Paper Reference(s)

WME02/01

Pearson Edexcel International Advanced Level

Mechanics M2

Advanced/Advanced Subsidiary

Monday 23 June 2014 – Morning

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Mathematical Formulae (Blue)	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

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}, and give your answer to either two significant figures or three significant figures.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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1. A particle P moves on the x-axis. The acceleration of P, in the positive x direction at time t seconds, is $(2t - 3)$ m s^{-2}. The velocity of P, in the positive x direction at time t seconds, is v m s^{-1}. When $t = 0$, $v = 2$.

(*a*) Find v in terms of t.

(4)

The particle is instantaneously at rest at times t_1 seconds and t_2 seconds, where $t_1 < t_2$.

(*b*) Find the values t_1 and t_2.

(3)

(*c*) Find the distance travelled by P between $t = t_1$ and $t = t_2$.

(4)

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2. A trailer of mass 250 kg is towed by a car of mass 1000 kg. The car and the trailer are travelling down a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{20}$.

The resistance to motion of the car is modelled as a single force of magnitude 300 N acting parallel to the road. The resistance to motion of the trailer is modelled as a single force of magnitude 100 N acting parallel to the road. The towbar joining the car to the trailer is modelled as a light rod which is parallel to the direction of motion. At a given instant the car and the trailer are moving down the road with speed 25 m s^{-1} and acceleration 0.2 m s^{-2}.

(*a*) Find the power being developed by the car's engine at this instant.

(6)

(*b*) Find the tension in the towbar at this instant.

(4)

3.

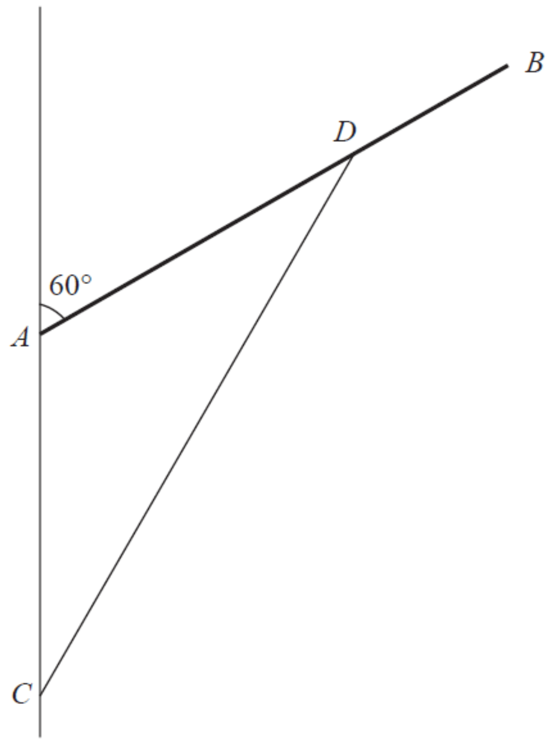

Figure 1

A uniform rod *AB* of weight *W* is freely hinged at end *A* to a vertical wall. The rod is supported in equilibrium at an angle of 60° to the wall by a light rigid strut *CD*. The strut is freely hinged to the rod at the point *D* and to the wall at the point *C*, which is vertically below *A*, as shown in Figure 1. The rod and the strut lie in the same vertical plane, which is perpendicular to the wall. The length of the rod is $4a$ and $AC = AD = 2.5a$.

(*a*) Show that the magnitude of the thrust in the strut is $\frac{4\sqrt{3}}{5}W$.

(3)

(*b*) Find the magnitude of the force acting on the rod at *A*.

(6)

4.

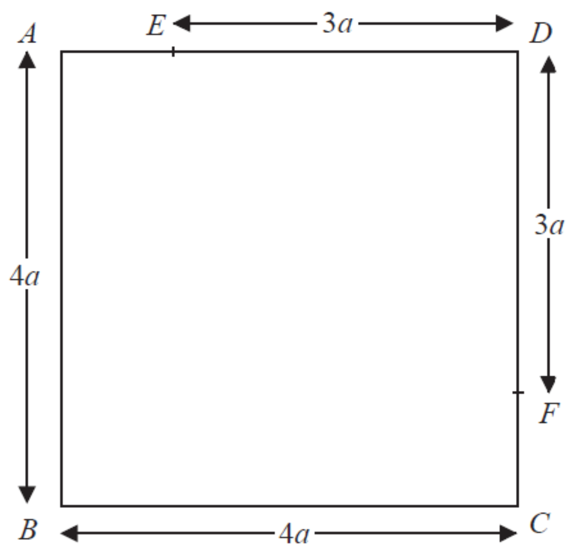

Figure 2

The uniform square lamina *ABCD* shown in Figure 2 has sides of length $4a$. The points *E* and *F*, on *DA* and *DC* respectively, are both at a distance $3a$ from *D*.

The portion *DEF* of the lamina is folded through 180° about *EF* to form the folded lamina *ABCFE* shown in Figure 3 below.

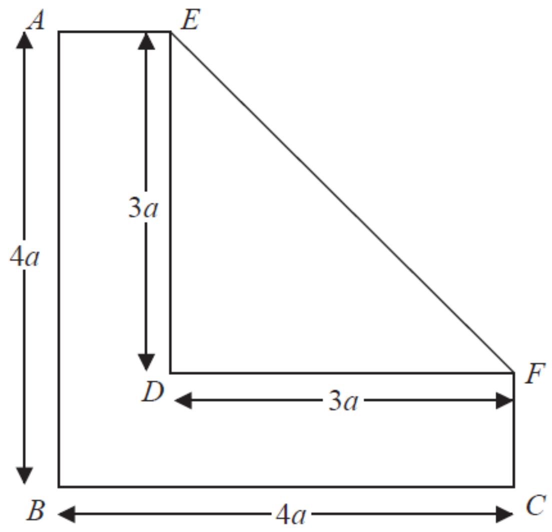

Figure 3

(*a*) Show that the distance from *AB* of the centre of mass of the folded lamina is $\frac{55}{32}a$.

(6)

The folded lamina is freely suspended from *E* and hangs in equilibrium.

(*b*) Find the size of the angle between *ED* and the downward vertical.

(4)

5. A particle of mass 0.5 kg is moving on a smooth horizontal surface with velocity $12\mathbf{i}$ m s^{-1} when it receives an impulse $K(\mathbf{i} + \mathbf{j})$ N s, where K is a positive constant. Immediately after receiving the impulse the particle is moving with speed 15 m s^{-1} in a direction which makes an acute angle θ with the vector $\mathbf{i}$.

Find

(i) the value of K,

(ii) the size of angle θ.

(7)

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6. Three particles P, Q and R have masses $3m$, km and $7.5m$ respectively. The three particles lie at rest in a straight line on a smooth horizontal table with Q between P and R. Particle P is projected towards Q with speed u and collides directly with Q. The coefficient of restitution between P and Q is $\frac{1}{9}$.

(*a*) Show that the speed of Q immediately after the collision is $\frac{10u}{3(3+k)}$.

(6)

(*b*) Find the range of values of k for which the direction of motion of P is reversed as a result of the collision.

(3)

Following the collision between P and Q there is a collision between Q and R. Given that $k = 7$ and that Q is brought to rest by the collision with R,

(*c*) find the total kinetic energy lost in the collision between Q and R.

(5)

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7. A particle P is projected from a fixed point A with speed 4 m s^{-1} at an angle α above the horizontal and moves freely under gravity. When P passes through the point B on its path, it has speed 7 m s^{-1}.

(*a*) By considering energy, find the vertical distance between A and B.

(4)

The minimum speed of P on its path from A to B is 2.5 m s^{-1}.

(*b*) Find the size of angle α.

(3)

(*c*) Find the horizontal distance between A and B.

(7)

TOTAL FOR PAPER: 75 MARKS

END