OCR
RECOGNISING ACHIEVEMENT

**ADVANCED SUBSIDIARY GCE**

# MATHEMATICS 4728

Mechanics 1

**QUESTION PAPER**

Candidates answer on the printed answer book.

**OCR supplied materials:**
- Printed answer book 4728
- List of Formulae (MF1)

**Other materials required:**
- Scientific or graphical calculator

**Monday 24 January 2011**
**Morning**

**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. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- 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 $g$ m s$^{-2}$. 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 **12** pages. The question paper consists of **4** pages. Any blank pages are indicated.

**INSTRUCTION TO EXAMS OFFICER / INVIGILATOR**

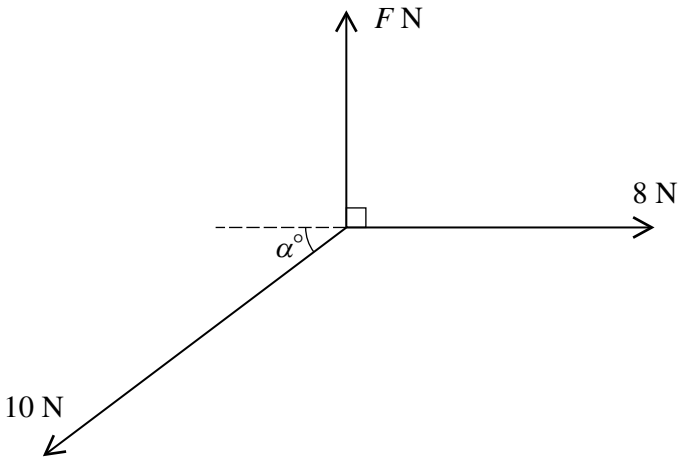
- Do not send this question paper for marking; it should be retained in the centre or destroyed.

**1** Two particles $P$ and $Q$ are projected directly towards each other on a smooth horizontal surface. $P$ has mass 0.5 kg and initial speed $2.4\,\text{m s}^{-1}$, and $Q$ has mass 0.8 kg and initial speed $1.5\,\text{m s}^{-1}$. After a collision between $P$ and $Q$, the speed of $P$ is $0.2\,\text{m s}^{-1}$ and the direction of its motion is reversed. Calculate

**(i)** the change in the momentum of $P$, **[2]**

**(ii)** the speed of $Q$ after the collision. **[4]**

**2**




Three horizontal forces of magnitudes $F$ N, 8 N and 10 N act at a point and are in equilibrium. The $F$ N and 8 N forces are perpendicular to each other, and the 10 N force acts at an obtuse angle $(90 + \alpha)^\circ$ to the $F$ N force (see diagram). Calculate

**(i)** $\alpha$, **[3]**

**(ii)** $F$. **[3]**

**3** A particle is projected vertically upwards with velocity $5\,\text{m s}^{-1}$ from a point 2.5 m above the ground.

**(i)** Calculate the speed of the particle when it strikes the ground. **[3]**

**(ii)** Calculate the time after projection when the particle reaches the ground. **[3]**

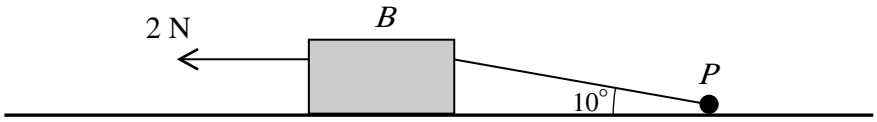
**(iii)** Sketch on separate diagrams

**(a)** the $(t, v)$ graph,

**(b)** the $(t, x)$ graph,

representing the motion of the particle. **[4]**

**4**

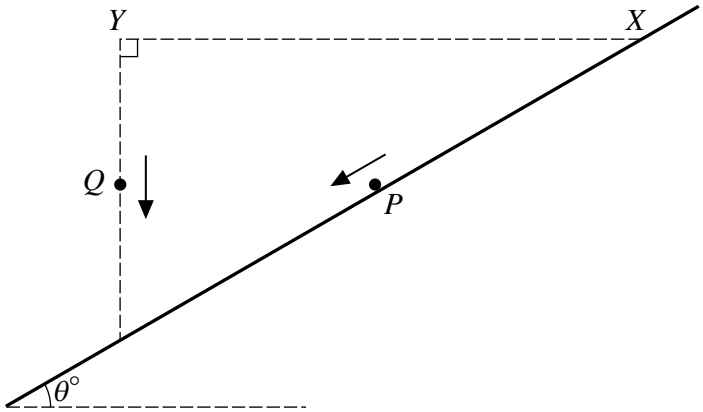



A block $B$ of mass 0.8 kg and a particle $P$ of mass 0.3 kg are connected by a light inextensible string inclined at 10° to the horizontal. They are pulled across a horizontal surface with acceleration $0.2\,\text{m s}^{-2}$, by a horizontal force of 2 N applied to $B$ (see diagram).

**(i)** Given that contact between $B$ and the surface is smooth, calculate the tension in the string. **[3]**

**(ii)** Calculate the coefficient of friction between $P$ and the surface. **[7]**

**5**




$X$ is a point on a smooth plane inclined at $\theta°$ to the horizontal. $Y$ is a point directly above the line of greatest slope passing through $X$, and $XY$ is horizontal. A particle $P$ is projected from $X$ with initial speed $4.9\,\text{m s}^{-1}$ down the line of greatest slope, and simultaneously a particle $Q$ is released from rest at $Y$. $P$ moves with acceleration $4.9\,\text{m s}^{-2}$, and $Q$ descends freely under gravity (see diagram). The two particles collide at the point on the plane directly below $Y$ at time $T$ s after being set in motion.

**(i) (a)** Express in terms of $T$ the distances travelled by the particles before the collision. **[3]**

**(b)** Calculate $\theta$. **[2]**

**(c)** Using the answers to parts **(a)** and **(b)**, show that $T = \frac{2}{3}$. **[3]**

**(ii)** Calculate the speeds of the particles immediately before they collide. **[3]**

**6** The velocity $v\,\text{m s}^{-1}$ of a particle at time $t$ s is given by $v = t^2 - 9$. The particle travels in a straight line and passes through a fixed point $O$ when $t = 2$.

**(i)** Find the displacement of the particle from $O$ when $t = 0$. **[4]**

**(ii)** Calculate the distance the particle travels from its position at $t = 0$ until it changes its direction of motion. **[6]**

**(iii)** Calculate the distance of the particle from $O$ when the acceleration of the particle is $10\,\text{m s}^{-2}$. **[5]**

**[Question 7 is printed overleaf.]**

**7** A particle $P$ of mass 0.6 kg is projected up a line of greatest slope of a plane inclined at $30^\circ$ to the horizontal. $P$ moves with deceleration $10\,\mathrm{m\,s^{-2}}$ and comes to rest before reaching the top of the plane.

**(i)** Calculate the frictional force acting on $P$, and the coefficient of friction between $P$ and the plane. **[7]**

**(ii)** Find the magnitude of the contact force exerted on $P$ by the plane and the angle between the contact force and the upward direction of the line of greatest slope,

**(a)** when $P$ is in motion, **[5]**

**(b)** when $P$ is at rest. **[2]**

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- List of Formulae (MF1)

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**Monday 24 January 2011**
**Morning**

**Duration:** 1 hour 30 minutes

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| Candidate forename | | Candidate surname | |
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| Centre number | | | | | | Candidate number | | | | |
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