OCR
Oxford Cambridge and RSA

Tuesday 9 June 2015 – Morning

AS GCE MATHEMATICS (MEI)

4761/01 Mechanics 1

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4761/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g\,\text{m}\,\text{s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

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- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Section A (36 marks)

1 Fig. 1 shows four forces acting at a point. The forces are in equilibrium.

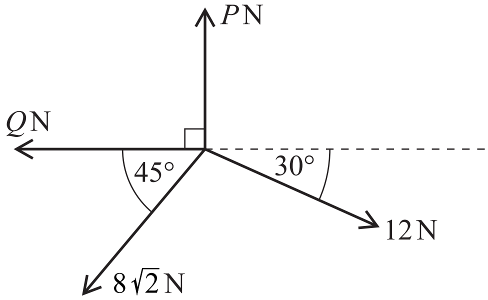

Fig. 1

Show that $P = 14$.

Find Q, giving your answer correct to 3 significant figures. **[5]**

2 Fig. 2 shows a 6 kg block on a smooth horizontal table. It is connected to blocks of mass 2 kg and 9 kg by two light strings which pass over smooth pulleys at the edges of the table. The parts of the strings attached to the 6 kg block are horizontal.

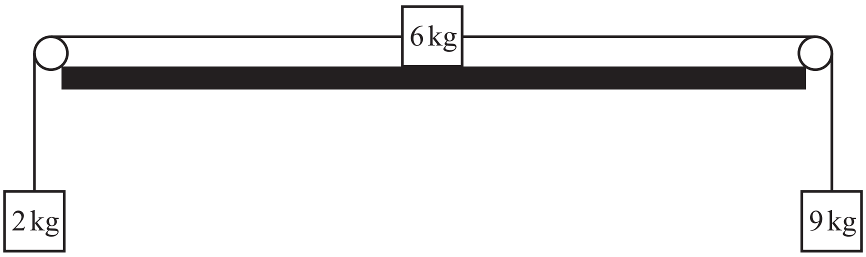

Fig. 2

(i) Draw three separate diagrams showing all the forces acting on each of the blocks. **[3]**

(ii) Calculate the acceleration of the system and the tension in each string. **[5]**

3 The map of a large area of open land is marked in 1 km squares and a point near the middle of the area is defined to be the origin. The vectors $\begin{pmatrix}1\\0\end{pmatrix}$ and $\begin{pmatrix}0\\1\end{pmatrix}$ are in the directions east and north.

At time t hours the position vectors of two hikers, Ashok and Kumar, are given by:

Ashok $\quad \mathbf{r}_A = \begin{pmatrix}-2\\0\end{pmatrix} + \begin{pmatrix}8\\1\end{pmatrix}t$,

Kumar $\quad \mathbf{r}_K = \begin{pmatrix}7t\\10-4t\end{pmatrix}$.

(i) Prove that the two hikers meet and give the coordinates of the point where this happens. **[4]**

(ii) Compare the speeds of the two hikers. **[3]**

4 Fig. 4 illustrates a straight horizontal road. A and B are points on the road which are 215 metres apart and M is the mid-point of AB.

When a car passes A its speed is $12\,\text{m s}^{-1}$ in the direction AB. It then accelerates uniformly and when it reaches B its speed is $31\,\text{m s}^{-1}$.

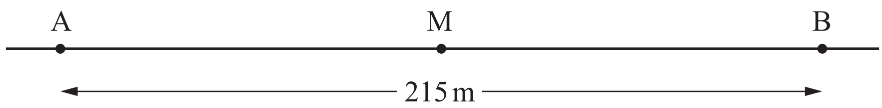

Fig. 4

(i) Find the car's acceleration. **[2]**

(ii) Find how long it takes the car to travel from A to B. **[2]**

(iii) Find how long it takes the car to travel from A to M. **[3]**

(iv) Explain briefly, in terms of the speed of the car, why the time taken to travel from A to M is more than half the time taken to travel from A to B. **[1]**

5 A golf ball is hit at an angle of 60° to the horizontal from a point, O, on level horizontal ground. Its initial speed is $20\,\text{m s}^{-1}$. The standard projectile model, in which air resistance is neglected, is used to describe the subsequent motion of the golf ball. At time t s the horizontal and vertical components of its displacement from O are denoted by x m and y m.

(i) Write down equations for x and y in terms of t. **[2]**

(ii) Hence show that the equation of the trajectory is

$$y = \sqrt{3}x - 0.049x^2.$$ **[2]**

(iii) Find the range of the golf ball. **[2]**

(iv) A bird is hovering at position $(20, 16)$.

Find whether the golf ball passes above it, passes below it or hits it. **[2]**

Section B (36 marks)

6 The battery on Carol and Martin's car is flat so the car will not start. They hope to be able to "bump start" the car by letting it run down a hill and engaging the engine when the car is going fast enough. Fig. 6.1 shows the road leading away from their house, which is at A. The road is straight, and at all times the car is steered directly along it.

- From A to B the road is horizontal.
- Between B and C, it goes up a hill with a uniform slope of 1.5° to the horizontal.
- Between C and D the road goes down a hill with a uniform slope of 3° to the horizontal. CD is 100 m. (This is the part of the road where they hope to get the car started.)
- From D to E the road is again horizontal.

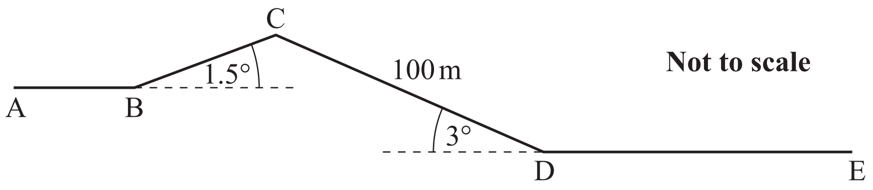

Fig. 6.1

The mass of the car is 750 kg, Carol's mass is 50 kg and Martin's mass is 80 kg.

Throughout the rest of this question, whenever Martin pushes the car, he exerts a force of 300 N along the line of the car.

(i) Between A and B, Martin pushes the car and Carol sits inside to steer it. The car has an acceleration of $0.25\,\text{m s}^{-2}$.

Show that the resistance to the car's motion is 100 N. **[3]**

Throughout the rest of this question you should assume that the resistance to motion is constant at 100 N.

(ii) They stop at B and then Martin tries to push the car up the hill BC.

Show that Martin cannot push the car up the hill with Carol inside it but can if she gets out.

Find the acceleration of the car when Martin is pushing it and Carol is standing outside. **[6]**

(iii) While between B and C, Carol opens the window of the car and pushes it from outside while steering with one hand. Carol is able to exert a force of 150 N parallel to the surface of the road but at an angle of 30° to the line of the car. This is illustrated in Fig. 6.2.

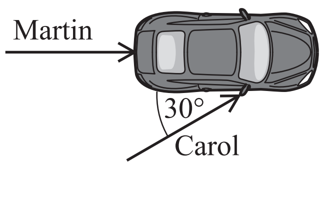

Fig. 6.2

Find the acceleration of the car. **[4]**

(iv) At C, both Martin and Carol get in the car and, starting from rest, let it run down the hill under gravity. If the car reaches a speed of $8\,\text{m s}^{-1}$ they can get the engine to start.

Does the car reach this speed before it reaches D? **[5]**

7 A box of emergency supplies is dropped to victims of a natural disaster from a stationary helicopter at a height of 1000 metres. The initial velocity of the box is zero.

At time t s after being dropped, the acceleration, $a\,\mathrm{m\,s^{-2}}$, of the box in the vertically downwards direction is modelled by

$$a = 10 - t \quad \text{for} \quad 0 \leqslant t \leqslant 10,$$
$$a = 0 \quad \text{for} \quad t > 10.$$

(i) Find an expression for the velocity, $v\,\mathrm{m\,s^{-1}}$, of the box in the vertically downwards direction in terms of t for $0 \leqslant t \leqslant 10$.

Show that for $t > 10$, $v = 50$. **[4]**

(ii) Draw a sketch graph of v against t for $0 \leqslant t \leqslant 20$. **[3]**

(iii) Show that the height, h m, of the box above the ground at time t s is given, for $0 \leqslant t \leqslant 10$, by

$$h = 1000 - 5t^2 + \frac{1}{6}t^3.$$

Find the height of the box when $t = 10$. **[4]**

(iv) Find the value of t when the box hits the ground. **[2]**

(v) Some of the supplies in the box are damaged when the box hits the ground. So measures are considered to reduce the speed with which the box hits the ground the next time one is dropped. Two different proposals are made. Carry out suitable calculations and then comment on each of them.

(A) The box should be dropped from a height of 500 m instead of 1000 m. **[2]**

(B) The box should be fitted with a parachute so that its acceleration is given by

$$a = 10 - 2t \quad \text{for} \quad 0 \leqslant t \leqslant 5,$$
$$a = 0 \quad \text{for} \quad t > 5.$$

[3]

END OF QUESTION PAPER

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Centre number						Candidate number				

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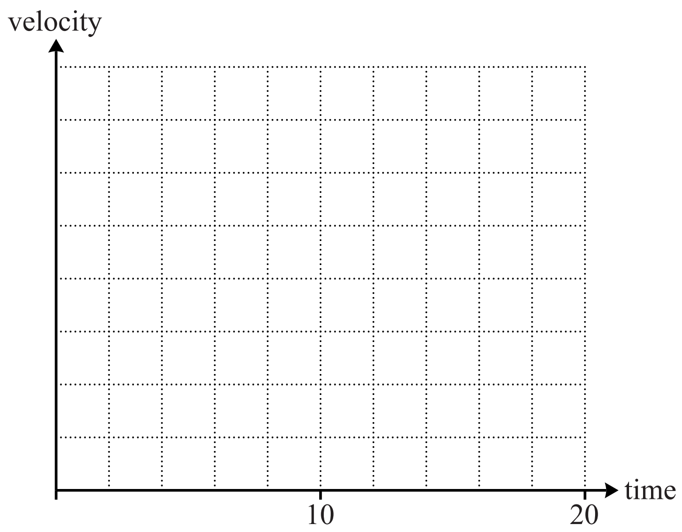
THE ANSWER SPACE FOR QUESTION 1 BEGINS ON PAGE 3.

PLEASE DO NOT WRITE IN THIS SPACE

7 (ii)	**Spare copy of diagram for question 7 (ii)**



Section A (36 marks)

1	

2 (i)	

2 (ii)	

3 (i)	

3 (ii)	

4 (i)	
4 (ii)	
4 (iii)	

4 (iv)	
5 (i)	
5 (ii)	

5 (iii)

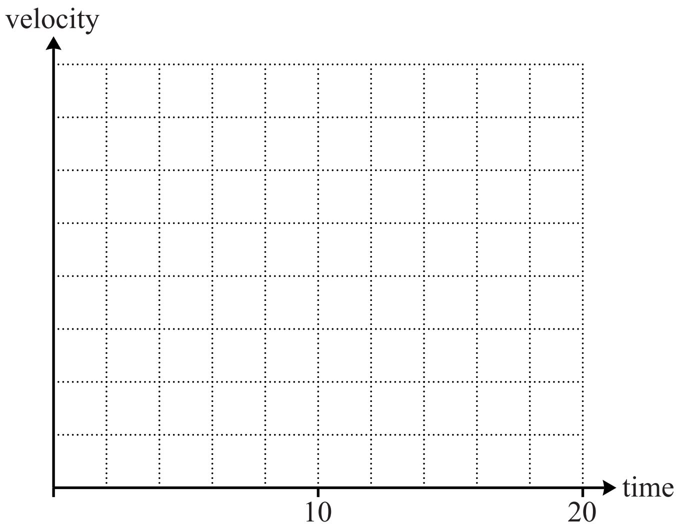
5 (iv)

Section B (36 marks)

6 (i)	
6 (ii)	
	(answer space continued on next page)

6 (ii)	**(continued)**
6 (iii)	

6 (iv)

7 (i)	
7 (ii)	**A spare copy of this diagram can be found on page 2.** 

7 (iii)

7 (iv)

7 (v)(*A*)	
7 (v)(*B*)	

Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions for GCE Mathematics (MEI) Mechanics strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more ‘method’ steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation ‘dep *’ is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be ‘follow through’. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)

We are usually quite flexible about the accuracy to which the final answer is expressed and we do not penalise over-specification.

When a value is given in the paper
Only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case.

When a value is not given in the paper
Accept any answer that agrees with the correct value to 2 s.f.

ft should be used so that only one mark is lost for each distinct error made in the accuracy to which working is done or an answer given. Refer cases to your Team Leader where the same type of error (e.g. errors due to premature approximation leading to error) has been made in different questions or parts of questions.

There are some mistakes that might be repeated throughout a paper. If a candidate makes such a mistake, (eg uses a calculator in wrong angle mode) then you will need to check the candidate's script for repetitions of the mistake and consult your Team Leader about what penalty should be given.

There is no penalty for using a wrong value for g. E marks will be lost except when results agree to the accuracy required in the question.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

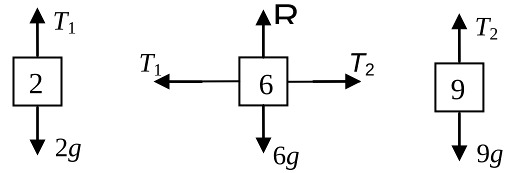
'Fresh starts' will not affect an earlier decision about a misread.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	Guidance	
1			$P = 8\sqrt{2}\sin 45° + 12\sin 30°$	**M1**	Considering equilibrium in the vertical direction	
				M1	Resolution of forces of 12 N and $8\sqrt{2}$ N in the vertical direction. Do not allow sin-cos interchange for the 30° angle.	
			$P = 14$	**A1**	Dependent on both M marks	
			$Q + 8\sqrt{2}\cos 45° = 12\cos 30°$	**B1**		
			$Q = 2.39$	**B1** **[5]**		

2	(i)			B1 B1 B1 **[3]**	Diagrams for both 2 and 9 kg blocks. The tensions must be different from each other. No extra forces. Tensions on 6 kg block. The tensions must be different from each other. No extra forces. 6*g* and *R* on 6 kg block. No extra forces. **Special Case** When the tensions are given as T_1, T_2, T_3, T_4 (or equivalent) award up to SC1 SC0 for the first two marks.	
2	(ii)		$9g - T_2 = 9a$ $T_2 - T_1 = 6a$ $T_1 - 2g = 2a$ $a = \frac{7}{17}g = 4.04 \text{ (m s}^{-2}\text{)}$ $T_1 = 27.7 \text{ (N)}$ $T_2 = 51.9 \text{ (N)}$	M1 M1 A1 A1 A1 **[5]**	First equation correct Both the remaining two equations correct. Do not give this mark if both tensions are shown as the same. The final three marks are dependent on both M marks a, T_1 and T_2 may be found in any order and FT should be allowed from the first of these found	
	(ii)		**Alternative: Whole system** $9g - 2g = 17a$ $a = \frac{7g}{17} = 4.04$ $T_1 - 2g = 2a$ and $9g - T_2 = 9a$ $T_1 = 27.7$ (N) $T_2 = 51.9$ (N)	 M1 A1 M1 A1 A1	 Both equations correct. Oe. The final two marks are dependent on both M marks. T_1 and T_2 may be found in either order and FT should be allowed from their value for a.	

3	(i)		**Either** $-2+8t=7t$ **Or** $t=10-4t$	M1	Forming an equation for t. Accept vector equation for this mark. May be implied by a statement that $t = 2$.	
			$\Rightarrow t=2$	A1		
			Substituting $t=2$ in **both** expressions	B1	oe, eg showing $t=2$ satisfies both equations or a vector equation.	
			They meet at (14, 2)	B1	Accept $\begin{pmatrix}14\\2\end{pmatrix}$	
				[4]		
3	(ii)		Ashok's speed is $\sqrt{8^2+1^2}=\sqrt{65}$	B1		
			Kumar's speed is $\sqrt{7^2+(-4)^2}=\sqrt{65}$ km h^{-1}	B1		
			They both walk at the same speed	B1	CAO from correct speeds SC1 for finding both velocities correctly but neither speed	
				[3]		

Follow through between parts of Question 4 should be allowed for the value of *a* found in part (i) into parts (ii) and (iii).						
4	**(i)**		$v^2 - u^2 = 2as$ $31^2 - 12^2 = 2 \times 215 \times a$ $a = 1.9$ so 1.9 m s^{-2}	**M1** **A1** **[2]**	Selection and use of appropriate equation(s)	
4	**(ii)**		$v = u + at$ $31 = 12 + 1.9t$ $t = 10$ so 10 s	**M1** **A1** **[2]**	Selection and use of appropriate equation(s) FT from their value of *a* from part (i).	

4	**(iii)**		$s = ut + \frac{1}{2}at^2$			
			$\frac{215}{2} = 12t + \frac{1}{2} \times 1.9 \times t^2$	**M1**	Selection and use of $s = ut + \frac{1}{2}at^2$, oe. Correct elements but condone minor arithmetic errors.	
			$\left(t = \frac{-12 \pm \sqrt{12^2 + 4 \times 0.95 \times 107.5}}{1.9} \right)$	**M1**	Use of quadratic formula (may be implied by answer), oe.	
			$t = 6.055$ (or -18.69)	**A1** **[3]**	FT their *a* only.	
			Alternative: Finding a 2-stage method			
			$v^2 - u^2 = 2as$ and $s = \frac{(u+v)}{2}t$			
			$v = \pm\sqrt{12^2 + 2 \times 1.9 \times 107.5} = (\pm)23.505...$	**M1**	Selection and use of a complete valid 2-stage method	
			$s = \frac{(u+v)}{2}t \Rightarrow t = \frac{2 \times 107.5}{(12 + 23.505...)}$ $\left(\text{or } t = \frac{2 \times 107.5}{(12 - 23.505...)} \right)$	**M1**	Using the output from the first stage to find *t*	
			$t = 6.055$ (or 18.69)	**A1**	FT their *a* only.	

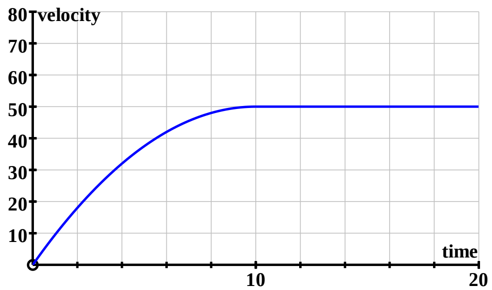
4	(iv)		Because it is accelerating, it travels less fast in the first half of the distance and so takes more time.	**B1** **[1]**	The answer must refer to the two parts of the distance (or "the same distance") so no credit is given to answers like "Because it is accelerating" and "Because its speed is not uniform". Most successful answers will refer to the times to cover AM and MB but this may be implicit. So B1 should be given for an answer like "It is travelling faster between M and B than it is between A and M" Notice that the fact that the acceleration is uniform is irrelevant.	

5	(i)		$x = 10t$ $y = 10\sqrt{3}t - 4.9t^2$	B1 B1 **[2]**	Allow x = 20cos60° t Allow $y = 20\sin 60°\, t - \frac{g}{2}t^2$ or $y = 17.3\, t - \frac{9.8}{2}t^2$	
5	(ii)		Substitute $t = \frac{x}{10}$ in equation for y $\Rightarrow y = \sqrt{3}x - 0.049x^2$	M1 A1 **[2]**	Substitution of a correct expression for t. Notice that this is a given result	
5	(iii)		When $y = 0$, $x = \frac{1.732}{0.049}$ (or 0) The range is 35.3 m	M1 A1 **[2]**	Use of y = 0, or 2 × Time to maximum height	
5	(iv)		When $x = 20, y = 1.732 \times 20 - 0.049 \times 20^2$ Height is 15.04 m so passes below the bird whose height is 16 m	M1 A1 **[2]**	Use of equation of trajectory **Special Case** Allow **SC2** for substituting y = 16 in the trajectory, showing the equation for x has no real roots and concluding the height of the ball is always less than16 m. This can also be done with the equation for vertical motion.	
	(iv)		**Alternative: Using time** When x = 20, t = 2 $y = 10\sqrt{3} \times 2 - 4.9 \times 2^2$ Height is 15.04 m so passes below the bird whose height is 16 m	M1 A1	Use of equation for the height	
	(iv)		**Alternative: Maximum height** The maximum height of the ball (is 15.3 m) Since15.3 < 16, it is always below the bird	M1 A1	A valid method for finding the maximum height	

Follow through between parts of Question 6 should be allowed for values found in parts (ii) and (iii) providing the questions are not simplified.						
6	**(i)**		$F - R = ma$	**M1**	Use of Newton's 2nd Law	
			$300 - R = (750 + 50) \times 0.25$	**A1**	Correct elements present	
			$R = 100$	**A1**	This is a given result	
				[3]		
6	**(ii)**		**Carol in** Component of weight down slope	**M1**	Resolving down the slope. Accept use of 750 instead of 800. For this mark only condone no *g* and allow sin-cos interchange.	
			$= 800g\sin 1.5°\ (= 205.2\text{ N})$	**A1**	Give M1 A1 for 800*g*sin15^{o} seen	
			Martin has to overcome 305.2 N			
			$300 < 305.2$ Martin cannot manage	**A1**	This mark may be awarded for an argument based on Newton's 2nd law leading towards *a* = -0.006	
			Carol out Martin has to overcome $750g\sin 1.5° + 100 = 292.4\text{N}$			
			$300 > 292.4$ so Martin manages	**B1**	Explanation, based on correct working, that Martin can manage. This can be given retrospectively with a comment on a positive value for *a*.	
			$300 - 292.4 = 7.6 = 750a$	**M1**	Use of Newton's 2nd Law	
			The acceleration is 0.010 m s^{-2}	**A1**	Cao. Accept 0.01 or an answer that rounds to 0.01.	
				[6]		
6	**(iii)**		Component of Carol's force parallel to the line of the car	**M1**	For attempt at resolution in the correct direction. For this mark only, condone sin-cos interchange.	
			$= 150\cos 30°\ (= 129.9)$	**A1**	Give M1 A1 for 150cos30^{o} seen	
			Resultant forward force $= 7.6 + 129.9 = 137.5$	**M1**	All forces parallel to the slope present and correct. Sign errors condoned.	
			$750a = 137.5$			
			The acceleration is 0.183 m s^{-2}	**A1**	FT their force parallel to the slope from part (ii) (correct value 7.6 N)	
				[4]		

6	**(iv)**		Component of weight down the slope $= (750 + 50 + 80) \times 9.8 \times \sin 3°$			
			$880a = 451.3 - 100$	**M1**	Newton's 2nd law with correct elements present. No sin-cos interchange. The same mass must be used in both places.	
			$a = 0.399$	**A1**		
			$v^2 - u^2 = 2as$			
			When $v = 8$, $s = 8^2 \div (2 \times 0.399)$	**M1**	Selection and use of an appropriate formula (unless with $a = g$)	
			$s = 80.1$	**A1**	FT their value of a	
			$80.1 < 100$ so Yes they get the car started	**A1**	FT their value of a	
				[5]		
	(iv)		**Alternative: Finding the speed after 100 m** Component of weight down the slope			
			$= (750 + 50 + 80) \times 9.8 \times \sin 3°$	**M1**	Newton's 2nd law with correct elements present. No sin-cos interchange	
			$880a = 451.3 - 100$			
			$a = 0.399$	**A1**		
			$v^2 - u^2 = 2as$			
			$v^2 = (0^2) + 2 \times 0.399 \times 100$	**M1**	Selection and use of an appropriate formula (unless with $a = g$)	
			$v = (\sqrt{79.8}) = 8.93...$	**A1**	FT their value of a	
			($v > 8$) so they get the car started	**A1**	FT their value of a	

Follow through between parts of Question 7 should be allowed for the value of *h* (when *t* = 10) found in part (iii) if it is used in part (iv) or in part (v)(*A*).

7	**(i)**		Integrate a to obtain v	**M1**	Attempt to integrate	
			$v = 10t - \frac{1}{2}t^2 \quad (+c)$	**A1**		
			$t = 10 \Rightarrow v = 100 - 50 = 50$	**M1**	Substitution of $t = 10$ to find v	
			Since $a = 0$ for $t > 10$, $v = 50$ for $t > 10$	**A1**	Sound argument required for given answer. It must in some way refer to $a = 0$.	
				[4]		
7	**(ii)**		Continuous two part v-t graph	**B1**	The graph must cover $t = 0$ to $t = 20$	
						
			Curve for $0 \le t \le 10$	**B1**		
			Horizontal straight line for $10 \le t \le 20$	**B1**	B0 if no vertical scale is given	
				[3]		

7	(iii)		Distance fallen = $\int\left(10t - \frac{1}{2}t^2\right)dt$ $d = 5t^2 - \frac{1}{6}t^3 + c \quad (c = 0)$ Height = 1000 – d Height = $1000 - 5t^2 + \frac{1}{6}t^3$ When $t = 10$, $h = 667$	M1 A1 A1 B1 [4]	Attempt to integrate This mark should only be given if the signs are correctly obtained. oe	
7	(iv)		Time at constant vel $= 667 \div 50 = 13.3$ Total time $t = 10 + 13.3 = 23.3$	B1 B1 [2]	FT for h from part (iii) FT	
7	(v)	*A*	Since $500 > 333$ The box will have reached terminal speed. So there is no improvement	M1 A1 [2]	For finding the height at which the crate reaches terminal velocity, eg h = 167, or equivalent relevant calculation. FT for h from part (iii) if used. Allow either one (or both) of these two statements.	
7	(v)	*B*	$v = 10t - t^2$ (for $t \le 5$) Terminal velocity is 25 m s^{-1} So better	M1 A1 A1 [3]	Integration to find v	

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4761 Mechanics 1

General Comments:

This paper was answered well by a large majority of the candidates. They showed good understanding of the principles underpinning mechanics at this level and of the particular techniques needed to answer the questions. Almost all candidates were able to answer at least some of the questions and so show what they could do.

The two areas that caused the greatest difficulty, and so loss of marks, were connected particles (question 2) and two-stage motion (question 7).

There was no evidence of the paper being found too long for the available time. Many candidates provided attempts at all the parts of all the questions.

Comments on Individual Questions

Section A

1. (Forces in equilibrium)

This question was answered correctly by almost all candidates. A small number made sign errors, particularly when finding Q. There were also those who did not give Q to 3 significant figures, as requested in the question.

2. (Connected particles)

This was the least well-answered question on the paper. Paradoxically it was probably the most routine of all the questions.

In part (i) candidates were asked to draw separate diagrams showing the forces on the three objects. There were two strings and the tensions in them were different. However, many candidates treated them as the same and just marked them as T. This was obviously a serious mistake which undermined the whole question and so caused a large loss of marks both in part (i) and, if continued, in part (ii).

In part (ii) they went on to find the acceleration of the system and the tensions in the two strings. Those who had drawn correct diagrams in part (i) usually got this completely correct but those who had not done so, rarely made much progress on this part.

3. (Vectors)

This question tested vectors in the context of two hikers. Most candidates answered it well and many obtained full marks. A few, but not many, did not know how to relate the information given in the equations in the question to the subsequent requests.

In part (i) they were asked to prove the two hikers meet and this involved showing their position vectors are the same at some time (t = 2). Many lost a mark by not showing that this was true for both components when the position vectors were equated.

In part (ii) they were asked to compare the speeds of the two hikers and most got this right. A few compared their velocities. Others did not know how to obtain the velocities from the given expressions in terms of t for the position vectors.

4. (Uniform acceleration)

This question, about the motion of a car on a road, was very well answered and nearly all candidates got the first 7 marks for selecting and using appropriate constant acceleration formulae.

The final part, for 1 mark, asked them to explain why the time to the mid-point of the distance is more than half the time for the whole journey (the car was accelerating throughout). This produced a number of excellent answers but many were unconvincing. A good answer made the point that the distance is the same in both parts but, because it is accelerating, the car is travelling slower in the first part than in the second part, and so takes more time.

5. (Projectile)

This question started with finding the equation of the trajectory of a projectile and then went on to apply it to the flight of a golf ball. It was very well answered. It was particularly pleasing to see that almost all candidates were able to handle the algebra in the first two parts.

In the final part candidates had to investigate whether the ball passed above, below or hit a hovering bird. This was easily done using the equation of the trajectory but some candidates found other interesting and valid methods.

Section B

6. (Motion on a slope)

This question was answered very well and many candidates got it completely right.

Almost all candidates were successful on part (i) involving the use of Newton's 2nd Law.

Part (ii) was about pushing a car up a slope. This was well-answered with most candidates resolving the weight correctly to find its component down the slope. Very few made the mistake of interchanging sin and cos.

In part (iii) the car was still being pushed up the slope but an extra force was now involved. This meant that the equation of motion had five terms and some candidates lost marks by omitting one (or more) of them.

In part (iv) the car travelled down a slope and many candidates were able to select the right information and methods to deal with this new situation. Some lost marks by forgetting one of the terms, for example the resistance.

Overall the response to this question was very pleasing.

7. (Two-stage motion)

This question was about a helicopter dropping a box of emergency supplies. Initially the box accelerated but then it reached terminal speed so there were two stages to the motion. Some candidates found this quite difficult to deal with.

In part (i) they were asked to find the velocity in each stage of the motion. This required the use of calculus and was quite well-answered. A common mistake was to omit the explanation that the terminal velocity is constant because the acceleration is known to be zero.

Part (ii) involved drawing a velocity-time graph for the two stages of the motion. This was well-answered but some candidates gave a straight line rather than a curve for the first stage.

Part (iii) involved going from the velocity of the box to its height and so involved further use of calculus. That part was well-done but many candidates failed to deal adequately with the sign change involved in going from the distance fallen from the helicopter to the height above the ground.

In part (iv) candidates were asked for the time taken for the box to fall. Only a few candidates got this right. Almost all forgot that there were two stages to the motion. Many set the cubic expression for height equal to zero and then tried to solve the resulting cubic equation. The correct approach was nothing like as difficult as that.

In part (v) two alternative methods of trying to limit the damage to the box on landing were considered. The first, in part (*A*), involved reducing the height from which the box was dropped; however, it would still have reached terminal velocity so this would not have helped. This was not answered very well with many candidates missing the point. The second, in part (*B*), involved fitting a parachute and this was very well answered, with many candidates obtaining full marks on it.

Overall this question was not answered badly. It was not difficult but a high mark on it did require clear thinking.

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GCE Mathematics (MEI)											
				Max Mark	a	b	c	d	e	u
4751	01	C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	58	53	48	43	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	50	44	39	34	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	56	51	46	41	36	0
4753	02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753	82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4754	01	C4 – MEI Applications of advanced mathematics (A2)	Raw	90	74	67	60	54	48	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	62	57	53	49	45	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	59	52	46	40	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	38	0
4758	02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758	82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4761	01	M1 – MEI Mechanics 1 (AS)	Raw	72	62	54	46	39	32	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	54	47	40	33	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	64	56	48	41	34	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	65	60	55	50	46	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	64	58	52	47	42	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – MEI Decision mathematics 1 (AS)	Raw	72	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	54	49	44	39	34	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – MEI Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
			UMS	100	80	70	60	50	40	0
4776	01	(NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	56	50	45	40	34	0
4776	02	(NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776	82	(NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
4777	01	NC – MEI Numerical computation (A2)	Raw	72	55	47	39	32	25	0
			UMS	100	80	70	60	50	40	0
4798	01	FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
			UMS	100	80	70	60	50	40	0

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GCE Statistics (MEI)										
			Max Mark	a	b	c	d	e	u
G241	01 Statistics 1 MEI (Z1)	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
G242	01 Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
G243	01 Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
		UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)									
			Max Mark	a	b	c	d	e	u
G244	01 Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02 Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
		UMS	100	80	70	60	50	40	0
G245	01 Statistics 1 MEI	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	56	51	46	41	37	0
		UMS	100	80	70	60	50	40	0