

**ADVANCED SUBSIDIARY GCE
MATHEMATICS**

Mechanics 1

4728

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:

- Printed answer book 4728
- List of Formulae (MF1)

Other materials required:

- Scientific or graphical calculator

**Monday 20 June 2011
Morning**

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the printed answer book and the question paper.

- The question paper will be found in the centre of the printed answer book.
- Write your name, centre number and candidate number in the spaces provided on the printed answer book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the printed answer book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- 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 $g = 9.8$.

INFORMATION FOR CANDIDATES

This information is the same on the printed answer book and the question paper.

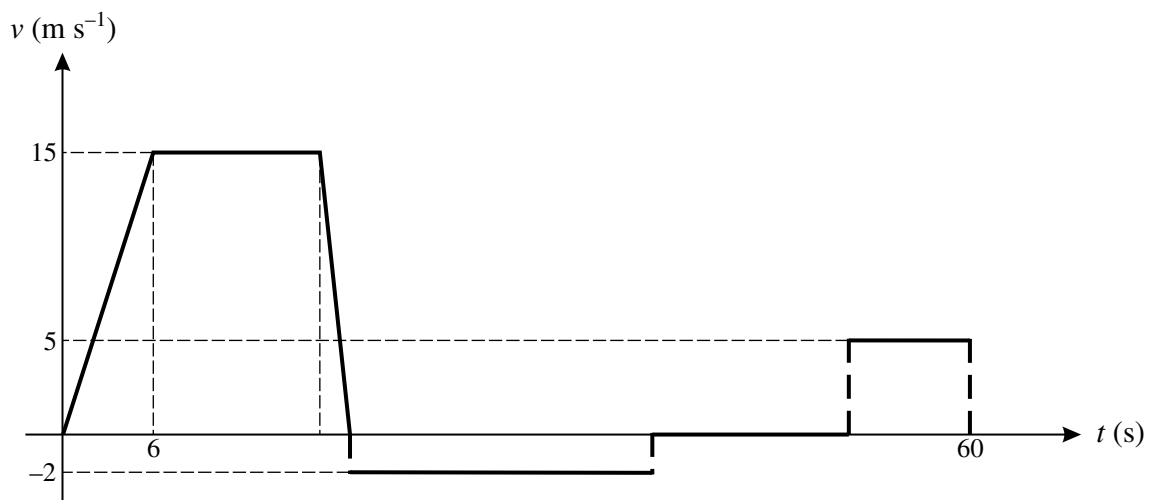
- The number of marks is given in brackets [] at the end of each question or part question on the question paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The printed answer book consists of **12** pages. The question paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do **not** send this question paper for marking; it should be retained in the centre or destroyed.

- 1 Two perpendicular forces have magnitudes 8 N and 15 N. Calculate the magnitude of the resultant force, and the angle which the resultant makes with the larger force. [4]
- 2 Particles P and Q , of masses 0.45 kg and m kg respectively, are attached to the ends of a light inextensible string which passes over a small smooth pulley. The particles are released from rest with the string taut and both particles 0.36 m above a horizontal surface. Q descends with acceleration 0.98 m s^{-2} . When Q strikes the surface, it remains at rest.
- (i) Calculate the tension in the string while both particles are in motion. [2]
- (ii) Find the value of m . [3]
- (iii) Calculate the speed at which Q strikes the surface. [2]
- (iv) Calculate the greatest height of P above the surface. (You may assume that P does not reach the pulley.) [3]
- 3 A block B of mass 0.8 kg is pulled across a horizontal surface by a force of 6 N inclined at an angle of 60° to the upward vertical. The coefficient of friction between the block and the surface is 0.2. Calculate
- (i) the vertical component of the force exerted on B by the surface, [2]
- (ii) the acceleration of B . [4]
- The 6 N force is removed when B has speed 4.9 m s^{-1} .
- (iii) Calculate the time taken for B to decelerate from a speed of 4.9 m s^{-1} to rest. [4]

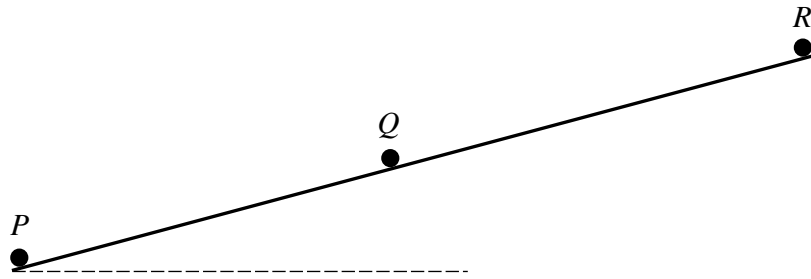
4



A car travelling on a straight road accelerates from rest to a speed of 15 m s^{-1} in 6 s. It continues at constant speed for 11 s and then decelerates to rest in 2 s. The driver gets out of the car and walks at a speed of 2 m s^{-1} for 20 s back to a shop which he enters. Some time later he leaves the shop and jogs to the car at a speed of 5 m s^{-1} . He arrives at the vehicle 60 s after it began to accelerate from rest. The diagram, which has six straight line segments, shows the (t, v) graph for the motion of the driver.

- (i) Calculate the initial acceleration and final deceleration of the car. [3]
- (ii) Calculate the distance the car travels. [3]
- (iii) Calculate the length of time the driver is in the shop. [4]

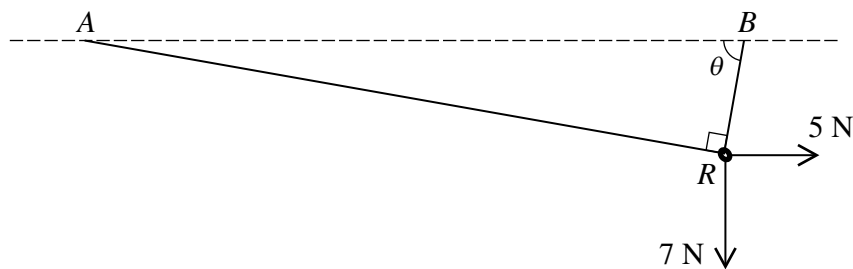
5



Three particles P , Q and R lie on a line of greatest slope of a smooth inclined plane. P has mass 0.5 kg and initially is at the foot of the plane. R has mass 0.3 kg and initially is at the top of the plane. Q has mass 0.2 kg and is between P and R (see diagram). P is projected up the line of greatest slope with speed 3 m s^{-1} at the instant when Q and R are released from rest. Each particle has an acceleration of 2.5 m s^{-2} down the plane.

- (i) P and Q collide 0.4 s after being set in motion. Immediately after the collision Q moves up the plane with speed 3.2 m s^{-1} . Find the speed and direction of motion of P immediately after the collision. [5]
- (ii) 0.6 s after its collision with P , Q collides with R and the two particles coalesce. Find the speed and direction of motion of the combined particle immediately after the collision [5]

6



A small smooth ring R of weight 7 N is threaded on a light inextensible string. The ends of the string are attached to fixed points A and B at the same horizontal level. A horizontal force of magnitude 5 N is applied to R . The string is taut. In the equilibrium position the angle ARB is a right angle, and the portion of the string attached to B makes an angle θ with the horizontal (see diagram).

- (i) Explain why the tension $T \text{ N}$ is the same in each part of the string. [1]
- (ii) By resolving horizontally and vertically for the forces acting on R , form two simultaneous equations in $T \cos \theta$ and $T \sin \theta$. [4]
- (iii) Hence find T and θ . [6]

[Question 7 is printed overleaf.]

7 A particle P is projected from a fixed point O on a straight line. The displacement x m of P from O at time t s after projection is given by $x = 0.1t^3 - 0.3t^2 + 0.2t$.

(i) Express the velocity and acceleration of P in terms of t . [4]

(ii) Show that when the acceleration of P is zero, P is at O . [3]

(iii) Find the values of t when P is stationary. [3]

At the instant when P first leaves O , a particle Q is projected from O . Q moves on the same straight line as P and at time t s after projection the velocity of Q is given by $(0.2t^2 - 0.4)$ m s⁻¹. P and Q collide first when $t = T$.

(iv) Show that T satisfies the equation $t^2 - 9t + 18 = 0$, and hence find T . [7]

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