OCR
Oxford Cambridge and RSA

AS Level Further Mathematics B (MEI)

Y411/01 Mechanics a

Practice Paper – Set 2

Time allowed: 1 hour 15 minutes

You must have:
- Printed Answer Booklet
- Formulae Further Mathematics B (MEI)

You may use:
- a scientific or graphical calculator

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.** If additional space is required you should use the lined page(s) at the end of the Printed Answer Booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION
- The total number of marks for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is used. You should communicate your method with correct reasoning.
- The Printed Answer Booklet consists of **12** pages. The Question Paper consists of **4** pages.

Answer **all** the questions.

1 Forces P and Q act on a particle. P has magnitude 6 N and Q is perpendicular to P. The resultant of the two forces has magnitude 10 N.

(i) Find the magnitude of force Q. **[2]**

(ii) Find the acute angle the resultant makes with force Q. **[2]**

2 Hooke's law states that when a spring is extended by a length x the magnitude F of the force in the spring is given by $F = kx$, where k is the stiffness of the spring.

(i) Write down the dimensions of force. **[1]**

(ii) Find the dimensions of k. **[2]**

A particle of mass m is attached to the end of a spring with stiffness k. The particle oscillates with amplitude d. The maximum speed v of the particle is given by $v = cm^{\alpha}k^{\beta}d^{\gamma}$, where c is a dimensionless constant.

(iii) Find the values of α, β and γ. **[4]**

3

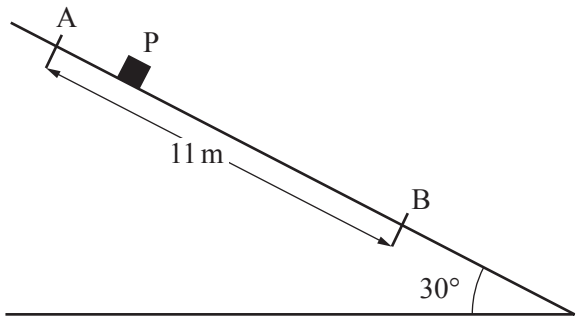

Fig. 3

A and B are points, 11 m apart, on a line of greatest slope of a uniformly rough plane, as shown in Fig. 3. The plane is inclined at an angle of 30° to the horizontal. A parcel P of mass 0.4 kg slides down the plane from A to B. Its speed at A is 7 m s^{-1} and its speed at B is 3 m s^{-1}.

Use an energy method to find the coefficient of friction between P and the plane. **[8]**

4

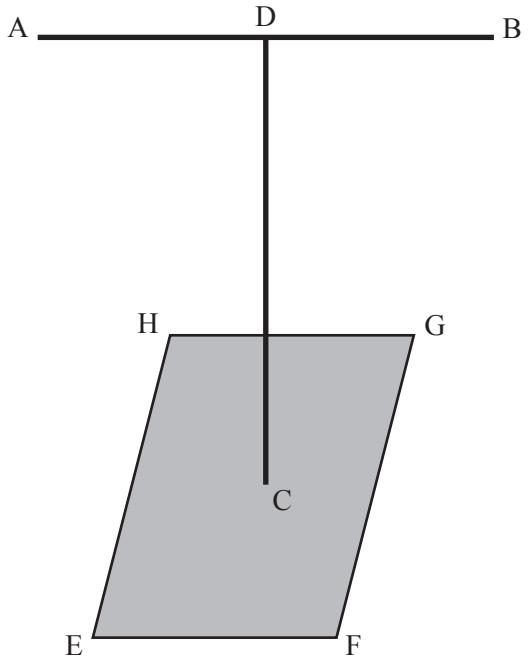

Fig. 5

Fig. 5 shows a stand made of a horizontal base EFGH, a vertical rod CD and a horizontal rod ADB. The rod ADB is parallel to the edge EF of the base.

The stand is modelled as follows:

- EFGH is a uniform horizontal rectangular lamina of mass 20 kg; EF is 20 cm and FG is 40 cm,
- CD is a uniform vertical rod of mass 5 kg and length 100 cm; C is the midpoint of the base EFGH,
- ADB is a uniform horizontal rod of mass 2 kg and length 50 cm; D is the midpoint of AB.

The centre of mass of the stand is at a point M.

(i) **(*A*)** Explain why M lies on CD. **[1]**

(*B*) Find the distance MC. **[3]**

A small object of mass 8 kg is attached to the rod ADB at a distance of 10 cm from A. The centre of mass of the stand together with the object is at a point Q.

(ii) Find the distance MQ. **[6]**

The stand, with the object still attached, is now tilted about one of its four edges until it just topples. Given that the angle through which the stand is tilted is as small as possible,

(iii) **(*A*)** determine which edge the stand is tilted about, **[1]**

(*B*) find the angle through which the stand is tilted. **[4]**

5 A disc R of mass 4 kg is at rest on a smooth horizontal table. A constant horizontal force of magnitude 12 N acts on the disc for 3 seconds.

(i) Find the magnitude of the impulse on R. **[1]**

(ii) Find the speed of R when the force stops acting. **[2]**

The disc R collides directly with a disc Q of mass 7 kg moving with speed $3\,\text{m s}^{-1}$ in the opposite direction to R. After the collision, R and Q both move in the same direction, and the speed of Q is twice the speed of R.

(iii) Find the impulse on Q in the collision. **[5]**

(iv) Find the coefficient of restitution between R and Q. **[3]**

6 A van of mass 2 tonnes is travelling uphill on a straight road. On one part of the road, the power developed by the van is modelled as constant at 30 kW for a period of 20 seconds. During this time the speed of the van increases from $10\,\text{m s}^{-1}$ to $15\,\text{m s}^{-1}$ and the work done against resistance to motion is modelled as 80 kJ.

(i) Calculate the height gained by the van during this period. **[6]**

(ii) State a limitation of the models used and how this could be improved. **[2]**

A different part of the road is inclined at a constant angle to the horizontal. When the van develops a power of 18 kW and the resistance to motion is 190 N the van travels up the slope at a constant speed of $8\,\text{m s}^{-1}$.

(iii) Find the inclination of this part of the road. **[7]**

END OF QUESTION PAPER