

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

Friday 11 January 2008 – Morning

Time: 1 hour 30 minutes

Examiner's use only

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Team Leader's use only

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[illegible]

Materials required for examination

Mathematical Formulae (Green)

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 for each question in the space following the question.

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.

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 28 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 must show sufficient working to make your methods clear to the Examiner.

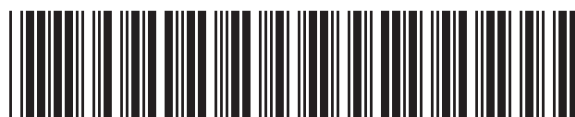
Answers without working may not gain full credit.

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1. Two particles A and B have masses 4 kg and $m\text{ kg}$ respectively. They are moving towards each other in opposite directions on a smooth horizontal table when they collide directly. Immediately before the collision, the speed of A is 5 m s^{-1} and the speed of B is 3 m s^{-1} . Immediately after the collision, the direction of motion of A is unchanged and the speed of A is 1 m s^{-1} .

- (a) Find the magnitude of the impulse exerted on A in the collision.

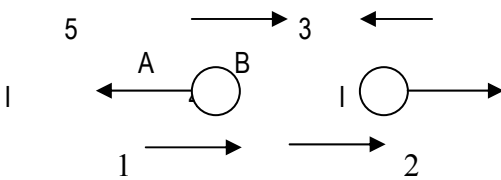
(2)

Immediately after the collision, the speed of B is 2 m s^{-1} .

- (b) Find the value of m .

(4)

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Mark Scheme

Question Number	Scheme	Marks
1(a)	 $I = 4(5 - 1) = \underline{16 \text{ N s}}$	M1 A1 (2)
(b)	<p>CLM: $4 \times 5 - m \times 3 = 4 \times 1 + m \times 2$</p> $\Rightarrow m = \underline{3.2}$ <p>or</p> $16 = m(3 + 2)$ $\Rightarrow m = \underline{3.2}$	<p>M1 A1</p> <p>DM1 A1 (4)</p> <p>or</p> <p>M1 A1</p> <p>DM1 A1 (4) 6</p>
2(a)	$27 = 0 + \frac{1}{2} a \cdot 3^2 \Rightarrow a = \underline{6}$	M1 A1 (2)
(b)	$v = 6 \times 3 = \underline{18 \text{ m s}^{-1}}$	M1 A1 f.t. (2)
(c)	<p>From $t = 3$ to $t = 5$, $s = 18 \times 2 - \frac{1}{2} \times 9.8 \times 2^2$</p> $\text{Total ht.} = s + 27 = \underline{43.4 \text{ m}, 43 \text{ m}}$	<p>M1 A1 f.t.</p> <p>M1 A1 (4)</p> <p>8</p>

2. A firework rocket starts from rest at ground level and moves vertically. In the first 3 s of its motion, the rocket rises 27 m. The rocket is modelled as a particle moving with constant acceleration $a \text{ m s}^{-2}$. Find

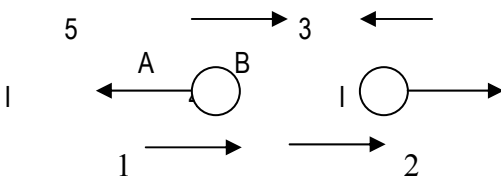
- (b) the speed of the rocket 3 s after it has left the ground. (2)

After 3 s, the rocket burns out. The motion of the rocket is now modelled as that of a particle moving freely under gravity.

- (c) Find the height of the rocket above the ground 5 s after it has left the ground. **(4)**

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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6677 Mechanics M1
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2(a)	$27 = 0 + \frac{1}{2} a \cdot 3^2 \Rightarrow a = \underline{6}$	M1 A1 (2)
(b)	$v = 6 \times 3 = \underline{18 \text{ m s}^{-1}}$	M1 A1 f.t. (2)
(c)	<p>From $t = 3$ to $t = 5$, $s = 18 \times 2 - \frac{1}{2} \times 9.8 \times 2^2$</p> $\text{Total ht.} = s + 27 = \underline{43.4 \text{ m}, 43 \text{ m}}$	<p>M1 A1 f.t.</p> <p>M1 A1 (4)</p> <p>8</p>

3. A car moves along a horizontal straight road, passing two points A and B . At A the speed of the car is 15 m s^{-1} . When the driver passes A , he sees a warning sign W ahead of him, 120 m away. He immediately applies the brakes and the car decelerates with uniform deceleration, reaching W with speed 5 m s^{-1} . At W , the driver sees that the road is clear. He then immediately accelerates the car with uniform acceleration for 16 s to reach a speed of $V \text{ m s}^{-1}$ ($V > 15$). He then maintains the car at a constant speed of $V \text{ m s}^{-1}$. Moving at this constant speed, the car passes B after a further 22 s .

- (a) Sketch, in the space below, a speed-time graph to illustrate the motion of the car as it moves from A to B .

(3)

- (b) Find the time taken for the car to move from A to B .

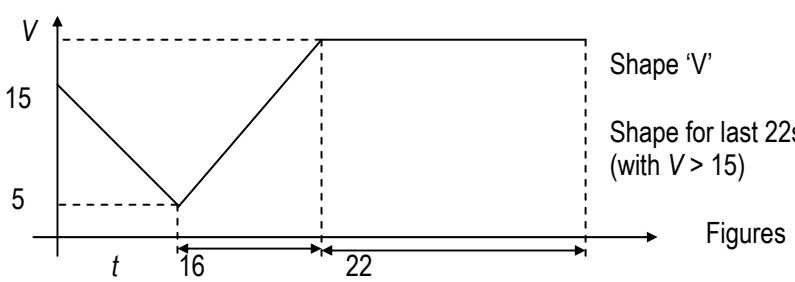
(3)

The distance from A to B is 1 km .

- (c) Find the value of V .

(5)



Question Number	Scheme	Marks
3.(a)		<p>B1</p> <p>B1</p> <p>B1 (3)</p>
(b)	$\frac{1}{2}(15 + 5) \times t = 120$ $\Rightarrow t = 12 \rightarrow T = 12 + 16 + 22 = \underline{50 \text{ s}}$	<p>M1</p> <p>M1 A1 (3)</p>
(c)	$120 + \frac{1}{2}(V + 5) \cdot 16 + 22V = 1000$ $\text{Solve: } 30V = 840 \Rightarrow V = \underline{28}$	<p>M1 <u>B1</u> A1</p> <p>DM1 A1 (5)</p> <p>11</p>
4.(a)	<p>R (// plane): $49 \cos \theta = 6g \sin 30$</p> $\Rightarrow \cos \theta = 3/5 *$	<p>M1 A1</p> <p>A1 (3)</p>
(b)	<p>R (perp to plane): $R = 6g \cos 30 + 49 \sin \theta$</p> $R \approx \underline{90.1 \text{ or } 90 \text{ N}}$	<p>M1 A1</p> <p>DM1 A1 (4)</p>
(c)	<p>R (// to plane): $49 \cos 30 - 6g \sin 30 = 6a$</p> $\Rightarrow a \approx \underline{2.17 \text{ or } 2.2 \text{ m s}^{-2}}$	<p>M1 A2,1,0</p> <p>A1 (4)</p> <p>11</p>

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Figure 1

A particle P of mass 6 kg lies on the surface of a smooth plane. The plane is inclined at an angle of 30° to the horizontal. The particle is held in equilibrium by a force of magnitude 49 N , acting at an angle θ to the plane, as shown in Figure 1. The force acts in a vertical plane through a line of greatest slope of the plane.

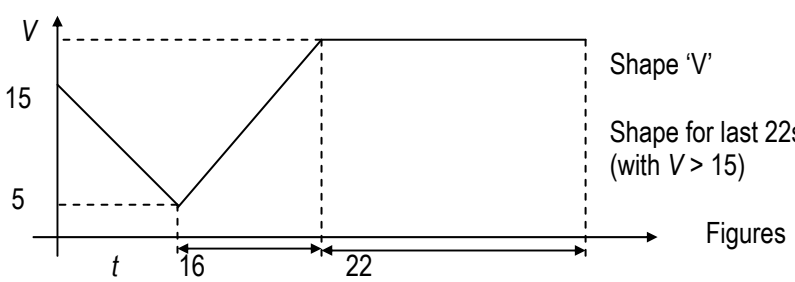
- (a) Show that $\cos \theta = \frac{3}{5}$. (3)

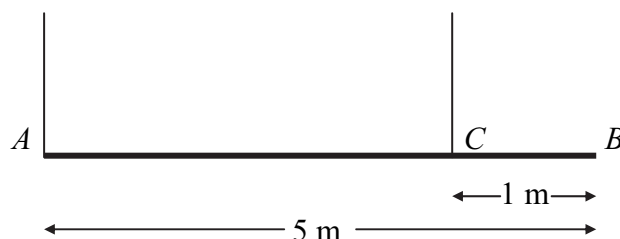
- (b) Find the normal reaction between P and the plane. (4)

The direction of the force of magnitude 49 N is now changed. It is now applied horizontally to P so that P moves up the plane. The force again acts in a vertical plane through a line of greatest slope of the plane.

- (c) Find the initial acceleration of P . (4)



Question Number	Scheme	Marks
3.(a)		<p>B1</p> <p>B1</p> <p>B1 (3)</p>
(b)	$\frac{1}{2}(15 + 5) \times t = 120$ $\Rightarrow t = 12 \rightarrow T = 12 + 16 + 22 = \underline{50 \text{ s}}$	<p>M1</p> <p>M1 A1 (3)</p>
(c)	$120 + \frac{1}{2}(V + 5) \cdot 16 + 22V = 1000$ $\text{Solve: } 30V = 840 \Rightarrow V = \underline{28}$	<p>M1 B1 A1</p> <p>DM1 A1 (5)</p> <p>11</p>
4.(a)	<p>R (// plane): $49 \cos \theta = 6g \sin 30$</p> $\Rightarrow \cos \theta = 3/5 *$	<p>M1 A1</p> <p>A1 (3)</p>
(b)	<p>R (perp to plane): $R = 6g \cos 30 + 49 \sin \theta$</p> $R \approx \underline{90.1 \text{ or } 90 \text{ N}}$	<p>M1 A1</p> <p>DM1 A1 (4)</p>
(c)	<p>R (// to plane): $49 \cos 30 - 6g \sin 30 = 6a$</p> $\Rightarrow a \approx \underline{2.17 \text{ or } 2.2 \text{ m s}^{-2}}$	<p>M1 A2,1,0</p> <p>A1 (4)</p> <p>11</p>



A beam AB has mass 12 kg and length 5 m. It is held in equilibrium in a horizontal position by two vertical ropes attached to the beam. One rope is attached to A , the other to the point C on the beam, where $BC = 1$ m, as shown in Figure 2. The beam is modelled as a uniform rod, and the ropes as light strings.

- (ii) the tension in the rope at A .

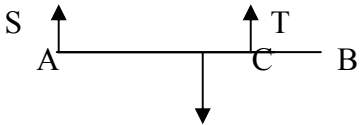
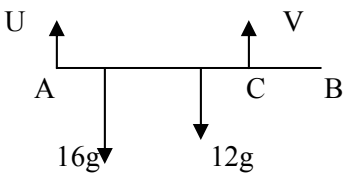
A small load of mass 16 kg is attached to the beam at a point which is y metres from A . The load is modelled as a particle. Given that the beam remains in equilibrium in a horizontal position,

- (3)

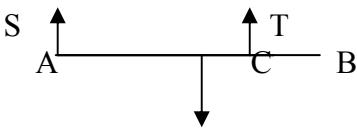
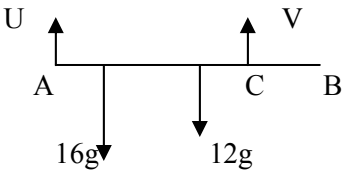
(c) Find the range of possible positions on the beam where the load can be attached without the rope at C breaking.

(3)



Question Number	Scheme	Marks
5.(a)	 $M(A): T \times 4 = 12g \times 2.5$ $T = \underline{7.5g \text{ or } 73.5 \text{ N}}$ $R(\uparrow) S + T = 12g$ $\Rightarrow S = \underline{4.5g \text{ or } 44.1 \text{ N}}$	<p>M1 A1</p> <p>A1</p> <p>M1</p> <p>A1 (5)</p>
(b)	 $M(A) V \times 4 = 16g \times y + 12g \times 2.5$ $V = \underline{4gy + 7.5g \text{ or } 39.2y + 73.5 \text{ N}}$	<p>M1 A1</p> <p>A1 (3)</p>
(c)	$V \leq 98 \Rightarrow 39.2y + 73.5 \leq 98$ $\Rightarrow y \leq 0.625 = 5/8$ <p>Hence “load must be no more than 5/8 m from A” (o.e.)</p>	<p>M1</p> <p>DM1</p> <p>A1 (3)</p> <p>11</p>
6.(a)	$\text{Speed} = \sqrt{5^2 + 8^2} \approx \underline{9.43 \text{ m s}^{-1}}$	<p>M1 A1 (2)</p>
(b)	<p>Forming $\arctan 8/5$ or $\arctan 5/8$ oe</p> $\text{Bearing} = 360 - \arctan 5/8 \text{ or } 270 + \arctan 8/5 = \underline{328}$	<p>M1</p> <p>DM1 A1 (3)</p>
(c)	<p>At $t = 3$, p.v. of $P = (7 - 15)\mathbf{i} + (-10 + 24)\mathbf{j} = -8\mathbf{i} + 14\mathbf{j}$</p> <p>Hence $-8\mathbf{i} + 14\mathbf{j} + 4(u\mathbf{i} + v\mathbf{j}) = \mathbf{0}$</p> $\Rightarrow \underline{u = 2, v = -3.5}$	<p>M1 A1</p> <p>M1</p> <p>DM1 A1 (5)</p>
(d)	<p>p.v. of P t secs after changing course $= (-8\mathbf{i} + 14\mathbf{j}) + t(2\mathbf{i} - 3.5\mathbf{j})$</p> $= 7\mathbf{i} + \dots$ <p>Hence total time $= \underline{10.5 \text{ s}}$</p>	<p>M1</p> <p>DM1</p> <p>A1 (3)</p> <p>13</p>



Question Number	Scheme	Marks
5.(a)	 $M(A): T \times 4 = 12g \times 2.5$ $T = \underline{7.5g \text{ or } 73.5 \text{ N}}$ $R(\uparrow) S + T = 12g$ $\Rightarrow S = \underline{4.5g \text{ or } 44.1 \text{ N}}$	M1 A1 A1 M1 A1 (5)
(b)	 $M(A) V \times 4 = 16g \times y + 12g \times 2.5$ $V = \underline{4gy + 7.5g \text{ or } 39.2y + 73.5 \text{ N}}$	M1 A1 A1 (3)
(c)	$V \leq 98 \Rightarrow 39.2y + 73.5 \leq 98$ $\Rightarrow y \leq 0.625 = 5/8$ <p>Hence “load must be no more than 5/8 m from A” (o.e.)</p>	M1 DM1 A1 (3)
6.(a)	$\text{Speed} = \sqrt{(5^2 + 8^2)} \approx \underline{9.43 \text{ m s}^{-1}}$	M1 A1 (2)
(b)	<p>Forming $\arctan 8/5$ or $\arctan 5/8$ oe</p> $\text{Bearing} = 360 - \arctan 5/8 \text{ or } 270 + \arctan 8/5 = \underline{328}$	M1 DM1 A1 (3)
(c)	<p>At $t = 3$, p.v. of $P = (7 - 15)\mathbf{i} + (-10 + 24)\mathbf{j} = -8\mathbf{i} + 14\mathbf{j}$</p> <p>Hence $-8\mathbf{i} + 14\mathbf{j} + 4(u\mathbf{i} + v\mathbf{j}) = \mathbf{0}$</p> $\Rightarrow \underline{u = 2, \quad v = -3.5}$	M1 A1 M1 DM1 A1 (5)
(d)	<p>p.v. of P t secs after changing course $= (-8\mathbf{i} + 14\mathbf{j}) + t(2\mathbf{i} - 3.5\mathbf{j})$</p> $= 7\mathbf{i} + \dots$ <p>Hence total time $= \underline{10.5 \text{ s}}$</p>	M1 DM1 A1 (3)
		11
		13

7.



Figure 3

(a) find the tension in the string immediately after the particles begin to move, (3)

(b) show that $\mu = \frac{2}{3}$. (5)

When B has fallen a distance h , it hits the ground and does not rebound. Particle A is then a distance $\frac{1}{3}h$ from P .

(c) Find the speed of A as it reaches P . (6)

(d) State how you have used the information that the string is light. (1)

[illegible]

Question Number	Scheme	Marks
7.(a)	$B: \quad 2mg - T = 2m \times 4g/9$ $\Rightarrow T = \underline{10mg/9}$	M1 A1 A1 (3)
(b)	$A: \quad T - \mu mg = m \times 4g/9$ <p>Sub for T and solve: $\mu = 2/3 *$</p>	M1 B1 A1 DM1 A1 (5)
(c)	<p>When B hits: $v^2 = 2 \times 4g/9 \times h$</p> <p>Deceleration of A after B hits: $ma = \mu mg \Rightarrow a = 2g/3$</p> <p>Speed of A at P: $V^2 = 8gh/9 - 2 \times 2g/3 \times h/3$</p> $\Rightarrow V = \frac{2}{3} \sqrt{gh}$	M1 A1 M1 A1 f.t. DM1 A1 (6)
(d)	Same tension on A and B	B1 (1) 15