Work, Energy and Power – 2023 June AS Math 9709

1. June/2023/Paper_9709/41/No.7

A car of mass 1200 kg is travelling along a straight horizontal road. The power of the car's engine is constant and is equal to 16 kW. There is a constant resistance to motion of magnitude 500 N.

(a) Find the acceleration of the car at an instant when its speed is $20\,\text{m}\,\text{s}^{-1}$. [3]

(b) Assuming that the power and the resistance forces remain unchanged, find the steady speed at which the car can travel. [2]

The car comes to the bottom of a straight hill of length 316 m, inclined at an angle to the horizontal of $\sin^{-1}\left(\frac{1}{60}\right)$. The power remains constant at 16 kW, but the magnitude of the resistance force is no longer constant and changes such that the work done against the resistance force in ascending the hill is 128 400 J. The time taken to ascend the hill is 15 s.

(c) Given that the car is travelling at a speed of $20\,\text{m}\,\text{s}^{-1}$ at the bottom of the hill, find its speed at the top of the hill. [6]

2. June/2023/Paper_9709/42/No.1

A particle of mass 1.6 kg is dropped from a height of 9 m above horizontal ground. The speed of the particle at the instant before hitting the ground is 12 m s^{-1}.

Find the work done against air resistance. [3]

3. June/2023/Paper_9709/43/No.4

A lorry of mass 15 000 kg moves on a straight horizontal road in the direction from A to B. It passes A and B with speeds 20 m s^{-1} and 25 m s^{-1} respectively. The power of the lorry's engine is constant and there is a constant resistance to motion of magnitude 6000 N. The acceleration of the lorry at B is 0.5 times the acceleration of the lorry at A.

(a) Show that the power of the lorry's engine is 200 kW, and hence find the acceleration of the lorry when it is travelling at 20 m s^{-1}. [5]

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The lorry begins to ascend a straight hill inclined at 1° to the horizontal. It is given that the power of the lorry's engine and the resistance force do not change.

(b) Find the steady speed up the hill that the lorry could maintain. [2]

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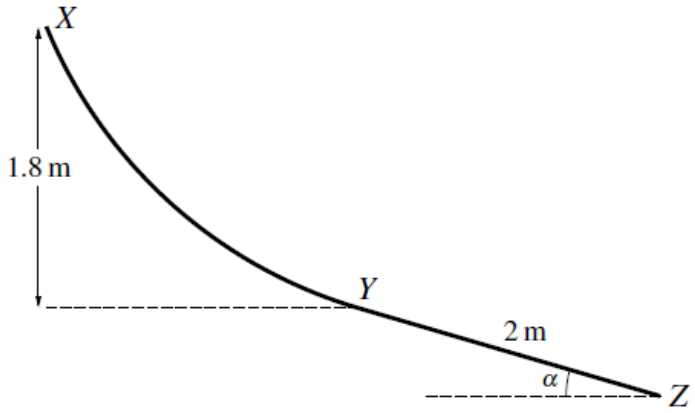
4. June/2023/Paper_9709/43/No.7



The diagram shows the vertical cross-section XYZ of a rough slide. The section YZ is a straight line of length 2 m inclined at an angle of α to the horizontal, where $\sin\alpha = 0.28$. The section YZ is tangential to the curved section XY at Y, and X is 1.8 m above the level of Y. A child of mass 25 kg slides down the slide, starting from rest at X. The work done by the child against the resistance force in moving from X to Y is 50 J.

(a) Find the speed of the child at Y. [4]

It is given that the child comes to rest at Z.

(b) Use an energy method to find the coefficient of friction between the child and YZ, giving your answer as a fraction in its simplest form. [6]