Paper Reference(s)

6677/01

Edexcel GCE

Mechanics M1

Gold Level G2

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Mathematical Formulae (Green)	Nil

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

Write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M1), the paper reference (6677), your surname, initials and signature.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
There are 7 questions in this question paper. The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner.
Answers without working may gain no credit.

Suggested grade boundaries for this paper:

A*	A	B	C	D	E
63	55	47	39	34	25

1. At time $t = 0$ a ball is projected vertically upwards from a point O and rises to a maximum height of 40 m above O. The ball is modelled as a particle moving freely under gravity.

(*a*) Show that the speed of projection is 28 m s^{-1}.

(3)

(*b*) Find the times, in seconds, when the ball is 33.6 m above O.

(5)

May 2011

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2. Two forces $(4\mathbf{i} - 2\mathbf{j})$ N and $(2\mathbf{i} + q\mathbf{j})$ N act on a particle P of mass 1.5 kg. The resultant of these two forces is parallel to the vector $(2\mathbf{i} + \mathbf{j})$.

(*a*) Find the value of q.

(4)

At time $t = 0$, P is moving with velocity $(-2\mathbf{i} + 4\mathbf{j})$ m s^{-1}.

(*b*) Find the speed of P at time $t = 2$ seconds.

(6)

June 2014 (R)

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3. A particle P of mass 0.4 kg is moving on rough horizontal ground when it hits a fixed vertical plane wall. Immediately before hitting the wall, P is moving with speed 4 m s^{-1} in a direction perpendicular to the wall. The particle rebounds from the wall and comes to rest at a distance of 5 m from the wall. The coefficient of friction between P and the ground is $\frac{1}{8}$.

Find the magnitude of the impulse exerted on P by the wall.

(7)

June 2016

4.

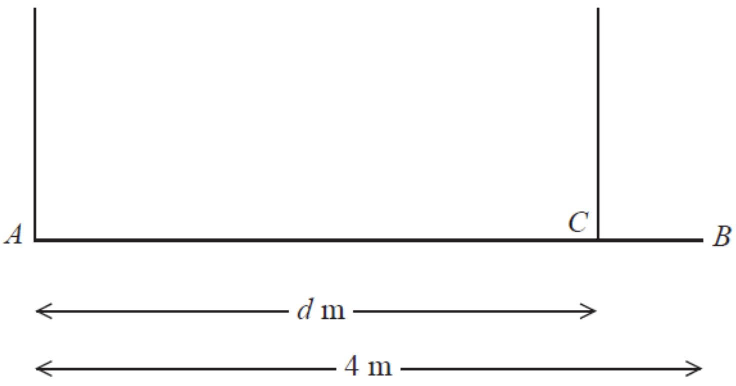

Figure 1

A beam AB has weight W newtons and length 4 m. The beam is held in equilibrium in a horizontal position by two vertical ropes attached to the beam. One rope is attached to A and the other rope is attached to the point C on the beam, where $AC = d$ metres, as shown in Figure 1. The beam is modelled as a uniform rod and the ropes as light inextensible strings. The tension in the rope attached at C is double the tension in the rope attached at A.

(*a*) Find the value of d.

(6)

A small load of weight kW newtons is attached to the beam at B. The beam remains in equilibrium in a horizontal position. The load is modelled as a particle. The tension in the rope attached at C is now four times the tension in the rope attached at A.

(*b*) Find the value of k.

(6)

June 2014

5.

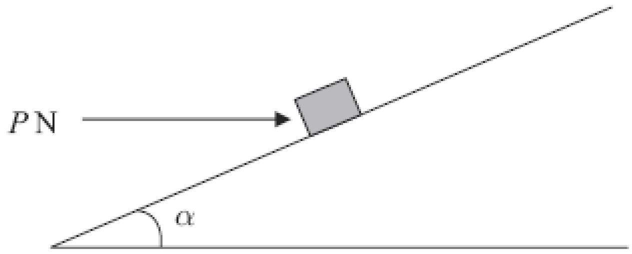

Figure 2

A small package of mass 1.1 kg is held in equilibrium on a rough plane by a horizontal force. The plane is inclined at an angle α to the horizontal, where tan $\alpha = \frac{3}{4}$. The force acts in a vertical plane containing a line of greatest slope of the plane and has magnitude P newtons, as shown in Figure 2.

The coefficient of friction between the package and the plane is 0.5 and the package is modelled as a particle. The package is in equilibrium and on the point of slipping down the plane.

(*a*) Draw, on Figure 2, all the forces acting on the package, showing their directions clearly.
(2)

(*b*) (i) Find the magnitude of the normal reaction between the package and the plane.

(ii) Find the value of P.
(11)

January 2009

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6. A car of mass 800 kg pulls a trailer of mass 200 kg along a straight horizontal road using a light towbar which is parallel to the road. The horizontal resistances to motion of the car and the trailer have magnitudes 400 N and 200 N respectively. The engine of the car produces a constant horizontal driving force on the car of magnitude 1200 N. Find

(*a*) the acceleration of the car and trailer,
(3)

(*b*) the magnitude of the tension in the towbar.
(3)

The car is moving along the road when the driver sees a hazard ahead. He reduces the force produced by the engine to zero and applies the brakes. The brakes produce a force on the car of magnitude F newtons and the car and trailer decelerate. Given that the resistances to motion are unchanged and the magnitude of the thrust in the towbar is 100 N,

(*c*) find the value of F.
(7)

May 2009

7.

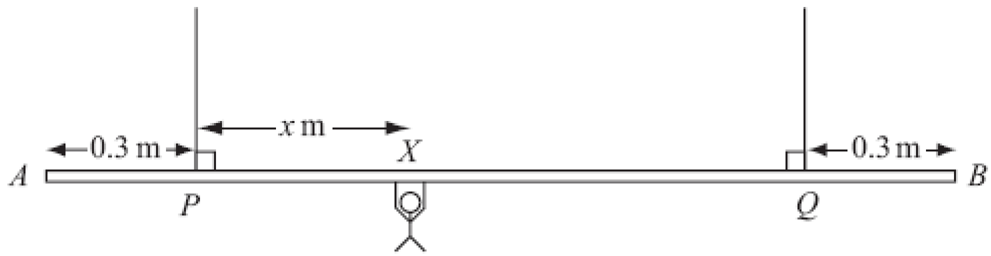


Figure 2

A beam AB is supported by two vertical ropes, which are attached to the beam at points P and Q, where $AP = 0.3$ m and $BQ = 0.3$ m. The beam is modelled as a uniform rod, of length 2 m and mass 20 kg. The ropes are modelled as light inextensible strings. A gymnast of mass 50 kg hangs on the beam between P and Q. The gymnast is modelled as a particle attached to the beam at the point X, where $PX = x$ m, $0 < x < 1.4$ as shown in Figure 2. The beam rests in equilibrium in a horizontal position.

(*a*) Show that the tension in the rope attached to the beam at P is $(588 - 350x)$ N.

(3)

(*b*) Find, in terms of x, the tension in the rope attached to the beam at Q.

(3)

(*c*) Hence find, justifying your answer carefully, the range of values of the tension which could occur in each rope.

(3)

Given that the tension in the rope attached at Q is three times the tension in the rope attached at P,

(*d*) find the value of x.

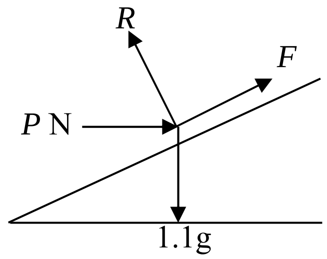
(3)

May 2009

TOTAL FOR PAPER: 75 MARKS

END

Question number	Scheme	Marks
1 (a)	$0^2 = u^2 - 2\text{x}9.8\text{x}40$ $u = 28$ m s^{-1} ** GIVEN ANSWER	M1 A1 A1 **(3)**
(b)	$33.6 = 28t - \frac{1}{2}9.8t^2$ $4.9t^2 - 28t + 33.6 = 0$ $t = \dfrac{28 \pm \sqrt{28^2 - 4\text{x}4.9\text{x}33.6}}{9.8}$ = 4 s or (1.7 s or 1.71 s)	M1 A1 M1 A1 A1 **(5)** **[8]**
2 (a)	$(4\mathbf{i} - 2\mathbf{j}) + (2\mathbf{i} + q\mathbf{j}) = (6\mathbf{i} + (q-2)\mathbf{j})$ $6 = 2(q-2)$ ratio 2:1 $q = 5$	M1A1 **DM**1 A1 **(4)**
(b)	$6\mathbf{i} + 3\mathbf{j} = 1.5\mathbf{a}$ $\mathbf{a} = (4\mathbf{i} + 2\mathbf{j})$ m s^{-2} $\mathbf{v} = \mathbf{u} + \mathbf{a}t = (-2\mathbf{i} + 4\mathbf{j}) + 2(4\mathbf{i} + 2\mathbf{j})$ $= 6\mathbf{i} + 8\mathbf{j}$ speed $= \sqrt{6^2 + 8^2}$ $= 10$ m s^{-1}	M1 A1 M1 A1**ft** **M**1 A1 **(6)** **[10]**
3	$F = \frac{1}{8} \times 0.4g$ $-\frac{1}{8} \square 0.4g = 0.4a$ $0 = u^2 + 2\left(-\frac{1}{8}g\right) \square 5$ $I = 0.4 \times (3.5 - -4) = 3$ N s	M1 M1 A1 M1 A1 M1 A1 **[7]**

Question number	Scheme	Marks
4 (a)	Resolving vertically: $T+2T\left(=3T\right)=W$	M1A1
	Moments about A: $2W=2T\times d$	M1A1
	Substitute and solve: $2W=2\frac{W}{3}d$	**DM1**
	$d=3$	A1
		(6)
(b)	Resolving vertically: $T+4T=W+kW \quad \left(5T=W\left(1+k\right)\right)$	M1A1 **ft**
	Moments about A: $2W+4kW=3\times 4T$	M1A1 **ft**
	Substitute and solve: $2W+4kW=\frac{12}{5}W\left(1+k\right)$	**DM1**
	$2+4k=\frac{12}{5}+\frac{12}{5}k$	
	$\frac{8}{5}k=\frac{2}{5}, \qquad k=\frac{1}{4}$	A1
		(6)
		[12]
5 (a)		B2 -1 e.e.o.o. (labels not needed)
		(2)
(b)(i)	$F=\frac{1}{2}R$	B1
	$(\uparrow)$, $R\cos\alpha+F\sin\alpha=mg$	
	$R=\dfrac{1.1g}{(\cos\alpha+\frac{1}{2}\sin\alpha)}=9.8$ N	M1 A2
		M1 A1
		(6)
(ii)	$(\rightarrow)$, $P+\frac{1}{2}R\cos\alpha=R\sin\alpha$	M1 A2
	$P=R(\sin\alpha-\frac{1}{2}\cos\alpha)$	M1
	$=1.96$	A1
		(5)
		[13]

Question number	Scheme	Marks
6 (a)	For whole system: $1200 - 400 - 200 = 1000a$	M1 A1
	$a = 0.6\ \text{m s}^{-2}$	A1 **(3)**
(b)	For trailer: $T - 200 = 200 \times 0.6$	M1 A1 **ft**
	$T = 320$ N	A1
		OR:
	OR: For car: $1200 - 400 - T = 800 \times 0.6$	M1 A1 **ft**
	$T = 320$ N	A1 **(3)**
(c)	For trailer: $200 + 100 = 200f$ or $-200f$	M1 A1
	$f = 1.5\ \text{m s}^{-2}$ (-1.5)	A1
	For car: $400 + F - 100 = 800f$ or $-800f$	M1 A2
	$F = 900$	A1
	(N.B. For both: $400 + 200 + F = 1000f$)	
		(7)
		[13]

Question number	Scheme	Marks
7 (a)	$M(Q)$, $50g(1.4 - x) + 20g$ x $0.7 = T_P$ x 1.4	M1 A1
	$T_P = 588 - 350x$ Printed answer	A1
		(3)
(b)	$M(P)$, $50gx + 20g$ x $0.7 = T_Q$ x 1.4 or R(↑), $T_P + T_Q = 70g$	M1 A1
	$T_Q = 98 + 350x$	A1
		(3)
(c)	Since $0 < x < 1.4$,	M1
	$98 < T_P < 588$ and $98 < T_Q < 588$	A1 A1
		(3)
(d)	$98 + 350x = 3(588 - 350x)$	M1
	$x = 1.19$	M1 A1
		(3)
		[12]

Examiner reports

Question 1

Part (a) was usually well-answered with most using $v^2 = u^2 + 2as$ but a surprising number of candidates put $u = 0$ and tried to find v , instead of the other way round. In the second part, those who wrote down a quadratic equation in t usually obtained a correct equation. Solving the equation proved more problematical, however, with some using an incorrect quadratic formula ($b^2 + 4ac$ was seen a number of times) while others appeared simply to be in alien territory. Some of the better candidates obtained a quadratic with integer coefficients, factorised successfully but then lost the final A1 for an answer of $\frac{12}{7}$.

The other popular choice was to find the velocity (±11.2) at a height of 33.6 m and then go on to find the times, but it was very rare for *two* times to emerge, with almost all just using +11.2.

Question 2

Part (a), most scored the first two marks for adding the two vectors to find the resultant but then many just equated their resultant to 2**i** + **j** and obtained $q = 3$ instead of using a ratio. Some subtracted the vectors to get the resultant rather than added. In the second part, some found a scalar quantity for the acceleration and then continued just using scalars. A sizeable minority obtained a velocity vector but then forgot to use Pythagoras to find the speed.

Question 3

This question involved a particle hitting a wall and rebounding, and then finally coming to rest as a result of friction. A significant minority of responses revealed a lack of understanding of the mechanics of the situation. Although virtually all candidates realised that a calculation of the frictional force was relevant, some then tried to use this with an extra unknown force in an equation of motion. Another surprisingly common error was to proceed to use the magnitude of the frictional force (0.49) as the deceleration. Others went straight to the use of a *suvat* equation to find the deceleration using the initial velocity as $u = 4$ (thereby assuming the particle rebounded from the wall with the same speed as before impact). There was much crossed out working seen as candidates realised they had equations which either contradicted each other or from which they could make no further progress. Those who developed a clear strategy (finding the deceleration from a valid equation of motion and then using this in an appropriate *suvat* equation to find the velocity immediately after impact) generally applied the formula for impulse successfully although there were occasional sign errors from not taking into account the change in direction of the velocities. A small number tried to use a formula for impulse involving time; this was not relevant here.

Question 4
The first part of this question proved to be fairly straight forward compared to previous moments questions and many scored 6 marks for not very much work if they chose the best method. Having said that, many students made their life more difficult than necessary by not taking the easy resolving option and using two moments equations. Many took moments about *B* and *C*, when *A* was clearly the most obvious choice. The resulting simultaneous equations sometimes proved too difficult to solve. There were very few cases of students mixing up the tensions.

Part (b) was generally more demanding, although again full marks were scored by many. The most common mistakes were to use just k rather than kW for the load, to use Wg and kWg and to assume that the tensions from part (a) still applied. The additional force inevitably meant that more students got lost in the algebra and failed to get to a correct final answer, but the question still gave plenty of scope to score well. The multitude of different possible solutions meant that this was the most difficult question to mark by far and this would have been helped by students making it clear what each equation was referring to and making the multiplication by a distance explicit in moments equations, even when the distance was 1.

Question 5
Part (a) was usually correct with the majority of candidates producing a correct diagram. A significant minority had the friction force acting down the plane. In the second part by far the most popular approach was to resolve parallel and perpendicular to the plane, producing two simultaneous equations in *P* and *R*. There were many who went on to solve these correctly, but a common error was to find *R* in terms of *P*, use this to find a value for *P*, but then forget to go back and use it to find the value for *R*. A few of the more able students appreciated the idea of resolving perpendicular to an unknown force, and resolved vertically to find *R*, without the need to solve simultaneous equations.

Question 6
Part (a) was well done by the majority of candidates and a good number went on to use the answer correctly in part (b). If mistakes were made they were the usual sign errors or more seriously, in terms of marks lost, missing terms.

The third part was poorly done. There was confusion over the direction of the forces and the concept of thrust. A few candidates halved the thrust and used 50N in each equation. Some used the values of the acceleration and tension from previous parts.

Question 7
Most candidates chose to take moments about *Q* in part (a). Common errors were incorrect distances, missing g's or lack of a distance in the moment of T_P. Some used the answer for part (a) and resolved vertically to obtain the answer for part (b).

The third part proved to be difficult for many candidates and answers with inequalities in *x* were offered. Some candidates used x = 0.1 or 1.39 to calculate the boundaries. A few managed to get the correct boundaries but did not express their answers correctly.

In the final part a significant minority lost marks by using $T_P = 3\ T_q$ to obtain their answer.

Statistics for M1 Practice Paper Gold Level G2

Qu	Max score	Modal score	Mean %	Mean score for students achieving grade: ALL	A*	A	B	C	D	E	U
1	8		69	5.50	7.29	6.98	6.00	5.19	4.36	3.56	2.05
2	10		60	5.98	8.45	7.31	5.39	4.45	3.82	2.98	2.34
3	7	7	61	4.25	6.30	5.68	4.41	3.52	2.71	2.02	1.11
4	12		77	9.28	11.72	11.25	10.38	9.27	7.91	5.92	2.78
5	13		61	7.93		10.50	8.22	6.40	5.33	3.52	1.90
6	13		46	5.96		8.37	6.38	5.09	3.89	2.99	1.58
7	12		51	6.09		9.39	6.91	5.07	3.25	1.93	0.58
	75		**59.99**	**44.99**	**33.76**	**59.48**	**47.69**	**38.99**	**31.27**	**22.92**	**12.34**