RECOGNISING ACHIEVEMENT

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

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

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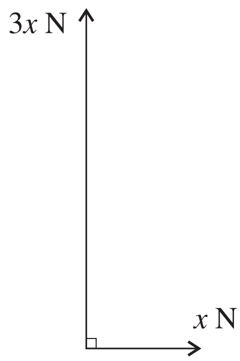
1



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]**

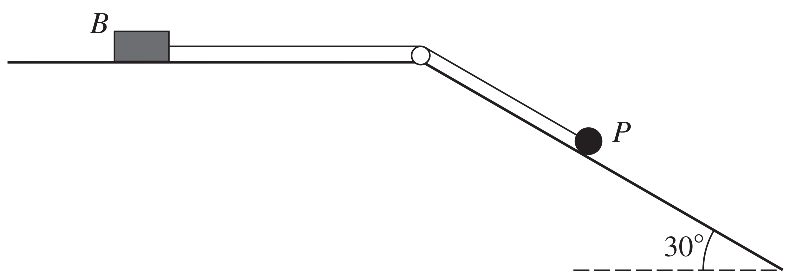
2 The driver of a car accelerating uniformly from rest sees an obstruction. She brakes immediately bringing the car to rest with constant deceleration at a distance of 6 m from its starting point. The car travels in a straight line and is in motion for 3 seconds.

(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 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 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 $7\,\mathrm{m\,s^{-1}}$. 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)**

Fig. 1

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 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 $v(m + 0.5) = -m + 3$. **[3]**

(ii)

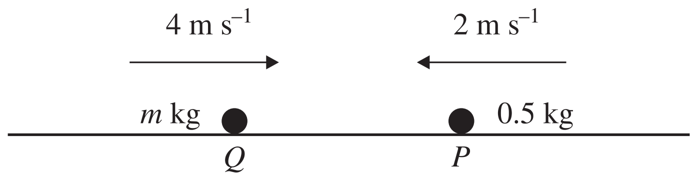


Fig. 2

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. **[4]**

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

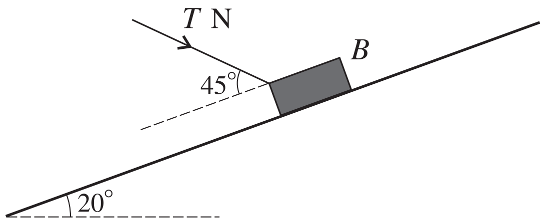
[Questions 6 and 7 are printed overleaf.]

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]**

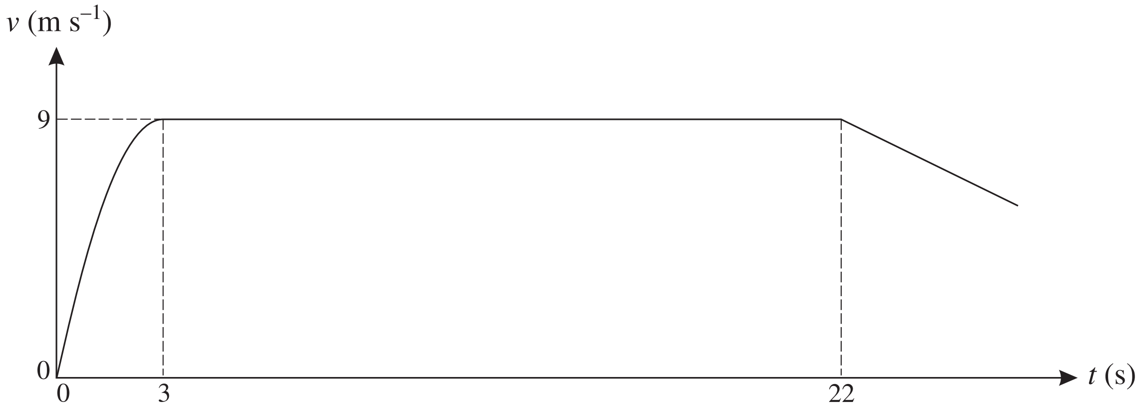
(b) Hence show that the coefficient of friction is 0.364, correct to 3 significant figures. **[2]**

(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 $(6t - t^2)\,\text{m s}^{-1}$. For $3 < t \leqslant 22$, 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 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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