

GCE Examinations

Mechanics

Module M1

Advanced Subsidiary / Advanced Level

Paper L

Time: 1 hour 30 minutes

Instructions and Information

Candidates may use any calculator except those with a facility for symbolic algebra and/or calculus.

Full marks may be obtained for answers to ALL questions.

Mathematical and statistical formulae and tables are available.

This paper has 7 questions.

When a numerical value of g is required, use $g = 9.8 \text{ m s}^{-2}$.

Advice to Candidates

You must show sufficient working to make your methods clear to an examiner. Answers without working will gain no credit.



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1. Two particles P and Q , of mass m and km respectively, are travelling in opposite directions on a straight horizontal path with speeds $3u$ and $2u$ respectively. P and Q collide and, as a result, the direction of motion of both particles is reversed and their speeds are halved.

(a) Find the value of k . **(4 marks)**

(b) Write down an expression in terms of m and u for the magnitude of the impulse which P exerts on Q during the collision. **(3 marks)**

2.

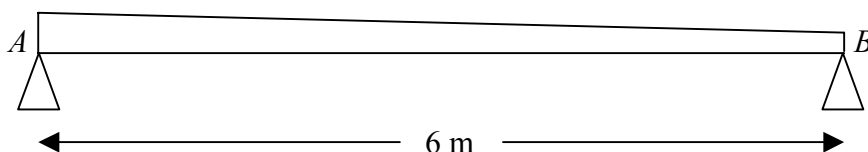


Fig. 1

Figure 1 shows a plank AB of mass 40 kg and length 6 m, which rests on supports at each of its ends. The plank is wedge-shaped, being thicker at end A than at end B .

A woman of mass 60 kg stands on the plank at a distance of 2 m from B .

(a) Suggest suitable modelling assumptions which can be made about

(i) the plank,

(ii) the woman. **(3 marks)**

Given that the reactions at each support are of equal magnitude,

(b) find the magnitude of the reaction on the support at A , **(2 marks)**

(c) calculate the distance of the centre of mass of the plank from A . **(4 marks)**

3.

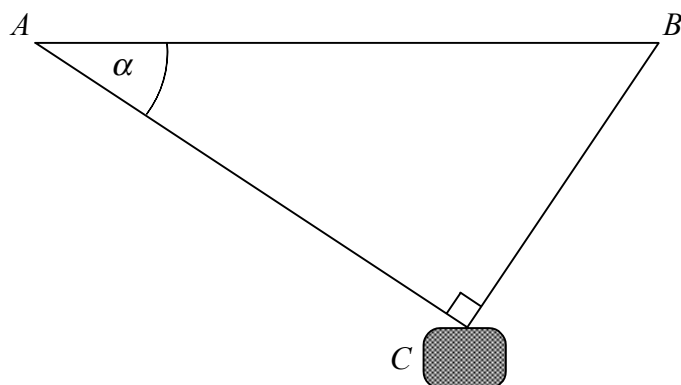


Fig. 2

Figure 2 shows a cable car C of mass 1 tonne which has broken down. The cable car is suspended in equilibrium by two perpendicular cables AC and BC which are attached to fixed points A and B , at the same horizontal level on either side of a valley. The cable AC is inclined at an angle α to the horizontal where $\tan \alpha = \frac{3}{4}$.

(a) Show that the tension in the cable AC is 5880 N and find the tension in the cable BC .

(7 marks)

A gust of wind then blows along the valley.

(b) Explain the effect that this will have on the tension in the two cables.

(2 marks)

4. Andrew hits a tennis ball vertically upwards towards his sister Barbara who is leaning out of a window 7.5 m above the ground to try to catch it. When the ball leaves Andrew's racket, it is 1.9 m above the ground and travelling at 21 m s^{-1} . Barbara fails to catch the ball on its way up but succeeds as the ball comes back down.

Modelling the ball as a particle and assuming that air resistance can be neglected,

(a) find the maximum height above the ground which the ball reaches.

(4 marks)

(b) find how long Barbara has to wait from the moment that the ball first passes her until she catches it.

(6 marks)

Turn over

5.

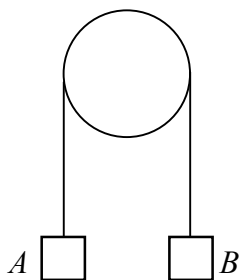


Fig. 3

Figure 3 shows two particles A and B of masses m and km respectively, connected by a light inextensible string which passes over a smooth fixed pulley.

When the system is released from rest with both particles 0.5 m above the ground, particle A moves vertically upwards with acceleration $\frac{1}{4} g \text{ m s}^{-2}$.

(a) Write down, with a brief justification, the magnitude and direction of the acceleration of B . **(2 marks)**

(b) Find the value of k . **(6 marks)**

Given that A does not hit the pulley,

(c) calculate, correct to 3 significant figures, the speed with which B hits the ground. **(3 marks)**

6. Two trains A and B leave the same station, O , at 10 a.m. and travel along straight horizontal tracks. A travels with constant speed 80 km h^{-1} due east and B travels with constant speed 52 km h^{-1} in the direction $(5\mathbf{i} + 12\mathbf{j})$ where \mathbf{i} and \mathbf{j} are unit vectors due east and due north respectively.

(a) Show that the velocity of B is $(20\mathbf{i} + 48\mathbf{j}) \text{ km h}^{-1}$. **(3 marks)**

(b) Find the displacement vector of B from A at 10:15 a.m. **(3 marks)**

Given that the trains are 23 km apart t minutes after 10 a.m.

(c) find the value of t correct to the nearest whole number. **(6 marks)**

7.

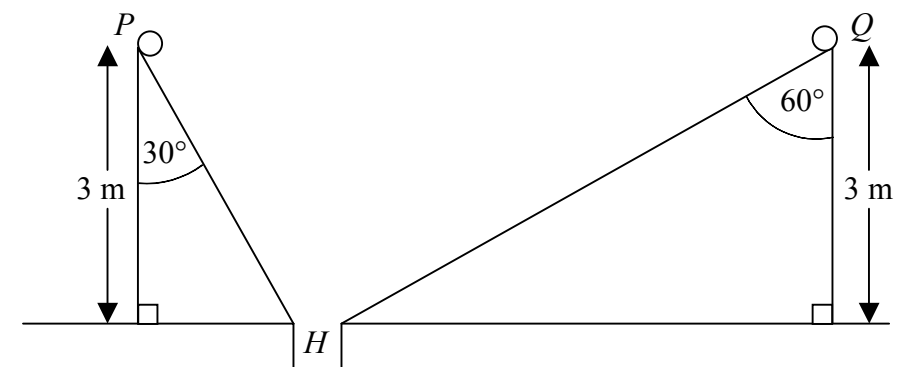


Fig. 4

Figure 4 shows two golf balls P and Q being held at the top of planes inclined at 30° and 60° to the vertical respectively. Both planes slope down to a common hole at H , which is 3 m vertically below P and Q .

P is released from rest and travels down the line of greatest slope of the plane it is on which is assumed to be smooth.

(a) Find the acceleration of P down the slope. **(3 marks)**

(b) Show that the time taken for P to reach the hole is 0.904 seconds, correct to 3 significant figures. **(5 marks)**

Q travels down the line of greatest slope of the plane it is on which is rough. The coefficient of friction between Q and the plane is μ .

Given that the acceleration of Q down the slope is 3 m s^{-2} ,

(c) find, correct to 3 significant figures, the value of μ . **(5 marks)**

In order for the two balls to arrive at the hole at the same time, Q must be released t seconds before P .

(d) Find the value of t correct to 2 decimal places. **(4 marks)**

END