



GCE AS/A level

0980/01

MATHEMATICS – M1
Mechanics

P.M. FRIDAY, 24 January 2014

1 hour 30 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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.

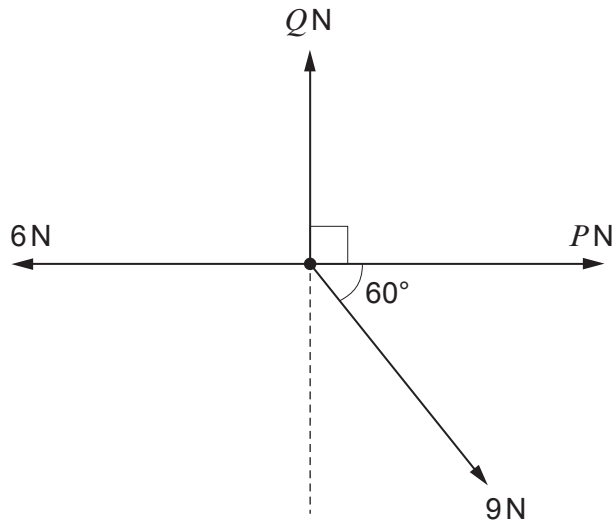
1. A vehicle travels on a straight horizontal road. As it passes a point A at time $t = 0$, it is moving with a constant velocity of 18 ms^{-1} . It continues travelling at this velocity for 48 seconds. It then decelerates at a constant rate for the next 12 s until it passes a point B with velocity 3 ms^{-1} .
 - (a) Sketch a velocity-time graph for the motion of the vehicle between A and B . [2]
 - (b) Find the magnitude of the deceleration of the vehicle. [2]
 - (c) Determine the distance between A and B . [3]

2. A pebble is projected vertically upwards with a speed of 7 ms^{-1} from the top of a cliff. It hits the ground at the bottom of the cliff 4 seconds later.
 - (a) Calculate the time for the pebble to reach its maximum height. [3]
 - (b) Determine the height of the cliff. [3]

3. A man of mass 65 kg stands in a lift which is ascending with acceleration 1.2 ms^{-2} . Find the magnitude of the reaction of the floor of the lift on the man. [3]

4. An object of mass 60 kg lies on a rough plane inclined at an angle of 25° to the horizontal. The coefficient of friction between the plane and the object is denoted by μ . Initially, the object is held at rest. It is then released.
 - (a) When $\mu = 0.3$, the object slides down the plane. Calculate
 - (i) the magnitude of the frictional force,
 - (ii) the acceleration of the object. [5]
 - (b) Given that when the object is released it remains stationary, calculate the least possible value of μ . [3]

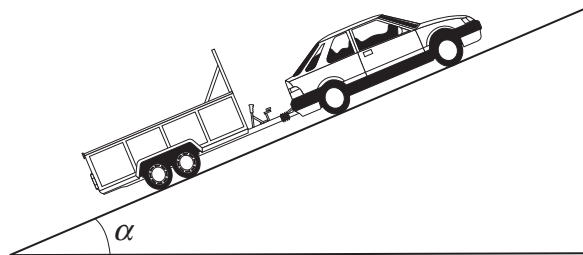
5. Four horizontal forces of magnitude 6 N, 9 N, P N and Q N acting at a point are in equilibrium. Directions are as shown in the diagram.



Find the value of P and the value of Q .

[5]

6. The diagram below shows a car of mass 1500 kg connected to a trailer of mass 600 kg by means of a rigid tow bar. The car is moving upwards along a slope inclined at an angle α to the horizontal, where $\sin \alpha = \frac{7}{25}$. A constant resistance of magnitude 400 N acts on the car and a constant resistance of 300 N acts on the trailer. The car's engine produces a constant forward force of 8400 N.



- (a) Calculate the acceleration of the car, giving your answer correct to three decimal places. [5]
- (b) Determine the tension in the tow bar. [4]

TURN OVER

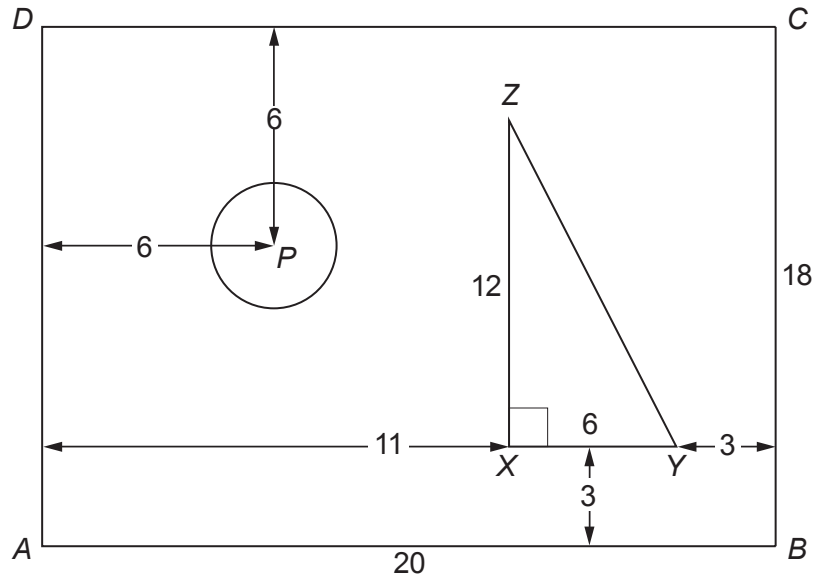
7. A uniform plank AB , of length 4.8 m and mass M kg, is resting on two smooth supports at points X and Y , such that $AX = BY = 1.2$ m.
- (a) A person of mass 84 kg stands on the plank at a point which is 0.8 m from B . The reaction of the support at X is of magnitude 156.8 N.
Find
- (i) the value of M ,
 - (ii) the magnitude of the reaction of the support at Y . [6]
- (b) The person of mass 84 kg walks along the plank towards A . At the instant that the plank starts to tilt about X , find
- (i) the magnitude of the reaction of the support at X ,
 - (ii) the distance of the person from X . [5]
8. An object of mass 1.8 kg moving with speed 3 ms⁻¹ on a smooth horizontal surface collides directly with another object of mass 0.2 kg, which is stationary. After the collision, the two objects move together.
- (a) (i) Show that the speed of the combined object after the collision is 2.7 ms⁻¹.
(ii) Write down the value of the coefficient of restitution between the objects. [4]
- (b) The resistance to motion of the combined object is 8 N.
- (i) Find the magnitude of the deceleration of the combined object.
 - (ii) Calculate the speed of the combined object 0.5 seconds after the collision.
 - (iii) Determine the distance of the combined object from the point of collision when its speed is 2 ms⁻¹. [8]

9. The diagram shows a lamina formed by **removing** a circle with centre P from a rectangle $ABCD$ made of a uniform material, and **adding** a right-angled triangle XYZ made of the same uniform material.

The area of the circle is 21 cm^2 .

The line XY is parallel to AB and $\hat{YXZ} = 90^\circ$.

Dimensions, in cm, are as shown in the diagram.



- (a) Find the distance of the centre of mass of the lamina from
- AD ,
 - AB .
- [10]
- (b) When the lamina is suspended freely from a point Q on DC , it hangs in equilibrium with DC making an angle of 45° with the vertical. Find the possible distances of Q from D .
- [4]

END OF PAPER

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