CSSA

CATHOLIC SECONDARY SCHOOLS ASSOCIATION
2020 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION
MATHEMATICS ADVANCED – MARKING GUIDELINES

These marking guidelines show the criteria to be applied to responses along with the marks to be awarded in line with the quality of responses. These guidelines are suggested and not prescriptive. This is not intended to be an exhaustive list but rather an indication of the considerations that students could include in their responses.

Section I
10 Marks

Questions 1-10 (1 mark each)

Question	Answer	Outcomes Assessed	Targeted Performance Bands
1	D	MA11-3	2-3
2	D	MA11-2	2-3
3	C	MA1-4, MA12-5	3-4
4	A	MA11-5	3-4
5	B	MA11-3	3-4
6	A	MA11-2	3-4
7	A	MA11-7	3-4
8	D	MA12-1	4
9	B	MA12-7	4-5
10	C	MA12-1	5-6

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Section II

90 Marks

Question 11 (2 marks)
Outcomes Assessed: **MA11-1**
Targeted Performance Bands: **2-3**

Criteria	Marks
• Correct answer	2
• Some progress towards the answer	1

Sample answer:

$$-1 \le 2x-3 \le 1$$
$$2 \le 2x \le 4$$
$$1 \le x \le 2$$

Question 12 (2 marks)
Outcomes Assessed: **MA11-5**
Targeted Performance Bands: **2-3**

Criteria	Marks
• Correct answer	2
• Some progress towards the answer	1

Sample answer:

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

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Question 13 (2 marks)
Outcomes Assessed: **MA12-7**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	2
• Correctly integrates the function	1

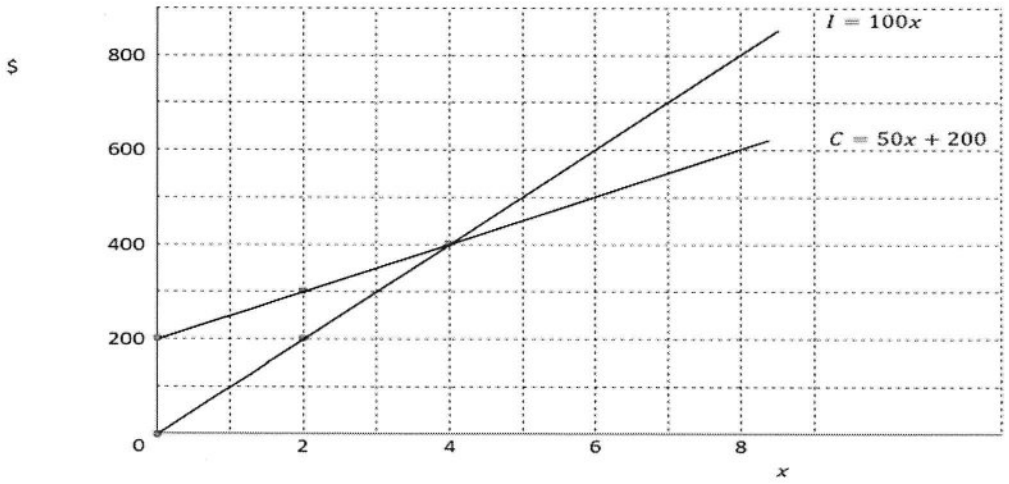
Sample answer:

$$\int_{-1}^{0}\left(3x^2-4x\right)dx=\left[x^3-2x^2\right]_{-1}^{0}$$
$$=(0)-(-1-2)$$
$$=3$$

Question 14
(a) (2 marks)
Outcomes Assessed: **MA12-1**
Targeted Performance Bands: **3**

Criteria	Marks
• TWO correct lines marked on the graph	2
• ONE correct line marked on the graph	1

Sample answer:



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Question 14
(b) (1 mark)
Outcomes Assessed: **MA11-1**
Targeted Performance Bands: **3**

Criteria	Mark
• Correct answer	1

Sample answer:

Break even = 4 items

Question 15 (2 marks)
Outcomes Assessed: **MA11-6**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	2
• Correctly differentiates the curve	1

Sample answer:

$$y' = e^x \times \cos x + e^x \times \sin x$$
$$= e^x\left(\cos x + \sin x\right)$$
at $x = 0, y' = e^0\left(\cos 0 + \sin 0\right) = 1$
so the gradient at $x = 0$ is 1.

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Question 16 (2 marks)
Outcomes Assessed: **MA11-7**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	2
• Some progress towards correct answer	1

Sample answer:

$$\begin{aligned} P(\text{sum} > 7) &= P(2,6) + P(3,\geq 5) + P(4,\geq 4) \\ &= \frac{1}{4}\times\frac{3}{6} + \frac{1}{4}\times\frac{2}{6} + \frac{1}{4}\times\frac{1}{6} \\ &= \frac{1\times(3+2+1)}{24} \\ &= \frac{1}{4} \end{aligned}$$

Question 17 (2 marks)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer and working	2
• Correct calculation of the standard deviation or other progress towards answer	1

Sample answer:

-2 to 1 = 3 standard deviations
3 standard deviations= 21-12 = 9
So each standard deviation is $9 \div 3 = 3 \quad (\sigma = 3)$

$$\begin{aligned} -2 &= \frac{12-\mu}{3} \\ -6 &= 12-\mu \\ \mu &= 12+6 \\ \mu &= 18 \end{aligned}$$

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Question 18
(a) (1 mark)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **3-4**

Criteria	Mark
• Correct answer	1

Sample answer:

$$\text{at } t = 0, C = 21 + \left(74 \times 3^{-0.2 \times 0}\right)$$
$$= 95°\text{C}$$

Question 18
(b) (1 mark)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **3-4**

Criteria	Mark
• Correct answer	1

Sample answer:

$$C = 21 + \left(74 \times 3^{-0.2 \times 10}\right)$$
$$= 21 + \left(74 \times 3^{-2}\right)$$
$$= 29.2222...$$
$$= 29°\text{C}\left(\text{to the nearest degree}\right)$$

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Question 18
(c) (2 marks)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	2
• Progress towards the correct answer	1

Sample answer:

$$50 = 21 + \left(74 + 3^{-0.2t}\right)$$

$$\frac{29}{74} = 3^{-0.2t}$$

$$\log_3\left(\frac{29}{74}\right) = -0.2t$$

$$t = -5\log_3\left(\frac{29}{74}\right)$$

$$= \frac{-5\log_{10}\left(\frac{29}{74}\right)}{\log_{10} 3}$$

$$\approx 4\text{minutes and 15 seconds}$$

$$\approx 4 \text{ minutes (nearest minute)}$$

Question 19 (2 marks)
Outcomes Assessed: **MA12-5**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct solution	2
• Some progress	1

Sample answer:

$$\text{LHS} = \frac{\sec\theta\left(1-\cos^4\theta\right)}{1+\cos^2\theta}$$

$$= \frac{1}{\cos\theta}\left(1-\cos^2\right)$$

$$= \frac{1}{\cos\theta} \times \sin^2\theta$$

$$= \sin\theta\tan\theta$$

$$= \text{RHS}$$

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Question 20
(a) (2 marks)
Outcomes Assessed: **MA12-4**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	2
• Some progress towards finding terms or sums	1

Sample answer:

$$S_1 = \frac{1\times 10}{2} = 5 \qquad T_1 = 5$$

$$S_2 = \frac{2\times 13}{2} = 13 \qquad T_2 = 13-5 = 8$$

$$T_3 = 24-13 = 11$$

$$S_3 = \frac{3\times 16}{2} = 24$$

So, the first three terms are 5,8 and 11.

Question 20
(b) (1 mark)
Outcomes Assessed: **MA12-4**
Targeted Performance Bands: **3-4**

Criteria	Mark
• Correct answer	1

Sample answer:

$$T_n = 5+(n-1)\times 3$$
$$= 2+3n$$

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Question 21 (3 marks)
Outcomes Assessed: **MA12-5**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	3
• ONE correct solution	2
• Correctly determines the acute-related angle, or some other progress	1

Sample answer:

$$\sin\left(x+\frac{\pi}{6}\right)=-\frac{\sqrt{3}}{2}$$

$$\text{acute-related angle } \left(x+\frac{\pi}{6}\right)=\frac{\pi}{3}$$

$$x+\frac{\pi}{6}=\frac{4\pi}{3},\frac{5\pi}{3}$$

$$x=\frac{7\pi}{6},\frac{3\pi}{2}$$

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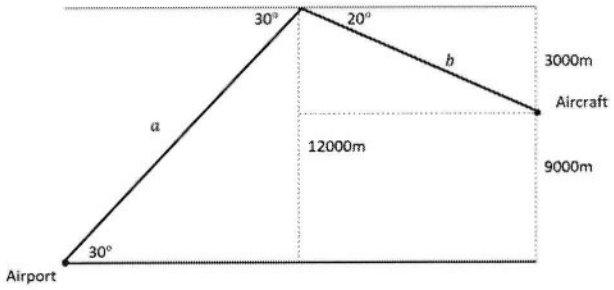
Question 22 (5 marks)
Outcomes Assessed: **MA11-4**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer and working	5
• Three correct answers for length a, length b, obtuse angle 130° AND correct substitution in the cosine rule	4
• Three correct answers for length a, length b, obtuse angle 130°	3
• Two correct answers for length a, length b, obtuse angle 130°	2
• One correct answer for length a, length b, obtuse angle 130°	1

Sample answer:



$$\sin 30° = \frac{12\,000}{a}$$

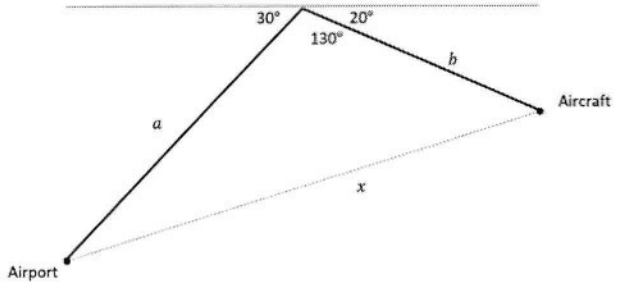
$$a = \frac{12\,000}{\sin 30°}$$

$$a = 24\,000\,\text{m}$$

$$\sin 20° = \frac{3000}{b}$$

$$b = \frac{3000}{\sin 20°}$$

$$a \approx 8771.14\,\text{m} \ (2 \text{ decimal places})$$



$$x^2 = a^2 + b^2 - 2ab\cos X$$

$$x^2 = 24\,000^2 + 8711.4132^2 - 2 \times 24\,000 \times 8711.4132 \times \cos 130°$$

$$x = 30390\,\text{m} \ (\text{to the nearest metre})$$

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Question 23 (3 marks)
(a) (2 marks)
Outcomes Assessed: **MA12-7**
Targeted Performance Bands: **4**

Criteria	Mark
• Correct answer	2
• Some progress towards the correct answer	1

Sample answer:

x	0	0.5	1	1.5	2
$\sqrt{3^x+1}$	1.41421	1.65289	2	2.48920	3.16227

$$R = \frac{0.5}{2}\left(1.41421 + 2\left(1.65289 + 2 + 2.48920\right) + 3.16227\right)$$
$$\approx 4.215165...$$
$$\approx 4.22\left(\text{to 2 decimal places}\right)$$

(b) (1 mark)
Outcomes Assessed: **MA12-7, MA12-10**
Targeted Performance Bands: **4**

Criteria	Mark
• Correct answer	1

Sample answer:

Overestimation – trapezia are bigger than the curve. i.e. it is concave up.

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Question 24 (5 marks)

(a) (1 marks)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **3**

Criteria	Mark
• Correct answer	1

Sample answer:

$r = 0.63$

(b) (2 marks)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **3**

Criteria	Marks
• Correct values and correct equation	2
• Correct gradient and/or correct y-intercept	1

Sample answer:

$m = 0.51$

$c = 40.16$

$y = 0.51x + 40.16$

(c) (1 mark)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **3-4**

Criteria	Mark
• Correct gradient and/or correct y-intercept	1

Sample answer:

The correlation coefficient will be lower/weaker when the additional student is included in the data. The value is now $r = 0.009$

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(d) (1 mark)
Outcomes Assessed: **MA12-8**
Targeted Performance Bands: **4-5**

Criteria	Mark
• Correct gradient and/or correct y-intercept	1

Sample answer:

Disagree. The original data indicated that there might be a correlation. However, when the additional student is included, it seems that there is almost no correlation between driving hours and marks in Visual Arts.

Question 25 (4 marks)
(a) (1 mark)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **4**

Criteria	Mark
• Correct answer	1

Sample answer:

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

(b) (3 marks)
Outcomes Assessed: **MA12-6**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer with reasoning	3
• Find the correct time	2
• Some progress towards the correct answer	1

Sample answer:

Possible min at $v = 0$

$$0 = 1 - 2e^{-2t}$$
$$e^{-2t} = \frac{1}{2}$$
$$e^{2t} = 2$$
$$2t = \ln 2$$
$$t = \frac{1}{2}\ln 2$$

$a = 4e^{-2t}$, which is positive for all t. So any turning point is a global minimum.

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Question 26 (2 marks)
Outcomes Assessed: **MA12-1**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct solution	2
• Some progress towards the correct answer	1

Sample answer:

$$g(f(x)) = \frac{1}{\sqrt{5x-2}}$$

so $5x-2>0$

$5x>2$

$x>\frac{2}{5}$

Question 27 (7 marks)
(a) (3 marks)
Outcomes Assessed: **MA12-6, MA11-7**
Targeted Performance Bands: **4**

Criteria	Marks
• Correctly determines both stationary points and their nature	3
• Correctly determines one stationary point and its nature	2
• Correctly determines a stationary point	1

Sample answer:

$y' = 2(x+1)(x-5)+(x+1)^2$

$=(x+1)[2x-10+x+1]$

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

Stationary point at $x=-1,3$

$y' = 3(x^2-2x-3)$

$y'' = 3(2x-2) = 6(x-1)$

at $x=-1, y''=-12<0$ so a local MAXIMUM

at $x=3, y''=12>0$ so a local MINIMUM

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(b) (2 marks)
Outcomes Assessed: **MA12-6, MA11-7**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct solution	2
• Solves $y''=0$	1

Sample answer:

Possible point of inflection at $y''=0=6(x-1)$, ie when $x=1$.

x	0	1	2
y''	-6	*	6
concavity	down	*	up

Concavity changes so there is a point of inflection at (1,-16)

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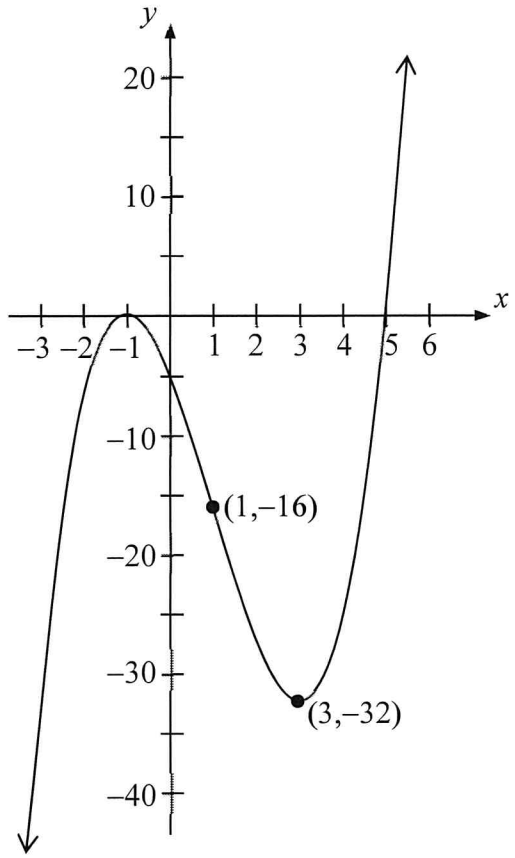
(c) (2 marks)

Outcomes Assessed: **MA12-6, MA11-7**

Targeted Performance Bands: **4**

Criteria	Marks
• Correct solution	2
• Correct shape, or labels a correct point	1

Sample answer:



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Question 28 (3 marks)
Outcomes Assessed: **MA11-1, MA12-2**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct solution	3
• TWO correct values of either *h, k* or *r*.	2
• ONE correct values of either *h, k* or *r*.	1

Sample answer:

$x^2+8x+16+y^2-4y+4=29+64+4$

$(x+4)^2+(y-2)^2=49$

Translate three units up and five units right

$(x+4-5)^2+(y-2-3)^2=49$

$(x-1)^2+(y-5)^2=7^2$

Question 29 (6 marks)
(a) (2 marks)
Outcomes Assessed: **MA12-8, MA12-7**
Targeted Performance Bands: **x**

Criteria	Marks
• Correctly shows that $k=6$	2
• Some progress towards the solution	1

Sample answer:

$$\frac{1}{36}\int_0^k\left(kx-x^2\right)dx=\frac{1}{36}\left[\frac{kx^2}{2}-\frac{x^3}{3}\right]_0^k$$

$$=\frac{1}{36}\left[\frac{k^3}{2}-\frac{k^3}{3}\right]=\frac{1}{36}\left[\frac{3k^3-2k^3}{6}\right]=\frac{k^3}{216}$$

so $\frac{k^3}{216}=1$

$k=\sqrt[3]{216}$

$k=6$

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(b) (1 marks)

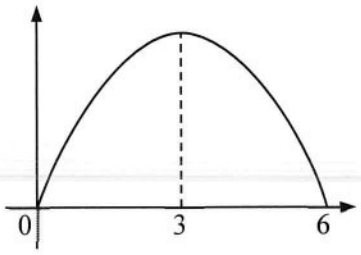
Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **4-5**

Criteria	Mark
• Correct answer	1

Sample answer:

$E(X)=3$



(c) (3 marks)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	3
• Some progress towards the answer	1-2

Sample answer:

$$\text{var}(X)=E\left(X^2\right)-E(X)^2$$

$$E\left(X^2\right)=\frac{1}{36}\int_0^6 x^3(6-x)\,dx$$

$$=\frac{1}{36}\int_0^6\left(6x^3-x^4\right)dx$$

$$=\frac{1}{36}\left[\frac{3x^4}{2}-\frac{x^5}{5}\right]_0^6$$

$$=\frac{1}{36}\left[1944-\frac{7776}{5}\right]$$

$$=10.8$$

$$\text{var}(X)=10.8-9$$

$$=1.8$$

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Question 30 (3 marks)
Outcomes Assessed: MA12-8
***Targeted Performance Bands:* 4-5**

Criteria	Marks
• Correct answer	3
• Correctly determines z-scores or one of the probabilities	2
• Some progress towards the correct answer.	1

Sample answer:

$$\text{Chickens} > 1.6\text{kg: } z = \frac{1.6-1.56}{0.025} = 1.6$$

$$\text{Chickens} < 1.5\text{kg: } z = \frac{1.5-1.56}{0.025} = -2.4$$

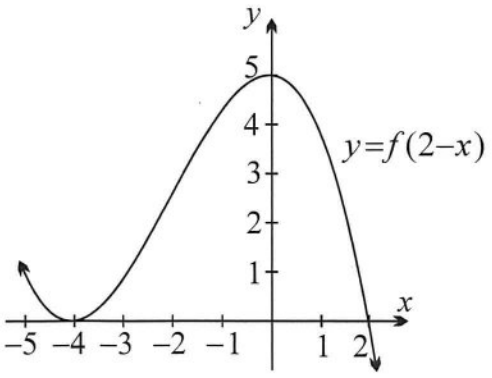
So, the probability of incorrectly classifying a size 15 chicken is:

$$\begin{aligned} 1-P(-2.4<z<1.6) &= P(z<-2.4)+P(z>1.6) \\ &= 0.0082+0.0548 \\ &= 0.063 \end{aligned}$$

Question 31 (2 marks)
***Outcomes Assessed:* MA12-1**
***Targeted Performance Bands:* 3-4**

Criteria	Marks
• Correct diagram with intercepts and maximum turning point labelled	2
• Correct shape, or two correct coordinates.	1

Sample answer:



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Question 32 (6 marks)
(a)(3 marks)
Outcomes Assessed: **MA12-4**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Shows the expressions correctly	3
• Finds the sum of the GP	2
• Some progress towards the solution	1

Sample answer:

$$A_0 = 650\,000$$

$$A_1 = 650\,000(1.005) - 4200$$

$$A_2 = \left(650\,000(1.005) - 4200\right) \times 1.005 - 4200$$

$$= 650\,000(1.005)^2 - 4200(1.005 + 1)$$

$$\vdots$$

$$A_n = 650\,000(1.005)^n - 4200\left(1.005^{n-1} + 1.005^{n-2} + \ldots + 1.005 + 1\right)$$

$$= 650\,000(1.005)^n - 4200\left(\frac{1.005^n - 1}{1.005 - 1}\right)$$

$$= 650\,000(1.005)^n - 840\,000\left(1.005^n - 1\right)$$

$$= 840\,000 - 190\,000 \times 1.005^n$$

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(b)(3 marks)
Outcomes Assessed: **MA11-6, MA12-4**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	3
• Correct expression for $(1.005)^n$	2
• Determines the new balance or some progress towards the answer	1

Sample answer:

Let B_n be the amount owing after n **<u>further</u>** months ($B_0 = 573\,722$)

$B_n = 573\,722(1.005)^n - 840\,000(1.005^n - 1)$

Paid off when $B_n = 0$

$$0 = 573\,722(1.005)^n - 840\,000(1.005^n - 1)$$

$$(1.005)^n = \frac{840\,000}{840\,000 - 573\,722}$$

$$n = \ln\left(\frac{840\,000}{840\,000 - 573\,722}\right) \div \ln(1.005)$$

$$\approx 230.4 \text{ months}$$

Therefore the loan is paid off after an extra **<u>231 months</u>**.

Question 33 (6 marks)
(a)(1 mark)
Outcomes Assessed: **MA12-7**
Targeted Performance Bands: **4-5**

Criteria	Mark
• Correct answer	1

Sample answer:

$$(x^2 + 3x - 4)(x - 3) = x^3 + 3x^2 - 4x - 3x^2 - 9x + 12$$

$$= x^3 - 13x + 12$$

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(b)(5 marks)

Outcomes Assessed: **MA12-7**

Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	5
• Correct area formula AND integrated correctly, with correct bounds	4
• Correct area formula and attempt to integrate correctly	3
• Some progress towards points of intersection	2
• Makes some progress towards the answer	1

Sample answer:

$$\frac{12}{x} = 13 - x^2$$

$$12 = 13x - x^3$$

$$x^3 - 13x + 12 = 0$$

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

$$x = 1, 3 \text{ and } 4$$

$$y = 12, 4 \text{ and } -3$$

So the points of intersection are (1, 12), (3, 4) and (-4, -3).

$$A = \int_1^3 \left(13 - x^2\right) - \left(\frac{12}{x}\right) dx$$

$$= \left[13x - \frac{x^3}{3} - 12\ln x\right]_1^3$$

$$= \left(39 - 9 - 12\ln 3\right) - \left(13 - \frac{1}{3} - 0\right)$$

$$= 17\frac{1}{3} - 12\ln 3$$

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Question 34 (2 marks)
Outcomes Assessed: **MA11-6**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct solution	2
• Some progress towards correct answer	1

Sample answer:

$$\frac{\ln x}{\ln 3}+\frac{\ln x}{\ln 3^2}=12$$
$$\frac{\ln x}{\ln 3}+\frac{\ln x}{2\ln 3}=12$$
$$\frac{2\ln x+\ln x}{2\ln 3}=12$$
$$3\ln x=24\ln 3$$
$$\ln x=8\ln 3$$
$$x=3^8$$

Question 35 (2 marks)
Outcomes Assessed: **MA11-7**
Targeted Performance Bands: **4-6**

Criteria	Marks
• Correct answer	2
• Some progress towards correct answer	1

Sample answer:

Let E = 4 appears at least once
Let F= the sum of the numbers is 6

$$E=\{(4,1),(4,2),(4,3),(4,4),(4,5),(4,6),(1,4),(2,4)(3,4),(5,4)(6,4)\}$$
$$F=\{(1,5),(2,4),(3,3),(4,2),(5,1)\}$$
$$E\cap F=\{(2,4),(4,2)\}$$
$$P(E)=\frac{11}{36},\ P(F)=\frac{5}{36}\quad\text{and}\quad P(E\cap F)=\frac{2}{36}$$
$$P(E|F)=\frac{P(E\cap F)}{P(F)}=\frac{\frac{2}{36}}{\frac{5}{36}}=\frac{2}{5}$$

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Question 36 (3 marks)
Outcomes Assessed: **MA11-4, MA12-5**
Targeted Performance Bands: **4-6**

Criteria	Marks
• Correct solution	3
• Correct expression for SG or OG	2
• Some progress towards correct answer	1

Sample answer:

Let $LG = h$.

In ΔOGL, $OG = 3\sqrt{3} \times \cos\alpha$ and $OG = \sqrt{\left(3\sqrt{3}\right)^2 - h^2}$ (By Pythagoras' theorem)

In ΔSGL, $SG = \sqrt{y^2 - h^2}$ (By Pythagoras' theorem)

In ΔOSG, by the cosine rule:

$$SG^2 = OG^2 + OS^2 - 2 \times OG \times OS \times \cos 30°$$

$$y^2 - h^2 = \left(3\sqrt{3}\right)^2 - h^2 + 10^2 - 2 \times 3\sqrt{3} \cos\alpha \times 10 \times \frac{\sqrt{3}}{2}$$

$$y^2 = 27 + 100 - \frac{90}{2}$$

$$y = \sqrt{82}$$

$$\approx 9.055385...$$

$$\approx 9\text{m} \text{ (to the nearest metre)}$$

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Question 37 (4 marks)
Outcomes Assessed: **MA11-4, MA12-5**
Targeted Performance Bands: **4-6**

Criteria	Marks
• Correct solution	4
• Correctly determines the first and second derivative	3
• Makes some progress towards an expression for the cost	2
• Some progress towards correct answer	1

Sample answer:

$S = \frac{D}{T}$, so $T = \frac{1200}{v}$ hours

$$\text{Cost of wages} = 55 \times 2 \times \frac{1200}{v} = \frac{132000}{v}$$

$$\text{Cost of fuel} = \left(10 + \frac{v^2}{100}\right) \times \frac{1200}{v} \times 1.50$$

$$= \left(10 + \frac{v^2}{100}\right) \times \frac{1800}{v}$$

$$= \frac{18000}{v} + 18v$$

$$\text{Total cost} = \frac{150000}{v} + 18v$$

$$\frac{dC}{dv} = \frac{-150000}{v^2} + 18$$

$$\frac{d^2C}{dv} = \frac{300000}{v^3}$$

stationary at $\frac{dC}{dv} = 0$

$$18v^2 = 150000$$

$$v^2 = \frac{150000}{18}$$

$$v \approx 91.287...$$

$$v \approx 91 \text{km/h}$$

at $v = 91, \frac{d^2C}{dv} = \frac{300000}{91^3} > 0$ so a MINIMUM when $v = 91$km/h

$$\text{so MINIMUM cost} = \frac{150000}{91} + 18 \times 91$$

$$\approx 3286.3516...$$

$$\approx \$3286 \text{(to the nearest dollar)}$$

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