Work, Energy & Power

Energy · 8 questions · step-by-step answers at the end

Name: Date: Score: / 8

USEFUL EQUATIONS

$K = \frac{1}{2}mv^2$ $U_g = mgh$ $U_s = \frac{1}{2}kx^2$ $W = Fd\cos\theta$ $K_i + U_i + W_{\text{other}} = K_f + U_f$

$P = \Delta E/\Delta t = Fv$

Questions

Show your working in the space under each question.

1. A spring (k = 400 N/m) compressed by 0.10 m launches a 0.20 kg block along a frictionless floor. How fast does the block go?

2. A 60 kg skier starts from rest at the top of a 20 m high slope. (a) How fast is she going at the bottom if the slope is frictionless? (b) What if friction does −3000 J of work?

3. A car's speed doubles. With the same braking force, how does its stopping distance change?

4. How much work is needed to stretch a spring (k = 200 N/m) from 0.10 m to 0.20 m beyond its natural length?

5. A pendulum bob is released 0.45 m above its lowest point. How fast does it go at the bottom?

6. A force $F = 3x^2$ N acts from $x = 0$ to 2 m. Find the work done.

7. A 2.0 kg block slides 3.0 m across a floor against a 6.0 N friction force. How much thermal energy is produced?

8. An elevator motor lifts 800 kg at 2.0 m/s. What is the minimum power?

Step-by-step answers

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1. $\frac{1}{2}kx^2 = \frac{1}{2}(400)(0.10)^2 = 2.0$ J $= \frac{1}{2}mv^2$, so $v = \sqrt{(2 \times 2.0 / 0.20)} \approx$ **4.5 m/s**.

2. 1. Initial energy: $U = mgh = (60)(9.8)(20) = 11\,760$ J, and $K = 0$.
2. (a) All of it becomes kinetic energy: $\frac{1}{2}mv^2 = 11\,760 \rightarrow v = \sqrt{(2gh)} =$ **19.8 m/s**. The mass cancels.
3. (b) $K = 11\,760 - 3000 = 8760$ J $\rightarrow v = \sqrt{(2 \times 8760 / 60)} =$ **17.1 m/s**.
4. The missing 3000 J became thermal energy in the snow and skis.

Answer: (a) 19.8 m/s (b) 17.1 m/s

3. $KE \propto v^2$, so it becomes **4 times** longer.

4. $W = \frac{1}{2}k(0.2^2 - 0.1^2) = 100(0.03) =$ **3.0 J**.

5. $v = \sqrt{(2gh)} = \sqrt{(8.82)} \approx$ **3.0 m/s**. Its mass doesn't matter.

6. $W = [x^3]_0^2 =$ **8 J**.

7. $\Delta E_{th} = f_k d =$ **18 J**.

8. $P = mgv = 800 \times 9.8 \times 2 \approx$ **15.7 kW**.