Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Thursday 7 June 2007 – Morning

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

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M1), the paper reference (6677), your surname, other name and signature.

Whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$.

When a calculator is used, the answer should be given to an appropriate degree of accuracy.

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.

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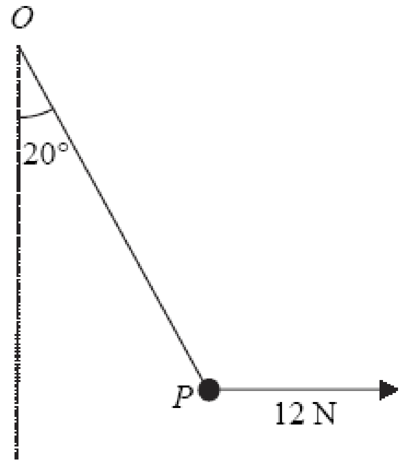
1. **Figure 1**



A particle P is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point O. A horizontal force of magnitude 12 N is applied to P. The particle P is in equilibrium with the string taut and OP making an angle of 20° with the downward vertical, as shown in Figure 1.

Find

(*a*) the tension in the string,

(3)

(*b*) the weight of P.

(4)

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2. Two particles A and B, of mass 0.3 kg and m kg respectively, are moving in opposite directions along the same straight horizontal line so that the particles collide directly. Immediately before the collision, the speeds of A and B are 8 m s^{-1} and 4 m s^{-1} respectively. In the collision the direction of motion of each particle is reversed and, immediately after the collision, the speed of each particle is 2 m s^{-1}.

Find

(*a*) the magnitude of the impulse exerted by B on A in the collision,

(3)

(*b*) the value of m.

(4)

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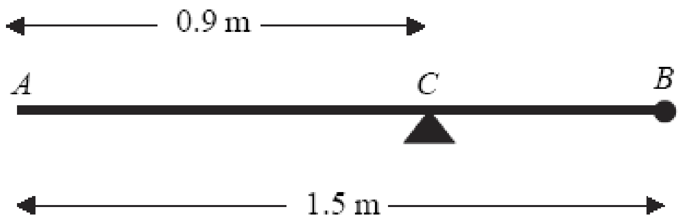
3. **Figure 3**



A uniform rod *AB* has length 1.5 m and mass 8 kg. A particle of mass *m* kg is attached to the rod at *B*. The rod is supported at the point *C*, where *AC* = 0.9 m, and the system is in equilibrium with *AB* horizontal, as shown in Figure 2.

(*a*) Show that $m = 2$.

(4)

A particle of mass 5 kg is now attached to the rod at *A* and the support is moved from *C* to a point *D* of the rod. The system, including both particles, is again in equilibrium with *AB* horizontal.

(*b*) Find the distance *AD*.

(5)

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4. A car is moving along a straight horizontal road. At time $t = 0$, the car passes a point *A* with speed 25 m s^{-1}. The car moves with constant speed 25 m s^{-1} until $t = 10$ s. The car then decelerates uniformly for 8 s. At time $t = 18$ s, the speed of the car is V m s^{-1} and this speed is maintained until the car reaches the point *B* at time $t = 30$ s.

(*a*) Sketch a speed–time graph to show the motion of the car from *A* to *B*.

(3)

Given that *AB* = 526 m, find

(*b*) the value of *V*,

(5)

(*c*) the deceleration of the car between $t = 10$ s and $t = 18$ s.

(3)

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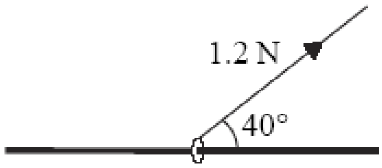
5. **Figure 3**



A small ring of mass 0.25 kg is threaded on a fixed rough horizontal rod. The ring is pulled upwards by a light string which makes an angle 40° with the horizontal, as shown in Figure 3. The string and the rod are in the same vertical plane. The tension in the string is 1.2 N and the coefficient of friction between the ring and the rod is μ. Given that the ring is in limiting equilibrium, find

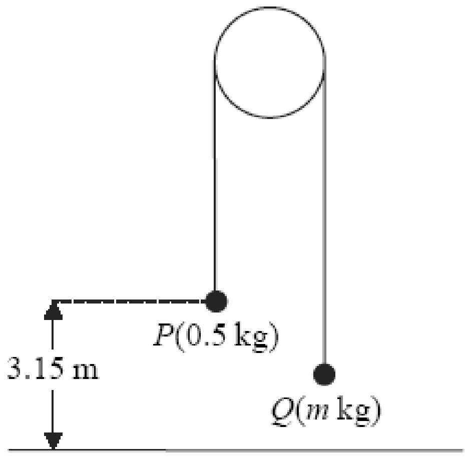
(*a*) the normal reaction between the ring and the rod,

(4)

(*b*) the value of μ.

(6)

6. **Figure 4**



Two particles P and Q have mass 0.5 kg and m kg respectively, where $m < 0.5$. The particles are connected by a light inextensible string which passes over a smooth, fixed pulley. Initially P is 3.15 m above horizontal ground. The particles are released from rest with the string taut and the hanging parts of the string vertical, as shown in Figure 4. After P has been descending for 1.5 s, it strikes the ground. Particle P reaches the ground before Q has reached the pulley.

(*a*) Show that the acceleration of P as it descends is 2.8 m s^{-2}.

(3)

(*b*) Find the tension in the string as P descends.

(3)

(*c*) Show that $m = \frac{5}{18}$.

(4)

(*d*) State how you have used the information that the string is inextensible.

(1)

When P strikes the ground, P does not rebound and the string becomes slack. Particle Q then moves freely under gravity, without reaching the pulley, until the string becomes taut again.

(*e*) Find the time between the instant when P strikes the ground and the instant when the string becomes taut again.

(6)

7. A boat B is moving with constant velocity. At noon, B is at the point with position vector $(3\mathbf{i} - 4\mathbf{j})$ km with respect to a fixed origin O. At 1430 on the same day, B is at the point with position vector $(8\mathbf{i} + 11\mathbf{j})$ km.

(*a*) Find the velocity of B, giving your answer in the form $p\mathbf{i} + q\mathbf{j}$.

(3)

At time t hours after noon, the position vector of B is $\mathbf{b}$ km.

(*b*) Find, in terms of t, an expression for $\mathbf{b}$.

(3)

Another boat C is also moving with constant velocity. The position vector of C, $\mathbf{c}$ km, at time t hours after noon, is given by

$$\mathbf{c} = (-9\mathbf{i} + 20\mathbf{j}) + t(6\mathbf{i} + \lambda\mathbf{j}),$$

where λ is a constant.

Given that C intercepts B,

(*c*) find the value of λ,

(5)

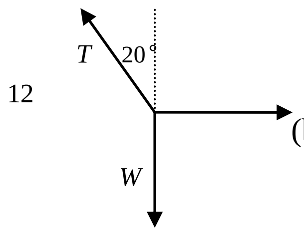
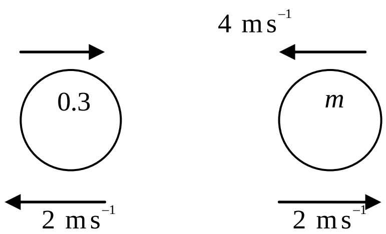
(*d*) show that, before C intercepts B, the boats are moving with the same speed.

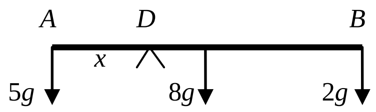
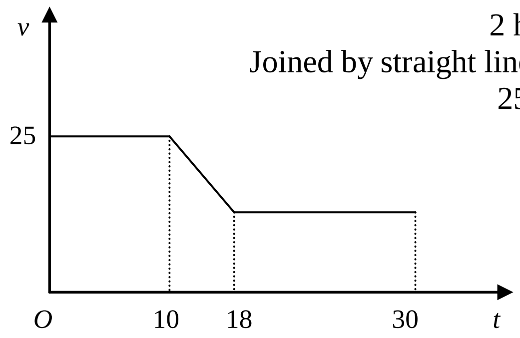
(3)

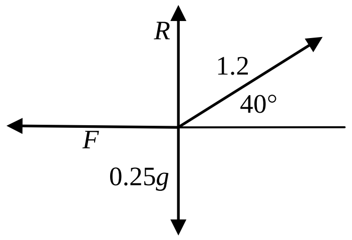
TOTAL FOR PAPER: 75 MARKS

END

June 2007
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1.	(a) $\rightarrow T\sin 20° = 12$ $T \approx 35.1 \; (\text{N})$ awrt 35  (b) $\uparrow W = T\cos 20°$ $\approx 33.0 \; (\text{N})$ awrt 33	M1 A1 A1 **(3)** M1 A1 DM1 A1 **(4)** **[7]**
2.	 (a) A: $I = 0.3(8 + 2)$ $= 3 \; (\text{Ns})$ (b) LM $0.3\times 8 - 4m = 0.3\times(-2) + 2m$ $m = 0.5$ *Alternative to* (b) B: $m(4+2) = 3$ $m = 0.5$ The two parts of this question may be done in either order.	M1 A1 A1 **(3)** M1 A1 DM1 A1 **(4)** **[7]** M1 A1 DM1 A1 **(4)**

Question Number	Scheme	Marks
3.	(a) M(C) $8g \times (0.9 - 0.75) = mg(1.5 - 0.9)$	M1 A1
	Solving to $m = 2$ * cso	DM1 A1 **(4)**
	(b)	
		
	M(D) $5g \times x = 8g \times (0.75 - x) + 2g(1.5 - x)$	M1 A2(1, 0)
	Solving to $x = 0.6$ (AD = 0.6 m)	DM1 A1 **(5)**
		[9]
4.	(a)	
		
	2 horizontal lines	B1
	Joined by straight line sloping down	B1
	25, 10, 18, 30 oe	B1 **(3)**
	(b) $25 \times 10 + \underline{\tfrac{1}{2}(25 + V) \times 8} + 12 \times V = 526$	M1 $\underline{\text{A1}}$ A1
	Solving to $V = 11$	DM1 A1 **(5)**
	(c) "$v = u + at$" $\Rightarrow$ $11 = 25 - 8a$ ft their V	M1 A1ft
	$a = 1.75$ (m s^{-2})	A1 **(3)**
		[11]

Question Number	Scheme		Marks
5.	(a) 		
	$\uparrow \quad \pm\ R + 1.2\sin 40° = 0.25g$		M1 A1
	Solving to $R = 1.7$ (N)	accept 1.68	DM1 A1 **(4)**
	(b) $\rightarrow \quad F = 1.2\cos 40° \quad (\approx 0.919)$		M1 A1
	Use of $F = \mu R$		B1
	$1.2\cos 40° = \mu R$	ft their R	DM1 A1ft
	$\mu \approx 0.55$	accept 0.548	A1 cao **(6)**
			[10]

Question Number	Scheme		Marks	
6.	(a) $s = ut + \frac{1}{2}at^2 \quad \Rightarrow \quad 3.15 = \frac{1}{2}a \times \frac{9}{4}$		M1 A1	
	$a = 2.8 \quad (\text{m s}^{-2})$ ∗	cso	A1	**(3)**
	(b) N2L for P: $0.5g - T = 0.5 \times 2.8$		M1 A1	
	$T = 3.5 \quad (\text{N})$		A1	**(3)**
	(c) N2L for Q: $T - mg = 2.8m$		M1 A1	
	$m = \dfrac{3.5}{12.6} = \dfrac{5}{18}$ ∗	cso	DM1 A1	**(4)**
	(d) The acceleration of P is equal to the acceleration of Q.		B1	**(1)**
	(e) $v = u + at \quad \Rightarrow \quad v = 2.8 \times 1.5$		M1 A1	
	(or $v^2 = u^2 + 2as \quad \Rightarrow \quad v^2 = 2 \times 2.8 \times 3.15$)			
	$(v^2 = 17.64, v = 4.2)$			
	$v = u + at \quad \Rightarrow \quad 4.2 = -4.2 + 9.8t$		DM1 A1	
	$t = \dfrac{6}{7}$, 0.86, 0.857 (s)		DM1 A1	**(6)**
				[17]

Question Number	Scheme	Marks
7.	(a) $\mathbf{v} = \dfrac{8\mathbf{i}+11\mathbf{j}-(3\mathbf{i}-4\mathbf{j})}{2.5}$ or any equivalent	M1 A1
	$\mathbf{v} = 2\mathbf{i}+6\mathbf{j}$	A1 **(3)**
	(b) $\mathbf{b} = 3\mathbf{i}-4\mathbf{j}+\mathbf{v}t$ ft their $\mathbf{v}$	M1 A1 ft
	$= 3\mathbf{i}-4\mathbf{j}+(2\mathbf{i}+6\mathbf{j})t$	A1cao **(3)**
	(c) $\mathbf{i}$ component: $-9+6t = 3+2t$	M1
	$t = 3$	M1 A1
	$\mathbf{j}$ component: $20+3\lambda = -4+18$	M1
	$\lambda = -2$	A1 **(5)**
	(d) $v_B = \sqrt{(2^2+6^2)}$ or $v_C = \sqrt{(6^2+(-2)^2)}$	M1
	Both correct	A1
	The speeds of *B* and *C* are the same cso	A1 **(3)**
		[14]