

Kinetic Energy

Define kinetic energy:

- Kinetic energy is the energy associated with the motion of an object
- Measured in Joules (J)

$$E_k: 0.5 \times m \times v \times v$$

Formula for kinetic energy:

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

E_k = kinetic energy (J) or (kg * m² / s²)

m = mass of object (kg)

v = velocity of object (m/s)

$$E_k = 0.5 mv^2$$

$$\frac{\text{kg} \cdot \text{m}^2}{\text{s}^2}$$

Example: An arrow with a mass of 150 g is moving with a velocity of 100 m/s. Calculate the kinetic energy of the arrow.

$$m = 150\text{g} = 0.150\text{kg}$$

$$v = 100\text{m/s}$$

$$E_k = ?$$

$$\begin{aligned} E_k &= 0.5 mv^2 \\ &= (0.5)(0.150\text{kg})(100\frac{\text{m}}{\text{s}})^2 \\ &= 750\text{J} \end{aligned}$$

Example: The kinetic energy of an object moving at a speed of 14.2 m/s was determined to be 950 J. What is the mass of the object?

$$m = ??$$

$$v = 14.2\text{m/s}$$

$$E_k = 950\text{J}$$

$$\begin{aligned} E_k &= 0.5 mv^2 \\ 950\text{J} &= 0.5 m (14.2\text{m/s})^2 \\ 950\text{J} &= 100.82\frac{\text{m}^2}{\text{s}^2} \times m \end{aligned}$$

$$m = 9.4227... \text{kg} = 9.42\text{kg}$$

Example: A moving toy with a mass of 7.4 kg has a kinetic energy of 18 J. What is the speed of the toy?

$$m = 7.4\text{kg}$$

$$E_k = 18\text{J}$$

$$v = ??$$

$$\begin{aligned} E_k &= 0.5 mv^2 \\ 18\text{J} &= (0.5)(7.4\text{kg})v^2 \\ 18\text{J} &= 3.7\text{kg} \times v^2 \\ \sqrt{4.864...} &= \sqrt{v^2} \\ 2.2056... \frac{\text{m}}{\text{s}} &= v \end{aligned}$$

$$v = 2.2\text{m/s}$$

Practice Sheet 2

1. A car with a mass of 3400 kg is moving with a velocity of 45 km/h. Calculate the kinetic energy of the car.

$$\begin{aligned}
 m &= 3400 \text{ kg} & v &= 12.5 \text{ m/s} & E_k &= 0.5 m v^2 \\
 & & & & &= 0.5 (3400 \text{ kg}) (12.5 \text{ m/s})^2 \\
 E_k & & & & &= 265625 \text{ J} = \boxed{2.7 \times 10^5 \text{ J}} \\
 & & & & & \text{0.27 MJ}
 \end{aligned}$$

2. A hockey puck travelling at a velocity of 25 m/s has 5000 J of kinetic energy, what is the mass of the hockey puck?

$$\begin{aligned}
 v &= 25 \text{ m/s} & E_k &= 5000 \text{ J} & E_k &= 0.5 m v^2 \\
 E_k &= 5000 \text{ J} & & & 5000 \text{ J} &= 0.5 (m) (25 \text{ m/s})^2 \\
 m & & & & 5000 \text{ J} &= 312.5 (m) \\
 & & & & & \boxed{m = 16 \text{ kg}}
 \end{aligned}$$

3. A teacher threw a hole punch that has a mass of 1250 g across a room with a kinetic energy of 6000 J. How fast is the hole punch moving?

$$\begin{aligned}
 E_k &= 6000 \text{ J} & m &= 1250 \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 1.250 \text{ kg} & 6000 \text{ J} &= 0.5 (1.250 \text{ kg}) (v^2) \\
 m &= 1250 \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 1.250 \text{ kg} & v &= ? & 6000 \text{ J} &= 0.625 (v^2) \\
 v &= ? & & & \sqrt{9600} = \sqrt{v^2} & \\
 & & & & v &= 97.979 \dots \text{ m/s} = \boxed{97.98 \text{ m/s}}
 \end{aligned}$$

4. A small toy moving horizontally at a uniform speed of 2.2 m/s has a kinetic energy of 18 J. Calculate the mass of the toy.

$$\begin{aligned}
 v &= 2.2 \text{ m/s} & E_k &= 18 \text{ J} & E_k &= 0.5 m v^2 \\
 E_k &= 18 \text{ J} & & & & \\
 m & & & & & \boxed{7.4 \text{ kg}}
 \end{aligned}$$

5. A baseball with a mass of 300 g has a kinetic energy of 304 J. Calculate the speed of the ball.

$$\begin{aligned}
 m &= 300 \text{ g} = 0.300 \text{ kg} & E_k &= 304 \text{ J} & 304 \text{ J} &= 0.5 (0.300 \text{ kg}) (v^2) \\
 E_k &= 304 \text{ J} & & & 304 \text{ J} &= 0.150 (v^2) \\
 v &= ? & & & \sqrt{2026.6 \dots} = \sqrt{v^2} & \\
 & & & & v &= 45.018 \dots \text{ m/s} \\
 & & & & & = \boxed{45.0 \text{ m/s}}
 \end{aligned}$$