Answers

Work/Potential Energy/Kinetic Energy

Determine whether these statements represent examples of work:

1. A teacher applies a force to a wall and becomes exhausted.

   N – no distance

2. A book falls off a table and falls freely to the ground.

   Y

3. A waiter carries a tray full of meals above his head by one arm across the room.

   Y

4. A rocket accelerates through space.

   Y

Practice problems:

5. Ben carries a 200.-N suitcase up three flights of stairs (a total height of 10.0 m) then pushes it with a horizontal force of 50.0 N at a constant speed of 0.500 m/s for a horizontal distance of 35.0 m. How much work does Ben do on the suitcase during the entire motion? 3750 J

6. How much work is done by an applied force to lift a 15-N block 3.0 m vertically at a constant speed?

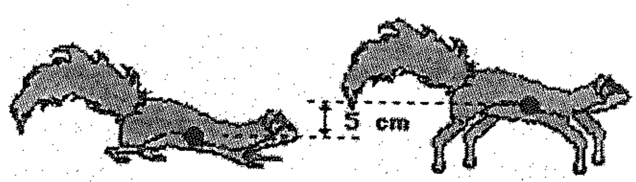
   45 J

7. A student with a mass of 80.0 kg runs up three flights of stairs in 12.0 seconds. The student has gone a vertical distance of 8.0 m. Determine the amount of work done by the student to elevate his body to this height. Assume that the speed is constant. 6300 J

8. Calculate the work done by a 2.0-N force (directed at a 30° angle to the vertical) to move a 500. gram box a horizontal distance of 400. cm across a rough floor with a constant speed of 0.500 m/s (HINT: be cautious with units.)

   4.0 J

9. A tired squirrel (mass of 1 kg) does push-ups by applying a force to elevate its center of mass by 5 cm. Determine the number of push-ups the squirrel must do in order to do a mere 5 J of work.



   10.2 push ups

10. A cart is loaded with a brick and pulled at a constant speed along an inclined plane to the height of a seat-top. If the mass of the loaded cart is 3.0 kg and the height of the seat-top is 0.45 m, then what is the potential energy of the loaded cart at the height of the seat-top?

    13 J

11. If a force of 15.0 N is used to drag the loaded cart (from the previous question) along the inline for a distance of 0.90 m, then how much work is done on the loaded cart?

    13.5 J

12. Determine the kinetic energy of a 1000-kg roller coaster car that is moving with a speed of 20 m/s.

    2×10^5 J

13. If the roller coaster car in the previous problem were moving with twice the speed, then what would be its new kinetic energy?

    8×10^5 J

14. Missy Dewaters, the former platform diver for the Ringling Brothers' Circus, had a kinetic energy of 15 000 J just prior to hitting the bucket of water. If Missy's mass is 50 kg, what is her speed?

24 m/s = 20 kg

15. A 750-kg compact car is moving at 100 km/hr has approximately 290 000 J of kinetic energy. What is the kinetic energy of the same car if it is moving at 50 km/hr?

73500J = 70 000J

16. Two physics students, Will N. Andable and Ben Pumpiniron, are in the weight lifting room. Will lifts the 100-pound barbell over his head 10 times in one minute; Ben lifts the same barbell over his head 10 times in 10 seconds. Which student does the most work? Which student delivers the most power? Explain your answers.

Same work
most Power - Ben, less time

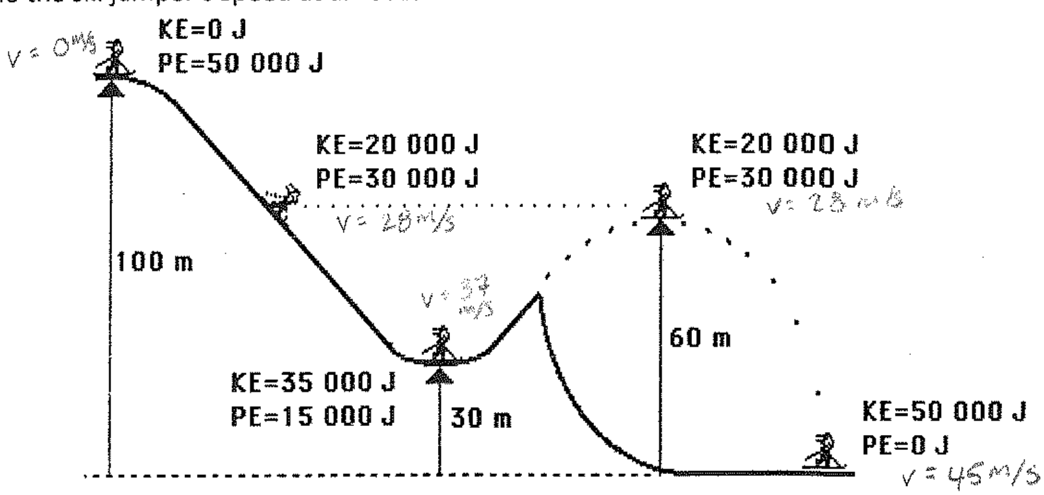
17. If little Nellie Newton lifts her 40-kg body a distance of 0.25 m in 2 seconds, then what is the power delivered by little Nellie's biceps?

50 W

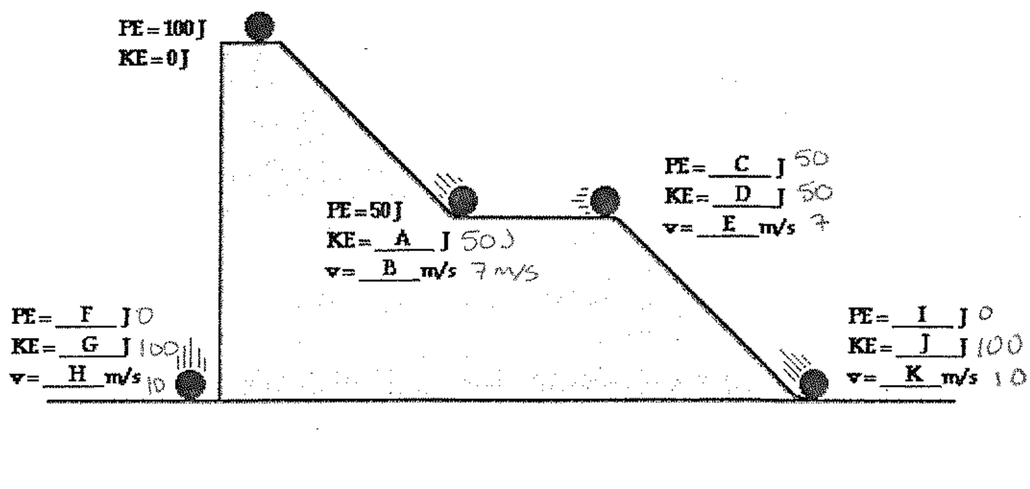
18. Your monthly electric bill is expressed in kilowatt-hours, a unit of energy delivered by the flow of 1 kilowatt of electricity for one hour. Use conversion factors to show how many joules of energy you get when you buy 1 kilowatt-hour of electricity.

3.6×10^6 J = 4×10^6 J

19. Determine the ski jumper's speed at all locations.



20. Consider the falling and rolling motion of the ball in the following two resistance-free situations. In one situation, the ball falls of the top of the platform to the floor. In the other situation, the ball rolls from the top of the platform along the staircase-like pathway to the floor. Fill in the blanks for the 2-kg ball.



Work / PE / KE

(5)
$F_1 = 200.\ N$
$d_1 = 10.0\ m$
$F_2 = 50.0\ N$
$v_2 = .500\ m/s$
$d_2 = 35.0\ m$
$W_{total} = ?$

$W = F_1 d_1 + F_2 d_2$
$= (200.\ N)(10.0\ m) + (50.0\ N)(35.0\ m)$
$= \boxed{3750\ J}$

(6)
$F = 15\ N$
$d = 3.0\ m$
$W = ?$

$W = Fd$
$= (15\ N)(3.0\ m)$
$= \boxed{45\ J}$

(7)
$m = 80.0\ kg$
$t = 12.0\ s$
$d = 8.0\ m$
$W = ?$

$W = Fd = mgd$
$= (80.0\ kg)(9.8\ m/s^2)(8.0\ m)$
$= 6272 = \boxed{6300\ J}$

(8)
$F = 2.0\ N$
$m = 500.\ g = .500\ kg$
$d = 400.\ cm = 4.00\ m$
$W = ?$

$F_x = 2.0\ N \cdot \sin\theta$
$= 1.0\ N$
$W = Fd$
$= (1.0\ N)(4.00\ m) = \boxed{4.0\ J}$

(9)
$m = 1\ kg$
$d = 5\ cm = .05\ m$
$W = 5\ J$
\# pushups = ?

$W = F \cdot d = mgh$
$W = mgh$
$h = \frac{W}{mg} = \frac{5\ J}{(1\ kg)(9.8\ m/s^2)}$
$= .51\ m$

$\frac{.51\ m}{.05\ m} = \boxed{10.2\ \text{pushups}}$

(10) $m = 3.0\,kg$

$h = .45\,m$

$PE = ?$

$PE = mgh$

$= (3.0\,kg)(9.8\,m/s^2)(.45\,m)$

$= \boxed{13\,J}$

(11) $F = 15.0\,N$

$d = .90\,m$

$W = ?$

$W = Fd$

$= (15.0\,N)(.90\,m)$

$= \boxed{13.5\,J}$

(12) $KE = ?$

$m = 1000\,kg$

$v = 20\,m/s$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2}(1000\,kg)(20\,m/s)^2$

$= \boxed{2 \times 10^5\,J}$

(13) $m = 1000\,kg$

$v = 40\,m/s$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2}(1000\,kg)(40\,m/s)^2$

$= \boxed{8 \times 10^5\,J}$

(14) $KE = 15\,000\,J$

$m = 50\,kg$

$v = ?$

$KE = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(15\,000\,J)}{50\,kg}}$

$= \boxed{24\,m/s}$

(15) $m = 750\,kg$

$v_1 = \frac{100\,km}{hr} \cdot \frac{1000\,m}{1\,km} \cdot \frac{1\,hr}{3600\,s} = 28\,m/s$

$KE = 290\,000\,J$

$v_2 = \frac{50\,km}{hr} \cdot \frac{1000\,m}{1\,km} \cdot \frac{1\,hr}{3600\,s} = 14\,m/s$

$KE = ?$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2}(750\,kg)(14\,m/s)^2$

$= \boxed{73500\,J}$

(16) most work: both do same work - same force + same distance

Most power: Ben - uses less time

(17) $m = 40\ kg$

$d = .25\ m$

$t = 2\ s$

$P = \frac{W}{t} = \frac{Fd}{t} = \frac{mgd}{t}$

$= \frac{(40\ kg)(9.8\ m/s^2)(.25\ m)}{2\ s}$

$= \boxed{50\ watts}$

(18) $\frac{1\ kW\ hr}{} \left| \frac{1000\ W}{1\ kW} \right| \frac{3600\ s}{1\ hr} = 3.6 \times 10^6\ W \cdot s$

$= \boxed{3.6 \times 10^6\ J}$

(19) A: $KE = 0\ J$

$\boxed{v = 0\ m/s}$

B: $KE = 20\ 000\ J$

$m = 50\ kg$

$\boxed{v = 28\ m/s}$

$KE = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2\ KE}{m}} = \sqrt{\frac{2(20\ 000\ J)}{50\ kg}} = \boxed{28\ m/s}$

C: $KE = 35\ 000\ J$

$m = 50\ kg$

$\boxed{v = 37\ m/s}$

$v = \sqrt{\frac{2\ KE}{m}} = \sqrt{\frac{2(35\ 000\ J)}{50\ kg}} = 37\ m/s$

D: $KE = 20000\ J$

$\boxed{v = 28\ m/s}$

E: $KE = 50\ 000\ J$

$m = 50\ kg$

$\boxed{v = 45\ m/s}$

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(50\ 000\ J)}{50\ kg}} = 45\ m/s$

(20) Total energy = 100 J

A: Total E − PE = KE

100 J − 50 J = **50 J KE**

B: KE = 50 J

m = 2 kg

v = ?

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(50J)}{2 kg}} = \boxed{7 m/s}$

C: **PE = 50 J** (no change in height)

D: **KE = 50 J**

E: KE = 50 J

v = 7 m/s

F: **PE = 0 J** h = 0 ∴ PE = 0

G: **KE = 100 J**

H: KE = 100 J

m = 2 kg

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(100J)}{2 kg}} = \boxed{10 m/s}$

I: **PE = 0 J**

J: **KE = 100 J**

K: **v = 10 m/s**