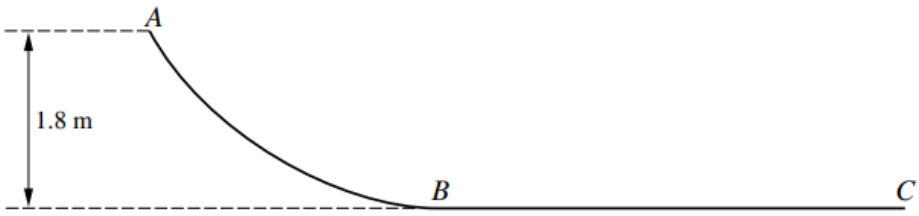
Energy, Work & Power 1

Q1.



The diagram shows the vertical cross-section ABC of a fixed 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 m s^{-1}, find the work done against the resistance to motion as the particle moves from B to C. [2]

Q2.

A car of mass 700 kg is travelling along a straight horizontal road. The resistance to motion is constant and equal to 600 N.

(i) Find the driving force of the car's engine at an instant when the acceleration is 2 m s^{-2}. [2]

(ii) Given that the car's speed at this instant is 15 m s^{-1}, find the rate at which the car's engine is working. [2]

Q3.

A load of mass 1250 kg is raised by a crane from rest on horizontal ground, to rest at a height of 1.54 m above the ground. The work done against the resistance to motion is 5750 J.

(i) Find the work done by the crane. [3]

(ii) Assuming the power output of the crane is constant and equal to 1.25 kW, find the time taken to raise the load. [2]

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Q4.

An object of mass 8 kg slides down a line of greatest slope of an inclined plane. Its initial speed at the top of the plane is $3\,\text{m s}^{-1}$ and its speed at the bottom of the plane is $8\,\text{m s}^{-1}$. The work done against the resistance to motion of the object is 120 J. Find the height of the top of the plane above the level of the bottom. [4]

Q5.

A car of mass 1250 kg is travelling along a straight horizontal road with its engine working at a constant rate of P W. The resistance to the car's motion is constant and equal to R N. When the speed of the car is $19\,\text{m s}^{-1}$ its acceleration is $0.6\,\text{m s}^{-2}$, and when the speed of the car is $30\,\text{m s}^{-1}$ its acceleration is $0.16\,\text{m s}^{-2}$. Find the values of P and R. [6]

Q6.

A lorry of mass 15 000 kg climbs a hill of length 500 m at a constant speed. The hill is inclined at 2.5° to the horizontal. The resistance to the lorry's motion is constant and equal to 800 N.

(i) Find the work done by the lorry's driving force. [4]

On its return journey the lorry reaches the top of the hill with speed $20\,\text{m s}^{-1}$ and continues down the hill with a constant driving force of 2000 N. The resistance to the lorry's motion is again constant and equal to 800 N.

(ii) Find the speed of the lorry when it reaches the bottom of the hill. [5]

Q7.

AB and BC are straight roads inclined at 5° to the horizontal and 1° to the horizontal respectively. A and C are at the same horizontal level and B is 45 m above the level of A and C (see diagram, which is not to scale). A car of mass 1200 kg travels from A to C passing through B.

(i) For the motion from A to B, the speed of the car is constant and the work done against the resistance to motion is 360 kJ. Find the work done by the car's engine from A to B. [3]

The resistance to motion is constant throughout the whole journey.

(ii) For the motion from B to C the work done by the driving force is 1660 kJ. Given that the speed of the car at B is 15 m s^{-1}, show that its speed at C is 29.9 m s^{-1}, correct to 3 significant figures. [4]

(iii) The car's driving force immediately after leaving B is 1.5 times the driving force immediately before reaching C. Find, correct to 2 significant figures, the ratio of the power developed by the car's engine immediately after leaving B to the power developed immediately before reaching C. [3]

Q8.

A racing cyclist, whose mass with his cycle is 75 kg, works at a rate of 720 W while moving on a straight horizontal road. The resistance to the cyclist's motion is constant and equal to R N.

(i) Given that the cyclist is accelerating at 0.16 m s^{-2} at an instant when his speed is 12 m s^{-1}, find the value of R. [3]

(ii) Given that the cyclist's acceleration is positive, show that his speed is less than 15 m s^{-1}. [2]

Q9.

A lorry of mass 16 000 kg climbs a straight hill $ABCD$ which makes an angle θ with the horizontal, where $\sin\theta = \frac{1}{20}$. For the motion from A to B, the work done by the driving force of the lorry is 1200 kJ and the resistance to motion is constant and equal to 1240 N. The speed of the lorry is 15 m s^{-1} at A and 12 m s^{-1} at B.

(i) Find the distance AB. [5]

For the motion from B to D the gain in potential energy of the lorry is 2400 kJ.

(ii) Find the distance BD. [1]

For the motion from B to D the driving force of the lorry is constant and equal to 7200 N. From B to C the resistance to motion is constant and equal to 1240 N and from C to D the resistance to motion is constant and equal to 1860 N.

(iii) Given that the speed of the lorry at D is 7 m s^{-1}, find the distance BC. [4]
