Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 6 7 7 / 0 1	Signature	

Paper Reference(s)

6677/01
Edexcel GCE
Mechanics M1
Advanced/Advanced Subsidiary

Wednesday 19 January 2011 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
Total	

Materials required for examination
Mathematical Formulae (Pink)

Items included with question papers
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 formulae stored in them.

Instructions to Candidates
In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
You must write your answer to each question in the space following the question.
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.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 7 questions in this question paper. The total mark for this paper is 75.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates
You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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1. Two particles B and C have mass m kg and 3 kg respectively. They are moving towards each other in opposite directions on a smooth horizontal table. The two particles collide directly. Immediately before the collision, the speed of B is 4 m s^{-1} and the speed of C is 2 m s^{-1}. In the collision the direction of motion of C is reversed and the direction of motion of B is unchanged. Immediately after the collision, the speed of B is 1 m s^{-1} and the speed of C is 3 m s^{-1}.

Find

(a) the value of m,

(3)

(b) the magnitude of the impulse received by C.

(2)

N 3 5 4 0 7 A 0 2 2 4

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Mechanics M1 6677
Mark Scheme

Question Number	Scheme	Marks
1. **(a)**	Conservation of momentum: $4m-6=m+9$ $m=5$	 M1 A1 A1 (3)
(b)	Impulse = change in momentum $=3\times3-(3\times-2)=15$	 M1 A1 (2) **[5]**

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2. A ball is thrown vertically upwards with speed u m s^{-1} from a point P at height h metres above the ground. The ball hits the ground 0.75 s later. The speed of the ball immediately before it hits the ground is 6.45 m s^{-1}. The ball is modelled as a particle.

(a) Show that $u = 0.9$

(3)

(b) Find the height above P to which the ball rises before it starts to fall towards the ground again.

(2)

(c) Find the value of h.

(3)

Question Number	Scheme	Marks
2.		
(a)	$-6.45 = u - 9.8 \times 0.75$	M1 A1
	$0.9 = u$ **	A1
		(3)
(b)	$0 = 0.81 - 2 \times 9.8 \times s$	M1
	$s = 0.041$ or 0.0413	A1
		(2)
(c)	$h = -0.9 \times 0.75 + 4.9 \times 0.75^2$	M1 A1
	$h = 2.1$ or 2.08	A1
		(3)
		[8]

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3.

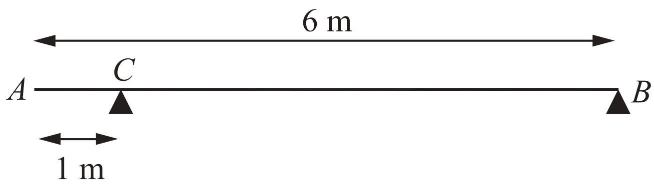


Figure 1

A uniform beam *AB* has mass 20 kg and length 6 m. The beam rests in equilibrium in a horizontal position on two smooth supports. One support is at *C*, where *AC* = 1 m, and the other is at the end *B*, as shown in Figure 1. The beam is modelled as a rod.

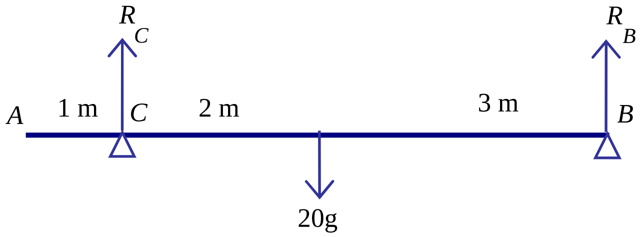
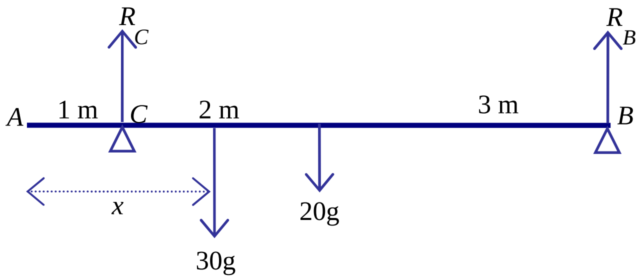
(a) Find the magnitudes of the reactions on the beam at *B* and at *C*.

(5)

A boy of mass 30 kg stands on the beam at the point *D*. The beam remains in equilibrium. The magnitudes of the reactions on the beam at *B* and at *C* are now equal. The boy is modelled as a particle.

(b) Find the distance *AD*.

(5)

Question Number	Scheme	Marks
3. **(a)**		
	Taking moments about B: $5 \times R_C = 20g \times 3$	M1A1
	$R_C = 12g$ or $60g/5$ or 118 or 120	A1
	Resolving vertically: $R_C + R_B = 20g$	M1
	$R_B = 8g$ or 78.4 or 78	A1
		(5)
(b)		
	Resolving vertically: 50g = R + R	B1
	Taking moments about B:	
	$5 \times 25g = 3 \times 20g + (6 - x) \times 30g$	M1 A1 A1
	$30x = 115$	
	x = 3.8 or better or 23/6 oe	A1
		(5) **[10]**

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4. A particle P of mass 2 kg is moving under the action of a constant force $\mathbf{F}$ newtons. The velocity of P is $(2\mathbf{i} - 5\mathbf{j})$ m s^{-1} at time $t = 0$, and $(7\mathbf{i} + 10\mathbf{j})$ m s^{-1} at time $t = 5$ s.

Find

(a) the speed of P at $t = 0$,

(2)

(b) the vector $\mathbf{F}$ in the form $a\mathbf{i} + b\mathbf{j}$,

(5)

(c) the value of t when P is moving parallel to $\mathbf{i}$.

(4)

Question Number	Scheme	Marks
4. **(a)**	speed $= \sqrt{2^2 + (-5)^2}$	M1
	$= \sqrt{29} = 5.4$ or better	A1
		(2)
(b)	$((7\mathrm{i} + 10\mathrm{j}) - (2\mathrm{i} - 5\mathrm{j}))/5$	M1 A1
	$= (5\mathbf{i} + 15\mathbf{j})/5 = \mathbf{i} + 3\mathbf{j}$	A1
	$\mathbf{F} = m\mathbf{a} = 2(\mathbf{i} + 3\mathbf{j}) = 2\mathbf{i} + 6\mathbf{j}$	DM1 A1ft
		(5)
(c)	$\mathbf{v} = \mathbf{u} + \mathbf{a}t = (2\mathbf{i} - 5\mathbf{j}) + (\mathbf{i} + 3\mathbf{j})t$	M1
	$(-5 + 3t)\mathrm{j}$	A1
	Parallel to $\mathrm{i} \Rightarrow -5 + 3t = 0$	M1
	$t = 5/3$	A1
		(4)
		[11]

Leave blank

5. A car accelerates uniformly from rest for 20 seconds. It moves at constant speed v m s^{-1} for the next 40 seconds and then decelerates uniformly for 10 seconds until it comes to rest.

(a) For the motion of the car, sketch

(i) a speed-time graph,

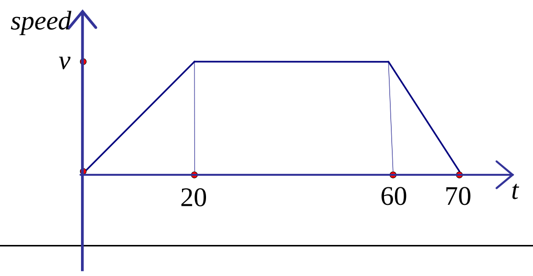
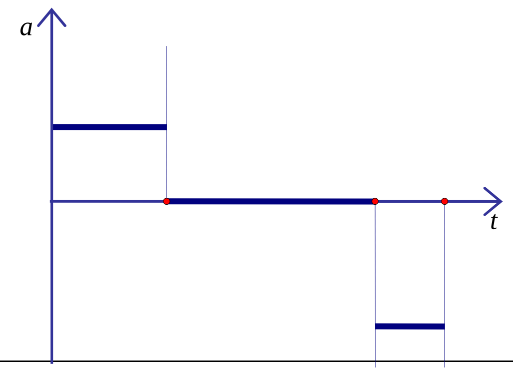
(ii) an acceleration-time graph.

(6)

Given that the total distance moved by the car is 880 m,

(b) find the value of v.

(4)

Question Number	Scheme	Marks
5. **(a) (i)**		
	1^{st} section correct	B1
	2^{nd} & 3^{rd} sections correct	B1
	Numbers and v marked correctly on the axes.	DB1
(ii)		
	1^{st} section correct	B1
	2^{nd} section correct	B1
	3^{rd} section correct and no "extras" on the sketch	B1
		(6)
(b)	$\frac{70+40}{2}\times v = 880$	M1 A1
	$v = 880\times\frac{2}{110} = 16$	DM1 A1
		(4)
		[10]

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6.

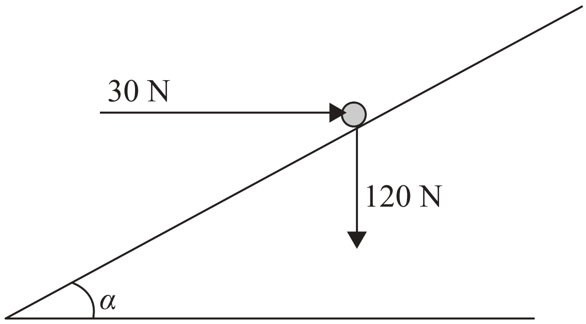


Figure 2

A particle of weight 120 N is placed on a fixed rough plane which is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$.

The coefficient of friction between the particle and the plane is $\frac{1}{2}$.

The particle is held at rest in equilibrium by a horizontal force of magnitude 30 N, which acts in the vertical plane containing the line of greatest slope of the plane through the particle, as shown in Figure 2.

(a) Show that the normal reaction between the particle and the plane has magnitude 114 N.
(4)

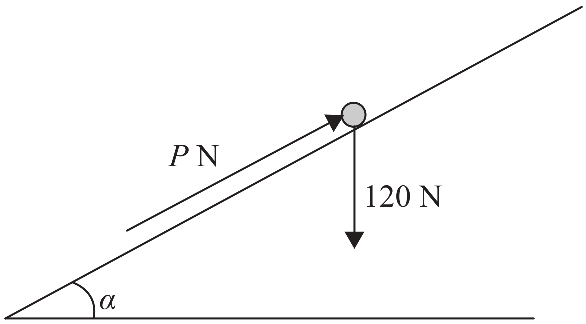
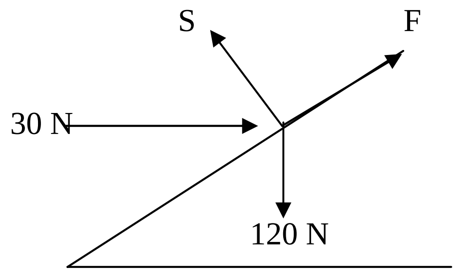
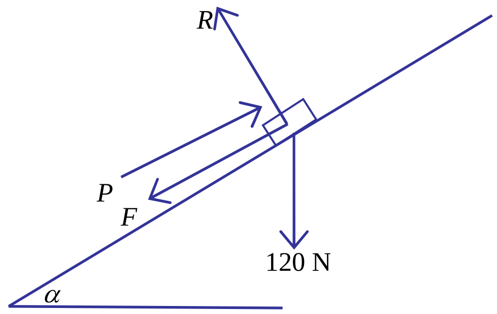


Figure 3

The horizontal force is removed and replaced by a force of magnitude P newtons acting up the slope along the line of greatest slope of the plane through the particle, as shown in Figure 3. The particle remains in equilibrium.

(b) Find the greatest possible value of P.
(8)

(c) Find the magnitude and direction of the frictional force acting on the particle when $P = 30$.
(3)

Question Number	Scheme	Marks
6. **(a)**		
	Resolving perpendicular to the plane: $S = 120\cos\alpha + 30\sin\alpha$ $= 114$ *	M1 A1 A1 A1 (4)
(b)		
	Resolving perpendicular to the plane: $R = 120\cos\alpha$ $= 96$ $F_{max} = \frac{1}{2}R$	M1 A1 A1 M1
	Resolving parallel to the plane: In equilibrium: $P_{max} = F_{max} + 120\sin\alpha$ $= 48 + 72 = 120$	M1 A(2,1,0) A1 (8)
(c)	$30 + F = 120\sin\alpha$ **OR** $30 - F = 120\sin\alpha$ So $F = 42\text{N}$ acting up the plane.	M1 A1 A1 (3) **[15]**

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7.

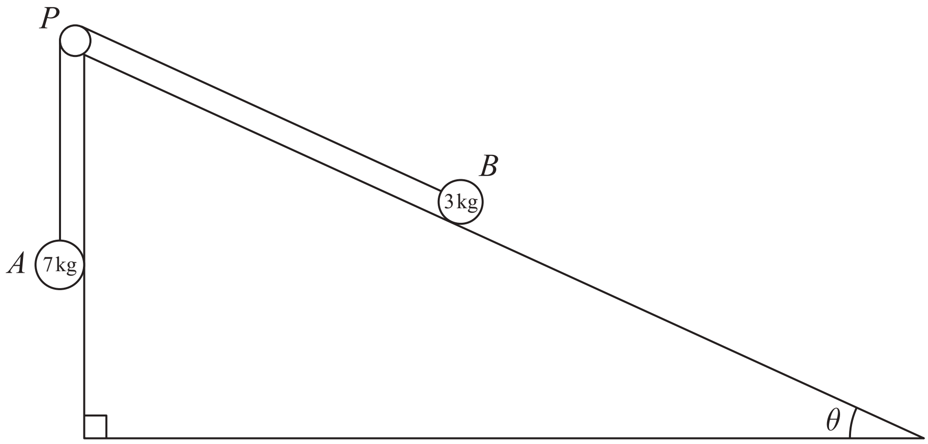


Figure 4

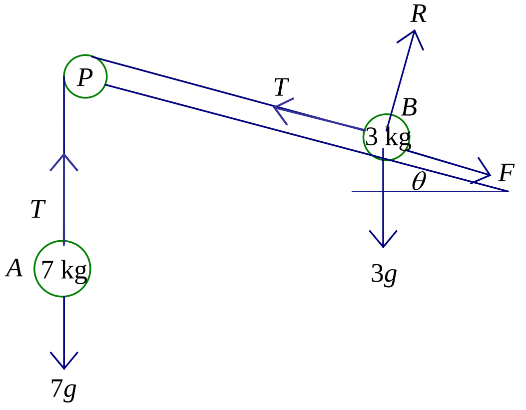
Two particles A and B, of mass 7 kg and 3 kg respectively, are attached to the ends of a light inextensible string. Initially B is held at rest on a rough fixed plane inclined at angle θ to the horizontal, where $\tan \theta = \frac{5}{12}$. The part of the string from B to P is parallel to a line of greatest slope of the plane. The string passes over a small smooth pulley, P, fixed at the top of the plane. The particle A hangs freely below P, as shown in Figure 4. The coefficient of friction between B and the plane is $\frac{2}{3}$. The particles are released from rest with the string taut and B moves up the plane.

(a) Find the magnitude of the acceleration of B immediately after release.
(10)

(b) Find the speed of B when it has moved 1 m up the plane.
(2)

When B has moved 1 m up the plane the string breaks. Given that in the subsequent motion B does not reach P,

(c) find the time between the instants when the string breaks and when B comes to instantaneous rest.
(4)

Question Number	Scheme	Marks
7. **(a)**	 $\tan\theta = \frac{5}{12}$, $\sin\theta = \frac{5}{13}$, $\cos\theta = \frac{12}{13}$	
	For A: $7g - T = 7a$	M1 A1
	For B: parallel to plane $T - F - 3g\sin\theta = 3a$	M1 A1
	perpendicular to plane $R = 3g\cos\theta$	M1 A1
	$F = \mu R = 3g\cos\theta = 2g\cos\theta$	M1
	Eliminating T, $7g - F - 3g\sin\theta = 10a$	DM1
	Equation in g and a: $7g - 2g \times \frac{12}{13} - 3g\frac{5}{13} = 7g - \frac{39}{13}g = 4g = 10a$	DM1
	$a = \frac{2g}{5}$ *oe* or 3.9 or 3.92	A1
		(10)
(b)	After 1 m,	
	$v^2 = u^2 + 2as$, $v^2 = 0 + 2 \times \frac{2g}{5} \times 1$	M1
	$v = 2.8$	A1
		(2)
(c)	$-(F + 3g\ \sin\theta) = 3a$	M1
	$\frac{2}{3} \times 3g \times \frac{12}{13} + 3g \times \frac{5}{13} = 3g = -3a$, $a = -g$	A1
	$v = u + at$, $0 = 2.8 - 9.8t$,	DM1
	$t = \frac{2}{7}$ oe, 0.29. 0.286	A1
		(4) **[16]**