CSSA

2021

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

MARKING GUIDELINES

Mathematics Advanced

The 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	MA12-8	2-3
2	A	MA11-3	2-3
3	B	MA12-8	3
4	D	MA22-7	3-4
5	C	MA11-7	4
6	B	MA12-1	3-4
7	A	MA11-1	2-3
8	C	MA11-6, MA12-1	4-5
9	A	MA11-5	4-6
10	D	MA12-4	5-6

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Question 11 (2 marks)
Outcomes Assessed: **MA-12-2**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	3
• Some progress towards the answer	2
• Correctly determines the value to use from the table	1

Sample answer:

$$4.1836 \times 2200 = \$9203.92$$

$$\text{Investment} = 2200 \times 4$$
$$= \$8800$$

$$\text{Interest} = \$9203.92 - \$8800$$
$$= \$403.92$$

Question 12 (2 marks)
Outcomes Assessed: **MA11-1, MA11-6**
Targeted Performance Bands: **3-4**

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

Sample answer:

$$\frac{729}{4\sqrt{3}-\sqrt{27}} = \frac{3^6}{4\times 3^{\frac{1}{2}} - 3\times 3^{\frac{1}{2}}}$$

$$= \frac{3^6}{3^{\frac{1}{2}}(4-3)}$$

$$= 3^{\frac{11}{2}}$$

$$\text{so } a = \frac{11}{2} \text{ or } 5\frac{1}{2}$$

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Question 13

(a) (2 marks)

Outcomes Assessed: **MA11-3**

Targeted Performance Bands: **3-4**

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

Sample answer:

$$\frac{BC}{\sin 70^\circ} = \frac{80}{\sin 50^\circ}$$

$$BC = \frac{80 \sin 70^\circ}{\sin 50^\circ}$$

$$\cong 98.1345...$$

$$\cong 98\,\text{m} (\text{to the nearest metre})$$

(b) (2 marks)

Outcomes Assessed: **MA11-3**

Targeted Performance Bands: **3-4**

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

Sample answer:

$$\cos 30^\circ = \frac{w}{98}$$

$$w = 98 \times \cos 30^\circ$$

$$\cong 84.8704...$$

$$\cong 85\,\text{m} (\text{to the nearest metre})$$

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Question 14

(a) (2 marks)

Outcomes Assessed: **MA11-2**

Targeted Performance Bands: 3-4

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

Sample answer:

solve simultaneously $\begin{cases} 9 = -3a + b \ldots\ldots\ldots\ldots \boxed{1} \\ -7 = 5a + b \ldots\ldots\ldots\ldots \boxed{2} \end{cases}$

$\boxed{1} - \boxed{2}$:

$-16 = 8a$

$a = -2$

Substituting back into $\boxed{1}$:

$9 = -3(-2) + b$

$b = 9 - 6 = 3$

So $a = -2, b = 3$

(b) (1 mark)

Outcomes Assessed: **MA11-2**

Targeted Performance Bands: 3-4

Criteria	Marks
• Correct answer	1

Sample answer:

$f(f(x)) = f(3-2x)$

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

$= 4x - 3$

so $f(f(x)) = 0$

$4x - 3 = 0$

$x = \frac{3}{4}$

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Question 15 (3 marks)
Outcomes Assessed: **MA12-4**
Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	3
• Significant progress towards an expression for A_3	2
• Correctly forms and expression for A_1	1

Sample answer:

$A_1 = 50\,000(1.0025) - 750 = 49\,375$

$A_2 = 49\,375(1.0025) - 750 = 48\,748.4375...$

$A_3 = 48\,748.44(1.0025) - 750 = 48\,120.31$

Reduction in balance $= 50\,000 - 48\,120.31$

$= 1879.69$

Question 16 (2 marks)
Outcomes Assessed: **MA11-6, MA12-3**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	2
• Significant progress towards a correct answer	1

Sample answer:

$\frac{dy}{dx} = \frac{1}{x}$ and $\frac{d^2y}{dx^2} = \frac{-1}{x^2}$

$$\text{LHS} = \frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = \frac{-1}{x^2} + \left(\frac{1}{x}\right)^2 = \frac{-1}{x^2} + \frac{1}{x^2} = 0$$

= RHS, as required

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Question 17

(a) (2 marks)

Outcomes Assessed: **MA12-7**

Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	2
• Significant progress towards a correct answer	1

Sample answer:

$$\text{Shaded area} \approx \frac{12.5}{2}(19+22)+\frac{12.5}{2}(22+18)+\frac{12.5}{2}(18+21)+\frac{12.5}{2}(21+32)$$

$$\approx 1081.25\,\text{m}^2$$

(b) (1 mark)

Outcomes Assessed: **MA11-1 MA11-9**

Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	1

Sample answer:

$$\frac{\text{shaded area}}{\text{total area}} \approx \frac{1081.25}{2500}\times\frac{100}{1}$$

$$\approx 43.25\%$$

Question 18

(a) (2 marks)

Outcomes Assessed: **MA12-8, MA12-9**

Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	2
• Significant progress towards a correct answer	1

Sample answer:

$v \approx 0.03w+18.75$

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(b) (2 marks)
Outcomes Assessed: **MA12-8, MA12-10**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	2
• Significant progress towards a correct answer	1

Sample answer:
$r \approx 0.199$ (3 decimal places)

This is a weak positive correlation. The data does not confirm that there is an association between bodyweight and vertical jump.

Question 19
(a) (2 marks)
Outcomes Assessed: **MA11-1**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	1

Sample answer:
at $x = 1$: $f(1) = 1$
to the right: $f(1) = 1$ these are not equal, so the function is not continuous at $x = 1$.
to the left: $f(1) = 2$

(b) (1 mark)
Outcomes Assessed: **MA11-2**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	1

Sample answer:
$f(-1) + f(2) = (-1)^2 - 2(-1) + 2 + 2 + 1 = 8$

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(c) (1 mark)

Outcomes Assessed: **MA11-2**

Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	2
• Significant progress towards a correct answer	1

Sample answer:

Check the values at the endpoints:

at $x=-3$, $y=(-3)^2-2(-3)+2=17$ at $x=1$, $y=(1)^2-2(1)+2=1$

at $x=1$, $y=(1)+1=2$ at $x=6$, $y=(6)+2=8$

So, the range is $1<y<17$.

Question 20

(a) (1 mark)

Outcomes Assessed: **MA11-6**

Targeted Performance Bands: **3-4**

Criteria	Marks
• Correct answer	1

Sample answer:

$$A=800\times(1.25)^4$$
$$=1953.125$$

The affected area after 4 weeks is approximately 1953 hectares.

(b) (2 marks)

Outcomes Assessed: **MA11-6**

Targeted Performance Bands: **4-5**

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

Sample answer:

$$24.1\times10^6=800\times(1.25)^n$$
$$(1.25)^n=\frac{24.1\times10^6}{800}$$
$$(1.25)^n=30125$$
$$n=\frac{\ln(30\,125)}{\ln(1.25)}$$
$$\approx 46.217\ldots$$

It will take the locusts approximately 47 weeks to take over Uganda.

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Question 21 (4 marks)
Outcomes Assessed: **MA11-2**
Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	4
• THREE correct steps of working	3
• TWO correct steps of working	2
• Progress towards formulating the correct quadratic equation	1

Sample answer:

$$6x - x^2 = 1.71$$

$$x^2 - 6x + 1.71 = 0$$

$$x = \frac{6 \pm \sqrt{36 - 4(1.71)}}{2}$$

$$= \frac{6 \pm 5.4}{2}$$

$$= 5.7 \text{ or } 0.3$$

So, at average head height, there is 5.7-0.3= 5.4 m of available horizontal distance.
$5.4 \div 1.3 \approx 4.15\ldots$
So, 4 people can walk down the path without getting wet.

Question 22
(a) (2 marks)
Outcomes Assessed: **MA12-3**
Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	2
• Some progress towards correct application of the product rule	1

Sample answer:

$$\frac{d}{dx}(x\cos x - \sin x) = \sin x - x\sin x - \sin x$$

$$= -x\sin x, \text{ as required.}$$

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(b) (2 marks)

Outcomes Assessed: **MA12-3, MA12-7**

Targeted Performance Bands: **4**

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

Sample answer:

$$\int_0^{\frac{\pi}{4}} x\sin x\,dx = -\left[x\cos x - \sin x\right]_0^{\frac{\pi}{4}}$$

$$= -\left(\frac{\pi}{4}\times\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{2}}\right)$$

$$= \frac{1}{\sqrt{2}}\left(1 - \frac{\pi}{4}\right)$$

$$= \frac{1}{4\sqrt{2}}(4-\pi)$$

Question 23

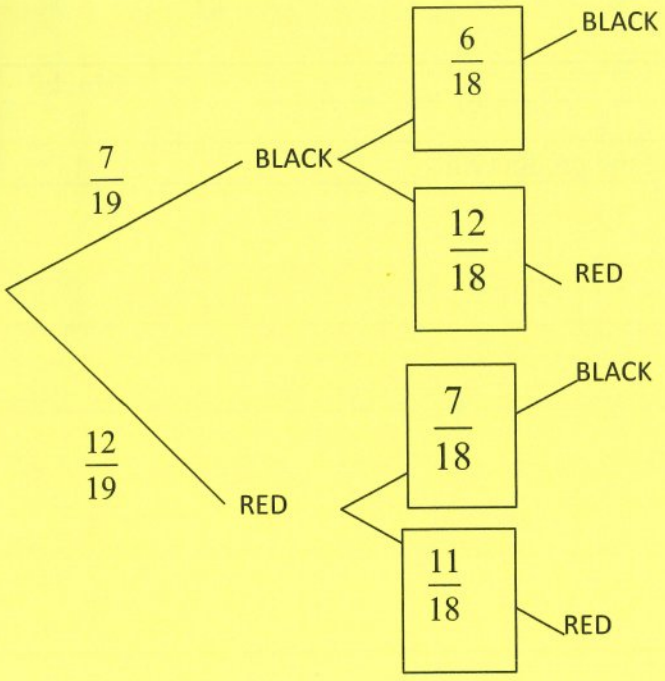
(a) (1 mark)

Outcomes Assessed: **MA11-7**

Targeted Performance Bands: ***3-4***

Criteria	Marks
• Correct answer	1

Sample answer:



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(b) (2 marks)

Outcomes Assessed: **MA11-7**

Targeted Performance Bands: 4

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

Sample answer:

$$P(\text{same colour}) = P(\text{black \& black}) + P(\text{red \& red})$$

$$= \frac{7}{19} \times \frac{6}{18} + \frac{12}{19} \times \frac{11}{18}$$

$$= \frac{174}{342}$$

$$= \frac{29}{57}$$

$$P(\text{different colour}) = 1 - P(\text{same colour})$$

$$= 1 - \frac{29}{57}$$

$$= \frac{28}{57}$$

So, Lucas is more likely to select two counters of the SAME colour.

Question 24 (3 marks)

Outcomes Assessed: **MA12-7**

Targeted Performance Bands: **4-5**

Criteria	Marks
• Correct answer	3
• Correctly completes TWO steps towards the correct answer	2
• Some progress towards correct answer	1

Sample answer:

$$\int_2^k \frac{dx}{x} = \int_k^{18} \frac{dx}{x}$$

$$\ln k - \ln 2 = \ln 18 - \ln k$$

$$2\ln k = \ln 36$$

$$\ln k = \ln \sqrt{36}$$

$$k = 6 \quad (k > 0)$$

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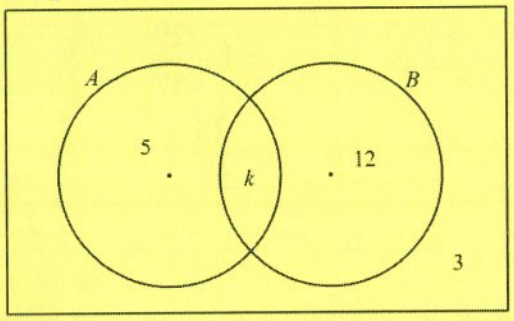
Question 25 (4 marks)
Outcomes Assessed: **MA12-8**
Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	4
• Correctly completes THREE steps towards the correct answer	3
• Correctly completes TWO steps towards the correct answer	2
• Some progress towards the correct answer	1

Sample answer:



$$P_1(A)=\frac{5+k}{20+k}$$
$$P_2(B)=\frac{12+k}{20+k}$$

Independent means:

$$\frac{5+k}{20+k}\times\frac{12+k}{20+k}=\frac{k}{20+k}$$
$$60+17k+k^2=20k+k^2$$
$$k=20$$

So, 20 students study both Art and Biology.

Question 26
(a) (2 marks)
Outcomes Assessed: **MA12-8**
Targeted Performance Bands: **4**

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

Sample answer:

x	3	4	5	6	7
$P(X=x)$	$\frac{1}{16}$	$\frac{4}{16}$	$\frac{6}{16}$	$\frac{4}{16}$	$\frac{1}{16}$

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(b) (2 marks)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: **4-5**

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

Sample answer:

$$P\left(X=5 \middle| X \geq 4\right)=\frac{6}{15}=\frac{2}{5}$$

Question 27

(a) (1 mark)

Outcomes Assessed: **MA12-3**

Targeted Performance Bands: **4**

Criteria	Marks
• Correct answer	1

Sample answer:

$$0.3t^2=30$$

$$t^2=100$$

$$t=10 \text{ seconds}$$

(b) (2 marks)

Outcomes Assessed: **MA12-3**

Targeted Performance Bands: ***4-5***

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

Sample answer:

$$x(t)=\int_0^{10}\left(0.3t^2\right)dt$$

$$=\left[\frac{0.3t^3}{3}\right]_0^{10}$$

$$=100-0$$

$$=100\,\text{m}$$

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(c) (1 mark)

Outcomes Assessed: **MA12-3**

Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	1

Sample answer:

$$\text{average speed} = \frac{100}{10}$$
$$= 10$$

So, the average speed is 10 m/s.

Question 28

(a) (2 marks)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	2
•	1

Sample answer:

$$P(X > 0.6) = 1 - F(0.6)$$
$$= 1 - \frac{1}{3}(0.6)^2(4 - 0.6^2)$$
$$= \frac{352}{625} \text{ or } 0.5632$$

(b) (1 mark)

Outcomes Assessed: **MA12-8**

Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	1

Sample answer:

$$f(x) = \frac{d}{dx}F(x)$$
$$= \frac{d}{dx}\frac{1}{3}x^2(4 - x^2)$$
$$= \frac{d}{dx}\frac{4}{3}x^2 - \frac{1}{3}x^4$$
$$= \frac{8x}{3} - \frac{4x^3}{3} \quad \text{for } 0 \le x \le 1.$$

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(c) (1 mark)

***Outcomes Assessed:*MA12-8**

Targeted Performance Bands:4-5

Criteria	Marks
• Correct answer	1

Sample answer:

$$f'(x)=\frac{4}{3}(2-3x^2)=0$$

$$\text{Mode}=\sqrt{\frac{2}{3}}\approx 0.816496...$$

$$=0.816\,(3\,\text{decimal places})$$

Question 29 (4 marks)

***Outcomes Assessed:* MA12-3, MA12-6**

Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	4
• Significant progress with THREE correct steps	3
• Significant progress with TWO correct steps	2
• Correctly differentiates the function	1

Sample answer:

$$\frac{dy}{dx}=3x^2+6x-9$$

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

Stationary at $\frac{dy}{dx}=0$, so $x=-3,1$.

$$\frac{d^2y}{dx^2}=6x+6$$

at $x=-3$, $\frac{d^2y}{dx^2}=-12$, <0 so a MAXIMUM at $(-3,27)$

at $x=1$, $\frac{d^2y}{dx^2}=12$, >0 so a MINIMUM at $(1,-5)$

Possible point of inflection at $\frac{d^2y}{dx^2}=0$

So (-1,11) is a point of inflection

x	-2	-1	0
$\frac{d^2y}{dx^2}$	-6	0	6
conc	$\cap$	*	$\cup$

The concavity changes, so it is a point of inflection

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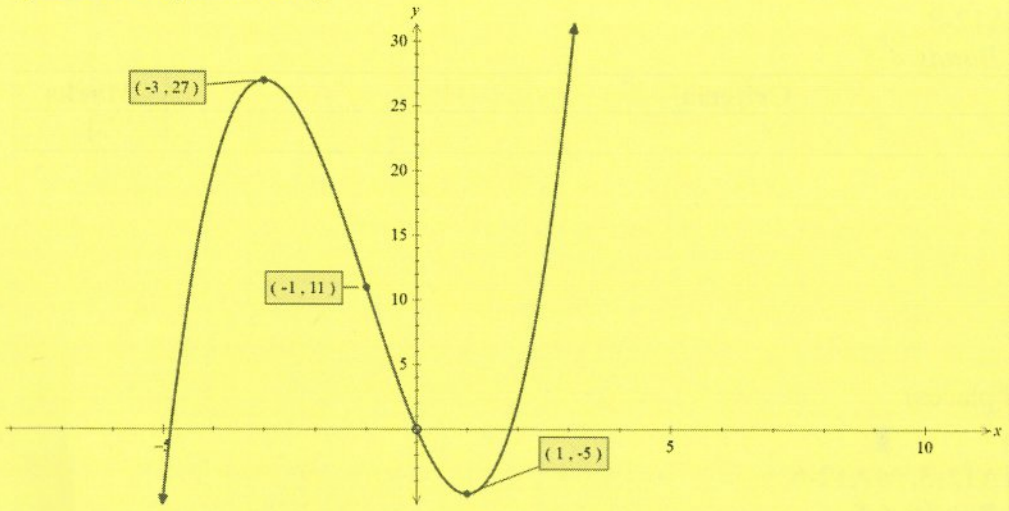
Question 29(continued)



Question 30 (2 marks)
***Outcomes Assessed:* MA12-4**
Targeted Performance Bands: 4-5

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

Sample answer:

$$\frac{a}{1-r} = 4(a+ar)$$

$$a = 4a(1-r^2)$$

$$\frac{1}{4} = 1-r^2$$

$$r^2 = \frac{3}{4}$$

$$r = \pm\frac{\sqrt{3}}{2}$$

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Question 31

(a) (1 mark)

Outcomes Assessed: **MA11-1**

Targeted Performance Bands: 4

Criteria	Marks
• Correct answer	1

Sample answer:

$$5-x=\frac{2}{x-2}$$

$$(5-x)(x-2)=2$$

$$x^2-7x+12=0$$

$$(x-3)(x-4)=0$$

$$x=3,4$$

So, A and B are 3 and 4 respectively

(b) (3 marks)

Outcomes Assessed: **MA12-7, MA12-10**

Targeted Performance Bands: 4-5

Criteria	Marks
• Correct answer	3
• Significant progress towards the correct answer	2
• One correct step towards the correct answer	1

Sample answer:

$$\int_3^4\left(5-x-\frac{2}{x-2}\right)=\left[5x-\frac{x^2}{2}-2\ln(x-2)\right]_3^4$$

$$=\left(20-8-2\ln 2\right)-\left(15-\frac{9}{2}-2\ln 1\right)$$

$$=\frac{3}{2}-2\ln 2$$

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Question 32

(a) (2 marks)

Outcomes Assessed: **MA12-5, MA12-10**

Targeted Performance Bands: 4-6

Criteria	Marks
• Correct answer	2
• ERROR in EITHER cosine calculation or difference but otherwise correct. (Common mistake will be September at t=9.)	1

Sample answer:

Kempsey's historical temp is 24.0. The cosine function predicts $K(8) = 24.6 + 4.6\cos\left(\frac{8\pi}{6}\right) = 22.3$

Therefore, the difference is 1.7 degrees.

(b) (2 marks)

Outcomes Assessed: **MA12-5, MA12-10**

Targeted Performance Bands: 5-6

Criteria	Marks
• Correct answer	2
• Correct substitution but subsequent error	1

Sample answer:

$$W(t) = 2\left(K(t) - 24.6\right) + 26.6$$

$$= 2\left(24.6 + 4.6\cos\left(\frac{\pi t}{6}\right) - 24.6\right)26.6$$

$$= 26.6 + 9.2\cos\left(\frac{\pi t}{6}\right)$$

(c) (3 marks)

Outcomes Assessed: **MA12-5, MA12-10**

Targeted Performance Bands: 5-6

Criteria	Marks
• Compared both variation and overall temperature, with reference to mathematical reasons	3
• Compared both but did not give adequate mathematical reasons, or compared one with reference to mathematical reasons	2
• Compares ONE factor without adequate reasons	1

Sample answer:

Wilcannia has greater variation in maximum temperatures, being colder in winter and hotter in summer. That is reflected in that the cosine curve for Wilcannia has double the magnitude (9.2) compared to the Kempsey curve (4.6).
Wilcannia is also generally hotter than Kempsey, when looking at the year as a whole. This is reflected in that the constant term of the Wilcannia function (26.6) is two degrees higher than the Kempsey function (24.6).

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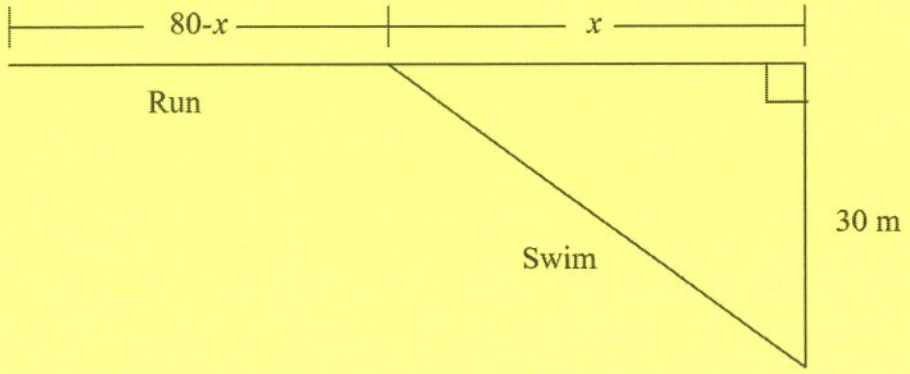
Question 33 (5 marks)
Outcomes Assessed: **MA12-1, MA12-6, MA12-10**
Targeted Performance Bands: 4-6

Criteria	Marks
• Correct answer	5
• At least FOUR correct steps towards finding the minimum value for x	4
• At least THREE correct steps towards find a stationary point	3
• At least TWO correct steps towards forming an expression for time and differentiating	2
• At least ONE correct step towards forming a correct expression for time	1

Sample answer:



$$\text{swim} = \sqrt{x^2 + 30^2}$$

$$\text{run} = 80 - x$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$T = \frac{\sqrt{x^2 + 30^2}}{2} + \frac{80 - x}{8}$$

$$= \frac{\left(x^2 + 900\right)^{\frac{1}{2}}}{2} + \frac{80 - x}{8}$$

$$\frac{dT}{dx} = \frac{\frac{1}{2} \times 2x\left(x^2 + 900\right)^{-\frac{1}{2}}}{2} - \frac{1}{8}$$

$$= \frac{x}{2\sqrt{x^2 + 900}} - \frac{1}{8}$$

$$= \frac{4x - \sqrt{x^2 + 900}}{8\sqrt{x^2 + 900}}$$

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stationary when $\frac{dT}{dx} = 0$

$$4x - \sqrt{x^2 + 900} = 0$$
$$\sqrt{x^2 + 900} = 4x$$
$$x^2 + 900 = 16x^2$$
$$15x^2 = 900$$
$$x^2 = 60$$
$$x = 2\sqrt{15}$$

x	7	$2\sqrt{15}$	8
$\frac{dT}{dx}$	–0.011	0	0.0038
slope	╲	―	╱

So, a MINIMUM when $x = 2\sqrt{15}$

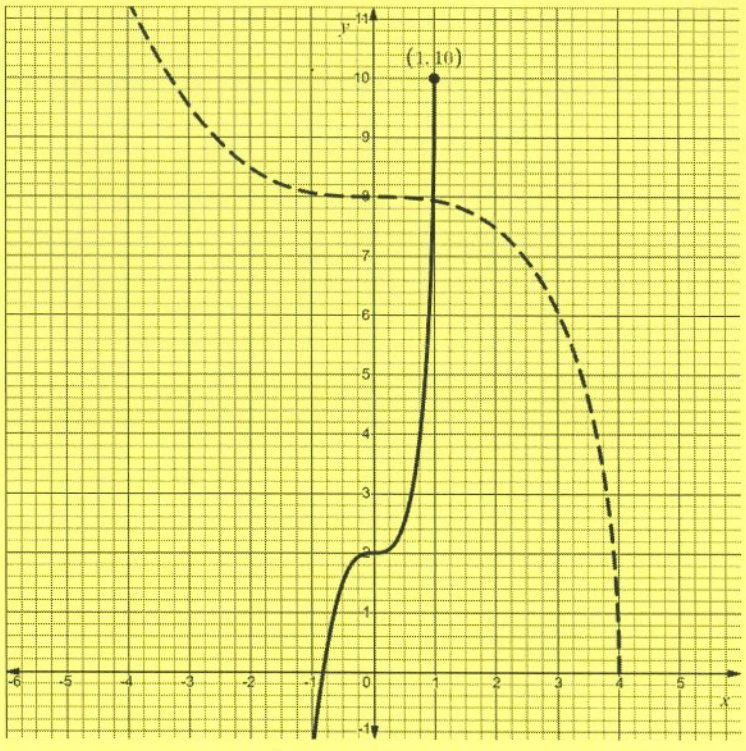
So the distance Kevin runs should be $\left(80 - 2\sqrt{15}\right) \approx 72.254\ldots$

So, Kevin should run approximately 72 m along the shore entering the water.

Question 34 (3 marks)
Outcomes Assessed: **MA12-1**
Targeted Performance Bands: 4-6

Criteria	Marks
• Correct answer, including shape and horizontal point of inflection at (0,2), and endpoint (1,10).	3
• ONE error, either in horizontal stretch, mistakenly adopting a vertical stretch, or other error	2
• TWO errors, but otherwise correct features	1

Sample answer:



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Question 35 (3 marks)
Outcomes Assessed: **MA12-1, MA12-3**
Targeted Performance Bands: 5-6

Criteria	Marks
• Correct answer	3
• At least TWO correct steps	2
• Correctly differentiates the function	1

Sample answer:

$$\frac{d}{dx}\left(x^3+ax^2-1\right)=3x^2+2ax$$

$$=x\left(3x+2a\right)$$

When $x=0, \quad y=-1(<0)$

When $x=-\frac{2a}{3}$, $y=-\frac{8a^3}{27}+\frac{4a^3}{9}-1=\frac{4a^3}{27}-1$

Solve $\frac{4a^3}{27}-1>0$

$$a^3>\frac{27}{4}$$

$$a>\frac{3}{\sqrt[3]{4}}$$

Check $y''=6x+2a$

$y''=0$ when $x=\frac{-a}{3}$

So, no stationary points are points of inflection, so there are three distinct intercepts.

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