OCR RECOGNISING ACHIEVEMENT

Monday 10 June 2013 – 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

4715770613

INSTRUCTIONS TO CANDIDATES

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

- The Question Paper will be found in the centre of 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 $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- 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 a pile of four uniform blocks in equilibrium on a horizontal table. Their masses, as shown, are 4 kg, 5 kg, 7 kg and 10 kg.

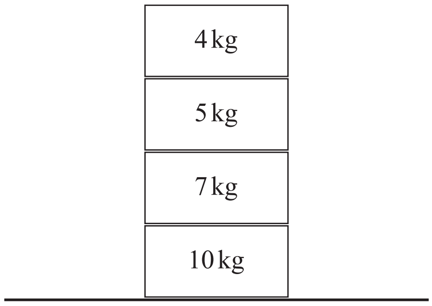

Fig. 1

Mark on the diagram the magnitude and direction of each of the forces acting on the 7 kg block. **[3]**

2 In this question, air resistance should be neglected.

Fig. 2 illustrates the flight of a golf ball. The golf ball is initially on the ground, which is horizontal.

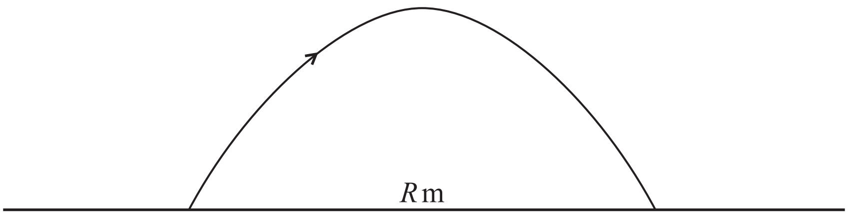

Fig. 2

It is hit and given an initial velocity with components of $15\,\mathrm{m\,s^{-1}}$ in the horizontal direction and $20\,\mathrm{m\,s^{-1}}$ in the vertical direction.

(i) Find its initial speed. **[1]**

(ii) Find the ball's flight time and range, R m. **[4]**

(iii) (A) Show that the range is the same if the components of the initial velocity of the ball are $20\,\mathrm{m\,s^{-1}}$ in the horizontal direction and $15\,\mathrm{m\,s^{-1}}$ in the vertical direction. **[1]**

(B) State, justifying your answer, whether the range is the same whenever the ball is hit with the same initial speed. **[2]**

3 **In this question take $g = 10$.**

The directions of the unit vectors $\begin{pmatrix}1\\0\\0\end{pmatrix}$, $\begin{pmatrix}0\\1\\0\end{pmatrix}$ and $\begin{pmatrix}0\\0\\1\end{pmatrix}$ are east, north and vertically upwards.

Forces **p**, **q** and **r** are given by $\mathbf{p} = \begin{pmatrix}-1\\-1\\5\end{pmatrix}$ N, $\mathbf{q} = \begin{pmatrix}-1\\-4\\2\end{pmatrix}$ N and $\mathbf{r} = \begin{pmatrix}2\\5\\0\end{pmatrix}$ N.

(i) Find which of **p**, **q** and **r** has the greatest magnitude. **[2]**

(ii) A particle has mass 0.4 kg. The forces acting on it are **p**, **q**, **r** and its weight.

Find the magnitude of the particle's acceleration and describe the direction of this acceleration. **[4]**

4 The directions of the unit vectors **i** and **j** are east and north.

The velocity of a particle, $\mathbf{v}\,\mathrm{m\,s^{-1}}$, at time t s is given by

$$\mathbf{v} = (16 - t^2)\mathbf{i} + (31 - 8t)\mathbf{j}.$$

Find the time at which the particle is travelling on a bearing of 045° and the speed of the particle at this time. **[6]**

5 Fig. 5 shows blocks of mass 4 kg and 6 kg on a smooth horizontal table. They are connected by a light, inextensible string. As shown, a horizontal force F N acts on the 4 kg block and a horizontal force of 30 N acts on the 6 kg block.

The magnitude of the acceleration of the system is $2\,\mathrm{m\,s^{-2}}$.

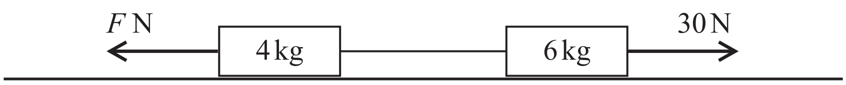

Fig. 5

(i) Find the two possible values of F. **[4]**

(ii) Find the tension in the string in each case. **[3]**

6 A particle moves along a straight line through an origin O. Initially the particle is at O.

At time t s, its displacement from O is x m and its velocity, $v\,\mathrm{m\,s^{-1}}$, is given by

$$v = 24 - 18t + 3t^2.$$

(i) Find the times, T_1 s and T_2 s (where $T_2 > T_1$), at which the particle is stationary. **[2]**

(ii) Find an expression for x at time t s.

Show that when $t = T_1$, $x = 20$ and find the value of x when $t = T_2$. **[4]**

Section B (36 marks)

7 Abi and Bob are standing on the ground and are trying to raise a small object of weight 250 N to the top of a building. They are using long light ropes. Fig. 7.1 shows the initial situation.

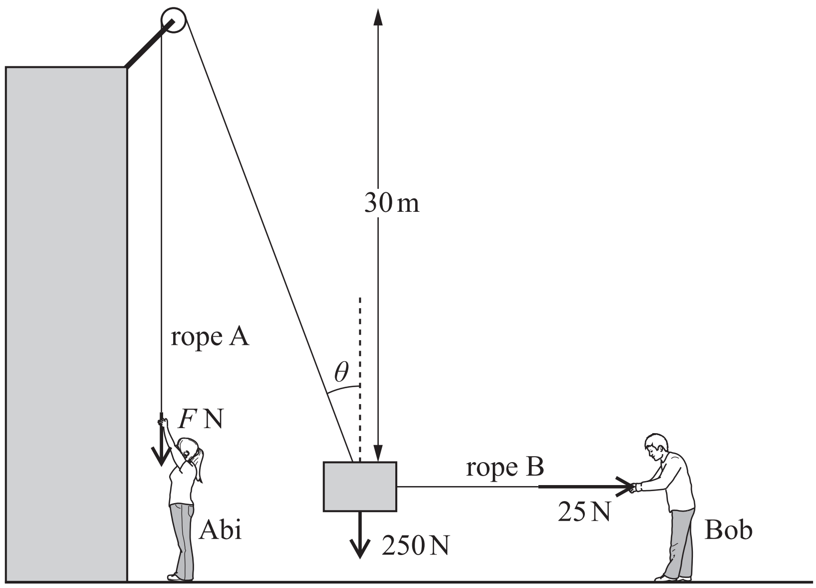

Fig. 7.1

Abi pulls vertically downwards on the rope A with a force F N. This rope passes over a small smooth pulley and is then connected to the object. Bob pulls on another rope, B, in order to keep the object away from the side of the building.

In this situation, the object is stationary and in equilibrium. The tension in rope B, which is horizontal, is 25 N. The pulley is 30 m above the object. The part of rope A between the pulley and the object makes an angle θ with the vertical.

(i) Represent the forces acting on the object as a fully labelled triangle of forces. **[3]**

(ii) Find F and θ.

Show that the distance between the object and the vertical section of rope A is 3 m. **[5]**

[Question 7 is continued on the next page.]

Abi then pulls harder and the object moves upwards. Bob adjusts the tension in rope B so that the object moves along a vertical line.

Fig. 7.2 shows the situation when the object is part of the way up. The tension in rope A is S N and the tension in rope B is T N. The ropes make angles α and β with the vertical as shown in the diagram. Abi and Bob are taking a rest and holding the object stationary and in equilibrium.

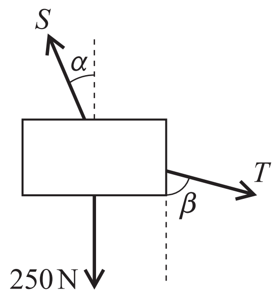

Fig. 7.2

(iii) Give the equations, involving S, T, α and β, for equilibrium in the vertical and horizontal directions. **[3]**

(iv) Find the values of S and T when $\alpha = 8.5°$ and $\beta = 35°$. **[4]**

(v) Abi's mass is 40 kg.

Explain why it is not possible for her to raise the object to a position in which $\alpha = 60°$. **[3]**

[Question 8 is printed overleaf.]

8 Fig. 8.1 shows a sledge of mass 40 kg. It is being pulled across a horizontal surface of deep snow by a light horizontal rope. There is a constant resistance to its motion.

The tension in the rope is 120 N.

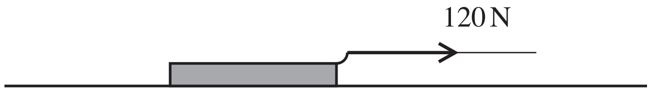

Fig. 8.1

The sledge is initially at rest. After 10 seconds its speed is $5\,\text{m}\,\text{s}^{-1}$.

(i) Show that the resistance to motion is 100 N. **[4]**

When the speed of the sledge is $5\,\text{m}\,\text{s}^{-1}$, the rope breaks.

The resistance to motion remains 100 N.

(ii) Find the speed of the sledge

(A) 1.6 seconds after the rope breaks, **[3]**

(B) 6 seconds after the rope breaks. **[1]**

The sledge is then pushed to the bottom of a ski slope. This is a plane at an angle of 15° to the horizontal.

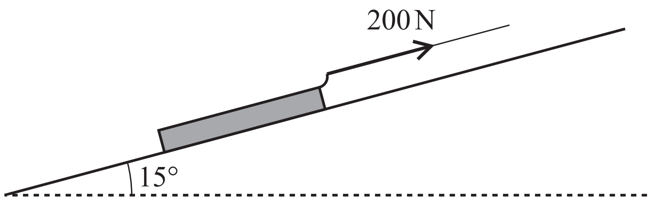

Fig. 8.2

The sledge is attached by a light rope to a winch at the top of the slope. The rope is parallel to the slope and has a constant tension of 200 N. Fig. 8.2 shows the situation when the sledge is part of the way up the slope.

The ski slope is smooth.

(iii) Show that when the sledge has moved from being at rest at the bottom of the slope to the point when its speed is $8\,\text{m}\,\text{s}^{-1}$, it has travelled a distance of 13.0 m (to 3 significant figures). **[4]**

When the speed of the sledge is $8\,\text{m}\,\text{s}^{-1}$, this rope also breaks.

(iv) Find the time between the rope breaking and the sledge reaching the bottom of the slope. **[6]**

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Monday 10 June 2013 – Morning

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4761/01 Mechanics 1

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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Section A (36 marks)

1	
2 (i)	

2 (ii)	
2 (iii) (*A*)	
2 (iii) (*B*)	

3 (i)	
3 (ii)	

4

5 (i)	

5 (ii)	

6 (i)	

6 (ii)	

Section B (36 marks)

7 (i)	

7 (ii)	

7 (iii)	
7 (iv)	

7 (v)	
8 (i)	

8 (ii) (*A*)	
8 (ii) (*B*)	

8 (iii)

8 (iv)	

OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4761:** Mechanics 1

Mark Scheme for June 2013

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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.

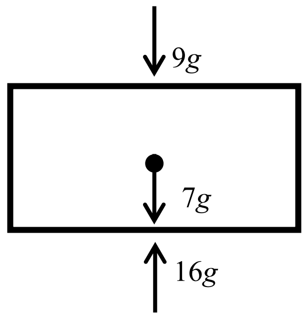
Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

'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				B1 B1 B1 **[3]**	One mark for each force with correct magnitude and direction Deduct 1 mark only for g missing 16g ↑ 7g ↓ 9g ↓ If all three forces are correct but there is at least one extra force, deduct 1 mark and so give 2 marks. Otherwise ignore extra forces. Note For $16g$ ↑ $16g$ ↓ Award B1 B0 B0
2	**(i)**		Initial speed is 25 m s^{-1}	B1 **[1]**	

Question			Answer	Marks	Guidance
2	(ii)		Vertical motion: $y = 20t - 4.9t^2$	M1	Forming an equation or expression for vertical motion
			When $y = 0$,	M1	Finding t when the height is 0
			$T = (0 \text{ or}) \dfrac{20}{4.9} = 4.08$ s	A1	
			$R = 15 \times 4.08... = 61.22$	F1	Allow $15\times$ their T Note If horizontal and vertical components of the initial velocity are interchanged treat it as a misread; if no other errors are present this gives 3 marks.
				[4]	
			Alternative Using time to maximum height		
			Vertical motion: $v = 20 - 9.8t$	M1	Forming an equation or expression for vertical motion
			Flight time = 2 × Time to top	M1	Using flight time is twice time to maximum height or equivalent for range.
			$T = 2\times\dfrac{20}{9.8} = 4.08$ s	A1	
			$R = 15 \times 4.08... = 61.22$	F1	Allow $15\times$ their T
			Alternative Using formulae		
			Finding angle of projection $\alpha = \arctan\left(\dfrac{20}{15}\right) = 53.1°$	M1	Only award this mark if there is a clear intention to use this method
			$R = \dfrac{2u^2 \sin\alpha\cos\alpha}{g} = \dfrac{2\times 25^2 \times \sin 53.1° \times \cos 53.1°}{9.8}$	M1	Allow the alternative form $R = \dfrac{u^2 \sin 2\alpha}{g}$ with substitution
			$R = 61.2$	A1	
			$T = \dfrac{2u\sin\alpha}{g} = 4.08$	A1	

Question			Answer	Marks	Guidance
2	**(iii)**	(*A*)	Flight time $=\frac{15}{4.9}$ Range $=20\times\frac{15}{4.9}=61.22$	B1 **[1]**	Allow FT from part (ii) for a correct argument that they should be the same
2	**(iii)**	(*B*)	No eg angle of projection 45°	M1 A1 **[2]**	Attempt at disproof or counter-example. There must be some reference to the angle. Complete argument

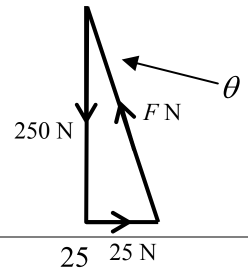
Question			Answer	Marks	Guidance
3	(i)		**p** $\sqrt{(-1)^2+(-1)^2+5^2}=\sqrt{27}$	M1	Use of Pythagoras
			q $\sqrt{(-1)^2+(-4)^2+2^2}=\sqrt{21}$		
			r $\sqrt{2^2+5^2+0^2}=\sqrt{29}$		Note Magnitudes are 5.196, 4.583 and 5.385 respectively
			Greatest magnitude: **r**	A1	
				[2]	
3	(ii)		Weight $=\begin{pmatrix}0\\0\\-4\end{pmatrix}$	B1	Condone $g=9.8$ giving weight is $\begin{pmatrix}0\\0\\-3.92\end{pmatrix}$ N. Accept 4↓.
			$\mathbf{p}+\mathbf{q}+\mathbf{r}+\mathbf{weight}=\begin{pmatrix}0\\0\\3\end{pmatrix}$		$g=9.8$ gives $\begin{pmatrix}0\\0\\3.08\end{pmatrix}$
			$0.4\mathbf{a}=\begin{pmatrix}0\\0\\3\end{pmatrix}$	B1	Relevant attempt at Newton's 2nd Law. The total force must be expressed as a vector in some form. For this mark allow the weight to be missing, in the wrong component or to have the wrong sign. Condone *mg* in place of *m* for this mark only.
			Magnitude of acceleration is 7.5 m s^{-2}	B1	CAO apart from using $g=9.8 \Rightarrow a=7.7$
			Direction is vertically upwards	B1	
				[4]	

Question			Answer	Marks	Guidance
4			Equate **i** and **j** components of **v**	M1	The candidate recognises that the **i** and **j** components must be equal.
			$16-t^2=31-8t$	A1	An equation is formed.
			$t^2-8t+15=0$		
			$(t-3)(t-5)=0$		
			$t=3$ or 5	A1	May be implied by later working.
			When $t=3$, $\mathbf{v}=7\mathbf{i}+7\mathbf{j}$	B1	
			Speed when $t=3$ is $7\sqrt{2}=9.9$ m s^{-1}	B1	
			The values of the **i** and **j** components must both be positive for the bearing to be 045° .	B1	This mark is dependent on obtaining A1 for the result $t=3$ or 5 . It is awarded if the speed for the case when $t=5$ is not included (since $t=5 \Rightarrow \mathbf{v}=-9\mathbf{i}-9\mathbf{j}$ and the bearing is 225°). Note Candidates who obtain **r** and equate the east and north components should be awarded SC1 for the whole question.
				[6]	

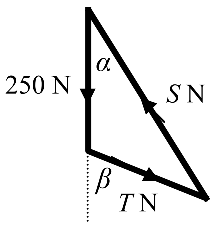
Question			Answer	Marks	Guidance
4			**Alternative Trial and error**		
			The i and j components of v must be equal	M1	The candidate recognises that the **i** and **j** components must be equal.
			The **i** and **j** components of **v** must both be positive for the bearing to be 045°.	B1	This can be demonstrated during the question either by a suitable convincing diagram including 45°, or by a suitable convincing argument
			At least one value of *t* is substituted	A1	Trial and error is used
			$t = 3$	A1	$t = 3$ is found by trial and error
			When $t = 3$, $\mathbf{v} = 7\mathbf{i} + 7\mathbf{j}$	B1	
			Speed when $t = 3$ is $7\sqrt{2} = 9.9$ m s^{-1}	B1	
					Note Candidates who obtain **r** and equate the east and north components should be awarded SC1 for the whole question.
				[6]	

Question			Answer	Marks	Guidance
5	(i)		If the acceleration is to the right		
			Overall $30 - F = (4+6)\times 2$	M1	Newton's 2nd Law in one direction. No extra forces allowed and signs must be correct.
			$F = 10$	A1	
			If the acceleration is to the left	M1	For considering second direction. No extra forces allowed and signs must be correct.
			$F = 50$	A1	
				[4]	
5	(ii)		6 kg block $30 - T = 6\times 2$	M1	Newton's 2nd law with correct elements on either block
			$\Rightarrow T = 18$	A1	CAO No follow through from part (i)
			In the other case $T = 42$	A1	CAO No follow through from part (i)
				[3]	

Question			Answer	Marks	Guidance
6	(i)		$v=0 \Rightarrow 3(t-2)(t-4)=0$	M1	Setting $v=0$ (may be implied)
			$T_1=2,\ T_2=4$	A1	Accept $t=2$ and $t=4$
				[2]	
6	(ii)		$x=\int v\,\mathrm{d}t$	M1	Use of integration
			$x=24t-9t^2+t^3+c:\ c=0$	A1	Condone omission of c
			$t=2 \Rightarrow x=48-36+8=20$	E1	CAO
			$t=4 \Rightarrow x=96-144+64=16$	A1	CAO
				[4]	

Question			Answer	Marks	Guidance
7	(i)		 **Or equivalent**	B1 B1 B1 **[3]**	Shape of triangle; ignore position of θ if marked in diagram 2 marks -1 per error but penalise no arrows only once and penalise no labels only once. Condone T written for F. In the case of a force diagram showing F, 25 and 250 allow maximum of 2 marks with -1 per error but penalise no arrows only once and penalise no labels only once
7	(ii)		$\tan\alpha = \frac{25}{250}$ $\Rightarrow \alpha = 5.7°$ $F = \sqrt{25^2 + 250^2}$ $F = 251.2$ Distance $= 30\tan\alpha = 30 \times 0.1 = 3$ m	M1 A1 M1 A1 B1 **[5]**	M1 for recognising and using α in the triangle Use of Pythagoras At least 3 significant figures required CAO
			Alternative $F\cos\theta = 250$ $F\sin\theta = 25$ $\tan\theta = \frac{25}{250}$ $\Rightarrow \theta = 5.7°$ $F\cos 5.7° = 250$ $F = 251.2$ Distance $= 30\tan\alpha = 30 \times 0.1 = 3$ m	 M1 A1 M1 A1 B1	 At least 3 significant figures required CAO

Question			Answer	Marks	Guidance
7	(iii)		Vertical equilibrium	M1	M1 for attempt at resolution in an equation involving both S and T; condone sin-cos errors for the M mark only
			$\uparrow\ S\cos\alpha = T\cos\beta + 250\ \downarrow$	A1	
			Horizontal equilibrium $S\sin\alpha = T\sin\beta$	A1	
				[3]	
7	(iv)		$S\sin 8.5° = T\sin 35° \Rightarrow S = 3.8805T$	M1	Using one equation to make S or T the subject in terms of the other
			$(3.8805T)\cos 8.5° = T\cos 35° + 250$	M1	Substituting in the other equation
			$T = 82.8$	A1	CAO
			$S = 321.4$	A1	CAO
				[4]	
			Alternative		**Use of linear simultaneous equations**
			$S\sin 8.5° - T\sin 35° = 0$ $S\cos 8.5° - T\cos 35° = 250$		
			$S\sin 8.5°\cos 35° - T\sin 35°\cos 35° = 0$ $S\cos 8.5°\sin 35° - T\cos 35°\sin 35° = 250\sin 35°$		
			$S(-\sin 8.5°\cos 35° + \cos 8.5°\sin 35°) = 250\sin 35°$	M1	Valid method that has eliminated terms in either S or T (execution need not be perfect)
			$S = 321.4$	A1	CAO First answer
			Substituting in either equation	M1	Substituting to find the second answer
			$\Rightarrow T = 82.8$	A1	CAO Second answer

Question			Answer	Marks	Guidance
7	(iv)		Alternative Triangle of forces 	M1	Either Drawing and using a triangle of forces Or Quoting and using Lami's Theorem
			$\frac{S}{\sin 145°} = \frac{T}{\sin 8.5°} = \frac{250}{\sin 26.5°}$	M1	Correct form of these equations
			$S = 321.4$	A1	CAO
			$T = 82.8$	A1	CAO

Question			Answer	Marks	Guidance
7	(v)		Abi's weight is $40g = 392$ N	M1	Consideration of Abi's weight
			When $\alpha = 60°$, $S\cos 60° > 250 \Rightarrow S > 500$	M1	Consideration of vertical forces on the object. Condone no mention of Bob's rope
			The tension in rope A would be greater than Abi's weight and so she would be lifted off the ground	A1	The argument must be of high quality and must include consideration of the tension in Bob's rope
				[3]	
			Alternative		
			If Abi is on the ground, the maximum possible tension in rope A is Abi's weight of 392 N	M1	Consideration of Abi's weight
			So the maximum upward force on the object is $392 \times \cos 60° = 192$ N		
			This is less than the weight of the object, and the tension in Bob's rope is pulling the box down.	M1	Consideration of vertical forces on the object. Condone no mention of Bob's rope Or the box accelerated downwards
			So Abi would be lifted off the ground	A1	The argument must be of high quality and must include consideration of the tension in Bob's rope

Question			Answer	Marks	Guidance
8	**(i)**		$v = u + at$	M1	Use of a suitable constant acceleration formula
			$5 = 0 + a \times 10 \Rightarrow a = 0.5$	A1	Notice The value of a is not required by the question so may be implied by subsequent working
			$F = ma \Rightarrow 120 - R = 40 \times 0.5$	M1	Use of Newton's 2nd Law with correct elements
			$R = 100\text{ N}$	E1	
				[4]	
8	**(ii)**	(A)	$F = ma \Rightarrow -100 = 40a$	M1	Equation to find a using Newton's 2nd Law
			$\Rightarrow a = -2.5$	A1	
			When $t = 1.6$ $v = 5 + (-2.5) \times 1.6 = 1\text{ ms}^{-1}$	A1	CAO
				[3]	
8	**(ii)**	(B)	When $t = 6$, it is stationary. $v = 0\text{ ms}^{-1}$	B1	
				[1]	

Question			Answer	Marks	Guidance
8	(iii)		Motion parallel to the slope:	B1	Component of the weight down the slope, ie $40g\sin 15°$ (= 101.457…)
			$200 - 40g\sin 15° = 40a$	M1	Equation of motion with the correct elements present. No extra forces.
			$a = 2.463...$		This result is not asked for in the question
			$v^2 - u^2 = 2as \Rightarrow 8^2 = 2 \times 2.46... \times s$	M1	Use of a suitable constant acceleration formula, or combination of formulae. Dependent on previous M1.
			$\Rightarrow s = 12.989...$ rounding to 13.0 m	E1	Note If the rounding is not shown for s the acceleration must satisfy $2.452... < a < 2.471...$
				[4]	
8	(iv)		Let a be acceleration up the slope		
			$-40 \times 9.8 \times \sin 15° = 40a$	M1	Use of Newton's 2nd Law parallel to the slope
			$a = -2.536...$, ie 2.536 m s^{-2} down the slope	A1	Condone sign error
			$s = ut + \frac{1}{2}at^2$		
			$-12.989... = 8t + \frac{1}{2} \times (-2.536...)t^2$	M1	Dependent on previous M1. Use of a suitable constant acceleration formula (or combination of formulae) in a relevant manner.
			$1.268...t^2 - 8t - 12.989... = 0$	A1	Signs must be correct
			$t = \frac{8 \pm \sqrt{64 - 4 \times 1.268... \times (-12.989...)}}{2 \times 1.268...}$	M1	Attempt to solve a relevant three-term quadratic equation
			$t = -1.339...$ or $7.647...$, so 7.65 seconds	A1	
				[6]	

Question			Answer	Marks	Guidance
8	(iv)		**Alternative 2-stage motion**		
			Let a be acceleration up the slope		
			$-40\times 9.8\times \sin 15° = 40a$	M1	Use of Newton's 2^{nd} Law parallel to the slope
			$a = -2.536...$, ie 2.536 m s^{-2} down the slope	A1	Condone sign error
			Motion to highest point		
			$v = u + at \quad \Rightarrow \quad 0 = 8 - 2.536...t$	M1	Dependent on previous M1. Use of a suitable constant acceleration formula, for either t or s, in a relevant manner.
			$t = 3.154...$	A1	For either t or s
			$s = ut + \frac{1}{2}at^2 \Rightarrow s = 8\times 3.154... - \frac{1}{2}\times 2.536...\times 3.154...^2$		
			$s = 12.616...$		
			Distance to bottom = 12.989.. + 12. 616... = 25.605...		
			$s = ut + \frac{1}{2}at^2 \Rightarrow 25.605... = \frac{1}{2}\times 2.536...\times t^2$	M1	Use of a suitable constant acceleration formula
			$t = 4.493...$		
			Total time = 3.154... + 4.493... = 7.647 ... s	A1	

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RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **A2 7895-8**

Advanced Subsidiary GCE **AS 3895-8**

OCR Report to Centres

June 2013

4761 Mechanics 1

General Comments

This paper produced a satisfactory mark distribution. Candidates of all abilities were able to show what they could do but there were places where even the most able were challenged.

Several questions on this paper required candidates to work in vectors, which were in various formats. It was very pleasing to note that this caused no problems to candidates; they were all entirely comfortable working with them.

Comments on Individual Questions

1) This question, about drawing a force diagram, was not well answered. Candidates were expected to identify the three forces acting on a block and to mark each of them on a given diagram. Many tried to combine two of them, even though they were quite different forces; other answers can only be described as chaotic.

2) This question was about a projectile (a golf ball). The horizontal and vertical components of its initial velocity were given. Nearly all candidates were able to find the initial speed in part (i) and the flight time and range in part (ii). Common mistakes were to interchange the vertical and horizontal components, and, for those who used the method of finding the time to maximum height, to fail to double it for the flight time.

   In part (iii) (*A*) candidates were asked to show that the range was the same if the components of the initial speed were interchanged; most did this by repeating the calculation from part (ii) but a few saw that this result could be deduced from the form of the expression for the range. Candidates went into part (iii) (*B*) having just met an example where the same initial speed but a different angle of projection produced the same range; they were asked whether this was generally true. Many candidates saw the point of the question and gave a counter-example (commonly the ball being projected vertically upwards). However, others incorrectly thought that the statement was generally true. There were also many answers which gave an inadequate explanation of the correct result.

3) In part (i) of this question candidates were asked to find which of three forces, given as 3-dimensional column vectors, had the greatest magnitude. Almost all candidates got this right.

   Part (ii) of this question was about the application of Newton's second law to an object subject to the same three forces and its weight. Candidates needed to write the weight of the object in vector form. Many candidates got this completely right but others made mistakes with the weight, some applying it in the wrong direction or all three directions.

4) In this question, candidates were given the velocity of a particle using **i**, **j** notation to denote east and north, and they were asked to find when it was travelling on a compass bearing of 045^o and its speed at that time. This involved equating the components of **v**; this gave a quadratic equation, leading to two possible times. Candidates then had to recognise that at one of these times the bearing was 225^o not 45^o.

   Many candidates obtained full marks on this question. A few made the mistake of trying to work with position vector instead of the velocity. A common mistake was to fail to eliminate the 225^o case.

   A small number of candidates set out to answer this question using a trial and error method and some credit was given for this.

5) This question was about connected particles, in the form of two blocks on a table.

Part (i) was best answered treating the system as a whole; part (ii) asked for the tension in the connecting string and so required candidates to work with one of the blocks.

Both parts were correctly answered by many candidates. However, a few candidates did not realise that an acceleration of magnitude 2 could be in either direction, to the left or to the right. A not uncommon mistake, particularly in part (ii), was to introduce extra forces into the equations of motion.

6) This question was about motion with non-constant acceleration along a straight line. It was very well answered with many candidates obtaining full marks.

In part (i) candidates used a given equation for v to find when the particle is stationary. In part (ii) they had to integrate to find an expression for the position and substitute in the two times they had found in part (i). It was pleasing to note an almost complete absence of attempts using constant acceleration formulae.

7) This question was about forces in equilibrium. It was set in the context of two people hoisting an object towards the top of a building.

In part (i) candidates were asked to draw a triangle of forces. While there were plenty of correct answers many marks were lost through incorrect or missing labelling and the absence of arrows. A lot of candidates drew a force diagram instead and so could only obtain 2 out of the 3 marks.

Candidates who had drawn a correct triangle of forces in part (i) were usually successful in part (ii), which asked for information that could easily be obtained from it. Those who had drawn force diagrams in part (i) could still answer part (ii) and many did so successfully but usually after a little more work.

In part (iii) the situation had changed and many of those candidates who had made mistakes in the earlier parts were able to recover. The question asked for the vertical and horizontal equilibrium equations and there were many correct answers. Common errors involved incorrect signs or the omission of one of the forces.

In part (iv) candidates were asked to solve the equations they had obtained in part (iii) with particular values given for the two angles. There were many right answers but also many careless mistakes.

In part (v) candidates were presented with another situation and asked to explain why it was impossible. This was probably the most challenging question on the paper. There were a few excellent answers but many candidates did not present a coherent argument.

8) This question involved a sledge being pulled, initially horizontally and then up a slope.

Part (i) asked for the resistance to motion and required the use of a constant acceleration formula and then Newton's 2^{nd} Law. It was very well answered. A few candidates lost marks by using the given final answer in an argument that was less than a valid verification.

In part (ii) the situation changed because the rope pulling the sledge broke. In part (*A*) candidates were asked to find the speed of the sledge at a time when it was still moving and in part (*B*) at a later time when it would have come to a halt. Most candidates obtained the right answers to both parts. However, a few did not recognise that the acceleration changed when the rope broke and continued with the same value as they had in part (i). A more common mistake was to give a negative speed in part (*B*) rather than zero.

In part (iii) the sledge was being pulled up a smooth slope. There were many correct answers to this part but a few candidates were unable to use the component of the weight down the slope.

In part (iv), there was no longer a pulling force (the rope had broken again) and the sledge started moving up the slope, came to a stop and then slid down to the bottom of the slope. Candidates were asked to find how long this took. Many candidates knew what they had to do and there were plenty of correct answers; however, there were also many sign errors. This was the last question on the paper and several low-scoring candidates did not get started on it. There were also those who substituted completely wrong numbers into their constant acceleration formulae, indicating incorrect analysis of the situation.

For a description of how UMS marks are calculated see:
www.ocr.org.uk/learners/ums_results.html

Unit level raw mark and UMS grade boundaries June 2013 series
AS GCE / Advanced GCE / AS GCE Double Award / Advanced GCE Double Award

GCE Mathematics (MEI)		Max Mark	a	b	c	d	e	u
4751/01 (C1) MEI Introduction to Advanced Mathematics	Raw	72	62	56	51	46	41	0
	UMS	100	80	70	60	50	40	0
4752/01 (C2) MEI Concepts for Advanced Mathematics	Raw	72	54	48	43	38	33	0
	UMS	100	80	70	60	50	40	0
4753/01 (C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	58	52	46	40	33	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
4753 (C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	80	70	60	50	40	0
4754/01 (C4) MEI Applications of Advanced Mathematics	Raw	90	66	59	53	47	41	0
	UMS	100	80	70	60	50	40	0
4755/01 (FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	63	57	51	45	40	0
	UMS	100	80	70	60	50	40	0
4756/01 (FP2) MEI Further Methods for Advanced Mathematics	Raw	72	61	54	48	42	36	0
	UMS	100	80	70	60	50	40	0
4757/01 (FP3) MEI Further Applications of Advanced Mathematics	Raw	72	60	52	44	36	28	0
	UMS	100	80	70	60	50	40	0
4758/01 (DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	62	56	51	46	40	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
4758 (DE) MEI Differential Equations with Coursework	UMS	100	80	70	60	50	40	0
4761/01 (M1) MEI Mechanics 1	Raw	72	57	49	41	33	25	0
	UMS	100	80	70	60	50	40	0
4762/01 (M2) MEI Mechanics 2	Raw	72	50	43	36	29	22	0
	UMS	100	80	70	60	50	40	0
4763/01 (M3) MEI Mechanics 3	Raw	72	64	56	48	41	34	0
	UMS	100	80	70	60	50	40	0
4764/01 (M4) MEI Mechanics 4	Raw	72	56	49	42	35	29	0
	UMS	100	80	70	60	50	40	0
4766/01 (S1) MEI Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
4767/01 (S2) MEI Statistics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4768/01 (S3) MEI Statistics 3	Raw	72	61	55	49	44	39	0
	UMS	100	80	70	60	50	40	0
4769/01 (S4) MEI Statistics 4	Raw	72	56	49	42	35	28	0
	UMS	100	80	70	60	50	40	0
4771/01 (D1) MEI Decision Mathematics 1	Raw	72	58	52	46	40	35	0
	UMS	100	80	70	60	50	40	0
4772/01 (D2) MEI Decision Mathematics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4773/01 (DC) MEI Decision Mathematics Computation	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	44	38	31	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
4776 (NM) MEI Numerical Methods with Coursework	UMS	100	80	70	60	50	40	0
4777/01 (NC) MEI Numerical Computation	Raw	72	55	47	39	32	25	0
	UMS	100	80	70	60	50	40	0
4798/01 (FPT) Further Pure Mathematics with Technology	Raw	72	57	49	41	33	26	0
	UMS	100	80	70	60	50	40	0
GCE Statistics (MEI)								
		Max Mark	**a**	**b**	**c**	**d**	**e**	**u**
G241/01 (Z1) Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
G242/01 (Z2) Statistics 2	Raw	72	55	48	41	34	27	0
	UMS	100	80	70	60	50	40	0
G243/01 (Z3) Statistics 3	Raw	72	56	48	41	34	27	0
	UMS	100	80	70	60	50	40	0