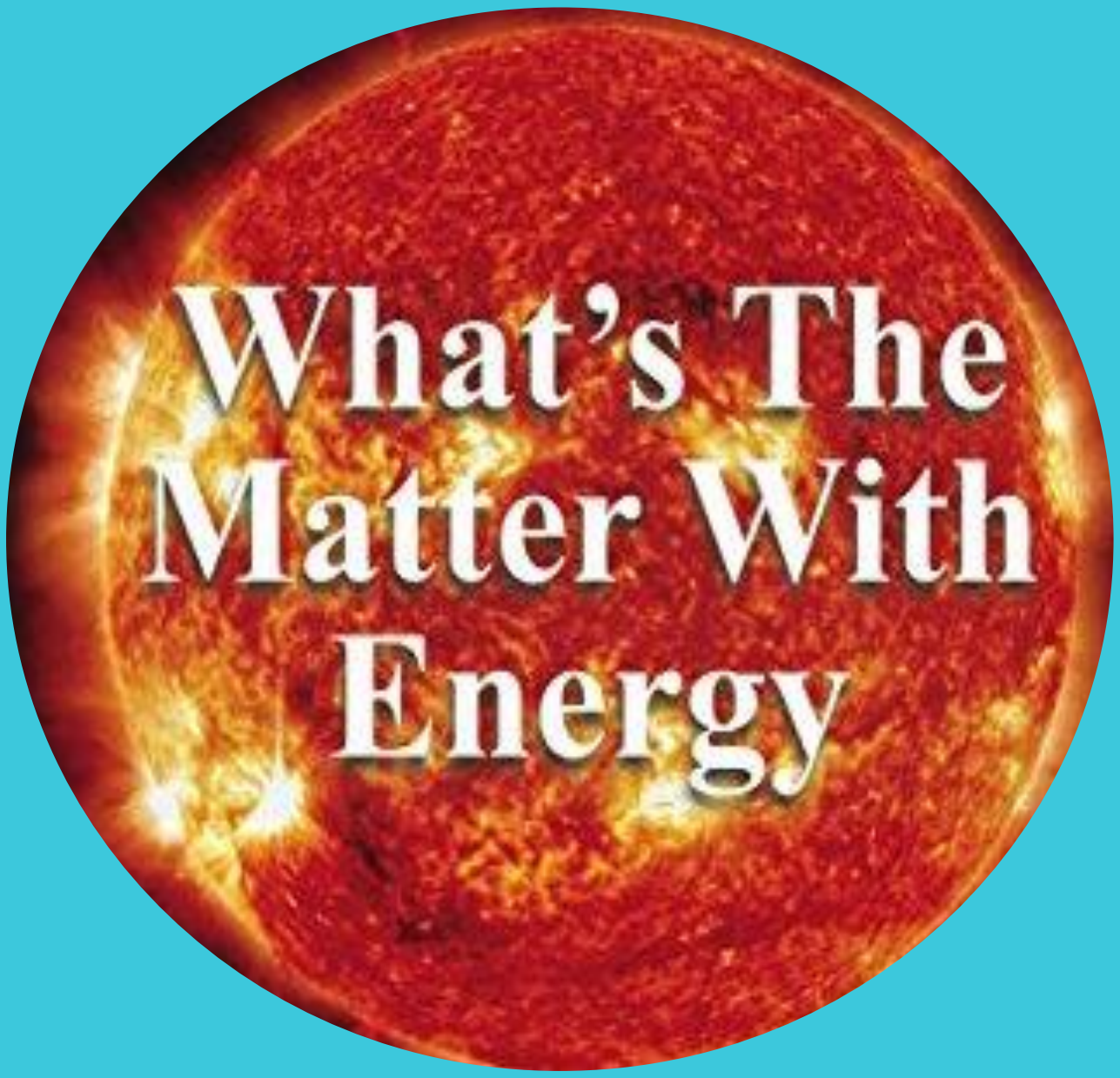
Researchers in Schools



Energy

Key Stage 4 Revision Programme

Pupil Name

Handbook Designed by Dr Tyagi

Timetable and Assignment Submission

Timetable – Tutorials

Tutorial	Date	Time	Location
1 (Baseline assessment)	13 December 2019	3pm	Room 51
2	17 January 2020	3pm	Room 51
3	24 January 2020	3pm	Room 51
4	31 January 2020	3pm	Room 51
5	7 February 2020	3pm	Room 51
6 (Final assessment)	28 February 2020	3pm	Room 51
7 (Feedback)	13 March 2020	3pm	Room 51

Timetable – Homework Assignments

Tutorial 1		
Tutorial 2		
Tutorial 3		
Tutorial 4		
Tutorial 5		

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Course Rationale

Hi and welcome to Uni Pathways 2 coursework. This coursework is designed to give you an opportunity for revision and practice sessions on certain concepts relating to energy. It takes you on a journey inside matter, showing you the internal energy and kinetic and potential energy of a system. We then look at specific heat capacity and specific latent heat.

In recent years, GCSE science exams have become mathematically demanding. So, the chosen topics are mathematically rigorous and gives an occasion for deliberate practice. The coursework will begin with a baseline test and finish with a final test. In between, there will be four tutorials, each one divided into three topics. Each topic begins with an objective summarising the theory, goes through a block of practice questions and finishes with an assessment question.

Practice is the key to master all the mathematics that waits for you in GCSE Physics. This coursework provides you in depth practice sessions relating to each concept covered.

Subject Vocabulary

Complete this vocabulary list during your tutorials. Use the free spaces for additional words.

Word	Definition	In a sentence
Energy		
Temperature		
Evaporation		
Internal Energy		
Rate of cooling		
Rate of heating		
Specific heat capacity		
Gradient		
Specific latent heat of fusion		
Specific latent heat of vaporisation		
Kinetic energy		

Gravitational Potential Energy		
Work done		
Power		

Tutorial 1 – Baseline assessment

What is the Purpose of Tutorial 1?

- Pre-SEF
- Baseline assessment

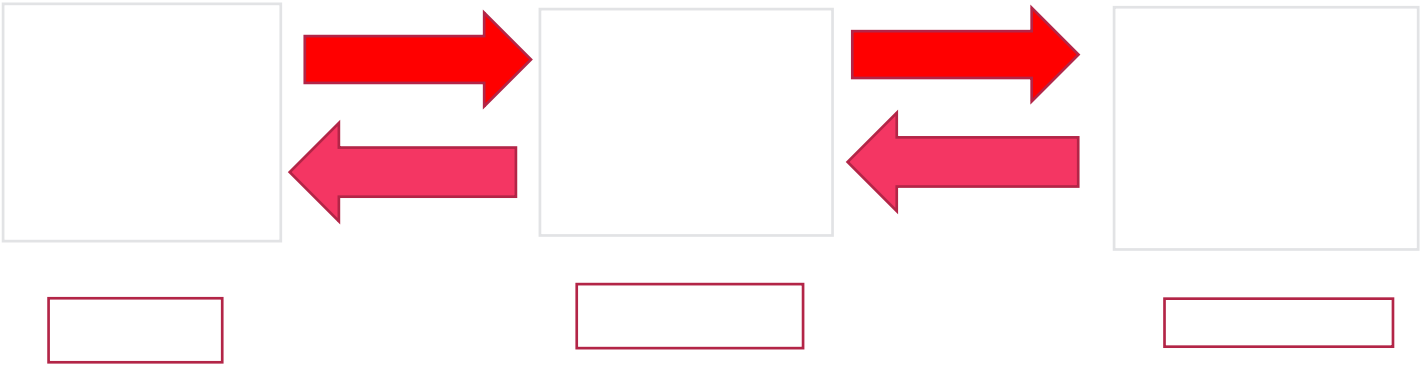
Tutorial 2 – Internal Energy

What is the Purpose of Tutorial 2?

- Change of state of matter
- Energy change during change of state of matter
- Interpret heating and cooling curves

STARTER

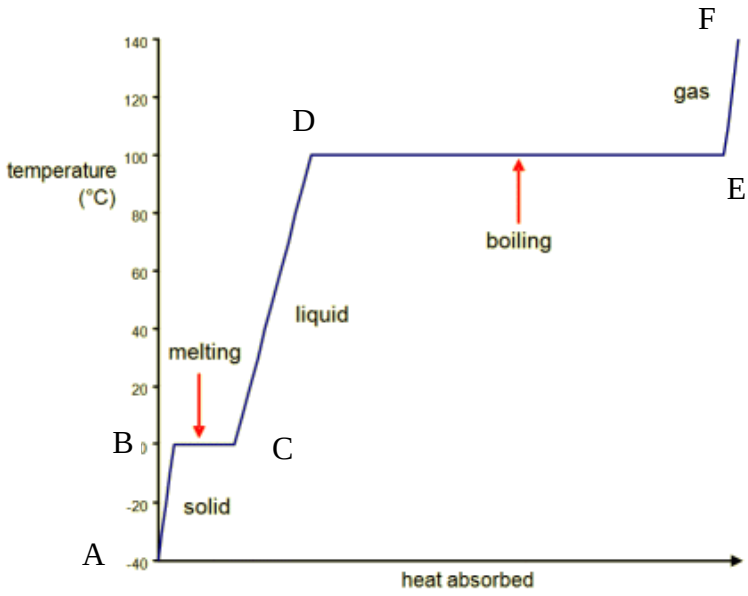
Complete the following pictures by writing the three states of matter in the blue boxes and drawing the particle model picture of them in the green box above them. Also, include the processes that happen during the change of state of matter.



OBJECTIVE A: Change of state of matter

Heating changes the energy stored within the system by increasing the energy of the particles that make up the system. This either raises the temperature of the system or produces a change of state.

Graph here shows the temperature of ice:
- At A it is Solid.
- At B, reaches 0 °C.
- From B to C there is no temperature change because the energy is used through melting.
- From C to D it is in liquid state.
- From D to E the water is boiling. This takes longer, because evaporation takes more energy than melting.
- From E to F the gas is heating.



Temperature is measured in °C, and heat is measured in J. When thermal energy is transferred to an object by heating, its temperature increase depends on:

- the mass of the object
- the substance the object is made from
- the amount energy transferred to the object.

Temperature measures how hot a substance is based on the average speed of the particles attributed to the kinetic energy of individual particles. Heat measures thermal energy contained inside the substance. Thermal energy is associated with the random, thermal motion of atoms or molecules within the substance.

PRACTICE A

1. For water-

   a) At what temperature does it boil?

   b) At what temperature does it freeze?

2. At what temperature does ice melt?

3. What is needed to melt a substance?

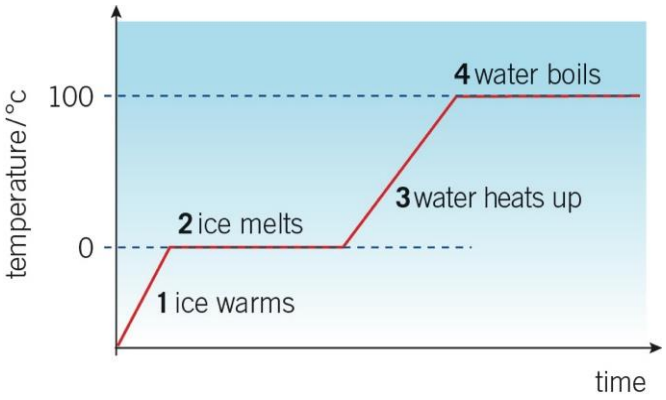
4. Explain what happens to the particles as a substance changes from liquid to gas.

5. What process occurs when a liquid absorbs energy gradually from its environment to change into a gas?

ASSESSMENT A

Study the graph and decide which of the following statements is correct.

1) The internal energy only increases at stages 1 and 3.
2) The potential and kinetic energy increase at every stage.
3) The potential energy of the particles remains the same at all stages.
4) At 2 and 4 the potential energy increases.

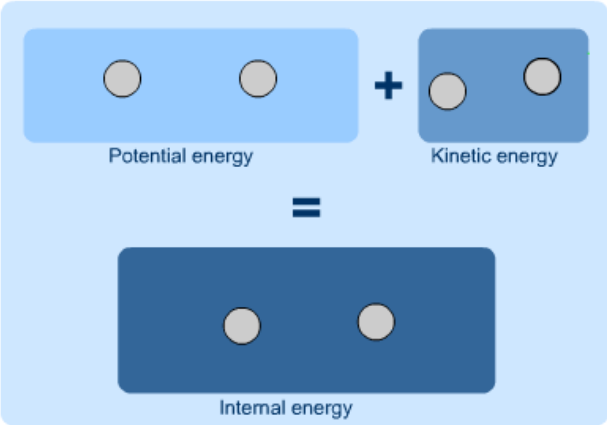


OBJECTIVE B: Internal Energy

Energy is stored inside a system by the particles (atoms and molecules) that make up the system. This is called internal energy.

Internal energy is a measure of the total energy of all the particles in the object or substance.

Internal energy is the sum of kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system. Kinetic Energy because of the motion of the particles while Potential Energy due to its position.

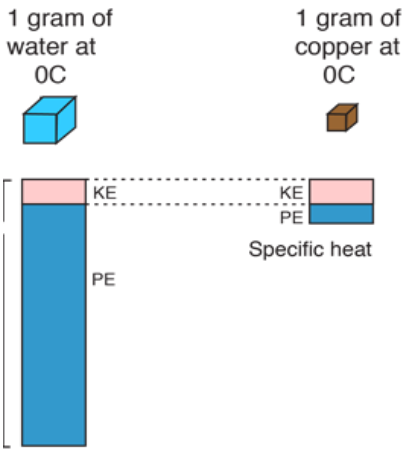


Example 1: Which of these has the largest total amount of internal (thermal) energy?

a) A teaspoon of hot water
b) A mug of hot water
c) A swimming pool of lukewarm water

The swimming pool will have much more internal energy in it than a mug or a teaspoon of hot water even if its temperature is much lower because there are many more particles.

Example 2: Which one among the following has more Internal Energy?



1 gram of water at 0 °C has more Internal Energy than 1 gram of copper at 0 °C. Even though they both have the same KE but PE of water is more than Copper and the IE = KE + PE.

PRACTICE B

1. What particles do in a system, if they have energy stored as kinetic energy?

2. What is the potential energy store of a system due to?

3. What stores the energy in a system?

4. How is the total energy of a system called?

5. Kinetic energy store + Potential energy store = ?

6. What occurs if you heat a system enough to break the bonds between different molecules?

7. What is heat?

8. What is temperature a measure of?

9. What is the difference between internal energy and thermal energy?

ASSESSMENT B

The figure shows a cyclist riding along a flat road. At a certain point the cyclist brakes to halt to a stop, causing the brake pads to get hot. How is the internal energy of the particles in the brake pads affected by the increase in temperature?

A) Decreased

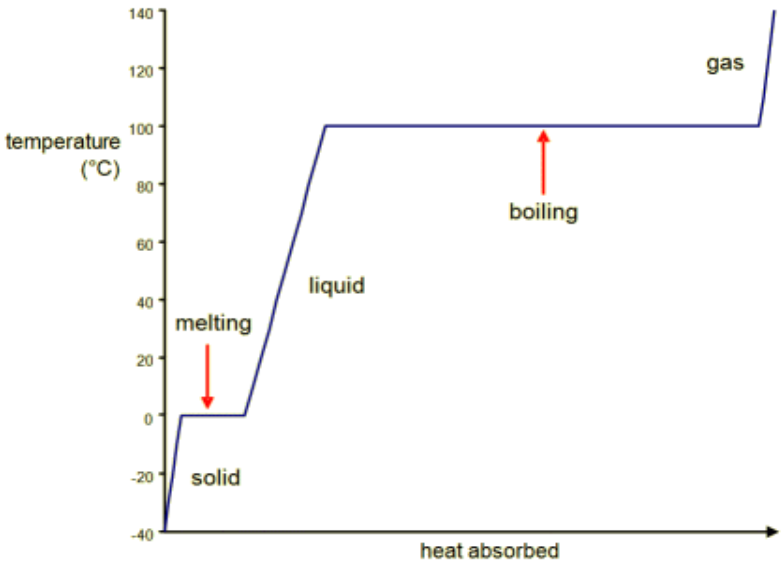
B) Increased

C) Not affected

OBJECTIVE C: Heating and cooling curves continued

When a material is heated or cooled, two changes may happen to the particles within the material:

- Change in temperature: particles speed up and gain kinetic energy;
- Change in state: energy is put in to breaking the bonds that are holding particles together, which increases the potential energy.



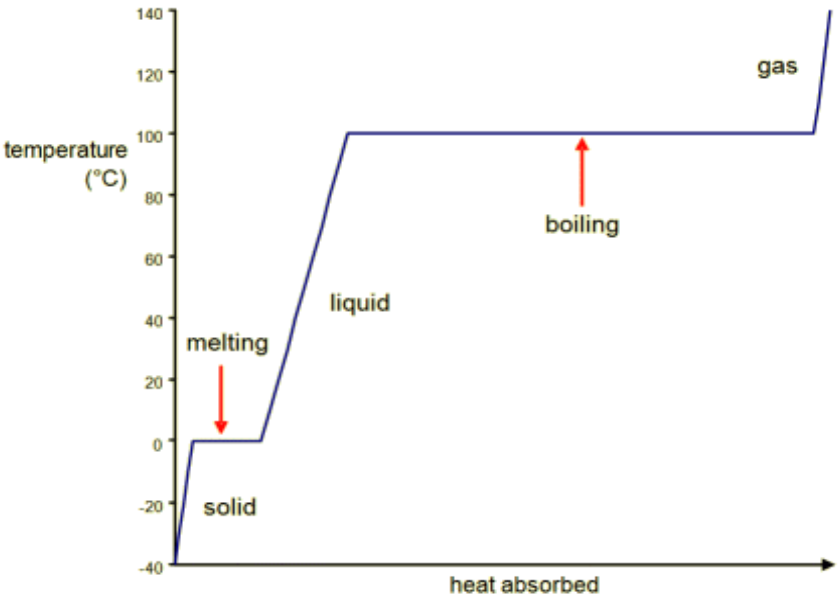
Whether the energy breaks bonds, increases the speed of the particles to stretch bonds, or just increases the speed of the particles depends on the temperature and state of the material.

When a substance is heated:

- if its temperature rises, the kinetic energy of its particles increases;
- if it melts or it boils, the potential energy of its particles increases.

PRACTICE C

1) What effect would decreasing the surface area of a liquid have on its rate of evaporation?



2) Answer the questions for the given processes.

Melting ice	Warming water	Boiling water
What is happening to the kinetic energy store? a) increases b) decreases c) remains constant	What is happening to the kinetic energy store? a) increases b) decreases c) remains constant	What is happening to the kinetic energy store? a) increases b) decreases c) remains constant
What is happening to the potential energy store and why?	What is happening to the potential energy store and why?	What is happening to the potential energy store and why?

ASSESSMENT C

Which statement about internal energy is correct?

A) More energy is required to melt 100 kg of ice to liquid water than is needed to boil it from a liquid to a gas.
B) Mass is not conserved in a physical change.
C) A change in internal energy of an object can only result in a change in temperature.
D) The temperature of a solid does not change when it is melting.

PLENARY

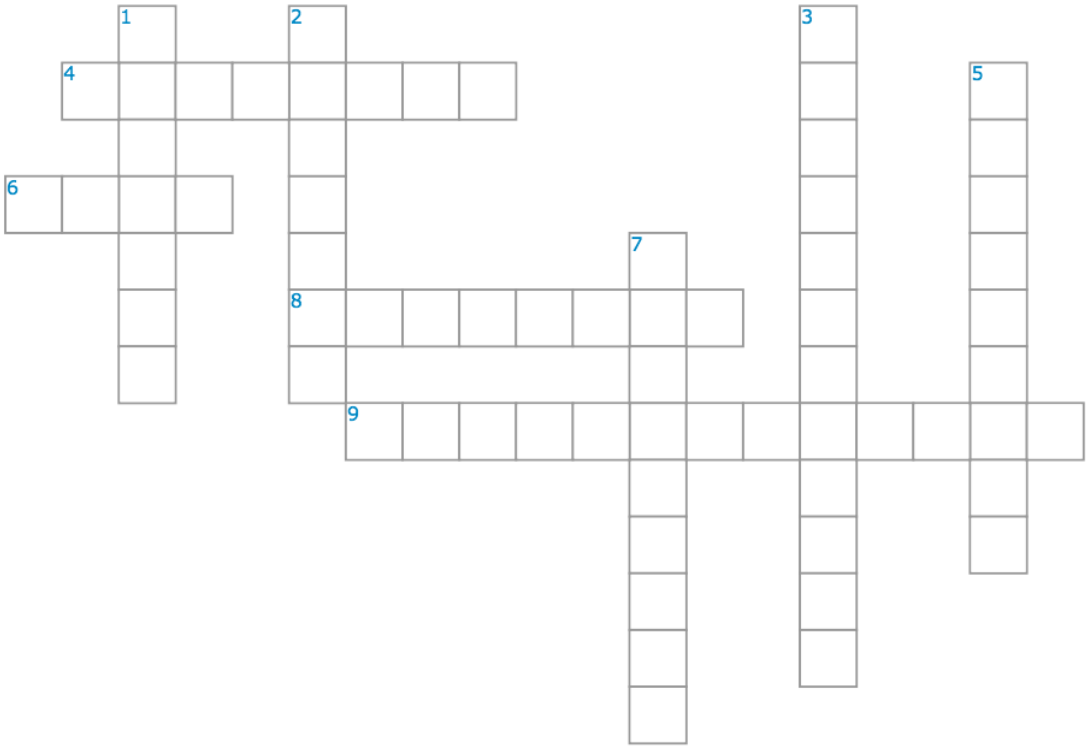
Discuss an example to illustrate the difference between heat and temperature.

Tutorial 3 – Specific heat capacity

What is the Purpose of Tutorial 3?

- Define specific heat capacity
- Calculate specific heat capacity
- Experiment to measure specific heat capacity

STARTER



Across

4 energy store found in fuels and food
6 energy transferred = _____ done
8 the higher the temperature of an object, the more _____ radiation it emits in a given time
9 when a car moves up a hill, it gains _____ potential energy

Down

1 energy store of a body due to its temperature
2 energy store of a moving object
3 the greater the thermal _____ of a material, the more energy per second it transfers by conduction
5 to waste energy to the surroundings
7 energy cannot be created or _____

OBJECTIVE A: Define specific heat capacity

- When we heat a substance in absence of a change of state, we transfer energy to it so the overall temperature is increased.
- The specific heat capacity is the amount of this energy required to raise the temperature of 1 kilogram of the substance by 1°C.
- Different substances have different specific heat capacities.
- The greater the specific heat capacity, the more energy required for each degree temperature change.
- The larger the mass of a substance being heated, the more energy required for each degree temperature change.

Example 1: The specific heat capacity of water is 4,200 joules per kilogram per Celsius degree (J/kg°C). This means that it takes 4,200 J to raise the temperature of 1 kg of water by 1°C.

Example 2: If we had a 2 kg piece of copper we would need to transfer twice the energy needed to raise the temperature of 1 kg of copper by the same amount.

PRACTICE A

1) Write the definition for specific heat capacity.

2) The specific heat capacity of Copper is 387 J/kg°C. What does this mean?

3) How much energy must be transferred into 1 kg of copper to raise its temperature by 1°C?

4) If the same amount of energy is transferred into 1 kg of two different materials, which one will have the largest temperature rise?

ASSESSMENT A

You have two beakers of different types of oil, which have different specific heat capacities. You put each beaker in a water bath at 50 °C. The water is heated and stays at 50 °C. Which statement is true?

A) The oil with the higher specific heat capacity will heat up more quickly regardless of the mass of oil.

B) If the mass of oil in the two beakers is the same, the oil with the lower specific heat capacity will heat up more quickly.

C) If the mass of oil in the two beakers is the same, the oil with the lower specific heat capacity will heat up more slowly.

D) If you put the same amount of oil in each beaker, the temperature of the oil in each beaker will be the same at all times.

OBJECTIVE B: Calculate specific heat

A change in temperature of a system depends on:

- the mass of the material
- the substance of the material
- the amount of energy put into the system

The amount of thermal energy stored or released as the temperature of a system changes can be calculated using the equation:

change in thermal energy = mass × specific heat capacity × temperature change

$$\Delta E = m\, c\, \Delta\theta$$

This is when:

- change in thermal energy (ΔE) is measured in joules (J)
- mass (m) is measured in kilograms (kg)
- specific heat capacity (c) is measured in joules per kilogram per degree Celsius (J/kg°C)
- temperature change ($\Delta\theta$) is measured in degrees Celsius (°C)

1) Each day the average European family uses 100 kg of hot water. To kill bacteria, the water going into the tank at 20 °C must be heated to 60 °C. Calculate the energy needed to increase the temperature of 100 kg of water by 40 °C. Remember that the specific heat capacity of water is 4,200 J/kg°C.

m = 100 kg
$\Delta\theta$ = 40 °C

c = 4200 J/kg °C

$\Delta E = m\,c\,\Delta\theta$

ΔE = 100 kg x 4200 J/kg°C x 40 °C
= 16,800,000 J
= 16.8 MJ

PRACTICE B

Rearrange the equation
$\Delta E = m\,c\,\Delta\theta$

1) to make m the subject of the equation

2) to make c the subject of the equation

3) to make $\Delta\theta$ the subject of the equation

Solve the following exercises:

1) Liquid water has a specific heat capacity of 4200 J/kg°C. How much energy is required to raise the temperature of 40 kg of water from 20°C to 85°C?

   Energy = mass × specific heat capacity × change in temperature

   Energy = ... kg × ..... J/kg°C × ..... °C

   Energy = ... J

2) A material requires 235,000 J of thermal energy for its temperature to increase by 30 °C. The material has a mass of 25 kg. What is the specific heat capacity of the material? Give your answer to 3 significant figures.

   Specific heat capacity = energy supplied ÷ (mass × change in temperature)

   Specific heat capacity = ... J ÷ (..... kg × ..... °C)

   Specific heat capacity = ... J/kg°C

3) Complete the following table by calculating the missing variables.

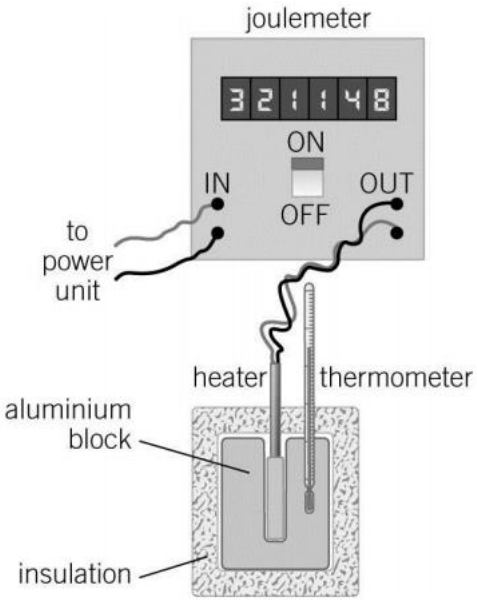
Object	Energy (J)	Mass (Kg)	SHC (J/Kg°C)	Initial temperature (°C)	Final temperature (°C)	Temperature difference (°C)
Oil		2	2,000	20	120	
Water	336,000	20	4,200		50	

Lead	5,000		126	20	250	
Water	20,000	0.5	4,200	15		
Metal	1,600	2		5	13	

ASSESSMENT B

The specific heat capacity of water is 4200 J per kg per °C. Which of the following will result in the smallest transfer of energy to the thermal store?
A) raising the temperature of a bath tub containing 300 kg of water by 2 °C
B) raising the temperature of a cup of water containing 200 g of water by 40 °C
C) raising the temperature of a cup of water containing 100 g of water by 100 °C
D) raising the temperature of a kettle of water containing 0.5 kg of water by 100 °C

OBJECTIVE C: Experiment for specific heat capacity



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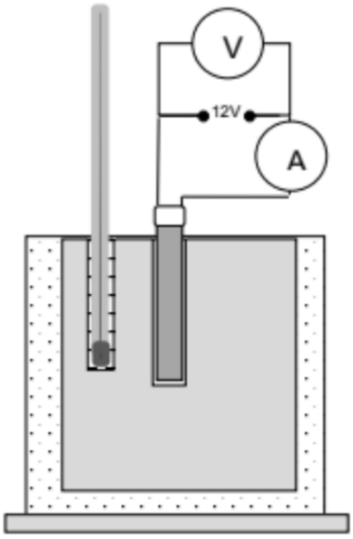


Method (from bbc.co.uk)

1. Place the immersion heater into the central hole at the top of the block.
2. Place the thermometer into the smaller hole and put a couple of drops of oil into the hole to make sure the thermometer is surrounded by hot material.
3. Fully insulate the block by wrapping it loosely with cotton wool.
4. Record the temperature of the block.
5. Connect the heater to the power supply and turn it off after ten minutes.

6. After ten minutes the temperature will still rise for some time even though the heater has been turned off. Later on, it will begin to cool. Record the highest temperature that it reaches and calculate the temperature rise during the experiment.

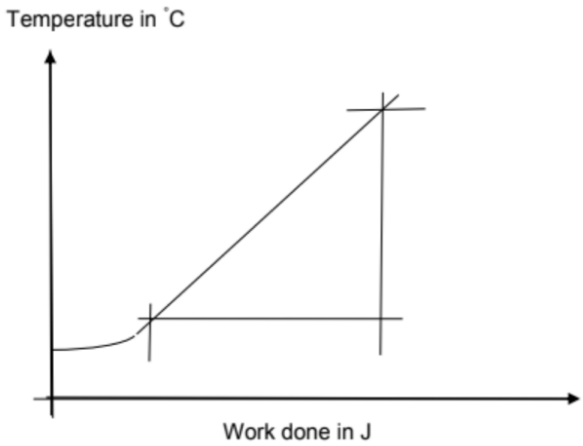
Ammeter reading (A)	Voltmeter reading (V)	Initial temperature (°C)	Final temperature (°C)
3.65	10.80	15	38

Energy transferred can be obtained by multiplying reading from Joulemeter and time. Else if an ammeter and voltmeter is used then,

energy transferred = potential difference × current × time

The specific heat capacity can either be calculated using the equation from OBJECTIVE A of this tutorial using the readings or by plotting a graph of temperature vs energy transferred (or work done). The gradient of the straight part of your graph can be calculated by gradient = $\frac{\Delta y}{\Delta x}$.

The heat capacity of the block is given by: $\frac{1}{\text{gradient}}$



PRACTICE C

1) Look at the data in the table.

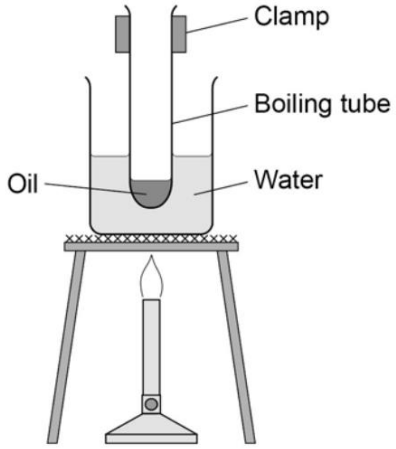
Substance	water	oil	aluminium	iron	copper	lead	concrete
Specific heat capacity in J/kg°C	4200	2100	900	390	385	130	850

Which material would be the best material to use in a storage heater? Give a reason for your answer

2) A student investigated the change in temperature when oils of different specific heat capacities were heated. She set up the apparatus as shown.

This is the method used.

1. Put 25 g of oil into a boiling tube.
2. Pour 100 ml of water into a beaker and heat it with a Bunsen burner.
3. When the water is boiling, put the boiling tube into the beaker. 4. When the temperature of the oil reaches 30 °C, heat for a further 30 seconds and record the rise in temperature.
5. Repeat with different oils.
6. Repeat the whole investigation.
Name two pieces of apparatus the student used that are not shown in the Figure shown.



What are the independent and dependent variables in the student's investigation?

Independent -

Dependent -

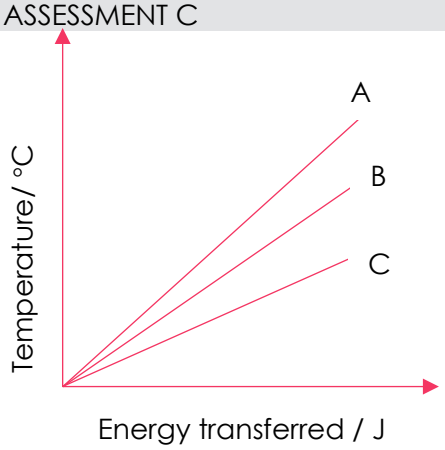
Give two safety precautions the student should have taken.

1)

2)

Suggest one improvement to the student's method.

ASSESSMENT C



A student uses a heater to provide energy to three 0.5 kg blocks made from different materials. She measures their temperature at regular intervals for 5 minutes. The graph shows her results. Choose the correct option for comparison of specific heat capacity of A, B and C.

1) A>B>C
2) A<B<C
3) A>B<C
4) A<B>C

PLENARY

Discussion question: Which materials are used for loft insulation and why?

Tutorial 4 – Specific latent heat

What is the Purpose of Tutorial 4?

- Define specific latent heat of fusion and specific latent heat of vaporisation
- Calculate specific latent heat
- Understand specific latent heat on heating graph

STARTER

You are working in the kitchen. Which one might give you more severe burns:
1) boiling water
2) boiling olive oil
3) it would make no difference

Explain your choice.

OBJECTIVE A: Define specific latent heat of fusion and specific latent heat of vaporisation

When water changes phase, thermal energy is exchanged between the water and its surroundings. The water either absorbs or releases heat depending on the phase change. This type of thermal energy is called *latent* heat, because the energy is *stored* or *hidden* until the phase change occurs. The specific latent heat is the energy required to cause 1 kg of material to change state at a constant temperature.

Heat is *absorbed* by water when water changes from liquid to gas (water vapour). The energy that is absorbed gives the molecules the additional potential energy that is needed to escape the surface of the liquid to become a gas. This process is known as evaporation, and the absorption of heat is called the latent heat of evaporation (or latent heat of vaporisation). Similarly, when the solid phase (ice) changes to liquid, melting occurs and heat is absorbed.

Heat is *released* when water changes from gas (water vapour) to liquid. This happens for example when warm and humid air rises through the atmosphere into cooler temperatures. Cooler air cannot hold as much moisture, so the water vapour condenses. The latent or hidden heat is then released, which is why this process is known as the latent heat of condensation. Heat is also released when water changes from the liquid phase to the solid phase (which is called freezing).

Substance	Latent heat of fusion (J/kg)	Latent heat of vaporisation (J/kg)
water	334,000	2,260,000
oxygen	14,000	210,000
silver	88,000	2,300,000

PRACTICE A

1) Fill in the gaps in the text below using the answers provided in the box. The answers may need to be used once, more than once, or not at all.

J	1 °C	Energy	1 kg	matter	liquid	fusion

Specific latent heat is the amount of ……..... required to convert

……..... of material from one state of ……..... to another. For example,

a mass of 1 kg will have a specific latent heat of ……..... of 250,000 J/kg

if an energy of 250,000 ……..... is required to change its state from a solid

to a …… at the same temperature.

2) What is it meant by the word 'latent'?

3) Explain the importance of the word 'specific' in the definitions for specific heat capacity and specific latent heat.

4) Why do you think that specific latent heat has units of J/kg and not J/kg °C?

ASSESSMENT A

Latent heat is…

A) the energy of 1 kg of material
B) the speed of state of change of 1 kg of material
C) the energy required to raise 1 °C of material by 1 kg
D) the energy required to change state of 1 kg of material

OBJECTIVE B: Calculate specific latent heat

The specific latent heat of a substance can be calculated by using the equation:
energy for a change of state = mass × specific latent heat
$E = m \times L$

- energy (E) measured in joules, J
- mass (m) measured in kilograms, kg
- specific latent heat (L) measured in joules per kilogram, J/kg

PRACTICE B

Worked example:

Calculate the mass of ice lost from an iceberg melting if the energy supplied was 835,000,000 J.

Step 1: Identify what you know and convert to standard units

Energy = 835,000,000 J.

Since it is a change of state between a solid and a liquid, you will need to use the latent heat of fusion. Latent heat of fusion of ice = 334,000 J/Kg

Step 2: Rearrange the equation to make mass the subject of the equation.

energy required = mass × specific latent heat → mass = $\frac{\text{energy required}}{\text{specific latent heat}}$

Step 3: Substitute the numbers into the equation

mass = $\frac{835000000\ \text{J}}{334000\ \text{J/kg}}$ = 2500 kg

1) It takes 60 kJ of energy to boil 300 g of liquid X into gas. Fill in the gaps to calculate the specific latent heat of vaporisation of liquid X in MJ/kg.

   Change g to kg: 300 g = …… kg

   Change kJ to MJ: There are …… kJ in 1 MJ, so 60 kJ = …… MJ

   specific latent heat of vaporisation (MJ/kg)
   = energy (MJ) ÷ …… (kg)
   = …… MJ ÷ …… kg
   = …… MJ/kg

2) A heater is used to keep water boiling. After 5 minutes, the joule meter reads 34 kJ and the reading on the balance decreases from 0.150 kg to 0.135 kg. Calculate the specific latent heat of vaporisation of water.

3) The specific latent heat of vaporisation for water is 2260 kJ/kg. Calculate the energy you need to transfer to boil water with a mass of 150 g.

4) Steam machines are used to sterilise kitchen work surfaces. Calculate the energy needed to change 60 g of water into steam. The latent heat of vaporisation for water is 2.26×10^6 J/kg

ASSESSMENT B

Water is cooled from 31 °C to 25°C by adding 40 g of ice. Which of the following statements are correct?

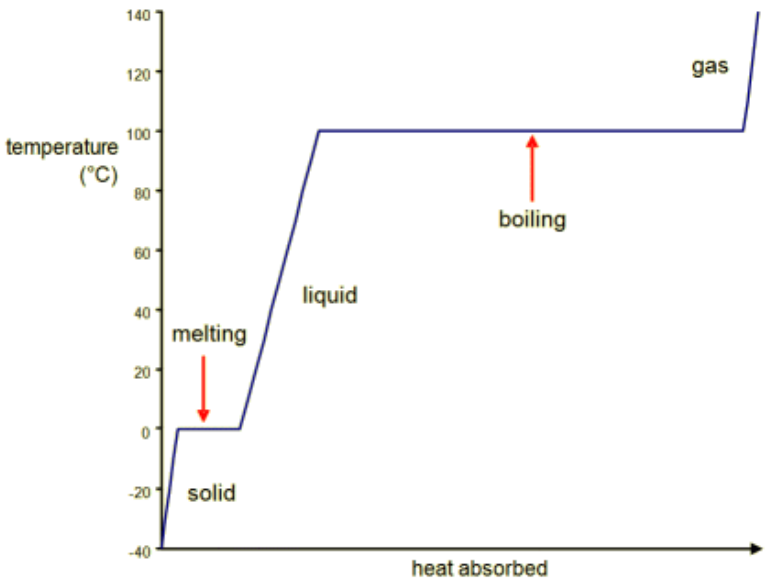
A) Energy lost by water = mass of water (kg) × 4200 J/Kg°C × 6 °C
B) Mass of the water = 667 g
C) The energy gained by the ice = 13360 J
D) Energy lost by the water = energy gained by ice
E) The mass of the water = 530 g

OBJECTIVE C: Specific latent heat on heating graph

Latent heat can be measured from a heating or cooling curve line graph. If a heater of known power is used, the temperature of a known mass of ice can be monitored each second. This will generate a graph that looks like the one in the figure.

The graph is horizontal at two places. These are the places where the energy is not being used to increase the kinetic energy of the particles (increasing temperature) but is being used to break the bonds between the particles to change the state.

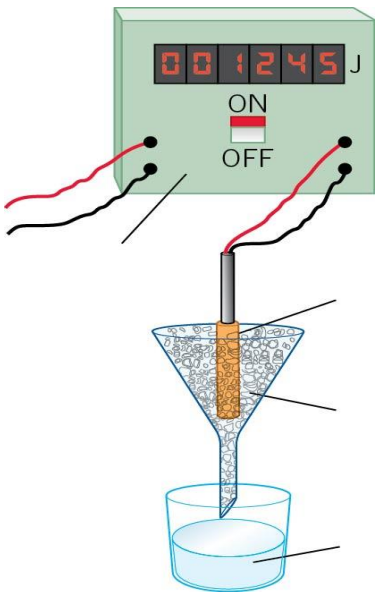
The longer the horizontal line, the more energy has been used to complete the change of state. The amount of energy represented by these horizontal lines is equal to the latent heat.



PRACTICE C

1) Which part of a cooling curve shows the changes of state?

a) The steepest lines b) The horizontal lines c) The vertical lines



2) The diagram shows an apparatus used to measure the specific latent heat of fusion of ice. Use the following labels to complete it.

Keywords: melted ice, joulemeter, ice, low voltage heater

ASSESSMENT C

How would you measure the specific latent heat of vaporisation of a liquid?
Highlight the correct order for the statements below.

1) B C A E D
2) A D E C B
3) D E A C B
4) C B D A E

A	Write down the mass of the liquid and turn the heater on.
B	Calculate latent heat by dividing the energy transferred by the change in mass.
C	Turn the heater off and write down the mass and the energy transferred.
D	Put a beaker with a known volume of liquid onto a digital balance.
E	Connect a heater to an energy meter and put the heater in the liquid.

PLENARY

Discussion the following question:
What is the reason behind a substance having two different forms of latent heat?

Tutorial 5 – Kinetic and gravitational potential energy

What is the Purpose of Tutorial 5?

- State and calculate Kinetic Energy
- State and calculate Potential Energy
- State and calculate Power

STARTER
For each of the statements below, state whether mechanical work is being done or not by writing "Yes" or "No" next to the statement:

- a girl riding a bicycle
- a spring being stretched
- a tug of war team pulling the other team towards them
- a man leaning against a wall
- a bag resting on a desk

OBJECTIVE A: Define and calculate kinetic energy

A moving object possesses kinetic energy. The name derives from the Greek word 'kinesis', meaning motion. An object of mass m is initially at rest. It is acted upon by a resultant force F and the object accelerates. This force acts over a distance s. Having travelled this distance, the object has a velocity v.
Work done in moving the object a distance s is: W = F × s

The kinetic energy of a moving object can be calculated using the equation:
kinetic energy = 0.5 × mass × speed^2

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

kinetic energy (E_k) is measured in joules, J
mass (m) is measured in kilograms, kg
speed (v) is measured in metres per second, m/s

Worked example:

Calculate the kinetic energy of a sprinter of mass 70 kg who is running at 10 m/s.

Step 1: Write down what you know (in standard units).
mass m = 70 kg
speed v = 10 m/s

Step 2: Use the equation for E_k to find kinetic energy.

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

$$= \frac{1}{2} \times 70 \text{ Kg} \times (10 \text{ m/s})^2 = 3500 \text{ J}$$

PRACTICE A

1) What is the origin of the word 'kinetic'?

2) Place the following moving objects in order of the size of their kinetic energies.
Place the smallest value at the top, then increasing values until the largest value at the bottom.

A) a particle of mass 0.5 g moving at 2 m/s
B) a pram of mass 16 kg moving at 2 m/s
C) a car of mass 1800 kg moving at 2 m/s
D) a motorcycle of mass 80 kg moving at 6 m/s
E) a firework of mass 1 kg moving at 20 m/s
F) a toy car of mass 2 kg moving at 4 m/s

4) Calculate the velocity of:
a) A bus travelling through town, with a mass of 5040 kg and kinetic energy of 493,900 J.

b) A lift travelling up to the top floor of the Empire State building with a mass of 4200 kg and a kinetic energy of 4116 J.

5) Calculate the mass of:
a) A wind turbine blade with a kinetic energy of 1 MJ turning at 6 m/s.

b) A child riding a bike at a speed of 0.6 m/s with a total kinetic energy of 12.4 J. If the mass of the child is 30 kg, what is the mass of the bike

6) A car moves at a constant velocity of 30 m/s and has 3.6×10^5 J of kinetic energy. The driver applies the brakes and the car stops in 95 m.

a) Calculate the force needed to stop the vehicle.

b) Calculate the mass of the vehicle.

7) A bike is moving at 12 m/s. Calculate the percentage increase of the kinetic energy caused by a velocity increase of 6 m/s.

8) Lorry A, of mass m, is travelling at speed v. A lorry B, of mass 2m, is travelling at speed v.

a) What is the ratio between the kinetic energies of lorry A and B?

b) Lorry C, of mass m, is travelling at speed 2v.
What is the ratio between the kinetic energies of lorry A and lorry C?

ASSESSMENT A

If the mass and velocity of an object both double, how will the kinetic energy change?

A	Two times less
B	It will stay the same
C	Eight times as large
D	Four times as large

OBJECTIVE B: Define and calculate gravitational potential energy

An object has gravitational potential energy when it is raised above the ground. The gain in gravitational potential energy is equal to the work done in raising the object. If the object has zero potential energy when it is on the ground, then the work done equals the amount of potential energy the object has when it is a height above the ground.
In general, the work done by a force is evaluated as:
work done = force needed × distance moved in direction of this force
The gravitational force on Earth is equal to
Gravitational force = mass × gravitational field strength
The amount of gravitational potential energy gained by an object of mass m raised above ground level at height h can then be calculated using the equation
g.p.e. = mass × gravitational field strength × height

$E_p = m\,g\,h$
gravitational potential energy (E_p) is measured in joules, J
mass (m) is measured in kilograms, kg
gravitational field strength (g) is measured in newtons per kilogram, N/kg
height (h) is measured in metres, m

Worked example:

Calculate the change in gravitational potential energy of a mountaineer who has climbed a mountain that is 3000 m high. The mass of the mountaineer is 70 kg. Remember that g is approximately 10 N/kg.

Step 1: Write down what you know (in standard units):
change in height h = 3000 m
mass m = 70 kg
g = 10 N/kg

Step 2: Use the equation for E_p to find gravitational potential energy:
$E_p = m \times g \times h$
$= 70\text{ kg} \times 10\text{ N/kg} \times 3000\text{ m}$
$= 2{,}100{,}000\text{ J}$

PRACTICE B

1) Explain why when you lift an object the work done is equal to the change in gravitational potential energy, but when you push an object across a desk it is not.

2) Describe what we mean by 'work' in Physics.

3) Where is the gravitational potential energy actually stored when a mass is raised through a vertical height of 200 m?

4) On other planets and moons, the value of g (gravitational field strength) is different. For example, on our Moon g = 1.6 N/kg and on Jupiter g = 26 N/kg.
   a) Suggest why g is different on Earth, Jupiter, and the Moon.

   b) Calculate the change in gravitational energy if an object of mass 5 Kg is moved up 2 m:
      on Earth

      on the Moon

      on Jupiter

ASSESSMENT B

If the mass and height of an object both double, how will the gravitational energy change?

A	Two times less
B	It will stay the same
C	Eight times as large
D	Four times as large

OBJECTIVE C: Define and calculate Power in terms of energy

Power is defined as the rate at which energy is transferred or the rate at which work is done. An energy transfer of 1 joule per second is equal to a power of 1 watt.

$$\text{Power} = \frac{\text{energy transferred}}{\text{time}}$$

$$P = \frac{E}{t}$$

Power (P) in watts, W
energy transferred (E) in joules, J
time (t) in seconds, s

PRACTICE C

1) Fill in the spaces in the statements below to complete the sentences. Use the words, numbers or units from the box provided, using each one only once.

600	more	longer	joule	J/s
shorter	kinetic	watt	scalar	greater

a) The unit of energy is the …… and the unit of power is the ……

b) The energy store of a moving car is mostly …… energy.

c) If a force of 20 N moves a distance of 30 m then the amount of work done will be …… J.

d) A power of 1 W is the same as 1 ……

e) The power rating will be greater if work is done over a …… period of time.

f) The …… that a device is used for and the …… its power rating, the …… energy will be transferred.

g) Energy and power have a size or magnitude, but no specific direction, so they are …… quantities.

2) Fill in the missing values in the table below.

Power	Energy transferred	Time in s
	3000 J	60
1200 W		3600
800 W	2.8×10^9 J	
	0.02 J	2×10^{-3}
1.2 kW	900 MJ	

3) A man of mass 85 kg runs up a flight of stairs of height 4.6 m in a time period of 12 s.

a) Calculate the man's power rating when doing this.

b A girl achieves a power rating of 70% of the man's power rating when she scales the stairs in a time of 9.6 s. Calculate the mass of the girl.

ASSESSMENT C

What is the power of a device which uses 300 kJ of energy in 1 hour?

A	0.83 kW
B	83.3 W
C	0.083 kW
D	5 kW

PLENARY

How can we decrease the power consumption used by the devices in our houses?

Tutorial 6 – Final Assessment

Tutorial 7 - Feedback

What is the Purpose of Tutorial 7?

- To receive feedback on final assessments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.
- To reflect on the programme including what was enjoyed and what was challenging.

Final assessment feedback

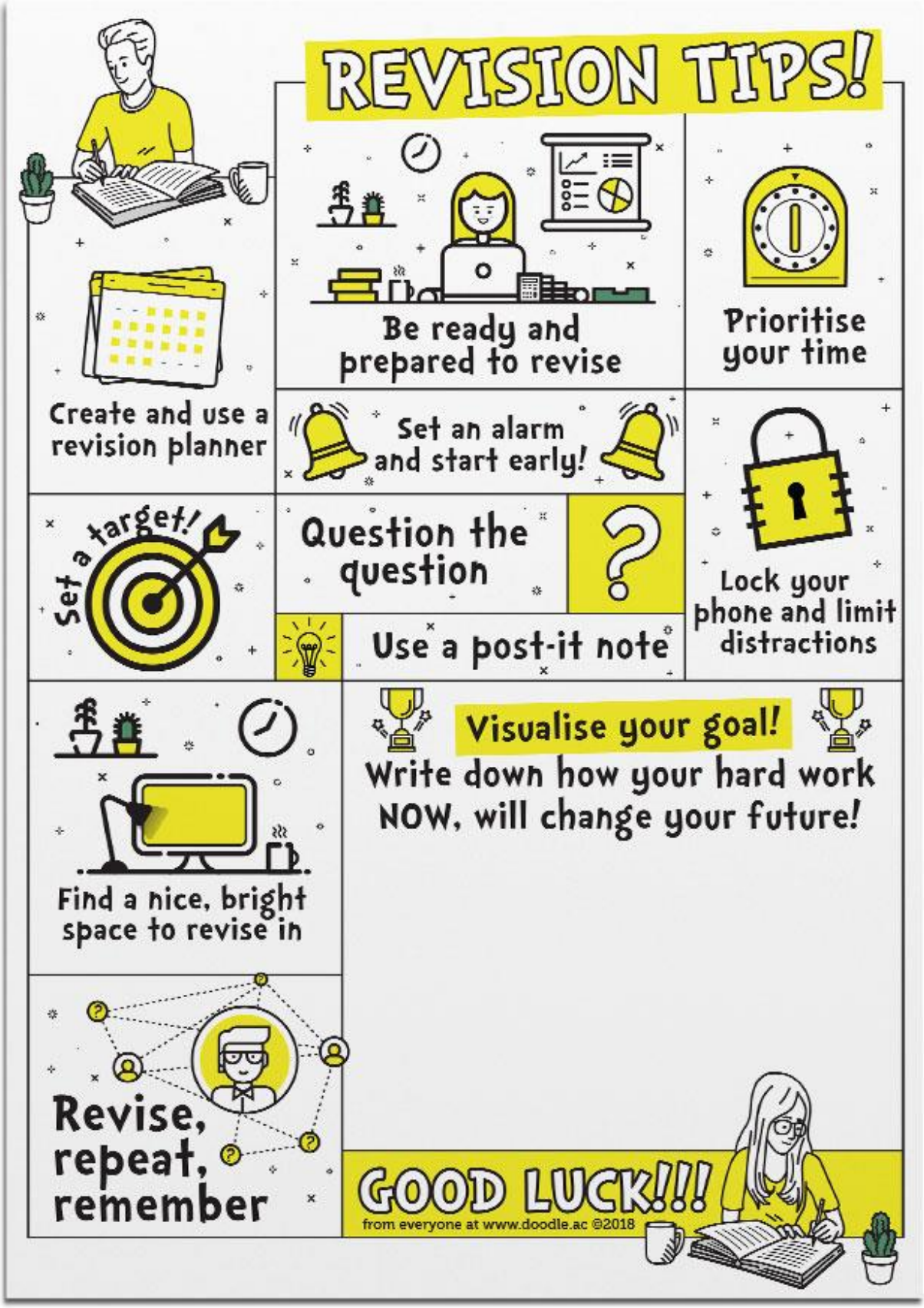
What I did well…	What I could have improved on…
•	•
•	•
•	•

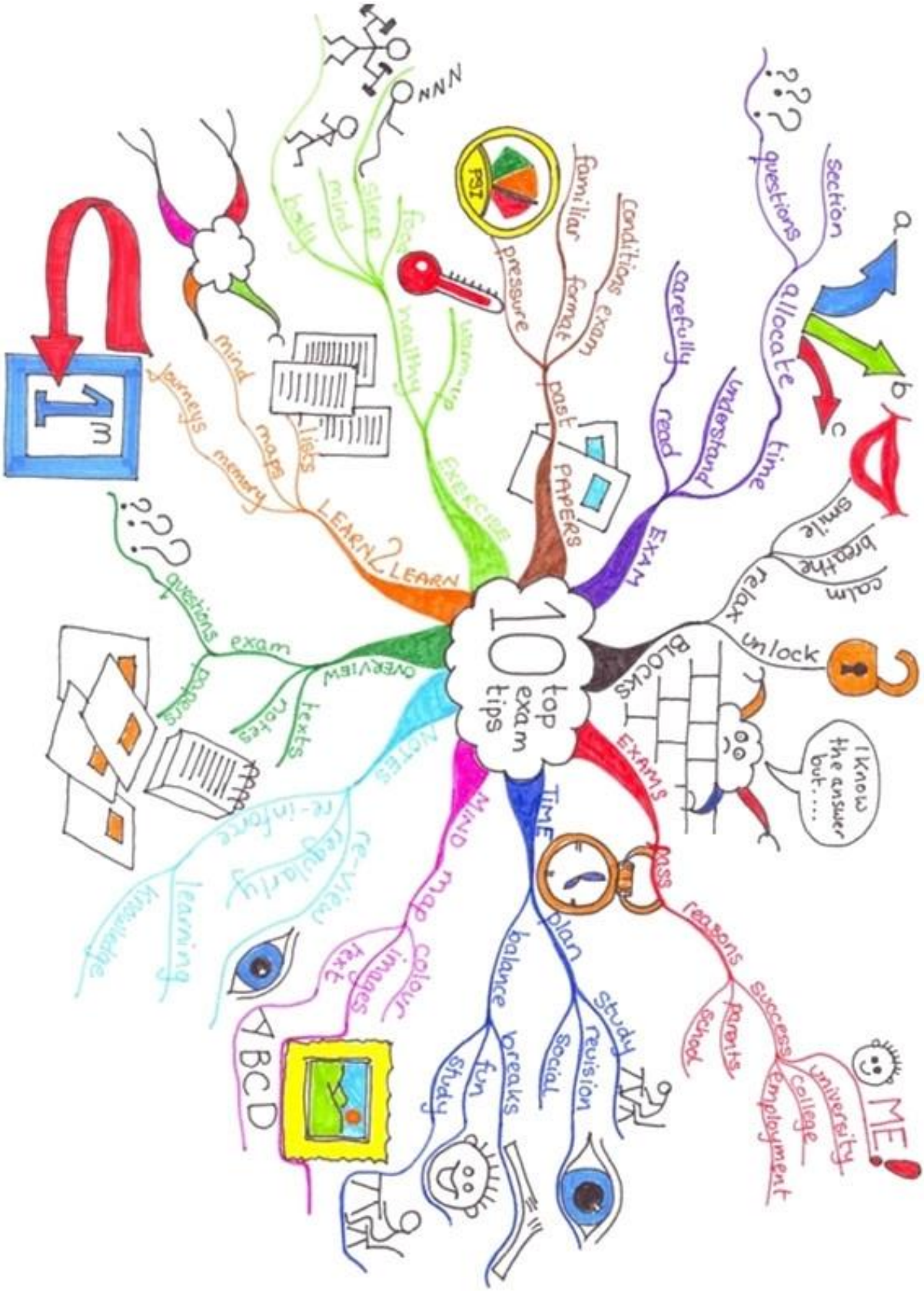
My target for future work is…

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
•   •   •

What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •


REVISION TIPS!
Create and use a revision planner
Be ready and prepared to revise
Prioritise your time
Set an alarm and start early!
Set a target!
Question the question
Lock your phone and limit distractions
Use a post-it note
Find a nice, bright space to revise in
Visualise your goal!
Write down how your hard work NOW, will change your future!
Revise, repeat, remember
GOOD LUCK!!!
from everyone at www.doodle.ac ©2018


10 top exam tips
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TIME
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warm up
healthy
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body
PAPERS
past
exam
conditions
familiar
format
pressure
PSI
EXAM
carefully
read
understand
time
allocate
questions
section
a
b
c
BLOCKS
relax
unlock
calm
breathe
smile
I know the answer but....

Notes

Notes

Notes

Notes

Notes

Energy

Key Stage 4 Programme

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