

Luckily that seems to stop your dog, but you start getting worried when your brother looks at you with a little fear. Moreover, you seem to have acquired an ability to fly.

4a-13 pts) Testing out your new ability, you (mass= 60 kg) decide to fly straight up to an altitude 10 km, where the air starts to get thin and gravity is lower. How much energy do you exert doing this?

$$\Delta U = \frac{GMm}{r_2} - \frac{GMm}{r_1} \quad \begin{array}{l} r_2 = R_e + h \\ r_1 = R_e \end{array}$$

$$\begin{aligned} \Delta U &= GMm \left[\frac{1}{R_e + h} - \frac{1}{R_e} \right] \\ &= 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \cdot 5.97 \times 10^{24} \text{ kg} \cdot 60 \text{ kg} \left[\frac{1}{6.38 \times 10^6} - \frac{1}{6.37 \times 10^6} \right] \\ &= 5.87 \times 10^6 \text{ J} \end{aligned}$$

Note: -5 if $\Delta U = mgh$ (unless justification is given)
 -6 if $U = \frac{GMm}{r_2}$ only (i.e. did not use ΔU)

4b - 12 pts) After exerting so much energy, you seek at Spark to for dinner and answers. You decide to cook dinner and can use either a stove top or microwave. The instructions tell you to cook the rice stew for 45 minutes at low heat on the stove top or for 15 minutes under high heat in the microwave. A burner on the stove top takes 1600 Watts and is on 30% of the time at low heat. The microwave takes 1000 Watts and is on 100% of the time at high power. If the cost of energy is \$0.20 per kW-hr, what appliance should you use and how much money will you save?

Cost of
 Oven: $0.3 \times \frac{3}{4} \text{ hour} \cdot 1600 \text{ J/s} \cdot \$0.20/\text{kW-hr} \times \frac{1 \text{ kW}}{1000 \text{ W}} = \0.072

Cost of
 Microwave = $1 \times \frac{1}{4} \text{ hour} \cdot 1000 \text{ J/s} \cdot \$0.20/\text{kW-hr} \times \frac{1 \text{ kW}}{1000 \text{ W}} = \0.050

Use microwave to save $\$0.072 - \$0.050 = \$0.02$ cents