

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

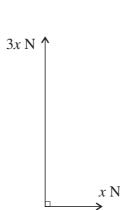


## INSTRUCTIONS TO CANDIDATES

- 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  $g \,\mathrm{m}\,\mathrm{s}^{-2}$ . 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.



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

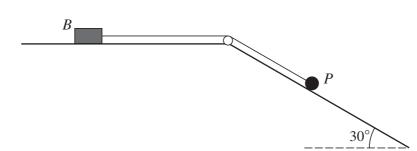
(i) Calculate <i>x</i> .	[3]
(ii) Find the angle the resultant makes with the smaller force.	[3]

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]
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- (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

1



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.

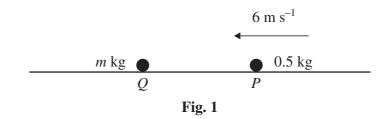
- (i) By considering the motion of *P*, show that the tension in the string is 3.76 N. [4]
- (ii) Calculate the coefficient of friction between *B* and the horizontal surface. [5]

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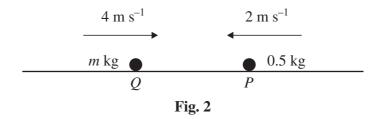
4 An object is projected vertically upwards with speed  $7 \text{ m s}^{-1}$ . Calculate

- (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  $5.7 \,\mathrm{m \, s^{-1}}$ . [3]
- 5 (i)



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)** 



*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]

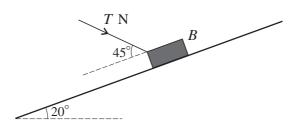
# [Questions 6 and 7 are printed overleaf.]

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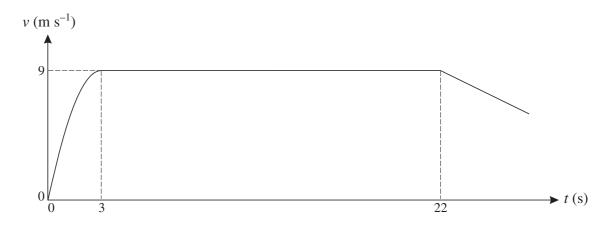
- 6 A block *B* of weight 10 N is projected down a line of greatest slope of a plane inclined at an angle of  $20^{\circ}$  to the horizontal. *B* travels down the plane at constant speed.
  - (i) (a) Find the components perpendicular and parallel to the plane of the contact force between *B* and the 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]

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  $(6t - t^2) \operatorname{m s}^{-1}$ . For  $3 < t \le 22$ , S runs at a constant speed of  $9 \operatorname{m s}^{-1}$ . For t > 22, S decelerates at  $0.6 \operatorname{m s}^{-2}$  (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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