OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4728/01**

MATHEMATICS

Mechanics 1

THURSDAY 17 JANUARY 2008 Afternoon

Time: 1 hour 30 minutes

Additional materials: Answer Booklet (8 pages)
List of Formulae (MF1)

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- 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 $g\,\mathrm{m\,s^{-2}}$. 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.
- The total number of marks for this paper is 72.
- **You are reminded of the need for clear presentation in your answers.**

This document consists of **4** printed pages.

[Turn over

1 A man of mass 70 kg stands on the floor of a lift which is moving with an upward acceleration of $0.3\,\text{m s}^{-2}$. Calculate the magnitude of the force exerted by the floor on the man. [4]

2 An ice skater of mass 40 kg is moving in a straight line with speed $4\,\text{m s}^{-1}$ when she collides with a skater of mass 60 kg moving in the opposite direction along the same straight line with speed $3\,\text{m s}^{-1}$. After the collision the skaters move together with a common speed in the same straight line. Calculate their common speed, and state their direction of motion. [5]

3 Two horizontal forces **X** and **Y** act at a point O and are at right angles to each other. **X** has magnitude 12 N and acts along a bearing of 090°. **Y** has magnitude 15 N and acts along a bearing of 000°.

(i) Calculate the magnitude and bearing of the resultant of **X** and **Y**. [6]

(ii) A third force **E** is now applied at O. The three forces **X**, **Y** and **E** are in equilibrium. State the magnitude of **E**, and give the bearing along which it acts. [2]

4 The displacement of a particle from a fixed point O at time t seconds is $t^4 - 8t^2 + 16$ metres, where $t \geqslant 0$.

(i) Verify that when $t = 2$ the particle is at rest at the point O. [5]

(ii) Calculate the acceleration of the particle when $t = 2$. [3]

5 A car is towing a trailer along a straight road using a light tow-bar which is parallel to the road. The masses of the car and the trailer are 900 kg and 250 kg respectively. The resistance to motion of the car is 600 N and the resistance to motion of the trailer is 150 N.

(i) At one stage of the motion, the road is horizontal and the pulling force exerted on the trailer is zero.

(a) Show that the acceleration of the trailer is $-0.6\,\text{m s}^{-2}$. [2]

(b) Find the driving force exerted by the car. [3]

(c) Calculate the distance required to reduce the speed of the car and trailer from $18\,\text{m s}^{-1}$ to $15\,\text{m s}^{-1}$. [2]

(ii) At another stage of the motion, the car and trailer are moving down a slope inclined at 3° to the horizontal. The resistances to motion of the car and trailer are unchanged. The driving force exerted by the car is 980 N. Find

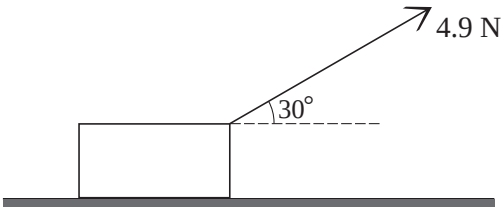
(a) the acceleration of the car and trailer, [4]

(b) the pulling force exerted on the trailer. [3]

6 A block of weight 14.7 N is at rest on a horizontal floor. A force of magnitude 4.9 N is applied to the block.

(i) The block is in limiting equilibrium when the 4.9 N force is applied horizontally. Show that the coefficient of friction is $\frac{1}{3}$. [2]

(ii)



When the force of 4.9 N is applied at an angle of 30° above the horizontal, as shown in the diagram, the block moves across the floor. Calculate

(a) the vertical component of the contact force between the floor and the block, and the magnitude of the frictional force, [5]

(b) the acceleration of the block. [5]

(iii) Calculate the magnitude of the frictional force acting on the block when the 4.9 N force acts at an angle of 30° to the upward vertical, justifying your answer fully. [4]

[Question 7 is printed overleaf.]

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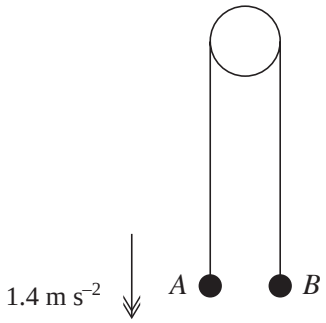

Particles A and B are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. The particles are released from rest, with the string taut, and A and B at the same height above a horizontal floor (see diagram). In the subsequent motion, A descends with acceleration $1.4\,\text{m s}^{-2}$ and strikes the floor 0.8 s after being released. It is given that B never reaches the pulley.

(i) Calculate the distance A moves before it reaches the floor and the speed of A immediately before it strikes the floor. [4]

(ii) Show that B rises a further 0.064 m after A strikes the floor, and calculate the total length of time during which B is rising. [4]

(iii) Sketch the (t, v) graph for the motion of B from the instant it is released from rest until it reaches a position of instantaneous rest. [2]

(iv) Before A strikes the floor the tension in the string is 5.88 N. Calculate the mass of A and the mass of B. [4]

(v) The pulley has mass 0.5 kg, and is held in a fixed position by a light vertical chain. Calculate the tension in the chain

(a) immediately before A strikes the floor, [2]

(b) immediately after A strikes the floor. [1]