



GCE AS/A level

980/01

MATHEMATICS M1
Mechanics 1

A.M. FRIDAY, 11 June 2010

1½ hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a 12 page answer book;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Take g as 9.8 ms^{-2} .

Sufficient working must be shown to demonstrate the **mathematical** method employed.

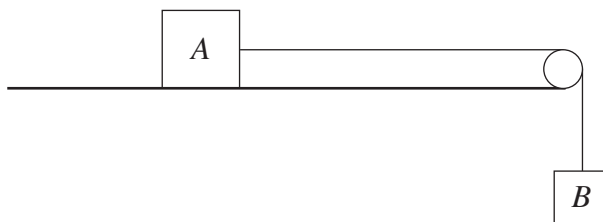
INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

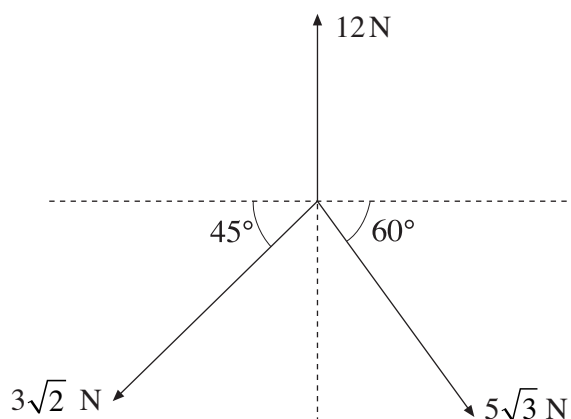
1. A pebble is projected vertically downwards with speed 2.1 ms^{-1} from the top of a well, which is 15.4 m deep.
- (a) Calculate the speed of the pebble when it hits the bottom of the well. [3]
- (b) Find the time taken by the pebble to reach the bottom of the well. [3]
2. An express lift in a skyscraper travels non-stop from the ground floor to the top floor. For the first 15 s of its journey, the lift accelerates uniformly from rest. It then travels at a constant speed of 2.7 ms^{-1} for 90 s before finally decelerating uniformly to rest. The total time for the journey is 2 minutes .
- (a) Sketch a velocity-time graph for the motion of the lift. [3]
- (b) Calculate the distance travelled by the lift. [3]
- A woman, of mass 75 kg , is standing on the floor of the lift during its journey.
- (c) Calculate the reaction exerted by the floor of the lift on the woman when the lift is accelerating. [4]
3. A boy sits on his toboggan and rides it down a straight line path on a snow-covered hill. The path may be modelled as a line of greatest slope of a plane inclined at an angle α to the horizontal, where $\sin \alpha = \frac{5}{13}$. The coefficient of friction between the toboggan and the slope is 0.2 . The combined mass of the boy and the toboggan is 52 kg . Find the magnitude of their acceleration. [6]
4. A particle A , of mass 2 kg , moving with speed 12 ms^{-1} on a smooth horizontal surface collides directly with a particle B , of mass 3 kg , moving with speed 7 ms^{-1} in the same direction as A . The coefficient of restitution between the particles is 0.6 .
- (a) Find the speeds of A and B after the collision. [7]
- (b) Find the magnitude of the impulse exerted by A on B during the collision. [2]

5. The diagram shows an object A , of mass 6 kg , lying on a rough horizontal table. The object A is connected by means of a light inextensible string passing over a smooth pulley at the edge of the table to another object B , of mass 4 kg , hanging freely.



The coefficient of friction between object A and the table is 0.4 . Initially, the system is held at rest with the string just taut. The system is then released.

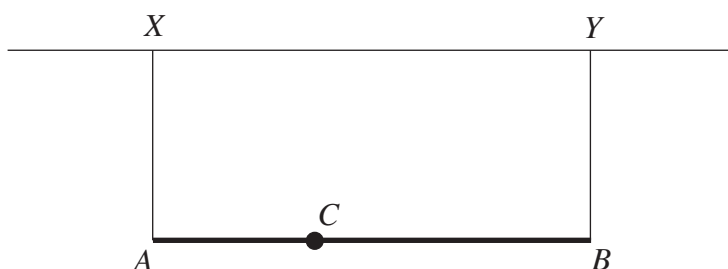
- (a) Find the magnitude of the acceleration of object A and the tension in the string. [9]
- (b) What assumption did the word ‘light’ underlined above enable you to make in your solution? [1]
6. Three horizontal forces of magnitudes 12 N , $5\sqrt{3}\text{ N}$ and $3\sqrt{2}\text{ N}$ act in the directions shown in the diagram below.



Find the magnitude and direction of the resultant of the three forces. [8]

TURN OVER

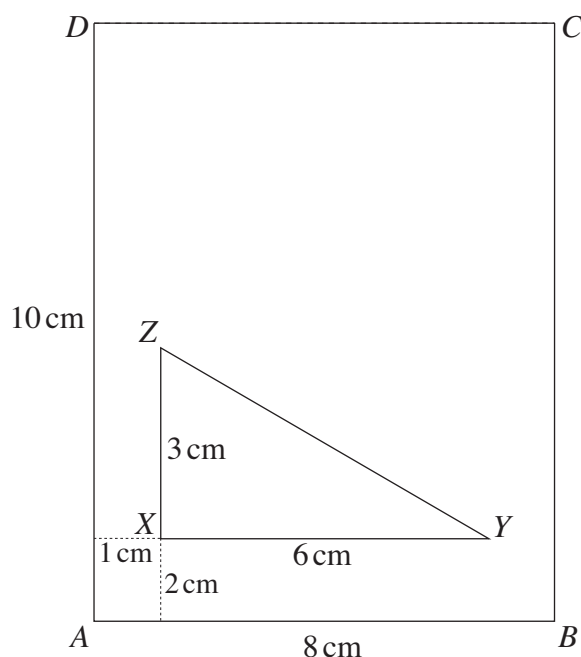
7. A uniform rod AB is suspended horizontally from the ceiling by means of two vertical light inextensible strings XA and YB of equal length.



The rod AB has mass 6 kg and length 1.4 m . A particle, of mass 10 kg , is attached to the rod at point C , where $AC = 0.3\text{ m}$. Calculate the tension in **each** of the strings XA and YB . [7]

8. A car is travelling along a straight road ABC with uniform acceleration $a\text{ ms}^{-2}$. The distance AB is 95 m . The time taken by the car to travel from A to B is 5 s and the time taken to travel from B to C is 2 s . At A the speed of the car is $u\text{ ms}^{-1}$ and at C , its speed is 29.8 ms^{-1} . Find the value of a and the value of u . [7]

9. The diagram below shows a decoration made from a uniform material. The rectangle $ABCD$ has $AB = 8\text{ cm}$ and $AD = 10\text{ cm}$. An extra triangular piece XYZ , of the same material, with $XY = 6\text{ cm}$, $XZ = 3\text{ cm}$ and $\hat{ZXY} = 90^\circ$ is glued onto $ABCD$ such that XZ is 1 cm from AD and XY is 2 cm from AB .



- (a) Find, correct to two decimal places, the distances of the centre of mass of the decoration from AD and AB . [9]
- (b) The decoration is suspended freely from the point D . Calculate the angle AD makes with the vertical. [3]