KEY

Work and Power

1.) A man pushes a wheelbarrow forward at a constant speed over level ground by exerting a steady force of $120.N$.

a.) How much work does he do in moving the wheelbarrow $8.0\ m$?

Answer - $W = \vec{F}d$ $W = (+120)(8.0)$ $W = 960\ J$

b.) How much work is done by friction while the wheelbarrow moves $8.0\ m$?

Answer - $W = \vec{F}d$ $W = (-120)(8.0)$ $W = 960\ J$

c.) The man continues to exert $120.N$, but the wheelbarrow hits a patch of soft soil and slows down for $6.0\ m$. How much work does he do during this time?

Answer - $W = \vec{F}d$ $W = (+120)(6.0)$ $W = 720\ J$

d.) The man continues to push with $120.N$, but the wheel barrow hits a rock and stops. How work is done while the wheelbarrow is stuck?

Answer – zero. Wheelbarrow is not moving.

e.) While pushing the wheelbarrow the man's partner drops a $20.0\ kg$ bag of cement into the wheelbarrow. How much work is done over the next $2.0\ m$?

Answer - $W = \vec{F}d$ $W = (+120)(2.0)$ $W = 240\ J$

f.) How much work is done by gravity on the bag of cement, as the man pushes the wheelbarrow $5.0\ m$?

Answer – zero. Wheelbarrow is moving in different direction than gravity. Since the cement bag is not moving up or down, gravity is doing no work.

2.) A car of mass $1.0 \times 10^3 kg$ is travelling at a constant speed of $50.\frac{km}{h}$. The force of friction on the car is $500\ N$. The engine force increases to $750.N$ so that the car accelerates for $6.0\ s$.

a.) How much work is done by the engine in the $6.0\ s$?

Answer - $\vec{F} = m\vec{a}$ $+250 = (1000)\vec{a}$ $\vec{a} = +0.25\frac{m}{s^2}$

$\vec{d} = \vec{v}_o t + 0.5\vec{a}t^2$ $\vec{d} = (+13.88)(6.0) + 0.5(+0.25)(6.0)^2$ $\vec{d} = +87.78\ m$

$W = \vec{F}d$ $W = (+750)(87.78)$ $W = 6.6 \times 10^4 J$

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b.) How much work is done by the force of friction during the same $6.0\ s$?

Answer - $W = \vec{F}d$ $W = (+500)(87.78)$ $W = 4.39 \times 10^4 J$

3.) An object of mass $2.0\ kg$ falls to the floor from an $80.0\ cm$ high table. How much work is done by the force of gravity?

Answer - $W = \vec{F}d$ $W = (2.0)(-9.81))(0.80)$ $W = 15.7\ J$

4.) Engine A can lift $50.0\ kg$ a distance of $12\ m$ in $15\ s$. Engine B can lift $110.\ kg$ a distance of $12\ m$ in $35\ s$.

a.) Which engine can exert the greater force?

Answer - $\vec{d} = \vec{v}_o t + 0.5\vec{a}t^2$ $12 = 0.5(\vec{a})(15)^2$ $\vec{a} = +0.106666 \frac{m}{s^2}$

$\vec{F}_{net} = m\vec{a}$ $\vec{F}_{net} = (50.0)(0.106666)$ $\vec{F}_{net} = +5.33\ N$

$\overrightarrow{W} = m\vec{g}$ $\overrightarrow{W} = 50(-9.81)$ $\overrightarrow{W} = -491\ N$ $\overrightarrow{F_a} = 491 + 5.33$ $\vec{F} = 496\ N$

$\vec{d} = \vec{v}_o t + 0.5\vec{a}t^2$ $12 = 0.5(\vec{a})(35)^2$ $\vec{a} = +0.019592 \frac{m}{s^2}$

$\vec{F}_B = m\vec{a}$ $\vec{F}_B = (110)(+0.0195912)$ $\vec{F}_B = +2.16\ N$

$\overrightarrow{W} = m\vec{g}$ $\overrightarrow{W} = 110(-9.81)$ $\overrightarrow{W} = -1079.1\ N$ $\overrightarrow{F_a} = 1079 + 2.16$ $\vec{F} = 1082\ N$

b.) Which engine is more powerful?

Answer - $W_A = \vec{F}d$ $W_A = (5.33)(12)$ $W_A = 63.96\ J$

$W_B = \vec{F}d$ $W_B = (2.16)(12)$ $W_B = 25.92\ J$

$P_A = \frac{W}{t}$ $P_A = \frac{63.96}{15}$ $P_A = 4.3\ W$ $P_B = \frac{W}{t}$ $P_B = \frac{25.92}{35}$ $P_B = 0.74\ W$

5.) What is the average power of a car engine that can accelerate a car of mass $1250\ kg$ from rest to $80. \frac{km}{h}$ in $10.0\ s$ when the force of friction on the car is $725\ N$?

Answer - $\vec{v}_f = \vec{v}_o + \vec{a}t$ $+22.22 = 0 + \vec{a}(10.0)$ $\vec{a} = +2.222 \frac{m}{s^2}$

$\vec{v}_f{}^2 = \vec{v}_o{}^2 + 2\vec{a}\vec{d}$ $(+22.22)^2 = 0^2 + 2(+2.22)\vec{d}$ $\vec{d} = +111.222\ m$

$\vec{F}_{net} = m\vec{a}$ $\vec{F}_{net} = (1250)(+2.22)$ $\vec{F} = +2777.778\ N$

$W = \vec{F}d$ $W = ((+2777.778) + (725\ )(+111.222)$ $W = 3.8959 \times 10^5 J$

$P = \frac{W}{t}$ $P = \frac{\vec{F}d}{t}$ $P = \frac{(725+2777.78\ )(111.222)}{10.0}$ $P = 3.90 \times 10^4\ W$

6.) If a $10.\ N$ force is needed to just keep a $1.6\ kg$ object from moving across a floor at a steady speed, how much work is done in moving it $3.2\ m$?

Answer - $W = \vec{F}d$ $W = (+10)(3.2)$ $W = 32\ J$

Answers - 1a.) $960\ J$ b.) $960\ J$ c.) $720\ J$ d.) 0 e.) $240\ J$ f.) 0 2a.) $6.58 \times 10^4\ J$ b.) $4.39 \times 10^4\ J$ 3.) $15.7\ J$ 4a.) engine A = $496\ N$, engine B = $1.08 \times 10^3\ N$ b.) engine A = $4.3\ W$, engine B = $0.74\ W$ 5.) $3.90 \times 10^4\ W$ 6.) $32\ J$