OCR
RECOGNISING ACHIEVEMENT

**ADVANCED SUBSIDIARY GCE**

# MATHEMATICS

Mechanics 1

**4728**

Candidates answer on the Answer Booklet

**OCR Supplied Materials:**
- 8 page Answer Booklet
- List of Formulae (MF1)

**Other Materials Required:**
None

**Thursday 11 June 2009**
**Morning**

**Duration:** 1 hour 30 minutes

*4728*

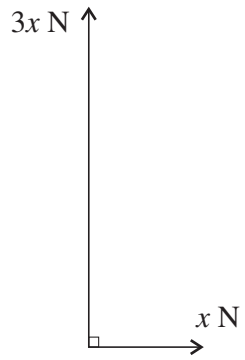
**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- 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 $g = 9.8$.
- You are permitted to use a graphical calculator in this paper.

**INFORMATION FOR CANDIDATES**

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

**1**




Two perpendicular forces have magnitudes $x$ N and $3x$ N (see diagram). Their resultant has magnitude 6 N.

**(i)** Calculate $x$. **[3]**

**(ii)** Find the angle the resultant makes with the smaller force. **[3]**

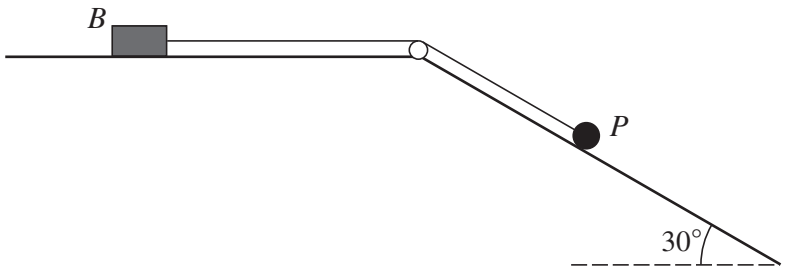
**2** The driver of a car accelerating uniformly from rest sees an obstruction. She brakes immediately bringing the car to rest with constant deceleration at a distance of 6 m from its starting point. The car travels in a straight line and is in motion for 3 seconds.

**(i)** Sketch the $(t, v)$ graph for the car's motion. **[2]**

**(ii)** Calculate the maximum speed of the car during its motion. **[3]**

**(iii)** Hence, given that the acceleration of the car is $2.4\,\text{m s}^{-2}$, calculate its deceleration. **[4]**

**3**




The diagram shows a small block $B$, of mass 3 kg, and a particle $P$, of mass 0.8 kg, which are attached to the ends of a light inextensible string. The string is taut and passes over a small smooth pulley. $B$ is held at rest on a horizontal surface, and $P$ lies on a smooth plane inclined at 30° to the horizontal. When $B$ is released from rest it accelerates at $0.2\,\text{m s}^{-2}$ towards the pulley.

**(i)** By considering the motion of $P$, show that the tension in the string is 3.76 N. **[4]**

**(ii)** Calculate the coefficient of friction between $B$ and the horizontal surface. **[5]**

**4** An object is projected vertically upwards with speed $7\,\text{m s}^{-1}$. Calculate

**(i)** the speed of the object when it is 2.1 m above the point of projection, **[3]**

**(ii)** the greatest height above the point of projection reached by the object, **[3]**

**(iii)** the time after projection when the object is travelling downwards with speed $5.7\,\text{m s}^{-1}$. **[3]**

**5** **(i)**


**Fig. 1**

A particle $P$ of mass 0.5 kg is projected with speed $6\,\text{m s}^{-1}$ on a smooth horizontal surface towards a stationary particle $Q$ of mass $m$ kg (see Fig. 1). After the particles collide, $P$ has speed $v\,\text{m s}^{-1}$ in its original direction of motion, and $Q$ has speed $1\,\text{m s}^{-1}$ more than $P$. Show that $v(m + 0.5) = -m + 3$. **[3]**

**(ii)**

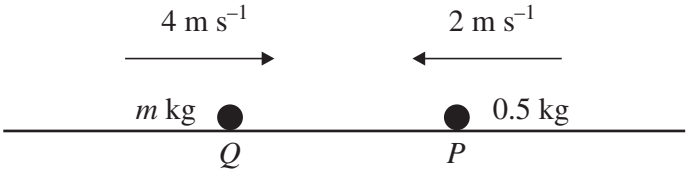



**Fig. 2**

$Q$ and $P$ are now projected towards each other with speeds $4\,\text{m s}^{-1}$ and $2\,\text{m s}^{-1}$ respectively (see Fig. 2). Immediately after the collision the speed of $Q$ is $v\,\text{m s}^{-1}$ with its direction of motion unchanged and $P$ has speed $1\,\text{m s}^{-1}$ more than $Q$. Find another relationship between $m$ and $v$ in the form $v(m + 0.5) = am + b$, where $a$ and $b$ are constants. **[4]**

**(iii)** By solving these two simultaneous equations show that $m = 0.9$, and hence find $v$. **[4]**

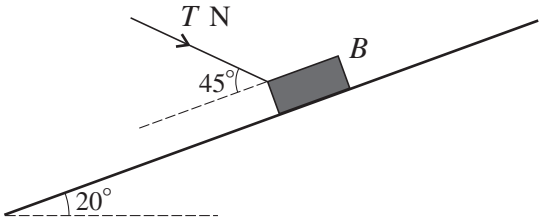
**[Questions 6 and 7 are printed overleaf.]**

**6** A block $B$ of weight 10 N is projected down a line of greatest slope of a plane inclined at an angle of 20° to the horizontal. $B$ travels down the plane at constant speed.

**(i)** **(a)** Find the components perpendicular and parallel to the plane of the contact force between $B$ and the plane. **[2]**

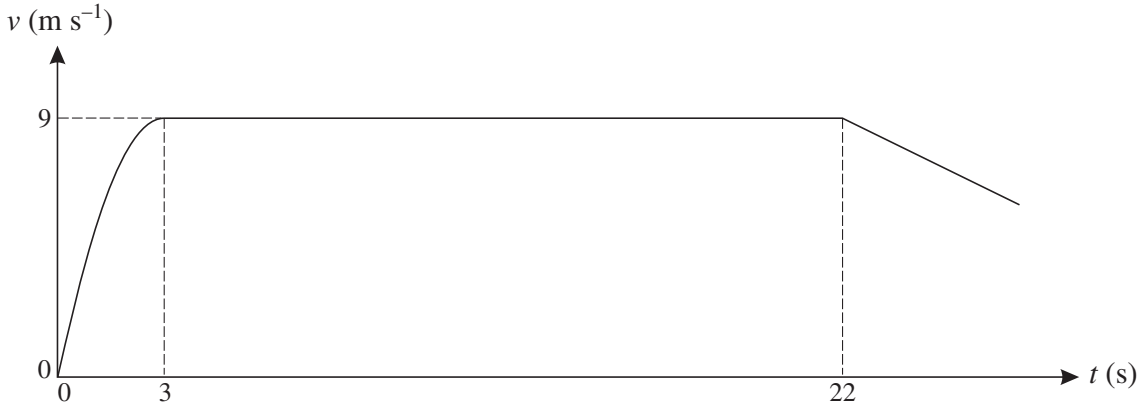
**(b)** Hence show that the coefficient of friction is 0.364, correct to 3 significant figures. **[2]**

**(ii)**




$B$ is in limiting equilibrium when acted on by a force of $T$ N directed towards the plane at an angle of 45° to a line of greatest slope (see diagram). Given that the frictional force on $B$ acts down the plane, find $T$. **[7]**

**7**




A sprinter $S$ starts from rest at time $t = 0$, where $t$ is in seconds, and runs in a straight line. For $0 \leqslant t \leqslant 3$, $S$ has velocity $(6t - t^2)$ m s$^{-1}$. For $3 < t \leqslant 22$, $S$ runs at a constant speed of 9 m s$^{-1}$. For $t > 22$, $S$ decelerates at 0.6 m s$^{-2}$ (see diagram).

**(i)** Express the acceleration of $S$ during the first 3 seconds in terms of $t$. **[2]**

**(ii)** Show that $S$ runs 18 m in the first 3 seconds of motion. **[5]**

**(iii)** Calculate the time $S$ takes to run 100 m. **[3]**

**(iv)** Calculate the time $S$ takes to run 200 m. **[7]**