OCR
Oxford Cambridge and RSA

Friday 17 June 2016 – Afternoon

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

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INSTRUCTIONS TO CANDIDATES

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

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

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

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Section A (36 marks)

1 Fig. 1 shows a block of mass M kg being pushed over level ground by means of a light rod. The force, T N, this exerts on the block is along the line of the rod.

The ground is rough.

The rod makes an angle α with the horizontal.

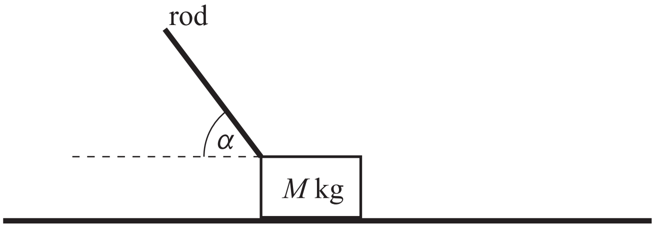


Fig. 1

(i) Draw a diagram showing all the forces acting on the block. **[3]**

(ii) You are given that $M = 5, \alpha = 60°, T = 40$ and the acceleration of the block is $1.5\,\mathrm{m\,s^{-2}}$.

Find the frictional force.

[3]

2

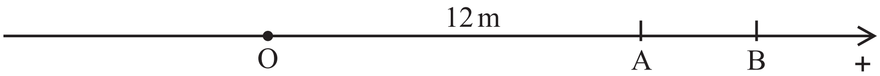


Fig. 2

A particle moves on the straight line shown in Fig. 2. The positive direction is indicated on the diagram.

The time, t, is measured in seconds. The particle has constant acceleration, $a\,\mathrm{m\,s^{-2}}$.

Initially it is at the point O and has velocity $u\,\mathrm{m\,s^{-1}}$.

When $t = 2$, the particle is at A where OA is 12 m. The particle is also at A when $t = 6$.

(i) Write down two equations in u and a and solve them. **[4]**

(ii) The particle changes direction when it is at B.

Find the distance AB. **[3]**

3 Fig. 3.1 shows a block of mass 8 kg on a smooth horizontal table.

This block is connected by a light string passing over a smooth pulley to a block of mass 4 kg which hangs freely. The part of the string between the 8 kg block and the pulley is parallel to the table.

The system has acceleration a m s^{-2}.

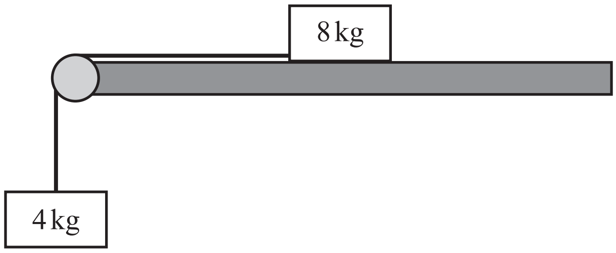


Fig. 3.1

(i) Write down two equations of motion, one for each block. **[2]**

(ii) Find the value of a. **[2]**

The table is now tilted at an angle of θ to the horizontal as shown in Fig. 3.2. The system is set up as before; the 4 kg block still hangs freely.

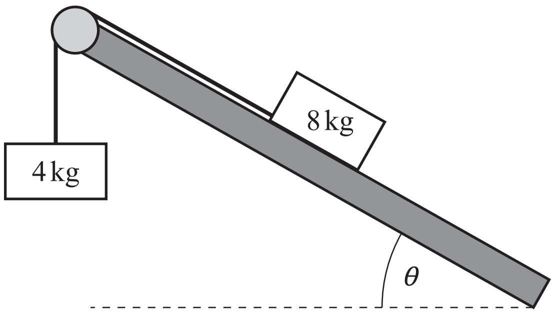


Fig. 3.2

(iii) The system is now in equilibrium. Find the value of θ. **[4]**

4 A particle is initially at the origin, moving with velocity $\mathbf{u}$. Its acceleration $\mathbf{a}$ is constant.

At time t its displacement from the origin is $\mathbf{r} = \begin{pmatrix} x \\ y \end{pmatrix}$, where $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 \\ 6 \end{pmatrix} t - \begin{pmatrix} 0 \\ 4 \end{pmatrix} t^2$.

(i) Write down $\mathbf{u}$ and $\mathbf{a}$ as column vectors. **[2]**

(ii) Find the speed of the particle when $t = 2$. **[3]**

(iii) Show that the equation of the path of the particle is $y = 3x - x^2$. **[3]**

5 Mr McGregor is a keen vegetable gardener. A pigeon that eats his vegetables is his great enemy.

One day he sees the pigeon sitting on a small branch of a tree. He takes a stone from the ground and throws it. The trajectory of the stone is in a vertical plane that contains the pigeon. The same vertical plane intersects the window of his house. The situation is illustrated in Fig. 5.

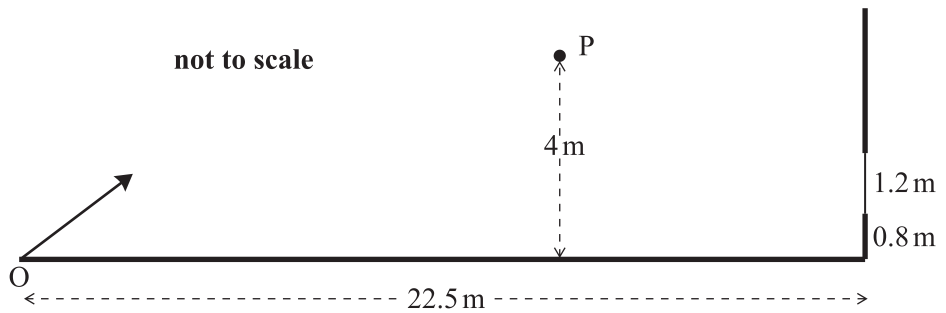


Fig. 5

- The stone is thrown from point O on level ground. Its initial velocity is $15\,\mathrm{m\,s^{-1}}$ in the horizontal direction and $8\,\mathrm{m\,s^{-1}}$ in the vertical direction.
- The pigeon is at point P which is 4 m above the ground.
- The house is 22.5 m from O.
- The bottom of the window is 0.8 m above the ground and the window is 1.2 m high.

Show that the stone does not reach the height of the pigeon.

Determine whether the stone hits the window. **[7]**

Section B (36 marks)

6 **In this question you should take g to be $10\,\mathrm{m\,s^{-2}}$.**

Piran finds a disused mineshaft on his land and wants to know its depth, d metres.

Local records state that the mineshaft is between 150 and 200 metres deep.

He drops a small stone down the mineshaft and records the time, T seconds, until he hears it hit the bottom. It takes 8.0 seconds.

Piran tries three models, A, B and C.

In model A, Piran uses the formula $d = 5T^2$ to estimate the depth.

(i) Find the depth that model A gives and comment on whether it is consistent with the local records.

Explain how the formula in model A is obtained. **[4]**

In model B, Piran uses the speed-time graph in Fig. 6.

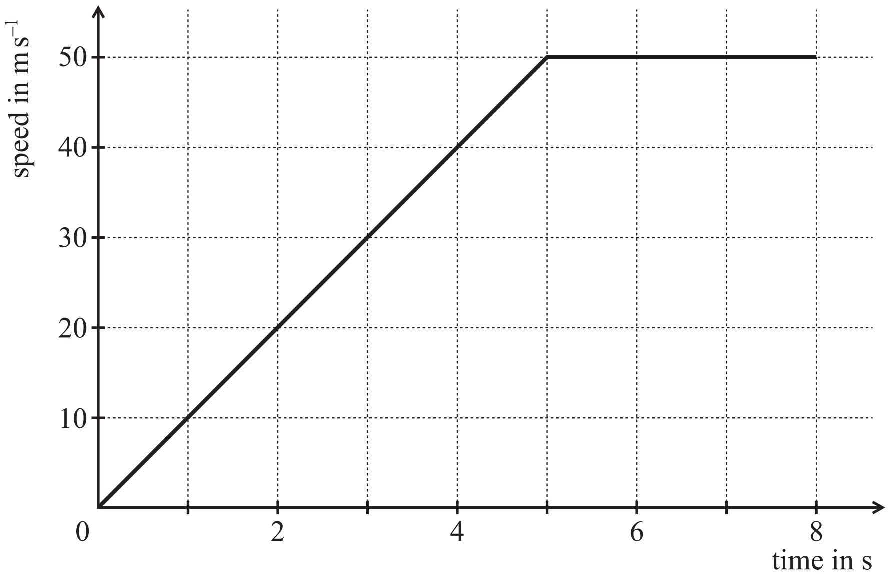


Fig. 6

(ii) Calculate the depth of the mineshaft according to model B.

Comment on whether this depth is consistent with the local records. **[4]**

(iii) Describe briefly one respect in which model B is the same as model A and one respect in which it is different. **[2]**

Piran then tries model C in which the speed, $v\,\mathrm{m\,s^{-1}}$, is given by

$$v = 10t - t^2 \text{ for } 0 \leqslant t \leqslant 5,$$

$$v = 25 \text{ for } 5 < t \leqslant 8\,.$$

(iv) Calculate the depth of the mineshaft according to model C.

Comment on whether this depth is consistent with the local records. **[6]**

(v) Describe briefly one respect in which model C is similar to model B and one respect in which it is different. **[2]**

7 Fig. 7 illustrates a situation on a building site. An unexploded bomb is being lifted by light ropes that pass over smooth pulleys. The ropes are attached to winches V and W.

- The weight of the bomb is 7500 N.
- The winches are on horizontal ground and are at the same level.
- The sloping parts of the ropes from V and W are at angles α and β to the horizontal.
- The point P is level with the horizontal sections of the ropes and is 16 m and 9 m from the two pulleys, as shown.
- The winches are controlled so that the bomb moves in a vertical line through P. The tension in the rope attached to winch W is kept constant at 8000 N. The tension, T N, in the rope attached to winch V is varied.
- The distance between the top of the bomb, B, and the point P is d metres.

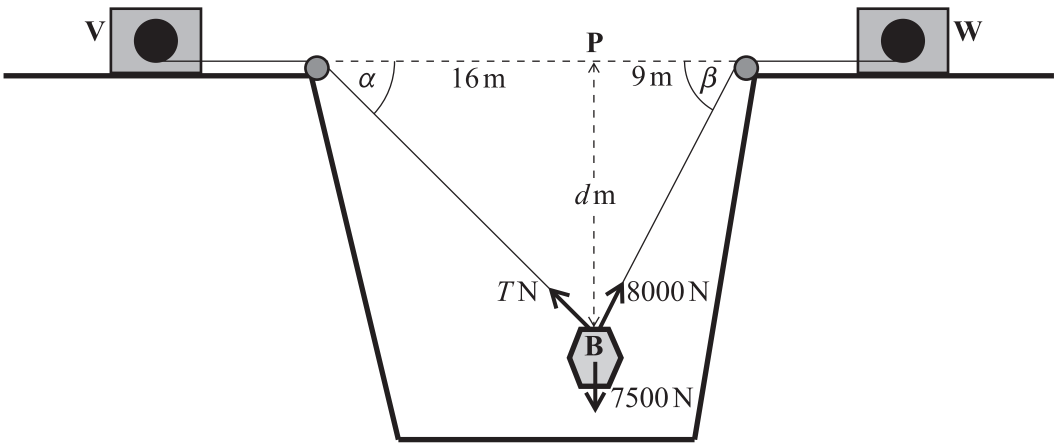


Fig. 7

At a particular stage in the lift, $d = 12$ and $T = 6000$.

(i) Find the values of $\cos\alpha$ and $\cos\beta$ at this stage. **[1]**

(ii) Verify that, at this stage, the horizontal component of the bomb's acceleration is zero. Find the vertical component of its acceleration. **[7]**

At a later stage, the bomb is higher up and so the values of d, T, α and β have all changed.

(iii) Show that $T = \dfrac{8000\cos\beta}{\cos\alpha}$.

Hence show that $T = \dfrac{4500\sqrt{d^2+256}}{\sqrt{d^2+81}}$. **[4]**

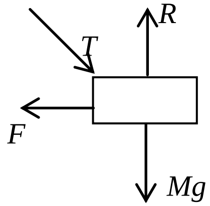
(iv) Find the acceleration of the bomb when $d = 6.75$. **[4]**

(v) Explain briefly why it is not possible for the bomb to be in equilibrium with B at P.

What could you say about the acceleration of the bomb if B were at P and the tensions in the two ropes were equal? **[2]**

END OF QUESTION PAPER

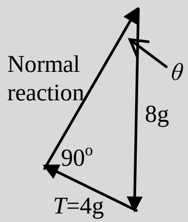
SECTION A

Qu	Part	Answer	Mark	Guidance
1.	(i)		B1 B1 B1	Forces **B0** if one force missing or an extra force present Labels Arrows **B0** if T in tension Allow T given in components provided it is clear they are not additional forces. Allow sin-cos interchange in this case. Give **B0 B0 B0** if 2 or more forces missing
			[3]	
	(ii)			Notice that the same solution applies if the direction of T was wrong in part (i), and full marks are available for part (ii) in this case.
		$T\cos\alpha - F = ma$	M1	Horizontal equation of motion with the right 3 elements
		$40\cos\alpha - F = 5\times1.5$	A1	A0 if sin-cos interchange
		$F = 12.5$ Frictional force of 12.5 N.	A1	CAO
			[3]	

Qu	Part	Answer	Mark	Guidance
2.	(i)	$s = ut + \frac{1}{2}at^2$		The final mark scheme will include commonly used alternative methods.
		$t = 2 \Rightarrow 2u + 2a = 12$	**B1**	Allow one equation with $v = 0$ and $t = 4$
		$t = 6 \Rightarrow 6u + 18a = 12$	**B1**	
		Solving the simultaneous equations	**M1**	Attempt to solve non-trivial simultaneous equations in u and a
		$u = 8,\ a = -2$	**A1**	CAO
			[4]	
	(ii)	At B, $v^2 - u^2 = 2as$		Follow through for their values of u and a.
		$\Rightarrow 0^2 - 8^2 = 2 \times -2 \times s$	**M1**	Allow the use of $s = ut + \frac{1}{2}at^2$ with $t = 4$.
		$s = 16$	**A1**	
		AB is 4 m.	**A1**	CAO
			[3]	

Qu	Part	Answer	Mark	Guidance
3.	(i)	$T = 8a$	B1	
		$4g - T = 4a$	B1	Allow if a is in the upwards direction but the two equations must be consistent in this.
			[2]	
	(ii)	Adding the two equations $\Rightarrow \quad 4g = 12a$	M1	Or equivalent method. No FT from part (i).
		$a = \frac{g}{3}$ (-3.27 m s^{-2})	A1	CAO but allow 3.26 .
			[2]	
	(iii)	Equilibrium equations $T - 4g = 0$ $T - 8g\sin\theta = 0$ $4g - 8g\sin\theta = 0$	 M1 M1 A1	 Vertical equation Award if $8g\sin\theta$ seen. Do not allow sin-cos interchange Correct equation with $T = 4g$ substituted
				Note Award **M1 M1 A1** for going straight to $4g = 8g\sin\theta$ oe Allow **M1 M1 A0** for 4 = 8sinθ with no previous work
		$\Rightarrow \quad \theta = 30°$	A1	CAO
			[4]	

4761 June 2016 Addition to Mark scheme Alternative method for 3(iii)

3.	**(iiii)**	**Alternative**		
		$T - 4g = 0$	**M1**	
		Triangle of forces for the 8 kg block 	**M1**	Dependent on the other M mark There must be an attempt to use the triangle for this mark to be awarded. The triangle must be labelled with $4g$, $8g$ and θ . The right angle must be drawn close to 90°.
		$\sin\theta = \dfrac{4g}{8g}$	**A1**	Dependent on both M marks.
		$\theta = 30°$	**A1**	CAO

Qu	Part	Answer	Mark	Guidance
4.	(i)	$\mathbf{u}=\begin{pmatrix}2\\6\end{pmatrix}$	B1	
		$\mathbf{a}=\begin{pmatrix}0\\-8\end{pmatrix}$	B1	
			[2]	
	(ii)	$\mathbf{v}=\mathbf{u}+\mathbf{a}t$		
		$t=2 \Rightarrow \mathbf{v}=\begin{pmatrix}2\\6\end{pmatrix}+\begin{pmatrix}0\\-8\end{pmatrix}\times 2$	M1	Or equivalent. FT for their **u** and **a**
		$=\begin{pmatrix}2\\-10\end{pmatrix}$	A1	Continue the FT for this mark
		Speed $=\sqrt{2^2+(-10)^2}=10.2\,\mathrm{m\,s^{-1}}$ (to 3 sf)	B1	FT from their **v**
			[3]	
	(iii)	$x=ut \Rightarrow x=2t \Rightarrow t=\frac{x}{2}$	M1	This mark may also be obtained for substituting x for $2t$ in the expression for y.
		$y=6t-4t^2$	B1	
		$y=6\times\frac{x}{2}-4\times\left(\frac{x}{2}\right)^2=3x-x^2$	A1	
			[3]	

Qu	Part	Answer	Mark	Guidance
4.	(iii)	**Alternative**		
		$x = 2t$		
		Substitute for x in given answer	**M1**	
		$y = 3x - x^2 \Rightarrow y = 6t - 4t^2$	**A1**	
		This is the given expression for y	**B1**	

Qu	Part	Answer	Mark	Guidance
5.		At maximum height	M1	For considering maximum height
		$v^2 - u^2 = 2as \;\Rightarrow\; 0^2 - 8^2 = 2\times(-9.8)\times h$	M1	Use of suitable *suvat* equation(s) eg finding and using t for maximum height (0.816 s). Allow for use of calculus.
		$h = 3.265...$	A1	CAO but allow 3.26 as well as 3.27
		($3.265... < 4$) so the stone misses the pigeon	A1	Dependent on previous mark
		Alternative		
		Substitute $y = 4$ in $y = 8t - 4.9t^2$	M1	
		Attempt to solve $4.9t^2 - 8t + 4 = 0$	M1	
		Discriminant (= $64 - 4 \times 4.9 \times 4 = -14.4$) < 0	A1	
		No value of t so the stone does not reach height 4 m	A1	
		Time to house is $\frac{22.5}{15} = 1.5$ s	B1	
		Height at house $= 8\times1.5 - \frac{1}{2}\times9.8\times1.5^2 = 0.975$ m	B1	Allow answers from essentially correct working that round to 0.96, 0.97 or 0.98, eg 0.96375 from $g = 9.81$
		$0.8 < 0.975 < 2.0$ so it hits the window.	B1	A 2-sided inequality must be given, either in figures or in words. Condone $0.8 < 0.975 < 1.2$ Dependent on previous mark
			[7]	

SECTION B

Qu	Part	Answer	Mark	Guidance
6.	(i)	$d = 5 \times 8^2 = 320$, so 320 m	**B1**	
		This value is too great. It is not between 150 and 200 m.	**B1**	Accept "inconsistent". Dependent on previous mark.
		$s = ut + \frac{1}{2}at^2$ with $s = d$, $(u = 0)$, $a = 10$ and $t = T$	**M1**	
		Giving $d = \frac{1}{2} \times 10 \times T^2 = 5T^2$	**A1**	
			[4]	
	(ii)	Depth = Area under the graph	**M1**	oe
		$= \frac{1}{2} \times 5 \times 50 + 3 \times 50$	**A1**	
		= 275 m	**A1**	
		Outside the 150 to 200 m interval so inconsistent	**B1**	A numerical comparison is required for this mark but may refer to values for it stated in part (i). Dependent on previous mark.
				Special Case Allow up to M1 A0 A1 B1 for a response in which the time at which v becomes constant is near but not equal to 5 (eg 4 or 4.5).
			[4]	
	(iii)	The same: initial constant acceleration (of 10 m s^{-2})	**B1**	Do not allow statements about the initial speed or the time taken
		Different: two part motion with constant speed at end	**B1**	
			[2]	

Qu	Part	Answer	Mark	Guidance
6.	(iv)	For $0 \le t \le 5$, the distance travelled is $\int_0^5 (10t - t^2)\mathrm{d}t$	**M1**	Or equivalent using indefinite integration
		$= \left[5t^2 - \frac{t^3}{3}\right]_0^5$	**A1**	Limits not required for this mark
		$5 \times 5^2 - \frac{5^3}{3} \ (= 83\frac{1}{3})$	**A1**	A $\Rightarrow$ M
		For $5 < t \le 8$, the distance travelled is 25 × 3 (= 75)	**B1**	Seen or implied
		$d = 83\frac{1}{3} + 75 = 158\frac{1}{3}$	**A1**	CAO
		This is within the given interval.	**B1**	Dependent on previous mark
			[6]	
	(v)	Similar: constant speed for $5 < t \le 8$	**B1**	
		Different: acceleration is not constant for $0 \le t \le 5$.	**B1**	
			[2]	

Qu	Part	Answer	Mark	Guidance
7.	(i)	$\cos\alpha = 0.8,\ \cos\beta = 0.6$	B1	Or equivalent statements
			[1]	
	(ii)	Horizontal forces $\rightarrow$ $8000\cos\beta$ - $6000\cos\alpha$	M1	Do not allow sin-cos interchange
		4800 - 4800 = 0 So the horizontal component of acceleration is 0	A1	Must state acceleration is zero
		Vertical forces $\uparrow$ $T\sin\alpha$ + 8000 sin β – 7500	M1	Do not allow if the weight is missing Allow $T\cos\beta$ + 8000 cos α – 7500
		sin α (= cos β) =0.6 and sin β (= cos α) = 0.8	B1	o.e. CAO May be seen or implied in the working
		6400 + 3600 -7500 = 2500	A1	CAO
		Mass of bomb $\frac{7500}{9.8}$ (= 765.3) kg	M1	
		$a = \frac{2500}{765.3} = 3.27$ The acceleration is 3.27 $\mathrm{m\,s^{-1}}$ upwards	A1	CAO Allow 3.26
			[7]	

Qu	Part	Answer	Mark	Guidance
7.	(iii)	No horizontal acceleration $\Rightarrow$ Resultant = 0		
		Horizontal forces $\rightarrow$ $8000\cos\beta - T\cos\alpha = 0$	**M1**	Horizontal must be indicated
		$T = \dfrac{8000\cos\beta}{\cos\alpha}$	**A1**	
		$\cos\alpha = \dfrac{16}{\sqrt{d^2+16^2}}, \quad \cos\beta = \dfrac{9}{\sqrt{d^2+9^2}}$	**M1**	
		$T = 8000 \times \dfrac{\dfrac{9}{\sqrt{d^2+81}}}{\dfrac{16}{\sqrt{d^2+256}}} = \dfrac{4500\sqrt{d^2+256}}{\sqrt{d^2+81}}$	**A1**	
			[4]	

Qu	Part	Answer	Mark	Guidance
	(iv)	When $d = 6.75$, $T = 4500 \times \dfrac{\sqrt{6.75^2 + 256}}{\sqrt{6.75^2 + 81}}$ $(= 6946.2\ ...)$	B1	May be implied by subsequent working Note In this situation $\alpha = 22.9^{\circ}$, $\beta = 36.9^{\circ}$
		Vertical forces ↑ $6946.2\sin\alpha + 8000\sin\beta - 7500$	M1	Their α and β. No sin-cos interchange . Note The forces are 2700 N and 4800N
		= 0	A1	Condone any resultant force that rounds to 0 to the nearest integer.
		So the (vertical) acceleration is zero.	A1	CAO
			[4]	
		Alternative		
		Vertical forces ↑ $T\sin\alpha + 8000\sin\beta - 7500$		
		$4500 \times \dfrac{\sqrt{6.75^2 + 256}}{\sqrt{6.75^2 + 81}} \times \dfrac{6.75}{\sqrt{6.75^2 + 256}} + 8000 \times \dfrac{6.75}{\sqrt{6.75^2 + 81}} - 7500$	M1 B1	
		$12500 \times \dfrac{6.75}{11.25} - 7500 = 0$	A1	
		So the (vertical) acceleration is zero.	A1	CAO
7.	(v)	When at P there would be no vertical components of the tensions to counteract the weight.	B1	
		The acceleration would be g vertically downwards .	B1	The acceleration must be stated to be g
			[2]	

4761 Mechanics 1

General Comments:

This paper was well answered. Almost all candidates found questions that allowed them to demonstrate their knowledge and the techniques with which they were confident. There were very few really low marks.

There was a noticeable improvement over previous years in certain particular areas: 2-stage motion; connected particles; extracting the cartesian equation of the path of a particle from its position vector at a general time.

Comments on Individual Questions:

Q1(i) In this question candidates were asked to draw a force diagram and many did this successfully. The most common mistake was to reverse the direction the thrust applied to the block, making it into a tension instead; a few candidates omitted the normal reaction. Some candidates replaced the thrust by its vertical and horizontal components and that was entirely acceptable provided that they were not presented as extra forces in addition to the actual thrust.

Q1(ii) In part (ii) candidates were expected to apply Newton's 2nd law to the block and to deduce the frictional force acting on it. Most candidates got this right but there were a few sign errors.
Answer 12.5 N

Q2(i) This question was about the movement of a particle along a straight line with constant acceleration. In part (i) candidates were asked to use the given information to find two equations for the initial velocity and the acceleration and to solve them. Most candidates got this right. Only a few failed to find the equations and there were also some careless mistakes when it came to solving them.
Answer $u = 8$, $a = -2$

Q2(ii) The question then went on to ask for a distance AB where B was the point where the particle was instantaneously at rest. Most candidates successfully found the distance OB but a common mistake was to fail to subtract OA to find the distance requested.
Answer 4 m

Q3(i) Question 3 involved two connected particles in two different situations. In part (i) candidates were asked to write down the equation of motion of each particle. Most did this correctly but a common mistake was to introduce the weight of the block that was on a smooth horizontal table as an extra force.

Q3(ii) The question then went on to ask candidates to solve the equations to find the acceleration of the system. Those who got the right equations in the previous part were almost entirely successful. By contrast those who made a mistake on one or both equations in part (i) were almost entirely unsuccessful. No follow through was allowed from wrong equations in part (i).
Answer $3.27\ \mathrm{m\,s^{-2}}$

Q3(iii) In part (iii) the table was titled and the system was in equilibrium. Candidates were asked to find the angle of the table. There were many correct answers. The most common mistake was to try to work with the weight of the block on the table rather than its resolved component down the slope. A few candidates lost a mark by missing g out altogether.
Answer 30^{o}

Q4(i) In this question the position of a particle at time t was given as a column vector. In part (i) candidates were asked to write down **u** and **a** as column vectors. Most were successful in this but a common mistake was to give **v** instead of **u**.

Answer $\begin{pmatrix} 2 \\ 6 \end{pmatrix}$, $\begin{pmatrix} 0 \\ -8 \end{pmatrix}$

Q4(ii) In the next part candidates were asked to find the speed at a certain time and this was well answered with many recovering from errors in part (i). Follow through was allowed for the values of **u** and **a** that they found in part (i). Common mistakes were sign errors and not distinguishing between speed and velocity.

Answer $\begin{pmatrix} 2 \\ -10 \end{pmatrix}$, 10.2 m s^{-2}

Q4(iii) In the final part candidates were asked to show that the position vector at time t led to a given cartesian equation for the path of the particle. This was answered confidently and almost entirely successfully.

Q5 This question was on projectiles. It involved Mr McGreggor throwing a stone at a pigeon, missing it and hitting the window of his house instead. It was extremely well answered.

Although presented as a single question for 7 marks, it actually broke down into two parts: showing that the stone did not go high enough to hit the pigeon and then showing that it did hit the window. Most candidates found the maximum height of the stone and showed that it was less than the height of the pigeon. However, a considerable number substituted the height of the pigeon in the quadratic equation for the height of the stone at time t and then showed that this equation had no real roots; this showed considerable mathematical understanding. Full marks were available for either method and for any correct variant on them, for example working with the equation of the stone's trajectory.

Most candidates found the correct height of the stone when it reached the house but many lost a mark by failing to give a convincing argument that this height was within the interval for the window.

Answers Max height of stone = 3.27 m, Height at the house = 0.975 m

Q6 Question 6 was about modelling. It involved building up a model in three stages of increasing sophistication. At each stage candidates were asked to comment on which aspects of the model had changed and which had remained the same. The context was estimating the depth of a mine shaft from the time it took a stone to reach the bottom. Throughout the model was checked against local records. This question was very well answered.

Q6(i) The question started with applying a simple model given by a formula and comparing the depth it gave to local records. It then went on to ask for an explanation of the model. Almost all candidates answered this fully correctly.
Answer 320 m

Q6(ii) The question then moved on to the second model which was given by a velocity time graph. Nearly all candidates obtained the correct distance but many lost a mark by not making a numerical comparison of their result with the local records.
Answer 275 m

Q6(iii) In this part candidates were asked to identify one respect in which the two models (so far) were the same and one in which they were different. Many candidates gave good answers. In both models the stone has acceleration of g for the first 5 second but then in model B it has constant velocity while in A it continues to accelerate. No marks were given for answers that referred to the conditions given in the question, such as that it takes 8 seconds, nor for answers that compared the mathematical presentation, for example algebra against a graph.

Q6(iv) The question then moved on to Model C where there was variable acceleration and so calculus had to be used. This was very well answered. Only a handful of candidates tried to use constant acceleration formulae. Most carried out the integration and did the appropriate substitution to find the distance covered in the first 5 seconds successfully, and then went on to add on the distance covered at constant velocity. All but few candidates handled the two stage motion correctly.

The final mark required the distance found to be related to the local records and in this case it was necessary to identify the interval within which it lay. Many candidates did not do so and so scored 5 out of 6.

Answer $158\frac{1}{3}$ m

Q6(v) This part was similar to part (iii) asking about how the model had developed. Those who had done well in part (iii) tended to do well here too. Both models involved terminal velocity but its value was different. In the new model the acceleration was variable for the first 5 seconds whereas it had been constant in the previous model.

Q7 This was the second of the long questions on the paper, worth 18 marks. It was set in the context of raising an unexploded bomb from a hole on a building site. This question was quite challenging and many candidates were unsuccessful on the later parts.

Q7(i) The question started with a straightforward piece of trigonometry for 1 mark, and almost all candidates were successful.
Answers 0.8 and 0.6.

Q7(ii) The question then went on to consider the horizontal and vertical components of acceleration in a particular situation. The first demand was to show that the horizontal component is zero. Most candidates got this right but some lost a mark by failing to take the step of going from zero resultant force to zero acceleration; this was a given result and so a high standard of argument was expected. The question then went on to find the vertical component of acceleration and this elicited many good answers. A few candidates failed to convert the weight of the bomb to its mass, and some missed it out completely.
There were fewer sin-cos interchanges than might have been the case a few years ago.
Answer 3.27 m s^{-2}.

Q7(iii) The question then went on to consider a general situation during the lift. The first request was derive a given result for *T*. Many candidates lost marks here by not relating it to the horizontal direction. Some candidates may not have been aware that because this was a given result a high standard of argument was expected.

Candidates were then asked to show that the given result for *T* could be written in a different form. While there were plenty of correct answers, there were also many that appeared to conjure the given result out of incorrect working.

Q7(iv) In this part of the question, the bomb was at the height at which its vertical acceleration was zero and candidates were expected to use the result given at the end of part (iii) to discover this. Only the stronger candidates were successful. Many of those who attempted to find the equation of motion used the wrong angles or the wrong tensions, or forgot about the weight completely.
Answer Acceleration = 0 m s^{-2}

Q7(v) In part (ii) the bomb was in a position where it was accelerating upwards. In part (iv) it was in a position where equilibrium was possible but there could be no upwards acceleration. The final part of the question considered the hypothetical situation where the bomb was at the top and so was at the same level as the winches. Candidates were asked to explain why equilibrium was impossible in this situation and to state the acceleration. While there were some excellent explanations many were garbled or wrong. Many candidates said there would be zero acceleration. Answer $g\,\mathrm{m\,s^{-2}}$ vertically downwards.