Answer on Question #49663-Physics-Mechanics-Kinematics-Dynamics

A car of weight W = 11000N drives up a hill that is h = 500m high and is l = 3.75km long at a constant speed of $v = 20ms^{-1}$. The friction force acting on the car is f = 550N

a) Calculate the time for the car to get to the top

b) Calculate the work done in getting to the top of the hill (taking into account friction)

c) Calculate the power developed by the engine in getting to the top of the hill using your answers from a and b

d) From the top of the hill the road goes in a straight line downwards for l' = 6.40 km, dropping a total height of 500m. To save fuel the driver switches off the engine and the car free wheels down the hill.

Calculate the speed of the car at the bottom of the hill if the force of friction is f' = 500N

e) Calculate acceleration of the car down the hill

Solution

a) The time for the car to get to the top is

$$t = \frac{l}{v} = \frac{3.75 \cdot 10^3 m}{20 m s^{-1}} = 187.5 \, s.$$

b) The work done in getting to the top of the hill is

$$W = W_W + W_f = Wh + fl = 11000N \cdot 500m + 550N \cdot 3.75 \cdot 10^3m = 7562.5 \cdot 10^3J = 7.56 MJ$$

c) The power developed by the engine in getting to the top of the hill is

$$P = \frac{W}{t} = \frac{7.56 \, MJ}{187.5 \, s} = 4.03 \, kW.$$

d) According to the law of conservation of energy:

$$\frac{mv^2}{2} + mgh = \frac{mv'^2}{2} + W_{f'}.$$

But $mgh = W_W$ and $m = \frac{W}{g} = \frac{11000N}{9.8\frac{m}{s^2}} = 11200kg$, so

$$v' = \sqrt{v^2 + \frac{2(W_W - W_{f'})}{m}} = \sqrt{20^2 + \frac{2(11000 \cdot 500 - 500 \cdot 6.40 \cdot 10^3)}{11200}} = 28.5 \frac{m}{s}.$$

e) The acceleration of the car down the hill is

$$a = \frac{{v'}^2 - v^2}{2l'} = \frac{28.5^2 - 20^2}{2 \cdot 6.40 \cdot 10^3} = 0.032 \frac{m}{s^2}$$

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