OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4728/01**

MATHEMATICS

Mechanics 1

FRIDAY 6 JUNE 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.

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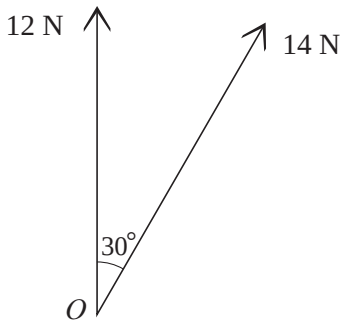
1 A car of mass 900 kg is travelling in a straight line on a horizontal road. The driving force acting on the car is 600 N, and a resisting force of 240 N opposes the motion.

(i) Show that the acceleration of the car is $0.4\,\text{m s}^{-2}$. [2]

(ii) Calculate the time and the distance required for the speed of the car to increase from $5\,\text{m s}^{-1}$ to $9\,\text{m s}^{-1}$. [4]

2

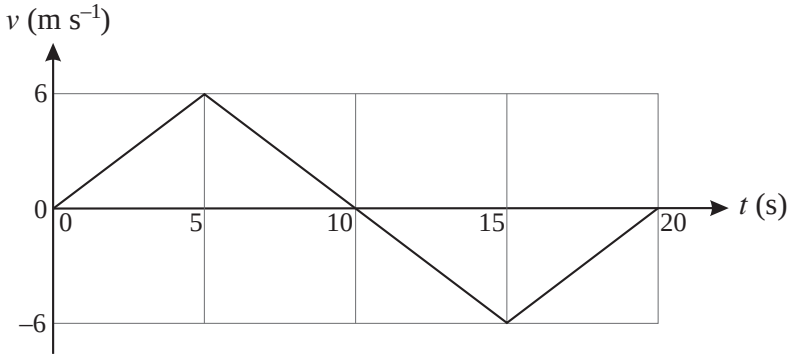


Two horizontal forces act at the point O. One force has magnitude 12 N and acts along a bearing of 000°. The other force has magnitude 14 N and acts along a bearing of 030° (see diagram).

(i) Show that the resultant of the two forces has magnitude 25.1 N, correct to 3 significant figures. [5]

(ii) Find the bearing of the line of action of the resultant. [3]

3



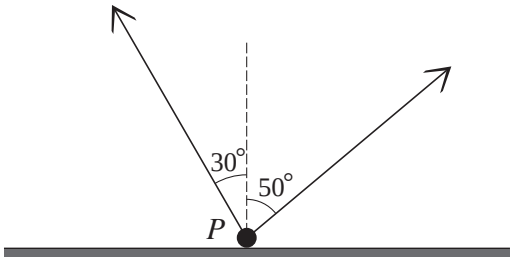
An athlete runs in a straight line from point A to point B, and back to point A. The diagram shows the (t, v) graph for the motion of the athlete. The graph consists of three straight line segments.

(i) Calculate the initial acceleration of the athlete. [2]

(ii) Calculate the total distance the athlete runs. [3]

(iii) Calculate the velocity of the athlete when $t = 17$. [3]

4



A particle P of weight 30 N rests on a horizontal plane. P is attached to two light strings making angles of 30° and 50° with the upward vertical, as shown in the diagram. The tension in each string is 15 N, and the particle is in limiting equilibrium. Find

(i) the magnitude and direction of the frictional force on P, [3]

(ii) the coefficient of friction between P and the plane. [5]

5 A railway wagon A of mass 2400 kg and moving with speed $5\,\text{m s}^{-1}$ collides with railway wagon B which has mass 3600 kg and is moving towards A with speed $3\,\text{m s}^{-1}$. Immediately after the collision the speeds of A and B are equal.

(i) Given that the two wagons are moving in the same direction after the collision, find their common speed. State which wagon has changed its direction of motion. [5]

(ii) Given instead that A and B are moving with equal speeds in opposite directions after the collision, calculate

(a) the speed of the wagons,

(b) the change in the momentum of A as a result of the collision.

[5]

6 A model train travels along a straight track. At time t seconds after setting out from station A, the train has velocity $v\,\text{m s}^{-1}$ and displacement x metres from A. It is given that for $0 \leqslant t \leqslant 7$

$$x = 0.01t^4 - 0.16t^3 + 0.72t^2.$$

After leaving A the train comes to instantaneous rest at station B.

(i) Express v in terms of t. Verify that when $t = 2$ the velocity of the train is $1.28\,\text{m s}^{-1}$. [3]

(ii) Express the acceleration of the train in terms of t, and hence show that when the acceleration of the train is zero $t^2 - 8t + 12 = 0$. [3]

(iii) Calculate the minimum value of v. [4]

(iv) Sketch the (t, v) graph for the train, and state the direction of motion of the train when it leaves B. [4]

(v) Calculate the distance AB. [2]

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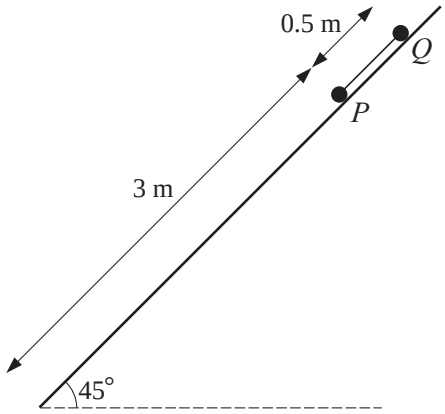
7



Two particles P and Q are joined by a taut light inextensible string which is parallel to a line of greatest slope on an inclined plane on which the particles are initially held at rest. The string is 0.5 m long, and the plane is inclined at 45° to the horizontal. P is below the level of Q and 3 m from the foot of the plane (see diagram). Each particle has mass 0.2 kg. Contact between P and the plane is smooth. The coefficient of friction between Q and the plane is 1. The particles are released from rest and begin to move down the plane.

(i) Show that the magnitude of the frictional force acting on Q is 1.386 N, correct to 4 significant figures. [2]

(ii) Show that the particles accelerate at $3.465\,\text{m}\,\text{s}^{-2}$, correct to 4 significant figures, and calculate the tension in the string. [5]

(iii) Calculate the speed of the particles at the instant when Q reaches the initial position of P. [2]

At the instant when Q reaches the initial position of P, Q becomes detached from the string and the two particles travel independently to the foot of the plane.

(iv) Show that Q descends at constant speed, and calculate the time interval between the arrival of P and the arrival of Q at the foot of the plane. [7]