2019 HSC Mathematics Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 11 (a)

Criteria	Marks
• Provides correct solution	2
• Correctly substitutes the given values into the sine rule, or equivalent merit	1

Sample answer:

$$\frac{x}{\sin 40°} = \frac{8}{\sin 110°}$$

$$x = \frac{8\sin 40°}{\sin 110°}$$

$$= 5.47$$

$$= 5.5$$

Question 11 (b)

Criteria	Marks
• Provides correct solution	2
• Attempts to use the product rule, or equivalent merit	1

Sample answer:

$$\frac{d}{dx}\left(x^2 \sin x\right) = x^2 \cos x + 2x \sin x$$

Question 11 (c)

Criteria	Marks
• Provides correct solution	2
• Attempts to use the quotient rule, or equivalent merit	1

Sample answer:

$$\frac{d}{dx}\left(\frac{2x+1}{x+5}\right) = \frac{(x+5)2-(2x+1)}{(x+5)^2}$$

Question 11 (d)

Criteria	Marks
• Provides correct solution	2
• Identifies the common ratio, or equivalent merit	1

Sample answer:

$$2000 - 1200 + 720 - 432 \ldots$$

$$a = 2000 \qquad r = \frac{-1200}{2000} = -0.6$$

$$S_\infty = \frac{a}{1-r} = \frac{2000}{1-(-0.6)} = 1250$$

Question 11 (e)

Criteria	Marks
• Provides correct solution	3
• Obtains correct primitive, or equivalent merit	2
• Obtains a primitive of the form $A(3x+2)^{-n}$, or equivalent merit	1

Sample answer:

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

$$= \left[\frac{(3x+2)^{-1}}{-3}\right]_0^1$$

$$= \frac{-1}{3}\left[\frac{1}{3x+2}\right]_0^1$$

$$= \frac{-1}{3}\left(\frac{1}{5} - \frac{1}{2}\right)$$

$$= \frac{-1}{3}\left(\frac{-3}{10}\right)$$

$$= \frac{1}{10}$$

Question 11 (f)

Criteria	Marks
• Provides correct solution	2
• Correctly provides one relevant probability, or equivalent merit	1

Sample answer:

$P(\text{gg}) \text{ or } P(\text{pp})$

$= \frac{5}{12} \times \frac{4}{11} + \frac{7}{12} \times \frac{6}{11}$

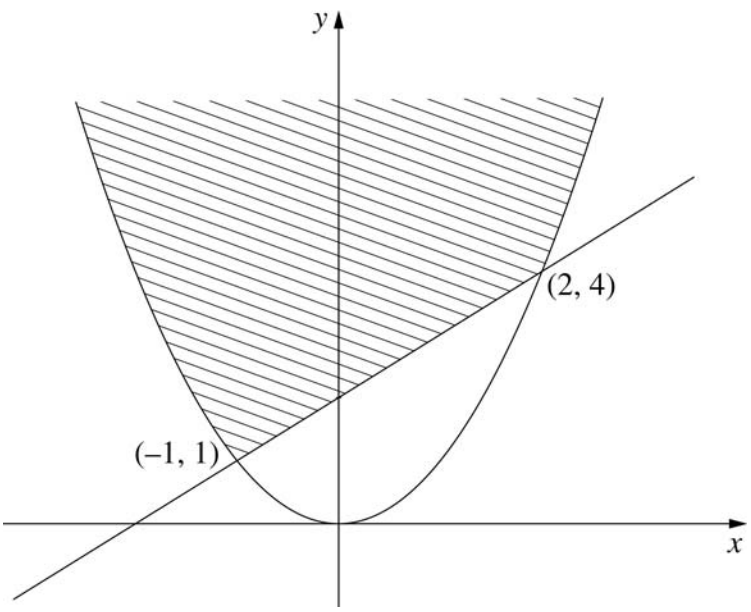
$= \frac{20 + 42}{132}$

$= \frac{31}{66}$

Question 11 (g)

Criteria	Marks
• Provides correct solution	2
• Correctly indicates one region, or equivalent merit	1

Sample answer:



Question 12 (a) (i)

Criteria	Marks
• Provides correct solution	2
• Obtains the slope of the line AB, or equivalent merit	1

Sample answer:

$$2y = x + 4$$

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

Slope of line AC is $\dfrac{-1}{\frac{1}{2}} = -2$

$$y = -2x + K$$

Passes through $A(8, 6)$

$$6 = -2 \times 8 + K$$

$$K = 22$$

$$y = -2x + 22$$

$$(\text{or } 2x + y - 22 = 0)$$

Question 12 (a) (ii)

Criteria	Marks
• Provides correct solution	2
• Finds the coordinates of B or C or the length of one side, or equivalent merit	1

Sample answer:

Height of $\triangle ABC$ is 6.

Base is distance between B and C.

B: $x - \text{int} \qquad y = 0$

$$x - 2 \times 0 + 4 = 0$$

$$x = -4$$

$$B(-4, 0)$$

C: $x - \text{int} \qquad y = 0$

$$2x + 0 - 22 = 0$$

$$x = 11$$

$$C(11, 0)$$

BC length is 15

$$\text{Area } \triangle ABC = \frac{1}{2} \times 15 \times 6$$

$$= 45$$

Question 12 (b)

Criteria	Marks
• Provides correct solution	3
• Obtains two equations involving a and d, or equivalent merit	2
• Obtains one equation involving a and d, or equivalent merit	1

Sample answer:

$$T_n = a + (n-1)d$$

$$6 = T_4 = a + 3d \quad \boxed{1}$$

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

$$120 = S_{16} = \frac{16}{2}(2a + 15d)$$

$$15 = 2a + 15d \qquad \boxed{2}$$

$$6 = a + 3d \qquad \boxed{1}$$

$$12 = 2a + 6d \qquad 2\times\boxed{1}$$

$$\boxed{2} - 2\times\boxed{1} \qquad 3 = 9d$$

$$d = \frac{1}{3}$$

Question 12 (c) (i)

Criteria	Marks
• Provides correct answer	1

Sample answer:

$$\begin{aligned} L(31) &= 200\,000e^{-0.14\times 31} \\ &= 2607.3\ldots \\ &= 2607 \text{ (nearest leaf)} \end{aligned}$$

Question 12 (c) (ii)

Criteria	Marks
• Provides correct solution	2
• Correctly differentiates $L(t)$, or equivalent merit	1

Sample answer:

$$L'(t) = -0.14 \times 200\,000e^{-0.14t}$$

$$L'(31) = -0.14 \times 200\,000e^{-0.14\times 31} \ (= -0.14L(31))$$

$$= -365.02\ldots$$

Question 12 (c) (iii)

Criteria	Marks
• Provides correct solution	2
• Obtains an exponential equation for t, or equivalent merit	1

Sample answer:

Want t so that $L(t) = 100$

$$100 = 200\,000e^{-0.14t}$$

$$\frac{1}{2000} = e^{-0.14t}$$

$$t = \frac{-1}{0.14}\ln\left(\frac{1}{2000}\right)$$

$$= 54.29\ldots$$

100 leaves left when $t = 54.29\ldots$

Question 12 (d)

Criteria	Marks
• Provides correct solution	3
• Obtains correct primitive, or equivalent merit	2
• Obtains correct definite integral, or equivalent merit	1

Sample answer:

As function is above x-axis in given interval we have

$$\text{Area} = \int_0^3 \frac{3x}{x^2+1}\,dx$$

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

$$= \frac{3}{2}\Big[\ln\big(x^2+1\big)\Big]_0^3$$

$$= \frac{3}{2}\big(\ln(10) - ln(1)\big)$$

$$= \frac{3}{2}\ln(10)$$

Question 13 (a)

Criteria	Marks
• Provides correct solution	3
• Correctly solves one case, or equivalent merit	2
• Identifies both cases to be considered or finds one correct answer, or equivalent merit	1

Sample answer:

$$2\sin x\cos x = \sin x$$

$$2\sin x\cos x - \sin x = 0$$

$$\sin x(2\cos x - 1) = 0$$

$\sin x = 0$

$x = 0,\ \pi,\ 2\pi$

$2\cos x - 1 = 0$

$2\cos x = 1$

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

$x = \frac{\pi}{3},\ \frac{5\pi}{3}$

Question 13 (b)

Criteria	Marks
• Provides correct solution	3
• Obtains the length of the chord AB, or equivalent merit	2
• Converts the angle at centre to radians or attempts to use the cosine rule, or equivalent merit	1

Sample answer:

$$AB^2 = 20^2 + 20^2 - 2 \times 20 \times 20 \cos 70$$

$$= 526.3838\ldots$$

$$AB = 22.94$$

$$AB_{\text{Arc}} = 20 \times \frac{70\pi}{180}$$

$$= 24.43$$

$$P = 22.94 + 24.43$$

$$= 47.37$$

$$= 47.4 \text{ cm}$$

Question 13 (c) (i)

Criteria	Marks
• Provides correct solution	2
• Attempts to use the chain rule, or equivalent merit	1

Sample answer:

$$\frac{d}{dx}(\ln x)^2 = 2 \ln x \times \frac{1}{x}$$

$$= \frac{2}{x} \ln x$$

Question 13 (c) (ii)

Criteria	Marks
• Provides correct answer	1

Sample answer:

$$\int \frac{\ln x}{x}\,dx$$

$$= \frac{1}{2}\int \frac{2}{x}\ln x\,dx$$

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

Question 13 (d)

Criteria	Marks
• Provides correct solution	3
• Obtains correct primitive, or equivalent merit	2
• Obtains correct integral, or equivalent merit	1

Sample answer:

$$V = \pi\int_0^1 \left(x - x^3\right)^2 dx$$

$$= \pi\int_0^1 x^2 - 2x^4 + x^6\,dx$$

$$= \pi\left[\frac{x^3}{3} - \frac{2x^5}{5} + \frac{x^7}{7}\right]_0^1$$

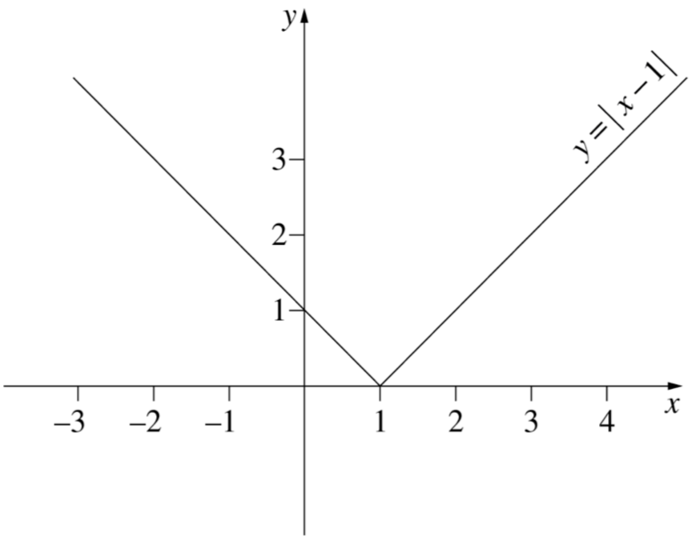
$$= \pi\left(\frac{1}{3} - \frac{2}{5} + \frac{1}{7}\right)$$

$$= \frac{8\pi}{105}$$

Question 13 (e) (i)

Criteria	Marks
• Provides correct sketch	1

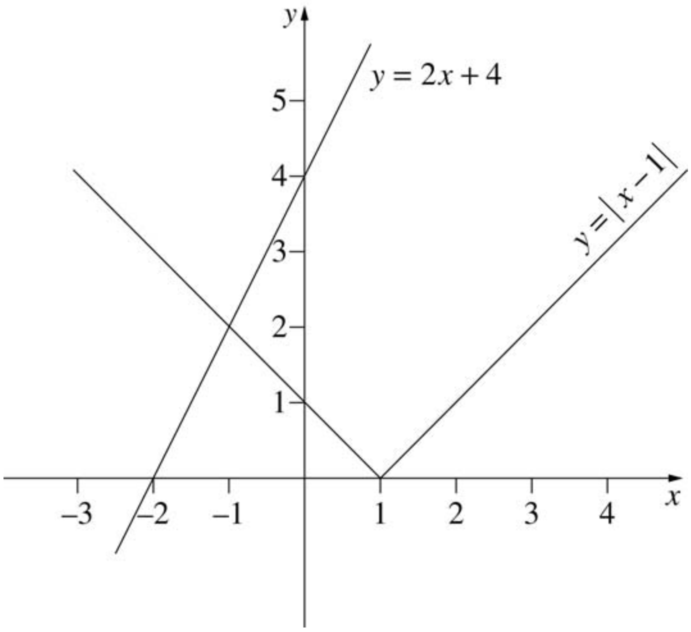
Sample answer:



Question 13 (e) (ii)

Criteria	Marks
• Provides correct solution	2
• Sketches $y = 2x + 4$ or attempts to solve $2x + 4 = -(x - 1)$, or equivalent merit	1

Sample answer:



$$2x + 4 = -(x - 1)$$
$$2x + 4 = -x + 1$$
$$3x = -3$$
$$x = -1$$

Question 14 (a)

Criteria	Marks
• Provides correct solution	2
• Attempts to integrate, or equivalent merit	1

Sample answer:

$a = e^{2t} - 4 \qquad t = 0$

$\qquad\qquad\qquad v = 0$

$$v = \int e^{2t} - 4\,dt$$

$$v = \frac{e^{2t}}{2} - 4t + c$$

$$0 = \frac{e^{2(0)}}{2} - 4(0) + c$$

$$0 = \frac{1}{2} + c$$

$$c = \frac{-1}{2}$$

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

Question 14 (b) (i)

Criteria	Marks
• Provides correct solution	2
• Finds both *x*-values or determines the nature of one stationary point, or equivalent merit	1

Sample answer:

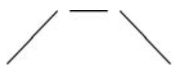
$f'(x) = 0$

$$0 = 3x^2 + 2x - 1$$

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

$x = -1$ $\qquad\qquad$ $x = \frac{1}{3}$

x	-2	-1	0
$f'(x)$	$+7$	0	-1



Maximum at $x = -1$

x	0	$\frac{1}{3}$	1
$f'(x)$	-1	0	$+4$

Minimum at $x = \frac{1}{3}$

Question 14 (b) (ii)

Criteria	Marks
• Provides correct solution	2
• Finds correct primitive, or equivalent merit	1

Sample answer:

$$f(x) = \frac{3x^3}{3} + \frac{2x^2}{2} - x + c$$

at the point (0, 4)

$$4 = 0^3 + 0^2 - 0 + c$$

$$4 = c$$

$$\therefore f(x) = x^3 + x^2 - x + 4$$

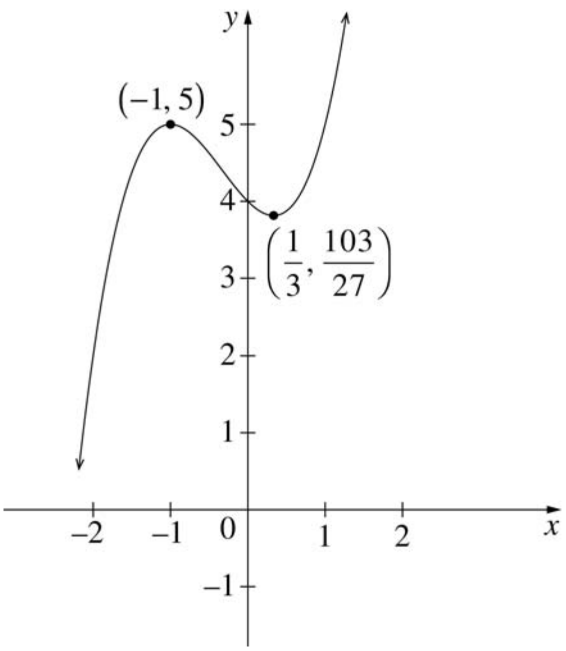
Question 14 (b) (iii)

Criteria	Marks
• Provides correct sketch	2
• Provides curve with correct shape, or equivalent merit	1

Sample answer:

$x = -1$ $\qquad$ $x = \dfrac{1}{3}$

$y = 5$ $\qquad$ $y = \dfrac{103}{27}$



Question 14 (b) (iv)

Criteria	Marks
• Provides correct solution	1

Sample answer:

$$f''(x) = 6x + 2$$

$$f''(x) < 0$$

$$6x + 2 < 0$$

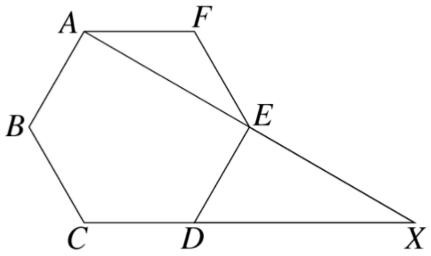
$$6x < -2$$

$$x < \frac{-1}{3}$$

Question 14 (c)

Criteria	Marks
• Provides correct solution	3
• Correctly finds two angles in $\triangle DEX$, or equivalent merit	2
• Finds vertex angle in a regular hexagon, or equivalent merit	1

Sample answer:



$ABCDEF$ is a regular hexagon of side length 1.

$$S = (6-2)\times 180$$

$$S = 720$$

$$\angle AFE = \frac{720°}{6}$$

$$= 120°$$

$\triangle AEF$ is isosceles, sides of a regular hexagon are equal.

$$\angle AEF = \frac{180° - 120°}{2}$$

$$= 30°$$

$$\angle AED = 120° - 30°$$

$$= 90°$$

$\angle DEX = 90°$ (supplementary $\angle$)

$\angle EDX = 60°$ (supplementary $\angle$)

$ED = 1$ (given)

$\tan 60° = \dfrac{EX}{1}$ ($\triangle DEX$ is right angled)

$\therefore\ EX = \sqrt{3}$

Question 14 (d)

Criteria	Marks
• Provides correct solution	3
• Obtains two equations in a and b, or equivalent merit	2
• Obtains the slope of the curve where $x = 2$ or shows point of tangency is $(2, -2)$, or equivalent merit	1

Sample answer:

$$y = x^3 + ax^2 + bx + 4$$

$$y' = 3x^2 + 2ax + b$$

$$y = x - 4$$

$$\therefore m = 1 \quad \text{at } x = 2$$

$$1 = 3(2)^2 + 2a(2) + b$$

$$1 = 12 + 4a + b$$

$$-11 = 4a + b \qquad ①$$

$$\text{at } x = 2$$

$$y = 2 - 4$$

$$y = -2$$

$$-2 = 2^3 + a(2)^2 + b(2) + 4$$

$$-2 = 8 + 4a + 2b + 4$$

$$-14 = 4a + 2b \qquad ②$$

②–①: $b = -3$

$$-11 = 4a - 3$$

$$-8 = 4a$$

$$\therefore a = -2$$

Question 15 (a)

Criteria	Marks
• Provides correct solution	2
• Obtains the quadratic equation in x, or equivalent merit	1

Sample answer:

$$e^{2\ln x} = x + 6 \qquad x > 0$$

$$e^{\ln x^2} = x + 6$$

$$x^2 = x + 6$$

$$x^2 - x - 6 = 0$$

$$(x - 3)(x + 2) = 0$$

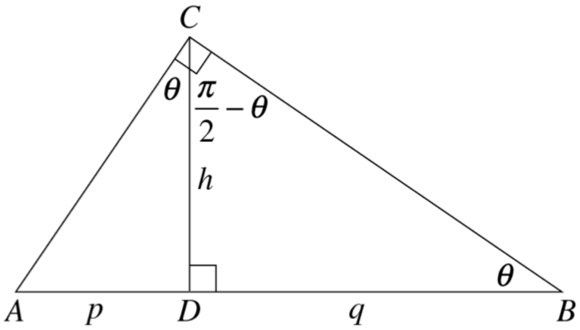
$$x = 3 \qquad (\text{as } x > 0)$$

Question 15 (b)

Criteria	Marks
• Provides correct solution	3
• Show one pair of triangles are similar, or equivalent merit	2
• Attempts to show that one pair of triangles are similar or uses p or q in a Pythagorean identity, or equivalent merit	1

Sample answer:

Method 1:



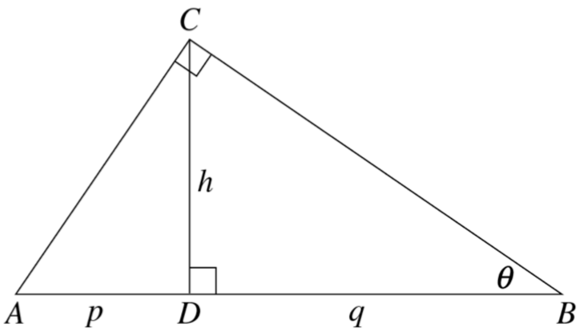
$\triangle ADC \,|||\, \triangle CDB$ (AA)

$$\frac{h}{p} = \frac{q}{h} \qquad \text{(corresponding sides in proportion)}$$

$$\therefore \quad h^2 = pq$$

$$h = \sqrt{pq} \qquad (h > 0)$$

Method 2:



Pythag in $\triangle ABC$

$$AB^2 = AC^2 + BC^2$$

$$(p+q)^2 = AC^2 + BC^2$$

Pythag in $\triangle ADC$ and $\triangle BDC$

$$\begin{aligned}(p+q)^2 &= p^2+h^2+q^2+h^2\\ p^2+2pq+q^2 &= p^2+2h^2+q^2\\ 2pq &= 2h^2\\ h^2 &= pq\\ h &= \sqrt{pq} \quad (h>0)\end{aligned}$$

Question 15 (c) (i)

Criteria	Marks
• Provides correct solution	3
• Shows that the length of *BR* is $\frac{8}{x}$, or equivalent merit	2
• Shows $\angle PBR$ is equal to $\angle APQ$, or equivalent merit	1

Sample answer:

$BR \parallel PQ$ (alternate angles).

So $\angle RBP = \angle QPA$ (corresponding angles).

$\angle BRP$ and $\angle PQA$ are both right angles.

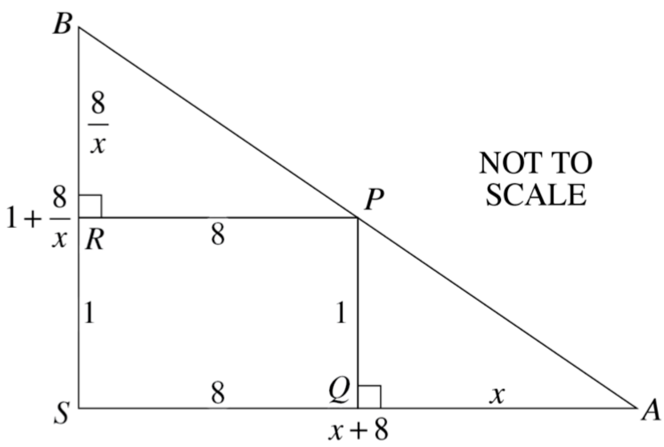
So $\triangle BRP$ and $\triangle PQA$ are similar (AA).

$$\frac{BR}{RP} = \frac{PQ}{QA}$$

$$\frac{BR}{8} = \frac{1}{x}$$

$$BR = \frac{8}{x}$$

BR and QA produced will meet at right angles at S.



So $D^2 = (x+8)^2 + \left(\frac{8}{x}+1\right)^2$

Question 15 (c) (ii)

Criteria	Marks
• Provides correct solution	3
• Verifies that a stationary point occurs at $x = 2$, or equivalent merit	2
• Differentiates D^2, or equivalent merit	1

Sample answer:

$$\frac{d\left(D^2\right)}{dx} = 2(x+8) + 2\left(\frac{8}{x}+1\right)\left(\frac{-8}{x^2}\right)$$

at $x = 2$ $\quad \dfrac{d\left(D^2\right)}{dx} = 2 \times 10 + 2 \times 5 \times (-2)$

$$= 20 - 20$$

$$= 0$$

So has a stationary point at $x = 2$

at $x = 1$ $\quad \dfrac{d\left(D^2\right)}{dx} = 2 \times 9 + 2 \times 9 \times (-8)$

$$= 18 - 144$$

$$< 0$$

at $x = 4$ $\quad \dfrac{d\left(D^2\right)}{dx} = 2 \times 12 + 2 \times 3\left(\dfrac{-1}{2}\right)$

$$= 24 - 3$$

$$> 0$$

Summary

x	1	2	4
$\dfrac{d\left(D^2\right)}{dx}$	\	—	/

So D^2 has a minimum at $x = 2$.

Question 15 (d) (i)

Criteria	Marks
• Provides correct solution	2
• Considers a complementary event, or equivalent merit	1

Sample answer:

$$\begin{aligned} P(\text{at least } 1) &= 1 - P(\text{none}) \\ &= 1 - (1 - 0.02)^2 \\ &= 0.0396 \end{aligned}$$

Question 15 (d) (ii)

Criteria	Marks
• Provides correct solution	2
• Obtains an inequality or equation for the number of people, or equivalent merit	1

Sample answer:

For n people

$$\begin{aligned} P(\text{at least } 1) &= 1 - P(\text{none}) \\ &= 1 - (1 - 0.02)^n \\ &= 1 - 0.98^n \end{aligned}$$

$$1 - 0.98^n \geq 0.4$$

$$0.6 \geq 0.98^n$$

$$\ln 0.6 \geq \ln\left(0.98^n\right) = n \ln 0.98$$

$$n \geq \frac{\ln 0.6}{\ln 0.98} = 25.28\ldots$$

So $n = 26$ is smallest number.

Question 16 (a) (i)

Criteria	Marks
• Provides correct solution	2
• Obtains the expression for A_1, or equivalent merit	1

Sample answer:

$$\text{Quarterly rate } = \frac{6}{100} \div 4$$

$$A_1 = 1\,000\,000(1.015)^4 - 80\,000$$

$$A_2 = A_1(1.015)^4 - 80000$$

$$= 1\,000\,000(1.015)^8 - 80\,000(1.015)^4 - 80\,000$$

$$= 1\,000\,000(1.015)^8 - 80\,000\left(1 + 1.015^4\right)$$

Question 16 (a) (ii)

Criteria	Marks
• Provides correct solution	3
• Correctly sums the series and equates A_n to zero, or equivalent merit	2
• Obtains an expression for A_n, or equivalent merit	1

Sample answer:

Continuing in this way,

$$A_n = 1\,000\,000(1.015)^{4n} - 80\,000\left(1 + 1.015^4 + 1.015^8 + \cdots + 1.015^{4(n-1)}\right)$$

$$= 1\,000\,000(1.015)^{4n} - 80\,000 \times \frac{(1.015)^{4n} - 1}{\left(1.015^4\right) - 1}$$

(geometric series with $a = 1$, $r = 1.015^4$, n terms).

Let $K = 1.015^{4n}$

We want to find n so that $A_n = 0$.

$$\text{ie } 1\,000\,000K = \frac{80000(K-1)}{0.06136}$$

$$0.06136 \times 100K = 8K - 8$$

$$6.136K = 8K - 8$$

$$\therefore 1.864K = 8$$

$$\therefore (1.015)^{4n} = \frac{8}{1.864} = 4.2918\ldots$$

$$4n\log(1.015) = \log(4.2918\ldots)$$

$$n = \frac{1}{4}\frac{\log(4.2918)}{\log(1.015)}$$

$$\approx 24.46$$

$\therefore$ Money can be withdrawn for 24 years.

Question 16 (b)

Criteria	Marks
• Provides correct solution	3
• Uses $t = 0$, $\frac{\pi}{4}$ and $\frac{\pi}{2}$ in Simpson's rule, or equivalent merit	2
• Finds the time at which the particle first comes to rest, or equivalent merit	1

Sample answer:

Particle first comes to rest when $v = 0$.

$\therefore e^{\cos t} = 1 \qquad \therefore \cos t = 0$

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

Distance travelled corresponds to area of region under the curve between $t = 0$ and $t = \frac{\pi}{2}$

$$\text{distance} = \int_0^{\frac{\pi}{2}} \left(e^{\cos t} - 1\right) dt$$

Using Simpson's Rule:

$$\frac{1}{6}\left(\frac{\pi}{2} - 0\right)\left[\left(e^{\cos 0} - 1\right) + 4\left(e^{\cos\frac{\pi}{4}} - 1\right) + \left(e^{\cos\frac{\pi}{2}} - 1\right)\right]$$

$$= \frac{\pi}{12}\left[e - 1 + 4e^{\frac{1}{\sqrt{2}}} - 4 + 0\right]$$

$$= \frac{\pi}{12}\left[e + 4e^{\frac{1}{\sqrt{2}}} - 5\right]$$

$\doteqdot$ 1.53 (to 2 decimal places)

Question 16 (c) (i)

Criteria	Marks
• Provides correct solution	2
• Finds the equation of the tangent at $(1, 1)$ or finds the equation of the line through $(1, 1)$ and $\left(\frac{r-1}{r}, 0\right)$, or equivalent merit	1

Sample answer:

$$y = x^r$$

$$\frac{dy}{dx} = rx^{r-1}$$

when $x = 1$ $\quad \frac{dy}{dx} = r$

Equation of tangent is $y - 1 = r(x - 1)$.

when $y = 0$ $\quad -1 = r(x - 1)$

$\therefore\ x - 1 = \frac{-1}{r}$

$\therefore\quad x = 1 - \frac{1}{r} = \frac{r-1}{r}$

Hence, the line meets the x-axis at $\left(\frac{r-1}{r}, 0\right)$

Question 16 (c) (ii)

Criteria	Marks
• Provides correct solution	2
• Recognises that the area of R is the difference of two areas, or equivalent merit	1

Sample answer:

$$\text{Area of } R = \int_0^1 x^r\,dx - \text{area of triangle}$$

$$= \left[\frac{x^{r+1}}{r+1}\right]_0^1 - \frac{1}{2}\times\left(1-\frac{r-1}{r}\right)\times 1$$

$$= \frac{1}{r+1} - \frac{1}{2}\left(\frac{r-(r-1)}{r}\right)$$

$$= \frac{1}{r+1} - \frac{1}{2r}$$

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

Question 16 (c) (iii)

Criteria	Marks
• Provides correct solution	3
• Finds the value of r at which there is a stationary point, or equivalent merit	2
• Finds the derivative of the area of R, or equivalent merit	1

Sample answer:

$$\text{Let } A = \frac{r-1}{2r(r+1)}$$

$$\frac{dA}{dr} = \frac{2r(r+1)\cdot 1-(r-1)(4r+2)}{4r^2(r+1)^2}$$

$$\frac{dA}{dr} = 0 \text{ when } 2r(r+1)-(r-1)(4r+2) = 0$$

$$-2r^2+4r+2=0$$

$$r^2-2r-1=0$$

$$r = \frac{2 \pm \sqrt{4+4}}{2} = 1 \pm \sqrt{2}$$

Since $r \geq 0$ we have $r = 1+\sqrt{2}$

When $r = 2$ $\quad \dfrac{dA}{dr} = \dfrac{2}{\text{positive}} > 0$

When $r = 3$ $\quad \dfrac{dA}{dr} = \dfrac{-4}{\text{positive}} < 0$

$\therefore$ maximum value of A occurs when $r = 1+\sqrt{2}$.

2019 HSC Mathematics Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	1.1	P3
2	1	1.4	P3
3	1	1.1	P3
4	1	9.5	P5
5	1	12.3	H3
6	1	3.2	H5
7	1	13.3	H5
8	1	14.3	H5
9	1	13.6	H5
10	1	14.3	H5

Section II

Question	Marks	Content	Syllabus outcomes
11 (a)	2	5.5	P3
11 (b)	2	8.8,13.5	H5
11 (c)	2	8.9	P7
11 (d)	2	7.3	H5
11 (e)	3	11.2	H5
11 (f)	2	3.2	H5
11 (g)	2	4.2,4.4	P4
12 (a) (i)	2	6.2	P4
12 (a) (ii)	2	6.8	P4
12 (b)	3	7.1	H5
12 (c) (i)	1	14.2	H3, H4
12 (c) (ii)	2	14.2	H3, H4
12 (c) (iii)	2	14.2	H3, H4, H5
12 (d)	3	11.4,12.5	H8
13 (a)	3	1.4,5.3,13.3	H5
13 (b)	3	5.5,13.1	H5
13 (c) (i)	2	12.4	H5
13 (c) (ii)	1	12.5,11.1	H5
13 (d)	3	11.4	H8
13 (e) (i)	1	1.2,4.2	P4
13 (e) (ii)	2	1.2,1.4,4.2	P4
14 (a)	2	12.5,14.1	H5
14 (b) (i)	2	10.2	H6

Question	Marks	Content	Syllabus outcomes
14 (b) (ii)	2	10.8	H6
14 (b) (iii)	2	10.5	H6
14 (b) (iv)	1	10.4	H6
14 (c)	3	6.8,5.3	H5
14 (d)	3	8.7,10.7	H5
15 (a)	2	12.2,1.4	H3
15 (b)	3	2.5	H5
15 (c) (i)	3	2.5	H4
15 (c) (ii)	3	10.6	H5
15 (d) (i)	2	3.2,3.3	H5
15 (d) (ii)	2	3.2,3.3,12.2	H3, H5
16 (a) (i)	2	7.5	H5
16 (a) (ii)	3	7.5	H5
16 (b)	3	11.3,14.3	H3, H5, H8
16 (c) (i)	2	10.7	H5
16 (c) (ii)	2	11.4	H5, H8
16 (c) (iii)	3	10.6	H5