OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

MATHEMATICS (MEI) 4762

Mechanics 2

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4762
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Monday 10 January 2011
Morning

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 **12** 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.

1 Fig. 1.1 shows block A of mass 2.5 kg which has been placed on a long, uniformly rough slope inclined at an angle α to the horizontal, where $\cos \alpha = 0.8$. The coefficient of friction between A and the slope is 0.85.

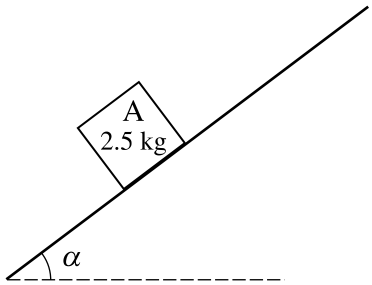

Fig. 1.1

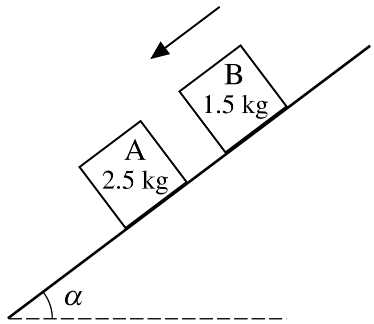

Fig. 1.2

(i) Calculate the maximum possible frictional force between A and the slope.

Show that A will remain at rest. **[6]**

With A still at rest, block B of mass 1.5 kg is projected down the slope, as shown in Fig. 1.2. B has a speed of $16\,\text{m}\,\text{s}^{-1}$ when it collides with A. In this collision the coefficient of restitution is 0.4, the impulses are parallel to the slope and linear momentum parallel to the slope is conserved.

(ii) Show that the velocity of A immediately after the collision is $8.4\,\text{m}\,\text{s}^{-1}$ down the slope.

Find the velocity of B immediately after the collision. **[6]**

(iii) Calculate the impulse on B in the collision. **[3]**

The blocks do not collide again.

(iv) For what length of time after the collision does A slide before it comes to rest? **[4]**

2 **(a)** A firework is instantaneously at rest in the air when it explodes into two parts. One part is the body B of mass 0.06 kg and the other a cap C of mass 0.004 kg. The total kinetic energy given to B and C is 0.8 J. B moves off horizontally in the **i** direction.

By considering both kinetic energy and linear momentum, calculate the velocities of B and C immediately after the explosion. **[8]**

(b) A car of mass 800 kg is travelling up some hills.

In one situation the car climbs a vertical height of 20 m while its speed decreases from 30 m s^{-1} to 12 m s^{-1}. The car is subject to a resistance to its motion but there is no driving force and the brakes are not being applied.

(i) Using an energy method, calculate the work done by the car against the resistance to its motion. **[4]**

In another situation the car is travelling at a constant speed of 18 m s^{-1} and climbs a vertical height of 20 m in 25 s up a uniform slope. The resistance to its motion is now 750 N.

(ii) Calculate the power of the driving force required. **[5]**

3

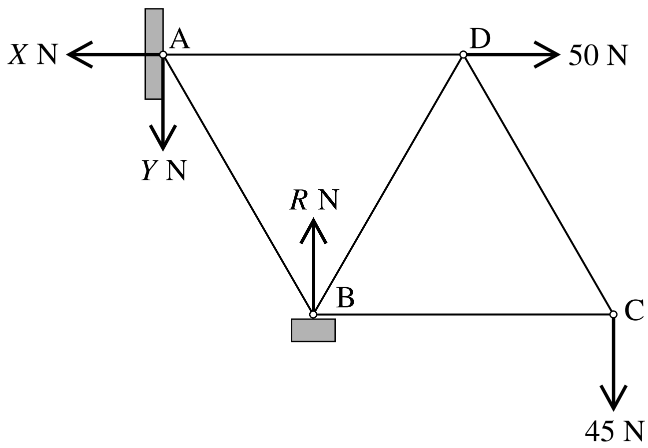

Fig. 3

Fig. 3 shows a framework in equilibrium in a vertical plane. The framework is made from the equal, light, rigid rods AB, AD, BC, BD and CD so that ABD and BCD are equilateral triangles of side 2 m. AD and BC are horizontal.

The rods are freely pin-jointed to each other at A, B, C and D. The pin-joint at A is fixed to a wall and the pin-joint at B rests on a smooth horizontal support.

Fig. 3 also shows the external forces acting on the framework: there is a vertical load of 45 N at C and a horizontal force of 50 N applied at D; the normal reaction of the support on the framework at B is R N; horizontal and vertical forces X N and Y N act at A.

(i) Write down equations for the horizontal and vertical equilibrium of the framework. **[2]**

(ii) Show that $R = 135$ and $Y = 90$. **[3]**

(iii) On the diagram in your printed answer book, show the forces internal to the rods acting on the pin-joints. **[2]**

(iv) Calculate the forces internal to the five rods, stating whether each rod is in tension or compression (thrust). [You may leave your answers in surd form. Your working in this part should correspond to your diagram in part **(iii)**.] **[10]**

(v) Suppose that the force of magnitude 50 N applied at D is no longer horizontal, and the system remains in equilibrium in the same position.

By considering the equilibrium at C, show that the forces in rods CD and BC are not changed. **[2]**

4 You are given that the centre of mass, G, of a uniform lamina in the shape of an isosceles triangle lies on its axis of symmetry in the position shown in Fig. 4.1.

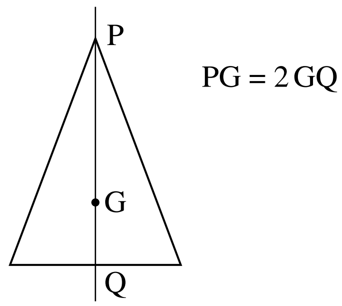

Fig. 4.1

Fig. 4.2 shows the cross-section OABCD of a prism made from uniform material. OAB is an isosceles triangle, where OA = AB, and OBCD is a rectangle. The distance OD is h cm, where h can take various positive values. All coordinates refer to the axes Ox and Oy shown. The units of the axes are centimetres.

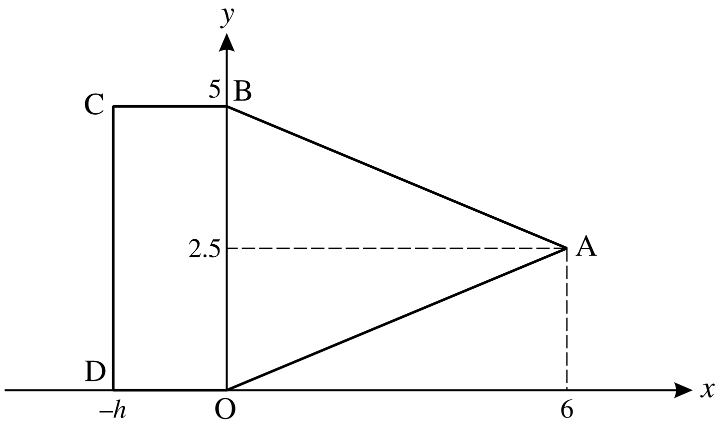

Fig. 4.2

(i) Write down the coordinates of the centre of mass of the triangle OAB. **[1]**

(ii) Show that the centre of mass of the region OABCD is $\left(\dfrac{12 - h^2}{2(h + 3)}, 2.5\right)$. **[6]**

The x-axis is horizontal.

The prism is placed on a horizontal plane in the position shown in Fig. 4.2.

(iii) Find the values of h for which the prism would topple. **[3]**

The following questions refer to the case where $h = 3$ with the prism held in the position shown in Fig. 4.2. The cross-section OABCD contains the centre of mass of the prism. The weight of the prism is 15 N. You should assume that the prism does not slide.

(iv) Suppose that the prism is held in this position by a vertical force applied at A. Given that the prism is on the point of tipping clockwise, calculate the magnitude of this force. **[3]**

(v) Suppose instead that the prism is held in this position by a force in the plane of the cross-section OABCD, applied at 30° below the horizontal at C, as shown in Fig. 4.3. Given that the prism is on the point of tipping anti-clockwise, calculate the magnitude of this force. **[4]**

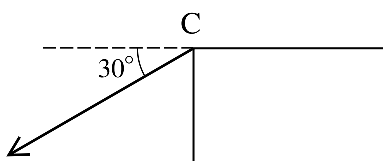

Fig. 4.3

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ADVANCED GCE

MATHEMATICS (MEI) **4762**

Mechanics 2

PRINTED ANSWER BOOK

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Monday 10 January 2011
Morning

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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1 (i)

1 (ii)

1 (iii)	
1 (iv)	

2 (a)	

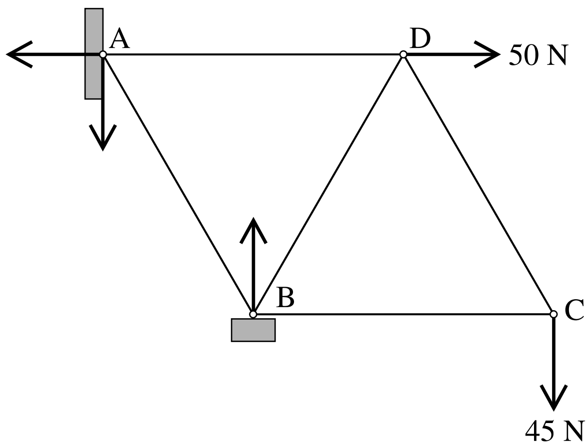
2 (b) (i)

2 (b) (ii)

3 (i)

3 (ii)

3 (iii)



3 (iv)

3 (v)

4 (i)	
4 (ii)	

4 (iii)	
4 (iv)	

4 (v)

PLEASE DO NOT WRITE ON THIS PAGE

GCE

Mathematics (MEI)

Advanced GCE

Unit **4762:** Mechanics 2

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

Any enquiries about publications should be addressed to:

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Marking instructions for GCE Mathematics (MEI): Mechanics strand

1. You are advised to work through the paper yourself first. Ensure you familiarise yourself with the mark scheme before you tackle the practice scripts.

2. You will be required to mark ten practice scripts. This will help you to understand the mark scheme and will not be used to assess the quality of your marking. Mark the scripts yourself first, using the annotations. Turn on the comments box and make sure you understand the comments. You must also look at the definitive marks to check your marking. If you are unsure why the marks for the practice scripts have been awarded in the way they have, please contact your Team Leader.

3. When you are confident with the mark scheme, mark the ten standardisation scripts. Your Team Leader will give you feedback on these scripts and approve you for marking. (If your marking is not of an acceptable standard your Team Leader will give you advice and you will be required to do further work. You will only be approved for marking if your Team Leader is confident that you will be able to mark candidate scripts to an acceptable standard.)

4. Mark strictly to the mark scheme. If in doubt, consult your Team Leader using the messaging system within *scoris*, by email or by telephone. Your Team Leader will be monitoring your marking and giving you feedback throughout the marking period.

   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.

5. 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.

6. 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.

7. 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.

8. 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 metre 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. premature approximation leading to error) has been made in different questions or parts of questions.

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.

9. **Rules for crossed out and/or replaced work**

If work is crossed out and not replaced, examiners should mark the crossed out work if it is legible.

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 two or more attempts are made at a question, and just one is not crossed out, examiners should ignore the crossed out work and mark the work that is not crossed out.

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.

10. 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 of 1 mark is generally appropriate and 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.

11.	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.

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

13.	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.

14. For answers scoring no marks, you must either award NR (no response) or 0, as follows:

Award NR (no response) if:

- Nothing is written at all in the answer space
- There is a comment which does not in any way relate to the question being asked ("can't do", "don't know", etc.)
- There is any sort of mark that is not an attempt at the question (a dash, a question mark, etc.)

The hash key [#] on your keyboard will enter NR.

Award 0 if:

- There is an attempt that earns no credit. This could, for example, include the candidate copying all or some of the question, or any working that does not earn any marks, whether crossed out or not.

15. The following abbreviations may be used in this mark scheme.

M1	method mark (M2, etc, is also used)
A1	accuracy mark
B1	independent mark
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
ft	follow through
isw	ignore subsequent working
oe	or equivalent
rot	rounded or truncated
sc	special case
soi	seen or implied
www	without wrong working

16. Annotating scripts. The following annotations are available:

✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained)
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 is also available to highlight any particular points on a script.

17. The comments box will be used by the Principal Examiner to explain his or her marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts.

Please do not type in the comments box yourself. Any questions or comments you have for your Team Leader should be communicated by the *scoris* messaging system, e-mail or by telephone.

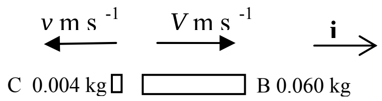
18. Write a brief report on the performance of the candidates. Your Team Leader will tell you when this is required. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

19. Link Additional Objects with work relating to a question to those questions (a chain link appears by the relevant question number) – see scoris assessor Quick Reference Guide page 19-20 for instructions as to how to do this – this guide is on the Cambridge Assessment Support Portal and new users may like to download it with a shortcut on your desktop so you can open it easily! For AOs containing just formulae or rough working not attributed to a question, tick at the top to indicate seen but not linked. When you submit the script, *scoris* asks you to confirm that you have looked at all the additional objects. Please ensure that you have checked all Additional Objects thoroughly.

20. The schedule of dates for the marking of this paper is displayed under 'OCR Subject Specific Details' on the Cambridge Assessment Support Portal. It is vitally important that you meet these requirements. If you experience problems that mean you may not be able to meet the deadline then you must contact your Team Leader without delay.

Q 1		mark	notes
(i)	Let normal reaction be R $\sin\alpha = \sqrt{1-0.8^2} = 0.6$ $R = 2.5\times 9.8\times 0.8$ $F_{max} = 0.85\times R = 16.66$ Wt cpt down slope is $2.5 \times 9.8 \times 0.6 = 14.7$ $16.66 > 14.7$ so at rest	B1 M1 B1 F1 B1 E1 6	Accept any form and implied Use of $F_{max} = \mu R$ Expression for R; may be implied FT their R FT if their F and weight component show given result If g omitted, allow B1M1B0F1B0E1, so 4/6 [Award as follows for use of $\tan\alpha < \mu$: B1 $\tan\alpha = \frac{3}{4}$ E1 $\tan\alpha < \mu$ shown]
(ii)	Let the speeds down the plane be v_A and v_B . PCLM down the plane $1.5\times 16 = 2.5v_A + 1.5v_B$ so $5v_A + 3v_B = 48$ NEL +ve down the plane $\frac{v_A - v_B}{0-16} = -0.4$ $v_A - v_B = 6.4$ $v_A = 8.4$ so 8.4 m s^{-1} down plane $v_B = 2$ so 2 m s^{-1} down plane	 M1 A1 M1 A1 E1 F1 6	 PCLM Any form NEL. Allow sign errors Any form Condone direction not clear if +8.4 seen Condone direction not clear if +2 seen. SC1 if 2 equations obtained and 8.4 substituted into one to obtain answer 2 (instead of E1F1)
(iii)	$1.5 \times (2 - 16)$ down plane $= -21$ N s down the plane so 21 Ns up the plane	M1 A1 A1 3	Use of $m(\mathbf{v} - \mathbf{u})$ If impulse on A found, treat as MR unless final answer relates this to impulse on B ± 21 N s Direction explicitly commented on

Q 1		mark	notes
(iv)	**either**		
	$(2.5 \times 9.8 \times 0.6 - F_{max}) \times t = 2.5(0 - 8.4)$	M1	Using Impulse-momentum (must use 8.4) . sufficient to consider one term on LHS
		B1	Either side correct
		A1	Allow only sign errors
	so t = 10.7142… 10.7 s (3 s. f.)	A1	cao
	or		
	Using N2L down the plane	M1	Using N2L ; sufficient to consider one force term
	$a = -0.784$	A1	Allow sign errors
		M1	Using appropriate *suvat* must use a or-a found by use of N2L and $u = 8.4$
	using $v = u + at$, t = 10.7142… 10.7 s (3 s. f.)	A1	cao
	or		
	$0.5 \times 2.5 \times 8.4^2 + (14.7 - 16.66)x = 0$	M1	Use energy with 8.4, sufficient to consider one non-KE term
	x= 45	A1	
		M1	Using appropriate *suvat*
	T = 10.7142….. 10.7 (3 s. f.)	A1	cao
		4	
		19	

Q 2		mark	notes
(a)			
	Energy: $\frac{1}{2}\times 0.004\times v^2 + \frac{1}{2}\times 0.060\times V^2 = 0.8$	M1	Use of KE in two terms in an equation.
	$v^2 + 15V^2 = 400$	A1	Any form
	PCLM in **i** direction: $0.06V - 0.004v = 0$	M1	PCLM. Accept sign errors.
	$v = 15V$	A1	Any form
	Solving	M1	Valid method for elimination of *v* or *V* from a linear and a quadratic
	$(15V)^2 + 15V^2 = 400$		
	so $V^2 = \frac{400}{240} = \frac{5}{3}$ and $\mathbf{V} = \sqrt{\frac{5}{3}}\mathbf{i}$	A1	Accept 1.29099…**i** Accept no direction
	$\mathbf{v} = -15\sqrt{\frac{5}{3}}\mathbf{i}$ $(= -\sqrt{375}\mathbf{i})$	F1	Accept – 19.3649…**i** Accept no direction Second answer follows from first
		A1	(Relative) directions indicated - accept diagram. Both speeds correct.
		8	
(b) (i)	W is work done by resistances on car		
	$\frac{1}{2}\times 800\times\left(12^2 - 30^2\right) = -800\times 9.8\times 20 + \text{W}$	M1	Use of WE. Must have KE, W and GPE. Allow -*W*
		B1	Both KE terms. Accept sign error
		A1	All correct with *W* or -*W*
	W = – 145 600		
	so 145 600 J done by car against resistances	A1	cao
		4	

Q 2		mark	notes
(ii)	**either** The slope is 18 × 25 = 450 m long $\dfrac{800 \times 9.8 \times 20 + 750 \times 450}{25}$ = 19 772 W	B1 M1 M1 A1 A1	 Use of P = (Work done) / (elapsed time) used for at least one work done term WD is force × distance used for at least one force Allow only sign errors both terms cao.
	or The angle of the slope is arcsin (1/22.5) $\left(800 \times 9.8 \times \dfrac{1}{22.5} + 750\right) \times 18$ = 19 772 W	 B1 M1 M1 A1 A1 5	 Use of $P = Fv$ used for at least one term Attempt at weight component Allow only sign errors both terms cao.
		17	

Q 3		mark	notes
(i)	Horizontal $X - 50 = 0$ Vertical: $R - Y - 45 = 0$	B1 B1 2	Any form Any form
(ii)	a. c. moments about A $1 \times R = 3 \times 45$ so $R = 135$ so $135 - Y - 45 = 0$ and $Y = 90$	 M1 E1 E1 3	 Clearly shown Shown
(iii)	In analysis below all internal forces are taken as tensions	B1 B1 2	Correct arrow pairs for all internal forces Correct labels

Q 3		mark	notes
(iv)		M1 M1 M1	Equilibrium attempted at a pin-joint Equilibrium attempted at a 2nd pin-joint Either Equilibrium equation for 2nd direction at a pin-joint or 3rd pin-joint considered
	At C ↑ $T_{CD}\cos 30 - 45 = 0$ so $T_{CD} = 30\sqrt{3}$	B1	At least 3 equations of resolution correct or follow through
	and force in CD is $30\sqrt{3}$ N (T) ← $T_{BC} + T_{CD}\cos 60 = 0$ so $T_{BC} = -15\sqrt{3}$	A1	
	and force in BC is $15\sqrt{3}$ N (C) At D ↓ $T_{BD}\cos 30 + T_{CD}\cos 30 = 0$ so $T_{BD} = -30\sqrt{3}$	F1	
	and force in BD is $30\sqrt{3}$ N (C) ← $T_{AD} + T_{BD}\cos 60 - T_{CD}\cos 60 - 50 = 0$ so $T_{AD} = 50 + 30\sqrt{3}$	F1	
	and the force in AD is $50 + 30\sqrt{3}$ N (T) At A ↓ $T_{AB}\cos 30 + 90 = 0$ so $T_{AB} = -60\sqrt{3}$	F1	
	and the force in AB is $60\sqrt{3}$ N (C)	F1	
		B1 10	At least 4 T/C correct
(v)	The equilibria at C depend only on the framework geometry and the 45 N.	E1	Resolve in two directions at *C* and obtain same results as in (iv) M1A1
	These are not changed so forces in CB and CD are not changed	E1 2	
		19	

Q 4		mark	notes
(i)	(2, 2.5)	B1 1	Condone writing as a vector
(ii)	By symmetry, $\bar{y} = 2.5$ For $\bar{x}$: $\left(5h + \frac{1}{2} \times 5 \times 6\right)\bar{x} = 5h \times \left(-\frac{h}{2}\right) + \frac{1}{2} \times 5 \times 6 \times 2$ so $\left(5h + 15\right)\bar{x} = -2.5h^2 + 30$ so $5\left(h + 3\right)\bar{x} = 2.5(12 - h^2)$ and $\bar{x} = \frac{12 - h^2}{2(h+3)}$	B1 M1 A1 A1 A1 E1 6	Some justification needed These next 4 marks may be obtained from correct FT of their “2” from (i) 1st term RHS correct (allow sign error) Either other term correct All correct Clearly shown, including signs.
(iii)	Need $\bar{x} > 0$ So $\frac{12 - h^2}{2(h+3)} > 0$ Hence $12 - h^2 > 0$ Since $h > 0$, $0 < h < 2\sqrt{3}$	M1 B1 A1 3	Allow $\bar{x} \geq 0$ or $= 0$ $2\sqrt{3}$ or $- 2\sqrt{3}$ oe seen Accept only +ve root mentioned. WWW for signs Accept $h < 2\sqrt{3}$ as answer strict inequality for final A mark

Q 4		mark	notes
Q4 (iv)	**continued** When $h = 3$, $\bar{x} = 0.25$ Let mag of vert force be T N a.c moments about axis thro' O $T \times 6 - 15 \times 0.25 = 0$ so $T = 0.625$ so 0.625 N	 B1 M1 A1 3	 Could be scored in (v) If moments about another point need all relevant forces. Allow sign errors. Condone use of $15g$ cao
(v)	Let magnitude of force be U N a.c. moments about axis thro' D $U \cos 30 \times 5 - 15 \times (3 + 0.25) = 0$ $U = 11.25833\ldots$ so 11.3 N (3 s. f.)	 M1 B1 A1 A1 4	 Each term must be a moment. If moments about another point need all relevant forces. Condone use of $15g$. moment of U ($5U\cos 30$ or …) oe $(3 + 0.25)$ oe cao
		17	

4762 Mechanics 2

General Comments

The standard of the responses to this paper was generally very good and often excellent. Most candidates were able to make a reasonable attempt at most parts of the paper. The standard of presentation varied, as usual. There were many neat, well-ordered answers but there were also a significant minority in which it was difficult to track the candidate's train of thought. The latter almost invariably led to inaccurate work and a loss of marks. It was pleasing to note, however, that most candidates seemed to have a good grasp of the mechanical principles involved, even if they were not able to carry their solutions through with accuracy.

Comments on Individual Questions

1) Many candidates scored high marks on this question and almost all candidates showed a pleasing understanding of the principles involved and an ability to apply them appropriately.

(i) This posed few problems for the majority of candidates. Some candidates, however, having found the value of the maximum frictional force, failed to go on to attempt to show that the block *A* remains at rest.

(ii) Almost all candidates showed a good understanding of the principle of conservation of momentum and of Newton's experimental law and many scored full marks. Candidates must realise that sufficient working must be shown when obtaining an answer given in the question. In this case, some evidence was expected of how the answer of 8.4 was obtained from the simultaneous linear equations. A few candidates found the velocity of *B* by assuming the given value for the velocity of *A*. Such attempts gained little credit.

(iii) Almost all candidates were able to find the magnitude of the impulse, but a significant number failed to specify its direction.

(iv) There are three common methods of approach to this part of the question and candidates showed no particular preference for one rather than the others. In each method, however, a significant number of candidates omitted one of the two forces acting on *A* parallel to the slope.

2) This was the least well-answered question on the paper. Candidates were usually aware of the principles of mechanics that were involved, but were often not able to apply them appropriately to the situation described in the question.

(a) Many candidates were able to apply the principle of conservation of linear momentum appropriately here, but a significant number seemed to ignore the first sentence in the question when applying conservation of energy. It was common to see candidates using a combined mass for *B* and *C* with a single combined velocity. This resulted in few marks being awarded. Of those who were successful in calculating the speeds of *B* and *C*, many lost a mark by failing to indicate the directions.

(b)(i) There were many pleasing answers, showing a sound understanding of the use of the work-energy equation. Any loss of marks was usually due to sign errors.

(b)(ii) This part of the question was poorly done by many candidates. The solutions offered showed much confusion in understanding. The formulae for work done as "*Pt*" or as "*Fd*" and for power as "*Fv*" often appeared to be used randomly in incoherent solutions. Method marks were awarded wherever possible. A major stumbling block was to assume that the vertical height of 20m gained by the car was in fact the distance travelled by the car along the slope.

3) Many excellent answers to this question were seen.

(i) This was almost always correctly answered.

(ii) Again, usually correct. The only source of error was to use a circular argument that assumed the results in order to prove them. Such errors gained no marks.

(iii) Again, usually correct. Any loss of a mark was through a failure to label the internal forces on the rods, needed to indicate their equality in magnitude for each rod.

(iv) There were many excellent solutions to this part of the question. Candidates who adopted a methodical and clearly structured approach often gained full marks. The most common errors were sign errors in resolving the forces at a pin-joint. A minority of candidates seemed to have no idea what was required. This is surprising because this was a fairly standard question on this topic.

(v) The simplest approach here, followed by most candidates who attempted this part of the question, was to resolve in two directions at *C* and obtain the same results as previously. Those who attempted to explain in words, along the lines that changes at *D* did not affect what happened at *C*, rarely presented a complete argument.

4) The standard of the solutions to most parts of this question was good; the request to find the centre of mass of the cross-section of the prism was particularly well-answered. Success in the last two parts of the question depended on the candidate's ability to choose the sensible point about which to take moments.

(i) This part of the question was almost always correctly answered.

(ii) About half of the candidates obtained full marks here. Others understood the essence of the method, but lost marks either through sign errors when taking moments or through a lack of evidence in reaching the given result.

(iii) The mechanics involved here was less of a problem to the candidates than a clear understanding of how to work with inequalities.

(iv) The majority of candidates realised that the prism would tip about the point *O* and consequently took moments about *O*. Errors crept in with finding the distances involved.

(v) Candidates who realised that the prism would tip about the point *D* and so took moments about *D* usually gained full marks. Many candidates, however, attempted to take moments about *O* and omitted the reaction at *D* between the prism and the horizontal plane. Such attempts rarely gained any marks.

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