

## **GCE A level Mathematics (9AM0) – Paper 32 Mechanics**

### **October 2020 student-friendly mark scheme**

**Please note that this mark scheme is not the one used by examiners for making scripts. It is intended more as a guide to good practice, indicating where marks are given for correct answers. As such, it doesn't show follow-through marks (marks that are awarded despite errors being made) or special cases.**

**It should also be noted that for many questions, there may be alternative methods of finding correct solutions that are not shown here – they will be covered in the formal mark scheme.**

**This document is intended for guidance only and may differ significantly from the final mark scheme published in December 2020.**

#### **Guidance on the use of codes within this document**

M1 – method mark. This mark is generally given for an appropriate method in the context of the question. This mark is given for showing your working and may be awarded even if working is incorrect.

A1 – accuracy mark. This mark is generally given for a correct answer following correct working.

B1 – working mark. This mark is usually given when working and the answer cannot easily be separated.

Some questions require all working to be shown; in such questions, no marks will be given for an answer with no working (even if it is a correct answer).

**Question 1 (Total 9 marks)**

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$R = mg \cos \alpha = \frac{4}{5} mg$	M1 3.4	This mark is given for a method to resolve perpendicular to the plane
		A1 1.1b	This mark is given for a correct expression for $R$
(b)	$F = mg \sin \alpha$	M1 3.4	This mark is given for a method to resolve parallel to the plane
		A1 1.1b	This mark is given for a correct expression for $F$
	$F = \mu R$	M1 2.1	This mark is given for a method to use $F = \mu R$ to solve for $\mu$
	$\mu = \frac{3}{4}$	A1 2.2a	The mark is given for fully correct working leading to the given answer
(c)	The forces acting on $Q$ will still balance as the $m$ terms cancel	B1 2.4	This mark is given for a correct explanation
(d)	$Q$ slides down the plane with constant speed $0.5 \text{ m s}^{-1}$	B1 2.4	This mark is given for a correct description of the constant speed of $Q$
	There is no resultant force down the plane so there is no acceleration	B1 2.4	This mark is given for a correct description of acceleration

## Question 2 (Total 8 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\mathbf{v} = (-2\mathbf{i} + 2\mathbf{j}) + 2(4\mathbf{i} - 5\mathbf{j})$	M1 3.1a	This mark is given for a method to use $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
	$= 6\mathbf{i} - 8\mathbf{j} \text{ m s}^{-1}$	A1 1.1b	This mark is given for a correct answer only
(b)	$(\lambda\mathbf{i} - 4.5\mathbf{j}) = (-2\mathbf{i} + 2\mathbf{j})t + \frac{1}{2}t^2(4\mathbf{i} - 5\mathbf{j})$	M1 3.1a	This mark is given for a method to use $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$
		A1 1.1b	This mark is given for a correct expression for $\mathbf{r}$
	$-4.5 = 2T - \frac{5}{2}T^2$	M1 2.1	This mark is given for a method to attempt to equate $\mathbf{j}$ components to give an equation in $T$ only
	$T = 1.8$	A1 1.1b	This mark is given for a correct answer only
(c)	$-2 \times 1.8 + \frac{1}{2}(1.8)^2 \times 4$	M1 3.1a	This mark is given for substituting the value of $T$ into the $\mathbf{i}$ component to find a value for $\lambda$
	$\lambda = 2.88$	A1 1.1b	This mark is given for a correct answer only

### Question 3 (Total 12 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\mathbf{v} = (t - 2t^2)\mathbf{i} + \left(3t - \frac{1}{3}t^3\right)\mathbf{j} (+ \mathbf{c})$	M1 3.4	This mark is given for a method to integrate $\mathbf{a}$ to find the velocity $\mathbf{v}$
		A1 1.1b	This mark is given for a correct expression for the velocity $\mathbf{v}$
	When $t = 4$ , $\frac{28}{3}$ $\mathbf{v} = 8\mathbf{i} - \frac{28}{3}\mathbf{j} \text{ m s}^{-1}$	A1 1.1b	This mark is given for a correct answer only
(b)(i)	$t - 2t^2 + 36 = 0$	M1 3.1a	This mark is given for a method to equate the $\mathbf{i}$ component of $\mathbf{v}$ to zero
		A1 1.1b	This mark is given for a correct expression in terms of $t$
	$t = 4.5$	A1 1.1b	This mark is given for a correct answer only
(b)(ii)	$\mathbf{v} = (2t - 1)\mathbf{i} + 3\mathbf{j}$	M1 3.4	This mark is given for a method to differentiate $\mathbf{r}$ to find the velocity $\mathbf{v}$
		A1 1.1b	This mark is given for a correct expression for $\mathbf{v}$
	$(2t - 1)^2 + 3^2 = 5^2$	M1 2.1	This mark is given for a method to use the magnitude to find an expression in terms of $t$
		A1 1.1b	This mark is given for a correct expression in terms of $t$
	$4t^2 - 4t + 1 + 9 = 25$ $4t^2 - 4t - 15 = 0$	M1 3.1a	This mark is given for a method to solve an equation for $t$
	$t = 2.5$	A1 1.1b	This mark is given for a correct answer only

#### Question 4 (Total 10 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$N \times \frac{4a}{\sin \alpha} = Mg \times 3a \cos \alpha$	M1 3.3	This mark is given for a method to take moments about $A$
		A1 1.1b	This mark is given for correctly taking moments about $A$
	$\frac{9Mg}{25}$	A1 1.1b	The mark is given for fully correct working leading to the given answer
(b)	$(\rightarrow) F = \frac{9Mg}{25} \sin \alpha$	M1 3.4	This mark is given for a method to resolve horizontally
		A1 1.1b	This mark is given for a correct expression for $(\rightarrow) F$
	$(\uparrow) R + \frac{9Mg}{25} \cos \alpha = Mg$	M1 3.4	This mark is given for a method to resolve vertically
		A1 1.1b	This mark is given for a correct expression for $(\uparrow) R$
	$F = \mu R$	M1 3.4	This mark is given for using $F = \mu R$
	$\frac{9Mg}{25} \times \frac{4}{5} = \mu \left( Mg - \frac{9Mg}{25} \times \frac{3}{5} \right)$ $36Mg = \mu \times 98Mg$	M1 3.1b	This mark is given for a method to eliminate $R$ and $F$ to solve for $\mu$
	$\mu = \frac{18}{49}$	A1 2.2a	This mark is given for a correct answer only

**Question 5 (Total 11 marks)**

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$U \cos 45^\circ t = 100$	M1 3.3	This mark is given for a method to use horizontal motion
		M1 1.1b	This mark is given for a correct equation in $U$ and $t$
	$U \sin 45^\circ t - \frac{1}{2}gt^2 = -25$	M1 3.4	This mark is given for a method to use vertical motion
		A1 1.1b	This mark is given for a correct equation in $U$ and $t$
	$t = \frac{100\sqrt{2}}{U}$ $\frac{U}{\sqrt{2}} \times \frac{100\sqrt{2}}{U} - \frac{1}{2}g\left(\frac{100\sqrt{2}}{U}\right)^2 = -25$ $100 - 4.9 \times \frac{20000}{U^2} = -25$	M1 3.1b	This mark is given for a method to eliminate $t$ and solve for $U$
	$U = 28$	A1 1.1b	The mark is given for fully correct working leading to the given answer
(b)	$0^2 = (28 \sin 45^\circ)^2 - 2gh$	M1 3.4	This mark is given for a method to use vertical motion
		A1 1.1b	This mark is given for finding a correct equation in terms of $h$ only
	Greatest height = 45 m	A1 1.1b	This mark is given for the correct answer only
(c)	The new value is greater than 28	B1 3.5a	This mark is given for a correct statement
(d)	For example: Account for the effects of wind Use a more accurate value for $g$ Account for the spin of the ball	B1 3.5c	This mark is given for a valid refinement