ABRHS PHYSICS (CP) NAME: KEY

Power

A. What is meant by the term "work?"

It is the amount of energy transfered from one place to another

B. What is power?

Power is the rate at which work happens $P = \frac{W}{t} \rightarrow = \frac{\text{Energy}}{\text{time}}$

C. What are the units of power?

W (Watts)

Calculations

1. What is the power of a person that can do 5000 J of work in 4 seconds?

$W = 5000$ J, $t = 4$ s $\quad P = \frac{W}{t} \quad P = \frac{5000}{4} \quad \boxed{P = 1250 \text{ W}}$

2. A force does 500 J of work in 1 minute. What is the power of the force?

$W = 500$ J, $t = 1$ minute $\quad t = (1 \text{ min})(60 \frac{\text{s}}{\text{min}})$, $t = 60$ s $\quad P = \frac{W}{t} \quad P = \frac{500}{60} \quad \boxed{P = 8.3 \text{ W}}$

3. How much energy is used by a 75 W light bulb in 2 minutes?

$P = 75$ W, $t = 2$ minutes $\quad t = (2 \text{ min})(\frac{60 \text{ s}}{\text{min}})$, $t = 120$ s $\quad P = \frac{W}{t} \quad 75 = \frac{W}{120} \quad \boxed{W = 9000 \text{ J}}$

4. How much energy does a 4500 W generator produce if it is running for 6 hours?

$P = 4500$ W, $t = 6$ hrs $\quad t = (6 \text{ hrs})(\frac{60 \text{ min}}{1 \text{ hr}})(\frac{60 \text{ s}}{1 \text{ min}})$, $t = 21{,}600$ s $\quad P = \frac{W}{t} \quad 4500 = \frac{W}{21{,}600} \quad \boxed{W = 97{,}200{,}000 \text{ J}}$

5. How long would it take a 40 W engine to do 5000 J of work?

$P = 40$ W, $W = 5000$ J $\quad P = \frac{W}{t} \quad 40 = \frac{5000}{t} \quad \boxed{t = 125 \text{ s}}$

6. How long would take something producing 250 W to do 1,000 J of work? How about 10,000 J?

$P = 250$ W, $W = 1000$ J [$W = 10{,}000$ J] $\quad P = \frac{W}{t} \quad 250 = \frac{1000}{t} \quad \boxed{t = 4 \text{ s}} \quad 250 = \frac{10{,}000}{t} \quad \boxed{t = 40 \text{ s}}$

7. How much power does it take to lift 20 kg to a height of 15 meters in only 5 seconds?

$m = 20$ kg, $h = 15$ m, $t = 5$ s

In lifting the object, it gains PE - so it PE is the work done on it:

$W = PE = mgh = (20)(10)(15) = 3000 \text{ J}$

Then $P = \frac{W}{t} = \frac{3000}{5}$

$\boxed{P = 600 \text{ W}}$

Power

8. How long would it take a 5,000 W crane to lift 150 kg to a height of 30 meters?

P = 5000 W
m = 150 kg
h = 30 m

The work done will be the PE gained, so
$W = PE = mgh = (150)(10)(30)$
$W = 45{,}000\ J$

$P = \frac{W}{t}$ $\quad 5000 = \frac{45{,}000}{t}$

$t = 9\ s$

9. Every year, there is a race at the Empire State Building, from the ground floor to the 86th floor observation deck. The participants climb 1576 stairs for a total height of 320 meters.
   a. The record for this event is a time of 9 minutes and 33 seconds. If that person had a mass of 70 kg, what was the power needed?

h = 320 m
m = 70 kg
t = 9 min 33 sec

$PE = mgh = (70)(10)(320)$
$PE = 224{,}000\ J$

This PE is the work done the person

So: $P = \frac{W}{t}$

$(9\ min)(60\ \frac{s}{min}) = 540\ s$
$t = 540 + 33 = 573\ s$

$P = \frac{224{,}000}{573}$

$P = 391\ W$

   b. Using <u>your</u> power output from the Power Lab, how long would it take you to complete this task? Do you think that is a realistic estimate of how long it might take you to do this?

P = Your Power
m = Your mass
h = 320 m

$W = PE = mgh$
$W = (\quad)(10)(320)$

Then plug in your power
$P = \frac{W}{t}$

10. Which is more powerful: doing 1000 J of work in 50 seconds or doing 500 J of work in 25 seconds?

$W_1 = 1000\ J$
$t_1 = 50\ s$

$W_2 = 500\ J$
$t_2 = 25\ s$

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

$P_1 = \frac{1000}{50} = 20\ W$

$P_2 = \frac{500}{25} = 20\ W$

} They are the same!

Answers:

1) 1250 W 2) 8.3 W 3) 9000 J 4) 97,200,000 J 5) 125 s 6) 4 s; 40 s
7) 600 W 8) 9 s 9. a) 391 W b) ---- 10) same, both 20 W