OCR
RECOGNISING ACHIEVEMENT

Monday 28 January 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

4734120113

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 $g\,\text{m}\,\text{s}^{-2}$. 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.

This paper has been pre modified for carrier language

Section A (36 marks)

1 Fig. 1 shows a block of mass 3 kg on a plane which is inclined at an angle of 30° to the horizontal.

A force P N is applied to the block parallel to the plane in the upwards direction.

The plane is rough so that a frictional force of 10 N opposes the motion.

The block is moving at constant speed up the plane.

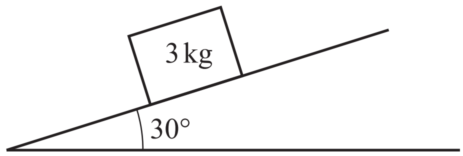


Fig. 1

(i) Mark and label all the forces acting on the block. **[3]**

(ii) Calculate the magnitude of the normal reaction of the plane on the block. **[1]**

(iii) Calculate the magnitude of the force P. **[2]**

2 In this question, the unit vectors $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ are in the directions east and north.

Distance is measured in metres and time, t, in seconds.

A radio-controlled toy car moves on a flat horizontal surface. A child is standing at the origin and controlling the car.

When $t = 0$, the displacement of the car from the origin is $\begin{pmatrix} 0 \\ -2 \end{pmatrix}$ m, and the car has velocity $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$ m s^{-1}.

The acceleration of the car is constant and is $\begin{pmatrix} -1 \\ 1 \end{pmatrix}$ m s^{-2}.

(i) Find the velocity of the car at time t and its speed when $t = 8$. **[4]**

(ii) Find the distance of the car from the child when $t = 8$. **[4]**

3 Fig. 3 shows two people, Sam and Tom, pushing a car of mass 1000 kg along a straight line l on level ground.

Sam pushes with a constant horizontal force of 300 N at an angle of 30° to the line l.

Tom pushes with a constant horizontal force of 175 N at an angle of 15° to the line l.

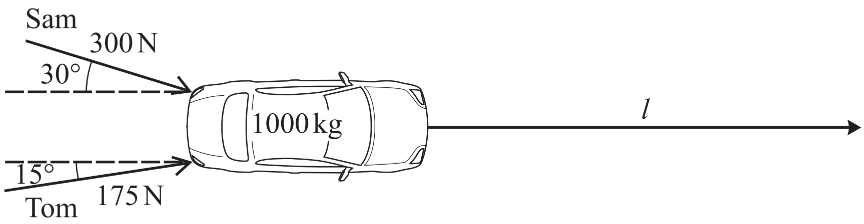


Fig. 3

(i) The car starts at rest and moves with constant acceleration. After 6 seconds it has travelled 7.2 m.

Find its acceleration. **[3]**

(ii) Find the resistance force acting on the car along the line l. **[4]**

(iii) The resultant of the forces exerted by Sam and Tom is not in the direction of the car's acceleration. Explain briefly why. **[1]**

4 A particle is travelling along a straight line with constant acceleration. P, O and Q are points on the line, as illustrated in Fig. 4. The distance from P to O is 5 m and the distance from O to Q is 30 m.

Fig. 4

Initially the particle is at O. After 10 s, it is at Q and its velocity is $9\,\mathrm{m\,s^{-1}}$ in the direction $\overrightarrow{OQ}$.

(i) Find the initial velocity and the acceleration of the particle. **[4]**

(ii) Prove that the particle is never at P. **[3]**

5 Ali is throwing flat stones onto water, hoping that they will bounce, as illustrated in Fig. 5.

Ali throws one stone from a height of 1.225 m above the water with initial speed $20\,\mathrm{m\,s^{-1}}$ in a horizontal direction. Air resistance should be neglected.

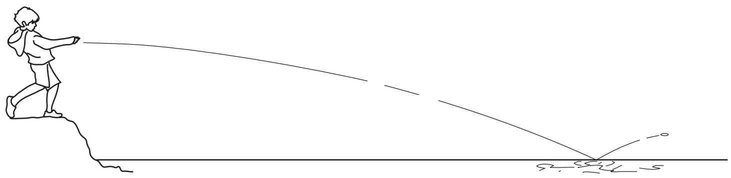


Fig. 5

(i) Find the time it takes for the stone to reach the water. **[2]**

(ii) Find the speed of the stone when it reaches the water and the angle its trajectory makes with the horizontal at this time. **[5]**

Section B (36 marks)

6 The speed of a 100 metre runner in $\mathrm{m\,s^{-1}}$ is measured electronically every 4 seconds.

The measurements are plotted as points on the speed-time graph in Fig. 6. The vertical dotted line is drawn through the runner's finishing time.

Fig. 6 also illustrates Model P in which the points are joined by straight lines.

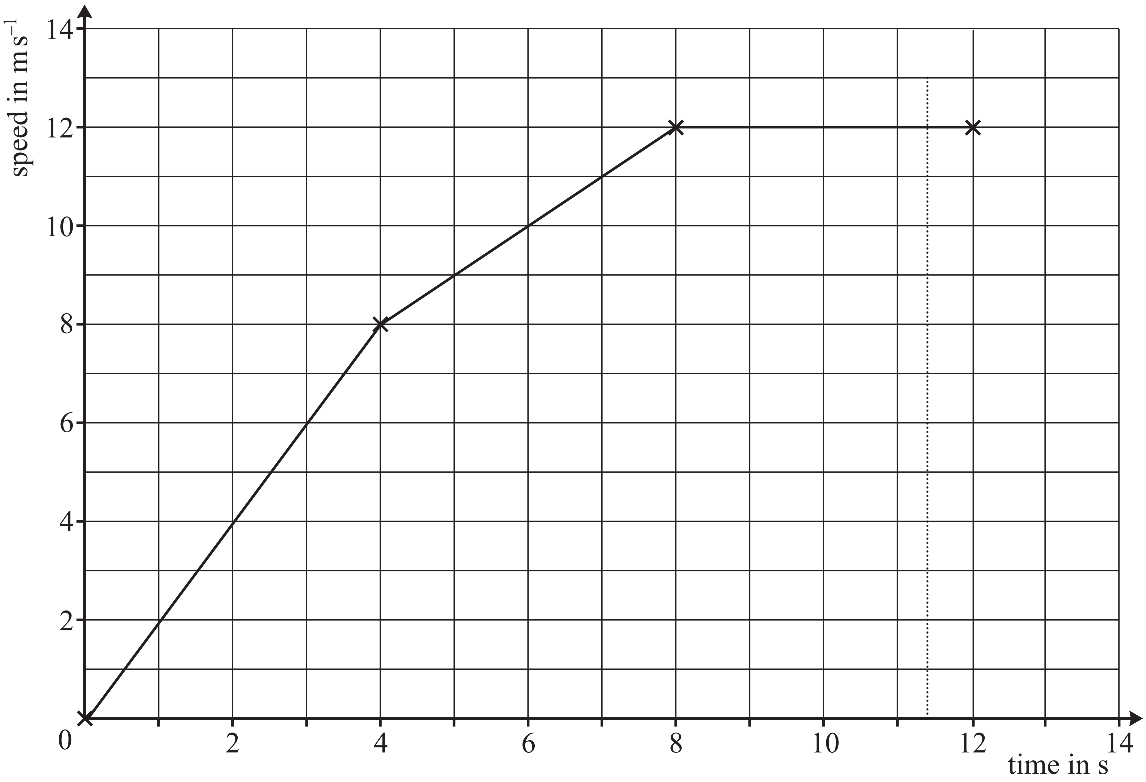


Fig. 6

(i) Use Model P to estimate

(A) the distance the runner has gone at the end of 12 seconds,

(B) how long the runner took to complete 100 m. **[6]**

A mathematician proposes Model Q in which the runner's speed, $v\ \mathrm{m\,s^{-1}}$ at time t s, is given by

$$v = \frac{5}{2}t - \frac{1}{8}t^2.$$

(ii) Verify that Model Q gives the correct speed for $t = 8$. **[1]**

(iii) Use Model Q to estimate the distance the runner has gone at the end of 12 seconds. **[4]**

(iv) The runner was timed at 11.35 seconds for the 100 m.

Which model places the runner closer to the finishing line at this time? **[3]**

(v) Find the greatest acceleration of the runner according to each model. **[4]**

7 A block of weight 50 N is in equilibrium, suspended from fixed points A and B which are 2 m apart on a horizontal ceiling.

Fig. 7.1 illustrates one way of doing this. A light, inextensible string of length 2.8 m is passed round a small smooth light pulley attached to a point C on the block. The parts of the string from C to A and from C to B should be treated as straight lines making angles θ and ϕ with the vertical.

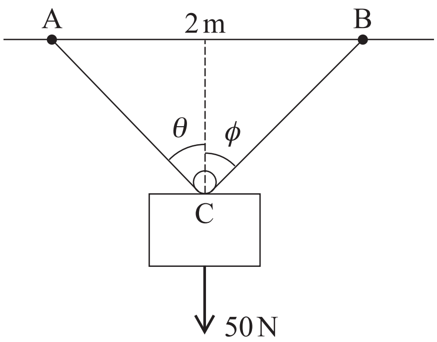


Fig. 7.1

(i) (*A*) State which piece of the information that you have been given tells you that the tension in the string is the same on each side of the pulley. **[1]**

(*B*) Hence show that $\theta = \phi$. **[2]**

(ii) Show that $\cos\theta = \frac{\sqrt{24}}{7}$. **[2]**

(iii) Find the tension in the string. **[3]**

Fig. 7.2 illustrates another way of suspending the block from the same two points, A and B, with the string now cut into two parts, AC and BC. The length of AC is 1.2 m and BC is 1.6 m. The angles the strings make with the horizontal are α and β. The tension in the string AC is T_1 N and the tension in the string BC is T_2 N.

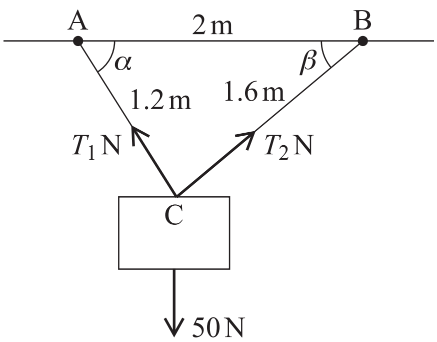


Fig. 7.2

(iv) Show that $\angle ACB = 90°$.

Write down the values of $\cos\alpha$ and $\cos\beta$. **[2]**

(v) Find T_1 and T_2. **[5]**

In a different arrangement, the string is cut so that the lengths of the two parts are 0.5 m and 2.3 m.

(vi) Describe how the block hangs in equilibrium in this case and state the tensions in the two strings. **[3]**

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE.

OCR
RECOGNISING ACHIEVEMENT

Monday 28 January 2013 – Morning

AS GCE MATHEMATICS (MEI)

4761/01 Mechanics 1

PRINTED ANSWER BOOK

Candidates answer on this Printed Answer Book.

OCR supplied materials:
- Question Paper 4761/01 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

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. 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 $g = 9.8$.

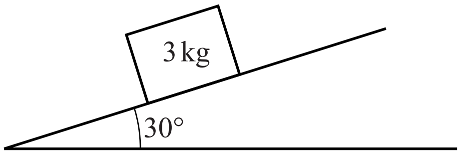
INFORMATION FOR CANDIDATES

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.

This paper has been pre modified for carrier language

Section A (36 marks)

1 (i)	
1 (ii)	
1 (iii)	

2 (i)	

2 (ii)	

3 (i)	

3 (ii)	
3 (iii)	

4 (i)	

4 (ii)	
5 (i)	

5 (ii)	

Section B (36 marks)

6 (i) (A)	
6 (i) (B)	

6 (ii)	
6 (iii)	

6 (iv)

6 (v)

(answer space continued on next page)

6 (v)	**(continued)**
7 (i) (*A*)	
7 (i) (*B*)	

7 (ii)	
7 (iii)	
7 (iv)	

7 (v)	

7 (vi)

RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4761:** Mechanics 1

Mark Scheme for January 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

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. (eg 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 (eg 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.

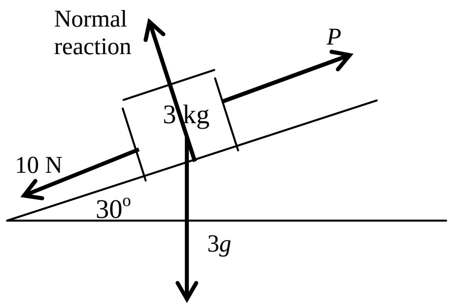
Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

'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	(i)			B1 B1 B1 **[3]**	3 marks –1 / error or omission Forces must have arrows and labels Accept "weight" and "friction"
1	(ii)		$R = 3g\cos 30° = 25.46... = 25.5$ (to 3 significant figures)	B1 **[1]**	Accept 25 or 26
1	(iii)		$P = 10 + 3g\sin 30°$ $P = 24.7$	M1 A1 **[2]**	Correct elements must be present Cao
2	(i)		$\mathbf{v} = \mathbf{u} + \mathbf{a}t$ Velocity $\mathbf{v} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} + t\begin{pmatrix} -1 \\ 1 \end{pmatrix}$ $\left(= \begin{pmatrix} 2-t \\ t \end{pmatrix} \right)$ When $t = 8$, $\mathbf{v} = \begin{pmatrix} -6 \\ 8 \end{pmatrix}$ speed $\sqrt{(-6)^2 + 8^2} = 10 \text{ m s}^{-1}$	M1 A1 A1 A1 **[4]**	May be implied by either of the next two answers but not the final answer. Evidence of use of vectors in question necessary. May be implied by the final answer Cao but condone no units Give SC2 for 10 without working

Question			Answer	Marks	Guidance
2	(ii)		$\mathbf{r} = \mathbf{r}_0 + \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$	M1	Use of correct equation with substitution. Condone omission of $\mathbf{r}_0$. Or equivalent equation
			$\mathbf{r} = \begin{pmatrix} 0 \\ -2 \end{pmatrix} + \begin{pmatrix} 2 \\ 0 \end{pmatrix} \times 8 + \frac{1}{2} \times \begin{pmatrix} -1 \\ 1 \end{pmatrix} \times 8^2$	A1	Condone omission of $\mathbf{r}_0$. Follow through for their value of $\mathbf{v}$
			$\mathbf{r} = \begin{pmatrix} -16 \\ 30 \end{pmatrix}$	A1	Cao but may be implied by a correct final answer.
			Distance = 34 m	A1	Allow for 35.77... from $\mathbf{r} = \begin{pmatrix} -16 \\ 32 \end{pmatrix}$ and 37.57... from $\mathbf{r} = \begin{pmatrix} -16 \\ 34 \end{pmatrix}$
				[4]	
3	(i)		$s = ut + \frac{1}{2}at^2$	M1	Substitution required
			$7.2 = \frac{1}{2} \times a \times 6^2$	A1	
			$a = 0.4 \text{ ms}^{-2}$	A1	Cao
				[3]	
3	(ii)		$F = ma$	M1	Attempt at Newton's second law
				M1	Attempt at resolving both S and T
			$300\cos 30° + 175\cos 15° - R = 1000 \times 0.4$	A1	(Correct elements present and no extras); follow through for a
			$R = 28.8 \text{ N}$	A1	Cao
				[4]	
3	(iii)		The resistance perpendicular to the line of motion has been ignored.	B1	Allow There is also a sideways resistance force
				[1]	

Question			Answer	Marks	Guidance
4	(i)		**Either** $s = \frac{1}{2}(u+v)t$ Take O as the origin.	M1	Use of one relevant equation, including substitution
			$30 = \frac{1}{2} \times (u+9) \times 10$		
			$u = -3$	A1	
			$v = u + at$	M1	Use of a second relevant equation including substitution
			$9 = -3 + 10a$		
			$a = 1.2$	A1	
			or $v = u + at \Rightarrow u + 10a = 9$	M1	Use of one relevant equation, including substitution
			$s = ut + \frac{1}{2}at^2 \Rightarrow u + 5a = 3$	M1	Use of a second relevant equation including substitution
			Solving simultaneously: $a = 1.2$	A1	
			$u = -3$	A1	
			or $s = vt - \frac{1}{2}at^2$	M1	Use of one relevant equation, including substitution
			$\Rightarrow a = 1.2$	A1	
			$v = u + at$	M1	Use of a second relevant equation including substitution
			$\Rightarrow u = -3$	A1	
				[4]	
4	(ii)		**Either** $s = ut + \frac{1}{2}at^2$		
			Solving for P: $-5 = -3t + \frac{1}{2} \times 1.2t^2$	M1	Quadratic equation with $s = -5$
			$0.6t^2 - 3t + 5 = 0$		
			Discriminant $= 3^2 - 4 \times 0.6 \times 5 = -3$	M1	Considering the discriminant or equivalent
			No real roots for t ($\Rightarrow$ Particle is never at P)	E1	Cao without wrong working in the whole question.

Question			Answer	Marks	Guidance
			Or Find when $v = 0$	M1	
			$v = u + at$, $v = 0 \Rightarrow t = 2.5$		
			$s = ut + \frac{1}{2}at^2$ and $t = 2.5$	M1	Or use $v^2 = u^2 + 2as$
			$\Rightarrow s = -3.75 > -5$	E1	Cao without wrong working in the whole question. Comparison necessary
			Special cases when their *u* > 0 and their *a* > 0	SC1	"It is always going to the right"
				SC1	Demonstration that it is at –5 for two negative times.
				[3]	
5	**(i)**		Vertical motion: $s = ut + \frac{1}{2}at^2$		
			At water: $-1.225 = 0 \times t + \frac{1}{2} \times (-9.8) \times t^2$	M1	Condone sign errors
			$\Rightarrow t = 0.5$ s	A1	Signs must be consistent
				[2]	
5	**(ii)**		Horizontal component of velocity = 20 m s^{-1}	B1	
			Vertical component = $0.5 \times 9.8 = 4.9$ m s^{-1}	B1	Follow through for "their *t* x 9.8"
			Speed $= \sqrt{20^2 + 4.9^2} = 20.6$	M1	Use of Pythagoras on previous two answers
			$\tan\alpha = \frac{4.9}{20}$	M1	Use of an appropriate trig ratio with their figures for **v**. Must be explicit if final answer is incorrect.
			$\alpha = 13.8°$	A1	Cao
				[5]	

Question			Answer	Marks	Guidance
6	(i)	(*A*)	Distance travelled = Area under the graph	M1	Attempt to find area
			$\frac{1}{2}\times 4\times 8+\frac{1}{2}\times 4\times (8+12)+4\times 12$	M1	Splitting into suitable parts
			104 m	A1	Cao
					Allow all 3 marks for 104 without any working
6	(i)	(*B*)	**Either**		
			Working backwards from distance when $t=12$	M1	
			$12-\frac{(104-100)}{12}$	M1	Allow this mark for 0.33… Follow through from their total distance
			11.67 s	A1	Cao
			Or		
			Working forwards from when $t=8$	M1	
			$8+\frac{(100-56)}{12}$	M1	Allow this mark for 3.67… Follow through from their distance at time 8s
			11.67 s	A1	Cao
				[6]	
6	(ii)		Substituting $t=8$ gives $v=\frac{5}{2}\times 8-\frac{1}{8}\times 8^2=12$	B1	
				[1]	

Question			Answer	Marks	Guidance
6	(iii)		Distance $=\int_0^{12}\left(\frac{5t}{2}-\frac{t^2}{8}\right)\mathrm{d}t$	M1	Integrating v. Condone no limits.
			$\left[\frac{5t^2}{4}-\frac{t^3}{24}\right]_0^{12}$	A1	Condone no limits
			$[180-72] \quad (-[0]\ )$	M1	Substituting $t=12$
			108 m	A1	
				[4]	
6	(iv)		Model P: distance at $t=11.35$ is 96.2	B1	Cao
			Model Q: distance at $t=11.35$ is		
			$\left[\frac{5t^2}{4}-\frac{t^3}{24}\right]_0^{11.35}=100.1$	M1	Substituting 11.35 in their expression from part **(iii)**
			Model Q places the runner closer	E1	Cao from correct previous working for both models
				[3]	
6	(v)		Model P: Greatest acceleration $\frac{8}{4}=2\ \mathrm{m\ s^{-2}}$	B1	
			Model Q: $a=\frac{\mathrm{d}v}{\mathrm{d}t}=\frac{5}{2}-\frac{t}{4}$	M1	Differentiating v
				A1	
			Model Q: Greatest acceleration is 2.5 m s^{-2}	B1	Award if correct answer seen
				[4]	

Question			Answer	Marks	Guidance
7	(i)	(*A*)	The pulley is smooth	B1 **[1]**	Award for "smooth" seen.
7	(i)	(*B*)	Horizontal equilibrium: $T\sin\theta = T\sin\phi$ $\Rightarrow \theta = \phi$	M1 E1 **[2]**	Attempt at horizontal equilibrium. Allow sin-cos interchange. The argument must be based on forces. Do not allow if sin-cos interchange
7	(ii)		Call M the mid point of AB. AM = 1, AC=1.4, $\angle\mathbf{AMC} = 90°$ Pythagoras $\Rightarrow$ $\mathbf{MC} = \sqrt{1.4^2 - 1^2} = \sqrt{0.96}$ $\cos\theta = \frac{\sqrt{0.96}}{1.4} = \frac{\sqrt{24}}{7}$	M1 E1 **[2]**	Setting up triangle and use of trigonometry If decimals are matched, at least 3 figures must be given
7	(iii)		Vertical equilibrium $2T\cos\theta = 50$ $T = 35.7$ N	M1 A1 A1 **[3]**	Use of vertical equilibrium Accept $T\cos\theta = 25$ as an equivalent statement Cao
7	(iv)		$1.2^2 + 1.6^2 = 2^2$ $\Rightarrow \angle\text{ACB} = 90°$ $\cos\alpha = 0.6,\ \cos\beta = 0.8$	 B1 B1 **[2]**	 Use of Pythagoras, or equivalent Both No marks for sin-cos interchange

Question			Answer	Marks	Guidance
7	(v)		**Either resolving horizontally and vertically**		
			$T_1 \cos\alpha = T_2 \cos\beta$	M1	Attempt at horizontal equation. Allow consistent sin-cos interchange
			$T_1 \sin\alpha + T_2 \sin\beta = 50$	M1	Attempt at vertical equation. Allow consistent sin-cos interchange
			$0.6T_1 = 0.8T_2$ $0.8T_1 + 0.6T_2 = 50$	A1	Substitution in both equations. Dependent on both M marks. Cao
			Solving simultaneously	M1	Dependent on both the previous M marks
			$T_1 = 40,\ T_2 = 30$	A1	Cao
			Or resolving in the direction of the strings		
			Resolving in both directions	M1	A serious attempt to use this method. Allow sin-cos interchange
			$T_1 = 50\sin\alpha$	M1	
			$\Rightarrow T_1 = 50 \times 0.8 = 40$	A1	
			$T_2 = 50 \times \sin\beta$	M1	
			$\Rightarrow T_2 = 50 \times 0.6 = 30$	A1	
			Or triangle of forces		
			Use of a triangle of forces	M1	The triangle must be closed and have a right angle opposite the weight
			Labels	M1	The sides must be correctly annotated
			Angles	M1	The angles must be correctly annotated
			$T_1 = 50 \times 0.8 = 40$	A1	Cao Dependent of first M mark
			$T_2 = 50 \times 0.6 = 30$	A1	Cao Dependent of first M mark
				[5]	

Question			Answer	Marks	Guidance
7	(vi)		Attempt to find $\angle CAB$	M1	May be implied by the remaining answers
			Tension in AC is 50 N (it takes all the weight)	B1	
			Tension in BC is zero (it is slack)	B1	
				[3]	

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

OCR Customer Contact Centre

Education and Learning
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

RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **A2 7895-8**

Advanced Subsidiary GCE **AS 3895-8**

OCR Report to Centres

January 2013

4761 Mechanics 1

General Comments

Most candidates were able to answer many of the questions on this paper well and to demonstrate their knowledge of the specification. However, the final parts of two questions proved to be quite challenging and as a result very high marks were rare.

Comments on Individual Questions

1 This question, about a block moving on a slope, was well answered. Most candidates scored full marks on the force diagram in part (i), an improvement on similar questions in previous papers. In part (ii) a few candidates did not resolve the weight correctly, or in some cases at all, to find the normal reaction. Part (iii) considered forces parallel to the slope and this was well answered.

2 This question was about motion in two dimensions using column vectors. It was well answered. Such marks as were lost were usually as a result of candidates not fully answering the questions, omitting the velocity at time t and the speed in part (i) and the distance travelled in part (ii).

3 The first two parts of this question, about two people pushing a car, were well answered. In part (i) almost all candidates found the car's acceleration correctly and in part (ii) many resolved the forces correctly to find the resistance to the car's motion. However, there were few good answers to part (iii); candidates were expected to comment on the sideways resistance to motion (acting on the car's tyres).

4 This question involved a particle travelling under constant acceleration along a straight line. In part (i) two constant acceleration formulae were required and most candidates obtained the right answers but there were some careless mistakes, and some mistakes in quoting the standard results. In part (ii) candidates were asked to **prove** that the particle was never at a certain point and it was a pleasure to see how well this was answered, usually either by setting up a quadratic equation and showing it had a negative discriminant, or by finding the turning point in the motion. A handful of candidates just tested some particular cases and no credit was given for this.

5 In this question a model was presented for the familiar game of "ducks and drakes", skimming a stone along the surface of some water. The stone's initial velocity was in the horizontal direction and this presented a difficulty for the many candidates who did not infer that the vertical component of the initial velocity was zero; it was common to give it the value of the horizontal component (20 m s-1) instead. Consequently, although there were many fully correct answers to this question, there were also many that were worth few marks, if any.

6 This was the first of the two Section B questions. It involved two models for the speed of a runner covering 100 metres. It was well answered. In part (i) candidates worked from a given speed-time graph and most were successful in doing so; however some did not realise that the second request needed some calculation and could not be obtained just from reading off the graph. The question then presented the second model as an equation for v in terms of t; most candidates realised that the questions on this involved the use of calculus and answered them correctly. The last two parts of the question involved comparing results from the two models and there were many correct answers, well presented with clear statements as to which model was being considered.

7 The final question was about different ways of suspending a block from two fixed points on a beam using a string of a given length. In the first three parts it was done using a smooth pulley. Initially candidates were expected to use mechanics and geometry to establish the symmetry of the situation; many lost marks on this but they were frequently able to recover to find the tension in the string correctly in part (iii). Parts (iv) and (v) dealt with a different situation in which the string was cut into two unequal parts, and this proved rather more familiar to candidates. In part (v), they were asked to find the tensions in the strings and, although most knew what they were trying to do, there were many careless mistakes with cos-sin interchanges and sign errors common. Most candidates resolved in the horizontal and vertical directions and tried to solve the resulting simultaneous equations; however, some used one of two other available methods (resolving in the directions of the strings, and a triangle of forces); because the strings were at right angles either of these required less work. In the last part of the question the situation was considered in which the string was cut at a different point; only a few candidates saw that with the given lengths all the weight would be carried by one of the strings and the other would be slack.