OCR
Oxford Cambridge and RSA

AS Level Further Mathematics A

Y533/01 Mechanics

Practice Paper – Set 1

Time allowed: 1 hour 15 minutes

You must have:
- Printed Answer Booklet
- Formulae AS Level Further Mathematics A

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 $g\,\text{m}\,\text{s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- **You are reminded of the need for clear presentation in your answers.**
- The Printed Answer Booklet consists of **12** pages. The Question Paper consists of **4** pages.

Answer **all** the questions.

1 A climber of mass 65 kg climbs from the bottom to the top of a vertical cliff which is 78 m in height. The climb takes 90 minutes so the velocity of the climber can be neglected.

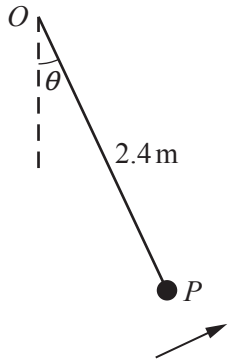
(i) Calculate the work done by the climber in climbing the cliff. **[2]**

(ii) Calculate the average power generated by the climber in climbing the cliff. **[2]**

2 The universal law of gravitation states that $F = \dfrac{Gm_1m_2}{r^2}$ where F is the magnitude of the force between two objects of masses m_1 and m_2 which are a distance r apart and G is a constant.

Find the dimensions of G. **[4]**

3

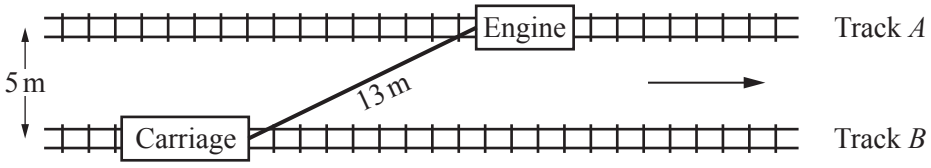


A particle P of mass 1.5 kg is attached to one end of a light inextensible string of length 2.4 m. The other end of the string is attached to a fixed point O. The particle is initially at rest directly below O. A horizontal impulse of magnitude 9.3 N s is applied to P. In the subsequent motion the string remains taut and makes an angle of θ radians with the downwards vertical at O, as shown in the diagram.

(i) Find the speed of P when $\theta = \frac{1}{6}\pi$. **[6]**

(ii) Determine whether P will reach the same horizontal level as O. **[2]**

4



A and *B* are two long straight parallel horizontal sections of railway track. An engine on track *A* is attached to a carriage of mass 6000 kg on track *B* by a light inextensible chain which remains horizontal and taut in the ensuing motion. The chain is 13 m in length and the points of attachment on the engine and carriage are a perpendicular distance of 5 m apart. The engine and carriage start at rest and then the engine accelerates uniformly to a speed of $5.6\,\text{m s}^{-1}$ while travelling 250 m. It is assumed that any resistance to motion can be ignored.

(i) Find the work done on the carriage by the tension in the chain. **[3]**

(ii) Find the magnitude of the tension in the chain. **[3]**

The mass of the engine is 10 000 kg.

(iii) At a point further along the track the engine and the carriage are moving at a speed of $8.4\,\text{m s}^{-1}$ and the power of the engine is 68 kW. Find the acceleration of the engine at this instant. **[3]**

5 Two discs, *A* and *B*, have masses 1.4 kg and 2.1 kg respectively. They are sliding towards each other in the same straight line across a large sheet of horizontal ice. Immediately before the collision *A* has speed $2\,\text{m s}^{-1}$ and *B* has speed $3\,\text{m s}^{-1}$. Immediately after the collision *A*'s speed is $4\,\text{m s}^{-1}$.

(i) Explain why it is impossible for *A* to be travelling in the same direction after the collision as it was before the collision. **[2]**

(ii) Find the velocity of *B* immediately after the collision. **[4]**

(iii) Calculate the coefficient of restitution between *A* and *B*. **[2]**

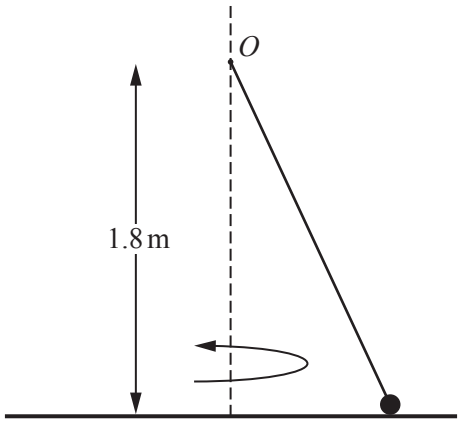
(iv) State what your answer to part **(iii)** means about the kinetic energy of the system. **[1]**

The discs are made from the same material. The discs will be damaged if subjected to an impulse of magnitude greater than 6.5 N s.

(v) Determine whether *B* will be damaged as a result of the collision. **[3]**

(vi) Explain why *A* will be damaged if, and only if, *B* is damaged. **[1]**

6



A particle of mass 0.2 kg is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point O which is 1.8 m above a smooth horizontal table. The particle moves on the table in a circular path at constant speed with the string taut (see diagram).

The particle has a speed of $0.5\,\text{m s}^{-1}$ and its angular velocity is $0.625\,\text{rad s}^{-1}$.

(i) Show that the radius of the circular path is 0.8 m. **[1]**

(ii) Find the magnitude of the normal contact force between the particle and the table. **[6]**

The speed is changed to $v\,\text{m s}^{-1}$. At this speed the particle is just about to lose contact with the table.

(iii) Find the value of v. **[3]**

7 The masses of two particles A and B are m and $2m$ respectively. They are moving towards each other on a smooth horizontal table. Just before they collide their speeds are u and $2u$ respectively. After the collision the kinetic energy of A is 8 times the kinetic energy of B. Find the coefficient of restitution between A and B. **[12]**

END OF QUESTION PAPER