Surname	Other na	mes
Pearson Edexcel International Advanced Level	Centre Number	Candidate Number
Mechanica Advanced/Advance		
Friday 22 June 2018 – Morr Time: 1 hour 30 minutes	ning	Paper Reference WME02/01

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  $g = 9.8 \text{ m s}^{-2}$ , 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.

Turn over ▶



1.	A particle P of mass 0.7 kg is moving with velocity $(\mathbf{i} - 2\mathbf{j}) \mathrm{m} \mathrm{s}^{-1}$ when it receives
1.	
	an impulse. Immediately after receiving the impulse, P is moving with velocity
	(3i + 4j) m s <sup>-1</sup> .
	(a) Ein 1 th a immula
	(a) Find the impulse.
	(3)
	(b) Find, in degrees, the size of the angle between the direction of the impulse and the
	direction of motion of P immediately before receiving the impulse.
	(3)



Question 1 continued	Leave blank
	Q1
(Total 6 marks)	



**(4)** 

**(5)** 

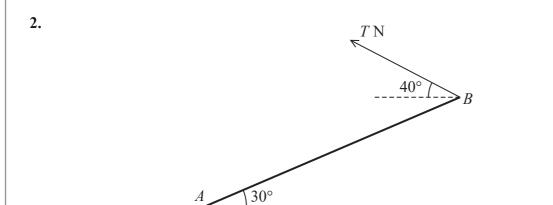


Figure 1

A uniform rod AB, of mass 6 kg and length 1.6 m, rests with its end A on rough horizontal ground. The rod is held in equilibrium at 30° to the horizontal by a light string attached to the rod at B. The string is at 40° to the horizontal and lies in the same vertical plane as the rod, as shown in Figure 1. The tension in the string is T newtons. The coefficient of friction between the ground and the rod is  $\mu$ .

- (a) Show that, to 3 significant figures, T = 27.1
- (b) Find the set of values of  $\mu$  for which equilibrium is possible.

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Question 2 continued	
Question 2 continued	



Question 2 continued		

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		Q2
	(Total 9 marks)	
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- 3. A cyclist and his bicycle, with a combined mass of 75 kg, move along a straight horizontal road. The cyclist is working at a constant rate of 180 W. There is a constant resistance to the motion of the cyclist and his bicycle of magnitude R newtons. At the instant when the speed of the cyclist is 4 m s<sup>-1</sup>, his acceleration is  $0.2 \text{ m s}^{-2}$ .
  - (a) Find the value of R.

**(4)** 

Later, the cyclist moves up a straight road with a constant speed  $v \, \text{m s}^{-1}$ . The road is inclined at an angle  $\theta$  to the horizontal, where  $\sin \theta = \frac{1}{21}$ . The cyclist is working at a rate of 180 W and the resistance to the motion of the cyclist and his bicycle from non-gravitational forces is again the same constant force of magnitude R newtons.

(b) Find the value of v.

**(4)** 

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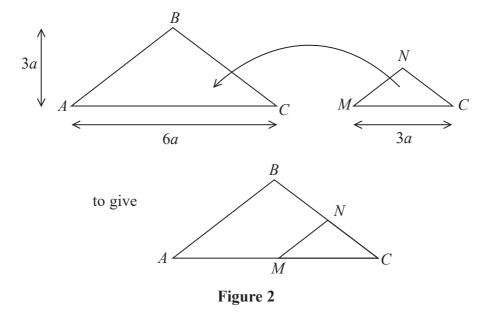
Question 3 continued		

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	Q3
(Total 8 marks)	



**(7)** 

4.



The uniform lamina ABC is an isosceles triangle with AB = BC, AC = 6a and the distance from B to AC is 3a.

The uniform lamina MNC is an isosceles triangle with MN = NC and MC = 3a. Triangles ABC and MNC are similar and are made of the same material.

The lamina L is formed by fixing triangle MNC on top of triangle ABC, as shown in Figure 2.

(a) Show that the distance of the centre of mass of L from AC is 
$$\frac{9}{10}a$$
 (5)

The lamina L is freely suspended from B and hangs in equilibrium.

(b) Find, to the nearest degree, the size of the angle between AB and the downward vertical.

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Question 4 continued	
	Q4
(Total 12 marks)	
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5. A particle *P* of mass 0.3 kg moves under the action of a single force **F** newtons. At time t seconds ( $t \ge 0$ ), *P* has velocity  $\mathbf{v}$  m s<sup>-1</sup>, where

$$\mathbf{v} = (3t^2 - 4t)\mathbf{i} + (3t^2 - 8t + 4)\mathbf{j}$$

(a) Find **F** when t = 4

(3)

At the instants when P is at the points A and B, particle P is moving parallel to the vector  $\mathbf{i}$ .

(b) Find the distance AB.

**(9)** 

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Question 5 continued		

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Question 5 continued	
	Q5
(Total 12 marks)	



6.	A particle $P$ is projected from a fixed point $A$ with speed $12 \mathrm{m  s^{-1}}$ at an angle $\alpha$ above horizontal and moves freely under gravity. As $P$ passes through the point $B$ on its $P$ is moving with speed $8 \mathrm{m  s^{-1}}$ at an angle $\beta$ below the horizontal.	
	(a) By considering energy, find the vertical distance between $A$ and $B$ .	(4)
	Particle <i>P</i> takes 1.5 seconds to travel from <i>A</i> to <i>B</i> .	
	(b) Find the size of angle $\alpha$ .	(3)
	(c) Find the size of angle $\beta$ .	(3)
	(d) Find the length of time for which the speed of $P$ is less than $8 \text{ m s}^{-1}$ .	(4)



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Question 6 continued	

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	Q6
(Total 14 marks)	



7. Three particles A, B and C have masses 2m, 3m and 4m respectively. The particles lie at rest in a straight line on a smooth horizontal surface, with B between A and C. Particle A is projected towards B with speed u and collides directly with B. The coefficient of restitution between A and B is e. The kinetic energy of A immediately after the collision is one ninth of the kinetic energy of A immediately before the collision.

Given that the direction of motion of A is unchanged by the collision,

(a) find the value of e.

**(7)** 

**(7)** 

After the collision between A and B there is a direct collision between B and C. The coefficient of restitution between B and C is f, where  $f < \frac{3}{4}$ . The speed of B immediately after the collision with C is V.

- (b) (i) Express V in terms of f and u.
  - (ii) Hence show that there will be a second collision between A and B.



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