1. Nov/2021/Paper_9709/41/No.5

A car of mass 1600 kg travels at constant speed 20 m s^{-1} up a straight road inclined at an angle of $\sin^{-1} 0.12$ to the horizontal.

(a) Find the change in potential energy of the car in 30 s. [3]

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(b) Given that the total work done by the engine of the car in this time is 1960 kJ, find the constant force resisting the motion. [3]

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(c) Calculate, in kW, the power developed by the engine of the car. [2]

(d) Given that this power is suddenly decreased by 15%, find the instantaneous deceleration of the car. [3]

2. Nov/2021/Paper_9709/42/No.2

A van of mass 3600 kg is towing a trailer of mass 1200 kg along a straight horizontal road using a light horizontal rope. There are resistance forces of 700 N on the van and 300 N on the trailer.

(a) The driving force exerted by the van is 2500 N.

Find the tension in the rope. [4]

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The driving force is now removed and the van driver applies a braking force which acts only on the van. The resistance forces remain unchanged.

(b) Find the least possible value of the braking force which will cause the rope to become slack. [2]

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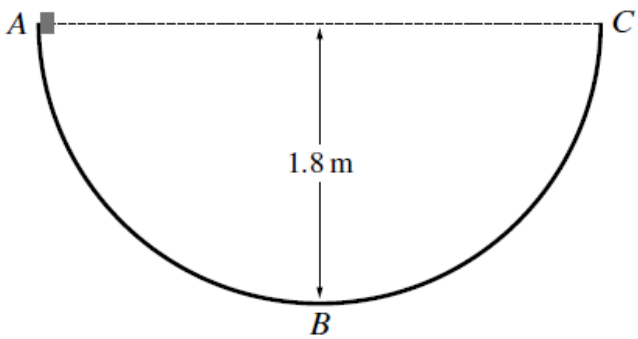
3. Nov/2021/Paper_9709/42/No.3



The diagram shows a semi-circular track ABC of radius 1.8 m which is fixed in a vertical plane. The points A and C are at the same horizontal level and the point B is at the bottom of the track. The section AB is smooth and the section BC is rough. A small block is released from rest at A.

(a) Show that the speed of the block at B is $6\,\text{m}\,\text{s}^{-1}$. [2]

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The block comes to instantaneous rest for the first time at a height of 1.2 m above the level of B. The work done against the resistance force during the motion of the block from B to this point is 4.5 J.

(b) Find the mass of the block. [3]

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4. Nov/2021/Paper_9709/42/No.5

A railway engine of mass 75 000 kg is moving up a straight hill inclined at an angle α to the horizontal, where $\sin\alpha = 0.01$. The engine is travelling at a constant speed of $30\,\text{m s}^{-1}$. The engine is working at 960 kW. There is a constant force resisting the motion of the engine.

(a) Find the resistance force. [3]

The engine comes to a section of track which is horizontal. At the start of the section the engine is travelling at 30 m s^{-1} and the power of the engine is now reduced to 900 kW. The resistance to motion is no longer constant, but in the next 60 s the work done against the resistance force is 46 500 kJ.

(b) Find the speed of the engine at the end of the 60 s. [4]

5. Nov/2021/Paper_9709/43/No.3

A ball of mass 1.6 kg is released from rest at a point 5 m above horizontal ground. When the ball hits the ground it instantaneously loses 8 J of kinetic energy and starts to move upwards.

(a) Use an energy method to find the greatest height that the ball reaches after hitting the ground.

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(b) Find the total time taken, from the initial release of the ball until it reaches this greatest height.

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6. Nov/2021/Paper_9709/43/No.4

A car of mass 1400 kg is moving on a straight road against a constant force of 1250 N resisting the motion.

(a) The car moves along a horizontal section of the road at a constant speed of 36 m s^{-1}.

(i) Calculate the work done against the resisting force during the first 8 seconds. [2]

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(ii) Calculate, in kW, the power developed by the engine of the car. [2]

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(iii) Given that this power is suddenly increased by 12 kW, find the instantaneous acceleration of the car. [3]

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(b) The car now travels at a constant speed of 32 m s^{-1} up a section of the road inclined at $\theta°$ to the horizontal, with the engine working at 64 kW.

Find the value of θ. [2]

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