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537165 pp		Pearson Edexcel International Advanced Level	Cen	tre Number		Candidate Nur
HA031		Time 1 hour 30 minutes		Paper reference	W	ΛΕ01/
		Mathematics International Advance Mechanics M1	d Su	ubsidiary	y/Advaı	nced Level

**Total Marks** 

Candidate Number

**MEO1/0** 

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Please check the examination details below before entering your candidate information

## Instructions

• Use **black** ink or ball-point pen.

You must have:

If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).

Mathematical Formulae and Statistical Tables (Yellow), calculator

- 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 q is required, take  $q = 9.8 \,\mathrm{m}\,\mathrm{s}^{-2}$ , and give your answer to either 2 significant figures or 3 significant figures.

## Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 8 questions in this question paper. 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**

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- 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.
- Good luck with your examination.

Turn over







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			actifices.	
	1.	Asp sveac sur	article $P$ has mass $3m$ and a particle $Q$ has mass $5m$ . The particles are moving towards hother in opposite directions along the same straight line on a smooth horizontal face. The particles collide directly.  The particles collide directly is $ku$ , where $k$ is a constant, and the speed $Q$ is $Q$ is $Q$ is $Q$ is $Q$ .	Market Section
nttp.	bill	Imr	mediately before the collision the speed of $P$ is $ku$ , where $k$ is a constant, and the speed $Q$ is $2u$ .	
		Imr	mediately after the collision the speed of $P$ is $u$ and the speed of $Q$ is $3u$ .	
		The	e direction of motion of $Q$ is reversed by the collision.	
		(a) Find, in terms of $m$ and $u$ , the magnitude of the impulse exerted on $Q$ by the collision.		Ĺ
			(2)	ı
		(b)	Find the two possible values of $k$ . (5)	)
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2. As a moves along a straight horizontal road with constant acceleration $a  \text{m s}^{-2}$ where $a > 0$ The car is modelled as a particle.
The call the vest thought straight horizontal road with constant accoleration with straight where $a > 0$
The car is modelled as a particle.
At time $t = 0$ , the car passes point A and is moving with speed $u  \text{m s}^{-1}$
In the first three seconds after passing $A$ the car travels 20 m.
In the fourth second after passing $A$ the car travels 10 m.
The speed of the car as it passes point $B$ is $20 \mathrm{ms^{-1}}$
Find the time taken for the car to travel from $A$ to $B$ .
(8)



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3. [Les this question i and j are perpendicular horizontal unit vectors.]

Three forces,  $\mathbf{F}_1$ ,  $\mathbf{F}_2$  and  $\mathbf{F}_3$ , are given by

$$\mathbf{F}_1 = (5\mathbf{i} + 2\mathbf{j})\mathbf{N}$$
  $\mathbf{F}_2 = (-3\mathbf{i} + \mathbf{j})\mathbf{N}$   $\mathbf{F}_3 = (a\mathbf{i} + b\mathbf{j})\mathbf{N}$ 

where a and b are constants.

The forces  $\mathbf{F}_1$ ,  $\mathbf{F}_2$  and  $\mathbf{F}_3$  act on a particle P of mass  $4\,\mathrm{kg}$ .

Given that *P* rests in equilibrium on a smooth horizontal surface under the action of these three forces,

(a) find the size of the angle between the direction of  $\mathbf{F}_3$  and the direction of  $-\mathbf{j}$ .

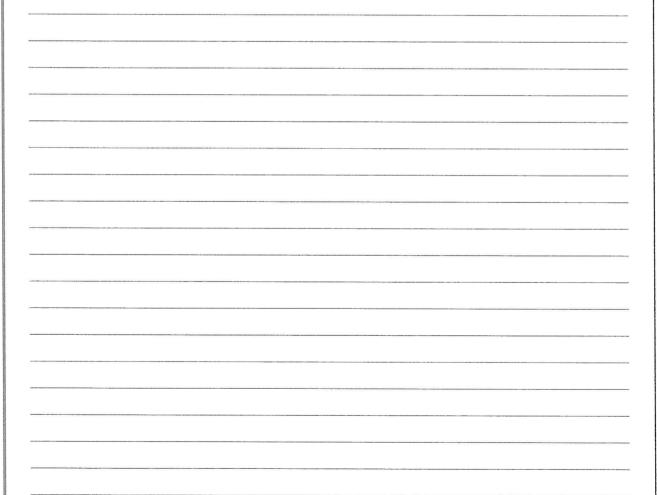
**(4)** 

The force  $\mathbf{F}_3$  is now removed and replaced by the force  $\mathbf{F}_4$  given by  $\mathbf{F}_4 = \lambda(\mathbf{i} + 3\mathbf{j})N$ , where  $\lambda$  is a positive constant.

When the three forces  $\mathbb{F}_1$ ,  $\mathbb{F}_2$  and  $\mathbb{F}_4$  act on P, the acceleration of P has magnitude 3.25 m s<sup>-2</sup>

(b) Find the value of  $\lambda$ .

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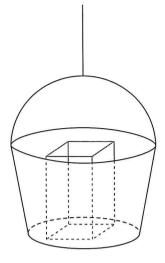


Figure 1

Figure 1 shows a large bucket used by a crane on a building site to move materials between the ground and the top of the building. The mass of the bucket is 15 kg.

The bucket is attached to a vertical cable with the bottom of the bucket horizontal. The cable is modelled as light and inextensible.

When the bucket is on the ground, a bag of cement of mass 25 kg is placed in the bucket.

The bucket with the bag of cement moves vertically upwards with constant acceleration  $0.2\,\mathrm{m\,s^{-2}}$ . Air resistance is modelled as being negligible.

(a) Find the tension in the cable.

(3)

At the top of the building, the bag of cement is removed. A box of tools of mass 12 kg is now placed in the bucket.

Later on the bucket with the box of tools is moving vertically downwards with constant deceleration  $0.1 \,\mathrm{m\,s^{-2}}$ . Air resistance is again modelled as being negligible.

find the magnitude of the normal reaction between the bucket and the box of tools (	3)



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5. [Let his question i and j are perpendicular horizontal unit vectors.]

A particle P is moving with constant acceleration  $\mathbf{i}$   $\mathbf{i}$   $\mathbf{j}$   $\mathbf{j}$  A particle P is moving with constant acceleration. At  $2 \,\mathrm{pm}$ , the velocity of P is

At time T hours after 2 pm, P is moving in the direction of the vector  $(-\mathbf{i} + 2\mathbf{j})$ 

(a) Find the value of T.

(6)

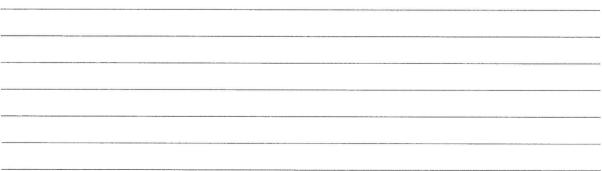
Another particle, Q, has velocity  $\mathbf{v}_Q$  km  $h^{-1}$  at time t hours after 2 pm, where

$$\mathbf{v}_{o} = (-4 - 2t)\mathbf{i} + (\mu + 3t)\mathbf{j}$$

and  $\mu$  is a constant.

Given that there is an instant when the velocity of P is equal to the velocity of Q,

(0)	ind the value of $\mu$ .			
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6. A particle of mass 6kg is projected with speed 5 mg-1 from line of greatest slope. Since  $\theta$  is projected with speed 5 mg-1 from  $\theta$  and  $\theta$  in  $\theta$  is projected with speed 5 mg-1 from  $\theta$  in  $\theta$ 

A particle of mass 6 kg is projected with speed 5 m s<sup>-1</sup> from a point A on the plane, up a line of greatest slope of the plane.

The coefficient of friction between the particle and the plane is  $\frac{1}{4}$ 

(a) Find the magnitude of the frictional force acting on the particle as it moves up the plane.

(3)

The particle comes to instantaneous rest at the point B.

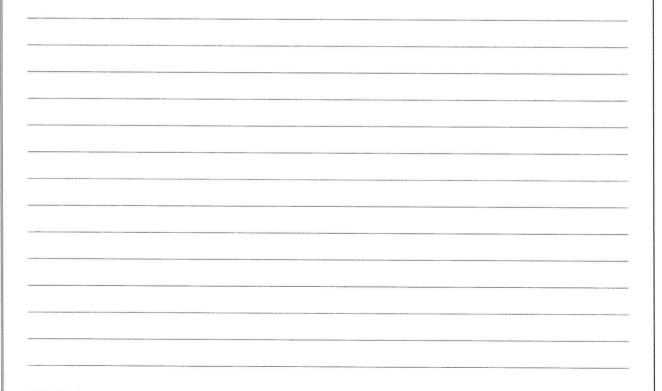
(b) Find the distance AB.

(5)

The particle now slides down the plane from B. At the instant when the particle passes through the point C on the plane, the speed of the particle is again 5 m s<sup>-1</sup>

(c) Find the distance BC.

(5)



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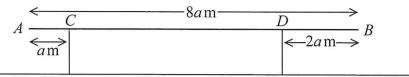


Figure 2

A non-uniform beam AB, of mass 60 kg and length 8a metres, rests in equilibrium in a horizontal position on two vertical supports. One support is at C, where AC = a metres and the other support is at D, where DB = 2a metres, as shown in Figure 2.

The magnitude of the normal reaction between the beam and the support at D is three times the magnitude of the normal reaction between the beam and the support at C.

By modelling the beam as a non-uniform rod whose centre of mass is at a distance x metres from A,

(a) find an expression for x in terms of a.

(5)

A box of mass M kg is placed on the beam at E, where AE = 2a metres.

The beam remains in equilibrium in a horizontal position.

The magnitude of the normal reaction between the beam and the support at C is now equal to the magnitude of the normal reaction between the beam and the support at D.

By modelling the box as a particle,

(b) find the value of M.

(5	)

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8. Two trams, tram A and tram B, run on parallel straight horizontal tracks. Initially the two trams are at rest in the depot and level with each other.

At time t = 0, tram A starts to move. Tram A moves with constant acceleration  $2 \text{ m s}^{-2}$  for 5 seconds and then continues to move along the track at constant speed.

At time t = 20 seconds, tram B starts from rest and moves in the same direction as tram A. Tram B moves with constant acceleration  $3 \text{ m s}^{-2}$  for 4 seconds and then continues to move along the track at constant speed.

The trams are modelled as particles.

(a) Sketch, on the same axes, a speed-time graph for the motion of tram A and a speed-time graph for the motion of tram B, from t = 0 to the instant when tram B overtakes tram A.

(3)

At the instant when the two trams are moving with the same speed, tram A is d metres in front of tram B.

(b) Find the value of d.

(5)

(c) Find the distance of the trams from the depot at the instant when tram B overtakes tram A.

(5)

(3)

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