AP Phys 1 Unit 7.6 Notes - Power

7.6 – Power

Power

Measure of energy transferred per time unit:

$P = \frac{\Delta E}{\Delta t}$ AP Equation	E = energy (J) t = time (s)

Energy is a broad term: it could be work (force times distance), change in kinetic energy (by the work-energy theorem), or any physical process during which energy transfer occurs.

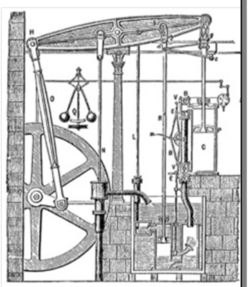
Horsepower!

Units of Power = Watts (W)

Named after James Watt, a Scottish engineer who made improvements on the steam engine.

Analysis: 1 W = 1 J/s.

Imperial Unit = horsepower (hp)
1 hp = 746 W



1. Example

A crane lifts a 1.0 metric ton (1000.0 kg) crate 25 m vertically in 9.0 seconds. What force lifts the crate?

A. How much work was done?

B. What is the power output of the crane during the lift?

1. Example

A. Tension opposes gravity, and does the work:

$$W = F_T \bullet d = F_g d = m \bullet g \bullet d$$
$$= 1000.0\,kg \bullet 9.81\,m/s^2 \bullet 25.0\,m$$
$$= 245{,}000\,J = 245\,kJ$$

B. Work done is the energy output, so power:

$$P = \frac{\Delta E}{\Delta t} = \frac{245\,kJ}{9.0\,s} = 27\,kW$$

2. Example

A vacuum has a power output of 0.750 hp.

A. How much work can it do in 3.00 minutes?

B. How long does it take to do 97.0 kJ of work?

2. Example

First, convert hp to Watts:

$$0.750\,hp \cdot \frac{746\,W}{1\,hp} = 560.W = 560.J/s$$

Note: expressing W as J/s is useful for many calculations.

A. Energy output equals work: $\Delta E = W$

$$P = \frac{W}{\Delta t}$$

$$W = P \cdot \Delta t = 560.\frac{J}{s} \cdot 3.00\,m \cdot \frac{60\,s}{1.0\,m} = 101{,}000\,J = 101\,kJ$$

2. Example

B. Time needed to expend 97.0 kJ:

$$P = \frac{\Delta E}{\Delta t}$$

$$\Delta t = \frac{\Delta E}{P} = \frac{9.70\,E\,4\,J}{560.\frac{J}{s}} = 173\,s$$

Efficiency (Symbol = ε)

Not all energy consumed in systems is useful - heat, light, and sound are wasted energy.

A measure of usefulness is efficiency:

$$\varepsilon = \frac{E_{output}}{E_{input}} \cdot 100\%$$

This is a unitless ratio expressed as a percentage, and energy could be in any form (power, work, etc.).

3. Example

An electric drill motor is 80.0% efficient.

A. What is the useful power output of the drill if its input power rating is 600.0 W?

B. How much useful work can it do in 30.0 seconds?

Example 3

A. Useful output of the drill:

$$\varepsilon = \frac{P_{output}}{P_{input}} \cdot 100\%$$

$$P_{output} = \frac{\varepsilon}{100\%} \cdot P_{input} = \frac{80.0\%}{100\%} \cdot 600.0\,W = 480.\,W$$

Example 3

B. Work done in 30 seconds:

$$P = \frac{\Delta E}{\Delta t}$$

$$P = \frac{W}{\Delta t}$$

$$W = P \cdot \Delta t = 480.\frac{J}{s} \cdot 30.0\,s = 14{,}400\,J = 14.4\,kJ$$

Homework

7.6 Problems in your Booklet
Due: next class

Also: Mousetrapmobile Registration Due!

Finish Unit 7 Review Problems Due!