BOARD OF STUDIES
NEW SOUTH WALES

2013 HSC Mathematics Extension 1 Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	C
2	D
3	C
4	D
5	A
6	B
7	A
8	D
9	B
10	C

Section II

Question 11 (a)

Criteria	Marks
• Correct answer	1

For any cubic $\alpha\beta\gamma = -\dfrac{d}{a}$, so

$$\alpha\beta\gamma = -\frac{7}{2}.$$

Question 11 (b)

Criteria	Marks
• Correct primitive	2
• Attempts to use standard integral, or equivalent merit	1

$$\int \frac{1}{\sqrt{49 - 4x^2}}\,dx$$

$$= \int \frac{1}{\sqrt{4\left(\frac{49}{4} - x^2\right)}}\,dx$$

$$= \frac{1}{2}\int \frac{1}{\sqrt{\left(\frac{7}{2}\right)^2 - x^2}}\,dx$$

$$= \frac{1}{2}\sin^{-1}\frac{x}{\frac{7}{2}} + c$$

$$= \frac{1}{2}\sin^{-1}\frac{2x}{7} + c$$

Question 11 (c)

Criteria	Marks
• Correct answer	2
• Identifies correct binomial coefficient, or equivalent merit	1

The probability is

$$\begin{aligned} {}^{10}C_7 \left(\frac{1}{4}\right)^7 \left(\frac{3}{4}\right)^3 &= \frac{10!}{7!3!} \frac{3^3}{4^{10}} \\ &= 120 \cdot \frac{3^3}{4^{10}} \\ &= 30 \cdot \frac{3^3}{4^9}. \end{aligned}$$

(For each question, the probability of choosing the correct option is $\frac{1}{4}$ and the probability of choosing an incorrect option is $\frac{3}{4}$.
The probability of choosing the correct option for exactly 7 out of 10 questions is the term in $\left(\frac{1}{4} + \frac{3}{4}\right)^{10}$ containing $\left(\frac{1}{4}\right)^7$.)

Question 11 (d) (i)

Criteria	Marks
• Correct solution	2
• Finds $f'(x)$	1

Domain: all real $x \neq \pm 2$

Using the quotient rule

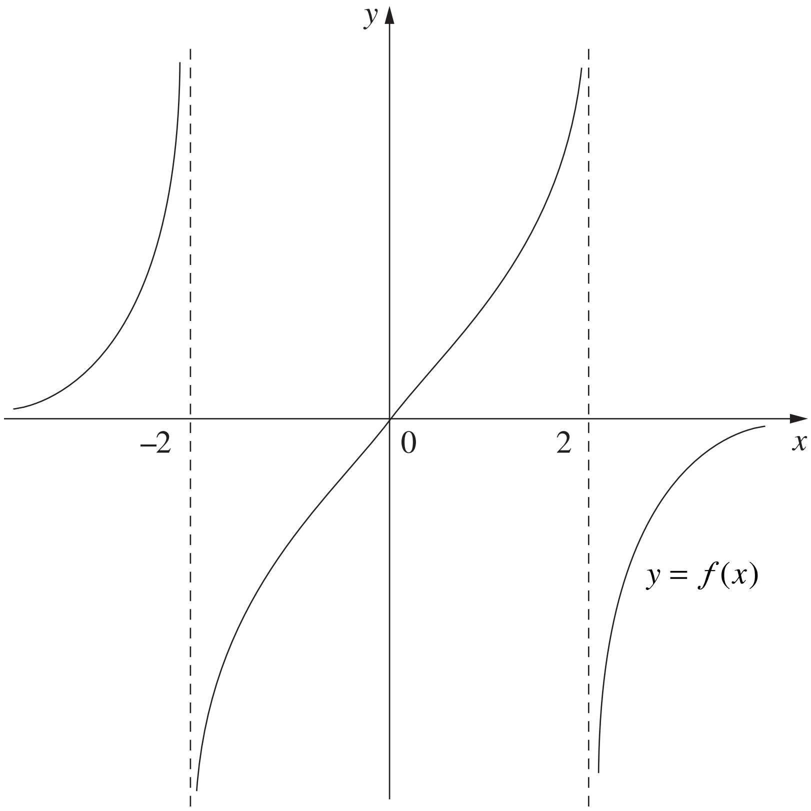
$$\begin{aligned} f'(x) &= \frac{(4 - x^2) \cdot 1 - x(-2x)}{(4 - x^2)^2} \\ &= \frac{4 - x^2 + 2x^2}{(4 - x^2)^2} \\ &= \frac{4 + x^2}{(4 - x^2)^2} \end{aligned}$$

$f'(x) > 0$ since $4 + x^2 > 0$ for all x, and $(4 - x^2)^2 > 0$ for all $x \neq \pm 2$

Hence $f'(x) > 0$ for all $x \neq \pm 2$.

Question 11 (d) (ii)

Criteria	Marks
• Correct graph	2
• Finds both vertical asymptotes, or equivalent merit	1



Question 11 (e)

Criteria	Marks
• Correct answer	1

$$\lim_{x \to 0} \frac{\sin \frac{x}{2}}{3x} = \lim_{x \to 0} \frac{1}{6} \frac{\sin \frac{x}{2}}{\frac{x}{2}}$$

$$= \frac{1}{6} \lim_{x \to 0} \frac{\sin \frac{x}{2}}{\frac{x}{2}}$$

$$= \frac{1}{6} \left(\text{since } \lim_{t \to 0} \frac{\sin t}{t} = 1. \right)$$

Question 11 (f)

Criteria	Marks
• Correct solution	3
• Finds a primitive of the form of $a\tan^{-1}u$	2
• Attempts to use given substitution	1

$u = e^{3x}$, $\dfrac{du}{dx} = 3e^{3x}$, $u^2 = e^{6x}$

If $x = 0$, then $u = e^0 = 1$

If $x = \dfrac{1}{3}$, then $u = e^{3\cdot\frac{1}{3}} = e$

Hence

$$\int_0^{\frac{1}{3}} \frac{e^{3x}}{e^{6x}+1}\,dx$$

$$= \frac{1}{3}\int_1^e \frac{1}{u^2+1}\,du$$

$$= \frac{1}{3}\Big[\tan^{-1}u\Big]_1^e$$

$$= \frac{1}{3}\left(\tan^{-1}e - \tan^{-1}1\right)$$

$$= \frac{1}{3}\left(\tan^{-1}e - \frac{\pi}{4}\right).$$

Question 11 (g)

Criteria	Marks
• Correct solution	2
• Uses correct derivative of $\sin^{-1}5x$, or equivalent merit	1

Using the product rule

$$f'(x) = x^2\frac{5}{\sqrt{1-25x^2}} + 2x\sin^{-1}5x$$

$$= \frac{5x^2}{\sqrt{1-25x^2}} + 2x\sin^{-1}5x.$$

Question 12 (a) (i)

Criteria	Marks
• Correct answer	1

We want

$$\sqrt{3}\cos x - \sin x = 2\cos(x+\alpha)$$

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

$$= \cos x \cos\alpha - \sin x \sin\alpha,$$

So $\cos\alpha = \frac{\sqrt{3}}{2}$ and $\sin\alpha = \frac{1}{2}$. Hence $\tan\alpha = \frac{1}{\sqrt{3}}$.

$$\therefore\ \alpha = \frac{\pi}{6} \left(\text{and } 0 < \frac{\pi}{6} < \frac{\pi}{2}\right)$$

Question 12 (a) (ii)

Criteria	Marks
• Correct solution	2
• Obtains an equation of the form $\cos(\_\_) = k$, or equivalent merit	1

Rearrange the equation and use part (i):

$$\sqrt{3}\cos x - \sin x = 1, \text{ ie } 2\cos\left(x+\frac{\pi}{6}\right) = 1$$

$$\cos\left(x+\frac{\pi}{6}\right) = \frac{1}{2}$$

$$\therefore x + \frac{\pi}{6} = \frac{\pi}{3} \quad \text{or} \quad x + \frac{\pi}{6} = \frac{5\pi}{3}$$

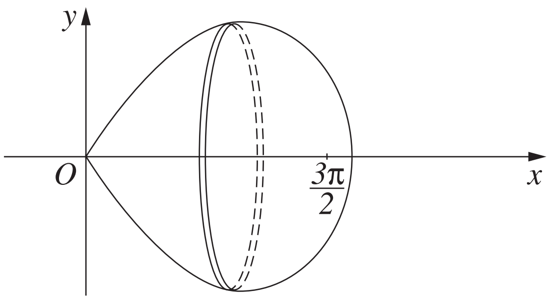
Hence the solutions satisfying $0 < x < 2\pi$ are

$$x = \frac{\pi}{3} - \frac{\pi}{6} = \frac{\pi}{6}$$

and $x = \frac{5\pi}{3} - \frac{\pi}{6} = \frac{3\pi}{2}$.

Question 12 (b)

Criteria	Marks
• Correct solution	3
• Finds correct primitive, or equivalent merit	2
• Finds correct integrand, or equivalent merit	1



Volume of solid is given by

$$V = \pi \int y^2 \, dx$$

$$V = \pi \int_0^{\frac{3\pi}{2}} \left(3\sin\frac{x}{2}\right)^2 dx$$

$$= 9\pi \int_0^{\frac{3\pi}{2}} \sin^2\frac{x}{2} \, dx$$

$$V = 9\pi \int_0^{\frac{3\pi}{2}} \frac{1}{2}(1 - \cos x) \, dx \qquad \left(\begin{aligned} \text{Note: } \cos x &= \cos^2\frac{x}{2} - \sin^2\frac{x}{2} \\ &= 1 - 2\sin^2\frac{x}{2} \\ \therefore \sin^2\frac{x}{2} &= \frac{1}{2}(1 - \cos x) \end{aligned}\right)$$

$$= \frac{9\pi}{2}\Big[(x - \sin x)\Big]_0^{\frac{3\pi}{2}}$$

$$= \frac{9\pi}{2}\left[\left(\frac{3\pi}{2} - \sin\frac{3\pi}{2}\right) - (0 - \sin 0)\right]$$

$$= \frac{9\pi}{2}\left(\frac{3\pi}{2} + 1\right)$$

The volume is $\frac{9\pi}{2}\left(\frac{3\pi}{2} + 1\right)$ units^3.

Question 12 (c)

Criteria	Marks
• Correct solution	3
• Finds values for A, B and k, or equivalent merit	2
• Finds value for A, or equivalent merit	1

As $t \to \infty$, T approaches the temperature of the room, and so $A = 22$.

When $t = 0$, $T = 22 + B$

$$= 80$$

$$\therefore \; B = 58.$$

Hence

$$T = 22 + 58e^{-kt}$$

To find k: After 10 minutes the temperature is $60°$ ($t = 10,\ T = 60$)

$$60 = 22 + 58e^{-k\times 10}$$

$$38 = 58e^{-10k}$$

$$\log_e\left(\frac{38}{58}\right) = -10k,$$

$$\text{so } k = \frac{-1}{10}\log_e\left(\frac{38}{58}\right)$$

To determine time to drop to 40°C:

$$40 = 22 + 58e^{\frac{1}{10}\log_e\left(\frac{38}{58}\right)t}$$

$$\frac{18}{58} = e^{\frac{1}{10}\log_e\left(\frac{38}{58}\right)t}$$

$$\log_e\frac{18}{58} = \frac{1}{10}\log_e\left(\frac{38}{58}\right)t$$

$$t = 10\frac{\log_e\left(\frac{18}{58}\right)}{\log_e\left(\frac{38}{58}\right)},$$

$$t = 27.67\ldots$$

$\therefore$ temperature drops to $40°$ after 28 minutes (to the nearest minute).

Question 12 (d) (i)

Criteria	Marks
• Correct solution	2
• Uses an appropriate method to attempt to find $D(t)$	1

Using the perpendicular distance formula from $P(t, t^2+3)$ to the line $y = 2x - 1$:

$$D(t) = \frac{\left|2t - (t^2+3) - 1\right|}{\sqrt{4+1}}$$

$$= \frac{\left|-t^2 + 2t - 4\right|}{\sqrt{5}}$$

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

$$= \frac{\left|t^2 - 2t + 4\right|}{\sqrt{5}}$$

Now $t^2 - 2t + 4 = (t-1)^2 + 3 > 0$ for all t, so

$D(t) = \dfrac{t^2 - 2t + 4}{\sqrt{5}}$ is the perpendicular distance.

Question 12 (d) (ii)

Criteria	Marks
• Correct answer	1

To find minimum distance, $D'(t) = 0$.

$$D'(t) = \frac{1}{\sqrt{5}}(2t - 2)$$

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

$$= 0$$

$\therefore\ t = 1$

Minimum because $D(t) \to \infty$ as $t \to \pm\infty$.

Alternative: $D(t)$ is a quadratic with minimum at $t = 1$ since $D(t) = \dfrac{1}{\sqrt{5}}\left((t-1)^2 + 3\right)$.

Question 12 (d) (iii)

Criteria	Marks
• Correct solution	1

$t = 1$ corresponds to $x = 1$, on the curve given by $y = x^2 + 3$.
$y' = 2x$, so the slope of the tangent at $x = 1$ is 2.
Also, the slope of the line $y = 2x - 1$ is 2.
$\therefore$ the line and the tangent are parallel, since their gradients are equal.

Question 12 (e)

Criteria	Marks
• Correct solution	2
• Correctly differentiates v^2 with respect to x, or equivalent merit	1

$$v^2 + 9x^2 = k$$
$$v^2 = k - 9x^2$$
$$\frac{1}{2}v^2 = \frac{1}{2}k - \frac{9}{2}x^2$$
$$\ddot{x} = \frac{d}{dx}\left(\frac{1}{2}v^2\right) = -9x$$

For SHM, $\ddot{x} = -n^2(x - b)$.
Now, $\ddot{x} = -9x$, is of this form with
$n = 3$ and $b = 0$
As $n = 3$, the period is $\frac{2\pi}{3}$.

Question 13 (a) (i)

Criteria	Marks
• Correct solution	1

Using $V = \frac{4}{3}\pi r^3$ and $A = 4\pi r^2$,

$$\begin{aligned} -10^{-4} A &= \frac{dV}{dt} \\ &= \frac{dV}{dr}\frac{dr}{dt} \\ &= 4\pi r^2 \frac{dr}{dt} \\ &= A\frac{dr}{dt} \end{aligned}$$

Hence $\frac{dr}{dt} = -10^{-4}$, which is constant.

Question 13 (a) (ii)

Criteria	Marks
• Correct answer	2
• Finds initial radius, or equivalent merit	1

From part (i) $\frac{dr}{dt} = 10^{-4}$

To determine the initial radius of the raindrop:

$\frac{4}{3}\pi r^3 = 10^{-6}$,

so $r^3 = \frac{3}{4\pi}10^{-6}$

$$\begin{aligned} r &= \sqrt[3]{\frac{3}{4\pi}}\ 10^{-2} \\ &= \frac{1}{10^2}\sqrt[3]{\frac{3}{4\pi}} \end{aligned}$$

Time to evaporate;

$$\begin{aligned} t &= \frac{r}{10^{-4}} \\ &= 10^2\sqrt[3]{\frac{3}{4\pi}} \end{aligned}$$

$\therefore$ time = 62 seconds (to the nearest second).

Question 13 (b) (i)

Criteria	Marks
• Correct solution	2
• Writes an unsimplified expression for the *x*- or *y*- coordinate of *G*, or equivalent merit	1

The point *G* divides *NT* in the ratio 2:1 externally means that *T* is the midpoint of *NG*.

Hence if $\left(x_0, y_0\right)$ are the coordinates of *G*, then

$$\frac{0 + x_0}{2} = ap \qquad (x\text{-coordinate of } T)$$

$$\frac{2a + ap^2 + y_0}{2} = 0 \qquad (y\text{-coordinate of } T)$$

$\therefore x_0 = 2ap$ and $y_0 = -2a - ap^2$

ie G is the point $(2ap,\ -2a - ap^2)$, as required

Question 13 (b) (ii)

Criteria	Marks
• Correct solution for G	2
• Shows that G lies on a parabola, or equivalent merit	1

The original parabola has focal length a and directrix $y = -a$. To show that G $(2ap, -2a - ap)^2$ lies on a parabola, eliminate p from $x = 2ap$, $\quad y = -2a - ap^2$

Now, $p = \dfrac{x}{2a}$, so

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

$$y = -2a - \frac{ax^2}{4a^2}$$

$$= -2a - \frac{x^2}{4a}$$

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

$$x^2 = -4a(y + 2a)$$

This is a parabola with focal length a and vertex $(0, -2a)$.

So the directrix is

$$y = -2a + a$$

$$= -a$$

Hence focal length and directrix are the same for both parabolas.

Alternative:

$(2ap, -ap^2)$ is the parabola obtained if the original parabola is reflected about the x-axis. It has focal length a and directrix $y = +a$.

Now $G(2ap, -2a - ap^2)$ is obtained by translating the reflected parabola down by $2a$ units. Translation preserves the focal length a, and the directrix becomes $y = a - 2a = -a$.

Question 13 (c) (i)

Criteria	Marks
• Correct solution	2
• Obtains an expression for $\dot{y}$, or equivalent merit	1

We need to find the time when the quadratic $y = ut\sin\alpha - \frac{g}{2}t^2$ is a maximum.

$$\frac{dy}{dt} = u\sin\alpha - gt$$
$$= 0 \text{ for max/min}$$
$$t = \frac{u\sin\alpha}{g}$$

This will be at the maximum height since $y = ut\sin\alpha - \frac{g}{2}t^2$ is a concave down parabola.

Question 13 (c) (ii)

Criteria	Marks
• Correct solution	1

Similarly from part (i), the projectile fired from B reaches its maximum height when

$$t = \frac{w\sin\beta}{g}.$$

The projectiles collide when they both reach their maximum height.

ie $\frac{u\sin\alpha}{g} = t = \frac{w\sin\beta}{g}$,

so $u\sin\alpha = w\sin\beta$.

Question 13 (c) (iii)

Criteria	Marks
• Correct solution	2
• Finds the distance one projectile has travelled	1

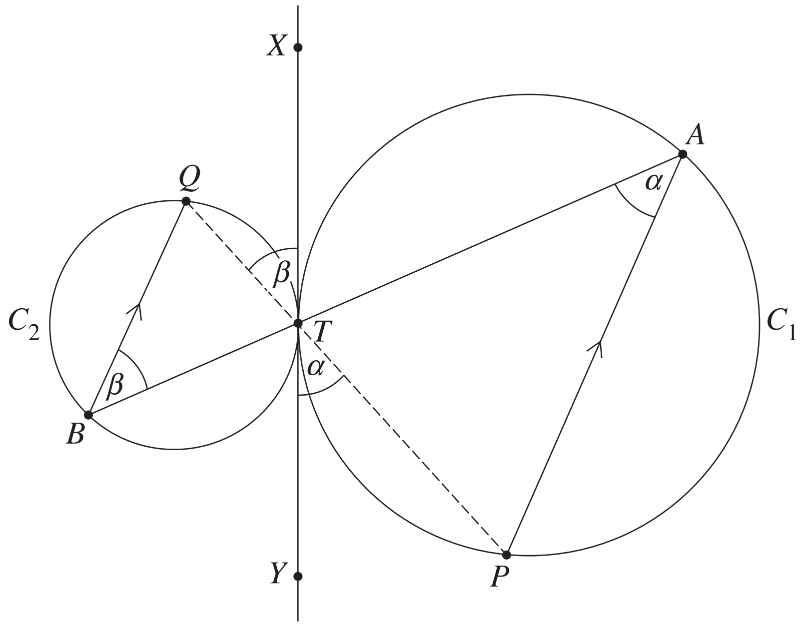
When the projectiles collide, the sum of the two distances travelled must be d. Both projectiles have travelled for time t.

$$t = \frac{u\sin\alpha}{g} \qquad = \frac{w\sin\beta}{g}, \text{ so}$$

$$\begin{aligned} d &= u\frac{u\sin\alpha}{g}\cos\alpha + w\frac{w\sin\beta}{g}\cos\beta \\ &= u\frac{w\sin\beta}{g}\cos\alpha + w\frac{u\sin\alpha}{g}\cos\beta \\ &= \frac{uw}{g}\left(\sin\beta\cos\alpha + \sin\alpha\cos\beta\right) \\ &= \frac{uw}{g}\sin\left(\alpha + \beta\right). \end{aligned}$$

Question 13 (d)

Criteria	Marks
• Correct solution	3
• Proves that $\angle QBT$ and $\angle PAT$ are equal AND uses the properties of the common tangent, or equivalent merit	2
• Proves that $\angle QBT$ and $\angle PAT$ are equal or uses the properties of the common tangent, or equivalent merit	1



The circles C_1 and C_2 have a common tangent at T.

Choose points X and Y on that tangent as marked on the diagram above.

$\angle YTP = \angle PAT = \alpha$ (angle in alternate segment, chord PT and tangent XY)

$\angle XTQ = \angle QBT = \beta$ (angle in alternate segment, chord QT and tangent XY)

But $\angle PAT = \angle QBT$ (alternate angles equal, $BQ \parallel PA$)

ie $\alpha = \beta$

$\therefore \angle YTP = \angle XTQ$

Hence QP is a straight line making equal vertically opposite angles with line XY at T.

$\therefore P, T, Q$ are collinear.

Question 14 (a) (i)

Criteria	Marks
• Correct solution	1

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

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

$$< 0 \ \left(\text{since } k+1 > k \text{ and } k > 0\right).$$

Question 14 (a) (ii)

Criteria	Marks
• Correct solution	3
• Uses correct assumption in an attempt to prove that $p(k) \Rightarrow p(k+1)$	2
• Establishes initial case, or equivalent merit	1

Case $n = 2$: $LHS \ \frac{1}{1} + \frac{1}{2^2} = 1 + \frac{1}{4} = \frac{5}{4}$ $\quad RHS$: $2 - \frac{1}{2} = \frac{3}{2}$

$LHS < RHS$

Hence true for $n = 2$

Assume true for some $k \geq 2$

ie $\sum_{p=1}^{k} \frac{1}{p^2} < 2 - \frac{1}{k}$

Need to show true for $n = k+1$

ie $\sum_{p=1}^{k+1} \frac{1}{p^2} < 2 - \frac{1}{k+1}$

Now

$$LHS = \sum_{p=1}^{k+1} \frac{1}{p^2} = \sum_{p=1}^{k} \frac{1}{p^2} + \frac{1}{(k+1)^2}$$

$$LHS < 2 - \frac{1}{k} + \frac{1}{(k+1)^2} \quad \text{(by induction assumption)}$$

$$< 2 - \frac{1}{k} + \frac{1}{k} - \frac{1}{k+1} \quad \left(\text{using part (i), ie } \frac{1}{(k+1)^2} < \frac{1}{k} - \frac{1}{k+1}\right)$$

ie $\sum_{p=1}^{k+1} \frac{1}{p^2} < 2 - \frac{1}{k+1}$

By the principle of Mathematical Induction, it is true for all $n \geq 2$.

Question 14 (b) (i)

Criteria	Marks
• Correct answer	1

From the binomial theorem

$$(1+x)^{4n} = \sum_{k=0}^{4n} \binom{4n}{k} x^{4n-k}$$

The coefficient of x^{2n} is $\binom{4n}{2n}$, choosing $k = 2n$.

Question 14 (b) (ii)

Criteria	Marks
• Correct solution	2
• Writes $\left(1+x^2+2x\right)^{2n}$ as $\left(1+x(x+2)\right)^{2n}$ or uses the binomial expansion, or equivalent merit	1

From the binomial theorem

$$\begin{aligned}\left(1+x^2+2x\right)^{2n} &= \left(1+x(x+2)\right)^{2n}\\ &= \sum_{k=0}^{2n} \binom{2n}{k} \left(x(x+2)\right)^{2n-k}\\ &= \sum_{k=0}^{2n} \binom{2n}{k} x^{2n-k}(x+2)^{2n-k}.\end{aligned}$$

Question 14 (b) (iii)

Criteria	Marks
• Correct solution	3
• Substitutes the given expression into part (ii) and makes progress towards the solution	2
• Connects $(1+x)^{4n}$ and $(1+x^2+2x)^{2n}$, or equivalent merit	1

$(1+x^2+2x) = (1+x)^2$, so

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

By part (i), $\binom{4n}{2n}$ is the coefficient of x^{2n} in $(1+x^2+2x)^{2n}$.

From part (ii) these are

the terms in $\binom{2n}{k} x^{2n-k}(x+2)^{2n-k}$ for $k = 0, \ldots, n$. If $k > n$ there is no term involving x^{2n}.

Using the given identity the coefficients of x^{2n} are:

$k = 0: \binom{2n}{0}\binom{2n-0}{0}2^{2n-0}$

$k = 1: \binom{2n}{1}\binom{2n-1}{1}2^{2n-1-1}$

$k = 2: \binom{2n}{2}\binom{2n-2}{2}2^{2n-2-2}$

$\vdots$

$k = n: \binom{2n}{n}\binom{2n-n}{n}2^{2n-n-n}$

Hence

$$\binom{4n}{2n} = \binom{2n}{0}\binom{2n}{0}2^{2n} + \binom{2n}{1}\binom{2n-1}{1}2^{2n-2} + \ldots + \binom{2n}{n}\binom{n}{n}2^0$$

$$= \sum_{k=0}^{n}\binom{2n}{k}\binom{2n-k}{k}2^{2n-2k}.$$

Question 14 (c) (i)

Criteria	Marks
• Correct solution	2
• Correctly applies Newton's method	1

Take $f(t) = e^t - \frac{1}{t}$

Then $f'(t) = e^t + \frac{1}{t^2}$

Apply Newton's method

$$t_1 = t_0 - \frac{f(t_0)}{f'(t_0)}$$

$$= 0.5 - \frac{e^{0.5} - 2}{e^{0.5} + 4}$$

$$= 0.5621\ldots$$

Hence $t_1 = 0.56$ is another approximate solution.

Question 14 (c) (ii)

Criteria	Marks
• Correct solution	3
• Uses part (c) (i) to find an approximate solution to $re^{rx} = \frac{1}{x}$, or equivalent merit	2
• Establishes $re^{rx} = \frac{1}{x}$, or equivalent merit	1

We need to determine r and x so that

$e^{rx} = \log_e x$ and $re^{rx} = \dfrac{1}{x}$

(common point and equal slope of tangents).

From the equal slopes

$e^{rx} = \dfrac{1}{rx}$

Setting $rx = t$ and using part (i), we have an approximate solution

$rx = 0.56$

Since the curves intersect at x,

$\log_e x = e^{rx} = e^{0.56}$

$x = e^{e^{0.56}} = 5.758\ldots$

now $rx = 0.56$

$\therefore r = \dfrac{0.56}{5.758\ldots}$

$= 0.0972$

$r \doteqdot 0.097$

Mathematics Extension 1

2013 HSC Examination Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	16.2	PE3
2	1	15.1	HE4
3	1	2.8	PE3
4	1	16.1	PE3
5	1	11.5	HE6
6	1	15.2	HE4
7	1	18.1	H5, PE3
8	1	5.7	H5, PE2
9	1	15.3	HE4
10	1	1.4E	PE3

Section II

Question	Marks	Content	Syllabus outcomes
11 (a)	1	16.3	PE3
11 (b)	2	15.5	HE4
11 (c)	2	18.2	HE3
11 (d) (i)	2	8.8	P7, HE4
11 (d) (ii)	2	10.5	H6, HE4
11 (e)	1	13.4	H5, HE7
11 (f)	3	11.5, 15.5	HE4, HE6
11 (g)	2	8.8, 15.5	P7, HE4
12 (a) (i)	1	5.7, 5.9	PE2
12 (a) (ii)	2	5.7, 5.9	PE2
12 (b)	3	11.4, 13.6E	H5, H8, HE7
12 (c)	3	14.2E	HE3
12 (d) (i)	2	6.5	P4
12 (d) (ii)	1	8.5, 10.6	P4, H5
12 (d) (iii)	1	8.5	P6
12 (e)	2	14.4	HE3
13 (a) (i)	1	14.1	HE5
13 (a) (ii)	2	14.1	HE5

Question	Marks	Content	Syllabus outcomes
13 (b) (i)	2	6.7E, 9.6	PE3
13 (b) (ii)	2	9.6	PE3, PE4
13 (c) (i)	2	14.3	HE3
13 (c) (ii)	1	14.3	HE3
13 (c) (iii)	2	5.7, 14.3	PE2, HE3
13 (d)	3	2.3, 2.9	P4, PE2, PE3, PE6
14 (a) (i)	1	1.4E	PE3
14 (a) (ii)	3	7.4	HE2
14 (b) (i)	1	17.3	HE3
14 (b) (ii)	2	17.3	HE3
14 (b) (iii)	3	17.3	HE3
14 (c) (i)	2	16.4	HE7
14 (c) (ii)	3	8.6, 12.2, 12.4, 12.5	P6, H3, HE7