Solutions for Power and Efficiency questions 16, 17 and 18

16. (a) The increase in Kinetic energy of the skateboarder is his work output (W_o)

$$\Delta E_K = 1600\text{ J} - 800\text{ J} = \boxed{800\text{ J} = W_o}$$

→ energy used only for Kinetic energy

$$\therefore P_o = \frac{W_o}{t}$$

$$= \frac{800\text{ J}}{20\text{ s}}$$

$$\boxed{P_o = 40\text{ W}}$$

(b) There are three versions of the Efficiency equation (see pg 31 notes) use:

$$Eff = \frac{E_O}{E_I}$$

→ E_O: same as W_O

→ E_I: energy input is the total amount of energy he expended during the activity!

$$Eff = \frac{800\text{ J}}{1500\text{ J}}$$

$$\boxed{Eff = 0.53}$$

or 53%

→ For every 100 J of energy he puts into the activity 53 J is used to increase Kinetic energy

17. (a) The car will need power to accelerate and overcome friction so we will need to use Kinematics to calculate acceleration and displacement

$V_1 = 0$

$V_2 = 30 m/s$

$t = 15 t$

$d = ?$

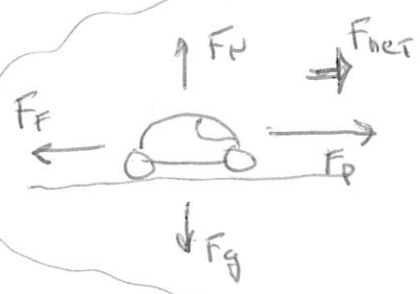
$a = ?$

$$a = \frac{V_2 - V_1}{t}$$

$$a = 2.0 m/s^2$$

$$d = \frac{V_2^2 - V_1^2}{2a}$$

$$d = 225 m$$



$\rightarrow F_{net} = F_p - F_F$

Solving for F_p can be used in $P = FV$ to find the maximum power displayed by engine

The power developed by the engine is the sum of the power to accelerate and overcome friction

$$P_o = \frac{W_o}{t} + \frac{W_o}{t}$$

$$= \frac{F_{net} d}{t} + \frac{F_F d}{t}$$

$$= \frac{mad + F_F d}{t}$$

$$= \frac{(1000)(2.0)(225) + (500)(225)}{15}$$

$$P_o = 37500 W$$

17 (b) $Eff = \frac{P_O}{P_I}$

$\rightarrow P_I = \frac{P_O}{Eff}$

$= \frac{37500\ W}{0.80}$

$= 46\,875\ W$

$P_I = 47\,000\ W$

→ only 80% of this is used to accelerate and overcome friction, the other 20% is used for other things. (lights, etc)

18 a) $W_I = F_1 d_1 + F_2 d_2$

$= (40)(6) + (100)(4)$

$= 640\ J$ → all the work she does

b) $E_K = \frac{mv^2}{2}$

$= \frac{30(5.0)^2}{2}$

$= 375\ J$ → also the ΔE_K which equals the work done to accelerate the mower

c) $Eff = \frac{E_O}{E_I}$ or $\frac{W_O}{W_I}$

$= \frac{375\ J}{640\ J}$

$= 0.59$