Physics Worksheet

Work and Energy Question & Solution

Question: A 1500 (kg) car is being driven up a 20° bridge for 130 m long. The kinetic friction is approximate 2760 (N). What should be the magnitude of the applied force, so that the net work done by all the forces acting on the car is $2.80 \times 10^5$ (J)?

Given: $m = 1500$ (kg), $f = 2760$ (N), $d = 130$ (m), $\theta = 20^\circ$, $W_{\text{total}} = 2.80 \times 10^5$ (J)

Find: Apply force $F_A$

Solution: $W_{\text{total}} = W_{mg} + W_N + W_f + W_{F_a}$

$W = F \cdot d \cdot \cos \theta$ ($\theta$ is the angle between Force and distance)

Next, I will show you how to calculate the work done by weight, normal force, friction force, and apply force.

$W_{mg} = mg \cdot d \cdot \cos \theta$, ($\theta = 20^\circ + 90^\circ = 110^\circ$)

$= (1500 \text{ kg})(9.8 \text{ m/s}^2)(130 \text{ m})(\cos 110^\circ)$

$= -6.54 \times 10^5$ (J)

$W_N = N \cdot d \cdot \cos 90^\circ = 0$
\[ W_f = f \cdot d \cdot \cos \theta \]
\[ = (2760N)(130m)(\cos 180^\circ) \]
\[ = -3.59 \times 10^5 (J) \]

\[ W_{fa} = F_a \cdot d \cdot \cos \theta \]
\[ \therefore F_a and d has same direction, \therefore \theta = 0^\circ \]
\[ W_{fa} = F_a (130m)(\cos 0^\circ) \]
\[ = F_a (130m)(1) \]
\[ = 130F_a \]

\[ \therefore W_{total} = W_{mg} + W_N + W_f + W_{fa} \]
\[ 2.80 \times 10^5 (J) = -6.54 \times 10^5 (J) + 0 + (-3.59 \times 10^5)(J) + 130F_a \]
\[ 2.80 \times 10^5 (J) = -1.013 \times 10^6 (J) + 130F_a \]
\[ 130F_a = 1.293 \times 10^6 \]
\[ F_a = 9946(N) \]