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?

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

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?

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.

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?

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.

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

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

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 cal/g-°C) are continually dropped in a 1 m-long PVC tube 200 times. Calculate the temperature rise (°C) in the pellets due to the work done on them.

$PE = Q \quad mgh = Cm\Delta t \rightarrow \Delta t = \frac{mgh}{Cm}$

$\frac{(200\,m)(1.0\,kg)(9.81\,m/s^2)}{(0.092\,\frac{cal}{g \cdot °C})(1000\,g)} \left(\frac{1.485}{1\,cal}\right)$

10. An experimental train with a mass of 2.5×10^4 kg is powered by a jet engine with a thrust of 5.0×10^5 N over a track length of 509 m.

a. Calculate the work done on the train.

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

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?

100m

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

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

$V = \sqrt{2gh}$

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?

$W = F\Delta S = (180\,N)(0.45\,m) = 81\,J$

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

$W = KE = \frac{1}{2}mv^2 \rightarrow V = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2W(0.80)}{m}} = 46.5\,\frac{m}{s}$

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

$W = PE \rightarrow (0.80)(81\,J) = mgh \rightarrow h = \frac{(0.80)(81\,J)}{(9.80)(0.060\,m)}$

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?

$P_b = m_b V_b = (0.012\,kg)(410\,m/s) = 4.92\,\frac{kg\,m}{s} = m_g V_g$

$V_g = 1.64\,m/s$

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

$KE_b = \frac{1}{2}mv^2 = \frac{1}{2}(0.012\,kg)(410\,m/s)^2 =$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(3.0\,kg)(1.64\,m/s)^2 =$

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?

$C.O.R = \sqrt{\frac{h_f}{h_i}} \rightarrow 0.78 = \sqrt{\frac{h_f}{2m}} \rightarrow 1.22\,M$

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

$E = mc^2 = (0.001\,kg)(3.0 \times 10^8\,m/s)^2(0.01)$

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