Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]

MONDAY 13 MAY, 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 accurate working, whether in calculation, readings from tables, graphs or answers.

MA indicates marks for combined method and accurate 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).

1 R(→): $P \cos 20° = 10 \cos 60°$ M1M1W1

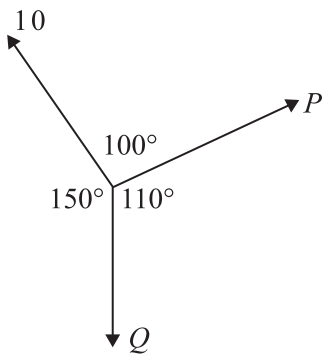
$$P = \frac{5}{\cos 20°} = 5.3208...$$ W1

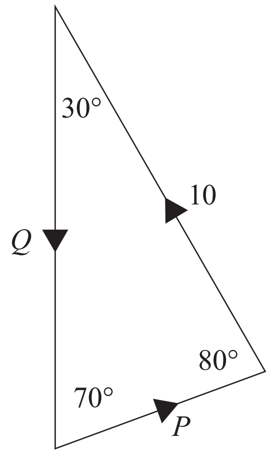
R(↑): $Q = P \cos 70° + 10 \cos 30°$ M1

$Q = 10.480\ldots$ W1

$P = 5.32$ (3 s.f.), $Q = 10.5$ (3 s.f.)

Alternative solution





Using Lami's Theorem:

$$\frac{10}{\sin 70°} = \frac{P}{\sin 30°} = \frac{Q}{\sin 80°}$$ M1W1

$$P = \frac{10 \sin 30°}{\sin 70°}$$ M1

$P = 5.32$ (3 s.f.) W1

$$Q = \frac{10 \sin 80°}{\sin 70°}$$ M1

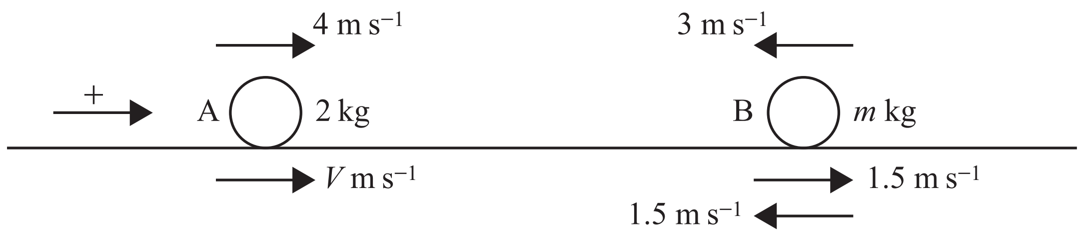
$Q = 10.5$ (3 s.f.) W1

AVAILABLE MARKS: 6

			AVAILABLE MARKS
2	**(i)** Using $s = ut + \frac{1}{2}at^2$	M1	
	$0 = u(3) + \frac{1}{2}(-9.8)(3)^2$	MW1W1	
	$u = 14.7$	W1	
	(ii) Using $v^2 = u^2 + 2as$	M1	
	$0 = (14.7)^2 + 2(-9.8)s$	MW1W1	
	$s = 11.025\,\text{m} \rightarrow 11.0$ m (3 s.f.)	W1	8
3	**(i)** Let T be the tension in the lift cable		
	Using $F = ma$ gives:	M1	
	$800g - T = 800 \times 0.9$	W2	
	$T = 7120$ N	W1	
	(ii) Let P = maximum number of passengers in the lift.		
	Using $F = ma$ gives	M1	
	$15000 - (800 + 80P)g = (800 + 80P) \times 0.9$	MW1W3	
	$15000 = (800 + 80P) \times 10.7$		
	$P = 7.5\ldots \rightarrow 7$	MW1	
	(iii) Any **two** assumptions from:		
	The lift cable is light.		
	The lift cable is inextensible.		
	The lift and any passengers are particles.	MW2	12

			AVAILABLE MARKS
4 **(i)**	$v = 2t^2 - 15t + 18$		
	$v = (2t - 3)(t - 6)$	M1	
	$v = 0$ when $t = 1\frac{1}{2}$ or $t = 6$	MW2	
(ii)	$s = \int v \, dt$	M1	
	$s = \frac{2}{3}t^3 - \frac{15}{2}t^2 + 18t + k$	W2	
	When $t = 0$, $s = 0$ (given). So, $k = 0$		
	$s = \frac{2}{3}t^3 - \frac{15}{2}t^2 + 18t$	MW1	
(iii)	$s(1) = \frac{2}{3}(1)^3 - \frac{15}{2}(1)^2 + 18(1) = 11\frac{1}{6}$ m	MW1	
	$s(1.5) = \frac{2}{3}(1.5)^3 - \frac{15}{2}(1.5)^2 + 18(1.5) = 12\frac{3}{8}$ m	MW1	
	$s(6) = \frac{2}{3}(6)^3 - \frac{15}{2}(6)^2 + 18(6) = -18$ m	MW1	
	Distance travelled in the time interval $1 \leqslant t \leqslant 6$		
	$= \frac{99}{8} + 18 + \frac{99}{8} - \frac{67}{6}$	M1	
	$= 31\frac{7}{12}$ m $= 31.6$ m (3 s.f.)	W1	12

5



AVAILABLE MARKS

(i) Let the velocity of A after the collision be $V\,\text{m s}^{-1}$

Impulse of B on A $= mv - mu$	M1M1
Impulse $= 2(V - 4) = -18$	W1
$V = -5\,\text{m s}^{-1}$	W1

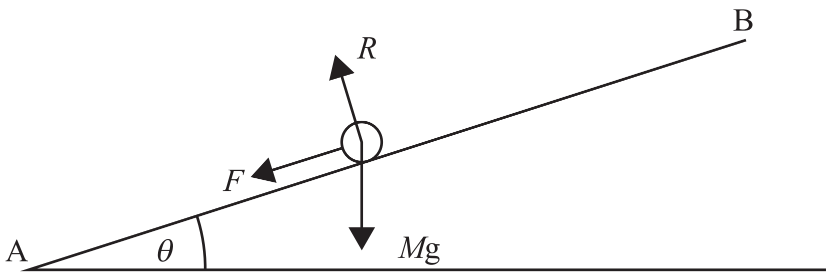
(ii)

Impulse of A on B $= 18\,\text{Ns}$	M1
$18 = m(\pm 1.5 + 3)$	MW2
$m = 12$ or 4	W2

Alternative solution

Since linear momentum is conserved,

$2(4) + m(-3) = 2(-5) + m(\pm 1.5)$	M1W1	
$18 = 4.5m$ or $18 = 1.5m$	M1	
$m = 4$ or $m = 12$	W2	9

			AVAILABLE MARKS
6	**(i)**		
		MW2	

(ii) R(⊥AB): $R = M\text{g}\cos\theta$ — M1W1

Friction is limiting: $F = \mu R$ — M1

If a m s^{-2} is the acceleration of the particle, then,
using Newton's second law of motion

$Ma = -M\text{g}\sin\theta - F$ — M1W1

$Ma = -M\text{g}\sin\theta - \mu M\text{g}\cos\theta$ — W2

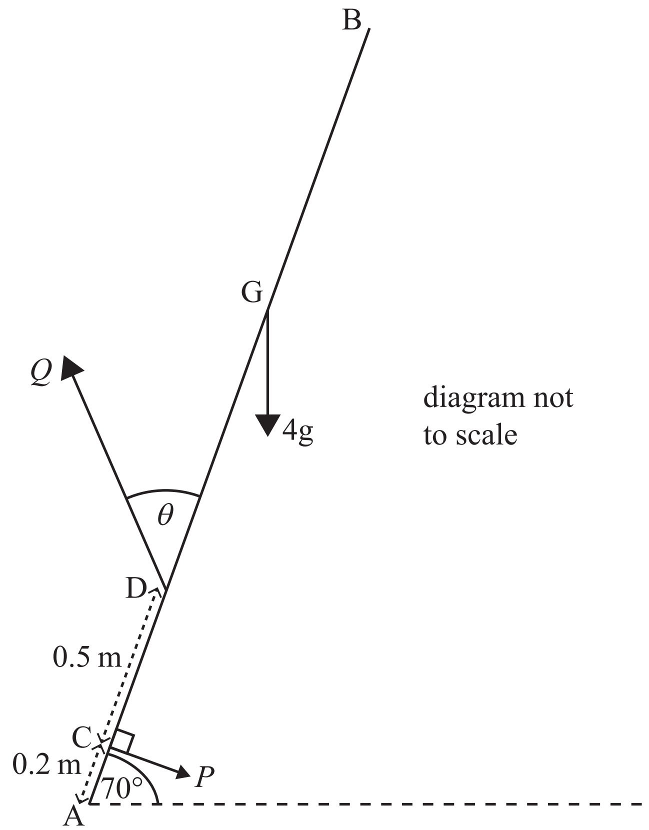
$a = -\frac{\text{g}}{5}(3 + 4\mu)$

$a = -6 - 8\mu$ — W1

(iii) Using $v = u + at$ gives $0 = U - (6 + 8\mu)T$ — M1W1

$U = (6 + 8\mu)T$ — W1 — 13

7 **(i)**



MW2

(ii) DG = 2.5 – 0.2 − 0.5 = 1.8 m — MW1

M(D): $P(0.5) = 4g\,(1.8 \sin 20°)$ — M1M1W1

$P = 48.266 \rightarrow 48.3$ (3 s.f.) — W1

(iii) R(AB): $Q\cos\theta = 4g\cos 20°$ — M1

$Q\cos\theta = 36.835...$ — W1

R(⊥ AB): $Q\sin\theta = P + 4g\cos 70°$ — M1

$Q\sin\theta = 61.673$ — W1

$Q = \sqrt{(36.835^2 + 61.673^2)}$ — M1

$Q = 71.8$ (3 s.f.) — W1

$\tan\theta = \dfrac{61.673}{36.835}$ — M1

$\theta = 59.2°$ (3 s.f.) — W1

AVAILABLE MARKS

AVAILABLE MARKS

Alternative solution

Let α be the angle Q makes with the upward vertical.

R($\rightarrow$): $P\cos 20^\circ = Q\sin\alpha$ M1W1

R($\uparrow$): $4g + P\cos 70^\circ = Q\cos\alpha$ M1W1

$\frac{Q\sin\alpha}{Q\cos\alpha} = \tan\alpha = \frac{48.266\cos 20^\circ}{4g + 48.266\cos 70^\circ}$, from **(ii)** M1

$\alpha = 39.151^\circ \rightarrow 39.2^\circ$ (3 s.f.)

So, Q makes an angle of $\alpha + 20^\circ = 59.2^\circ$ (3 s.f.) with the pole. MW1

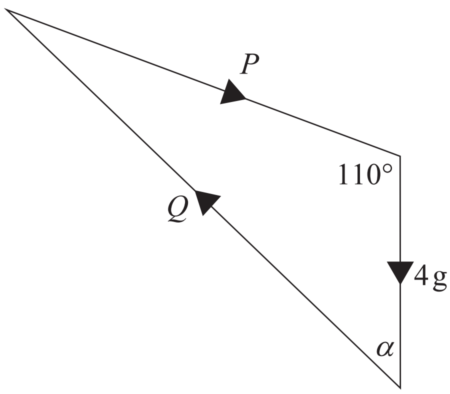
$Q = \frac{48.266\cos 20^\circ}{\sin 39.151^\circ}$ M1

$Q = 71.8$ (3 s.f.) W1

Alternative solution

Let α be the angle Q makes with the upward vertical.

The three forces P N, Q N and 4g N are in equilibrium: M1



$Q^2 = P^2 + (4g)^2 - 2P(4g)\cos 110^\circ$ M1W1

From **(ii)**, $Q^2 = (48.266)^2 + (4g)^2 - 2(48.266)(4g)\cos 110^\circ$

$Q = 71.8$ (3 s.f.) W1

$\frac{Q}{\sin 110^\circ} = \frac{P}{\sin\alpha}$ M1W1

$\sin\alpha = \frac{48.266(\sin 110^\circ)}{71.836}$

$\alpha = 39.151^\circ \rightarrow 39.2^\circ$ (3 s.f.) W1

So, Q makes an angle of $\alpha + 20^\circ = 59.2^\circ$ (3 s.f.) with the pole. MW1 15

Total **75**