Efficiency Exercises Name:_____

1. A lightbulb takes in 62 J of electric energy and outputs 24 J of light energy. What is the efficiency of the lightbulb?

$$Eff = \frac{W_{out}}{W_{in}} = \frac{24}{62} = 0.387 \times 100\%$$

$$\approx 39\%$$

2. How long will it take a 25.0 W motor with an efficiency of 65% to do 6 000 J of work?

$$P_{out} = 25 \times 0.65 = 16.25\ W$$

$$P = \frac{W}{t} \rightarrow t = \frac{W}{P} = \frac{6000}{16.25} = 369.23$$

$$\approx 370\ sec$$

3. A 5.00×10^3 W electric motor lifts a 200.0 kg object 5.00 m in 3.50 s. What is the efficiency of the motor?

$$P_{in} = 5000\ W$$

$$P_{out} = Fv = mgv$$

$$= mg\frac{d}{t} = 200 \times 9.8 \times \frac{5}{3.5} = 2800\ W$$

$$Eff = \frac{P_{out}}{P_{in}} = \frac{2800}{5000}$$

$$56\%$$

4. If a 125 W motor has an efficiency of 82%, how long will it take to lift a 50.0 kg object to a height of 8.00 m?

$$P_{out} = P_{in} \times Eff = 125 \times 0.82 = 102.5\ W$$

$$P_{out} = \frac{W}{t} = \frac{\Delta E}{t} = \frac{mgh}{t} \rightarrow t = \frac{mgh}{P_{out}}$$

$$= 38\ sec$$

Efficiency Exercises Name:_____

5. An 850 kg elevator is pulled up at a constant velocity of 1.00 m/s by a 10.0 kW motor. Calculate the efficiency of the motor.

$10\,kW = 10\,000\,W$

$P_{out} = F\bar{v} = mgv = 850 \times 9.8 \times 1 = 8330\,W$

$P_{in} = 10\,000\,W$

$Eff = \frac{P_{out}}{P_{in}} = \frac{8330}{10000} = 0.833 \times 100\% = 83\%$

6. A 2700 W heating plate is used to heat 0.80 kg of water from 20°C to 60°C in 56 seconds. [specific heat capacity of water is 4200 $\frac{J}{kg\,°C}$]

$W_{in} = Pt = 2700 \times 56 = 151\,200\,J$

$W_{out} = E_h = mc\Delta T = 0.80 \times 4200 \times 40$
$= 134\,400\,J$

$Eff = \frac{134\,400}{151\,200} = 0.89 \times 100\% = 89\%$

7. A 2700 W heating plate which is 56% efficient is used to heat water. How long will it take to heat 2.2 kg of water from 25°C to 100°C.

$2700\,W \times 0.56 = 1512\,W \leftarrow$ power out

$E_h = mc\Delta T = 2.2 \times 4200 \times 75 = 693000\,J$

$P = \frac{W}{t} \rightarrow t = \frac{W}{P} = \frac{693000}{1512} = 458\,sec$

$\simeq 460\,sec$

Efficiency Exercises Name:_____

8. A motor is 64% efficient, how much energy does it use to move a 1300 kg car at a constant velocity of 22 m/s a distance of 750m over a surface with force of friction of 2500 N.

① How much work was done?

$$W = Fd = 2500 \times 750 = 1\,875\,000\ J$$

② $$0.64 = \frac{1\,875\,000}{W_{in}} \rightarrow W_{in} = \frac{1\,875\,000}{0.64}$$

$$= 2929687.5\ J$$

$$\approx \boxed{2.9 \times 10^6\ J}$$

9. A motor uses 1260 J of energy to lift a 25 kg object to a height of 3.0m. What is the efficiency of the motor?

① How much work was done?

$$E_p = mgh = 25 \times 9.8 \times 3 = 735\ J$$

② $$\frac{735}{1260} = 0.58 \times 100\% = \boxed{58\%}$$

Efficiency Exercises Name:_____

10. A 955.0 kg car is accelerated uniformly from rest to 16.0 m/s while moving 18.0 m across a level surface with negligible friction. If the car uses 125 000 W of power, what is the efficiency of the car?

$P_{in} = 125000\,W$

$P_{out} = \frac{W}{t} \leftarrow \frac{1}{2}mv^2 = \frac{122\,240\,J}{t}$

↖ need to find t

$V_0 = 0$

$V_f = 16\,m/s$

$d = 18$

Use $V_f^2 = V_0^2 + 2ad$ to find a

$a = 7.11\,m/s^2$

Use $V_f = V_0 + at$ to find t

$t = 2.25\,sec$

$P_{out} = \frac{122\,240}{2.25} = 54329\,W$

$Eff = \frac{54329\,W}{125000\,W} = 0.43 \times 100\% = 43\%$