Paper Reference(s)

6677

Edexcel GCE

Mechanics M1

Advanced/Advanced Subsidiary

Wednesday 21 May 2008 – Afternoon

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 $g = 9.8$ 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 8 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.

1. Two particles P and Q have mass 0.4 kg and 0.6 kg respectively. The particles are initially at rest on a smooth horizontal table. Particle P is given an impulse of magnitude 3 N s in the direction PQ.

(a) Find the speed of P immediately before it collides with Q.

(3)

Immediately after the collision between P and Q, the speed of Q is 5 m s^{-1}.

(b) Show that immediately after the collision P is at rest.

(3)

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2. At time $t = 0$, a particle is projected vertically upwards with speed u m s^{-1} from a point 10 m above the ground. At time T seconds, the particle hits the ground with speed 17.5 m s^{-1}. Find

(a) the value of u,

(3)

(b) the value of T.

(4)

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3. A particle P of mass 0.4 kg moves under the action of a single constant force **F** newtons. The acceleration of P is $(6\mathbf{i} + 8\mathbf{j})$ m s^{-2}. Find

(a) the angle between the acceleration and **i**,

(2)

(b) the magnitude of **F**.

(3)

At time t seconds the velocity of P is **v** m s^{-1}. Given that when $t = 0$, $\mathbf{v} = 9\mathbf{i} - 10\mathbf{j}$,

(c) find the velocity of P when $t = 5$.

(3)

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4. A car is moving along a straight horizontal road. The speed of the car as it passes the point A is 25 m s^{-1} and the car maintains this speed for 30 s. The car then decelerates uniformly to a speed of 10 m s^{-1}. The speed of 10 m s^{-1} is then maintained until the car passes the point B. The time taken to travel from A to B is 90 s and AB = 1410 m.

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

(2)

(b) Calculate the deceleration of the car as it decelerates from 25 m s^{-1} to 10 m s^{-1}.

(7)

5.

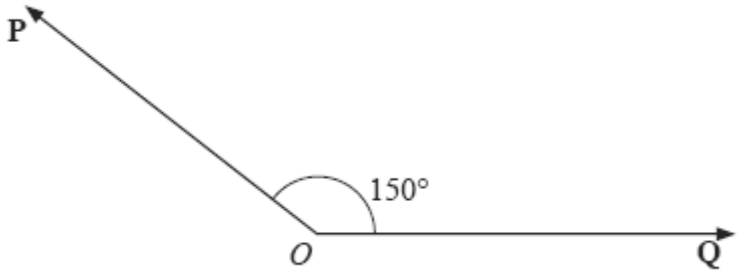


Figure 1

Two forces **P** and **Q** act on a particle at a point O. The force **P** has magnitude 15 N and the force **Q** has magnitude X newtons. The angle between **P** and **Q** is 150°, as shown in Figure 1. The resultant of **P** and **Q** is **R**.

Given that the angle between **R** and **Q** is 50°, find

(a) the magnitude of **R**,

(4)

(b) the value of X.

(5)

6.

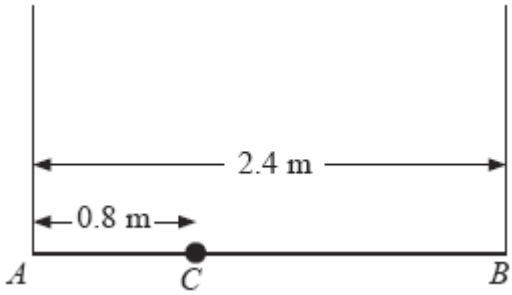


Figure 2

A plank AB has mass 12 kg and length 2.4 m. A load of mass 8 kg is attached to the plank at the point C, where $AC = 0.8$ m. The loaded plank is held in equilibrium, with AB horizontal, by two vertical ropes, one attached at A and the other attached at B, as shown in Figure 2. The plank is modelled as a uniform rod, the load as a particle and the ropes as light inextensible strings.

(a) Find the tension in the rope attached at B.

(4)

The plank is now modelled as a non-uniform rod. With the new model, the tension in the rope attached at A is 10 N greater than the tension in the rope attached at B.

(b) Find the distance of the centre of mass of the plank from A.

(6)

7.

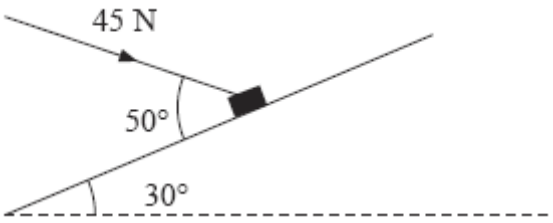


Figure 3

A package of mass 4 kg lies on a rough plane inclined at 30° to the horizontal. The package is held in equilibrium by a force of magnitude 45 N acting at an angle of 50° to the plane, as shown in Figure 3. The force is acting in a vertical plane through a line of greatest slope of the plane. The package is in equilibrium on the point of moving up the plane. The package is modelled as a particle. Find

(a) the magnitude of the normal reaction of the plane on the package,

(5)

(b) the coefficient of friction between the plane and the package.

(6)

8.

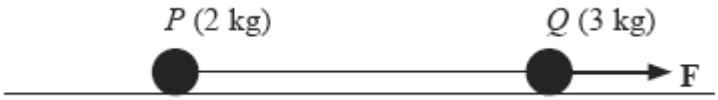


Figure 4

Two particles P and Q, of mass 2 kg and 3 kg respectively, are joined by a light inextensible string. Initially the particles are at rest on a rough horizontal plane with the string taut. A constant force **F** of magnitude 30 N is applied to Q in the direction PQ, as shown in Figure 4. The force is applied for 3 s and during this time Q travels a distance of 6 m. The coefficient of friction between each particle and the plane is μ. Find

(*a*) the acceleration of Q,

(2)

(*b*) the value of μ,

(4)

(*c*) the tension in the string.

(4)

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

(1)

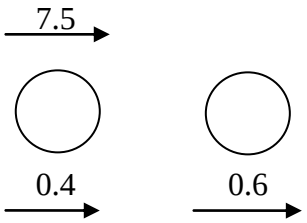
When the particles have moved for 3 s, the force **F** is removed.

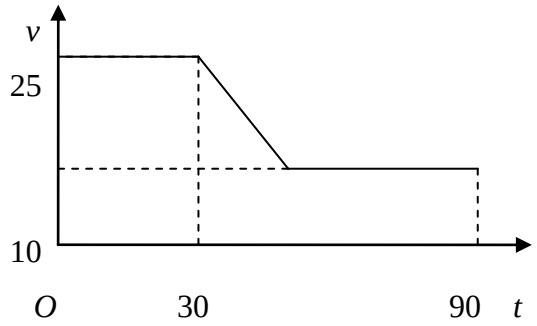
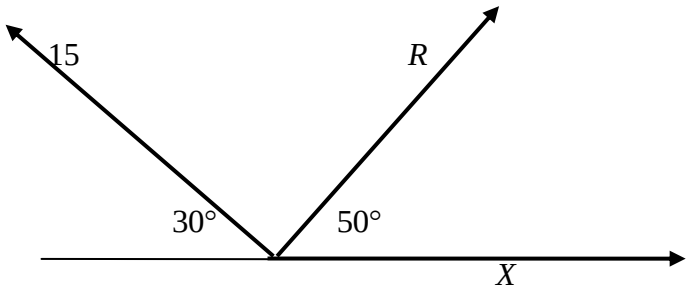
(*e*) Find the time between the instant that the force is removed and the instant that Q comes to rest.

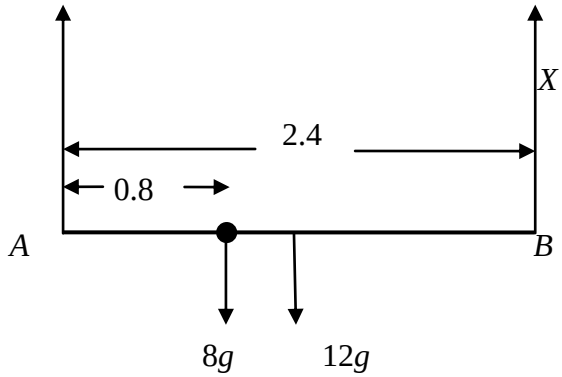
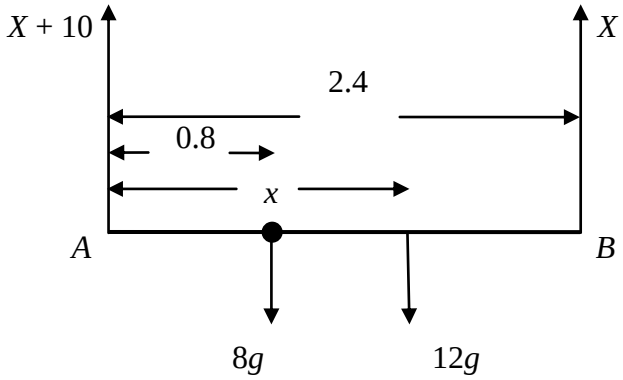
(4)

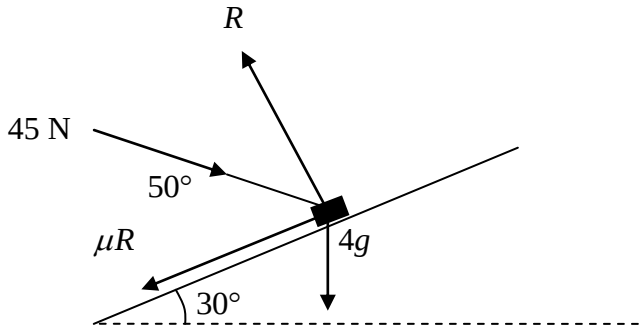
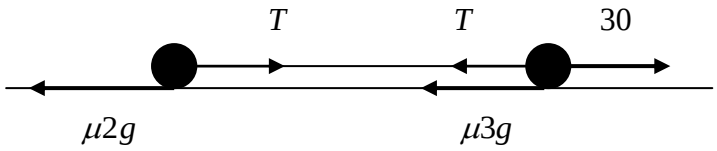
TOTAL FOR PAPER: 75 MARKS

END

Question Number	Scheme	Marks
1. (*a*)	$I = mv \Rightarrow 3 = 0.4 \times v$	M1 A1
	$v = 7.5 \ (\text{ms}^{-1})$	A1 (3)
(*b*)		
	v 5	
	LM $0.4 \times 7.5 = 0.4v + 0.6 \times 5$	M1 A1
	$0 = 0.4v \Rightarrow v = 0$ ∗ cso	A1 cso (3)
		(6 marks)
2. (*a*)	$v^2 = u^2 + 2as \Rightarrow 17.5^2 = u^2 + 2 \times 9.8 \times 10$	M1 A1
	Leading to $u = 10.5$	A1 (3)
(*b*)	$v = u + at \Rightarrow 17.5 = -10.5 + 9.8T$	M1 A1 ft.
	$T = 2\frac{6}{7}$ (s)	M1 A1 (4)
		(7 marks)
3. (*a*)	$\tan\theta = \frac{8}{6}$	M1
	$\theta \approx 53°$	A1 (2)
(*b*)	$\mathbf{F} = 0.4(6\mathbf{i} + 8\mathbf{j}) \ (= 2.4\mathbf{i} + 3.2\mathbf{j})$	M1
	$\lvert\mathbf{F}\rvert = \sqrt{(2.4^2 + 3.2^2)} = 4$	M1 A1 (3)
(*c*)	$\mathbf{v} = 9\mathbf{i} - 10\mathbf{j} + 5(6\mathbf{i} + 8\mathbf{j})$	M1 A1
	$= 39\mathbf{i} + 30\mathbf{j} \ (\text{ms}^{-1})$	A1 (3)
		(8 marks)

Question Number	Scheme	Marks
4. (*a*)		
	shape	B1
	25, 10, 30, 90	B1 (2)
(*b*)	(b) $30\times 25+\frac{1}{2}(25+10)t+10(60-t)=1410$	M1 A1 A1
	$7.5t=60$	
	$t=8\ (\text{s})$	M1 A1
	$a=\frac{25-10}{8}=1.875\ (\text{ms}^{-2})$ $1\frac{7}{8}$	M1 A1 (7)
		(9 marks)
5. (*a*)		
	$(\uparrow)\quad 15\sin 30^\circ = R\sin 50^\circ$	M1 A1
	$R\approx 9.79\ (\text{N})$	M1 A1 (4)
(*b*)	$(\rightarrow)\ X-15\cos 30^\circ = R\cos 50^\circ$ ft their *R*	M1 A2 ft
	$X\approx 19.3\ (\text{N})$	M1 A1 (5)
		(9 marks)

Question Number	Scheme	Marks
6.	(a) 	
	$M(A)$ $8g \times 0.8 + 12g \times 1.2 = X \times 2.4$	M1 A1
	$X \approx 85$ (N) accept 84.9, $\frac{26g}{3}$	DM1 A1 (4)
	(*b*) 	
	$R(\uparrow)$ $\underline{(X+10)} + \underline{X} = 8g + 12g$	M1 <u>B1</u> A1
	$(X = 93)$	
	$M(A)$ $8g \times 0.8 + 12g \times x = X \times 2.4$	M1 A1
	$x = 1.4$ (m) accept 1.36	A1 (6)
		(10 marks)

Question Number	Scheme	Marks
7. (*a*)		
	$R = 45\cos 40° + 4g\cos 30°$	M1 A2, 1, 0
	$R \approx 68$ accept 68.4	M1 A1 (5)
(*b*)	Use of $F = \mu R$	M1
	$F + 4g\sin 30 = 45\cos 50°$	M1 A2, 1, 0
	Leading to $\mu \approx 0.14$ accept 0.136	M1 A1(6)
		(11 marks)
8. (*a*)		
	$s = ut + \frac{1}{2}at^2 \Rightarrow 6 = \frac{1}{2}a \times 9$	M1
	$a = 1\frac{1}{3}\ \left(\text{ms}^{-2}\right)$	A1 (2)
(*b*)	N2L for system $30 - \mu 5g = 5a$ ft their *a*, accept symbol	M1 A1ft
	$\mu = \frac{14}{3g} = \frac{10}{21}$ or awrt 0.48	M1 A1 (4)
(*c*)	N2L for *P* $T - \mu 2g = 2a$ ft their μ, their *a*, accept symbols	M1 A1 ft
	$T - \frac{14}{3g} \times 2g = 2 \times \frac{4}{3}$	
	Leading to $T = 12\ (\text{N})$ awrt 12	M1 A1 (4)
(*d*)	The acceleration of *P* and *Q* (or the whole of the system) is the same.	B1 (1)

Question Number	Scheme	Marks
(*e*)	$v = u + at \quad \Rightarrow \quad v = \frac{4}{3} \times 3 = 4$	B1 ft on a
	N2L (for system or either particle)	
	$-5\mu g = 5a$ or equivalent	M1
	$a = -\mu g$	
	$v = u + at \quad \Rightarrow \quad 0 = 4 - \mu g t$	M1
	Leading to $t = \frac{6}{7}$ (s) accept 0.86, 0.857	A1 (4)
		(15 marks)