1. March/2022/Paper_9709/42/No.1

A crane is used to raise a block of mass 600 kg vertically upwards at a constant speed through a height of 15 m. There is a resistance to the motion of the block, which the crane does 10000 J of work to overcome.

(a) Find the total work done by the crane. [2]

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(b) Given that the average power exerted by the crane is 12.5 kW, find the total time for which the block is in motion. [2]

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2. March/2022/Paper_9709/42/No.3

A car of mass m kg is towing a trailer of mass 300 kg down a straight hill inclined at 3° to the horizontal at a constant speed. There are resistance forces on the car and on the trailer, and the total work done against the resistance forces in a distance of 50 m is 40 000 J. The engine of the car is doing no work and the tow-bar is light and rigid.

(a) Find the value of m. [3]

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The resistance force on the trailer is 200 N.

(b) Find the tension in the tow-bar between the car and the trailer. [2]

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3. June/2022/Paper_9709/41/No.5

Two racing cars A and B are at rest alongside each other at a point O on a straight horizontal test track. The mass of A is 1200 kg. The engine of A produces a constant driving force of 4500 N. When A arrives at a point P its speed is $25\,\text{m s}^{-1}$. The distance OP is d m. The work done against the resistance force experienced by A between O and P is 75 000 J.

(a) Show that $d = 100$. [3]

Car B starts off at the same instant as car A. The two cars arrive at P simultaneously and with the same speed. The engine of B produces a driving force of 3200 N and the car experiences a constant resistance to motion of 1200 N.

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

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(c) Find the steady speed which B can maintain when its engine is working at the same rate as it is at P. [3]

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4. June/2022/Paper_9709/42/No.6

A car of mass 900 kg is moving up a hill inclined at $\sin^{-1} 0.12$ to the horizontal. The initial speed of the car is $11\,\text{m s}^{-1}$. After 12 s, the car has travelled 150 m up the hill and has speed $16\,\text{m s}^{-1}$. The engine of the car is working at a constant rate of 24 kW.

(a) Find the work done against the resistive forces during the 12 s. [5]

The car then travels along a straight horizontal road. There is a resistance to the motion of the car of $(1520 + 4v)$ N when the speed of the car is v m s^{-1}. The car travels at a constant speed with the engine working at a constant rate of 32 kW.

(b) Find this speed. [3]

5. June/2022/Paper_9709/43/No.5

A cyclist is riding along a straight horizontal road. The total mass of the cyclist and her bicycle is 70 kg. At an instant when the cyclist's speed is $4\,m\,s^{-1}$, her acceleration is $0.3\,m\,s^{-2}$. There is a constant resistance to motion of magnitude 30 N.

(a) Find the power developed by the cyclist. [3]

The cyclist comes to the top of a hill inclined at 5° to the horizontal. The cyclist stops pedalling and freewheels down the hill (so that the cyclist is no longer supplying any power). The magnitude of the resistance force remains at 30 N. Over a distance of d m, the speed of the cyclist increases from $6\,\text{m s}^{-1}$ to $12\,\text{m s}^{-1}$.

(b) Find the change in kinetic energy. [2]

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(c) Use an energy method to find d. [3]

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