

# ADVANCED SUBSIDIARY GCE MATHEMATICS

4728

Mechanics 1

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



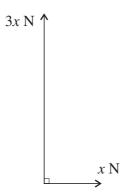
### **INSTRUCTIONS TO CANDIDATES**

- 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.

1

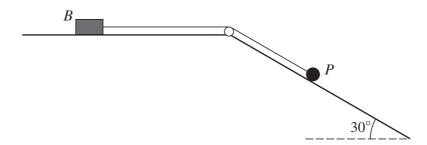


Two perpendicular forces have magnitudes x N and 3x N (see diagram). Their resultant has magnitude 6 N.

(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  $2.4 \,\mathrm{m \, s^{-2}}$ , calculate its deceleration. [4]

3



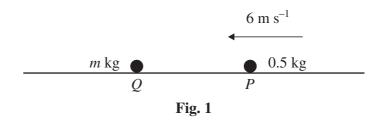
The diagram shows a small block B, of mass 3 kg, and a particle P, of mass 0.8 kg, which are attached to the ends of a light inextensible string. The string is taut and passes over a small smooth pulley. B is held at rest on a horizontal surface, and P lies on a smooth plane inclined at  $30^{\circ}$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

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- 4 An object is projected vertically upwards with speed 7 m s<sup>-1</sup>. 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  $5.7 \,\mathrm{m \, s^{-1}}$ . [3]

## 5 (i)



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

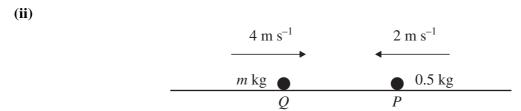


Fig. 2

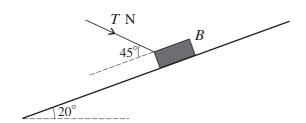
Q and P are now projected towards each other with speeds  $4 \,\mathrm{m\,s^{-1}}$  and  $2 \,\mathrm{m\,s^{-1}}$  respectively (see Fig. 2). Immediately after the collision the speed of Q is  $v \,\mathrm{m\,s^{-1}}$  with its direction of motion unchanged and P has speed  $1 \,\mathrm{m\,s^{-1}}$  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.

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

# [Questions 6 and 7 are printed overleaf.]

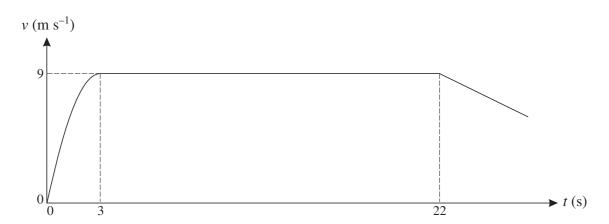
- A block B of weight 10 N is projected down a line of greatest slope of a plane inclined at an angle of  $20^{\circ}$  to the horizontal. B travels down the plane at constant speed.
  - (i) (a) Find the components perpendicular and parallel to the plane of the contact force between B and the plane. [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 N directed towards the plane at an angle of  $45^{\circ}$  to a line of greatest slope (see diagram). Given that the frictional force on B acts down the plane, find T.

7



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



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