



Rewarding Learning

ADVANCED
General Certificate of Education
2022

Mathematics

Assessment Unit A2 2

assessing

Applied Mathematics

[AMT21]

THURSDAY 14 JUNE, AFTERNOON

**MARK
SCHEME**

GCE ADVANCED/ADVANCED SUBSIDIARY (AS) MATHEMATICS

Introduction

The mark scheme normally provides the most popular solution to each question. Other solutions given by candidates are evaluated and credit given as appropriate; these alternative methods are not usually illustrated in the published mark scheme.

The marks awarded for each question are shown in the right-hand column and they are prefixed by the letters **M**, **W** and **MW** as appropriate. The key to the mark scheme is given below:

M indicates marks for correct method.

W indicates marks for working.

MW indicates marks for combined method and working.

The solution to a question gains marks for correct method and marks for an accurate working based on this method. Where the method is not correct no marks can be given.

A later part of a question may require a candidate to use an answer obtained from an earlier part of the same question. A candidate who gets the wrong answer to the earlier part and goes on to the later part is naturally unaware that the wrong data is being used and is actually undertaking the solution of a parallel problem from the point at which the error occurred. If such a candidate continues to apply correct method, then the candidate's individual working must be followed through from the error. If no further errors are made, then the candidate is penalised only for the initial error. Solutions containing two or more working or transcription errors are treated in the same way. This process is usually referred to as "follow-through marking" and allows a candidate to gain credit for that part of a solution which follows a working or transcription error.

Positive marking:

It is our intention to reward candidates for any demonstration of relevant knowledge, skills or understanding. For this reason we adopt a policy of **following through** their answers, that is, having penalised a candidate for an error, we mark the succeeding parts of the question using the candidate's value or answers and award marks accordingly.

Some common examples of this occur in the following cases:

- (a) a numerical error in one entry in a table of values might lead to several answers being incorrect, but these might not be essentially separate errors;
- (b) readings taken from candidates' inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

When the candidate misreads a question in such a way as to make the question easier only a proportion of the marks will be available (based on the professional judgement of the examining team).

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

Section A

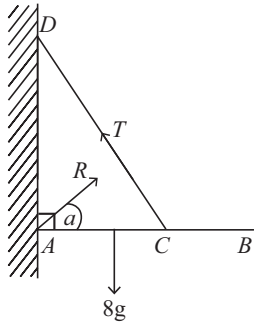
Mechanics

AVAILABLE
MARKS

<p>1 (i) $3(5) + 2(2) = 5v$ $19 = 5v$ $v = 3.8 \text{ m s}^{-1}$</p> <p>(ii) $I = 3(3.8 - 5)$ $= -3.6 \text{ N s}$</p>	<p>M2W1</p> <p>W1</p> <p>M1</p> <p>W1</p>	6
<p>2 (i) $\mathbf{r} = 12t^2\mathbf{i} + (-t^3 + 5t^2 + 18t)\mathbf{j}$ $\mathbf{v} = (24t\mathbf{i} + (-3t^2 + 10t + 18)\mathbf{j}) \text{ m s}^{-1}$</p> <p>(ii) $\mathbf{a} = 24\mathbf{i} + (-6t + 10)\mathbf{j}$</p> <p>Parallel to \mathbf{i} when $-6t + 10 = 0$</p> <p style="margin-left: 40px;">$t = \frac{5}{3}$</p>	<p>M1W2</p> <p>M1W1</p> <p>M1</p> <p>W1</p>	7
<p>3 (i) $s = \int v \, dt$</p> <p>$s = \int (5t^2 + 2t - 3) \, dt$</p> <p>$s = \left(\frac{5t^3}{3} + t^2 - 3t + c\right) \text{ m}$</p> <p>$t = 0, s = 0.5$</p> <p>$0.5 = 0 + c$</p> <p>$s = \left(\frac{5t^3}{3} + t^2 - 3t + 0.5\right) \text{ m}$</p> <p>(ii) Particle at rest</p> <p style="margin-left: 40px;">$5t^2 + 2t - 3 = 0$</p> <p style="margin-left: 40px;">$(5t - 3)(t + 1) = 0$</p> <p style="margin-left: 40px;">$t = 0.6 \text{ or } t = -1$</p> <p>$t = 0, s = 0.5$</p> <p>$t = 0.6, s = -0.58$</p> <p>$t = 3, s = 45.5$</p> <p>Distance = $0.5 + 0.58 + 0.58 + 45.5$ $= 47.16 \text{ m}$ $= 47.2 \text{ m (3 s.f.)}$</p>	<p>M1</p> <p>W2</p> <p>MW1</p> <p>M1</p> <p>M1</p> <p>W1</p> <p>MW1</p> <p>MW1</p> <p>MW1</p> <p>M1</p> <p>W1</p>	12

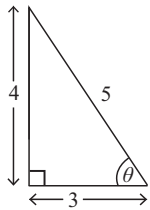
		AVAILABLE MARKS
4 (i)	Horizontal velocity = $50 \cos 65^\circ$	MW1
	Vertical Motion:	
	$u = 50 \sin 65^\circ$	
	$a = -9.8$	
	$t = 4$	
	$v = u + at$	
	$v = 50 \sin 65^\circ + (-9.8)(4)$	M1
	$v = 6.115\dots$	W1
	Speed = $\sqrt{(6.115\dots)^2 + (50 \cos 65^\circ)^2}$	M1
	$= 22.0 \text{ m s}^{-1}$	MW1
	Direction $\theta = \tan^{-1} \left(\frac{6.115\dots}{50 \cos 65^\circ} \right)$	
	$\theta = 16.1^\circ$ to the horizontal	MW1
(ii)	Horizontal Motion:	
	$u = 50 \cos 65^\circ$	M1
	$s = 180$	
	$180 = (50 \cos 65^\circ)t$	
	$t = 8.5183\dots$	W1
	Vertical Motion:	
	$u = 50 \sin 65^\circ$	M1
	$t = 8.518\dots$	
	$a = -9.8$	
	$s = ut + \frac{1}{2} at^2$	
	$s = (50 \sin 65^\circ)(8.51\dots) + \frac{1}{2} (-9.8)(8.51\dots)^2$	
	$s = 30.5$	W1
	Therefore the ball will clear the tree	MW1
		11

5 (i)



MW3

(ii)



$$\sin \theta = \frac{4}{5}$$

$$\cos \theta = \frac{3}{5}$$

MW1

$$M(A): \quad 2 \times 8g = 3 \times T \sin \theta$$

M2

$$16g = 3T \left(\frac{4}{5} \right)$$

W1

$$T = \frac{20g}{3}$$

$$T = 65.3 \text{ N}$$

W1

$$R(\uparrow): \quad R \sin \alpha + T \sin \theta = 8g$$

M1

$$R \sin \alpha = 8g - \left(\frac{20g}{3} \right) \left(\frac{4}{5} \right)$$

$$R \sin \alpha = \frac{8g}{3}$$

W1

$$R(\rightarrow): \quad R \cos \alpha = T \cos \theta$$

$$R \cos \alpha = \left(\frac{20g}{3} \right) \left(\frac{3}{5} \right)$$

$$R \cos \alpha = 4g$$

MW1

$$\frac{R \sin \alpha}{R \cos \alpha} = \frac{\frac{8g}{3}}{4g}$$

M1

$$\tan \alpha = \frac{2}{3}$$

$$\alpha = 33.7^\circ$$

MW1

$$R = 47.1 \text{ N}$$

MW1

AVAILABLE
MARKS

14

Section B

Statistics

**AVAILABLE
MARKS**

- 6 (i)** The null hypothesis is an assumption made about the value of a population parameter which a hypothesis test aims to nullify. M2
- (ii)** The mechanic believes that there is sufficient negative correlation between the depth of tyre tread and fuel consumption per mile. M2
- (iii)** $r < -0.5494$ MW1
- (iv)** Since $r < -0.5494$, the mechanic can conclude that there is sufficient evidence at the 5% level of significance to suggest that cars with smaller tyre treads consume more fuel. MW2

7

- 7 (i)** Let B be the systolic blood pressure of healthy adults

$$B \sim N(112, 100)$$

$$\begin{aligned} P(B < 125) &= P\left(Z < \frac{125 - 112}{10}\right) && \text{MW1} \\ &= \Phi(1.3) \\ &= 0.903 && \text{W1} \end{aligned}$$

(ii) $\Phi\left(\frac{Q_3 - 112}{10}\right) = 0.75$ M1 W1

$$Q_3 = 118.7448\dots \quad \text{W1}$$

$$\begin{aligned} \Phi\left(\frac{Q_1 - 112}{10}\right) &= 0.25 \\ Q_1 &= 105.2551\dots && \text{MW1} \end{aligned}$$

$$\begin{aligned} \text{IQR} &= 118.7448\dots - 105.2551\dots \\ &= 13.5 \text{ mmHg} && \text{MW1} \end{aligned}$$

(iii) $P(B < 104) = P\left(Z < \frac{104 - 112}{10}\right)$ M1

$$\begin{aligned} &= 1 - \Phi(0.8) \\ &= 0.2118\dots && \text{W1} \end{aligned}$$

$$\begin{aligned} P(B > 130) &= P\left(Z > \frac{130 - 112}{10}\right) \\ &= 1 - \Phi(1.8) \\ &= 0.03593\dots && \text{MW1} \end{aligned}$$

$$\begin{aligned} P[(B < 104) \cup (B > 130)] &= 0.2118\dots + 0.03593\dots && \text{M2} \\ &= 0.2477\dots \end{aligned}$$

Percentage of healthy adults eligible for the trial = 24.8% MW1

13

8 (i)

$$z = \frac{\bar{x} - \mu}{\sqrt{\frac{\sigma^2}{n}}}$$

M1

$$z = \frac{3.7 - 3.5}{\sqrt{\frac{0.43}{50}}}$$

MW2

$$z = 2.16$$

W1

(ii)

$$H_0: \mu = 3.5$$

MW1

$$H_1: \mu > 3.5 \text{ (one-tailed test)}$$

MW1

5% level of significance so reject H_0 if $z > 1.645$

MW1

Test statistic: $z = 2.16$

MW1

Since $2.16 > 1.645$ we reject H_0 and conclude that there is sufficient evidence at the 5% level of significance to suggest that the mean breaking strength has increased.

MW3

AVAILABLE
MARKS

11

9 (i)

$$P(A \cap B) = P(A | B) P(B)$$

M1

$$0.18 = 0.45 \times P(B)$$

MW1

$$P(B) = 0.4$$

W1

$$P(A \cap B) = P(B | A) P(A)$$

$$0.18 = 0.72 \times P(A)$$

MW1

$$P(A) = 0.25$$

W1

(ii)

$$P(A) \times P(B) = 0.4 \times 0.25$$

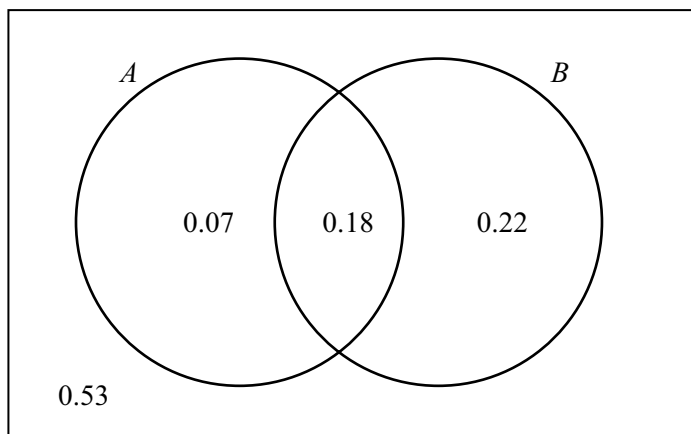
$$= 0.1$$

MW1

$P(A \cap B) \neq P(A) \times P(B)$ so events A and B are not independent.

W1

(iii)



MW2

$$P(\bar{A} \cap \bar{B}) = 0.53$$

MW1

10

Alternative solution

$$P(\bar{A} \cap \bar{B}) = 1 - P(A \cup B)$$

M1

$$= 1 - (0.25 + 0.4 - 0.18)$$

MW1

$$= 0.53$$

W1

10	$H_0: p = 0.15$	MW1	AVAILABLE MARKS
	$H_1: p > 0.15$ (one-tailed test)	MW1	
	Let X = number of athletes who test positive for the banned substance.		
	$X \sim \text{Bin}(20, 0.15)$ under H_0	M1 W1	
	$P(X \geq 6) = 1 - P(X \leq 5)$	M1	
	$= 1 - 0.93269$		
	$= 0.0673$	W1	
	Since $0.0673 > 0.05$ we do not reject H_0 and conclude that there is insufficient evidence at the 5% level of significance to suggest that more than 15% of athletes take the banned substance.		
		MW3	9
		Total	100