

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?

$W = F \Delta s = W \Delta s = m g \Delta s = (150 \text{ kg})(9.8 \text{ m/s}^2)(8 \text{ m})$

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

$W = m g \Delta s$ so $m = \frac{W}{g \Delta s} = \frac{176 \text{ Nm}}{(9.8 \text{ m/s}^2)(0.30 \text{ m})}$

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?

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

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.

$\sin 31^\circ = \frac{h}{227}$

$W = PE = m g h$

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?

$W = PE = m g h = (2.2 \text{ kg})(9.8 \text{ m/s}^2)(1.6 \text{ m}) = 35.2 \text{ J}$

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.

$\cos 32^\circ = \frac{805}{x}$ $x = \frac{805}{\cos 32^\circ}$

$W = F \Delta s \cos \theta$

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

$W = F \Delta s = (805 \text{ N})(22 \text{ m})$

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

$P = \frac{W}{t} = \frac{17710 \text{ J}}{8 \text{ s}} = 2213.75 \text{ W}$

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?

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

- a. Calculate her kinetic energy.

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

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.

$$P.E. = mgh = (1\text{kg})(9.8\text{m/s}^2)(200\text{m}) = 1960\text{J} \cdot \frac{1\text{cal}}{4.18\text{J}} = 469\text{cal}$$

$$Q = cm\Delta T = (.092\text{ cal/g}^\circ\text{C})(1\text{kg})\Delta T \text{ so } \Delta T = ?$$

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.

$$W = F\Delta S = (5.0 \times 10^5 \text{ N})(509\text{m}) = 2.545 \times 10^8 \text{ J}$$

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

$$W = K.E. = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh} = \sqrt{2(9.80\text{m/s}^2)(509\text{m})}$$

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?

$$P.E. = mgh = (20\text{kg})(9.8\text{m/s}^2)(100\text{m}) = 1.96 \times 10^4 \text{ J}$$

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

$$v = \sqrt{2gh} = \sqrt{2(9.8\text{m/s}^2)(100\text{m})}$$

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?

$$W = F\Delta S = (180\text{N})(.45\text{m}) = 8.1 \times 10^1 \text{ J}$$

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

$$W = P.E. = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2(8.1\text{J})}{.06\text{kg}}} = 16.5\text{m/s}$$

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

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?