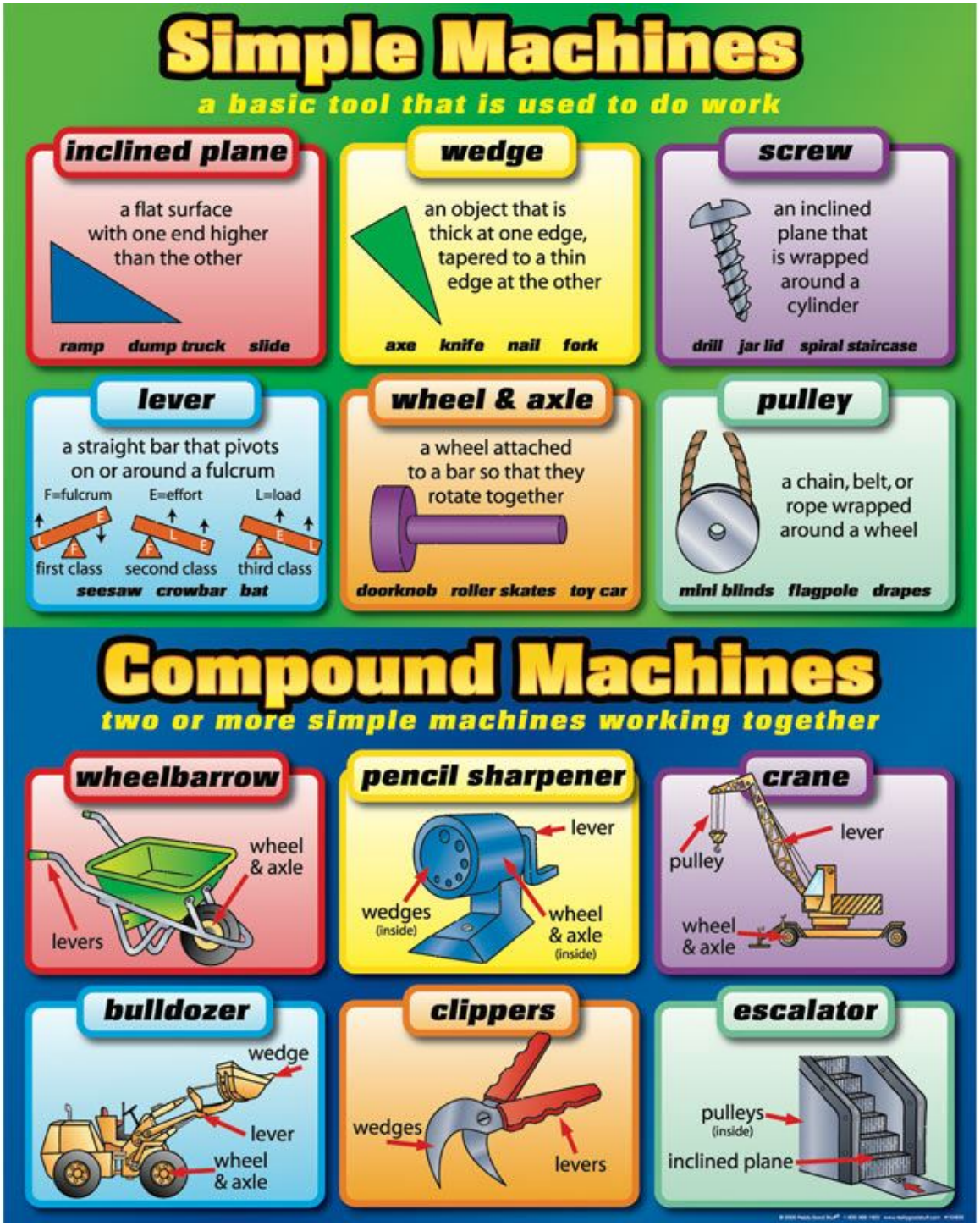
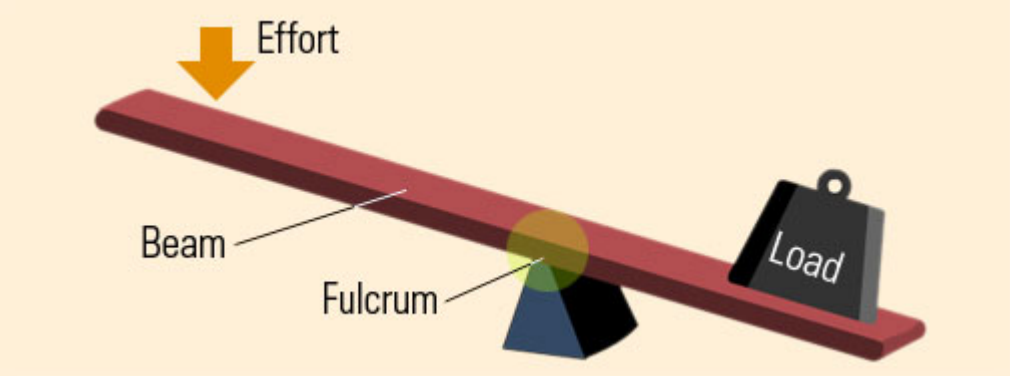
Lesson # 10 Simple Machines

1. There are six types of simple machines: Wedge, inclined plane, lever, screw, pulley, wheel and axle. Simple machines are considered to be the simplest form of all more complicated machines sometimes called compound machines (made of two or more simple machines).



2. Simple machines can change the direction or the magnitude of the applied force. A simple machine uses a single applied force to do work on a single load force. A simple machine can change the amount of output force but has a proportional change in the distance moved by the load.



3. The ratio of the output to the applied force (input) is known as the mechanical advantage, MA. The mechanical advantage of a simple machine can be determined by taking the ratio of the force output and dividing by the force input.

$$MA = F_{out}/F_{in}$$

4. The above equation assumes that the simple machine does not lose energy to frictional forces, this is known as an ideal simple machine. Ideal simple machines also have the following relationships for power and work:

Power output = Power input,

Work output = Work input

5. If power is defined by the rate at which work is done, then the following is true:

Power output = power input

Work output/time = Work input/time

$$\frac{\text{Force x distance output}}{\text{Time}} = \frac{\text{Force x distance input}}{\text{Time}}$$

Force x Velocity output = Force x velocity input

$$\frac{\text{Force output}}{\text{Force input}} = \frac{\text{Velocity input}}{\text{Velocity output}}$$

And

$$\frac{\text{Force x distance output}}{\text{Time}} = \frac{\text{Force x distance input}}{\text{Time}}$$

$$\frac{\text{Force output}}{\text{Force input}} = \frac{\text{Distance input}}{\text{Distance output}}$$

Or altogether

$$MA = F_{out}/F_{in} = V_{in}/V_{out} = d_{in}/d_{out}$$

6. Example: You apply a force of 9 N on to the end of a lever to open a paint can lid. The resistance of the lid is 18 N. Calculate the MA.

$$MA = F_{out}/F_{in}$$

$$MA = 18/9 = 2$$

7. Example: You apply a force on a crowbar to open a stuck door. The effort length of the crowbar is 24 cm long and the resistance length is 4 cm. Calculate the MA.

$$MA = d_{in}/d_{out}$$

$$MA = 24/4 = 6$$

8. Example: The mechanical advantage for a lever is 3. The lever is being pushed with a speed of 2m/s what is the speed of the end of the lever?

$$MA = V_{in}/V_{out}$$

$$V_{out} = V_{in}/MA$$

$$V_{out} = 2/3 \text{ m/s}$$