OCR
RECOGNISING ACHIEVEMENT

Friday 1 June 2012 – Morning

A2 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

Duration: 1 hour 30 minutes

4715790612

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

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1 **(a)** A stone of mass 0.6 kg falls vertically 1.5 m from A to B against resistance. Its downward speeds at A and B are $5.5\,\text{m}\,\text{s}^{-1}$ and $7.5\,\text{m}\,\text{s}^{-1}$ respectively.

(i) Calculate the change in kinetic energy and the change in gravitational potential energy of the stone as it falls from A to B. **[3]**

(ii) Calculate the work done against resistance to the motion of the stone as it falls from A to B. **[2]**

(iii) Assuming the resistive force is constant, calculate the power with which the resistive force is retarding the stone when it is at A. **[4]**

(b) A uniform plank is inclined at 40° to the horizontal. A box of mass 0.8 kg is on the point of sliding down it. The coefficient of friction between the box and the plank is μ.

(i) Show that $\mu = \tan 40°$. **[4]**

The plank is now inclined at 20° to the horizontal.

(ii) Calculate the work done when the box is pushed 3 m up the plank, starting and finishing at rest. **[5]**

2 The rigid object shown in Fig. 2.1 is made of thin non-uniform rods. ABC is a straight line; BC, BE and ED form three sides of a rectangle. The centre of mass of the object is at G. The lengths are in centimetres. The weight of the object is 15 N.

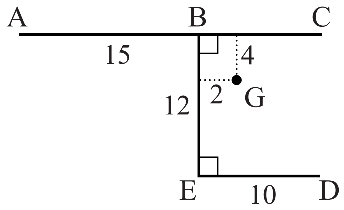

Fig. 2.1

Initially, the object is suspended by light vertical strings attached to B and to C and hangs in equilibrium with AC horizontal.

(i) Calculate the tensions in each of the strings. **[4]**

In a new situation the strings are removed. The object can rotate freely in a vertical plane about a fixed horizontal axis through A and perpendicular to ABCDE. The object is held in equilibrium with AC horizontal by a force of magnitude T N in the plane ABCDE acting at C at an angle of 30° to CA. This situation is shown in Fig. 2.2.

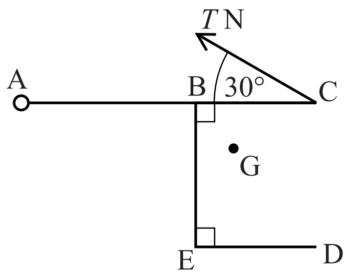

Fig. 2.2

(ii) Calculate T.

Calculate also the magnitude of the force exerted on the object by the axis at A. **[6]**

The object is now placed on a rough horizontal table and is in equilibrium with ABCDE in a vertical plane and DE in contact with the table. The coefficient of friction between the edge DE and the table is 0.65. A force of slowly increasing magnitude (starting at 0 N) is applied at A in the direction AB. Assume that the object remains in a vertical plane.

(iii) Determine whether the object slips before it tips. **[6]**

3 **(a)** You are given that the position of the centre of mass, G, of a right-angled triangle cut from thin uniform material in the position shown in Fig. 3.1 is at the point $(\frac{1}{3}a, \frac{1}{3}b)$.

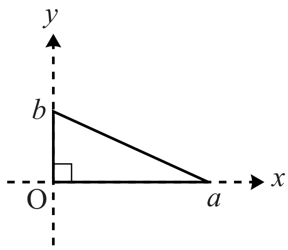

Fig. 3.1

A plane thin uniform sheet of metal is in the shape OABCDEFHIJO shown in Fig. 3.2. BDEA and CDIJ are rectangles and FEH is a right angle. The lengths of the sides are shown with each unit representing 1 cm.

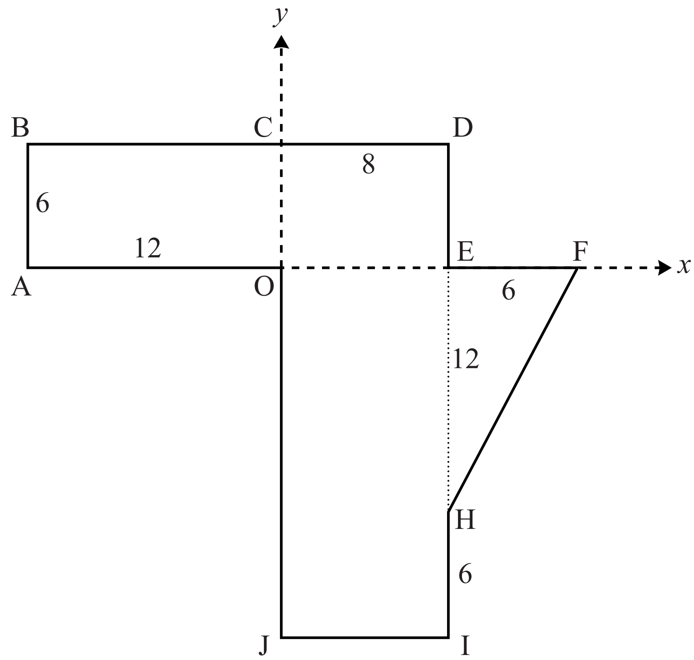

Fig. 3.2

(i) Calculate the coordinates of the centre of mass of the metal sheet, referred to the axes shown in Fig. 3.2. **[5]**

The metal sheet is freely suspended from corner B and hangs in equilibrium.

(ii) Calculate the angle between BD and the vertical. **[4]**

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(b) Part of a framework of light rigid rods freely pin-jointed at their ends is shown in Fig. 3.3. The framework is in equilibrium.

All the rods meeting at the pin-joints at A, B and C are shown. The rods connected to A, B and C are connected to the rest of the framework at P, Q, R, S and T.

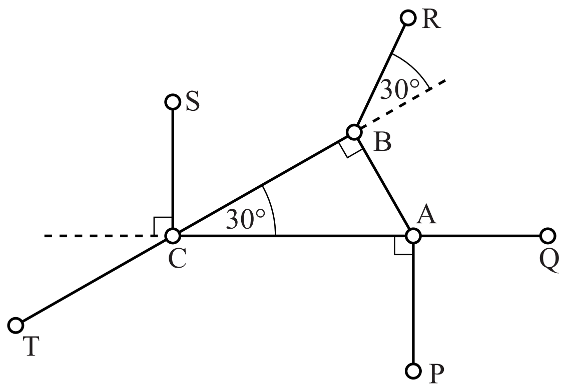

Fig. 3.3

There is a tension of 18 N in rod AP and a thrust (compression) of 5 N in rod AQ.

(i) Show the forces internal to the rods acting on the pin-joints at A, B and C. **[2]**

(ii) Calculate the forces internal to the rods AB, BC and CA, stating whether each rod is in tension or compression. [You may leave your answers in surd form. Your working in this part should be consistent with your diagram in part **(i)**.] **[7]**

4 P and Q are circular discs of mass 3 kg and 10 kg respectively which slide on a smooth horizontal surface. The discs have the same diameter and move in the line joining their centres with no resistive forces acting on them. The surface has vertical walls which are perpendicular to the line of centres of the discs. This information is shown in Fig. 4 together with the direction you should take as being positive.

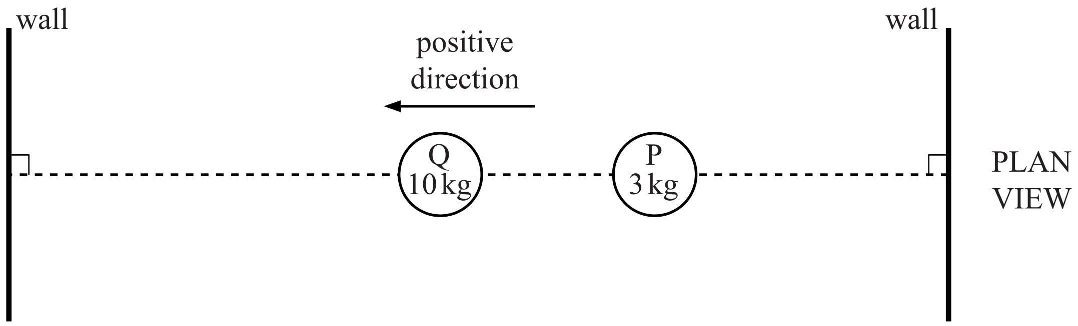

Fig. 4

(i) For what time must a force of 26 N act on P to accelerate it from rest to $13\,\text{m s}^{-1}$? **[2]**

P is travelling at $13\,\text{m s}^{-1}$ when it collides with Q, which is at rest. The coefficient of restitution in this collision is e.

(ii) Show that, after the collision, the velocity of P is $(3 - 10e)\,\text{m s}^{-1}$ and find an expression in terms of e for the velocity of Q. **[7]**

(iii) For what set of values of e does the collision cause P to reverse its direction of motion? **[2]**

(iv) Determine the set of values of e for which P has a greater speed than Q immediately after the collision. **[4]**

You are now given that $e = \frac{1}{2}$. After P and Q collide with one another, each has a perfectly elastic collision with a wall. P and Q then collide with one another again and in this second collision they stick together (coalesce).

(v) Determine the common velocity of P and Q. **[4]**

(vi) Determine the impulse of Q on P in this collision. **[1]**

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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

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1 (b) (i)	
1 (b) (ii)	

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2 (i)	
2 (ii)	

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2 (iii)

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3 (a) (i)

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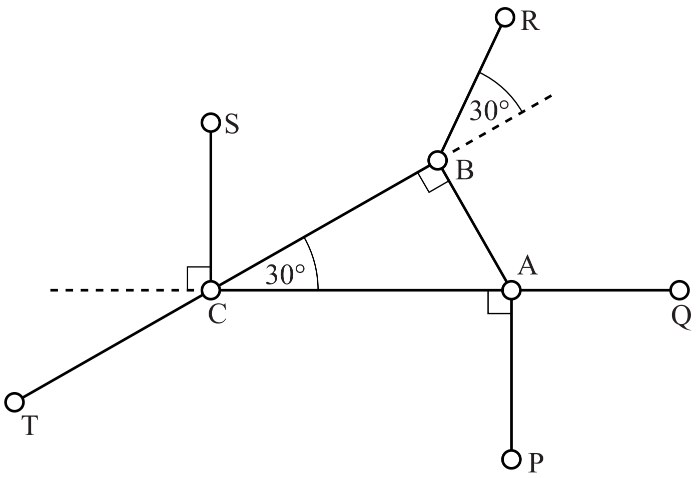
3 (a) (ii)

3 (b) (i)



3 (b) (ii)

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3 (b) (ii)	**(continued)**

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4 (i)	
4 (ii)	

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4 (iii)	
4 (iv)	

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4 (v)	
4 (vi)	

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GCE

Mathematics (MEI)

Advanced GCE

Unit **4762:** Mechanics 2

Mark Scheme for June 2012

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It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	

Other abbreviations in mark scheme	Meaning
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions

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 accuracy error, except for errors due to premature approximation which should be penalised only once in the examination.

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.

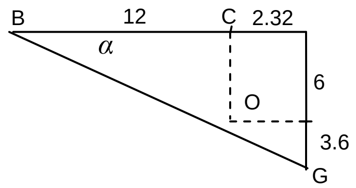
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

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	(a)	(i)	KE change: $\frac{1}{2}\times 0.6\times\left(7.5^2-5.5^2\right)$ = 7.8 J GPE change: 0.6 × 9.8 × 1.5 = 8.82 J	M1 A1 B1 **[3]**	Difference of two KE terms Allow –8.82J
1	(a)	(ii)	*W* is work done against resistance 7.8 = 8.82 – *W* so *W* = 1.02 J	 M1 A1 **[2]**	 W–E all terms. Allow sign errors FT (i) only. Also FT only if mod (their KE) < mod (their PE) –1.02 gets M1A0; 16.62 gets M1A0
1	(a)	(iii)	Average resistance is *F* so *F* × 1.5 = 1.02 so *F* = 0.68 Power is 0.68 × 5.5 = 3.74 so 3.74 W	 M1 A1 M1 A1 **[4]**	 Use of WD = *Fs* OR find *a* = 8.667 and use F = 0.6*g* – 0.6 × 8.667 May be implied. FT (ii) Use of *P* = *Fv* any calculated F cao
1	(b)	(i)	$R = mg\cos 40$ $F_{max} = mg\sin 40$ $F_{max} = \mu R$ so $\mu = \frac{mg\sin 40}{mg\cos 40} = \tan 40$	B1 B1 M1 E1 **[4]**	Seen or implied Seen or implied Use of $F = \mu R$: substitute *F* and *R* This is the minimum amount of working needed to earn the E1 Must see explicit evidence of method Note: *g* omitted, treat as MR
1	(b)	(ii)	**EITHER** tan 40 × 0.8 × 9.8 × cos 20 × 3 (= 18.545) (+)0.8 × 9.8 × 3 sin 20 (= 8.044) = 26.5897… so 26.6 J (3 s.f.)	 B1 M1 B1 M1 A1	 Use of $F_{max} = \mu R$ with tan 40 and cos 20 Use of WD = *Fs* NOTE: This mark may be awarded here or for use in PE term Use of *mgh* Allow sin ↔ cos interchange Two relevant terms added Cao Allow 26.7 Allow 27 Omission of *g* can get B0M1B1M1A0

Question			Answer	Marks	Guidance
			OR		
			tan 40 × 0.8 × 9.8 × cos 20 (= 6.182)	B1	Use of $F_{max} = \mu R$ with tan 40 and cos 20
			(+) 0.8 × 9.8 × sin 20 (= 2.68)	B1	Allow $\sin \leftrightarrow \cos$ interchange
			(= 8.8632444…)	M1	Two relevant forces added
			WD is 3 × 8.8632444…	M1	Use of WD = Fs (for at least one of forces)
			= 26.5897… so 26.6 J (3 s.f.)	A1	cao
				[5]	Omission of g can get B0B1M1M1A0
2	(i)		a.c. moments about B		
			$10T_C - 15 \times 2 = 0$	M1	Moments with all forces present, no extra forces.
			so $T_C = 3$. Tension at C is 3 N	A1	
			$\uparrow$ $T_C + T_B - 15 = 0$	M1	May take moments again
			so $T_B = 12$. Tension at B is 12 N	F1	
				[4]	
2	(ii)		a.c. moments about A		
			$25T\sin 30 - 15 \times 17 = 0$	M1	Attempt at moments with resolution; allow $\cos \leftrightarrow \sin$ error. All forces present, no extra forces
			so $T = 20.4$	A1	cao
			At A Let force $\uparrow$ be Y N		
			$\uparrow$ $Y + T\sin 30 - 15 = 0$ so $Y = 4.8$	B1	FT (can take moments about C)
			$\rightarrow X = T\cos 30 = 17.6669\ldots$ N	B1	FT Need not be evaluated
			$\sqrt{4.8^2 + (T\cos 30)^2}$	M1	
			= 18.3073755… so 18.3 N (3 s.f.)	A1	cao
				[6]	
2	(iii)		Let force be P.		
			a.c. moments about D.		
			$8 \times 15 - 12 \times P = 0$	M1	Moments about D with all forces present, no extra forces
			so $P = 10$ on point of tipping	A1	cao
			Using $F_{max} = \mu R$ on point of slipping	M1	
			with $R = 15$	B1	
			gives $F_{max} = 0.65 \times 15 = 9.75$	A1	cao
			so slips first	E1	cao and WWW
				[6]	

Question			Answer	Marks	Guidance
3	(a)	(i)	$300\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix}=72\begin{pmatrix}-6\\3\end{pmatrix}+192\begin{pmatrix}4\\-6\end{pmatrix}+36\begin{pmatrix}10\\-4\end{pmatrix}$	B1 M1 B1	Correctly identifying the position of the c.m of triangle EFH (10, –4) A systematic method for at least 1 cpt *Either* all x or all y values correct *or* 2 vector terms correct *or* allow one common error in both components, e.g. one wrong mass, misunderstanding of c.m. of triangle
			$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix}=\begin{pmatrix}696\\-1080\end{pmatrix}$ so $\bar{x}=2.32$ $\bar{y}=-3.6$	A1 A1 **[5]**	Allow FT for either if only error is common to both
3	(a)	(ii)	 centre of mass is at G		
			tan $\alpha=\frac{9.6}{14.32}$ so $\alpha=33.8376...$ so 33.8° (3 s.f.)	M1* B1 M1dep* A1 **[4]**	Identifying correct angle. May be implied At least 1 relevant distance found. FT (i) Use of arctan $\frac{9.6}{14.32}$ or arctan $\frac{14.32}{9.6}$ o.e. cao or 180° – 33.8°
3	(b)	(i)	Marking given tension and thrust Marking all other forces internal to rods acting on A, B and C (as T or C)	B1 B1 **[2]**	Each labelled with magnitude and correct direction Need ALL forces at *A, B* and *C*. Need pairs of arrows on *AB*, *AC* and *BC*

Question			Answer	Marks	Guidance
3	(b)	(ii)	Equilibrium at A ↑ $T_{AB}\cos 30 - 18 = 0$ $T_{AB} = 12\sqrt{3}$. Force in AB: $12\sqrt{3}$ N (T) A ← $T_{AC} + T_{AB}\cos 60 + 5 = 0$ $T_{AC} = -(5 + 6\sqrt{3})$. Force in AC: $(5 + 6\sqrt{3})$ N (C) At B in direction AB $T_{BR}\cos 60 - T_{AB} = 0$ so $T_{BR} = 24\sqrt{3}$ At B in direction BC $T_{BC} - T_{BR}\cos 30 = 0$ $T_{BC} = 36$. Force in BC: 36 N (T)	M1 A1 M1 F1 M1 F1 A1 **[7]**	Equilibrium at one pin-joint 20.8 Sign consistent with tension on their diagram –15.39 FT their T_{AB} Allow FT Other methods are possible, but award this M1 only for a complete method that would lead to T_{BC} cao WWW T/C all correct
4	(i)		$26t = 3 \times 13$ $t = 1.5$ so 1.5 s	M1 A1 **[2]**	Use of $Ft = m(v - u)$ or N2L to find a (= 26/3) and use $v = u + at$ cao
4	(ii)		PCLM $10 \times 0 + 3 \times 13 = 10v_Q + 3v_P$ $39 = 10v_Q + 3v_P$ NEL $\frac{v_Q - v_P}{0 - 13} = -e$ $v_Q - v_P = 13e$ $v_Q = 3(1 + e)$ $v_P = 3 - 10e$	M1 A1 M1 A1 M1 B1 E1 **[7]**	Use of PCLM Any form Use of NEL. Allow sign errors but not inversion Any form Eliminating one of v_Q or v_P OR allow substitution of given result in one equation and check both answers in other equation cao; aef Properly shown

Question			Answer	Marks	Guidance
4	(iii)		Need $v_P < 0$ so $3 - 10e < 0$ Hence $\frac{3}{10} < e \le 1$	M1 A1 **[2]**	Accept ≤ cao (Allow $e \le 1$ omitted) Correct answer www gets 2/2
4	(iv)		When $e > \frac{3}{10}$, its speed is $10e - 3$ We require $(10e - 3) > 3(1 + e)$ so $7e > 6$ and so $\frac{6}{7} < e \le 1$	M1 M1 A1 A1 **[4]**	 FT their v_Q SC1 for $(3 - 10e) > \pm 3(1 + e)$ FT their v_Q cao. Allow $e > \frac{6}{7}$ (0.857) Correct answer www gets 4/4
4	(v)		**Either** $v_Q = 4.5$ and $v_P = -2$ When they collide the speed of Q is -4.5 and of P is 2 PCLM $10 \times -4.5 + 3 \times 2 = 13V$ so $V = -3$ and velocity is –3 m s^{-1}	M1 M1 M1 A1 **[4]**	Substitute $e = 0.5$; FT their v_Q Change signs of their velocities Use of PCLM Allow sign errors cao; OR 3 m s^{-1} to the right or use argument about final LM is –ve of original LM
			Or $10(-3(1+e)) + 3(10e-3) = 13V$ $-39 = 13V$ so $V = -3$ and velocity is – 3 m s^{-1}	M1 M1 M1 A1 **[4]**	Use of PCLM; Allow sign errors ; FT their v_Q Change signs of their velocities Simplify cao; OR 3 m s^{-1} to the right
4	(vi)		$3(-3-2) = -15$ N s	B1 **[1]**	FT $3(\text{their}(v) - 2)$ Using 10(–3 +4.5) = 15 gets B0 until it leads to correct answer

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4762 Mechanics 2

General Comments

The general standard of the work was pleasing. Many candidates showed a sound understanding of the methods and techniques involved and most presented their solutions with clarity. It is worth emphasising, however, that a good clear diagram is often the key to a successful solution. It is also important that candidates read the question carefully. When there is a supporting diagram, information may be given in the text or on the diagram, or both. Particularly careful reading is required when a scenario changes in the later parts of questions to ensure that only relevant information is carried forward.

Comments on Individual Questions

1) (a) Work, energy and power

(i) The vast majority of candidates were able to state and use the formulae for kinetic and potential energy and scored full marks. A minority found only the kinetic energy change.

(ii) Most candidates who found the energy changes in part (i) were able to combine them appropriately to find the work done against resistance. A few made sign errors. Those candidates who did not find the potential energy change in part (i) usually gave it as the answer to this part of the question.

(iii) The most concise solutions to this request involved the use of the two formulae, 'work done = force x distance' and 'power = force x velocity.' Many candidates, however, pursued an incorrect method, using *suvat* to calculate a time and then dividing their answer for the work done from part (ii) by this calculated time. This resulted in an 'average' power, which was indicative of a lack of understanding of the fact that power changes with velocity. Other candidates calculated a force, often the weight of the stone, and multiplied this by 5.5.

(b) Frictional force

(i) This was answered well by almost all candidates. A few solutions were rather too brief and candidates should be aware that they need to give adequate working to support a given answer. A small minority of candidates either omitted *g* in their calculations or lost accuracy when using numerical values for the trigonometric functions.

(ii) Only a minority of candidates scored full marks on this question. Many offered incomplete solutions, including only one of the two required terms, usually the potential energy term. A significant number of candidates changed the value of the coefficient of friction because the angle of inclination of the plane was changed.

2) Rigid body in equilibrium

(i) Most candidates scored full marks. A small percentage of candidates misread the question and attached the strings to *A* and *C* instead of *B* and *C*.

(ii) Most candidates were able to calculate *T* correctly, by taking moments about *A*. The vast majority of candidates then went on to calculate just *one* component of the force exerted on the object by the axis at *A* usually the horizontal component. Of those candidates who calculated both components, a significant number did not proceed to find the magnitude of the resultant force.

(iii) There were some very concise fully correct solutions to this part of the question, displaying a sound understanding of the principles involved. Candidates who did not score full marks seemed confident in considering the slipping situation, but were unsure about how to get a condition for tipping. They attempted to take moments, but often not about the point *D*. A significant minority of candidates did not read the question carefully and retained the force *T*, from part (ii).

3) (a) Centre of mass

(i) Both the presentation and the accuracy of the solutions to this part of the question were very good. Some candidates lost marks because they used the distance from *OJ* of the centre of mass of the triangular part of the metal sheet as the *x*-coordinate in their calculations.

(ii) The majority of candidates realised which angle they needed to calculate and did so accurately from their answer in part (i). Other candidates assumed that triangle *BDG*, where *G* is the centre of mass of the whole sheet, was right-angled at *G*. The minority of candidates who did not attempt to draw a diagram were rarely successful.

(b) Light framework

(i) Almost all candidates marked the forces internal to the rods *AB*, *BC* and *CA*, but many candidates omitted showing any forces on the rods *CT, CS,* and *BR*. Others put arrows in the wrong direction for each of the given forces in *AP* and *AQ*.

(ii) The majority of candidates were able to resolve horizontally at *A* to find the force in the rod *AB* and then vertically to find the force in the rod *AC.* A significant number of candidates made a sign error in the vertical resolution. Finding the tension in the rod *BC* proved difficult for many candidates and it was common to see attempts at resolutions at *B* and *C* with forces missing and incorrect signs. A minority of candidates attempted to find the forces in all of the rods shown in the framework.

4) Momentum and impulse

(i) The vast majority of candidates scored full marks.

(ii) Most candidates were able to apply the Principle of conservation of linear momentum and Newton's experimental law effectively and then solve the resulting simultaneous equations to find the two required velocities. A small number of candidates made algebraic or arithmetic slips.

(iii) Again, most candidates scored full marks.

(iv) Only a minority of candidates scored more than a single mark on this part of the question. The common error was in not realising that the direction of *P* must have been reversed in the collision. This resulted in the inequality $e < 0$, contradicting the fact that *e* is a positive quantity, but this rarely alerted candidates to think again about their solution.

(v) The majority of candidates realised that the velocities of *P* and *Q* needed to be reversed in direction when applying the Principle of conservation of linear momentum.

(vi) Although candidates knew that the impulse was equal to the change in momentum, only a minority dealt successfully with the signs involved.

GCE Mathematics (MEI)											
			Max Mark	**90% cp**	**a**	**b**	**c**	**d**	**e**	**u**
4753/01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	66	60	53	47	41	34	0
4753/02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	16	15	13	11	9	8	0
4753/82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	16	15	13	11	9	8	0
4753	(C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	90	80	70	60	50	40	0
4754/01	(C4) MEI Applications of Advanced Mathematics	Raw	90	73	65	57	50	43	36	0
		UMS	100	90	80	70	60	50	40	0
4756/01	(FP2) MEI Further Methods for Advanced Mathematics	Raw	72	66	61	53	46	39	32	0
		UMS	100	90	80	70	60	50	40	0
4757/01	(FP3) MEI Further Applications of Advanced Mathematics	Raw	72	61	54	47	40	34	28	0
		UMS	100	90	80	70	60	50	40	0

4758/01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	68	63	57	51	45	39	0
4758/02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	16	15	13	11	9	8	0
4758/82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	16	15	13	11	9	8	0
4758	(DE) MEI Differential Equations with Coursework	UMS	100	90	80	70	60	50	40	0
4762/01	(M2) MEI Mechanics 2	Raw	72	65	58	51	44	38	32	0
		UMS	100	90	80	70	60	50	40	0
4763/01	(M3) MEI Mechanics 3	Raw	72	67	63	56	50	44	38	0
		UMS	100	90	80	70	60	50	40	0
4764/01	(M4) MEI Mechanics 4	Raw	72	63	56	49	42	35	29	0
		UMS	100	90	80	70	60	50	40	0
4767/01	(S2) MEI Statistics 2	Raw	72	66	61	55	49	43	38	0
		UMS	100	90	80	70	60	50	40	0
4768/01	(S3) MEI Statistics 3	Raw	72	65	58	51	44	38	32	0
		UMS	100	90	80	70	60	50	40	0
4769/01	(S4) MEI Statistics 4	Raw	72	63	56	49	42	35	28	0
		UMS	100	90	80	70	60	50	40	0
4772/01	(D2) MEI Decision Mathematics 2	Raw	72	62	56	50	44	39	34	0
		UMS	100	90	80	70	60	50	40	0
4773/01	(DC) MEI Decision Mathematics Computation	Raw	72	52	46	40	34	29	24	0
		UMS	100	90	80	70	60	50	40	0
4777/01	(NC) MEI Numerical Computation	Raw	72	63	55	47	39	32	25	0
		UMS	100	90	80	70	60	50	40	0