OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4761

Mechanics 1

Candidates answer on the Answer Booklet

OCR Supplied Materials:

- 8 page Answer Booklet
- Graph paper
- MEI Examination Formulae and Tables (MF2)

Other Materials Required:
None

Thursday 11 June 2009
Morning

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that 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 graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g\,\text{m}\,\text{s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- 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**.
- This document consists of **8** pages. Any blank pages are indicated.

Section A (36 marks)

1 The velocity-time graph shown in Fig. 1 represents the straight line motion of a toy car. All the lines on the graph are straight.

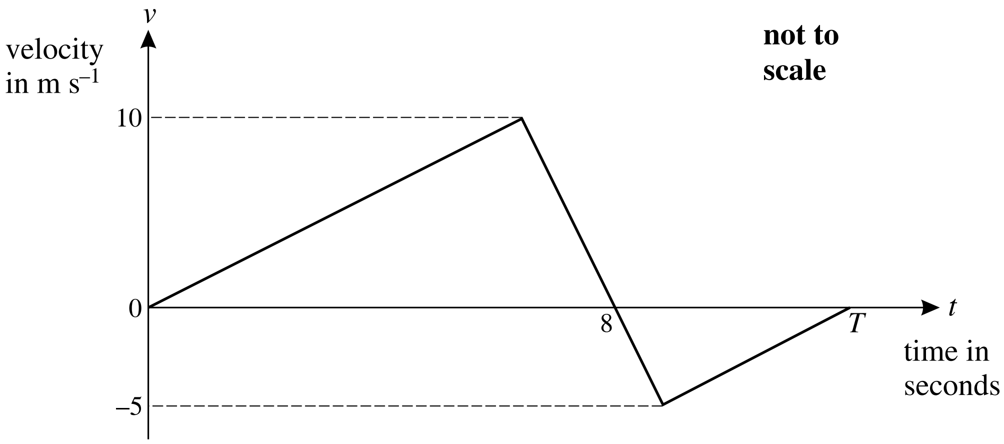

Fig. 1

The car starts at the point A at $t = 0$ and in the next 8 seconds moves to a point B.

(i) Find the distance from A to B. **[2]**

T seconds after leaving A, the car is at a point C which is a distance of 10 m from B.

(ii) Find the value of T. **[3]**

(iii) Find the displacement from A to C. **[1]**

2 A small box has weight $\mathbf{W}$ N and is held in equilibrium by two strings with tensions $\mathbf{T}_1$ N and $\mathbf{T}_2$ N. This situation is shown in Fig. 2 which also shows the standard unit vectors $\mathbf{i}$ and $\mathbf{j}$ that are horizontal and vertically upwards, respectively.

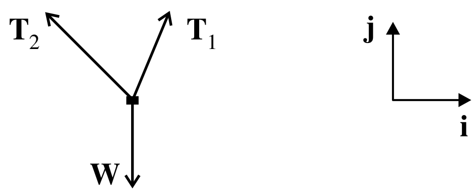

Fig. 2

The tension $\mathbf{T}_1$ is $10\mathbf{i} + 24\mathbf{j}$.

(i) Calculate the magnitude of $\mathbf{T}_1$ and the angle between $\mathbf{T}_1$ and the vertical. **[3]**

The magnitude of the weight is w N.

(ii) Write down the vector $\mathbf{W}$ in terms of w and $\mathbf{j}$. **[1]**

The tension $\mathbf{T}_2$ is $k\mathbf{i} + 10\mathbf{j}$, where k is a scalar.

(iii) Find the values of k and of w. **[3]**

3 Fig. 3 is a sketch of the velocity-time graph modelling the velocity of a sprinter at the start of a race.

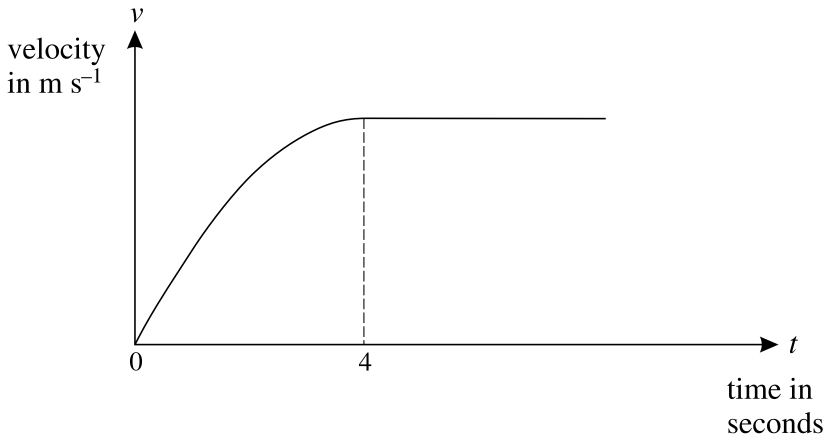

Fig. 3

(i) How can you tell from the sketch that the acceleration is not modelled as being constant for $0 \leqslant t \leqslant 4$? **[1]**

The velocity of the sprinter, $v\,\mathrm{m\,s^{-1}}$, for the time interval $0 \leqslant t \leqslant 4$ is modelled by the expression

$$v = 3t - \tfrac{3}{8}t^2.$$

(ii) Find the acceleration that the model predicts for $t = 4$ and comment on what this suggests about the running of the sprinter. **[3]**

(iii) Calculate the distance run by the sprinter from $t = 1$ to $t = 4$. **[4]**

4 Fig. 4 shows a particle projected over horizontal ground from a point O at ground level. The particle initially has a speed of $32\,\mathrm{m\,s^{-1}}$ at an angle α to the horizontal. The particle is a horizontal distance of 44.8 m from O after 5 seconds. Air resistance should be neglected.

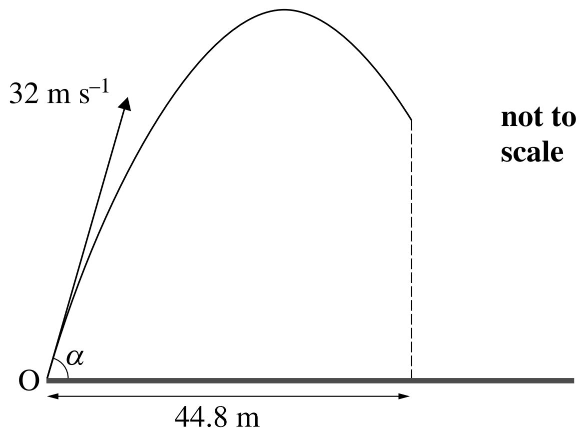

Fig. 4

(i) Write down an expression, in terms of α and t, for the horizontal distance of the particle from O at time t seconds after it is projected. **[1]**

(ii) Show that $\cos\alpha = 0.28$. **[2]**

(iii) Calculate the greatest height reached by the particle. **[4]**

5 The position vector of a toy boat of mass 1.5 kg is modelled as $\mathbf{r} = (2 + t)\mathbf{i} + (3t - t^2)\mathbf{j}$ where lengths are in metres, t is the time in seconds, $\mathbf{i}$ and $\mathbf{j}$ are horizontal, perpendicular unit vectors and the origin is O.

(i) Find the velocity of the boat when $t = 4$. **[3]**

(ii) Find the acceleration of the boat and the horizontal force acting on the boat. **[3]**

(iii) Find the cartesian equation of the path of the boat referred to x- and y-axes in the directions of $\mathbf{i}$ and $\mathbf{j}$, respectively, with origin O. You are not required to simplify your answer. **[2]**

Section B (36 marks)

6 An empty open box of mass 4 kg is on a plane that is inclined at 25° to the horizontal.

In one model the plane is taken to be smooth.

The box is held in equilibrium by a string with tension T N parallel to the plane, as shown in Fig. 6.1.

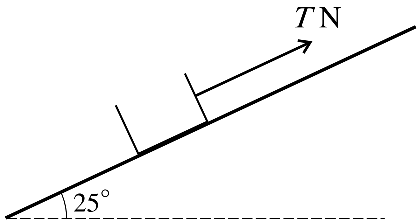

Fig. 6.1

(i) Calculate T. **[2]**

A rock of mass m kg is now put in the box. The system is in equilibrium when the tension in the string, still parallel to the plane, is 50 N.

(ii) Find m. **[3]**

In a refined model the plane is rough.

The empty box, of mass 4 kg, is in equilibrium when a frictional force of 20 N acts down the plane and the string has a tension of P N inclined at 15° to the plane, as shown in Fig. 6.2.

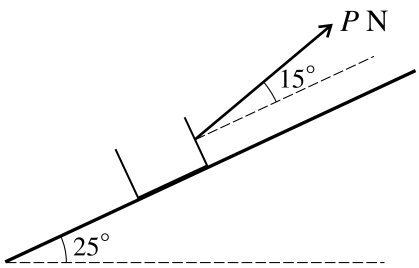

Fig. 6.2

(iii) Draw a diagram showing all the forces acting on the box. **[2]**

(iv) Calculate P. **[5]**

(v) Calculate the normal reaction of the plane on the box. **[4]**

  Turn over

7 A box of mass 8 kg slides on a horizontal table against a constant resistance of 11.2 N.

(i) What horizontal force is applied to the box if it is sliding with acceleration of magnitude $2\,\mathrm{m\,s^{-2}}$? **[3]**

Fig. 7 shows the box of mass 8 kg on a long, rough, horizontal table. A sphere of mass 6 kg is attached to the box by means of a light inextensible string that passes over a smooth pulley. The section of the string between the pulley and the box is parallel to the table. The constant frictional force of 11.2 N opposes the motion of the box. A force of 105 N parallel to the table acts on the box in the direction shown, and the acceleration of the system is in that direction.

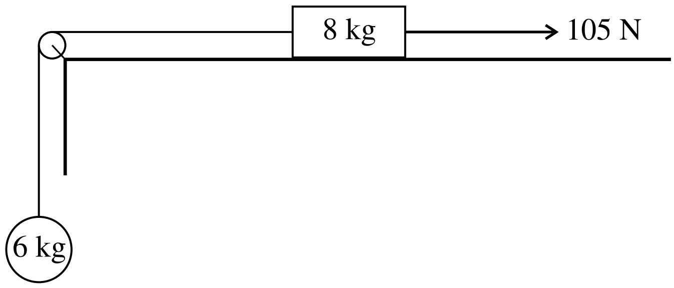

Fig. 7

(ii) What information in the question indicates that while the string is taut the box and sphere have the same acceleration? **[1]**

(iii) Draw two separate diagrams, one showing all the horizontal forces acting on the box and the other showing all the forces acting on the sphere. **[2]**

(iv) Show that the magnitude of the acceleration of the system is $2.5\,\mathrm{m\,s^{-2}}$ and find the tension in the string. **[7]**

The system is stationary when the sphere is at point P. When the sphere is 1.8 m above P the string breaks, leaving the sphere moving upwards at a speed of $3\,\mathrm{m\,s^{-1}}$.

(v) (*A*) Write down the value of the acceleration of the sphere after the string breaks. **[1]**

(*B*) The sphere passes through P again at time T seconds after the string breaks. Show that T is the positive root of the equation $4.9T^2 - 3T - 1.8 = 0$. **[2]**

(*C*) Using part (*B*), or otherwise, calculate the total time that elapses after the sphere moves from P before the sphere again passes through P. **[4]**

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Q 1		mark	comment	sub
(i)	$0.5 \times 8 \times 10 = 40$ m	M1	Attempt to find whole area or … If *suvat* used in 2 parts, accept any *t* value $0 \le t \le 8$ for max.	2
		A1	cao	
(ii)	$0.5 \times 5(T-8) = 10$	M1	$0.5 \times 5 \times k = 10$ seen. Accept ±5 and ±10 only. If *suvat* used need whole area; if in 2 parts, accept any *t* value $8 \le t \le T$ for min.	
		B1	Attempt to use $k = T - 8$.	
	$T = 12$	A1	cao. [Award 3 if $T = 12$ seen]	3
(iii)	40 – 10 = 30 m	B1	FT **their** 40.	1
		6		

Q 2		mark	comment	sub
(i)	$\sqrt{10^2 + 24^2} = 26$ so 26 N	B1		
	arctan ($^{10}/_{24}$)	M1	Using arctan or equiv. Accept arctan ($^{24}/_{10}$) or equiv.	
	= 22.619… so 22.6° (3 s. f.)	A1	Accept 157.4°.	3
(ii)	**W** = $-w$ **j**	B1	Accept $\begin{pmatrix} 0 \\ -w \end{pmatrix}$ and $\begin{pmatrix} 0 \\ -w\mathrm{j} \end{pmatrix}$	1
(iii)	$\mathbf{T}_1 + \mathbf{T}_2 + \mathbf{W} = \mathbf{0}$	M1	Accept in any form and recovery from **W** = *w* **j**. Award if not explicit and part (ii) and **both** *k* and *w* correct.	
	$k = -10$	B1	Accept from wrong working.	
	$w = 34$	B1	Accept from wrong working but not – 34. [Accept – 10 **i** *or* 34 **j** but not both]	3
		7		

Q 3		mark	comment	sub
(i)	The line is not straight	B1	Any valid comment	1
(ii)	$a = 3 - 6t/8$	M1	Attempt to differentiate. Accept 1 term correct but not $3 - \frac{3t}{8}$.	
	$a(4) = 0$	F1		
	The sprinter has reached a steady speed	E1	Accept 'stopped accelerating' but not just a = 0. Do not FT $a(4) \neq 0$.	3
(iii)	We require $\int_1^4 \left(3t - \frac{3t^2}{8}\right) dt$	M1	Integrating. Neglect limits.	
	$= \left[\frac{3t^2}{2} - \frac{t^3}{8}\right]_1^4$	A1	One term correct. Neglect limits.	
	$= (24 - 8) - \left(\frac{3}{2} - \frac{1}{8}\right)$	M1	Correct limits subst in integral. Subtraction seen. If arb constant used, evaluated to give s = 0 when t = 1 and then sub t = 4.	
	= $14\frac{5}{8}$ m (14.625 m)	A1	cao. Any form. [If trapezium rule used M1 use of rule (must be clear method and at least two regions) A1 correctly applied M1 At least 6 regions used A1 Answer correct to at least 2 s.f.)]	4
		8		

Q 4		**mark**	**comment**	**sub**
(i)	$32\cos\alpha t$	B1		1
(ii)	$32\cos\alpha \times 5 = 44.8$	M1	FT **their** *x*.	
	so $160\cos\alpha = 44.8$ and $\cos\alpha = 0.28$	E1	Shown. Must see some working e.g $\cos\alpha = 44.8/160$ or $160\cos\alpha = 44.8$. If 32 × 0.28 × 5 = 44.8 seen then this needs a statement that 'hence $\cos\alpha = 0.28$'.	2
(iii)	$\sin\alpha = 0.96$	B1	Need not be explicit e.g. accept sin(73.73…) seen.	
	either			
	$0 = (32\times 0.96)^2 - 2\times 9.8\times s$	M1	Allow use of '*u*' = 32, *g* = ± (10, 9.8, 9.81).	
		A1	Correct substitution.	
	s = 48.1488… so 48.1 m (3 s. f.)	A1	cao	
	or			
	Time to max height is given by 32 × 0.96 -9.8 *T* = 0 so *T* = 3.1349….	B1	Could use ½ total time of flight to the horizontal.	
	$y = 32 \times 0.96\, t - 4.9\, t^2$	M1	Allow use of '*u*' = 32, *g* = ± (10, 9.8, 9.81) May use $s = \frac{(u+v)}{2}t$.	
	putting *t* = *T*, *y* = 48.1488 so 48.1 m (3 s. f.)	A1	cao	4
		7		

Q 5		mark	comment	sub
(i)	$\mathbf{v} = \mathbf{i} + (3-2t)\mathbf{j}$	M1	Differentiating **r.** Allow 1 error. Could use const accn.	
		A1		
	v(4) = **i** – 5**j**	F1	Do not award if $\sqrt{26}$ is given as vel (accept if **v** given and *v* given as well called speed or magnitude).	
				3
(ii)	**a** = – 2**j**	B1	Diff **v.** FT **their v.** Award if – 2**j** seen & isw.	
	Using N2L **F** = $1.5 \times$ (– 2**j)**	M1	Award for $1.5 \times (\pm$ **their a** or $a)$ seen.	
	so – 3**j** N	A1	cao Do not award if final answer is not correct. [Award M1 A1 for – 3**j** WW]	
				3
(iii)	$x = 2 + t$ and $y = 3t - t^2$	B1	Must have both but may be implied.	
	Substitute $t = x - 2$			
	so $y = 3(x-2) - (x-2)^2$	B1	cao. isw. Must see the form *y* = ….	
	$[= (x-2)(5-x)]$			
				2
		8		

Q 6		mark	comment	sub
(i)	Up the plane $T - 4g\sin 25 = 0$	M1	Resolving parallel to the plane. If any other direction used, all forces must be present. Accept $s \leftrightarrow c$. Allow use of *m*. No extra forces.	
	T = 16.5666… so 16.6 N (3 s. f.)	A1		
				2
(ii)	Down the plane, $(4+m)g\sin 25 - 50 = 0$	M1	No extra forces. Must attempt resolution in at least 1 term. Accept $s \leftrightarrow c$. Accept *Mg*sin25. Accept use of mass.	
		A1	Accept *Mg*sin25	
	m = 8.0724… so 8.07 (3 s. f.)	A1		
				3
(iii)	Diagram	B1	Any 3 of weight, friction normal reaction and *P* present	

			in approx correct directions with arrows.	
		B1	All forces present with suitable directions, labels and arrows. Accept W, mg, $4g$ and 39.2.	
				2
(iv)	Resolving up the plane	M1	Resolving parallel to the plane or All forces must be present . Accept $s \leftrightarrow c$. Allow use of m. At least one resolution attempted and accept wrong angles. Allow sign errors.	
		B1	$P\cos 15$ term correct. Allow sign error.	
	$P\cos 15 - 20 - 4g\sin 25 = 0$	B1	Both resolutions correct. Weight used. Allow sign errors. FT use of $P\sin 15$.	
		A1	All correct but FT use of $P\sin 15$.	
	P = 37.8565…. so 37.9 N (3 s. f.)	A1		
				5
(v)	Resolving perpendicular to the plane	M1	May use other directions. All forces present. No extras. Allow $s \leftrightarrow c$. Weight not mass used. Both resolutions attempted. Allow sign errors.	
	$R + P\sin 15 - 4g\cos 25 = 0$	B1	Both resolutions correct. Allow sign errors. Allow use of $P\cos 15$ if $P\sin 15$ used in (iv).	
		F1	All correct. Only FT **their** P and their use of $P\cos 15$.	
	R = 25.729… so 25.7 N	A1	cao	
				4
		16		

If there is a consistent $s \leftrightarrow c$ error in the weight term throughout the question, penalise only two marks for this error. In the absence of other errors this gives
(i) 35.52… (ii) 1.6294… (iv) 57.486… (v) 1.688…

For use of mass instead of weight lose maximum of 2.

Q 7		mark	comment	sub
	With the 11.2 N resistance acting to the left			
(i)				
	N2L $F - 11.2 = 8 \times 2$	M1	Use of N2L (allow *F* = *mga*). Allow 11.2 omitted; no extra forces.	
		A1	All correct	
	F = 27.2 so 27.2 N	A1	cao	
				3
(ii)	The string is inextensible	E1	Allow 'light inextensible' but not other irrelevant reasons given as well (e.g. smooth pulley).	
				1
(iii)		B1	One diagram with all forces present; no extras; correct arrows and labels accept use of words.	
		B1	Both diagrams correct with a common label.	
				2
(iv)	**method (1)**	M1	For either box or sphere, *F* = *ma*. Allow omitted force and sign errors but not extra forces. Need correct mass. Allow use of mass not weight.	
	box N2L $\rightarrow 105 - T - 11.2 = 8a$	A1	Correct and in any form.	
	sphere N2L ↑ $T - 58.8 = 6a$	A1	Correct and in any form.	
			[box and sphere equns with consistent signs]	
	Adding 35 = 14*a*	M1	Eliminating 1 variable from 2 equns in 2 variables.	
	a = 2.5 so 2.5 m s^{-2}	E1		
	Substitute *a* = 2.5 giving *T* = 58.8 + 15	M1	Attempt to substitute in either box or sphere equn.	
	T = 73.8 so 73.8 N	A1		
	method (2)			
	105 – 11.2 – 58.8 = 14*a*	M1	For box and sphere, *F* = *ma*. Must be correct mass. Allow use of mass not weight.	
	a = 2.5	A1		
		E1	Method made clear.	
		M1	For **either** box **or** sphere, *F* = *ma*. Allow omitted force and sign errors but not extra forces. Need correct mass. Allow use of mass not weight.	
	either: box N2L $\rightarrow 105 - T - 11.2 = 8a$			
	or: sphere N2L ↑	A1	Correct and in any form.	

	$T - 58.8 = 6a$			
	Substitute *a* = 2.5 in either equn	M1	Attempt to substitute in either box or sphere equn.	
	T = 73.8 so 73.8 N	A1	[If AG used in either equn award M1 A1 for that equn as above and M1 A1 for finding *T*. For full marks, both values must be shown to satisfy the second equation.]	7
(v) **(A)**	*g* downwards	B1	Accept $\pm g,\ \pm 9.8,\ \pm 10,\ \pm 9.81$	1
(B)	Taking ↑ + ve, $s = -1.8$, *u* = 3 and $a = -9.8$	M1	Some attempt to use $s = ut + 0.5at^2$ with $a = \pm 9.8$ etc $s = \pm 1.8$ and $u = \pm 3$. Award for *a* = *g* even if answer to (A) wrong.	
	so $-1.8 = 3T - 4.9T^2$			
	and so $4.9T^2 - 3T - 1.8 = 0$	E1	Clearly shown. No need to show +ve required.	2
(C)	See over			
(C)	Time to reach 3 m s^{-1} is given by $3 = 0 + 2.5t$ so *t* = 1.2	B1		
	remaining time is root of quad	M1	Quadratic solved and + ve root added to time to break.	
	time is 0.98513… s	B1	Allow 0.98. [Award for answer seen WW]	
	Total 2.1851…so 2.19 s (3 s. f.)	A1	cao	
	With the 11.2 N resistance acting to the right			
(i)	*F* + 11.2 = 8 × 2 so *F* = 4.8		The same scheme as above	
(iii)			The 11.2 N force may be in either direction, otherwise the same scheme	
(iv)	The same scheme with + 11.2 N instead of – 11.2 N acting on the box method (1) box N2L $\rightarrow 105 - T + 11.2 = 8a$ sphere as before			

	method (2) 105 + 11.2 – 58.8 = 14*a* These give *a* = 4.1 and *T* = 83.4		Allow 2.5 substituted in box equation to give *T* = 96.2 If the sign convention gives as positive the direction of the sphere descending, *a* = – 4.1. Allow substituting *a* = 2.5 in the equations to give *T* = 43.8 (sphere) or 136.2 (box).
(v)			In (C) allow use of a = 4.1 to give time to break as 0.73117..s. and total time as 1.716…s 4
	20		

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General Comments

Most of the candidates were able to make some progress with every question and many gave at least good answers to most of the questions. It was very pleasing to see many perfect solutions to Q3 which required calculus and Q4 on projectile motion. The two questions requiring the use of vector notation were not answered well by many candidates, partly because of errors caused by poor notation and partly because of poor understanding.

The presentation of the scripts was generally reasonably good but some candidates made mistakes because they were unable to follow their own working

Although many candidates showed a good understanding of all of the topics examined, others seemed to have no knowledge of some of them; for instance, quite few candidates did not know how to resolve or deal with a problem involving equilibrium on a slope.

Comments on Individual Questions

Section A

1) **Use of a velocity-time graph**

Most of the candidates who attempted to solve the problem using the areas under the graph were quite successful and there were many perfect answers. Few of those who tried to apply the constant acceleration results made much progress with parts (i) or (ii).

(i) This was done well by many candidates.

(ii) There was some confusion with the signs but the most common error was to find the time taken to go from B to C instead of from A to C

(iii) Many candidates answered this part correctly after failing to make progress with parts (i) and (ii). Quite a few candidates did not recognise that the 10 m displacement from B to C was negative.

2) **Use of vectors to represent forces and static equilibrium**

There were many sign errors seen in the attempts at this question and many examples of poor notation that hindered accurate solutions.

(i) This part was generally done very well, the only common mistake being to find the angle with the horizontal instead of the vertical.

(ii) Many candidates wrote $w\mathbf{j}$ instead of $-w\mathbf{j}$. Quite a few candidates gave answers such as – j and w – j .

(iii) Many candidates used $\mathbf{T}_1 + \mathbf{T}_2 = \mathbf{W}$. There were many sign errors including $k+10=10 \Rightarrow k=10$, which was quite commonly seen.

3) **Interpretation and the application of calculus in kinematics**

It was very pleasing to see the efficient way in which many of the candidates used calculus to answer this question

(i) Most candidates made a statement to the effect that constant acceleration would have been represented by a straight line.

(ii) This was generally done very well with relatively few attempts not involving calculus. The interpretation was usually good but a fairly common error was to suggest that $a = 0$ meant that the velocity was now constant or 0, the latter being a general comment not relevant to this problem.

(iii) The integration was typically done well and it was pleasing to see so many adopting this correct method. Errors included reversing the limits or substituting $t = 3$.

4) **The greatest height reached by a projectile**

There were many very confident, neat and efficient solutions to this question.

(i) Most candidates did this correctly.

(ii) The most common error here was to not establish the given answer sufficiently clearly.

(iii) It was pleasing to see so many candidates using the efficient method of using $v^2 = u^2 + 2as$. The common error was to use $u = 32$ instead of $u\sin\alpha$. Those who went via the time to the highest point and then used the equation for the height at time t were more likely to make mistakes. Apart from the wrong value for '*u*', common mistakes were to use the half the time or even the whole time taken to travel the 44.8 m.

5) **A 2 dimensional kinematics problem in vector form and forming the cartesian equation of a path**

The answers of many candidates suffered from their poor use of vector notation and/or understanding of how to manipulate vectors and interpret their results.

(i) Those who kept the vector form usually did quite well but a substantial number worked out **r**(4) instead of **v**(4). Many candidates rapidly lost any trace of a vector and some of those that retained the vector form gave the speed instead of the velocity.

(ii) This part was done quite well by those who retained a vector form except that many ignored the definition of the direction of the **j** direction, assumed it was horizontal and so said there was zero horizontal force.

(iii) This was done very well by some candidates; others could only write x and y in terms of t or did not know what was required. Many showed no attempt.

6) **The static equilibrium of a box on an inclined plane**

Quite a few candidates recognised the standard situations being investigated and wrote down perfect solutions. Almost all of the candidates who knew how to resolve made some progress through the question but quite few did not seem to know this technique. Candidates who resolved horizontally or vertically instead of parallel and perpendicular to the plane rarely included all the forces correctly resolved. As in recent series, many candidates occasionally or consistently used sine instead of cosine and vice versa and quite a few occasionally or consistently used mass when they needed weight; these errors were found in all of the parts and have not been repeated in the notes below.

(i) This was done quite well by many candidates. A quite common error was to resolve the T instead of the weight.

(ii) This part presented problems to quite a few candidates who did not see how similar it was to part (i). Candidates who did not write out their expressions properly often found themselves working with $4g$ and m instead of $4g$ and mg. Quite a few candidates found the new mass instead of the extra mass.

(iii) The most common mistakes were to miss out the normal reaction and/or forget an arrow or a label. A good answer here helped with the latter parts of the question (as intended).

(iv) This part was not done well by many candidates who had coped well with parts (i) and (ii). Many candidates failed to carry out systematic resolution parallel to the plane. Most commonly, forces were omitted or not resolved.

(v) This part was not done well even by some candidates who had made a good or even correct attempt at part (iv). The errors were again most commonly the omission of forces or failure to resolve them. Many candidates seem to believe that the normal reaction is the resolved part of the weight perpendicular to the plane.

7) **The dynamics of a system of connected particles**

It is very much regretted that this question was poorly worded and there was an ambiguity about the direction of the frictional force in parts (i), (iii) and (iv). The question does not say that the system starts from rest and so the velocity need not be in the direction of the acceleration. This ambiguity did not cause problems in part (i) but in part (iv) it meant that a candidate could reason properly and fail to establish the given answer. Fortunately, in part (iv) almost all of the candidates did take the velocity and hence the friction to be in the directions intended. The very few candidates who obtained a different acceleration to the given answer mostly seemed to go straight on to use the given value in the rest of the part and their attempts were credited bearing in mind that they had made no mistake. Any scripts where it was thought that there could be evidence of a candidate being disadvantaged were reviewed by the Principal Examiner.

(i) This was done well by most candidates. The most common error was to omit the frictional force.

(ii) Many candidates wrote done several or even all of the modelling assumptions stated in the question and were not given the mark. The only exception made was to allow the quotation that it was a 'light inextensible string' rather than just 'an inextensible string'.

(iii) The diagrams were not always clearly labelled and many candidates falsely gave the tensions as 6*g* and/or 93.8.

(iv) The 'round the corner' method for finding the acceleration was accepted but the final mark for establishing the given answer was awarded only if it was made clear how Newton's second law was being applied to the situation. Candidates who established separate equations of motion for the sphere and the box and solved them simultaneously were generally more successful overall in this part; the common mistakes made in this method were not to have the same sign convention in the two equations or to omit a force acting on the box. Many candidates who used the 'round the corner' method failed to find the tension in the string as they did not produce an equation of motion for either the box or the sphere; many using this method took the tension to be the force in the string that would hold the sphere in equilibrium. Quite a few candidates did not match their forces to the appropriate mass.

(v)

(A) Many candidates stated that the acceleration was still 2.5 m s^{-2}, even though they used *g* in part (v)(B).

(B) This was done quite well but many candidates did not derive the given expression properly; expressions with wrong signs in the penultimate line 'became correct' in the final statement. Quite few candidates solved the quadratic equation instead of deriving it.

(C) Many candidates did not realize that they had to add the time to the string breaking with an acceleration of 2.5 m s^{-2} upwards to the positive root of the equation in (v)(B). A common error was to add the two quadratic roots, either signed or in modulus. However, many strong candidates answered this part efficiently and accurately.