



**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



**INSTRUCTIONS TO CANDIDATES**

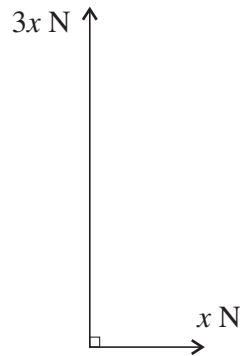
- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- 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  $g \text{ m s}^{-2}$ . 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.

2

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]

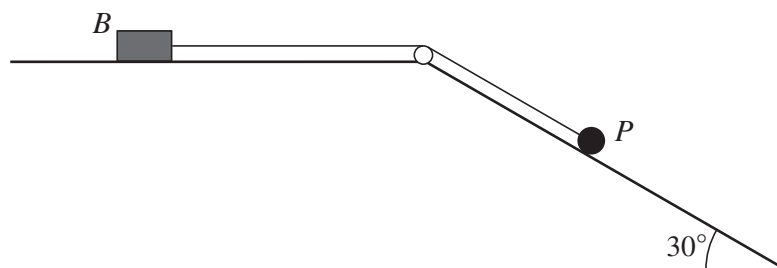
2 The driver of a car accelerating uniformly from rest sees an obstruction. She brakes immediately bringing the car to rest with constant deceleration at a distance of 6 m from its starting point. The car travels in a straight line and is in motion for 3 seconds.

(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  $30^\circ$  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]

## 3

- 4 An object is projected vertically upwards with speed  $7 \text{ m s}^{-1}$ . Calculate
- (i) the speed of the object when it is  $2.1 \text{ m}$  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)

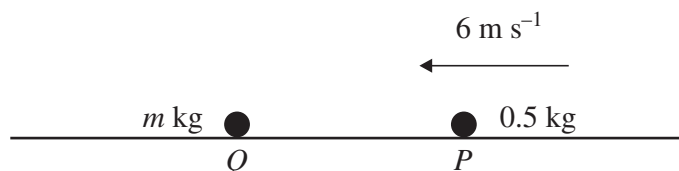


Fig. 1

A particle  $P$  of mass  $0.5 \text{ kg}$  is projected with speed  $6 \text{ m s}^{-1}$  on a smooth horizontal surface towards a stationary particle  $Q$  of mass  $m \text{ kg}$  (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)

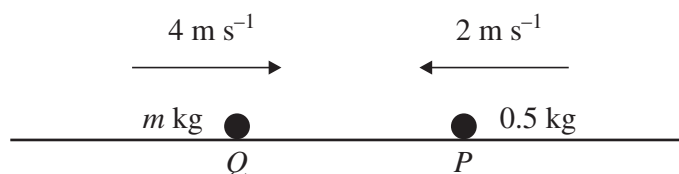


Fig. 2

$Q$  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.]

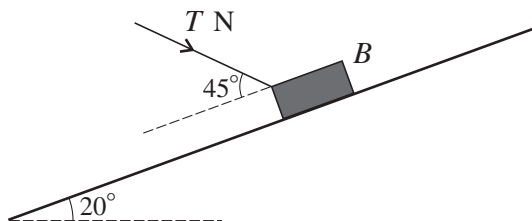
4

6 A block  $B$  of weight  $10\text{ N}$  is projected down a line of greatest slope of a plane inclined at an angle of  $20^\circ$  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]

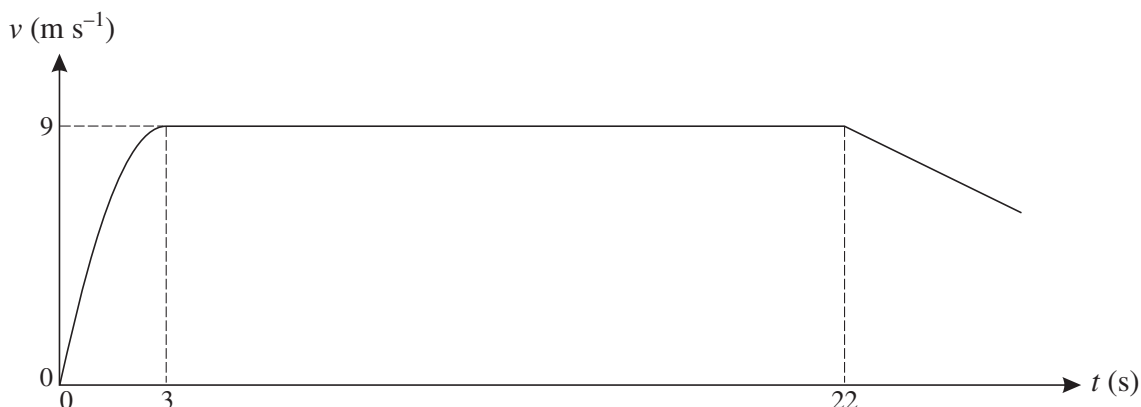
(b) Hence show that the coefficient of friction is  $0.364$ , correct to 3 significant figures. [2]

(ii)



$B$  is in limiting equilibrium when acted on by a force of  $T\text{ N}$  directed towards the plane at an angle of  $45^\circ$  to a line perpendicular to the plane (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  $0 \leq t \leq 3$ ,  $S$  has velocity  $(6t - t^2)\text{ m s}^{-1}$ . For  $3 < t \leq 22$ ,  $S$  runs at a constant speed of  $9\text{ m s}^{-1}$ . For  $t > 22$ ,  $S$  decelerates at  $0.6\text{ m s}^{-2}$  (see diagram).

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

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

(iii) Calculate the time  $S$  takes to run  $100\text{ m}$ . [3]

(iv) Calculate the time  $S$  takes to run  $200\text{ m}$ . [7]



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