4. How much work is required to lift a 4.0 kg concrete block to a height of 2.0 m?

$$W = F \times D$$

$$F = m \times a \ \ where\ a = 9.80\frac{m}{s^2}$$

$$W = m \times 9.80\frac{m}{s^2} \times D$$

$$W = 4.0kg \times 9.80\frac{m}{s^2} \times 2.0m$$

$$W = 78\frac{kgm}{s^2}$$

$$W = 78N$$

12. Which has more kinetic energy: a 0.0020-kg bullet traveling at 400 m/s or a 6.4 x 10^7-kg ocean liner traveling at 10 m/s (20 knots)? Justify your answer.

$$KE = \frac{1}{2}mv^2$$

Bullet

$$\text{KE} = \frac{1}{2} \times 0.0020\ kg\ \times\ (400\ m/s)^2$$

$$\text{KE} = 0.0010\ kg\ \times\ 160{,}000\frac{m^2}{s^2}$$

$$\text{KE} = 160\ \frac{kg \cdot m^2}{s^2}$$

$$\text{KE} = 1.6\ X\ 10^2\ \frac{kg \cdot m^2}{s^2}$$

Ocean Liner

$$\text{KE} = \frac{1}{2} \times\ 6.1\ x\ 10^7\ kg\ \times\ (10\ m/s)^2$$

$$\text{KE} = 3.0\ x\ 10^7\ kg\ \times\ 100\frac{m^2}{s^2}$$

$$\text{KE} = 3.0\ x\ 10^9\ \frac{kg \cdot m^2}{s^2}$$

The Ocean Liner has more kinetic energy

15. What is the potential energy of a 3.00 kg object at the bottom of a well 10.0 m deep as measured from ground level? Explain the sign of the answer.

$$PE = mgh \ \ where \ g = 9.80\frac{m}{s^2}$$

$$PE = 3.00\ kg\ \times\ 9.80\frac{m}{s^2} \times -10.0\ m$$

$$PE = -294\frac{kg\ m^2}{s^2}$$

$$PE = -294J$$

The sign is negative because the object is below ground level.

16. How much work is required to lift a 3.00 kg object from the bottom of a 10.0 m deep well?

Since the potential energy will be zero at ground level and using the answer from question 13, the energy required to lift the object will be 294 J.

20. A 35.0 kg child starting from rest slides down a water slide with a vertical height of 20.0 m. What is the child's speed at

    a. Halfway down the slide's vertical distance?

    Knowing that the potential energy will all be converted to kinetic energy, we can use the following formal:

$$KE = PE$$
$$\frac{1}{2}mv^2 = mgh$$
$$v = \sqrt{2gh}$$

    At a vertical distance of 10.0 m the child's velocity will be:

$$v = \sqrt{2gh}$$
$$v = \sqrt{2 \times 9.80\ \frac{m}{s^2} \times 10.0\ m}$$
$$v = \sqrt{196\ \frac{m^2}{s^2}}$$
$$v = 14.0\ \frac{m}{s}$$

    b. Three quarters of the way down?

    At a vertical distance of 15.0 m the child's velocity will be:

$$v = \sqrt{2gh}$$
$$v = \sqrt{2 \times 9.80\ \frac{m}{s^2} \times 15.0\ m}$$
$$v = \sqrt{294\ \frac{m^2}{s^2}}$$
$$v = 17.1\ \frac{m}{s}$$

24. A 130 lb student races up stairs with a vertical height of 8.0 m in 5.0 s to get to a class on the second floor. How much power in watts does the student expend in doing work against gravity?

First we need to convert 130 lbs to kg:

$$130\ lbs\ \times \frac{1\ kg}{2.20\ lb} = 59\ kg$$

Next we need the formula:

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

$$W = F \times D$$

$$F = m \times a\ \ where\ a = 9.80\frac{m}{s^2}$$

Combining all of the above…

$$P = \frac{m \times a \times D}{t}$$

$$P = \frac{59\ kg \times 9.80\frac{m}{s^2} \times 8.0\ m}{5.0\ s}$$

$$P = 930\ \frac{kgm^2}{s^3}$$

$$P = 930\ Watts$$