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Key

WORK AND ENERGY

AT Work and Energy (20)

Directions: Solve the following problems showing all work.

Use the situation given here in bold to respond to questions 1-9.

A roller coaster has a hill that is that is 20 m high. The train and the people in it have a mass of 450 kg.

1) *How much work is done to lift the train to the top of this hill?*

$W = PE = mgh$

$W = (450\,kg)(9.8\,m/s^2)(20\,m)$

$W = 88200\,J$

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A roller coaster has a hill that is that is 20 m high. The train and the people in it have a mass of 450 kg.

2) *What is the weight of the train and people in the train?*

$W = (450kg)(9.8 m/s^2)$

$W = 4410 N$

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3) *Determine the force needed to pull the train (with the people in it) up the hill if the hill is 66 m long*

$W = Fx$

$882003 = F(66m)$

$13360 = F$

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4) *How fast would you expect the train to be traveling at the bottom of the "first drop", assuming that it goes all the way to the ground.*

$$PE = KE$$

$$mgh = \frac{1}{2}mv^2$$

$$\sqrt{2gh} = v$$

$$\sqrt{2(9.8\,m/s^2)(20m)} = 19.8\,m/s$$

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5) *The train is measured to be traveling at 17.5 m/s at the bottom of the hill. With the curves and angle of decline, there is 22 m of track to the lowest point where the speed was measured. Determine the average resistive force during the downhill run of the train. (This is the only question involving resistive forces or forces of "loss".)*

$$PE = KE + W$$

$$mgh = \frac{1}{2}mv^2 + Fx$$

$$\frac{mgh - \frac{1}{2}mv^2}{x} = F$$

$$\frac{(450\,kg)\left[(9.8\,m/s^2)(20\,m) - \left(\frac{1}{2}\right)(17.5\,m/s)^2\right]}{~~26m~~\ 22\,m} = F$$

~~292 N~~ = F

876 N

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6) *Assume no energy is lost during the ride. Determine the force needed to stop the train at the end of the ride if the braking section is 8 m long.*

$$PE = W$$

$$mgh = Fx$$

$$\frac{(450kg)(9.8m/s^2)(20m)}{8m} = F$$

$$11025N = F$$

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7) *How much power is needed to get the train to the top of the hill in 1.5 min?*

$$P = \frac{\text{Work}}{\text{time}} = \frac{88200\,J}{(1.5\,\text{min})(60\,s/\text{min})} = \boxed{980\ \text{watts}}$$

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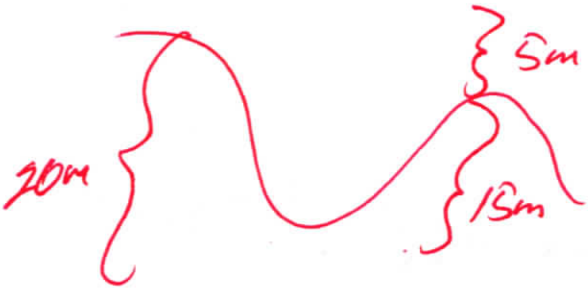
8) *Assuming no losses, determine the speed of the train over the top of the second hill, which is 15m high.*



PE = KE

$mgh = \frac{1}{2}mv^2$

$\sqrt{2gh} = \sqrt{(2)(9.8\,m/s^2)(5m)} = 9.9\ m/s$

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9) *Written Essay: Notice that the force determined in #3 is different than the weight of the train found in #2. Using the ideas of work and energy, explain why these forces are different. Keep this short, concise, and to the point. You may write in a bulleted list and use fragments. Feel free to explain with equations so long as terms are defined. Let me throw a term at you that may help or at least offer guidance: Simple Machine.*

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10) Determine the work that must be done to a 12 kg cart to get it moving from rest to 8 m/s.

$W = KE$

$W = \frac{1}{2}mv^2$

$\left(\frac{1}{2}\right)(12 kg)(8 m/s)^2$

Work = 384 J

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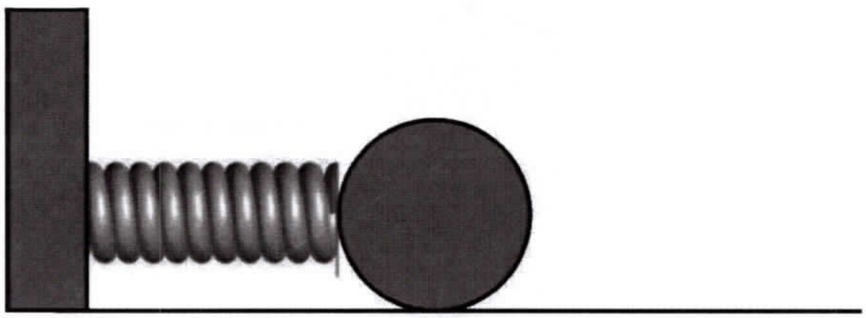
(5 point bonus, partial credit available, just like any other problem).

11) A 0.02kg ball is at rest against a compressed 62N/m spring. The spring is compressed a distance of 22cm. Determine the speed of the ball when the ball leaves the spring after it has been released. (Think like a spring launched toy "gun").



$$\frac{1}{2}Fx = \frac{1}{2}mv^2$$

$$Fx = mv^2$$

$$Kx \cdot x = mv^2$$

$$Kx^2 = mv^2$$

$$\sqrt{\frac{Kx^2}{m}} = v$$

$$\sqrt{\frac{(62\,N/m)(.22m)^2}{.02kg}} = v = 12.2\,m/s$$

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