Work done by Force

Question Paper 3

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Energy, Work and Power
Sub Topic	Work done by a force
Booklet	Question Paper 3

Time Allowed: **61 minutes**

Score: **/51**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A particle of mass 0.8 kg slides down a rough inclined plane along a line of greatest slope AB. The distance AB is 8 m. The particle starts at A with speed $3\,\text{m}\,\text{s}^{-1}$ and moves with constant acceleration $2.5\,\text{m}\,\text{s}^{-2}$.

(i) Find the speed of the particle at the instant it reaches B. [2]

(ii) Given that the work done against the frictional force as the particle moves from A to B is 7 J, find the angle of inclination of the plane. [4]

When the particle is at the point X its speed is the same as the average speed for the motion from A to B.

(iii) Find the work done by the frictional force for the particle's motion from A to X. [3]

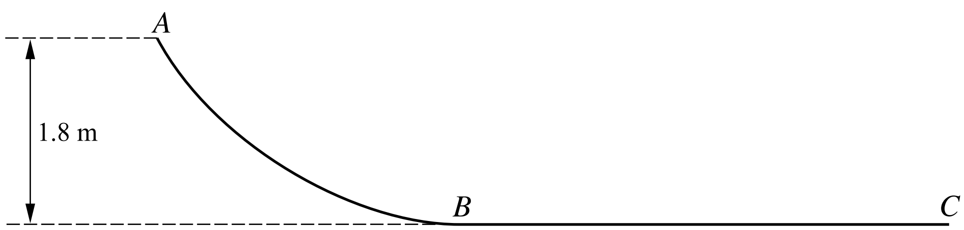
2 A cyclist, working at a constant rate of 400 W, travels along a straight road which is inclined at 2° to the horizontal. The total mass of the cyclist and his cycle is 80 kg. Ignoring any resistance to motion, find, correct to 1 decimal place, the acceleration of the cyclist when he is travelling

(i) uphill at $4\,\text{m}\,\text{s}^{-1}$,

(ii) downhill at $4\,\text{m}\,\text{s}^{-1}$.

[5]

3



The diagram shows the vertical cross-section ABC of a f xed surface. AB is a curve and BC is a horizontal straight line. The part of the surface containing AB is smooth and the part containing BC is rough. A is at a height of 1.8 m above BC. A particle of mass 0.5 kg is released from rest at A and travels along the surface to C.

(i) Find the speed of the particle at B. [2]

(ii) Given that the particle reaches C with a speed of $5\,\text{m}\,\text{s}^{-1}$, f nd the work done against the resistance to motion as the particle moves from B to C. [2]

4 A car of mass 1250 kg travels along a horizontal straight road. The power of the car's engine is constant and equal to 24 kW and the resistance to the car's motion is constant and equal to R N. The car passes through the point A on the road with speed $20\,\mathrm{m\,s^{-1}}$ and acceleration $0.32\,\mathrm{m\,s^{-2}}$.

(i) Find the value of R. [3]

The car continues with increasing speed, passing through the point B on the road with speed $29.9\,\mathrm{m\,s^{-1}}$. The car subsequently passes through the point C.

(ii) Find the acceleration of the car at B, giving the answer in $\mathrm{m\,s^{-2}}$ correct to 3 decimal places. [2]

(iii) Show that, while the car's speed is increasing, it cannot reach $30\,\mathrm{m\,s^{-1}}$. [2]

(iv) Explain why the speed of the car is approximately constant between B and C. [1]

(v) State a value of the approximately constant speed, and the maximum possible error in this value at any point between B and C. [1]

The work done by the car's engine during the motion from B to C is 1200 kJ.

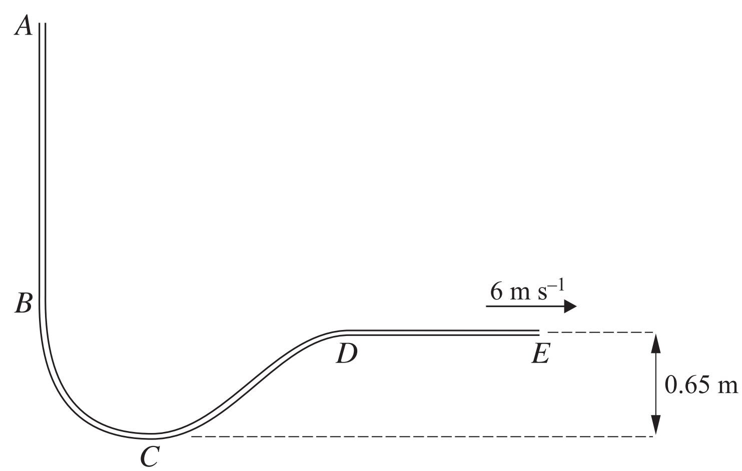
(vi) By assuming the speed of the car is constant from B to C, f nd, in either order,

(a) the approximate time taken for the car to travel from B to C,

(b) an approximation for the distance BC.

[4]

5



A smooth narrow tube AE has two straight parts, AB and DE, and a curved part BCD. The part AB is vertical with A above B, and DE is horizontal. C is the lowest point of the tube and is 0.65 m below the level of DE. A particle is released from rest at A and travels through the tube, leaving it at E with speed $6\,\mathrm{m\,s^{-1}}$ (see diagram). Find

(i) the height of A above the level of DE, [2]

(ii) the maximum speed of the particle. [2]

6

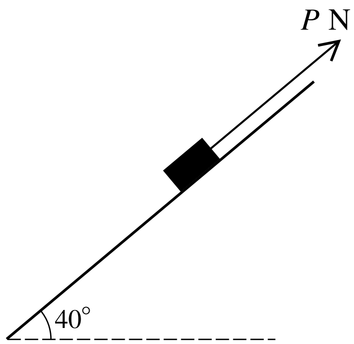


Fig. 1

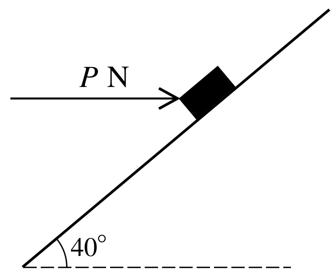


Fig. 2

A small block of weight 12 N is at rest on a smooth plane inclined at 40° to the horizontal. The block is held in equilibrium by a force of magnitude P N. Find the value of P when

(i) the force is parallel to the plane as in Fig. 1, [2]

(ii) the force is horizontal as in Fig. 2. [2]

7 A car of mass 1250 kg travels along a horizontal straight road with increasing speed. The power provided by the car's engine is constant and equal to 24 kW. The resistance to the car's motion is constant and equal to 600 N.

(i) Show that the speed of the car cannot exceed 40 m s^{-1}. [3]

(ii) Find the acceleration of the car at an instant when its speed is 15 m s^{-1}. [3]

8 A block of mass 20 kg is at rest on a plane inclined at 10° to the horizontal. A force acts on the block parallel to a line of greatest slope of the plane. The coefficient of friction between the block and the plane is 0.32. Find the least magnitude of the force necessary to move the block,

(i) given that the force acts up the plane,

(ii) given instead that the force acts down the plane.

[6]