Holly Lodge High School

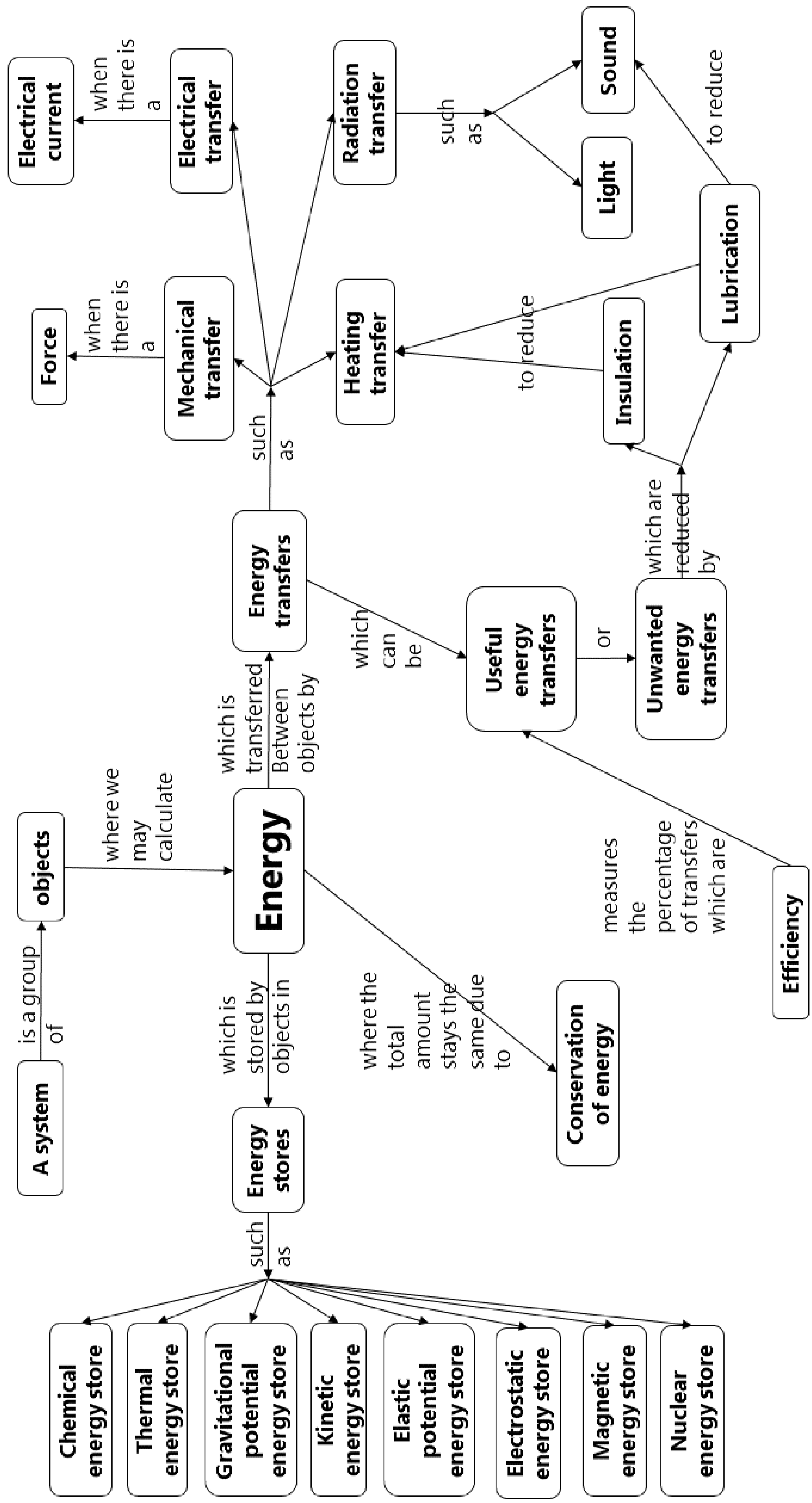
Name ______________________________

Class ______________________________

Teacher ______________________________

Energy Part 1

Energy overview



Episode 1: Fuels and conservation of energy.

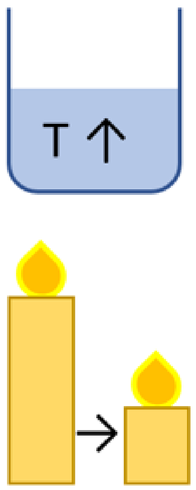
Learning purpose:

Today we are learning what fuels are so that we can understand what energy is.

Core Questions

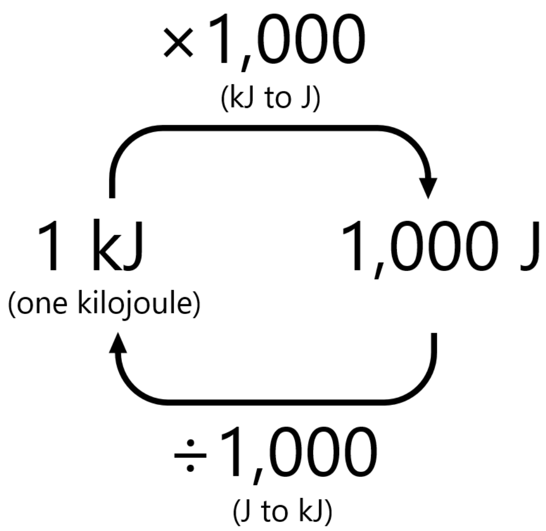
1	What is a chemical energy store?	Energy stored because of the chemical composition of a material: food, fuel, and batteries
2	What will happen to the chemical energy store of a fuel as a fuel is burned?	It will decrease.
3	What is a thermal energy store?	Energy stored by an object of its temperature.
4	If the thermal energy store of an object increases, what happens to the temperature of the object?	It increases.
5	How is energy moved between different stores?	By an energy transfer.
6	What is the transfer of energy involved when one object heats up another?	Heating transfer.
7	What is the unit for energy?	J (joules)
8	What does the principle of conservation of energy tell us?	Energy can never be created or destroyed only transferred from one store to others.
9	What does kilo mean?	1000

Core Diagrams



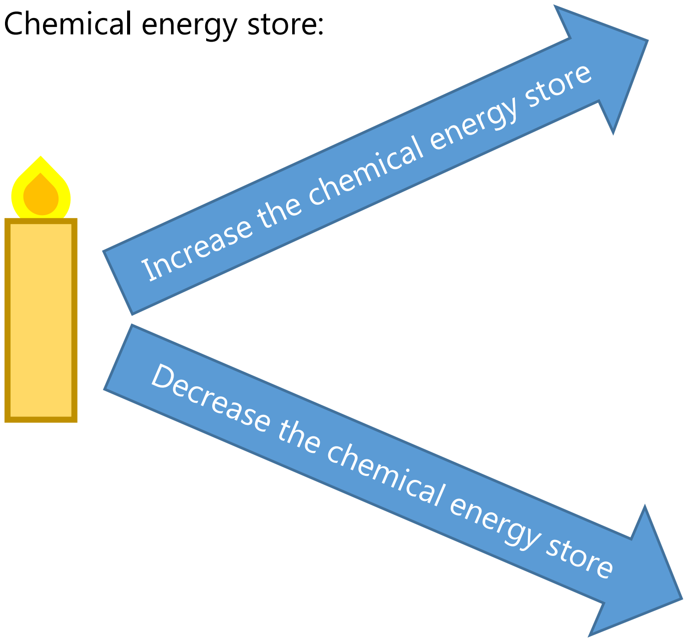
The candle burns down and the water heats up.
The chemical energy store of the candle decreases.
The thermal energy store of the water increases.

Converting between joules and kilojoules



Stop and jot

Chemical energy store:



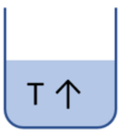
Units of energy:

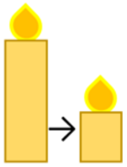
Thermal energy store:

The thermal energy store increases when…

The thermal energy store decreases when…

Heating transfers:

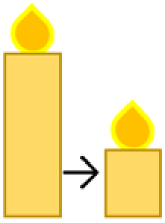




Chemical energy store

Petrol, diesel, gas, wood, food, batteries are all example of fuels. All of these things store energy within the chemicals that make them. We call this the *chemical energy store*.

When these fuels are burned or used, a chemical reaction happens and the fuel is left with less energy stored inside it. We say the chemical energy store decreases.



The chemical energy store of the candle has decreased

If we 'top-up' the fuel levels and add more fuel, the chemical energy store increases.

The chemical energy store of the car has increased

When we discuss energy stores, we always name the energy store and the object that it is attached to, e.g. *the chemical energy store of the wood.*

Quick consolidation

1. Give five examples of fuels.
2. What is the store of energy in fuels?
3. What do I need to do to make the chemical energy store decrease?
4. What happens to the chemical energy store if we increase the amount of fuel?
5. I burn a pile of logs. Describe what happens to chemical energy store of the wood.
6. A student is talking about a battery and says "When I use it, the chemical store changes". Improve their answer.

Units of energy

We can be more specific than just saying the chemical energy store increases/decreases. We can measure how much energy there is.

We measure the amount of energy there is with the unit joules, which we give the symbol J (capital letter).

The chemical energy store of the battery decreased from 500 J to 200 J.

When we eat food, our chemical energy store increases.

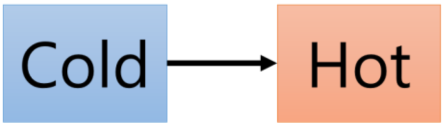
A bite of banana has 300 J in its chemical energy store. When I eat it, my chemical energy store increases by 300 J.

Quick consolidation

1. In words and symbols, what is the unit for energy?
2. I add more fuel to a fuel tank. The chemical energy store of the fuel tank goes from being 2,500 J to 4,500 J. How much has the chemical energy store of the fuel tank increased by?
3. What happens to the chemical energy store if we burn some fuel?
4. A chocolate bar has a chemical energy store of 500 J. I eat half of the chocolate bar. How much energy have I added to my own chemical energy store?
5. What do I need to do to make the chemical energy store increase?
6. When my petrol tank is a quarter full, there is 100 J in the chemical energy store. How much will be in there if the tank is full?
7. A student writes the following *"Energy is measured in Joules and this has the symbol j",* why are they wrong?
8. My phone uses 10 J of energy from its chemical energy store if it is used for one hour. How much does it use in twenty minutes?

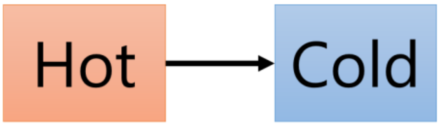
Thermal energy store

If we want to warm an object up a cup of water, we need to give it energy. The object absorbs (takes in) this energy and gets hotter. When this happens, it is the thermal energy store of the water that is increasing.



The thermal energy store of the box increases.

If I leave a hot pizza from the oven out on the side, it cools down. It has less energy than it has when it came out of the oven. We say that the thermal energy store of the pizza has decreased.



The thermal energy store of the box decreases.

I take a beaker of 200 ml of water and warm it up over a Bunsen burner for 5 s. It's temperature goes from 15 °C to 20 °C.

I start again and take 200 ml of water and warm it up over a Bunsen burner for 30 s. It's temperature goes from 15 °C to 45 °C.

The second beaker has gained more energy in its thermal energy store than the first.

Quick consolidation

1. When does the thermal energy store of an object increase?
2. A cup of tea starts off at 75 °C. I leave it on my desk and it cools to 50 °C. What has happened to the thermal energy store?
3. How could I make the thermal energy store of the cup of tea change by even more?
4. A student says "*When I warm up soup, the chemical energy store of the soup increases"* Explain why they are wrong and correct their answer.
5. A candle has 250 J in its chemical energy store. I burn half of it.

a. What is the chemical energy store of the candle now?
b. What has happened to the temperature of the air in the room?
c. What has happened to the thermal energy store of the room?

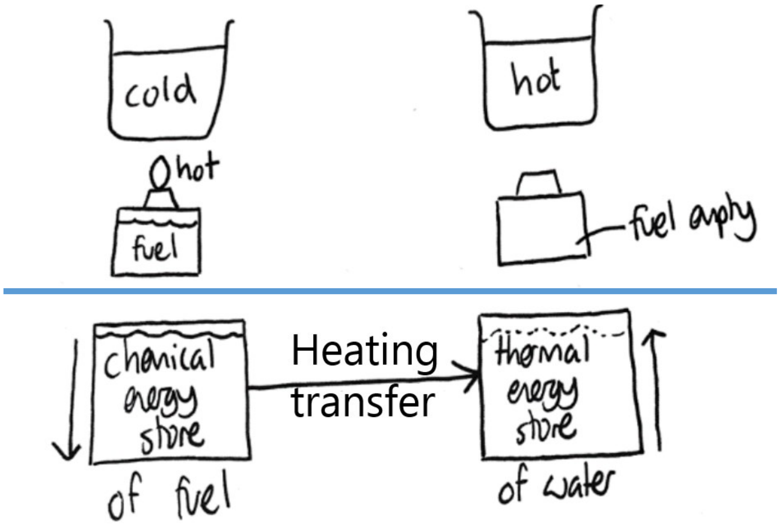
Heating transfers

When a fuel is burned to warm up another object, the chemical energy store of the fuel goes down and the thermal energy store of the object being warmed goes up.

When a hot object is placed to cool inside a cooler object, the thermal energy store of the hot object goes down and the thermal energy store of the cold object goes up.

We say that this exchange of energy is a *transfer*. When energy is lost from one store and gained by another we say it is *transferred*.

There are many types of energy transfer, but when one object is heated up, we say it is a *heating transfer*.



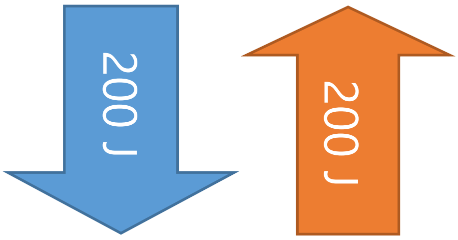
Quick consolidation

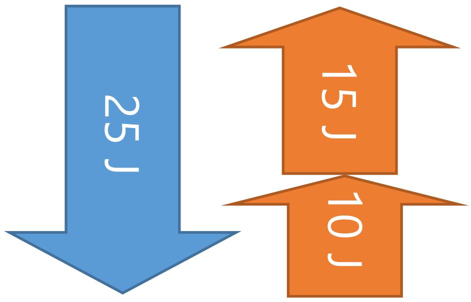
1. When is there a transfer of energy?
2. When does a heating transfer take place?
3. A burn a match and use it to heat up a small metal cube.
    a. Which store of energy is decreasing?
    b. Which store of energy is increasing?
    c. Which transfer is taking place?
4. I leave a cake from the oven out to cool in the air.
    a. Which store of energy is decreasing?
    b. Which store of energy is increasing?
    c. Which transfer is taking place?

Conservation of energy

If I burn a small piece of wood, the chemical energy store of the wood decreases by 250 J as the fuel is burned. This energy cannot disappear. I feel the air around the burning wood get warm. The energy goes through a heating transfer to the thermal energy store of the air. The thermal energy store of the air increases by 250 J.

Conserve means to '*keep the same'.* When one energy store decreases, that energy has to go somewhere, it can't just disappear. The energy is transferred so that another energy store increases or multiple energy stores increase by the same total.





We say that conservation of energy means that "*energy can't be created or destroyed, only transferred from one store to others".*

Quick consolidation

1. The thermal store of a beaker of water increases by 450 J when it is heated by a burning candle. How much did the chemical energy store of the candle decrease by?
2. What does conserve mean?
3. A hot cup of tea is left to cool down outside. The thermal energy store of the tea decreases by 1,200 J. How much does the thermal energy store of the air increase by?
4. What does conservation of energy mean?
5. I burn two matches completely to heat up a piece of chocolate. The thermal energy store of the chocolate increases by 5,000 J. How much was in the chemical energy store of each match?

Kilojoules

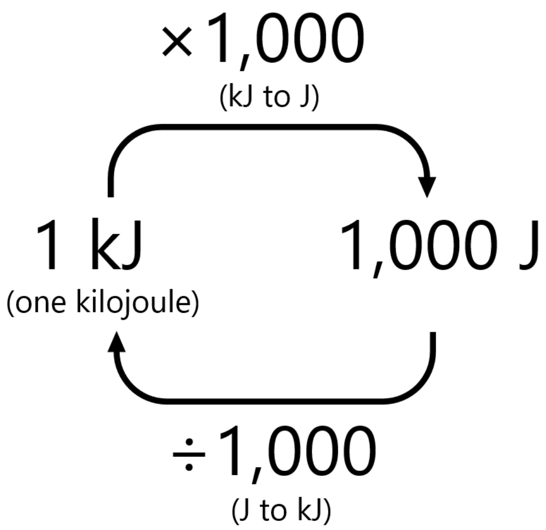
One joule is actually a very small amount of energy. Each heartbeat in our chest takes about 1 J. This means that we use a lot of energy every day. Each day we must consume food containing around 2,000,000 J to keep ourselves going.

Instead of having huge numbers, we use a different unit to measure energy sometimes – we call it the *kilojoule, kJ.*

Kilo means 1,000, so

- 1 kJ = 1 × 1,000 J = 1,000 J
- 2 kJ = 2 × 1,000 J = 2,000 J

To go from kilojoules to joules, we multiply by 1,000. To go from joules to kilojoules, we divide by 1,000.



Quick consolidation

1. What number does 'kilo' represent?
2. What is 5 kJ in J?
3. What is 8 kJ in J?
4. What is 3,000 J in kJ?
5. What is 7,000 J in kJ?
6. What is 12 kJ in J?
7. What is 13,000 J in kJ?
8. What is 15.3 kJ in J?
9. What is 4,300 J in kJ?
10. What is 200 J in kJ?

Practice makes permanent

#	Question	Done?
1)	Fuels are things that we can burn or use for the energy stored inside themselves. a) Name three examples of fuels. b) What is the name for the store of energy in fuels? c) What happens to the store of energy from b) as we burn a fuel?	
2)	There are 5kJ in the chemical energy store of a crisp. In a bag of crisps there are 30 crisps, all of which are exactly the same size. a) Convert 5 kJ into joules. b) How big is the chemical energy store of an entire bag of crisps? c) How big is the chemical energy store of 3 entire bags of crisps? d) How big is the chemical energy store of half a bag of crisps? e) If I eat half a bag of crisps, what is the maximum amount of energy that could be transferred into my own chemical energy store?	
3)	A match has 500 J in its chemical energy store. I burn it until it burns out. a) How much energy is in the chemical energy store of the match when it's burned out? b) How much energy is gained by the thermal energy store of the air around the match? c) What is 500 J in kJ?	
4)	I take a cake out of the oven. a) Over time what happens to the temperature of the cake? b) Over time what happens to the thermal energy store of the cake? c) Over time what must happen to the thermal energy store of the room? d) Over time what must happen to the temperature of the room? e) If the cake loses 10 000 J of energy from its thermal energy store, how much energy is transferred into the thermal energy store of the room?	
5)	When you rub your hands together, you can warm them up. a) What store of energy is decreasing in your body when you do this? b) What store of energy is increasing in your hands?	
6)	A Bunsen burner is used to heat up some acid. The thermal energy store of the acid increases by 300 J. The thermal energy store of the air increases by 100 J. How much has the chemical energy store of the gas in the Bunsen burner decreased by?	

#	Question	Done?
7)	Explain, with examples, how you know when: a) The chemical energy store is decreasing? b) The thermal energy store is increasing? c) There is a heating transfer taking place? d) The thermal energy store is decreasing? e) The chemical energy store is increasing?	
8)	A student says "When a log fire is lit, the energy from the logs just disappears". a) What is the store of energy that is decreasing in the logs? b) Why can't the energy from the logs just disappear? c) What store of energy increases when the logs burn?	
9)	A car's petrol tank is empty. If it were to be filled with petrol, it would contain 350,000 kJ of energy. a) How much energy is in the empty petrol tank? b) How much energy is in the tank when it is half full? c) Which energy store is increasing when the car is filled with fuel? d) The car is filled up with petrol and has the engine running. But the car stays parked up in the car park. i) Is the chemical energy store of the fuel increasing or decreasing? ii) If the chemical energy store is changing, one other energy store must be changing too. Which other store of energy changes?	

Episode 2: Making objects move.

Learning purpose:

Today we are learning about the kinetic, gravitational and elastic energy stores so that we can explain how energy is involved in more complicated situations.

Core Questions

1	What is a kinetic energy store?	Energy an object has because it is moving
2	What happens to an objects kinetic energy store as the object slows down?	It decreases.
3	When is the kinetic energy store of an object zero?	When it is stationary.
4	What is the equation for kinetic energy?	Kinetic energy = ½ × mass × velocity^2 $E_k = ½ \times m \times v^2$
5	Two objects of different masses are travelling at the same speed. Which has more energy in its kinetic energy store?	The one with the larger mass
6	What is a gravitational energy store?	Energy an object has because it is above the Earth's (or any other planet's) surface
7	How can I increase the gravitational energy store of an object?	Lift it higher. Move to a planet with a larger gravitational field strength.
8	What is the equation for gravitational potential energy?	Gravitational potential energy = mass × gravitational field strength × height $E_g = m \times g \times h$
9	What does gravitational field strength mean?	How strong the pull of gravity is on a planet.
10	What is the gravitational field strength of Earth?	g=9.8 N/kg
11	Two objects of different masses are lifted to the same height on Earth. Which has more energy in its gravitational energy store?	The object with the larger mass.
12	When is the gravitational energy store of an object zero?	When it is on the ground.
13	What is an elastic energy store?	Energy stored by an object because it has been stretched or squashed
14	I stretch an elastic band further and further. What happens to the elastic energy store?	It increases.

15	How is a spring with a large spring constant different to one with a small spring constant?	The one with a large spring constant is more difficult to stretch. The one with the smaller spring constant is easier to stretch.
16	What is the equation for elastic potential energy?	Elastic potential energy = ½ × spring constant × extension^2 $E_e = \frac{1}{2} \times k \times e^2$
17	What is the transfer of energy whenever there is a force?	Mechanical transfer.

Core Diagrams

	The person falls downwards.	**The trampoline starts to stretch.**	**The trampoline goes back to its original shape.**	**The person rises upwards.**
Gravitational energy store of the person:	Decreases (they get lower).	Decreases a little (they get a little lower).	Increases a little (they get a little higher).	Increases (they get higher).
Kinetic energy store of the person:	Increases (they get faster).	Decreases (they get slower).	Increases (they get faster).	Decreases (they get slower).
Elastic energy store of the trampoline:	Zero (the trampoline isn't stretched).	Increases (the trampoline stretches more).	Decreases to zero (the trampoline stretches less).	Zero (the trampoline isn't stretched).

Stop and jot: the kinetic energy store

The kinetic energy store of an object

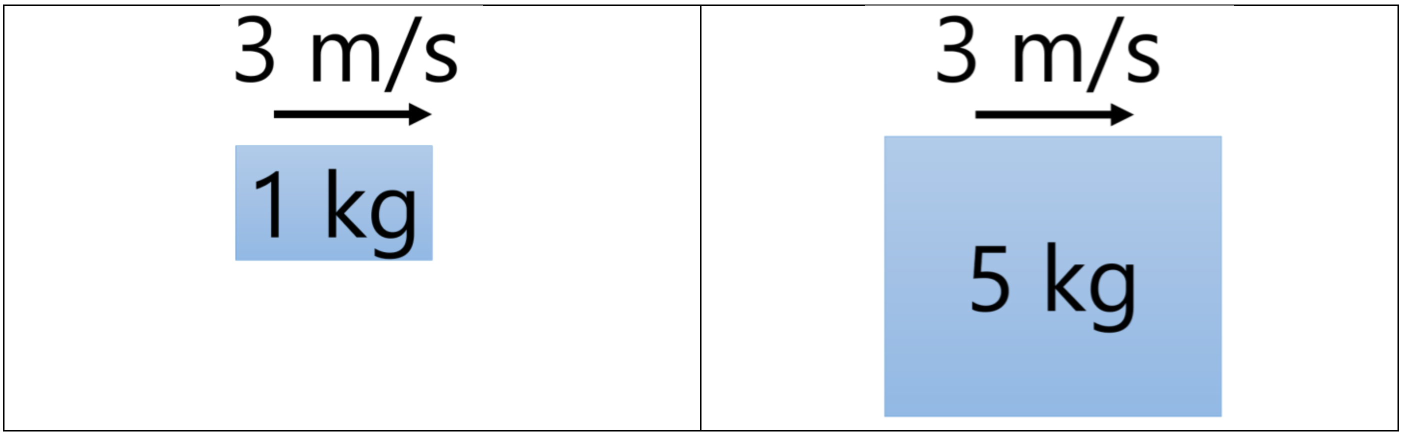
The kinetic energy store is to do with the movement of an object. Moving objects have energy in their kinetic energy store.

When objects move faster, their kinetic energy store increases.

When objects move slower, their kinetic energy store decreases.

The kinetic energy store is zero when the object is stationary.

Imagine that two boxes are moving like below.



It will have taken more energy to get the 5 kg box up to speed than the 1 kg box.

The kinetic energy store doesn't just depend on how quickly the object is moving but also the mass of the object. The higher the mass, the energy it has in its kinetic energy store.

Quick consolidation

1. How can I increase the kinetic energy store of a ball?
2. How can I decrease the kinetic energy store of a toy car?
3. What is the value of the kinetic energy store if an object is not moving?
4. Which has more energy in its kinetic energy store: a 2 kg ball thrown at 4 m/s or a 8 kg ball thrown at 4 m/s?
5. A car is stationary with the engine running. It then accelerates quickly.
    a. Which energy store is decreasing?
    b. Which energy store is increasing?
6. Ranjit pushes a car and loses 50 J from his chemical energy store. How much energy is there in the kinetic energy store of the car?
7. Which two things affect the kinetic energy store of an object?

The equation for the kinetic energy store

$$E_k = \frac{1}{2} \times m \times v^2$$

Kinetic energy	=	½	×	mass	×	velocity^2
[J]				[kg]		[m/s]

- As the mass increases, the kinetic energy store increases.
- As the velocity (or speed) increases, the kinetic energy store increases.

Quick consolidation

1. What are the units of mass?
2. What happens to the kinetic energy store if the mass decreases?
3. What are the units of kinetic energy?
4. What does the subscript 'k' mean next to the 'E' in the symbol equation?
5. What does the little 2 mean next to velocity?
6. What are the units of velocity (or speed)?

Calculating the kinetic energy store

	A dog has a mass of 4 kg and is running at 5 m/s. How much energy is in its kinetic energy store?	A cat has a mass of 2 kg and is jogging at 2 m/s. How much energy is in its kinetic energy store?
Equation	$E_k = ½ \times m \times v^2$	$E_k = ½ \times m \times v^2$
Values	E_k = ? m = 4 kg v = 5 m/s	
Enter values	$E_k = ½ \times 4 \times 5^2$	
Result	E_k = 50	
Yoonits	E_k = 50 J	

Quick consolidation

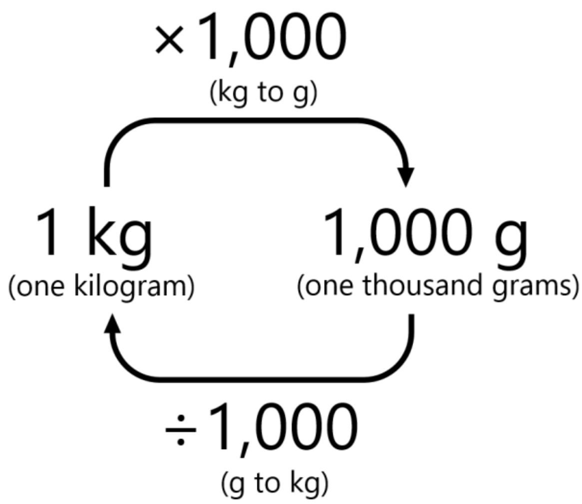
1. A car with a mass of 1000 kg is traveling at a speed of 20 m/s. How much energy is in the kinetic energy store of the car?
2. A tennis ball is traveling at a speed of 45 m/s and has a mass of 0.057 kg. How much energy is in the kinetic energy store of the tennis ball?

3. A model airplane with a mass of 10 kg is traveling at a speed of 25 m/s. How much energy is in the kinetic energy store of the model airplane?
4. A bullet is traveling at a speed of 1000 m/s and has a mass of 0.005 kg. How much energy is in the kinetic energy store?
5. A cyclist with a mass of 70 kg is traveling at a speed of 10 m/s. How much energy is in the kinetic energy store?

Converting grams to kilograms

Mass isn't always measured in kilograms. Sometimes we see mass in grams. Equations in physics only work when we use the correct units, so if a value is given in grams, we have to convert to kilograms.

We convert in the same way that we converted between joules and kilojoules, except now we always want to be in *kilo*grams whereas before we wanted to be in just joules.



Quick consolidation

1. Convert 2,000 g into kg.
2. Convert 5,000 g into kg.
3. Convert 4 kg into g.
4. Convert 5.4 kg into g.
5. Convert 600 g into kg.
6. Convert 250 g into kg.
7. Convert 0.87 kg into g.
8. Convert 642 g into kg.
9. Convert 37 g into kg.
10. Convert 9 g into kg.
11. Convert 0.083 kg into g.

Stop and jot: the gravitational potential energy store

The gravitational potential energy store of an object

To lift up an object requires energy. When we lift something, our chemical energy store decreases and this energy must go somewhere.

When an object is dropped, it gets faster and faster, so its kinetic energy store increases. But this energy has to come from somewhere.

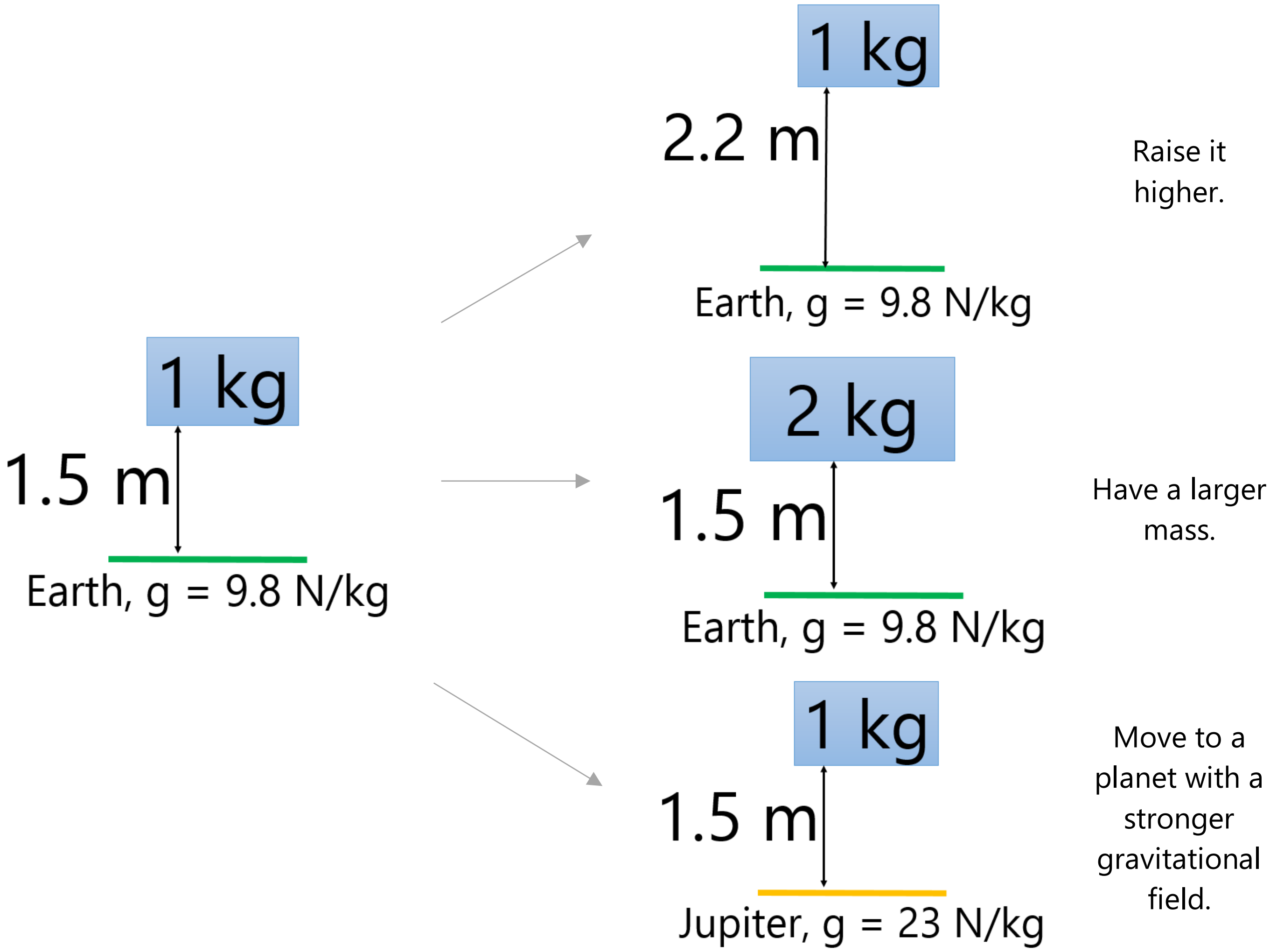
The gravitational potential energy store is to do with the raising objects up in a gravitational field. Objects that are raised up have energy in their gravitational potential energy store.

When objects are raised higher, their gravitational potential energy store increases.

When objects get lower or fall, their gravitational potential energy store decreases.

The gravitational potential energy store is zero when the object is not raised up at all.

To increase the gravitational energy store of an object, we could:



The gravitational potential energy store depends upon the height of the object above a surface, the mass of the object and the gravitational field strength.

Quick consolidation

1. How can I increase the gravitational potential energy store of a bag of sugar?
2. How can I decrease the gravitational potential energy store of a bird in the air?
3. Which has more energy in its gravitational potential energy store: a 2 kg ball raised 3 m into the air or a 8 kg ball raised 3 m into the air?
4. A book falls off a shelf.
    a. Which energy store is decreasing?
    b. Which energy store is increasing?
5. Mahadia lifts up a chair and she loses 225 J from her chemical energy store. How much energy is there in the gravitational potential energy store of the chair?
6. The moon has a weaker gravitational field than earth. Where will lifting an object require less energy to lift: the moon or earth?
7. A bouncy ball has 25 J in its gravitational potential energy store. It is dropped and when it bounces back up, it only has 18 J in its gravitational potential energy store. How much energy has been gained by the thermal energy store of the ball (and floor)?
8. Complete the sentence: *the gravitational potential energy store increases when…*

The equation for the gravitational potential energy store

$$E_g = m \times g \times h$$

Gravitational potential energy	=	mass	×	gravitational field strength	×	height
[J]		[kg]		[N/kg]		[m]

- As the mass increases, the gravitational potential energy store increases.
- As the gravitational field strength increases, the gravitational potential energy store increases.
- As the height increases, the gravitational potential energy store increases.
- On Earth, the gravitational field strength is 9.8 N/kg.

Quick consolidation

1. What are the units of mass?
2. What happens to the gravitational potential energy store if the mass decreases?
3. What are the units of gravitational potential energy?
4. What are the units of height?
5. What happens to the gravitational potential energy store if the gravitational field strength is larger?
6. What is the value for the gravitational field strength of earth?
7. What does the subscript ‘g’ mean next to the ‘E’ in the symbol equation?
8. Reggie throws a ball straight up in the air. When it leaves his hand it has 340 J in its kinetic store. At its maximum height, the ball is briefly stationary.
    a. How much energy is in the kinetic energy store when the ball is stationary?
    b. How much energy has been gained by the gravitational potential energy store of the ball?

Calculating the gravitational potential energy store

	A chimpanzee has a mass of 60 kg and jumps on earth, where g = 9.8 N/kg. It jumps 0.6 m into the air. How much energy is gained in the gravitational potential energy store of the chimpanzee?	A child has a mass of 30 kg. They jump on the moon, where g = 1.6 N/kg. They jump 0.8 m off the surface of the moon. How much energy is gained in the gravitational potential energy store of the child?
Equation	$E_g = m \times g \times h$	$E_g = m \times g \times h$
Values	E_g = ? m = 60 kg g = 9.8 N/kg h = 0.6 m	
Enter values	$E_g = 60 \times 9.8 \times 0.6$	
Result	E_g = 352.8	
Yoonits	E_g = 352.8 J	

Quick consolidation

1. An object with a mass of 5 kg is on a shelf that is 2 meters above the ground on Mars. If the gravitational field strength on Mars is 3.7 N/kg, how much energy is in the gravitational potential energy store of the object?
2. A person with a mass of 70 kg is on a cliff that is 100 meters above the ground on Earth. If the gravitational field strength on Earth is 9.8 N/kg, how much energy is in the gravitational potential energy store of the person?
3. A satellite orbits Jupiter, where g = 25 N/kg. The satellite has a mass of 1000 kg is in orbit at an altitude of 1000 m. How much energy is in the gravitational potential energy store of the satellite?
4. A rover with a mass of 50 kg is on the surface of the Moon. If the gravitational field strength on the Moon is 1.6 N/kg and the rover is on a hill that is 20 meters high, how much energy is in the gravitational potential energy store?
5. A bird with a mass of 0.1 kg is on a branch that is 5 meters above the ground on Mars. If the gravitational field strength on Mars is 3.7 N/kg, how much energy is in the gravitational potential energy store of the bird?

Calculating the height using the gravitational potential energy equation.

Sometimes we might be asked to find something that isn't the subject of the equation e.g. finding what the height is when $E_g = m \times g \times h$.

The equation doesn't say h = …., so we need to *rearrange*.

The best way to do this is to do as many steps of EVERY as you can, like normal and *rearrange* at the fourth stage (now called **R**esult or **R**earrange) when you can just rearrange numbers.

Remember, to move something from the left to the right or from the right to the left of an equation, we do the *inverse (opposite) operation*.

	A ball is stuck up in a tree. The ball has 29.4 J in its gravitational potential energy store. The mass of the ball is 1.5 kg. On Earth, g = 9.8 N/kg. How high up is the ball?	A child has jumps on a trampoline. The child has 1617 J in their gravitational potential energy store. The child has a mass of 55 kg and is on Earth where g = 9.8 N/kg. How high off the trampoline are they?
Equation	$E_g = m \times g \times h$	$E_g = m \times g \times h$
Values	E_g = 29.4 J m = 1.5 kg g = 9.8 N/kg h = ?	
Enter values	29.4 = 1.5 × 9.8 × h	
Result or **R**earrange	29.4 ÷ 1.5 ÷ 9.8 = h or 29.4 ÷ (1.5 × 9.8) = h	
Yoonits	h = 2 m	

Quick consolidation

1. An object with a mass of 5 kg is on a shelf on Earth, where g = 9.8 N/kg and has a gravitational potential energy of 196 J. What is the height of the shelf above the ground?
2. A person with a mass of 80 kg is on a hill on Mars, where g = 4 N/kg. The person has 3.92 kJ in their gravitational potential energy store. What is the height of the hill above the ground? HINT: Convert kJ into J.
3. A boulder with a mass of 1000 kg is on a cliff that is 500 meters above the ground on Earth. If the gravitational field strength on Earth is 9.81 N/kg, how much energy is in the gravitational potential energy store? HINT: Check what the question is asking you to find!
4. A ball with a mass of 0.1 kg is on a shelf on Venus, and has a gravitational potential energy of 3.15 J. Venus has a gravitational field strength of 9 N/kg. What is the height of the shelf above the ground?

5. Jupiter has a gravitational field strength of approximately 25 N/kg. A satellite with a mass of 500 kg is in orbit around Jupiter, and has a gravitational potential energy of 18,750, kJ. What is the altitude of the satellite above the surface of Jupiter? HINT: Convert kJ into J.

Stop and jot: the elastic potential energy store

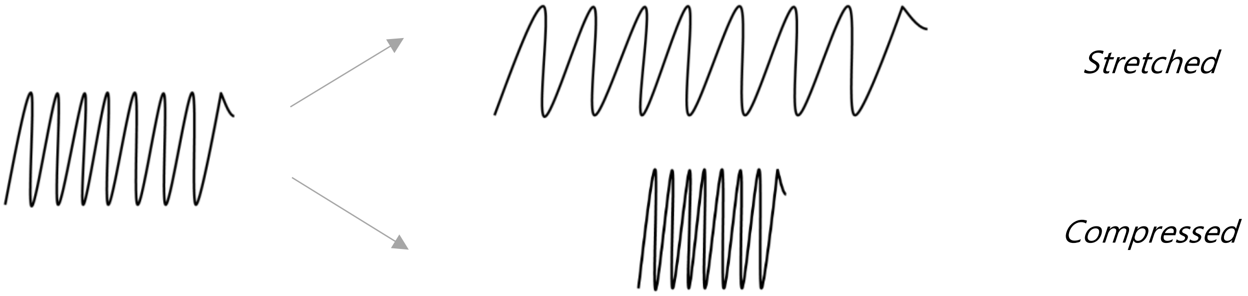
The elastic potential energy store

Springs, elastic bands and rubber balls can all be stretched or squashed but go back to their original shape afterwards. We say they are *elastic*.

To stretch or squash something elastic, though, requires energy. Our chemical energy store will decrease if we try and squash a spring. This energy has to go somewhere.

If I let a stretched catapult go, it can increase the speed of whatever object I fire out of it. The kinetic energy store of the flying object will have increased. This energy can't come from nowhere.

We say that elastic objects that are stretched or squashed have energy in their *elastic potential energy store.*



If I stretch a rubber band more, the elastic potential energy store increases.

If I don't stretch or squash an object at all, the elastic potential energy store is zero.

Quick consolidation

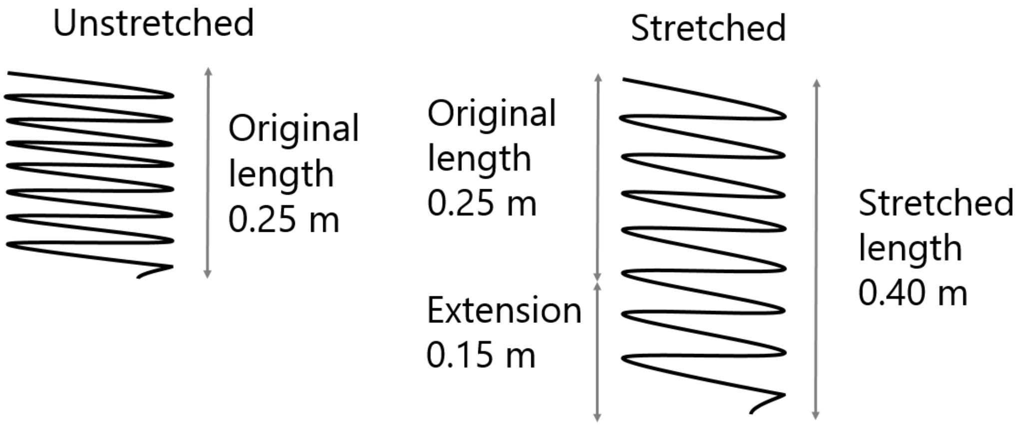
1. What does *compress* mean?
2. What does *stretch* mean?
3. Give the name for objects that return to their original shape.
4. How can the elastic potential energy store of a rubber band be increased?
5. Claudi stretch a spring. How can I decrease the elastic potential energy store of the spring?
6. Jo attaches a mass to a spring. I drop the mass and it stretches the spring.
    a. Which store of energy has increased?
    b. Which store of energy has decreased?
7. Abdulla pulls back a catapult. The elastic potential energy store of the catapult increases by 300 J. How much did his chemical energy store decrease by?

Extension

If an unstretched spring is 0.1 m long and I stretch it so that it is now 0.3 m long, then the spring has been made longer. The *difference* in length is called an *extension*.

stretched length – original length = extension

So the extension of the spring in our example is 0.3 – 0.1 = 0.2 m.



Spring constant

Some things are harder to stretch than others. If elastic is hard to stretch or squash, we say that it is *stiff.*

We can say how stiff an object is with a number called the spring constant. This tells us how much force is required to extend or squash the object by 1 m.

Imagine we have two springs:

Spring A	*Spring B*
Spring constant, k = 750 N/m	*Spring constant, k = 300 N/m*

Spring A is stiffer since to extend it needs 750 N of force *for each metre of extension*. Spring B only needs a force of 300 N for each metre of extension.

Quick consolidation

1. A piece of elastic is 0.5 m long. I stretch it until it is 0.7 m long. What is the extension?
2. Rubber band A has a spring constant of 250 N/m. Rubber band B has a spring constant of 270 N/m. Explain which rubber band is stiffer.
3. Uday says "*When I stretch a piece of rubber, it is 0.3 m long. So the extension is 0.3 m*". Why is Uday wrong?
4. What does it mean if the spring constant of a spring is 1500 N/m?
5. A spring is 0.42 m long. When stretched, it has an extension of 0.14 m. What is the stretched length of the spring?
6. What is the definition of extension?
7. What is the definition of spring constant?

The equation for the elastic potential energy store

$$E_e = \frac{1}{2} \times k \times e^2$$

Elastic potential energy [J]	=	½	×	spring constant [N/m]	×	$extension^2$ [m]

- If the spring constant increases, the elastic potential energy store increases.
- If the extension increases, the elastic potential energy store increases.

Calculating the elastic potential energy store

	A spring has a spring constant of 350 N/m. It is initially 0.3 m long but when it is stretched, it is 0.5 m long. Calculate the increase in the elastic potential energy store.	A spring has a spring constant of 650 N/m. It is initially 0.2 m long but when it is stretched, it is 0.3 m long. Calculate the increase in the elastic potential energy store.
Equation	$E_e = ½ \times k \times e^2$	$E_e = ½ \times k \times e^2$
Values	E_e = ? k = 350 N/m e = 0.5 – 0.3 = 0.2 m	
Enter values	$E_e = ½ \times 350 \times 0.2^2$	
Result or **R**earrange	E_e = 7	
Yoonits	E_e = 7 J	

Quick consolidation

1. A spring with a spring constant of 50 N/m is stretched 0.2 m from its unstretched length. What is the elastic potential energy stored in the spring?
2. A spring is stretched 0.3 m and has a spring constant of 100 N/m. What is the elastic potential energy stored in the spring?
3. A piece of rubber has an original length of 0.28 m. It is stretched to be 0.45 m long. If the spring constant of the rubber is 550 N/m, how much energy is stored in the elastic potential energy store of the rubber?

4. When stretched, a spring is 1.2m long. Before it was stretched, it was 80 cm long. If the spring constant is 450 N/m, what is the energy stored in the elastic potential energy store of the spring?
5. A very thick spring has a spring constant of 25 kN/m. It's initial length is 10 cm and it is stretched to 12 cm. How much energy is stored in the elastic potential energy store?

Calculating the extension from the elastic potential energy store

Just like when we looked at the gravitational potential energy store, we might need to rearrange if we're asked to calculate something that *isn't* the elastic potential energy store.

If we are asked to calculate the extension of a spring, we have to be careful as the equation includes *extension squared (e^2)*. So when we rearrange, we have to be careful to make sure we take the square root (to undo the squaring).

	A spring has a spring constant of 350 N/m. There are 700 J in the elastic potential energy store. What is the extension of the spring?	A spring has a spring constant of 200 N/m. There are 900 J in the elastic potential energy store. What is the extension of the spring?
Equation	$E_e = ½ \times k \times e^2$	$E_e = ½ \times k \times e^2$
Values	E_e = 700 J k = 350 N/m e = ?	
Enter values	$700 = ½ \times 350 \times e^2$	
Result or **R**earrange	$700 \div ½ \div 350 = e^2$ $4 = e^2$ Now we must take the square root $\sqrt{4} = e$	
Yoonits	e = 2 m	

Quick consolidation

1. A rubber band has a spring constant of 800 N/m. There are 100 J in the elastic potential energy store. What is the extension of the rubber band?
2. A rubber sheet has 1562.5 J in its elastic potential store. The rubber has a spring constant of 500 N/m. How much is it extended by?
3. A spring with a spring constant of 250 N/m is stretched 0.15 m from its unstretched length. What is the elastic potential energy stored in the spring? HINT: Check what the question is asking for.
4. I raise a spring 0.4 m off the floor. The spring has a mass of 0.5 kg. What is the *gravitational potential energy store* of the spring. HINT: Think about the equation.

5. A rubber band has a spring constant of 2000 N/m. There are 2.25 kJ in the elastic potential energy store. What is the extension of the rubber band? HINT: Look carefully at the units.

Stop and jot: the mechanical transfer

The mechanical transfer

Earlier, we said that energy can be transferred from one store to another by heating. But if I push a box and make it move faster so that it's kinetic energy store increases, this isn't because of heating, it is because I pushed it.

Whenever a force changes something about an object – it's position, its movement, its shape – there is a transfer of energy from the thing applying the force to the thing that changes. This is called the *mechanical transfer*.

Quick consolidation

1. What causes there to be a mechanical transfer of energy?
2. When there's a mechanical transfer of energy, what three things can change about an object?
3. A student says "when a car's engine is running it gets hot, this is the mechanical transfer" – why are they wrong?
4. A ball is thrown upwards. As it moves upwards it slows down.
    a. Explain which store of energy is increasing.
    b. Explain which store of energy is decreasing.
    c. Why is this the mechanical transfer?
5. I stretch a rubber band with my hands.

a. Explain which store of energy is increasing.
b. Explain which store of energy is decreasing.
c. Why is this the mechanical transfer?

Practice makes permanent

#	Question	Done?
1)	A car is stationary. It then accelerates until it is moving at 8 m/s. a) Which store of energy is increasing? b) Which store of energy is decreasing? c) Which transfer of energy took place? d) If the car has a mass of 850 kg, calculate how much has the kinetic energy store increased by when it accelerated. The car then slows down to 3 m/s. e) Calculate the size of the kinetic energy store of the car now. f) How much has the kinetic energy store decreased by? This energy that has been lost from the kinetic energy store has to go somewhere. It is transferred to the brakes which get hotter. g) Which store of energy is increasing in the brakes? h) How much energy do the brakes gain?	
2)	An apple falls from a tree. a) Which store of energy is increasing? b) Which store of energy is decreasing? The apple has a mass of 200 g and was at a height of 3.4 m when it started falling. c) Convert 850 g into kg. d) Calculate how much energy was in the gravitational potential energy store of the apple before it started falling. e) How much energy would be lost from my chemical store to lift this apple from the ground to a height of 3.4 m? f) When the apple hits the ground, how much energy is in its gravitational potential store? g) How much energy has been lost from the gravitational potential store as it fell? h) How much energy has been gained by the kinetic energy store as the apple fell?	

#	Question	Done?
3)	Alex stretches an elastic band back with her hands. a) Explain why it is the chemical energy store of Alex that is decreasing. b) Which store of energy is increasing? Alex releases the elastic band and the elastic band moves suddenly. c) Explain which store of energy decreased. d) Explain which store of energy increased. The elastic band now moves vertically upwards. As it does so, it slows down. e) Explain which store of energy decreased. f) Explain which store of energy increased. The elastic band then falls back to earth. As it does so, it speeds up. g) Explain which store of energy decreased. h) Explain which store of energy increased.	
4)	Momeena sets off running. She has a mass of 50 kg and is jogging at 6 m/s. a) Calculate how much energy is in her kinetic energy store. b) Where did this energy come from? c) Why is this the mechanical transfer? Momeena starts to slow down and her kinetic energy store decreases. d) Explain which store of energy increases.	
5)	A car has its engine running. The chemical energy store of the fuel decreases by 3 kJ. But the car doesn't move anywhere, it stays parked. a) Convert 3 kJ into J. b) Explain where the energy goes, giving the names of any energy stores involved. c) Explain why this is *not* the mechanical transfer, and write which transfer of energy is actually is.	
6)	Tyrell kicks a ball straight upwards into the air. The ball has a mass of 600 g. The ball is initially moving at 12 m/s. a) Convert 600 g into kg. b) Calculate the amount of energy in the kinetic energy store of the ball. c) Explain why the gravitational potential energy store increases. d) What happens to the kinetic energy store? Just before the ball comes back to the ground, there is a moment when it is completely stationary. e) How much energy is in the kinetic energy store of a stationary object? f) Explain why the ball must have 43.2 J in its gravitational potential energy store at this point. g) Explain why this was *not* the thermal transfer of energy taking place. h) Which transfer of energy was taking place?	

#	Question	Done?

The ball now falls back towards the ground

i) Explain in as much detail as you can what changes in energy stores happen as it falls. Include any names of energy stores, transfers or possible values for amounts of energy.

7) A model rocket takes off.

a) Explain which stores of energy are changing.

The rocket has a mass of 5 kg. It reaches a height of 1.2 km above the ground (on earth g = 9.8 N/kg)

b) Convert 1.2 km into m.

c) Calculate how much the gravitational potential energy store has increased by since it was on the ground.

When the rocket is 1.2 km above the ground, it is still moving upwards very quickly.

d) Explain why the chemical energy store of the fuel has decreased by more than 58,800 J.

8) I burn a candle to heat a room.

a) Explain how this shows conservation of energy.

b) If I wanted to heat the room up by more, what would I have to do?

c) Explain why this scenario doesn't demonstrate the elastic potential energy store.

9) Harkirat stretches a catapult back to fire a piece of paper. The elastic in the catapult has a spring constant of 300 N/m. He stretches it by 10 cm.

a) Convert 10 cm to m.

b) What would be the value of the elastic potential store of the catapult *before* it was stretched?

c) Calculate the increase in the elastic potential store that has happened once it is stretched.

When the catapult is released, it transfers its energy to the piece of paper which moves off quickly.

d) Explain which store of energy is increasing.

e) Explain why this is the mechanical transfer of energy.

The piece of paper has a mass of 10 g.

f) Convert 10 g into kg.

g) If all of the energy from part c), is transferred to the piece of paper's kinetic energy store, calculate the speed of the piece of paper. Remember to rearrange carefully by taking the square root.

Episode 3: Systems and other stores and transfers.

Learning purpose:

Today we are learning the names of all of the stores of energy so that we can use the language of energy to explain *every* physical situation that could occur.

Core Questions

1	What is a system?	An object or group of objects
2	What is a closed system?	A system which energy cannot leave or enter
3	What is an electrostatic energy store?	Energy stored between objects with charge attracting or repelling one another.
4	What is a magnetic energy store?	Energy stored between magnetic objects attracting or repelling one another.
5	What is a nuclear energy store?	Energy stored within the nucleus of an atom, accessed through nuclear reactions.
6	Name the eight stores of energy.	Chemical energy store, thermal energy store, kinetic energy store, gravitational energy store, elastic energy store, electrostatic energy store, magnetic energy store, nuclear energy store.
7	What is the name for the transfer of energy whenever light or sound are given out?	Radiation transfer.
8	What is the name for the transfer of energy that occurs in electric circuits?	Electrical transfer.
9	Name the four transfers of energy.	Heating transfer, mechanical transfer, radiation transfer, electrical transfer.

Core Diagrams

To remember the eight energy stores: CEMENT KG

Stop and jot

Systems and closed systems

When we've looked at problems so far, we have focussed on just one or two objects and pretended that nothing else exists.

If I have a ball falling to earth, I focus on just the ball and the earth. I ignore the air, I ignore the weather, I ignore other objects. This make-believe scenario when we ignore the effects of everything else is called a *system*.

A system is the objects that we are including in our problem.

In physics, if we close off our system so that energy cannot be added to it, and energy cannot be taken away from it, we call it a *closed system*.

Quick consolidation

1. What do we call the law that "energy cannot be created or destroyed"?
2. If a student throws a ball upwards and it falls back down, what are the three objects in the system?
3. If I use a match to heat up a beaker of water, what are the two objects in the system?
4. If a student does a bungee jump on a piece of thick elastic and falls to earth, what are the three objects in the system?
5. What is the difference between a system and a closed system?

Magnetic energy store

Imagine taking two magnets that repelling and trying to push them together. It would take a lot of energy to do this. The more energy you put in, the closer they get. Whilst you're pushing, your chemical energy store is decreasing and as there is a push, there's a mechanical transfer of energy taking place. This energy is being transferred into the *magnetic energy store.*

If I release the two repelling magnets, they suddenly move and their kinetic energy store increases. This energy came from the magnetic energy store which decreases as the magnets get further away.

This is also true when magnets are attracting: the closer they are together, the more energy is in their magnetic energy store.

The magnets strongly repel and there is lots of energy stored in the magnetic energy store.

The magnets weakly repel and there is less energy stored in the magnetic energy store.

The magnets strongly attract and there is lots of energy stored in the magnetic energy store.

The magnets weakly attract and there is less energy stored in the magnetic energy store.

The magnetic energy store is the energy stored between two magnetic objects that are attracting or repelling.

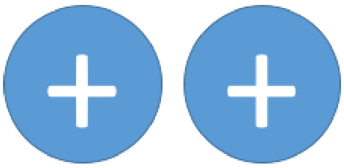
Quick consolidation

1. When does the magnetic energy store increase?
2. When does the magnetic energy store decrease?
3. Two magnets are close together and repelling when they are released.
    a. Why does the magnetic energy store decrease?
    b. Why does the kinetic energy store increase?
    c. What is the name of the transfer of energy that occurs?
4. Why do two bits of plastic that are close to one another not have any energy stored in the magnetic energy store?

Electrostatic energy store

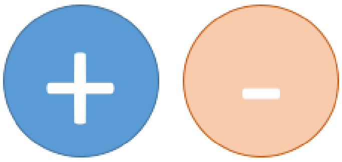
Objects can have electric charge e.g. protons have a positive electric charge and electrons have a negative electric charge.

Charged objects can attract and repel. When the charges are both positive, they repel. When the charges are both negative, they repel. If we have a positive and a negative charge they attract.



The charges strongly repel and there is lots of energy stored in the electrostatic energy store.

The charges weakly repel and there is less energy stored in the electrostatic energy store.



The charges strongly attract and there is lots of energy stored in the electrostatic energy store.

The charges weakly attract and there is less energy stored in the electrostatic energy store.

Quick consolidation

1. When does the electrostatic energy store decrease?
2. When does the electrostatic energy store increase?
3. Two negative charges are pushed together by a person.
    a. Why does the electrostatic energy store increase?
    b. Why does the chemical energy store of the person decrease?
    c. What is the name of the transfer of energy that occurs?
4. What are some similarities between the electrostatic energy store and the magnetic energy store?

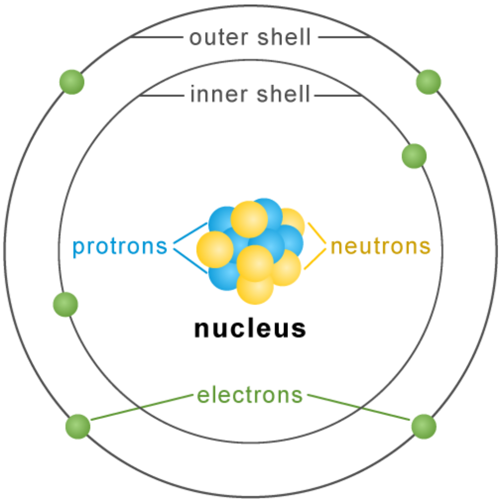
5. What are some differences between the electrostatic energy store and the magnetic energy store?

Nuclear energy store

You may have heard of nuclear power stations. In these places, a special type of reaction takes place called a *nuclear reaction*. This is not like a chemical reaction where atoms change their bonding (which is to do with the electrons).

In a nuclear reaction, we change the nucleus of an atom. We can either split the nucleus up into smaller bits, or bring two small nuclei together.

When this happens, there is a change in the amount of energy stored in the nucleus – we call this the *nuclear energy store*.



The nuclear energy store is the amount of energy stored in the nuclei of atoms.

We can now name eight different stores of energy: **c**hemical energy store, **e**lastic potential energy store, **m**agnetic energy store, **e**lectrostatic energy store, **n**uclear energy store, **t**hermal energy store, **k**inetic energy store, and the **g**ravitational potential energy store. We can remember these from their first letters in **cement kg.**

Quick consolidation

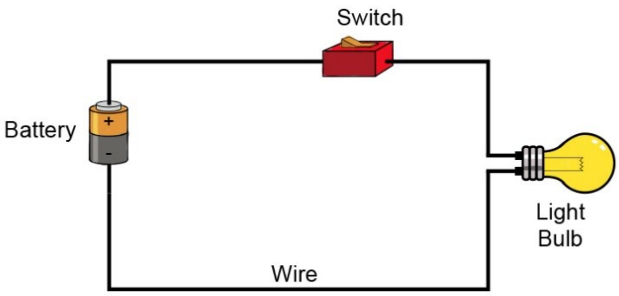
1. What do we call the energy stored in the nucleus of an atom?
2. What are the two ways in which we can alter the nuclear energy store?
3. Where do we use the changing of the nuclear energy store to generate electricity?
4. In a nuclear power station, the nuclear reaction transfers energy which is used to heat water.
    a. Why is the thermal energy store of the water increasing?
    b. What must be happening to the nuclear energy store of the atoms?
    c. What is the transfer of energy when one thing warms up another?
5. In nuclear reactions, there are *huge* amounts of energy.
    a. Why is a kilojoule bigger than a joule?
    b. Convert 3.5 kJ into J.
6. What are the names of the eight stores of energy?

Other transfers of energy: the electrical transfer and the radiation transfer

So far we have looked at two ways in which energy can be transferred from one store to another:

- The heating transfer – when one object warms up another
- The mechanical transfer – when there is a force

These are not the only ways of transferring energy.



In an electrical circuit, the aim is to transfer energy from the battery (or the socket) to our device. This energy is transferred along the wires of the circuit and it is transferred by the moving electrons in the wire. We call this the *electrical transfer.*

When you clap, the kinetic energy store of your hands decreases suddenly and a sound is made. Sound is a wave that travels outwards – we say it *radiates*.
Sound is one examples of the *radiation transfer* – the transfer of energy by waves.

A torch radiates light. Light is another example of a wave, like sound.
Light is another example of the *radiation transfer* – the transfer of energy by waves.

Quick consolidation

1. What is the name for the transfer of energy when waves are emitted from something?
2. What is the name for the transfer of energy that occurs in the wires of circuits?
3. What are the names of the four transfers of energy?
4. Give two examples of the radiation transfer.
5. A battery is attached to a bulb.
    a. Justify why it is the electrical transfer that occurs between the battery and the bulb.
    b. Justify why it is the radiation transfer that occurs between the bulb and the environment.

6. A speaker is plugged into the wall and plays music.
    a. What is the name of the transfer of energy from the battery to the bulb?
    b. What is the name of the transfer of energy from the bulb to the outside world?

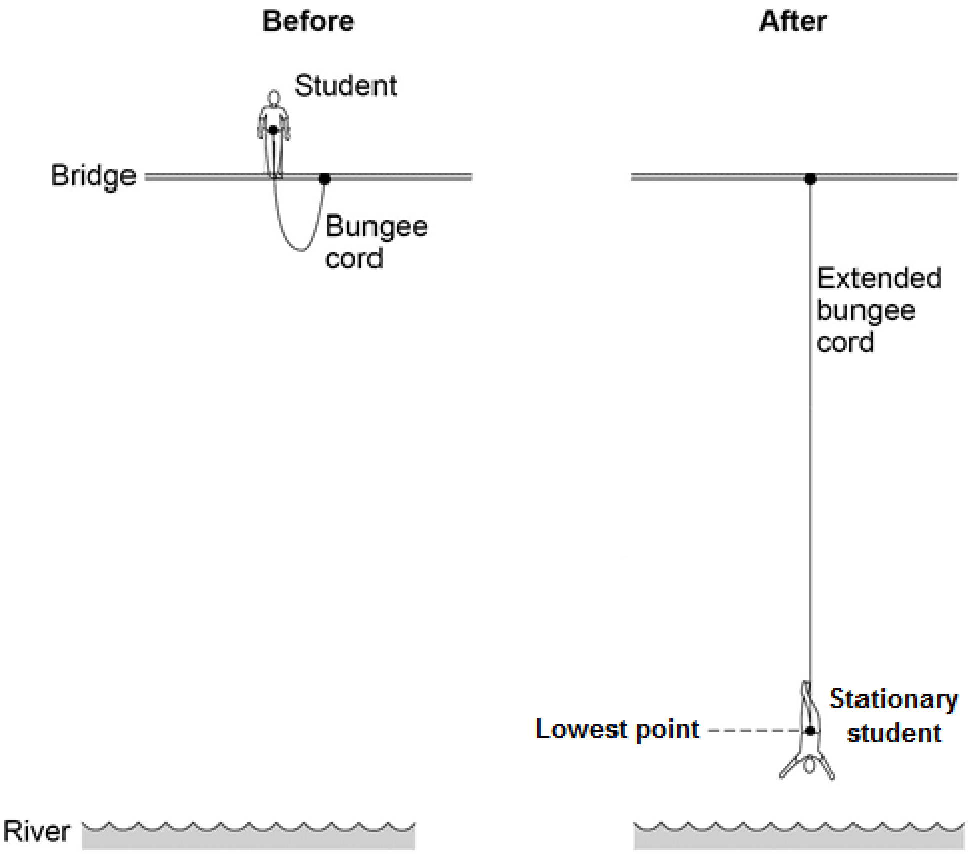
Practice makes permanent

#	Question	Done?
1)	Magnetic braking is used in roller coasters to slow down moving vehicles. The moving vehicle has magnets in the floor and when they get close to a braking point, magnets in the track are positioned to repel the magnets in the vehicle. a) Justify why the kinetic energy store is decreasing during magnetic braking. b) Justify why the magnetic energy store is increasing during magnetic braking. The car on the track has a mass of 850 kg and is moving at 12 m/s. c) Calculate the kinetic energy store of the moving car, The car is stopped by magnetic braking. d) What is the speed of the car when it is stopped? e) What is the size of the kinetic energy store when the car is stopped? f) How much has the kinetic energy store decreased by during braking? g) How much has the magnetic energy store increased by during braking? h) What is the transfer of energy that has occurred? Another way of slowing the car would be to have it roll up a hill. i) Which energy store increases as the car goes uphill? j) How high would the car have to go to bring it to a halt from its original speed of 12 m/s (if there was no magnetic braking)?	
2)	List the eight stores of energy and next to each one, explain what we'd have to do to increase them.	
3)	List the four transfers of energy and give an example of where we'd see each one.	
4)	A nuclear power plant uses nuclear reactions to heat water. a) Justify why the thermal energy store of the water increasing. b) Justify why the nuclear energy store of the nuclear fuel is decreasing. If 0.1 g of nuclear fuel reacts, 3.2 kJ of energy is lost from the nuclear energy store. c) Convert 3.2 kJ into J. d) How much does the thermal energy store of the water increase by? The water boils and turns to steam. The steam turns a turbine (like a windmill). The turbine has a mass of 900 g and is moving at 54 m/s. e) Convert 900 g into kg. f) Calculate the kinetic energy store of the turbine.	

#	Question	Done?
5)	Explain the differences between the nuclear energy store and the chemical energy store.	
6)	A student says "when I charge my phone, the electrostatic energy store of the battery increases". This is wrong. Explain why.	
7)	Jahaan is about to go jump off a diving board onto a trampoline. He is stationary and is 5 m above the trampoline. a) Why is the elastic potential energy store of the trampoline zero? b) Why is the kinetic energy store of Jahaan zero? c) What extra information do you need to calculate the gravitational potential energy store? d) When he steps off the diving board, explain which energy stores will change as he falls. Jahaan has a mass of 60 kg and is on Earth, where g = 9.8 N/kg. e) Calculate how much energy was in his gravitational potential energy store before he jumped. Jahaan falls and is now at the level of the trampoline surface. f) How much has his gravitational potential energy store decreased by? g) How much has his kinetic energy store increased by? h) Calculate how fast is travelling. Remember to rearrange carefully by taking the square root. Jahaan now lands on the trampoline and it stretches. i) What happens to the elastic potential energy store of the trampoline? j) Explain what happens to the kinetic energy store of Jahaan. k) Explain why this shows the mechanical transfer. When the trampoline is stretched, it has 2,940 J in its elastic potential energy store. It is stretched by 30 cm. l) Convert 20 cm into m. m) Calculate what e^2 is for the extension you have from part l) i.e. square your value from part l) n) Calculate the spring constant of the trampoline.	

Exam Practice

A student is doing a bungee jump and jumps off the bridge.



Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential gravitational
potential kinetic sound thermal

Before the student jumps from the bridge he has a store of

______________________ energy.

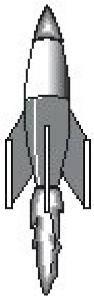
When he is falling, the student's store of ______________________

energy increases.

When the bungee cord is stretched, the cord stores energy as

______________________ energy.

A rocket has a mass of 5000 kg and is travelling at a speed of 600 m/s.



Calculate the rocket's kinetic energy in kilojoules. Show your working. **(3)**

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Kinetic energy = _______________ kJ

A car which is moving has kinetic energy.

The faster a car goes, the more kinetic energy it has. The kinetic energy of this car was 472 500 J when travelling at 30 m/s.
Calculate the total mass of the car.
Show clearly how you work out your answer and give the unit. **(5)**

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Mass of the car = ______________________________

A car and its passengers have a mass of 1200 kg. It is travelling at 12 m/s.

Calculate the increase in kinetic energy when the car increases its speed to 18 m/s.

Show clearly how you work out your answer and give the unit.

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Increase in kinetic energy = ____________________

The image shows a battery-powered drone.

Complete the sentences.

Choose the answers from the box.

	chemical	**elastic potential**
gravitational potential	**kinetic**	**nuclear**

As the drone accelerates upwards

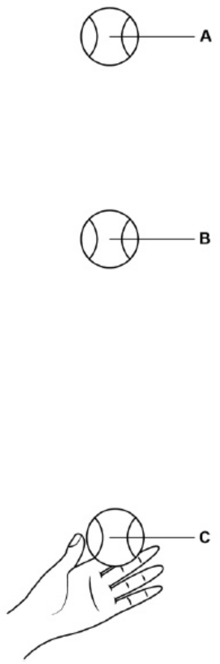
its ____ energy increases

and its ____ energy increases.

The ____ energy store

of the battery decreases.

The diagram shows a tennis ball thrown vertically into the air.



At position **C**, the ball has just left the tennis player's hand at a speed of 5.0 m/s

The tennis ball has a mass of 0.058 kg

(a) Write down the equation that links kinetic energy, mass and speed.

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(b) Calculate the kinetic energy of the tennis ball at position **C**.

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Kinetic energy = ______________________ J

(c) At position **A** the tennis ball is at maximum height.

What is the gravitational potential energy of the tennis ball at position **A**?

Ignore the effect of air resistance.

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At position **B** the tennis ball has 0.38 J of gravitational potential energy.

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

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(e) Calculate the height of the tennis ball above the tennis player's hand when at position **B**.

gravitational field strength = 9.8 N/kg

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Height = ____________________ m

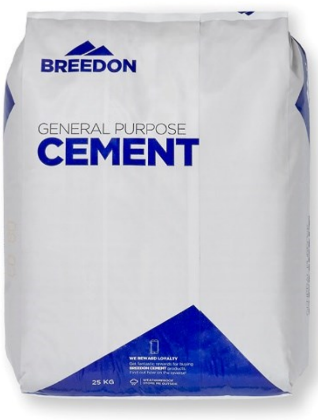
Energy: Core Knowledge

Core Questions

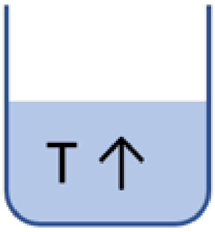
1	What is a chemical energy store?	Energy stored because of the chemical composition of a material: food, fuel, and batteries
2	What will happen to the chemical energy store of a fuel as a fuel is burned?	It will decrease.
3	What is a thermal energy store?	Energy stored by an object of its temperature.
4	If the thermal energy store of an object increases, what happens to the temperature of the object?	It increases.
5	How is energy moved between different stores?	By an energy transfer.
6	What is the transfer of energy involved when one object heats up another?	Heating transfer.
7	What is the unit for energy?	J (joules)
8	What does the principle of conservation of energy tell us?	Energy can never be created or destroyed only transferred from one store to others.
9	What does kilo mean?	1,000
10	What is a kinetic energy store?	Energy an object has because it is moving
11	What happens to an objects kinetic energy store as the object slows down?	It decreases.
12	When is the kinetic energy store of an object zero?	When it is stationary.
13	What is the equation for kinetic energy?	Kinetic energy = ½ × mass × velocity^2 $E_k = \frac{1}{2} \times m \times v^2$
14	Two objects of different masses are travelling at the same speed. Which has more energy in its kinetic energy store?	The one with the larger mass
15	What is a gravitational energy store?	Energy an object has because it is above the Earth's (or any other planet's) surface
16	How can I increase the gravitational energy store of an object?	Lift it higher. Move to a planet with a larger gravitational field strength.
17	What is the equation for gravitational potential energy?	Gravitational potential energy = mass × gravitational field strength × height $E_g = m \times g \times h$
18	What does gravitational field strength mean?	How strong the pull of gravity is on a planet.

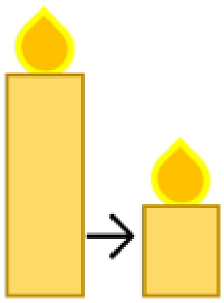
19	What is the gravitational field strength of Earth?	g=9.8 N/kg
20	Two objects of different masses are lifted to the same height on Earth. Which has more energy in its gravitational energy store?	The object with the larger mass.
21	When is the gravitational energy store of an object zero?	When it is on the ground.
22	What is an elastic energy store?	Energy stored by an object because it has been stretched or squashed
23	I stretch an elastic band further and further. What happens to the elastic energy store?	It increases.
24	How is a spring with a large spring constant different to one with a small spring constant?	The one with a large spring constant is more difficult to stretch. The one with the smaller spring constant is easier to stretch.
25	What is the equation for elastic potential energy?	Elastic potential energy = ½ × spring constant × extension^2 $E_e = \frac{1}{2} \times k \times e^2$
26	What is the transfer of energy whenever there is a force?	Mechanical transfer.
27	What is a system?	An object or group of objects
28	What is a closed system?	A system which energy cannot leave or enter
29	What is an electrostatic energy store?	Energy stored between objects with charge attracting or repelling one another.
30	What is a magnetic energy store?	Energy stored between magnetic objects attracting or repelling one another.
31	What is a nuclear energy store?	Energy stored within the nucleus of an atom, accessed through nuclear reactions.
32	Name the eight stores of energy.	Chemical energy store, thermal energy store, kinetic energy store, gravitational energy store, elastic energy store, electrostatic energy store, magnetic energy store, nuclear energy store.
33	What is the name for the transfer of energy whenever light or sound are given out?	Radiation transfer.
34	What is the name for the transfer of energy that occurs in electric circuits?	Electrical transfer.
35	Name the four transfers of energy.	Heating transfer, mechanical transfer, radiation transfer, electrical transfer.

Core Diagrams



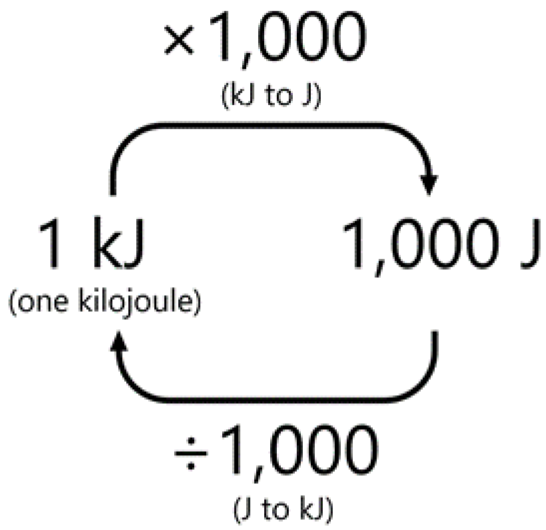
To remember the eight energy stores: CEMENT KG





The candle burns down and the water heats up.
The chemical energy store of the candle decreases.
The thermal energy store of the water increases.

Converting between kJ and J



The person falls downwards.	**The trampoline starts to stretch.**	**The trampoline goes back to its original shape.**	**The person rises upwards.**
Gravitational energy store of the person decreases (they get lower).	Gravitational energy store of the person decreases a little (they get a little lower).	Gravitational energy store of the person increases a little (they get a little higher).	Gravitational energy store of the person increases (they get higher).
Kinetic energy store of the person increases (they get faster).	Kinetic energy store of the person decreases (they get slower).	Kinetic energy store of the person increases (they get faster).	Kinetic energy store of the person decreases (they get slower).
Elastic energy store of the trampoline is zero (the trampoline isn't stretched).	Elastic energy store of the trampoline increases (the trampoline stretches more).	Elastic energy store of the trampoline decreases to zero (the trampoline becomes less stretched).	Elastic energy store of the trampoline is zero (the trampoline isn't stretched).

Worked Examples

Calculating the kinetic energy store

	A dog has a mass of 4 kg and is running at 5 m/s. How much energy is in its kinetic energy store?
Equation	$E_k = ½ \times m \times v^2$
Values	E_k = ? m = 4 kg v = 5 m/s
Enter values	$E_k = ½ \times 4 \times 5^2$
Result	E_k = 50
Yoonits	E_k = 50 J

Calculating the height from the gravitational potential energy store

	A ball is stuck up in a tree. The ball has 29.4 J in its gravitational potential energy store. The mass of the ball is 1.5 kg. On Earth, g = 9.8 N/kg. How high up is the ball?
Equation	$E_g = m \times g \times h$
Values	E_g = 29.4 J m = 1.5 kg g = 9.8 N/kg h = ?
Enter values	$29.4 = 1.5 \times 9.8 \times h$
Result or **R**earrange	$29.4 \div 1.5 \div 9.8 = h$ or $29.4 \div (1.5 \times 9.8) = h$
Yoonits	h = 2 m

Calculating the extension from the elastic potential energy store

	A spring has a spring constant of 350 N/m. There are 700 J in the elastic potential energy store. What is the extension of the spring?
Equation	$E_e = ½ \times k \times e^2$
Values	E_e = 700 J k = 350 N/m e = ?
Enter values	$700 = ½ \times 350 \times e^2$
Result or **R**earrange	$700 \div ½ \div 350 = e^2$ $4 = e^2$ Now we must take the square root $\sqrt{4} = e$
Yoonits	e = 2 m