

WORK-ENERGY PROBLEM WORKSHEET

1. The third floor of a house is 8 m above street level. How much work is needed to move a 150 kg refrigerator to the third floor?

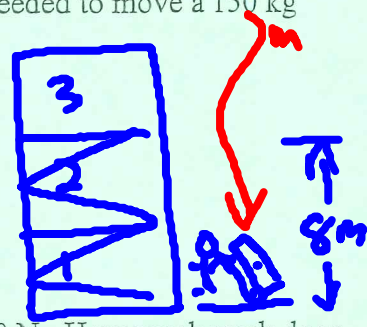
$$W_f = F \Delta s = W_{\Delta s} = m g \Delta s =$$

2. If Stan does 176 J of work lifting himself 0.30 m, what is Stan's mass?

$$W = mgh \text{ so } m = \frac{W}{gh} = \frac{176 \text{ N} \cdot \text{m}}{9.8 \text{ m/s}^2 \times 0.3 \text{ m}} = 59.9 \text{ kg}$$

3. Lee pushes a 20 kg box 10 m across the floor with a horizontal force of 80 N. How much work does Lee do?

$$W = F \Delta s = (80 \text{ N})(10 \text{ m}) = 800 \text{ N} \cdot \text{m} = 800 \text{ J}$$



4. Sau-Lan, with a mass of 52 kg, rides the up escalator at Ocean Park in Hong Kong, the world's longest. If the escalator has a length of 227 m and angle of 31°, calculate the work done by the escalator to lift Sau-Lan.

$$W = F \Delta s \sin 31^\circ = \frac{1}{2} (227 \text{ m})^2 \sin 31^\circ$$

$$W = (52 \text{ kg})(9.8 \text{ m/s}^2)(116.9 \text{ m})$$

5. A librarian lifts a 2.2 kg book from the floor to a height of 1.25 m; carries the book 8.0 m to the stacks, and places the book on a shelf 0.35 m above the floor. How much work is done on the book?

$$W = PE = mgh = (2.2 \text{ kg})(9.80 \text{ m/s}^2)(0.35 \text{ m})$$

6. A horizontal force of 805 N is needed to drag a crate across the floor with a constant speed. If the rope used to drag the crate makes an angle of 32° with the floor:

- a. Calculate the force applied along the rope.

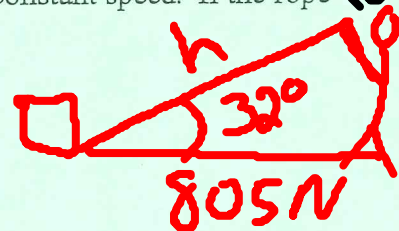
$$\cos 32^\circ = \frac{805 \text{ N}}{F}$$

- b. Calculate the work done to pull the crate a distance of 22 m.

$$W = F \Delta s$$

- c. If the job is done in 8 seconds, how much power is developed?

$$P = \frac{W}{\Delta t} = \frac{\text{ans b}}{8}$$



7. Mary weighs 505 N. If she walks down a flight of stairs to a level 5.5 m below, what is the change in her potential energy?

$$PE = mgh = (505 \text{ N})(-5.5 \text{ m}) = -2777.5 \text{ J}$$

8. Toni has a mass of 45 kg and is moving with a speed of 10 m/s.

- a. Calculate her kinetic energy.

$$KE = \frac{1}{2} mv^2 = \frac{1}{2} (45 \text{ kg})(10 \text{ m/s})^2 = 2250 \text{ J}$$

- b. If Toni's speed changes to 5 m/s, what is her kinetic energy? Compare to part a answer.

$$KE = \frac{1}{2} (45 \text{ kg})(5 \text{ m/s})^2 = 562.5 \text{ J}$$

$$\frac{2250 \text{ J}}{562.5 \text{ J}} = 4$$

9. 1000 g of copper pellets ($c = .092 \text{ cal/g}^\circ\text{C}$) are continually dropped in a 1 m-long PVC tube 200 times. Calculate the temperature rise ($^\circ\text{C}$) in the pellets due to the work done on them.

$$PE = Q \rightarrow mgh = C_m \Delta t$$

$$\Delta t = \frac{mgh}{(4.18) C_m}$$

kg
mgh
g

10. An experimental train with a mass of $2.5 \times 10^4 \text{ kg}$ is powered by a jet engine with a thrust of $5.0 \times 10^5 \text{ N}$ over a track length of 509 m.

a. Calculate the work done on the train.

$$W = F \Delta s = (5.0 \times 10^5 \text{ N})(509 \text{ m})$$

b. Calculate the final velocity of the train (assume no friction).

$$W = KE = \frac{1}{2} mv^2 \Rightarrow 2KE = mv^2 \rightarrow \sqrt{v^2} = \sqrt{\frac{2KE}{m}}$$

11. A 20 kg rock is on the edge of a 100 m tall vertical cliff.

a. What is the rock's potential energy relative to the base of the cliff?

$$PE = mgh = (20 \text{ kg})(9.80 \text{ m/s}^2)(100 \text{ m})$$

b. If the rock falls off the cliff, what is its speed just before it strikes the ground?

$$PE_i = KE_f \quad PE_a = \frac{1}{2} mv^2$$

12. A bow hunter places a 60 g arrow on the bowstring and exerts an average force of 180 N to pull the bowstring back 0.45 m.

a. How much work has she done?

$$W = F \Delta s = (180 \text{ N})(0.45 \text{ m})$$

b. If the bow is 80% efficient, at what speed does the arrow leave the bow?

$$KE = W = \frac{1}{2} mv^2 \Rightarrow 2W = mv^2 \rightarrow \sqrt{\frac{2W}{m}} = v$$

c. If fired vertically into the air, what height would the arrow achieve (assume 80% efficiency)?

$$v_f^2 - v_i^2 = 2a \Delta s \rightarrow -v_f^2 = 2gh \rightarrow h = \frac{-v_i^2}{2g}$$

13. A 3.0 kg gun, resting on a frictionless surface, fires a 12 g bullet with a muzzle velocity of 410 m/s.

a. Calculate the momenta of the bullet and gun after firing. Is momentum conserved?

b. Calculate the kinetic energy of the bullet and gun after firing. Is mechanical energy conserved?

14. A superball has a coefficient of restitution of 0.78. If it is dropped from a height of 2 m above the floor, to what height will it rebound?

15. If you could convert matter to energy with 1% efficiency, how much energy would 1 g of water produce?