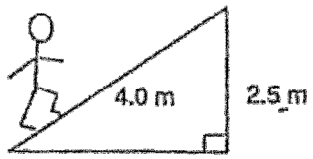
Power

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

Example Problems:

1. 

A 60.0 kg student runs at a constant velocity up the incline described in the diagram in 4.5 s. Calculate the power output by the student.

Find the work first. Since the work is against gravity, we use the formula

$$W = mgh$$
$$= (60.0\text{ kg})(9.81\text{ m/s}^2)(2.5\text{ m})$$
$$= 1.47 \times 10^3\text{ J}$$

$$P = \frac{W}{t}$$
$$= \frac{1.47 \times 10^3\text{ J}}{4.5\text{ s}}$$
$$= 3.3 \times 10^2\text{ W}$$

2. A 1.0×10^3 kg car accelerates from rest to a velocity of 15.0 m/s in 4.00 s. Calculate the power output of the car in this 4.00 s.

$$a = \frac{v_f - v_i}{t}$$
$$= \frac{15.0\text{ m/s}}{4.00\text{ s}}$$
$$= 3.75\text{ m/s}^2$$

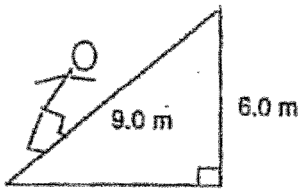
$$F = ma$$
$$= (1.00 \times 10^3\text{ kg})(3.75\text{ m/s}^2)$$
$$= 3.75 \times 10^3\text{ N}$$

$$d = \frac{v_f + v_i}{2}$$
$$= \left(\frac{15.0\text{ m/s}}{2}\right) 4.00\text{ s}$$
$$= 30.0\text{ m}$$

$$W = Fd$$
$$= (3.75 \times 10^3\text{ N})(30.0\text{ m})$$
$$= 1.13 \times 10^5\text{ J}$$

$$P = \frac{W}{t}$$
$$= \frac{1.13 \times 10^5\text{ J}}{4.00\text{ s}}$$
$$= 2.81 \times 10^4\text{ W}$$

Practice Problems:

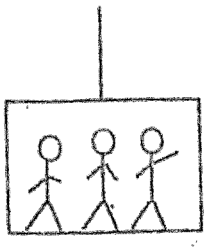
1. 

A 45.0 kg student runs at a constant velocity up the incline described in the diagram. If the power output of the student is 1.50×10^3 W, how long does it take the student to run the 9.0 m along the incline?

2. A 20.0 kg object is lifted vertically at a constant velocity 2.50 m in 2.00 s by a student. Calculate the power output of the student.

3. A 2.00 kg object is accelerated uniformly from rest to 3.00 m/s while moving 1.5 m across a level frictionless surface. Calculate the power output.

4.



An 8.5×10^2 kg elevator (including occupants) is pulled up at a constant velocity of 1.00 m/s by an electric motor. Calculate the power output of the motor.

5. A 5.0 kg object is accelerated uniformly from rest to 6.0 m/s while moving 2.0 m across a level surface. If the force of friction is 4.0 N, calculate the power output.