

How moving and lifted objects store energy

Grade 7 science (Year 8 · Class 7) · Worksheet answers

Each answer shows the formula, the substitution and the result with its unit in bold. Compare your method as well as your final number, because a correct method with a small slip still earns most of the credit in a real assessment.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS3-1, MS-PS3-2

Problem 1 Which store of energy?

1. A rolling football is moving: **kinetic energy**.
2. A book on a high shelf is high above the ground: **gravitational potential energy**.
3. The diver is at rest but high up: **gravitational potential energy**.
4. A running dog is moving: **kinetic energy**.

Problem 2 Formulas and units

1. $KE = \frac{1}{2} \times m \times v^2$.
2. $GPE = m \times g \times h$ ($g = 9.8 \text{ N/kg}$).
3. Energy is measured in **joules (J)** and mass in **kilograms (kg)**.

Problem 3 Heavy or fast?

1. The speeds are equal, so the larger mass wins: **trolley Y** has more kinetic energy (it has three times as much).
2. Speed doubles, so energy rises by $2^2 =$ **four times (quadruples)**.

Problem 4 A kicked football

1. $KE = \frac{1}{2} \times m \times v^2$.
2. $KE = \frac{1}{2} \times 0.43 \times 10^2 = 0.215 \times 100 =$ **21.5 J**.

Problem 5 Bag on a shelf

1. $GPE = 2.0 \times 9.8 \times 1.5 =$ **29.4 J**.
2. On the floor $h = 0$, so $GPE =$ **0 J** (taking the floor as the zero level).

Problem 6 Boxes on supports

1. P: $1.0 \times 9.8 \times 0.5 = \mathbf{4.9 \text{ J}}$. Q: $1.0 \times 9.8 \times 1.0 = \mathbf{9.8 \text{ J}}$. R: $1.0 \times 9.8 \times 2.0 = \mathbf{19.6 \text{ J}}$.
2. Box R has the most. $19.6 \div 4.9 = \mathbf{4 \text{ times}}$ more than P, because its height is four times as large.

Problem 7 Mass in grams

1. $250 \text{ g} \div 1000 = \mathbf{0.25 \text{ kg}}$.
2. $\text{GPE} = 0.25 \times 9.8 \times 4.0 = \mathbf{9.8 \text{ J}}$.

Problem 8 Cyclist in km/h

1. $18 \text{ km/h} = 18\,000 \text{ m} \div 3600 \text{ s} = \mathbf{5 \text{ m/s}}$.
2. $\text{KE} = \frac{1}{2} \times 70 \times 5^2 = 35 \times 25 = \mathbf{875 \text{ J}}$.

Problem 9 Twice as fast

1. $\text{KE} = \frac{1}{2} \times 0.50 \times 6^2 = 0.25 \times 36 = \mathbf{9 \text{ J}}$.
2. $\text{KE} = \frac{1}{2} \times 0.50 \times 12^2 = 0.25 \times 144 = \mathbf{36 \text{ J}}$.
3. $36 \div 9 = \mathbf{4 \text{ times}}$ larger. The speed is squared, so doubling the speed multiplies the energy by $2^2 = 4$.

Problem 10 Reading an energy graph

1. At 3 m/s the energy is **9 J**.
2. A kinetic energy of 16 J occurs at **4 m/s**.
3. Kinetic energy depends on speed squared, so it increases faster and faster. A straight line would mean energy simply proportional to speed.

Problem 11 Height of a crate

1. $h = \text{GPE} \div (m \times g)$.
2. $h = 147 \div (5.0 \times 9.8) = 147 \div 49 = \mathbf{3.0 \text{ m}}$.

Problem 12 Falling apple

1. $\text{GPE lost} = 0.50 \times 9.8 \times 2.0 = \mathbf{9.8 \text{ J}}$.
2. With no air resistance, all of it becomes kinetic energy: **9.8 J**.

Problem 13 On a playground swing

1. At the highest point the swing is momentarily at rest, so it has the **most gravitational potential energy and no kinetic energy**.
2. At the lowest point the height is smallest and the speed is greatest: **maximum kinetic energy, minimum potential energy**.
3. Friction at the pivot and air resistance transfer some energy to the surroundings as thermal energy on every swing, so the swing rises less and less.

Problem 14 Scooter or car?

1. Scooter: $\frac{1}{2} \times 150 \times 10^2 = 75 \times 100 = \mathbf{7500 \text{ J}}$. Car: $\frac{1}{2} \times 1200 \times 5^2 = 600 \times 25 = \mathbf{15\,000 \text{ J}}$.
2. The car has more, by $15\,000 \div 7500 = \mathbf{2 \text{ times}}$.

Problem 15 Find the error

1. She left out the $\frac{1}{2}$ in $\frac{1}{2} \times m \times v^2$, and doubling the speed does not double the energy because speed is squared.
2. At 3 m/s: $\frac{1}{2} \times 4 \times 9 = \mathbf{18 \text{ J}}$. At 6 m/s: $\frac{1}{2} \times 4 \times 36 = \mathbf{72 \text{ J}}$, which is four times 18 J.

Problem 16 Mass from energy

1. $\mathbf{m = 2 \times KE \div v^2}$.
2. $m = 2 \times 360 \div 6.0^2 = 720 \div 36 = \mathbf{20 \text{ kg}}$.

Problem 17 Speed of a cricket ball

1. $\mathbf{v^2 = 2 \times KE \div m}$.
2. $v^2 = 2 \times 30 \div 0.15 = 400$, so $v = \sqrt{400} = \mathbf{20 \text{ m/s}}$.

Problem 18 Smooth track

1. $\text{GPE} = 0.80 \times 9.8 \times 0.50 = \mathbf{3.92 \text{ J}}$.
2. The track is smooth, so all of it becomes kinetic: $\mathbf{3.92 \text{ J}}$.
3. $v^2 = 2 \times 3.92 \div 0.80 = 9.8$, so $v = \sqrt{9.8} = \mathbf{3.1 \text{ m/s}}$.

Problem 19 Stopping a car

1. At 20 m/s: $\frac{1}{2} \times 1000 \times 400 = \mathbf{200\,000 \text{ J}}$. At 30 m/s: $\frac{1}{2} \times 1000 \times 900 = \mathbf{450\,000 \text{ J}}$.

2. $450\,000 \div 200\,000 = \mathbf{2.25 \text{ times.}}$

3. The speed is only 1.5 times larger, but the energy is $1.5^2 = 2.25$ times larger. The brakes must remove all of it, so the stopping distance grows much more than the speed.

Problem 20 High jump

1. $KE = \frac{1}{2} \times 60 \times 7.0^2 = 30 \times 49 = \mathbf{1470 \text{ J.}}$

2. $h = GPE \div (m \times g) = 1470 \div (60 \times 9.8) = 1470 \div 588 = \mathbf{2.5 \text{ m.}}$

3. Not all kinetic energy can be converted: some is transferred as thermal energy in the muscles and the ground, and the jumper keeps some forward speed over the bar.