Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Mathematics

Assessment Unit AS 2

assessing

Applied Mathematics

[SMT21]

WEDNESDAY 22 MAY, MORNING

MARK SCHEME

General Marking Instructions

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 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.

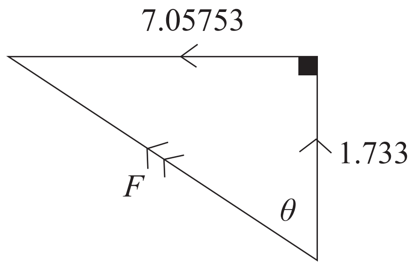
Some common examples of this occur in the following cases:

(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;

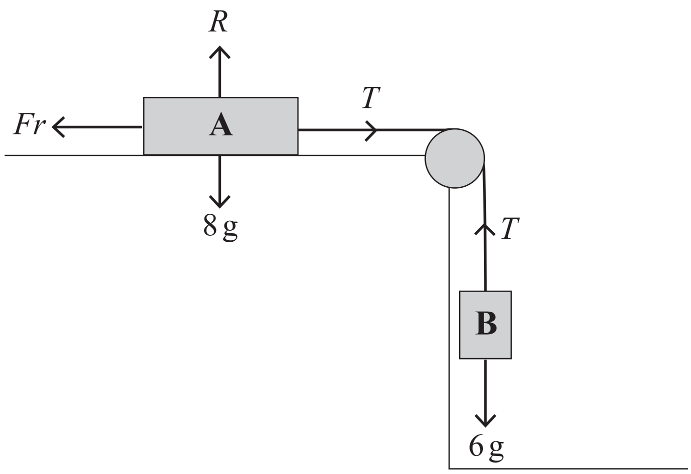
(b) readings taken from a candidate's inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

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).

			AVAILABLE MARKS
1	R (↑) $5 + 10\sin 12° - 6\sin 63°$ $= 1.733\ldots$N	M1 W1	
	R(→) $6\cos 63° - 10\cos 12°$ $= -7.05753\ldots$N	MW1	



	From diagram using Pythagoras' Theorem: $F = 7.27$N (3 sf)	M1 W1	
	$\theta = \tan^{-1}\dfrac{7.05753}{1.733}$		
	$\theta = 76.2°$ (3 sf) to the vertical OR 13.8° to the horizontal	W1	6
2	$\mathbf{u} = 2\mathbf{i} - 7\mathbf{j}\,\text{m s}^{-1}$ $\mathbf{v} = 14\mathbf{i} + \mathbf{j}\,\text{m s}^{-1}$ $t = 4$ s		
	(i) $\mathbf{v} = \mathbf{u} + \mathbf{a}t$	M1	
	$14\mathbf{i} + \mathbf{j} = 2\mathbf{i} - 7\mathbf{j} + 4\mathbf{a}$	W1	
	$12\mathbf{i} + 8\mathbf{j} = 4\mathbf{a}$		
	$\therefore\ \mathbf{a} = (3\mathbf{i} + 2\mathbf{j})\,\text{m s}^{-2}$	MW1	
	(ii) $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$	M1	
	$\mathbf{s} = (2\mathbf{i} - 7\mathbf{j})(4) + \frac{1}{2}(3\mathbf{i} + 2\mathbf{j})(4)^2$	W1	
	$\mathbf{s} = 8\mathbf{i} - 28\mathbf{j} + 24\mathbf{i} + 16\mathbf{j}$ $\mathbf{s} = (32\mathbf{i} - 12\mathbf{j})$ m	MW1	
	Alternative solution		
	$\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$	M1	
	$\mathbf{s} = \frac{1}{2}(2\mathbf{i} - 7\mathbf{j} + 14\mathbf{i} + \mathbf{j})(4)$	W1	
	$\mathbf{s} = (32\mathbf{i} - 12\mathbf{j})$ m	MW1	
	$\therefore$ distance $= \sqrt{(32)^2 + (-12)^2} = 34.176\ldots$ m	M1	
	$= 34.2$ m (3 sf)	W1	8

				AVAILABLE MARKS
3	**(i)**	Constant acceleration from $0\,\text{m}\,\text{s}^{-1}$ to $10\,\text{m}\,\text{s}^{-1}$	MW1	
	(ii)	Distance = area under the graph	M1	
		$100 = 0.5(3)(10) + (T-3)(10) + 0.5(10 + 6\frac{2}{3})(11.8 - T)$	MW3	
		$100 = 15 + 10T - 30 + \frac{1}{2} \times (11.8 - T) \times \frac{50}{3}$		
		$115 = 10T - \frac{25}{3}T + \frac{295}{3}$		
		$345 = 30T - 25T + 295$		
		$T = 10$	MW1	6
4	**(i)**		MW2	
	(ii)	**<u>B</u>**		
		$v^2 = u^2 + 2as$	M1	
		$3.7^2 = 0 + 5a$		
		$\therefore a = 2.738\,\text{m}\,\text{s}^{-2}$	W1	
		Whole System: $F = ma$	M1	
		$6g - Fr = (8a + 6a)$	W1 W1	
		$\therefore Fr = 20.468\,\text{N}$		
		<u>A</u>		
		R(↑)		
		$R = 8g$		
		$Fr = \mu R$	M1	
		$20.468 = 8g\mu$	MW1	
		$\therefore \mu = 0.261$ (3 sf)	W1	

			AVAILABLE MARKS
(iii)	Need new value of a:		
	$0 - Fr = 8a$	M1	
	$-20.468 = 8a$		
	$\therefore\ a = -2.5585$	W1	
	$v^2 = u^2 + 2as$		
	$0 = (3.7)^2 + 2(-2.5585)s$		
	$-13.69 = -5.117s$		
	$\therefore\ s = 2.68\,\text{m}$	MW1	
	As 2.68 > 2.5 box A will collide with the pulley.	MW1	
(iv)	Light or inextensible or any other suitable.	MW1	15

5 **(a)** A census is a survey conducted on the full set of objects belonging to a given population: every member of the population is included. MW1

A sample is a small part or quantity of the population intended to represent what the whole population is like. It is a subset of the population. MW1

(b) The sample may not be a sample of the population at all. Not all those questioned will be nurses.

He is only questioning women, ignoring male nurses.

He is only questioning one area (RVH), ignoring other hospitals or medical centres/doctor surgeries, etc.

He is carrying out his survey on a Monday morning, ignoring the rest of the week/nightshift, etc.

Any 2 of the above MW2 — 4

					AVAILABLE MARKS
6	(a)	(i)	$\sum x^2 = 831067$ $\sum x = 2995$ $n = 11$	M2	
			$\bar{x} = 272.27$, 272 (3 sf) $\sigma_x = 37.67$, 37.7 (3 sf)	W2	
		(ii)	221, 248, 251, 255, 259, 263, 264, 272, 291, 297, 374.		
			LQ = 251 UQ = 291 Median = 263		
			IQR = 291 – 251 = 40	MW1	
			$40 \times 1.5 = 60$		
			(LQ – 60 = 191)		
			UQ + 60 = 351	MW1	
			374 is greater than 351 therefore it is an outlier	MW1	
		(iii)	Standard deviation will decrease.	MW1	
		(iv)	Interquartile range will stay the same.	MW1	
	(b)	(i)	$1.8 \times 30 = 54$ or $18 \times 3 = 54$	MW1	
		(ii)	$2.4 \times 20 = 48$ or $24 \times 2 = 48$ 48 + 54 + 35 = 137	MW1	
			Probability $= \frac{137}{306}$	W1	12

AVAILABLE MARKS

7 **(i)** Summary statistics are as follows:

$\sum U = 19.1 \quad \sum W = 36 \quad \sum U^2 = 37.53 \quad \sum W^2 = 134.26 \quad \sum UW = 67.13$ M1 W3

From calculator, $r = -0.737$ W1

Alternative Solution:

Summary statistics are as follows:

$\sum U = 19.1 \quad \sum W = 36 \quad \sum U^2 = 37.53 \quad \sum W^2 = 134.26 \quad \sum UW = 67.13$ M1 W3

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n}}\sqrt{\sum y^2 - \frac{(\sum y)^2}{n}}}$$

$$r = \frac{67.13 - \frac{19.1 \times 36}{10}}{\sqrt{37.53 - \frac{19.1^2}{10}}\sqrt{134.26 - \frac{36^2}{10}}}$$

$$r = \frac{-\frac{163}{100}}{(1.024)(2.1587)}$$

$r = -0.737$ W1

(ii) The lower the percentage unemployment rate, the higher the percentage change in wages (vice versa). M1 6

		AVAILABLE MARKS
8 **(i)** $P(X = 1) = {}^{15}C_1 p(1 - p)^{14}$	M2	
$= 15p(1 - p)^{14}$	W1	
(ii) $P(X = 2) = {}^{15}C_2 p^2(1 - p)^{13}$	M1	
$= 105p^2(1 - p)^{13}$	W1	
$105p^2(1 - p)^{13} = 45p(1 - p)^{14}$	M1	
$\frac{7}{3}p = 1 - p$		
$\frac{10}{3}p = 1$		
$p = 0.3$	W1	
(iii) $x = 3, 4, 5, 6\ldots$		
$P(X \geqslant 3) = 1 - P(X = 0) - P(X = 1) - P(X = 2)$	M1 W1	
${}^{15}C_0\,(0.3)^0(0.7)^{15}$ or 0.0047475615		
${}^{15}C_1(0.3)^1(0.7)^{14}$ or 0.030520038		
${}^{15}C_2(0.3)^2(0.7)^{13}$ or 0.0915601148	MW3	
Final answer $= 0.8731722857$ $= 0.873$ (3 sf)	W1	
Alternative solution:		
$P(X \geqslant 3) = 1 - P(X = 0) - P(X = 1) - P(X = 2)$	M1 W1	
from tables, $x = 2$, $n = 15$		
$P(X \leqslant 2) = 0.1268$	MW3	
Hence $P(X \geqslant 3) = 1 - 0.1268 = 0.8732$ $= 0.873$ (3sf)	W1	13
	Total	**70**