Lesson 1

Work and Energy

Energy: the capacity to do work. (see chart p. 324)

Work: a measure of the amount of energy transferred from one object to another.

$$W = Fd$$

Where
W = work done (Joules)
F = force (Newtons)
d = displacement (metres)

According to this formula, work has units,

$$W = N \cdot m = Joule$$
$$1 Joule = 1 N \cdot m$$

Example:
How much work is required when a horizontal force of 5.0 N is applied to a box of books that moves 4.1 m?

Example:
How much work is done if the same force is applied at an angle of 37° to the horizontal?

Objects moved vertically

When objects are moved vertically at a constant speed, the object's weight must be overcome to lift an object to height h. In this case,

$$W = Fd$$
$$W = mgd$$

Example:
How much work is required to lift a 0.50 kg physics book to a height of 6.0 m at a constant speed?

Power

Power is the rate of doing work or transforming energy.

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

and since work is the amount of energy transferred,

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

$$units: 1W = 1\frac{J}{s}$$

In electrical appliances, power is usually specified in watts or kilowatts (eg. electric kettle 1500 W, coffee maker 900 W, toaster 850 W)

Example:
What is the power of a cyclist who transforms 2.7×10^4 J of energy in 3.0 minutes?

Example:
What is the power of a motor for a hoist that will lift a 2.0×10^2 kg object through 10.0 m in 10.0 s?

Another commonly used unit of power is horsepower.

1 horsepower = 746 W

Example:
How much energy is consumed when an 800.0 W dryer element in an electric dishwasher operates for 5.0 minutes?

Notice that energy and work are both measured in Joules since by definition, work is the transfer of energy.