

Friday 25 January 2013 – Afternoon

**AS GCE MATHEMATICS**

**4728/01** Mechanics 1

**QUESTION PAPER**

Candidates answer on the Printed Answer Book.

**OCR supplied materials:**

- Printed Answer Book 4728/01
- List of Formulae (MF1)

**Other materials required:**

- Scientific or graphical calculator

**Duration:** 1 hour 30 minutes



**INSTRUCTIONS TO CANDIDATES**

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration due to gravity is denoted by  $g \text{ ms}^{-2}$ . Unless otherwise instructed, when a numerical value is needed, use  $g = 9.8$ .

**INFORMATION FOR CANDIDATES**

This information is the same on the Printed Answer Book and the Question Paper.

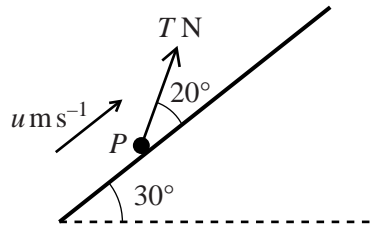
- The number of marks is given in brackets [ ] at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

**INSTRUCTION TO EXAMS OFFICER/INVIGILATOR**

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- 1 Three horizontal forces, acting at a single point, have magnitudes 12 N, 14 N and 5 N and act along bearings  $000^\circ$ ,  $090^\circ$  and  $270^\circ$  respectively. Find the magnitude and bearing of their resultant. [5]
- 2 A particle  $P$  moves in a straight line. The displacement of  $P$  from a fixed point on the line is  $(t^4 - 2t^3 + 5)$  m, where  $t$  is the time in seconds. Show that, when  $t = 1.5$ ,
- (i)  $P$  is at instantaneous rest, [3]
- (ii) the acceleration of  $P$  is  $9 \text{ m s}^{-2}$ . [3]

3



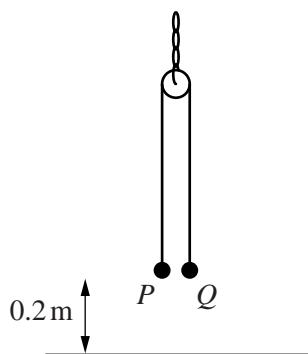
A particle  $P$  of mass  $0.25 \text{ kg}$  moves upwards with constant speed  $u \text{ m s}^{-1}$  along a line of greatest slope on a smooth plane inclined at  $30^\circ$  to the horizontal. The pulling force acting on  $P$  has magnitude  $T \text{ N}$  and acts at an angle of  $20^\circ$  to the line of greatest slope (see diagram). Calculate

- (i) the value of  $T$ , [3]
- (ii) the magnitude of the contact force exerted on  $P$  by the plane. [3]

The pulling force  $T \text{ N}$  acting on  $P$  is suddenly removed, and  $P$  comes to instantaneous rest  $0.4 \text{ s}$  later.

- (iii) Calculate  $u$ . [4]

- 4 The acceleration of a particle  $P$  moving in a straight line is  $(t^2 - 9t + 18) \text{ m s}^{-2}$ , where  $t$  is the time in seconds.
- (i) Find the values of  $t$  for which the acceleration is zero. [2]
- (ii) It is given that when  $t = 3$  the velocity of  $P$  is  $9 \text{ m s}^{-1}$ . Find the velocity of  $P$  when  $t = 0$ . [4]
- (iii) Show that the direction of motion of  $P$  changes before  $t = 1$ . [2]



A small smooth pulley is suspended from a fixed point by a light chain. A light inextensible string passes over the pulley. Particles  $P$  and  $Q$ , of masses  $0.3\text{ kg}$  and  $m\text{ kg}$  respectively, are attached to the opposite ends of the string. The particles are released from rest at a height of  $0.2\text{ m}$  above horizontal ground with the string taut; the portions of the string not in contact with the pulley are vertical (see diagram).  $P$  strikes the ground with speed  $1.4\text{ m s}^{-1}$ . Subsequently  $P$  remains on the ground, and  $Q$  does not reach the pulley.

- (i) Calculate the acceleration of  $P$  while it is in motion and the corresponding tension in the string. [4]
- (ii) Find the value of  $m$ . [3]
- (iii) Calculate the greatest height of  $Q$  above the ground. [4]
- (iv) It is given that the mass of the pulley is  $0.5\text{ kg}$ . State the magnitude of the tension in the chain which supports the pulley
- (a) when  $P$  is in motion, [2]
- (b) when  $P$  is at rest on the ground and  $Q$  is moving upwards. [1]
- 6 Particle  $P$  of mass  $0.3\text{ kg}$  and particle  $Q$  of mass  $0.2\text{ kg}$  are  $3.6\text{ m}$  apart on a smooth horizontal surface.  $P$  and  $Q$  are simultaneously projected directly towards each other along a straight line. Before the particles collide  $P$  has speed  $4\text{ m s}^{-1}$  and  $Q$  has speed  $5\text{ m s}^{-1}$ .
- (i) Given that the particles coalesce in the collision, calculate their common speed after they collide. [3]
- (ii) It is given instead that one particle is at rest immediately after the collision.
- (a) State which particle is in motion after the collision and find the speed of this particle. [4]
- (b) Find the time taken after the collision for the moving particle to return to its initial position. [4]
- (c) On a single diagram sketch the  $(t, v)$  graphs for the two particles, with  $t = 0$  as the instant of their initial projection. [4]

- 7  $A$  and  $B$  are two points on a line of greatest slope of a plane inclined at  $45^\circ$  to the horizontal and  $AB = 2$  m. A particle  $P$  of mass  $0.4$  kg is projected from  $A$  towards  $B$  with speed  $5 \text{ m s}^{-1}$ . The coefficient of friction between the plane and  $P$  is  $0.2$ .
- (i) Given that the level of  $A$  is above the level of  $B$ , calculate the speed of  $P$  when it passes through the point  $B$ , and the time taken to travel from  $A$  to  $B$ . [7]
- (ii) Given instead that the level of  $A$  is below the level of  $B$ ,
- (a) show that  $P$  does not reach  $B$ , [3]
- (b) calculate the difference in the momentum of  $P$  for the two occasions when it is at  $A$ . [4]

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