Lesson 1 Calculating kinetic energy

Recap of types of energy stores

Complete the table with the type of energy store being described (the answers are at the end for you to check)

|  |  |
| --- | --- |
| Energy Store | Description |
|  | The energy stored in an object which is moving. |
|  | The energy stored in an object which is hot. |
|  | The energy stored in foods and fuels. |
|  | The energy stored in anything above the ground (anything which can fall). |
|  | The energy stored in objects which are stretched, squashed or twisted. |
|  | The energy stored when two charges attract or repel one another. |
|  | The energy stored when two magnets attract or repel one another. |
|  | The energy stored when atomic nuclei release energy during nuclear reactions.  |

|  |  |
| --- | --- |
| Energy stores to choose from :* Kinetic energy store
* Gravitational energy store
* Magnetic energy store
* Electrostatic energy store
 | * Chemical energy store
* Nuclear energy store
* Chemical energy store
* Thermal energy store
 |

Kinetic energy

A moving object has energy in its kinetic energy store.

* When an object is moving, it has energy in its kinetic energy store
* Energy is transferred to this store if an object speeds up and away from this store if it slows down.
* How much energy is in this store depends on both the object’s mass and it’s speed.
* The greater it’s mass, and the faster it is going, the more energy it has in its kinetic energy store.
* For example, a high-speed train will have a lot more energy in its kinetic energy store than you running.
* If you double the mass, the energy in the kinetic energy store doubles.
* If you double the speed, though, the energy in the kinetic energy store quadruples (increases by a factor of 4) – because of the speed2 in the formula.

You need to be able to recall this equation. Make a flash card to help test yourself or come up with a pneumonic to remember it. Miss Bond uses ‘Kelly drank ½ my Vimto twice’

You can find the kinetic energy store using;

$$kinetic energy=\frac{1}{2} x mass x velocity^{2}$$

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

Measured in metres per second, m/s

Measured in kilograms, kg

Measured in Joules, J

Worked Example 1 (calculating kinetic energy)

A car of mass 1450kg is travelling at 28m/s. Calculate the energy in its kinetic energy store, giving your answer to 2 significant figures.

Step 1 : take the values from the equation

Step 2 : recall the equation you will need

Step 3 : rearrange if you need to

Step 4 : substitute the numbers and calculate your answer

m = 1450kg

v = 28m/s

KE = ½ x m x v2 = ½ x 1450 x 282 = 568,400J = 570,000J (to 2s.f.)

It is a common mistake for people to miss the square!

Worked Example 2 (calculating kinetic energy)

A van of mass 2450kg is travelling at 40 m/s. Calculate the energy in its kinetic energy store.

m = 2450 kg

v = 40 m/s

KE = ½ x m x v2 = ½ x 2450 x 402 = 1,960,000J

Worked example 3 (calculating mass)

A moped with 11700J of energy in its kinetic energy store travels at 12m/s. What is the mass of the moped?

KE = 11700J

v = 12m/s

KE = ½ x m x v2

m = $\frac{KE x 2 }{v^{2}}= \frac{11700 x 2 }{12^{2}}=162.5 kg $

Worked example 4 (calculating velocity)

A car has 23kJ of energy in its kinetic energy store and a mass of 1500kg. Calculate the velocity of the car.

KE = 23,000J

m = 1500 kg

KE = ½ x m x v2

$v= \sqrt{\frac{KE x 2}{m}}= \sqrt{\frac{23000 x 2}{1500}}=5.6 m/s $

Questions

1. Which has more kinetic energy when moving at a speed of 5m/s; a 5kg medicine ball or a 10kg medicine ball?
2. Define kinetic energy.
3. Rank the following from high to low kinetic energy: an aeroplane, somebody on a bicycle, a lorry on the motorway, and a football.
4. A car accelerates on a road. Explain whether the kinetic energy of the car changes.
5. A lorry is driving along a motorway and accidentally drops some parcels from the back. Explain what happens to the kinetic energy of the lorry.

Calculation Questions

1. Cristiano Ronaldo kicks a football of mass 500g at a speed of 40m/s. calculate the kinetic energy of the football.
2. A bullet of mass 10.5g has a velocity of 670m/s. How much kinetic energy does it have?
3. A fighter jet travels at a velocity of 400m/s. the pilot has a mass of 70kg. Calculate the kinetic energy of the pilot.
4. An elephant of mass 1,800kg runs at a constant speed of 3.5m/s. How much kinetic energy does it have?
5. In 2016, Cate Campbell set the Olympic record for the women’s 100m freestyle with a time of 52.71s If Cate’s mass was 74kg, how much was her kinetic energy during the race? You should assume she swims at a constant speed.
6. Serena Williams serves a tennis ball at a velocity of 60m/s, and gives it 90J of kinetic energy. Calculate the mass of the tennis ball.
7. A car of mass 800kg is travelling with a kinetic energy of 1,440,000J. Calculate it’s velocity.
8. A car is travelling at 10m/s has 75kJ of kinetic energy. Calculate the car’s mass.
9. A bullet was fired from a gun. The bullet had a mass of 50g and the kinetic energy of the bullet was 25,000J. How fast did it go?
10. A truck carrying heavy equipment travelled at 40m/s and had a kinetic energy of 9,000,000J, what was its mass?
11. A man started out with 1kJ of kinetic energy and a mass of 100kg. He then increased his kinetic energy to 2kJ. What was his speed after that?

Answers

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| --- | --- |
| Energy Store | Description |
| Kinetic energy store  | The energy stored in an object which is moving. |
| Thermal energy store | The energy stored in an object which is hot. |
| Chemical energy store | The energy stored in foods and fuels. |
| Gravitational potential energy store | The energy stored in anything above the ground (anything which can fall). |
| Elastic potential energy store  | The energy stored in objects which are stretched, squashed or twisted. |
| Electrostatic energy store | The energy stored when two charges attract or repel one another. |
| Magnetic energy store | The energy stored when two magnets attract or repel one another. |
| Nuclear energy store  | The energy stored when atomic nuclei release energy during nuclear reactions.  |

1. Which has more kinetic energy when moving at a speed of 5m/s; a 5kg medicine ball or a 10kg medicine ball?

The 10kg medicine ball has a larger kinetic energy store because it has a larger mass.

KE = ½ x m x v2

1. Define kinetic energy.

Kinetic energy is the energy stored in any object which is moving.

1. Rank the following from high to low kinetic energy: an aeroplane, somebody on a bicycle, a lorry on the motorway, and a football.

An aeroplane, a lorry on the motorway, somebody on a bicycle, a football.

1. A car accelerates on a road. Explain whether the kinetic energy of the car changes.

Acceleration is when the velocity of an object increases. If the velocity of the car is increasing, the kinetic energy store of the car is also increasing as kinetic energy of an object depends on the objects velocity.

1. A lorry is driving along a motorway and accidentally drops some parcels from the back. Explain what happens to the kinetic energy of the lorry.

When the parcels are dropped, the mass of the lorry will decrease. When the mass of the lorry decreases, the kinetic energy of the lorry will also decrease because the kinetic energy of an object depends on the mass of that object.

Calculation Questions

1. Cristiano Ronaldo kicks a football of mass 500g at a speed of 40m/s. Calculate the kinetic energy of the football.

m = 500g = 0.5kg

v = 40m/s

KE = ½ x m x v2 = ½ x 0.5 x 402 = 400 J

1. A bullet of mass 10.5g has a velocity of 670m/s. How much kinetic energy does it have?

m = 10.5g = 0.0015kg

v = 670m/s

KE = ½ x m x v2 = ½ x 0.0015 x 6702 = 340 J

1. A fighter jet travels at a velocity of 400m/s. the pilot has a mass of 70kg. Calculate the kinetic energy of the pilot.

v = 400m/s

m = 70kg

KE = ½ x m x v2 = ½ x 70 x 4002 = 5,600,000J = 5.6 MJ

1. An elephant of mass 1,800kg runs at a constant speed of 3.5m/s. How much kinetic energy does it have?

m = 1800kg

v = 3.5m/s

KE = ½ x m x v2 = ½ x 1800 x 3.52 = 11,025 J = 11kJ

1. In 2016, Cate Campbell set the Olympic record for the women’s 100m freestyle with a time of 52.71s If Cate’s mass was 74kg, how much was her kinetic energy during the race? You should assume she swims at a constant speed.

Distance = 100m

Time = 52.17s

Use $speed= \frac{distance}{time}= \frac{100}{52.17}= 1.92m/s$

v = 1.92m/s

m = 74kg

KE = ½ x m x v2 = ½ x 74 x 1.922 = 85J

1. Serena Williams serves a tennis ball at a velocity of 60m/s, and gives it 90J of kinetic energy. Calculate the mass of the tennis ball.

V = 60m/s

KE = 90J

KE = ½ x m x v2

 $m= \frac{KE x 2}{v^{2}}= \frac{90 x 2}{60^{2}}=0.05kg=50g$

1. A car of mass 800kg is travelling with a kinetic energy of 1,440,000J. Calculate it’s velocity.

m = 800kg

KE = 1,440,000 J

KE = ½ x m x v2

$$v= \sqrt{\frac{KE x 2}{m}}=\sqrt{\frac{1,440,000 x 2}{800}}=60m/s$$

1. A car is travelling at 10m/s has 75kJ of kinetic energy. Calculate the car’s mass.

v = 10m/s

KE = 75kJ = 75,000J

KE = ½ x m x v2

$$m= \frac{KE x 2}{v^{2}}= \frac{75000 x 2}{10^{2}}=1,500kg$$

1. A bullet was fired from a gun. The bullet had a mass of 50g and the kinetic energy of the bullet was 25,000J. How fast did it go?

m = 50g = 0.05kg

KE = 25,000J

KE = ½ x m x v2

$$v= \sqrt{\frac{KE x 2}{m}}=\sqrt{\frac{25000 x 2}{0.05}}=1,000m/s$$

1. A truck carrying heavy equipment travelled at 40m/s and had a kinetic energy of 9,000,000J, what was its mass?

v = 40m/s

KE = 9,000,000J

KE = ½ x m x v2

$$m= \frac{KE x 2}{v^{2}}= \frac{9000000 x 2}{40^{2}}=11,250kg$$

1. A man started out with 1kJ of kinetic energy and a mass of 100kg. He then increased his kinetic energy to 2kJ. What was his speed after that?

KE = 2kJ = 2,000J

m = 100kg

KE = ½ x m x v2

$$v= \sqrt{\frac{KE x 2}{m}}=\sqrt{\frac{2000 x 2}{100}}=6.3 m/s$$