  		
(i) Amplitude $= \frac{28-12}{2} = 8$ Hence $A = 8$	1 (½)	For value of A, If A expressed as -8, in contrast to what is stated in the question.
Period, $T = 14\ hours$ Hence $\frac{2\pi}{n} = 14$ $\Rightarrow n = \frac{\pi}{7}$	1	For correct n
(ii) Approach I $x = 20 + 8\cos(\frac{\pi}{7}t + \alpha)$ When $t = 0, x = 12$: $\alpha = \pi$ $\Rightarrow x = 20 - 8\cos\frac{\pi}{7}t$ For water level to be greater than 22 m, then $x > 22$. $\Rightarrow 20 - 8\cos\frac{\pi}{7}t > 22$ $\Rightarrow \cos\frac{\pi}{7}t < -\frac{1}{4}$	½	For correct α, with working
Now $\cos\frac{\pi}{7}t = -\frac{1}{4}$, yields $1.823 < \frac{\pi}{7}t < 4.459 \ldots$ $4.063 < t < 9.9369 \ldots hours$ i.e. 4 hours and 4 minutes or 9 hours 56 minutes 	½	For formulation of inequality

Thus the period of time the water level is greater than 22 m is between 6.04 am and 11.56 am <u>Approach II:</u> $$x = 20 - 8\cos(\frac{\pi}{7}t + \alpha)$$ When $t = 0, x = 12,$ then $\alpha = 0$ And a similar result is obtained	1 1	For correct solutions For correct times Max 2 ½ if 4.56 am and 1.04 pm Max 2 if 4.56 am and 1.04 pm, but ignored α completely
(b) (i) From $v^2 = 4x^2 - 9$, it is clear that $v^2 \geq 0$ Thus $4x^2 - 9 \geq 0 \Rightarrow x \leq -\frac{3}{2}$ or $x \geq \frac{3}{2}$ However, when $t = 0, x = \sqrt{3}$ And so $x \geq \frac{3}{2}$ is the required domain for the particle's motion. (ii) $a = \frac{d}{dx}\left(\frac{1}{2}v^2\right)$ $= \frac{d}{dx}\left(2x^2 - \frac{9}{2}\right)$ $= 4x$ (iii)  From $x = \sqrt{3}$, the particle moves left with speed $\sqrt{3}$. As the acceleration ($\ddot{x} = 4\sqrt{3}$) is always directed to the right, the particle slows down and stops at $x = \frac{3}{2}$. Due to this acceleration directed to the right, the particle then changes direction at $x = \frac{3}{2}$, and speeds up continuously (ad infinitum).	½ ½ 1 ½ ½ ½ ½	For arriving at $x \leq -\frac{3}{2}$ or $x \geq \frac{3}{2}$ For arriving at $x \geq \frac{3}{2}$ due to the condition that $x = +\sqrt{3}$ Easy mark , but ½ if $\ddot{x} = 8x$ For slowing down to the left For stopping at $x = \frac{3}{2}$ due to force acting to the right For saying particle reverses direction at $x = \frac{3}{2}$ due to positive force acting to the right For particle speeding up to the right forever.

MATHEMATICS Extension 1 : Question 4

Suggested Solutions	Marks	Marker's Comments

a) $P(t) = M + Ae^{kt}$

$M = 800$

$\therefore P = 800 + Ae^{kt}$

1970: $t = 0$ and $P = 500$

$500 = 800 + A$

$A = -300$ — 1

$\therefore P = 800 - 300e^{kt}$ - - - - - - - ①

1980: $t = 10$, $P = 600$

$600 = 800 - 300e^{10k}$

$e^{10k} = \frac{2}{3}$

$\therefore 10k = \ln\left(\frac{2}{3}\right)$

$k = \frac{1}{10}\ln\left(\frac{2}{3}\right)$ - - - - ② — 1

well done. question given as e^{kt} so k should be negative.

when $P = 650$

$650 = 800 - 300e^{\frac{1}{10}\ln\left(\frac{2}{3}\right)t}$

$e^{\frac{1}{10}\ln\left(\frac{2}{3}\right)t} = \frac{150}{300}$ — 1

$\therefore \frac{1}{10}\ln\left(\frac{2}{3}\right)t = \ln\frac{1}{2}$

$t = \ln\frac{1}{2} \div \frac{1}{10}\ln\left(\frac{2}{3}\right)$

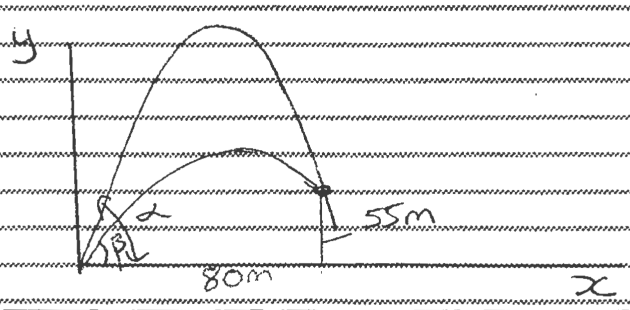
$\approx 17.0951129 1$ ✓

≈ 17 years. — 1

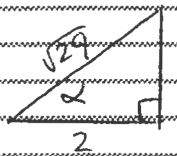
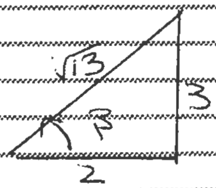
$\therefore$ population exceeds 650 in 1987

Make sure you read question carefully.

b(i)



MATHEMATICS Extension 1 : Question 4

Suggested Solutions	Marks	Marker's Comments
b) (i) when $x = 80$ and $y = 55$ $y = x\tan\alpha - x^2\left(\frac{\sec^2\alpha}{320}\right)$ $55 = 80\tan\alpha - \frac{6400\sec^2\alpha}{320}$		A number of careless errors particularly with 80^2
$55 = 80\tan\alpha - 20 - 20\tan^2\alpha$	1	1 mark
$20\tan^2\alpha - 80\tan\alpha + 75 = 0$ $4\tan^2\alpha - 16\tan\alpha + 15 = 0$ $(2\tan\alpha - 5)(2\tan\alpha - 3) = 0$		
$\tan\alpha = \frac{5}{2}$ or $\frac{3}{2}$	1	1 mark
$\tan\beta$ is also solution to same equation. Second missile arrives in shorter time $\tan\alpha > \tan\beta$		Had to distingu between $\tan\alpha$, $\tan\beta$
$\therefore \tan\alpha = \frac{5}{2}$ $\tan\beta = \frac{3}{2}$	1	1 mark
(ii) $x = 40t\cos\alpha$ $t = \frac{x}{40\cos\alpha}$		
$t = \frac{2}{\cos\alpha}$	1	1 for $t = \frac{2}{\cos\alpha}$
 $t = \frac{2}{\frac{2}{\sqrt{29}}}$ 	1	1 for triangles.
Time difference is $\sqrt{29} - \sqrt{13}$ seconds		other answers were accepted.

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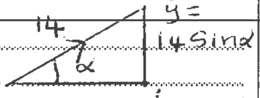
TERM 2 ASSESSMENT 2013 X1 **MATHEMATICS: Question** 5 p 1/2

Suggested Solutions	Marks	Marker's Comments
a) $\ddot{x} = -24e^{-4x}$		
$\dfrac{d}{dx}\left(\dfrac{v^2}{2}\right) = -24e^{-4x}$		
$\dfrac{v^2}{2} = 6e^{-4x} + \dfrac{c}{2}$		
$\underline{\underline{v^2 = 12e^{-4x} + c}}$	½	
When $x = 0$, $v = 2\sqrt{3}$		
$\therefore 12 = 12 + c \quad \therefore c = 0$		
$\therefore \underline{\underline{v^2 = 12e^{-4x}}}$	½	
$\therefore v = \pm 2\sqrt{3}e^{-2x}$	½	½ for $\pm$ or implied $\pm$ and
But initially, $x = 0 \Rightarrow v = 2\sqrt{3}$ (>0)	½	½ for reason.
$\therefore \underline{\underline{v = 2\sqrt{3}e^{-2x}}}$		
b) $\therefore \dfrac{dx}{dt} = 2\sqrt{3}e^{-2x}$		
$\therefore \dfrac{dt}{dx} = \dfrac{e^{2x}}{2\sqrt{3}}$	1	
$\therefore t = \dfrac{e^{2x}}{4\sqrt{3}} + c$	1	
But $x = 0$ when $t = 0$ $\therefore c = \dfrac{-1}{4\sqrt{3}}$	½	
$\therefore \underline{\underline{t = \dfrac{e^{2x} - 1}{4\sqrt{3}}}}$	½	
c) Changing subject:		One mark off for each error, including getting to the wrong answer.
$4\sqrt{3}t = e^{2x} - 1$		½ off for inventing unnecessary absolute values
$e^{2x} = 1 + 4\sqrt{3}t$		
$2x = \ln(1 + 4\sqrt{3}t)$		
$\underline{\underline{x = \dfrac{1}{2}\ln(1 + 4\sqrt{3}t)}}$	2	

Suggested Solutions	Marks	Marker's Comments
d) From part (b), substitute $x=5$; $t = \dfrac{e^{10}-1}{4\sqrt{3}}$ (secs)	2	Pretty easy marks as long as (b) was correct.
(Alternatively using (c): Substitute $x=5$ and solve for t: $5 = \frac{1}{2}\ln(1+4\sqrt{3}\,t)$; $10 = \ln(1+4\sqrt{3}\,t)$; $e^{10} = 1+4\sqrt{3}\,t$; $4\sqrt{3}\,t = e^{10}-1$; $t = \dfrac{e^{10}-1}{4\sqrt{3}}$ (secs))		

MATHEMATICS EXTENSION 1: Question 6		
Suggested Solutions	**Marks**	**Marker's Comments**
(a) $x = 8\sin\left(3t + \frac{\pi}{3}\right)$		
$\frac{dx}{dt} = 24\cos\left(3t + \frac{\pi}{3}\right)$	1	Differentiate
When $t = 0$, $\frac{dx}{dt} = 24\cos\left(0 + \frac{\pi}{3}\right)$		
$= 24 \times \frac{1}{2}$		
$= 12$	1	Evaluate velocity
$\therefore$ Velocity is 12m/s.		
(b) When $x = 4$, $8\sin\left(3t + \frac{\pi}{3}\right) = 4$		
$\sin\left(3t + \frac{\pi}{3}\right) = \frac{1}{2}$		
$3t + \frac{\pi}{3} = \cdots \frac{\pi}{6}, \frac{5\pi}{6} \cdots$	1	Solutions for $\sin\theta = \frac{1}{2}$
$3t = \cdots \frac{-\pi}{6}, \frac{\pi}{2} \cdots$		
$t = \cdots \frac{-\pi}{18}, \frac{\pi}{6} \cdots$		
But $t \geq 0$, so first time is after $\frac{\pi}{6}$ seconds.	1	Identify valid solution
(c) $y = 8\sin\left(3t + \frac{\pi}{3}\right) + \sin 3t$		
$\dot{y} = 24\cos\left(3t + \frac{\pi}{3}\right) + 3\cos 3t$		
$\ddot{y} = -72\sin\left(3t + \frac{\pi}{3}\right) - 9\sin 3t$	1	Acceleration equation
$= -9\left[8\sin\left(3t + \frac{\pi}{3}\right) + \sin 3t\right]$		
$\ddot{y} = -n^2 y$ where $n = 3$	1	Relate to definition of S.H.M.
$\therefore$ P is moving in simple harmonic motion		
(d) $y = 8\sin\left(3t + \frac{\pi}{3}\right) + \sin 3t$		
$= 8\left(\sin 3t\cos\frac{\pi}{3} + \cos 3t\sin\frac{\pi}{3}\right) + \sin 3t$		
$= 8\left(\frac{1}{2}\sin 3t + \frac{\sqrt{3}}{2}\cos 3t\right) + \sin 3t$		
$= 4\sin 3t + 4\sqrt{3}\cos 3t + \sin 3t$		Expand & simplify
$= 5\sin 3t + 4\sqrt{3}\cos 3t$	1	trigonometric expressions
But $5\sin 3t + 4\sqrt{3}\cos 3t \equiv R\sin(x + \alpha)$	1	Relate to auxiliary angle form
where $R = \sqrt{5^2 + (4\sqrt{3})^2}$ $\{R > 0\}$		
$= \sqrt{25 + 48}$		
$= \sqrt{73}$	1	Evaluate amplitude
$\therefore$ Amplitude of motion is $\sqrt{73}$ metres.		

MATHEMATICS Extension 1 : Question 7

Suggested Solutions	Marks	Marker's Comments
a) (i) $\ddot{x} = 0$ Horizontal $t=0$  $\dot{x} = C_1$ $t=0$ $\dot{x} = 14\cos\alpha$ ∴ $C_1 = 14\cos\alpha$ $\dot{x} = 14\cos\alpha$ $x = 14t\cos\alpha + C_2$ $x = 0$ $t = 0$ ∴ $C_2 = 0$ $x = 14t\cos\alpha$. (ii) $\ddot{y} = -g$ $g = 10$ $\dot{y} = -10t + C_3$ $t = 0$ $\dot{y} = 14\sin\alpha$ ∴ $C_3 = 14\sin\alpha$ $\dot{y} = -10t + 14\sin\alpha$ $y = -5t^2 + 14t\sin\alpha + C_4$ $t = 0$ $y = -2$ ∴ $C_4 = -2$ $y = -5t^2 + 14t\sin\alpha - 2$.	(2)	① + ① mark for each correct equation (working not necessary Many students left off "−2" from y equation ($\frac{1}{2}$ mark given if working shown)
b) $\alpha = 30^\circ$ Many alternative methods to see if ball clears sand bunker. use Cartesian equation $t = \frac{x}{14\cos\alpha} = \frac{x}{14\times\frac{\sqrt{3}}{2}} = \frac{x}{7\sqrt{3}}$ $y = \frac{-5x^2}{49\times 3} + \frac{14x}{7\sqrt{3}}\times\frac{1}{2} - 2$ $= \frac{-5x^2}{147} + \frac{x}{\sqrt{3}} - 2$ If $x = 14$ then $y \doteqdot -0.58 < 0$ ∴ Does not clear If $y = 0$ ∴ $0 = \frac{-5x^2}{147} + \frac{x}{\sqrt{3}} - 2$ $x = \dfrac{-\frac{1}{\sqrt{3}} \pm \sqrt{\frac{1}{3} - \frac{4\times 5\times 2}{147}}}{-10/147}$ $x = 4.85$ or 12.12. Both answers less than 14 ∴ Does not clear. Other methods involved finding t when $y = 0$ ∴ $t = 2/5$ or 1	(2)	All methods needed 2 calculations ① + ① mark for each.
c) Maximum height $\dot{y} = 0$ $14\sin\alpha - 10t = 0$ $\alpha = 30^\circ$ $7 - 10t = 0$ $t = 7/10$ Max Height $h = 14(t)\sin\alpha - 5t^2 - 2$. $= 14\times 7/10 \times 1/2 - 5(7/10)^2 - 2$ $= 0.45$ Max height is 0.45 m	(2)	① time $= \frac{7}{10}$ ① height $= 0.45$

MATHEMATICS Extension 1 : Question.......

Suggested Solutions	Marks	Marker's Comments
a) $x = 14t\cos\alpha \quad t = \dfrac{x}{14\cos\alpha}$	③	
$y = 14t\sin\alpha - 5t^2 - 2$		
$= 14\left(\dfrac{x}{14\cos\alpha}\right)\sin\alpha - 5\left(\dfrac{x}{14\cos\alpha}\right)^2 - 2$		
$= x\tan\alpha - \dfrac{5x^2}{196}(\sec^2\alpha) - 2$		
solve when $x = 14 \quad y > 0$		
$14\tan\alpha - \dfrac{5(14)^2}{196}(1+\tan^2\alpha) - 2 > 0$		① Correct Inequality (or equation)
$-5\tan^2\alpha + 14\tan\alpha - 7 > 0$		
$5\tan^2\alpha - 14\tan\alpha + 7 < 0$		
For equality $\tan\alpha = \dfrac{14 \pm \sqrt{196 - 4(5)(7)}}{2\times5}$		
$\doteq 2.148331477$ or 0.651668522		① Solution for $\tan\alpha$
$\therefore \alpha \doteq 65^\circ 2'$ or $33^\circ 5'$		
$\therefore$ Required range (to nearest degree)		① Correct range.
$33^\circ < \alpha < 65^\circ$		