OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4761

Mechanics 1

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4761
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Thursday 16 June 2011
Afternoon

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 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. 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 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 destroyed.

Section A (36 marks)

1 A pellet is fired vertically upwards at a speed of $11\,\text{m}\,\text{s}^{-1}$. Assuming that air resistance may be neglected, calculate the speed at which the pellet hits a ceiling 2.4 m above its point of projection. **[3]**

2 A particle travels with constant acceleration along a straight line. A and B are points on this line 8 m apart.

The motion of the particle is as follows.

- Initially it is at A.
- After 32 s it is at B.
- When it is at B its speed is $2.25\,\text{m}\,\text{s}^{-1}$ and it is moving away from A.

In either order, calculate the acceleration and the initial velocity of the particle, making the directions clear. **[5]**

3 Force $\mathbf{F}$ is $\begin{pmatrix} -2 \\ 3 \\ -4 \end{pmatrix}$ N, force $\mathbf{G}$ is $\begin{pmatrix} -6 \\ y \\ z \end{pmatrix}$ N and force $\mathbf{H}$ is $\begin{pmatrix} 3 \\ -5 \\ -1 \end{pmatrix}$ N.

(i) Given that $\mathbf{F}$ and $\mathbf{G}$ act in parallel lines, find y and z. **[2]**

Forces $\mathbf{F}$ and $\mathbf{H}$ are the only forces acting on an object of mass 5 kg.

(ii) Calculate the acceleration of the object. Calculate also the magnitude of this acceleration. **[5]**

4 Fig. 4 shows a block of mass 15 kg on a smooth plane inclined at 20° to the horizontal. The block is held in equilibrium by a horizontal force of magnitude P N.

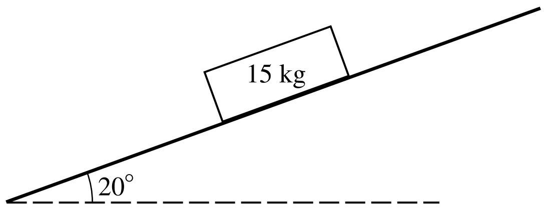

Fig. 4

(i) Show all the forces acting on the block. **[2]**

(ii) Calculate P. **[3]**

5 A small object is projected over horizontal ground from a point O at ground level and makes a loud noise on landing. It has an initial speed of $30\,\text{m}\,\text{s}^{-1}$ at 35° to the horizontal.

Assuming that air resistance on the object may be neglected and that the speed of sound in air is $343\,\text{m}\,\text{s}^{-1}$, calculate how long after projection the noise is heard at O. **[8]**

6 In this question, $\mathbf{i}$ and $\mathbf{j}$ are unit vectors east and north respectively. Position vectors are with respect to an origin O. Time t is in seconds.

A skater has a constant acceleration of $-2\mathbf{j}\,\mathrm{m\,s^{-2}}$. At $t = 0$, his velocity is $4\mathbf{i}\,\mathrm{m\,s^{-1}}$ and his position vector is $3\mathbf{j}$ m.

(i) Find expressions in terms of t for the velocity and the position vector of the skater at time t. **[5]**

(ii) Calculate as a bearing the direction of motion of the skater when $t = 2.5$. **[3]**

Section B (36 marks)

7 A ring is moving on a straight wire. Its velocity is $v\,\mathrm{m\,s^{-1}}$ at time t seconds after passing a point Q.

Model A for the motion of the ring gives the velocity-time graph for $0 \leqslant t \leqslant 6$ shown in Fig. 7.

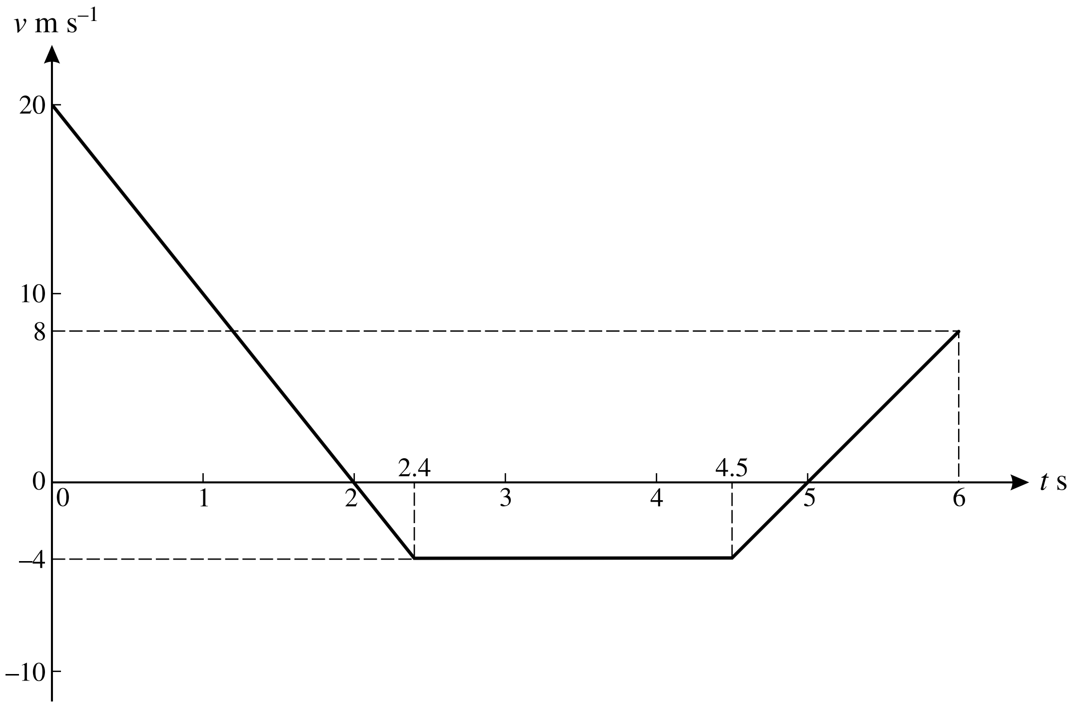

Fig. 7

Use model A to calculate the following.

(i) The acceleration of the ring when $t = 0.5$. **[2]**

(ii) The displacement of the ring from Q when

(A) $t = 2$,

(B) $t = 6$. **[5]**

In an alternative model B, the velocity of the ring is given by $v = 2t^2 - 14t + 20$ for $0 \leqslant t \leqslant 6$.

(iii) Calculate the acceleration of the ring at $t = 0.5$ as given by model B. **[3]**

(iv) Calculate by how much the models differ in their values for the least v in the time interval $0 \leqslant t \leqslant 6$. **[4]**

(v) Calculate the displacement of the ring from Q when $t = 6$ as given by model B. **[4]**

8 A trolley C of mass 8 kg with rusty axle bearings is initially at rest on a horizontal floor.

The trolley stays at rest when it is pulled by a horizontal string with tension 25 N, as shown in Fig. 8.1.

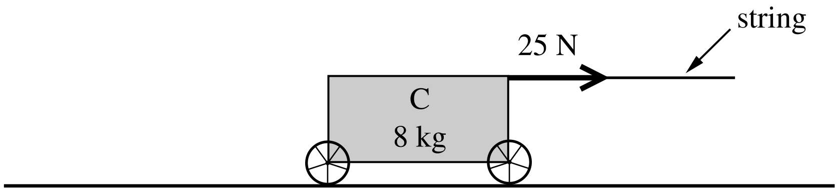

Fig. 8.1

(i) State the magnitude of the horizontal resistance opposing the pull. **[1]**

A second trolley D of mass 10 kg is connected to trolley C by means of a light, horizontal rod.

The string now has tension 50 N, and is at an angle of 25° to the horizontal, as shown in Fig. 8.2. The two trolleys stay at rest.

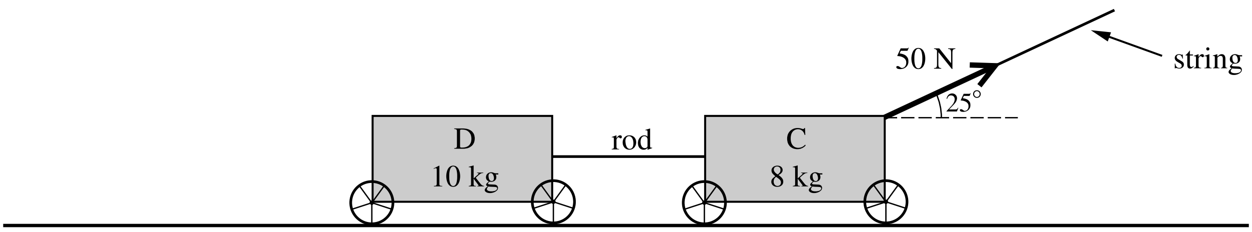

Fig. 8.2

(ii) Calculate the magnitude of the total horizontal resistance acting on the two trolleys opposing the pull. **[2]**

(iii) Calculate the normal reaction of the floor on trolley C. **[3]**

The axle bearings of the trolleys are oiled and the total horizontal resistance to the motion of the two trolleys is now 20 N. The two trolleys are still pulled by the string with tension 50 N, as shown in Fig. 8.2.

(iv) Calculate the acceleration of the trolleys. **[3]**

In a new situation, the trolleys are on a slope at 5° to the horizontal and are initially travelling down the slope at $3\,\mathrm{m\,s^{-1}}$. The resistances are 15 N to the motion of D and 5 N to the motion of C. There is no string attached. The rod connecting the trolleys is parallel to the slope. This situation is shown in Fig. 8.3.

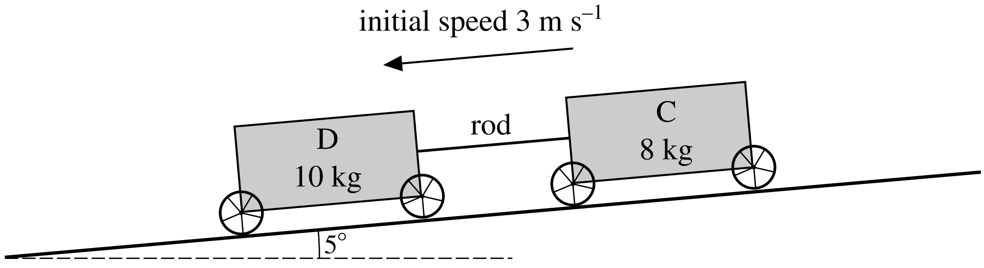

Fig. 8.3

(v) Calculate the speed of the trolleys after 2 seconds and also the force in the rod connecting the trolleys, stating whether this rod is in tension or thrust (compression). **[9]**

BLANK PAGE

BLANK PAGE

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4761

Mechanics 1

PRINTED ANSWER BOOK

Candidates answer on this printed answer book.
OCR supplied materials:
• Question paper 4761 (inserted)
• MEI Examination Formulae and Tables (MF2)
Other materials required:
• Scientific or graphical calculator

Thursday 16 June 2011
Afternoon

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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. 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.

Section A (36 marks)

1

2

3 (i)

3 (ii)

4 (i)

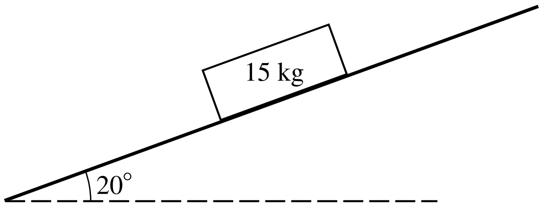

Fig. 4

4 (ii)

5	

5	(continued)

6 (i)

6 (ii)

Section B (36 marks)

7 (i)	
7 (ii) (*A*)	

7 (ii) (*B*)	
7 (iii)	

7 (iv)

7 (v)

8 (i)	
8 (ii)	
8 (iii)	

8 (iv)

8 (v)

(answer space continued overleaf)

8 (v)	(continued)

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4761:** Mechanics 1

Mark Scheme for June 2011

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

comment
You should expect to follow through from one part to another unless the scheme says otherwise but not follow through within a part unless the scheme specifies this. Each script must be viewed as a whole at some stage so that (i) a candidate's writing of letters, digits, symbols on diagrams etc can be better interpreted; (ii) repeated mistakes can be recognised (e.g. calculator in wrong angle mode throughout – penalty 1 in the script and FT except given answers). You are advised to 'set height' in *scoris*, particularly for question 7(ii). Questions 5 and 8(v) also spread onto two pages.

Q 1		mark	notes
	$v^2 = 11^2 + 2 \times (-9.8) \times 2.4$	M1	Use of $v^2 = u^2 + 2as$ or complete sequence of correct *suvat*. Accept sign errors in substitution.
		A1	All correct
	v = 8.6 so 8.6 m s^{-1}.	A1	cao [Award all marks if 8.6 seen WWW] Do not condone ±8.6.
		3	

Q 2		mark	comment
	either for u first: $8=\frac{1}{2}(u+2.25)\times 32$ $u=-1.75$ so 1.75m s^{-1} $2.25=-1.75+32a$ $a=0.125$ so 0.125 m s^{-2} Directions of u and a are defined	M1 A1 M1 F1 F1 5	Using $s=\frac{1}{2}(u+v)t$ Use of any appropriate *suvat* with **their** values and correct signs Sign must be consistent with their u, FT from their value of u Establish directions of both u and a in terms of A and B. May be shown by a diagram, eg showing A and B and a line between them together with an arrow to show the positive direction. Without a diagram, the wording must be absolutely clear: eg do not accept left/right, forwards/backwards without a diagram or more explanation. Dependent on both M marks.
	Or for a first: $8=2.25\times 32-\frac{1}{2}\times a\times 32^2$ $a=0.125$ so 0.125 m s^{-2} $2.25=u+32\times 0.125$ $u=-1.75$ so 1.75m s^{-1} Directions of u and a are defined	M1 A1 M1 F1 F1 5	Using $s=vt-\frac{1}{2}at^2$ Use of any appropriate *suvat* with **their** values and correct signs Sign must be consistent with their a, FT from their value of a Establish directions of both u and a in terms of A and B. May be shown by a diagram, eg showing A and B and a line between them together with an arrow to show the positive direction. Without a diagram, the wording must be absolutely clear: eg do not accept left/right, forwards/backwards without a diagram or more explanation. Dependent on both M marks.
	Or *using simultaneous equations* Set up one relevant equation with a and u. Set up second relevant equation with a and u. Solving to find $u=-1.75$ so 1.75m s^{-1} Solving to find $a=0.125$ so 0.125 m s^{-2} Directions of u and a are defined	M1 M1 A1 F1 F1 5	Using **one** of $v=u+at$, $s=ut+\frac{1}{2}at^2$ and $v^2=u^2+2as$ Using **another** of $v=u+at$, $s=ut+\frac{1}{2}at^2$ and $v^2=u^2+2as$ FT from their value of u or a, whichever found first Establish directions of both u and a in terms of A and B. May be shown by a diagram, eg showing A and B and a line between them together with an arrow to show the positive direction. Without a diagram, the wording must be absolutely clear: eg do not accept left/right, forwards/backwards without a diagram or more explanation. Dependent on both M marks.
		5	

Q 3		mark	Notes
(i)	$-6 = -2 \times 3$ so $y = 3 \times 3 = 9$ and $z = -4 \times 3 = -12$	M1 A1 2	May be implied Both correct [Award 2 for both correct answers seen WW]
(ii)	$\begin{pmatrix} -2 \\ 3 \\ -4 \end{pmatrix} + \begin{pmatrix} 3 \\ -5 \\ -1 \end{pmatrix} = 5\mathbf{a}$	M1 B1	Use of Newton's 2^{nd} Law in vector form for all 3 cpts of attempted resultant Treat use of wrong vectors as MR. Correct LHS
	$\mathbf{a} = \begin{pmatrix} 0.2 \\ -0.4 \\ -1 \end{pmatrix}$ so accn is $\begin{pmatrix} 0.2 \\ -0.4 \\ -1 \end{pmatrix}$ m s^{-2}	A1	The acceleration may be written as a magnitude in a given direction.
	Magnitude is $\sqrt{0.2^2 + (-0.4)^2 + (-1)^2}$ $= 1.09544\ldots$ so 1.10 m s^{-2}, (3 s. f.)	M1 F1 5	FT **their** values. Condone missing brackets. Condone no – signs. Accept 1.1. Accept surd form. Must come from a vector with 3 non-zero components for **a**
		7	

Q 4		mark	Comment
(i)		B1 B1 2	Any one force in correct direction correctly labelled with arrow **or** all forces with correct directions and arrows. A force may be replaced by its components if labelled correctly eg $mg\cos20°$, $mg\sin20°$. All correct (Accept words for labels and weight as W, mg, 147 (N)) No extra or duplicate forces. Do not allow force **and** its components unless components are clearly distinguished, eg by broken lines.
(ii)	**Either** Up the plane $P\cos20 - 15 \times 9.8 \times \sin20 = 0$ $P = 53.50362\ldots$ so 53.5 (3 s. f.)	 M1 A1 A1 3	 Attempt to resolve at least one force up plane. Accept mass not weight. No extra forces. If other directions used, all forces must be present but see below for resolving vertically and horizontally. Accept only error as consistent $s \leftrightarrow c$. Cao
	Or Vertically and horizontally $R\cos 20° = 15g, \quad R\sin 20° = P$ Eliminate R $P = \frac{15g}{\cos 20°} \times \sin 20°$ $P = 53.5$ (3.s.f.)	 M1 A1 A1 3	 Attempt to resolve all forces both horizontally and vertically and attempt to combine into a single equation. No extra forces. Accept $s \leftrightarrow c$. Accept mass not weight. Accept only error as consistent $s \leftrightarrow c$. Cao
	Or Triangle of forces Triangle drawn and labelled $\frac{P}{15g} = \tan 20°$ $P = 53.5$ (3.s.f.)	 M1 A1 A1 3	 All sides must be labelled and in correct orientation; three forces only; condone no arrows Oe Cao
		5	

Q 5		mark	notes
	Usual notation **either** consider height: Attempt to substitute for *u* and *a* in $s = ut + \frac{1}{2}at^2$ $y = 30\sin 35\ t - 4.9t^2$ Need *y* = 0 for time of flight *T* giving $T = \dfrac{30\sin 35}{4.9}$ (= 3.511692…)	 M1 A1 B1 A1	 Accept: *g* as *g*, ±9.8, ±9.81, ±10; *u* = 30; $\text{s} \leftrightarrow \text{c}$. Derivation need not be shown cao. Any form. May not be explicit.
	Or Consider time to top Attempt to substitute for *u* and *a* in $v = u + at$ $v = 30\sin 35 - 9.8t$ Need *v* = 0 and to double for time of flight *T* giving $T = \dfrac{30\sin 35}{4.9}$ (= 3.511692…)	 M1 A1 B1 A1	 Accept: *g* as *g*, ±9.8, ±9.81, ±10; *u* = 30; $\text{s} \leftrightarrow \text{c}$. Derivation need not be shown cao. Any form. May not be explicit.
	then $x = 30\cos 35\ T$ so $x = 30\cos 35 \times \dfrac{30\sin 35}{4.9}$ (= 86.29830…) Required time for sound is *x*/343 Total time is 3.511692… + 0.251598… = 3.76329… so 3.76 s (3 s. f.)	 M1 F1 M1 A1	 Accept $\text{s} \leftrightarrow \text{c}$ if consistent with above FT for their time Condone consistent $\text{s} \leftrightarrow \text{c}$ error (which could lead to correct answer here). FT from their *x* cao following fully correct working throughout question.
		8	

Q6		mark	notes
			Column vectors may be used throughout; lose 1 mark once if **j** components put at top or if fraction line included. . Notation used must be clear.
	Either using *suvat*:		
(i)	Use of $\mathbf{v} = \mathbf{u} + t\mathbf{a}$	M1	substitution required. Must be vectors.
	$\mathbf{v} = 4\mathbf{i} - 2t\mathbf{j}$	A1	
	Use of $\mathbf{r} = (\mathbf{r}_0 +)\ t\mathbf{u} + \frac{1}{2}t^2\mathbf{a}$	M1	substitution required. $\mathbf{r}_0$ not required. Must be vectors.
	$+ 3\mathbf{j}$	B1	May be seen on either side of a meaningful equation for **r**
	$\mathbf{r} = 4t\mathbf{i} + (3 - t^2)\mathbf{j}$	A1	Accept $\mathbf{r} = 3\mathbf{j} + 4t\mathbf{i} - \frac{1}{2} \times 2 \times t^2\,\mathbf{j}$ oe written in a correct notation. Isw, providing not reduced to scalar: (see 12c in marking instructions)
		5	
	Or using integration:		
	$\mathbf{v} = \int \mathbf{a}\,dt$	M1	Attempt at integration. Condone no '+**c**'. Must be vectors.
	$\mathbf{v} = 4\mathbf{i} - 2t\mathbf{j}$	A1	cao
	$\mathbf{r} = \int \mathbf{v}\,dt$	M1	Integrate their **v** but must contain 2 components. Must be vectors.
	$+ 3\mathbf{j}$	B1	May be seen on either side of a meaningful equation for **r**
	$\mathbf{r} = 4t\mathbf{i} + (3 - t^2)\mathbf{j}$	A1	Accept $\mathbf{r} = 3\mathbf{j} + 4t\mathbf{i} - \frac{1}{2} \times 2 \times t^2\,\mathbf{j}$ oe written in a correct notation. Isw, providing not reduced to scalar: (see 12e in marking instructions)
		5	
		5	
(ii)	$\mathbf{v}(2.5) = 4\mathbf{i} - 5\mathbf{j}$	B1	FT **their v**
	Angle is $(90+)\arctan\frac{5}{4}$	M1	Award for arctan attempted oe. FT **their** values. Allow argument to be ± (**their i** cpt)/(**their j** cpt) or ± (**their j** cpt)/(**their i** cpt). Allow this mark if bearing of position vector attempted.
	= 141.34019… so 141° (3 s. f.)	A1	cao
		3	
		8	

Q7		mark	notes
(i)	$\frac{-20}{2} = -10$	M1	Use of a suitable triangle to attempt at $\Delta v / \Delta t$ for suitable interval. Accept wrong sign.
	– 10 m s^{-2}	A1	cao. Allow both marks if correct answer seen.
		2	
(ii) (A)	Signed area under graph	M1	Using the relevant area or other complete method
	$\frac{1}{2} \times 2 \times 20 = 20$	A1	
(B)	**either** using areas		
	Signed area $2 \le t \le 5$ is		
	$\frac{1}{2} \times \left((5-2) + (4.5-2.4)\right) \times (-4) = -10.2$	B1	Allow + 10.2.
	Signed area $5 \le t \le 6$ is $\frac{1}{2} \times 1 \times 8 = 4$	B1	
	Total displacement is 13.8 m	B1	cao but FT from their 20 in part (A)
	or using *suvat*		
	From *t* = 0 to *t* = 2.4: 19.2	B1	
	From *t* = 4.5 to *t* = 6: 3.0	B1	
	From *t* = 2.4 to *t* = 4.5: – 8.4	B1	Both required and both must be correct.
	Total : 13.8		
		5	
(iii)	$a = 4t - 14$	M1	Differentiate. Do not award for division by *t*.
		A1	
	$a(0.5) = -12$ so – 12 m s^{-2}	A1	
		3	
(iv)	Model A gives – 4 m s^{-1}	B1	May be implied by other working
	For model B we need *v* when *a* = 0	M1	Using (iii) or an argument based on symmetry or sketch graph that *a* = 0 when *t* = 3.5
	$v\left(\frac{7}{2}\right) = -4.5$	A1	
	so model B is 0.5 m s^{-1} less	F1	Accept values without more or less
		4	

(v)			Do not penalise poor notation
	Displacement is $\int_0^6 \left(2t^2 - 14t + 20\right)\, dt$	M1	Limits not required.
	$= \left[\frac{2t^3}{3} - 7t^2 + 20t\right]_0^6$	A1	Limits not required. Accept 2 terms correct.
		M1	Substitute limits
	= 12 so 12 m.	A1	cao. Accept bottom limit not substituted.
		4	
		18	

Q 8		mark	notes
(i)	25 N	B1 1	Condone no units. Do not accept -25 N.
(ii)	50 cos25 = 45.31538… so 45.3 N (3 s. f.)	M1 A1 2	Attempt to resolve 50 N. Accept s ↔ c. No extra forces. cao but accept – 45.3.
(iii)	Resolving vertically $R + 50 \sin 25 - 8 \times 9.8 = 0$ $R = 57.26908\ldots$ so 57.3 N (3 s. f.)	M1 A1 A1 3	All relevant forces with resolution of 50 N. No extras. Accept s ↔ c. All correct.
(iv)	Newton's 2nd Law in direction DC $50\cos 25 - 20 = 18a$ $a = 1.4064105\ldots$ so 1.41 m s^{-2} (3 s. f.)	M1 A1 A1 3	Newton's 2nd Law with $m = 18$. Accept $F = mga$. Attempt at resolving 50 N. Allow 20 N omitted and s ↔ c. No extra forces. Allow only sign error and s ↔ c. cao
Q8 (v)	continued Resolution of weight down the slope	B1	$mg\sin5°$ where m = 8 or 10 or 18, wherever first seen
	either Newton's 2nd Law down slope overall $18 \times 9.8 \times \sin5 - 20 = 18a$ $a = -0.2569\ldots$ Newton's 2nd Law down slope. Force in rod can be taken as tension or thrust. Taking it as tension T gives For D: $10\times9.8\times\sin5-15-T=10a$ (For C: $8\times9.8\times\sin5-5+T=8a$) $T = -3.888\ldots = -3.89$ N (3 s. f.) The force is a thrust	M1 A1 M1 F1 A1 A1	$F = ma$. Must have 20 N and $m = 18$. Allow weight not resolved and use of mass. Accept s ↔ c and sign errors (including inconsistency between the 15 N and the 5 N). cao $F = ma$. Must consider the motion of either C or D and include: component of weight, resistance and T. No extra forces. Condone sign errors and s ↔ c. Do not condone inconsistent value of mass. FT only applies to a, and only if direction is consistent. '+T' if T taken as a thrust '-T' if T taken as a thrust If T taken as thrust, then T = +3.89. Dependent on T correct

	or Newton's 2nd Law down slope. Force in rod can be taken as tension or thrust. Taking it as tension T gives	M1 M1	$F = ma$. Must consider the motion of C and include: component of weight, resistance and T. No extra forces. Condone sign errors and $s \leftrightarrow c$. Do not condone inconsistent value of mass. $F = ma$. Must consider the motion of D and include: component of weight, resistance and T. No extra forces. Condone sign errors and $s \leftrightarrow c$. Do not condone inconsistent value of mass.
	For C: $8 \times 9.8 \times \sin 5 - 5 + T = 8a$ For D: $10 \times 9.8 \times \sin 5 - 15 - T = 10a$	A1	Award for either the equation for C or the equation for D correct. '$-T$' if T taken as a thrust '$+T$' if T taken as a thrust
	$a = -0.2569\ldots$ $T = -3.888\ldots = -3.89$ N (3s.f.)	A1 F1	First of a and T found is correct. If T taken as thrust, then $T = +3.89$. The second of a and T found is FT
	The force is a thrust	A1	Dependent on T correct
	then After 2 s: $v = 3 + 2 \times a$ $v = 2.4860303..$ so 2.49 m s^{-1} (3 s. f.)	M1 F1 9	Allow sign of a not followed. FT their value of a. Allow change to correct sign of a at this stage. FT from magnitude of **their** a but must be consistent with its direction.
		18	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

4761: Mechanics 1

General Comments

This paper was well answered and there were few very low scores. Most candidates were clearly well prepared for it. Many of them used the conventions for writing mathematics well, and so were able to communicate their intentions effectively. There were, however, some cases of poor arithmetical and algebraic manipulation.

While many candidates predictably lost marks on the more mathematically challenging parts of the paper, it was also the case that many, including some who were clearly very strong, lost marks through not reading the paper carefully; this was particularly evident in questions 2, 3, 4 and 5.

There was no evidence of candidates being under time pressure.

Comments on Individual Questions

1 **Motion in a vertical straight line**

The majority of candidates got this question right but a few made errors such as giving the wrong sign to *g*, attempting to apply an incorrect formula or not distinguishing between the speed of the pellet on the way up and that which it would have had on the way down if it had not hit the ceiling.

While the simplest way to answer this question involved using the formula $v^2 = u^2 + 2as$, it was also possible to use a sequence of *suvat* equations, for example $s = ut + \frac{1}{2}at^2$ followed by $v = u + at$. It was noticeable that many candidates who adopted such less efficient strategies also made arithmetical and algebraic errors.

2 **Motion along a straight line with constant acceleration**

Many candidates scored 4 out of the 5 marks for this question by finding the correct values of the initial velocity and the acceleration of the particle. However, it was only a minority who obtained the final mark for making the directions clear; many candidates made no attempt to answer this part of the question. Algebraic and arithmetical errors on this question were not uncommon among generally weaker candidates.

3 **Forces given as 3-dimensional column vectors**

In part (i) of this question candidates were asked to find the missing components of a force parallel to a given force, when they were given one component. Many candidates did this successfully but there were also many who did not realise that a scalar multiple was needed to answer such a question and tried to use addition instead.

In part (ii), candidates were asked to find the acceleration when two of the forces were applied to a particle. This was well answered, with most candidates knowing just what to do. Many candidates, however, lost marks by misreading either figures in the given vectors or sometimes the whole of this part-question.

4 **Forces in equilibrium**

Many candidates lost marks on this question.

In part (i), they were asked to draw a force diagram but only a minority were successful in doing this. The most common mistake was to draw the horizontal force parallel to the sloping plane. Another common mistake was to omit the normal reaction to the plane, or to draw it acting vertically upwards.

Most of those candidates who had drawn the horizontal force parallel to the plane went on to lose further marks in part (ii) where they were required to find the magnitude of that force. Continuing on from that earlier mistake simplified the problem and so some of the marks were not available to them; however, some credit was given for a sensible attempt at resolution in this situation: for example, considering the component of the weight parallel to the slope.

5 **Projectile**

This question attracted a full range of scores; many candidates got it fully right, including some who obtained few marks elsewhere on the paper.

A few candidates did not distinguish between horizontal and vertical motion and they lost most, and sometimes all, of the marks. A more common, but much less expensive, mistake was not to read the final request for the time after projection at which the impact was heard, and instead to give the time after the projectile hit the ground.

6 **Motion described in vectors**

In part (i) of this question, candidates were required to use given information to find expressions for the velocity and position vector of a skater at a general time. Most knew what was expected of them, but a minority did not realise that vectors were required or found it difficult to use vectors in this context. Others did not know how to use the information in the question about the initial position vector of the skater.

In part (ii) the direction of motion at a particular time was asked for as a compass bearing. Many candidates made the mistake of finding the bearing of the skater's position instead of his direction of motion.

7 **Models for motion involving constant and non-constant acceleration**

This question was well answered and it allowed many candidates who had, until then, obtained rather few marks, to show their understanding of this part of the syllabus.

Parts (i) and (ii) were based on a velocity-time graph and asked for the acceleration in part (i) and displacement in part (ii). Most candidates knew what they had to do, but there were some careless mistakes in carrying it out. Some candidates tried to do this using constant acceleration formulae, rather than the properties of the graph, and they were usually unsuccessful.

The question then switched to a different model using an expression for the velocity based on non-constant acceleration. Almost all candidates were able to use the requisite calculus and so there were many correct answers to parts (iii), (iv) and (v). However, in part (iv) some weaker candidates did not recognise that the least value of the velocity occurred when the acceleration was zero and spent time trying out various informal methods.

8 **Connected particles**

This question involved first one and then two (connected) trolleys being pulled by a string. The early parts, (i) to (iv), dealing with relatively straightforward situations, were well answered. In part (iii), the string was at an angle to the horizontal and candidates were asked to calculate the normal reaction of the floor on that trolley; a particularly common mistake was to forget about the vertical component of the tension in the string.

The final part, (v), carrying half of the marks for the question, allowed the stronger candidates to show their expertise. There was a wide spread of marks. It involved a more complicated situation in which the trucks were on a slope and this proved a challenge to most candidates. Many did not fully analyse the situation and this often led to inconsistent use of signs. Some candidates failed to realise that the two trolleys must have the same acceleration. It was common for those candidates who were able to get started at all to find the acceleration correctly and substitute into $v = u + at$ to find the velocity; and so obtain 5 of the 9 marks. In the last part, where candidates were asked to find the force in the coupling, sign errors were common as was the omission of relevant forces. However, many strong candidates obtained full marks for perfect answers.

GCE Mathematics (MEI)

			Max Mark	a	b	c	d	e	u
4751/01	(C1) MEI Introduction to Advanced Mathematics	Raw	72	55	49	43	37	32	0
		UMS	100	80	70	60	50	40	0
4752/01	(C2) MEI Concepts for Advanced Mathematics	Raw	72	53	46	39	33	27	0
		UMS	100	80	70	60	50	40	0
4753/01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	54	48	42	36	29	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	63	56	50	44	38	0
		UMS	100	80	70	60	50	40	0
4755/01	(FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	59	52	45	39	33	0
		UMS	100	80	70	60	50	40	0
4756/01	(FP2) MEI Further Methods for Advanced Mathematics	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
4757/01	(FP3) MEI Further Applications of Advanced Mathematics	Raw	72	55	48	42	36	30	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	39	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	60	52	44	36	28	0
		UMS	100	80	70	60	50	40	0
4762/01	(M2) MEI Mechanics 2	Raw	72	64	57	51	45	39	0
		UMS	100	80	70	60	50	40	0
4763/01	(M3) MEI Mechanics 3	Raw	72	59	51	43	35	27	0
		UMS	100	80	70	60	50	40	0
4764/01	(M4) MEI Mechanics 4	Raw	72	54	47	40	33	26	0
		UMS	100	80	70	60	50	40	0
4766/01	(S1) MEI Statistics 1	Raw	72	53	45	38	31	24	0
		UMS	100	80	70	60	50	40	0
4767/01	(S2) MEI Statistics 2	Raw	72	60	53	46	39	33	0
		UMS	100	80	70	60	50	40	0
4768/01	(S3) MEI Statistics 3	Raw	72	56	49	42	35	28	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	51	45	39	33	27	0
		UMS	100	80	70	60	50	40	0
4772/01	(D2) MEI Decision Mathematics 2	Raw	72	58	53	48	43	39	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	62	55	49	43	36	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