OXFORD CAMBRIDGE AND RSA EXAMINATIONS

AS GCE

4728

MATHEMATICS

Mechanics 1

QUESTION PAPER

THURSDAY 31 MAY 2012: Morning
DURATION: 1 hour 30 minutes
plus your additional time allowance

MODIFIED ENLARGED

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

READ INSTRUCTIONS OVERLEAF

DC (CW/SW) 12MEP06412 64814

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.**
- **Candidates answer on the printed answer book or any suitable paper provided by the centre. The printed answer book may be enlarged by the centre.**
- **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. HB pencil may be used for graphs and diagrams only.**
- **Answer ALL the questions.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **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 m s^{-2}. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.**

INFORMATION FOR CANDIDATES

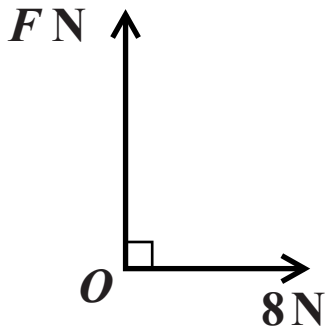
This information is the same on the Printed Answer Book and the Question Paper.

- **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.**

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- **Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.**

1 Look at the following diagram.



Two perpendicular forces of magnitudes F N and 8 N act at a point O (see diagram above). Their resultant has magnitude 17 N.

(i) Calculate F and find the angle which the resultant makes with the 8 N force. [4]

A third force of magnitude E N, acting in the same plane as the two original forces, is now applied at the point O. The three forces of magnitudes E N, F N and 8 N are in equilibrium.

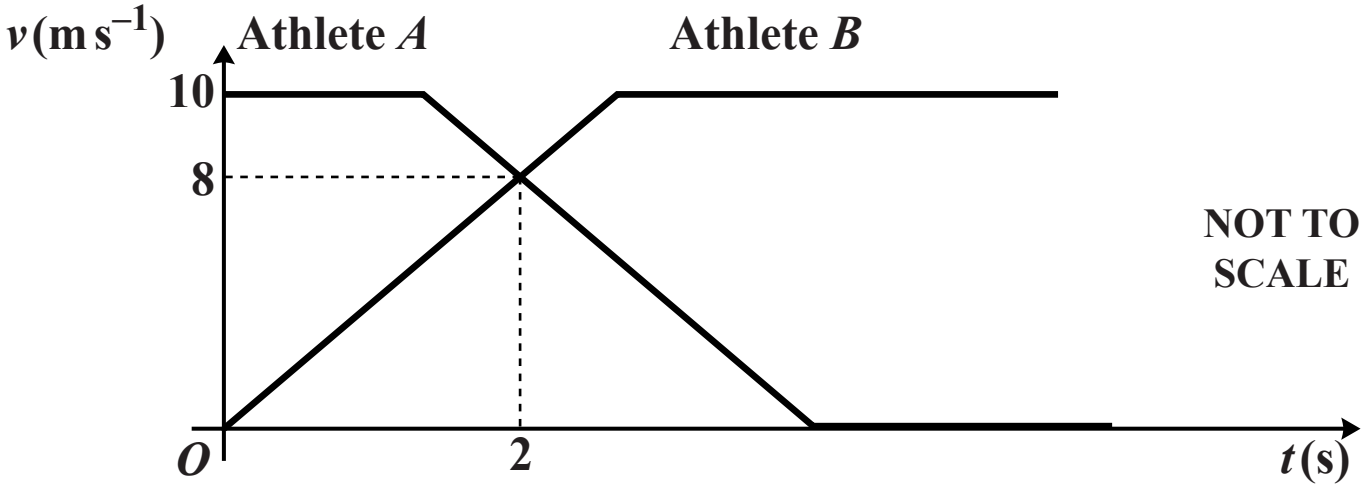
(ii) State the value of E and the angle between the directions of the E N and 8 N forces. [2]

2 A particle is projected vertically upwards with speed 7 m s^{-1} from a point on the ground.

(i) Find the speed of the particle and its distance above the ground 0.4 s after projection. [4]

(ii) Find the total distance travelled by the particle in the first 0.9 s after projection. [4]

3 Look at the following diagram.



The diagram above shows the (t, v) graphs for two athletes, A and B, who run in the same direction in the same straight line while they exchange the baton in a relay race. A runs with constant velocity $10\,\text{m s}^{-1}$ until he decelerates at $5\,\text{m s}^{-2}$ and subsequently comes to rest. B has constant acceleration from rest until reaching his constant speed of $10\,\text{m s}^{-1}$. The baton is exchanged 2 s after B starts running, when both athletes have speed $8\,\text{m s}^{-1}$ and B is 1 m ahead of A.

(i) Find the value of t at which A starts to decelerate. [2]

(ii) Calculate the distance between A and B at the instant when B starts to run. [5]

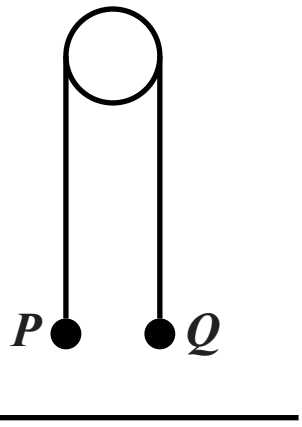
4 **A block *B* of weight 28 N is pulled at constant speed across a rough horizontal surface by a force of magnitude 14 N inclined at 30° above the horizontal.**

(i) Show that the coefficient of friction between the block and the surface is 0.577, correct to 3 significant figures. [4]

The 14 N force is suddenly removed, and the block decelerates, coming to rest after travelling a further 3.2 m.

(ii) Calculate the speed of the block at the instant the 14 N force was removed. [6]

5 Look at the following diagram.



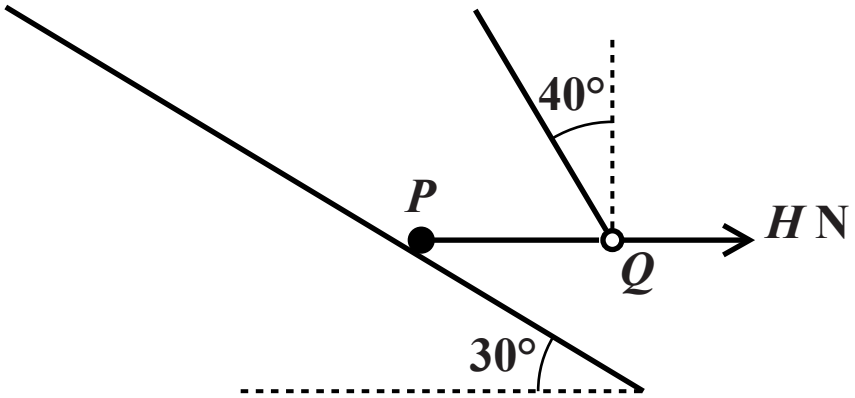
Particles *P* and *Q*, of masses 0.4 kg and *m* kg respectively, are joined by a light inextensible string which passes over a smooth pulley. The particles are released from rest at the same height above a horizontal surface; the string is taut and the portions of the string not in contact with the pulley are vertical (see diagram above). *Q* begins to descend with acceleration 2.45 m s^{-2} and reaches the surface 0.3 s after being released. Subsequently, *Q* remains at rest and *P* never reaches the pulley.

(i) Calculate the tension in the string while *Q* is in motion. [3]

(ii) Calculate the momentum lost by *Q* when it reaches the surface. [5]

(iii) Calculate the greatest height of *P* above the surface. [5]

6 Look at the following diagram.



A particle *P* lies on a slope inclined at 30° to the horizontal. *P* is attached to one end of a taut light inextensible string which passes through a small smooth ring *Q* of mass *m* kg. The portion *PQ* of the string is horizontal and the other portion of the string is inclined at 40° to the vertical. A horizontal force of magnitude *H* N, acting away from *P*, is applied to *Q* (see diagram above). The tension in the string is 6.4 N, and the string is in the vertical plane containing the line of greatest slope on which *P* lies. Both *P* and *Q* are in equilibrium.

(i) Calculate *m*. [2]

(ii) Calculate *H*. [2]

(iii) Given that the weight of *P* is 32 N, and that *P* is in limiting equilibrium, show that the coefficient of friction between *P* and the slope is 0.879, correct to 3 significant figures. [6]

***Q* and the string are now removed.**

(iv) Determine whether *P* remains in equilibrium. [3]

7

The diagram above shows two particles *P* and *Q*, of masses 0.2 kg and 0.3 kg respectively, which move on a horizontal surface in the same direction along a straight line. A stationary particle *R* of mass 1.5 kg also lies on this line. *P* and *Q* collide and coalesce to form a combined particle *C*. Immediately before this collision *P* has velocity 4 m s^{-1} and *Q* has velocity 2.5 m s^{-1}.

(i) Calculate the velocity of *C* immediately after this collision. [3]

At time *t* s after this collision the velocity *v* m s^{-1} of *C* is given by $v = V_0 - 3t^2$ for $0 < t \leqslant 0.3$. *C* strikes *R* when $t = 0.3$.

(ii) (a) State the value of V_0. [1]

(b) Calculate the distance *C* moves before it strikes *R*. [4]

(c) Find the acceleration of *C* immediately before it strikes *R*. [3]

Immediately after *C* strikes *R*, the particles have equal speeds but move in opposite directions.

(iii) Find the speed of *C* immediately after it strikes *R*. [4]

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