Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]

FRIDAY 20 JANUARY, 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.

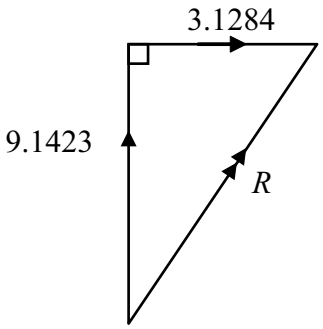
Some common examples of this occur in the following cases:

(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).

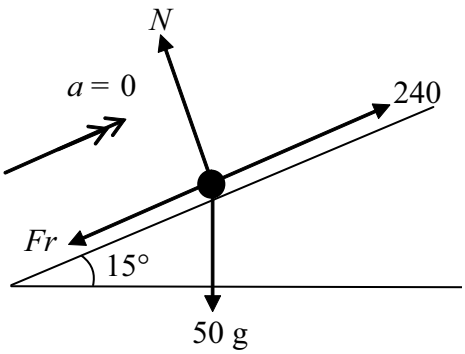
			AVAILABLE MARKS
1	R(↑) : $8\cos 50° + 4 = 9.1423$	M1 M1 W1	
	R(→) : $8\cos 40° - 3 = 3.1284$	M1 W1	
	Magnitude $= \sqrt{9.1423^2 + 3.1284^2}$	M1	
	$= \sqrt{93.368}$		
	$= 9.66$ N (3 s.f.)	W1	7



2	**(i)** Acceleration = gradient		
	$1.5 = \frac{20 - v}{10}$	M1	
	$\Rightarrow 15 = 20 - v$		
	$\Rightarrow v = 5$ ms^{-1}	W1	
	Alternative solution: $v = u + at$	M1	
	$\Rightarrow v = 20 - 1.5 \times 10$		
	$\Rightarrow v = 5$ m s^{-1}	W1	
	(ii) Distance = Area under graph		
	$= \frac{1}{2}(20 + 5) \times 10$	M1 M1	
	$= 125$ m	W1	
	Alternative solution: $v^2 = u^2 + 2as$	M1	
	$\Rightarrow 25 = 400 - 2 \times 1.5 \times s$	W1	
	$\Rightarrow 3s = 375$		
	$\Rightarrow s = 125$ m	W1	
	(iii) 2nd Area $= 4 \times 5 = 20$		
	$\Rightarrow$ 3rd Area $= 200 - 20 - 125$	M1	
	$= 55$	W1	
	$\Rightarrow \frac{1}{2} \times 5 \times t = 55$		
	$\Rightarrow t = 22$	MW1	
	$\Rightarrow$ Total time $= 22 + 4 + 10 = 36$ seconds	MW1	9

		AVAILABLE MARKS

3 **(i)**



MW2

(ii) R (perp. to slope): $\Rightarrow N = 50\text{ g} \cos 15° \ (= 473.30)$ M1 W1

R (up slope): $240 - Fr - 50\text{ g} \cos 75° = 0$ M1 M1 W1

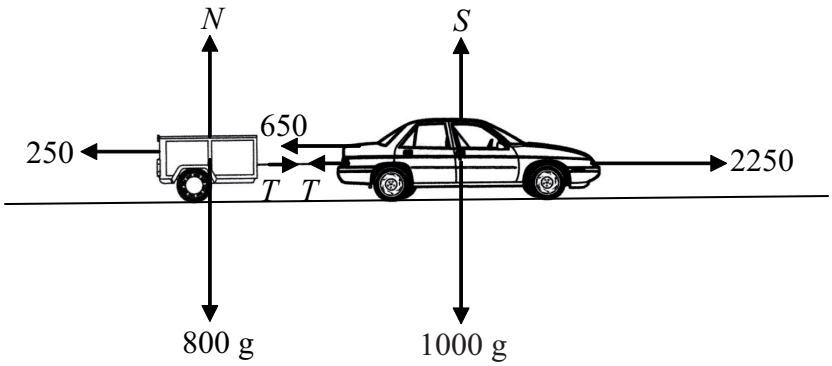
$\Rightarrow Fr = 113.179$ W1

When in motion, $Fr = \mu N$ M1

$\Rightarrow 113.179 = 473.30\mu$

$\Rightarrow \mu = 0.239$ (3 s.f.) W1 — 10

4 **(i)**



MW2

(ii) Use $F = ma$

Overall system: $2250 - 250 - 650 = 1800\,a$ M1 M1 W2

$\Rightarrow 1350 = 1800\,a$

$\Rightarrow a = 0.75\text{ m s}^{-2}$ W1

Alternative Solution

Use $F = ma$

Car: $2250 - 650 - T = 1000\,a$ M1 W1

Trailer: $T - 250 = 800a$ MW1

Adding: $\Rightarrow 1350 = 1800a$ M1

$\Rightarrow a = 0.75\text{ m s}^{-2}$ W1

Trailer: $T - 250 = 800 \times 0.75$ M1

$\Rightarrow T = 850$ N W1

(iii) Trailer: $-250 = 800a$ MW1

$\Rightarrow a = -0.3125$ W1

$u = 15$ Use $v^2 = u^2 + 2as$ M1

$a = -0.3125$ $\Rightarrow 0 = 225 - 2 \times 0.3125 \times s$ W1

$v = 0$ $\Rightarrow s = 360$ m W1

$s = ?$ — 14

		AVAILABLE MARKS

5 **(i)** $v = \frac{ds}{dt}$

$= t^3 - 6t^2$ M1 W2

(ii) $a = \frac{dv}{dt}$ M1

$= 3t^2 - 12t$ W1

(iii) When velocity is minimum, $\frac{dv}{dt} = 0$

$\Rightarrow 3t^2 - 12t = 0$ M1

$\Rightarrow 3t(t - 4) = 0$

$\Rightarrow t = 0, 4$ W1

Check 2nd derivative: $\frac{d^2v}{dt^2} = 6t - 12$ M1

If $t = 0$, $\frac{d^2v}{dt^2} = -12$, which is negative and gives a maximum velocity.

If $t = 4$, $\frac{d^2v}{dt^2} = 24 - 12$, which is positive and gives a minimum velocity. W1

Therefore, the minimum velocity of P is $v = 64 - 96$

$= -32 \text{ m s}^{-1}$ MW1 10

6 **(i)** Positive direction ⟶

A	**B**
$m_1 = 3m$	$m_2 = 2m$
$u_1 = u$	$u_2 = -2u$
$v_1 = ?$	$v_2 = u$

Using conservation of momentum M1

$3mu - 4mu = 3mv_1 + 2mu$ M1 W1

$\Rightarrow 3mv_1 = -3mu$

$\Rightarrow v_1 = -u$ W1

i.e. velocity of A is u in the opposite direction to its original motion

(ii) Positive direction ⟶

B	**C**
$m_2 = 2m$	$m_3 = 4m$
$u_2 = u$	$u_3 = -u$
$v_2 = v$	$v_3 = v$

Using conservation of momentum

$2mu - 4mu = 6mv$ M1W1

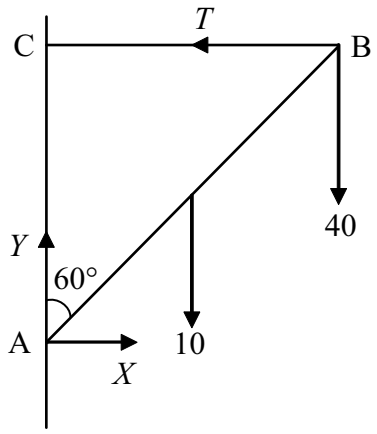
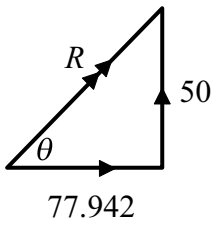
$\Rightarrow -2mu = 6mv$

$\Rightarrow v = -\frac{1}{3}u$ W1

i.e. **speed** of both B and C is $\frac{1}{3}u$ W1

(iii) A is moving to left with speed u, while combined object is moving to left with speed $\frac{1}{3}u$. MW1

Since speed of combined object is less than that of A, then it will not catch up with A and there will be no further collision. MW1 10

			AVAILABLE MARKS
7	**(i)** 	MW2	
	(ii) M(A): $10 \times 0.15 \sin 60° + 40 \times 0.3 \sin 60° = T \times 0.3 \cos 60°$	M1 M1 W3	
	$\Rightarrow 15\,T = 1169.13$		
	$\Rightarrow T = 77.942$ N		
	$\Rightarrow T = 77.9$ N (3 s.f.)	W1	
	(iii) R(→) : $X = T$	M1 W1	
	R(↑) : $Y = 40 + 10 = 50$	MW1	
	$R = \sqrt{77.942^2 + 50^2}$ 	M1	
	$= 92.6$ N (3 s.f.)	W1	
	$\theta = \tan^{-1}\left(\frac{50}{77.942}\right)$	M1	
	i.e. 32.7° (3 s.f.) to the horizontal	W1	15
		Total	**75**