MEADOW PARK SCHOOL

Physics Paper 1 Knowledge and Exam Practice

Thursday 25th May 2023

Higher Tier

Topics – Energy, Particles, Electricity and Atomic Structure

How to use this booklet

MEADOW PARK SCHOOL

Rehearse the content using to knowledge organiser pages.
You can look-cover-say-check.
Make flash cards for content you find more difficult.

Then complete the exam practice questions.

AQA Combined Science: **Physics Topic 1 Energy**

Required Practical

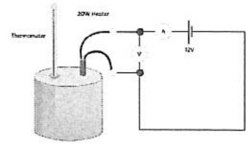
Investigating Specific Heat Capacity

independent variable – material

dependent variable – specific heat capacity

control variables – insulating layer, initial temperature, time taken

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



Method:

1. Using the balance, measure and record the mass of the copper block in kg.
2. Wrap the insulation around the block.
3. Put the heater into the large hole in the block and the block onto the heatproof mat.
4. Connect the power pack and ammeter in series and the voltmeter across the power pack.
5. Using the pipette, put a drop of water into the small hole.
6. Put the thermometer into the small hole and measure the temperature.
7. Switch the power pack to 12V and turn it on.
8. Read and record the voltmeter and ammeter readings – during the experiment, they shouldn't change.
9. Turn on the stop clock and record the temperature every minute for 10 minutes.
10. Record the results in the table.
11. Calculate work done and plot a line graph of work done against temperature.

Equations

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

$E_p = mgh$

$E_e = \frac{1}{2}ke^2$

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

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

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

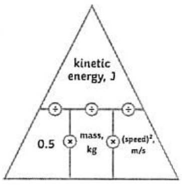
Kinetic and Potential Energy Stores

Movement Energy

kinetic energy = $\frac{1}{2}$ x mass × speed²

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

(J) (kg)(m/s)

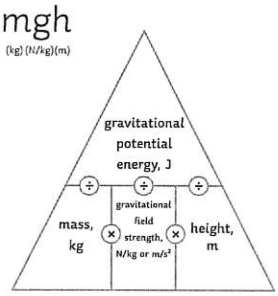


When something is off the ground, it has gravitational potential energy

gravitational potential energy = mass x gravitational field strength x height

$$E_p = mgh$$

(J) (kg) (N/kg)(m)



When an object falls, it loses gravitational potential energy and gains kinetic energy.

Stretching an object will give it elastic potential energy.

elastic potential energy = $\frac{1}{2}$ × spring constant × extension²

$$E_e = \frac{1}{2}ke^2$$

(J) (N)(m)

Transferring Energy by Heating

Heating a material transfers the energy to its thermal energy store - the temperature increases.

E.g. a kettle: energy is transferred to the thermal energy store of the kettle. Energy is then transferred by heating to the waters thermal energy store. The temperature of the water will then increase.

Some materials need more energy to increase their temperature than others.

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

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

(J) (kg) (J/kg°C) (°C)

Specific heat capacity is the amount of energy needed to raise the temperature of 1kg of a material by 1°C.

Energy Stores and Systems

Energy Stores	
kinetic	Moving objects have kinetic energy.
thermal	All objects have thermal energy.
chemical	Anything that can release energy during a chemical reaction.
elastic potential	Things that are stretched.
gravitational potential	Anything that is raised.
electrostatic	Charges that attract or repel.
magnetic	Magnets that attract or repel.
nuclear	The nucleus of an atom releases energy.

Energy can be transferred in the following ways:

mechanically – when work is done;

electrically – when moving charge does work;

heating – when energy is transferred from a hotter object to a colder object.

Conservation of Energy

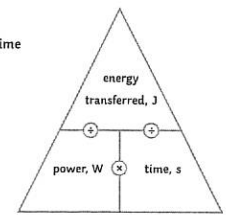
Energy can never be created or destroyed, just transferred from one form to another. Some energy is transferred usefully and some energy gets transferred into the environment. This is mostly wasted energy.

Power

Power is the rate of transfer of energy – the amount of work done in a given time.

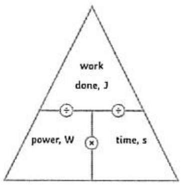
power = energy transferred ÷ time

P (W) = E (J) ÷ t (s)



power = work done ÷ time

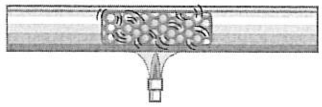
P (W) = W (J) ÷ t (s)



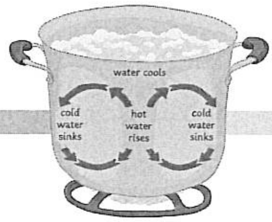
Energy Transfer

Lubrication reduces the amount of friction. When an object moves, there are frictional forces acting. Some energy is lost into the environment. Lubricants, such as oil, can be used to reduce the friction between the surfaces.

Conduction – when a solid is heated, the particles vibrate and collide more, and the energy is transferred.

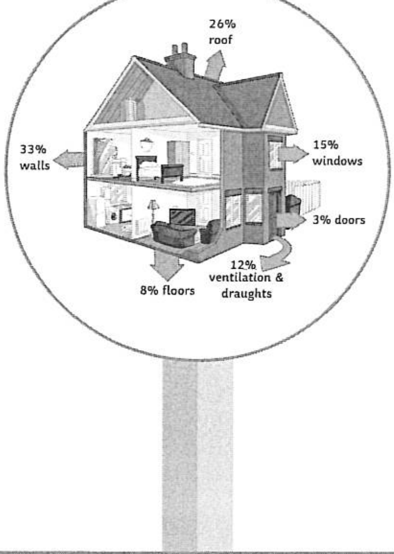


Convection – when a liquid or a gas is heated, the particles move faster. This means the liquid or gas becomes less dense. The denser region will rise above the cooler region. This is a convection current.



Insulation – reduces the amount of heat lost. In your home, you can prevent heat loss in a number of ways:

- thick walls;
- thermal insulation, such as:
- loft insulation (reducing convection);
- cavity walls (reduces conduction and convection);
- double glazing (reduces conduction).

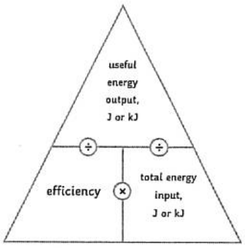


Efficiency

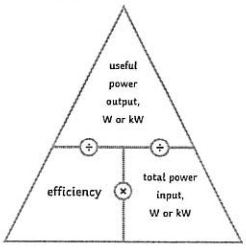
When energy is transferred, some energy is wasted. The less energy that is wasted during the transfer, the more efficient the transfer.

There are two equations to calculate efficiency:

$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$



$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$



Some energy is always wasted. Nothing is 100% efficient.

Efficiency

Non-renewable – coal, oil, gas - they will all run out, they damage the environment, but provide most of the energy.

Renewable – they will never run out, can be unreliable and do not provide as much energy.

Energy Resource	Advantages	Disadvantages
solar – using sunlight	Renewable, no pollution, in sunny countries it is very reliable.	Lots of energy needed to build, only works during the day, cannot increase power if needed.
geothermal – using the energy of hot rocks	Renewable and reliable as the rocks are always hot. Power stations have a small impact on environment.	May release some greenhouse gases and only found in specific places.
wind – using turbines	Renewable, no pollution, no lasting damage to the environment, minimal running cost.	Not as reliable, do not work when there is no wind, cannot increase supply if needed.
hydroelectric – uses a dam	Renewable, no pollution, can increase supply if needed.	A big impact on the environment. Animals and plants may lose their habitats.
wave power – wave powered turbines	Renewable, no pollution.	Disturbs the seabed and habitats of animals. Unreliable.
tidal barrages – big dams across rivers	Renewable, very reliable, no pollution.	Changes the habitats of wildlife, fish can be killed in the turbines.
biofuels	Renewable, reliable, carbon neutral.	High costs, growing biofuels may cause a problem with regards to space, clearance of natural forests.
non-renewable – fossil fuels	Reliable, enough to meet current demand, can produce more energy when there is more demand.	Running out, release CO_2, leading to global warming, and also release SO_2 which causes acid rain.

Trends in energy resources – most of our electricity is generated by burning fossil fuels and nuclear. The UK is trying to increase the amount of renewable energy resources. The governments are aware that non-renewable energy resources are running out; targets of renewable resources have been set. Electric and hybrid cars are also now on the market.

However, changing the fuels we use and building renewable power plants cost money. Many people are against the building of the plants near them and do not want to pay the extra in their energy bills. Hybrid and electric cars are also quite expensive.

AQA Combined Science: **Physics Topic 2 Electricity – Foundation and Higher**

Required Practical

Investigating Resistance in a Wire

Independent variable: length of the wire.

Dependent variable: resistance.

Control variables: type of metal, diameter of the wire.

Conclusion: As the length of the wire increases, the resistance of the wire also increases.

Investigating Series and Parallel Circuits with Resistors

Independent variable: circuit type (series, parallel).

Dependent variable: resistance.

Control variables: number of resistors, type of power source.

Conclusion: Adding resistors in series increases the total resistance of the circuit. In a parallel circuit, the more resistors you add, the smaller the resistance.

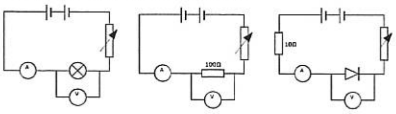
Investigating I-V Relationships in Circuits (Using a filament bulb, ohmic conductor, diode.)

Independent variable: potential difference/volts (V).

Dependent variable: current (A).

Control variable: number of components (e.g. 1 filament bulb, 1 resistor), type of power source.

Set up the circuits as shown below and measure the current and the potential difference.



Draw graphs of the results once collected.

Equations and Maths

Equations

Charge:	$Q = It$
Potential difference:	$V = IR$
Energy transferred:	$E = Pt$
Energy transferred:	$E = QV$
Power:	$P = VI$
Power:	$P = I^2R$

Maths

1kW = 1000W

0.5kW = 500W

Charge

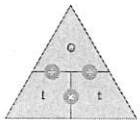
Electric current is the flow of electric charge. It only flows when the circuit is complete.

The **charge** is the current flowing past a point in a given time. Charge is measured in **coulombs (C)**.

Calculating Charge

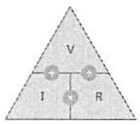
charge flow (C) = current (A) × time (s)

$Q = It$



potential difference = current x resistance

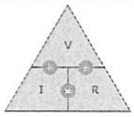
V (V) = I (A) × R (Ω)



Resistance

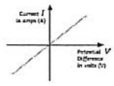
voltage (V) = current (A) × resistance (Ω)

V = IR

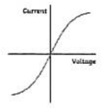


Graphs of I-V Characteristics for Components in a Circuit

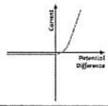
1. **Ohmic conductor**: the current is directly proportional to the potential difference - it is a straight line (at a constant temperature).



2. **Filament lamp**: as the current increases, so does the temperature. This makes it harder for the current to flow. The graph becomes less steep.



3. **Diode**: current only flows in one direction. The resistance is very high in the other direction which means no current can flow.



Current and Circuit Symbols

Current: the flow of electrical charge.

Potential difference (voltage): the push of electrical charge.

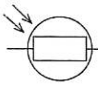
Resistance: slows down the flow of electricity.

cell		closed switch		fuse	
resistor		ammeter	A	LDR	
battery		voltmeter	V	LED	
variable resistor		bulb		thermistor	
open switch		diode			

AQA Combined Science: **Physics Topic 2 Electricity – Foundation and Higher**

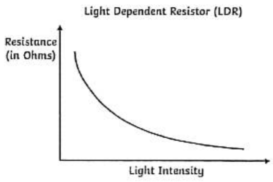
Circuit Devices

LDR – Light Dependent Resistor

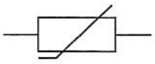


An LDR is dependent on light intensity. In bright light the resistance falls and at night the resistance is higher.

Uses of LDRs: outdoor night lights, burglar detectors.

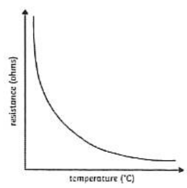


Thermistor



A thermistor is a temperature dependent resistor. If it is hot, then the resistance is less. If it becomes cold, then the resistance increases.

Uses of thermistors: temperature detectors.



Series and Parallel Circuits

Series Circuits

Once one of the components is broken then all the components will stop working.

Potential difference – the total p.d. of the supply is shared between all the components.

$V_{total} = V_1 + V_2$

Current – wherever the ammeter is placed in a series circuit the reading is the same.

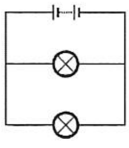
$I_1 = I_2 = I_3$

Resistance – In a series circuit, the resistance will add up to make the total resistance.

$R_{total} = R_1 + R_2$

Parallel Circuits

They are much more common - if one component stops working, it will not affect the others. This means they are more useful.



Potential Difference – this is the same for all components.

$V_1 = V_2$

Current – the total current is the total of all the currents through all the components.

$I_{total} = I_1 + I_2 + I_3$

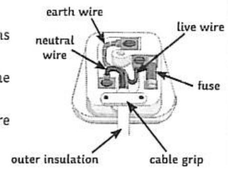
Resistance – adding resistance reduces the total resistance.

Electricity in the Home

AC – alternating current. Constantly changing direction - UK mains supply is 230V and has a frequency of 50 hertz (Hz).

DC – direct current. Supplied by batteries and only flows in one direction.

Cables – most have three wires: live, neutral and earth. They are covered in plastic insulation for safety.



Live wire – provides the potential difference from the mains.

Neutral wire – completes the circuit.

Earth wire – protection. Stops the appliance from becoming live. Carries a current if there is a fault.

Touching the live wire can cause the current to flow through your body. This causes an electric shock.

Energy Transferred – this depends on how long the appliance is on for and its power.

energy transferred (J) = power (W) × time (s) $E = Pt$

Energy is transferred around a circuit when the charge moves.

energy transferred (J) = charge flow (C) × potential difference (V) $E = QV$

power (W) = potential difference (V) × current (A) $P = VI$

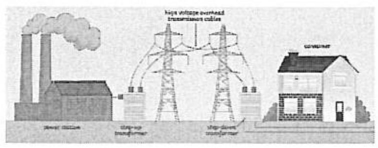
power (W) = current² (A) × resistance (Ω) $P = I^2R$

The National Grid

The National Grid is a system of cables and transformers. They transfer electrical power from the power station to where it is needed. Power stations are able to change the amount of electricity that is produced to meet the demands. For example, more energy may be needed in the evenings when people come home from work or school. Electricity is transferred at a low current, but a high voltage so less energy is being lost as it travels through the cables.

Step-up transformers – increase the voltage as the electricity flows through the cables.

Step-down transformers – decrease the potential difference to make it safe.



AQA Combined Science: **Physics Topic 3 Particle Model of Matter**

Required Practical

Measuring the density of a regularly shaped object:

- Measure the mass using a balance.
- Measure the length, width and height using a ruler.
- Calculate the volume.
- Use the density (ρ = m/V) equation to calculate density.

Measuring the density of an irregularly-shaped object:

- Measure the mass using a balance.
- Fill a eureka can with water.
- Place the object in the water - the water displaced by the object will transfer into a measuring cylinder.
- Measure the volume of the water. This equals the volume of the object.
- Use the density (ρ = m/V) equation to calculate density.

Density

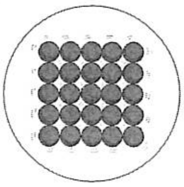
Density is a measure of how much mass there is in a given space.

Density (kg/m³) = mass (kg) ÷ volume (m³)

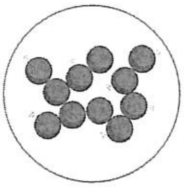
A more dense material will have more particles in the same volume when compared to a less dense material.

Particles

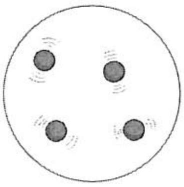
Solids have strong forces of attraction. They are held together very closely in a fixed, regular arrangement. The particles do not have much energy and can only vibrate.



Liquids have weaker forces of attraction. They are close together, but can move past each other. They form irregular arrangements. They have more energy than particles in a solid.



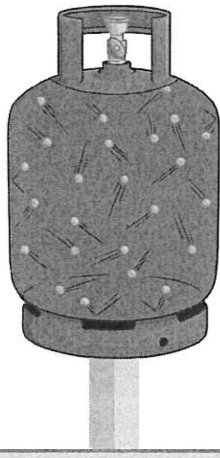
Gases have almost no forces of attraction between the particles. They have the most energy and are free to move in random directions.



Particles

Gas particles can move around freely and will collide with other particles and the walls of the container. This is the pressure of the gas.

If the temperature of the gas increases, then the pressure will also increase. The hotter the temperature, the more kinetic energy the gas particles have. They move faster, colliding with the sides of the container more often.



Density

The density of an object is 8050kg/m³ and it has a volume of 3.4m³ - what is its mass in kg?

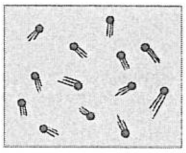
8050 = mass ÷ 3.4

8050 × 3.4 = mass

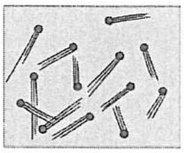
27 370kg

Internal Energy

Particles within a system have kinetic energy when they vibrate or move around. The particles also have a potential energy store. The total internal energy of a system is the kinetic and potential energy stores.



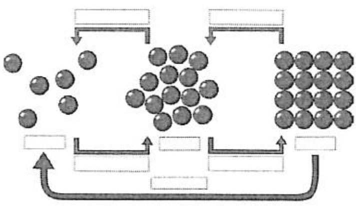
Low Temperature



High Temperature

If the system is heated, the particles will gain more kinetic energy, so increasing the internal energy.

Changing State

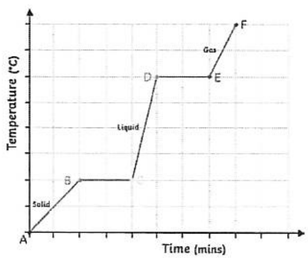


If a system gains more energy, it can lead to a change in temperature or change in state. If the system is heated enough, then there will be enough energy to break bonds.

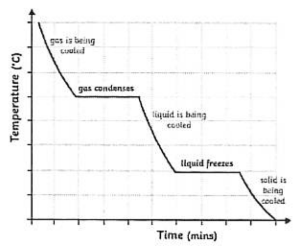
When something changes state, there is no chemical change, only physical. No new substance is formed. The substance will change back to its original form. The number of particles does not change and mass is conserved.

Specific Latent Heat

Energy is being put in during melting and boiling. This increases the amount of internal energy. The energy is being used to break the bonds, so the temperature does not increase. This is shown by the parts of the graph that are flat.



When a substance is condensing or freezing, the energy put in is used to form the bonds. This releases energy. The internal energy decreases, but the temperature does not go down.



The energy needed to change the state of a substance is called the latent heat.

Specific latent heat is the amount of energy needed to change 1kg of a substance from one state to another without changing the temperature. Specific latent heat will be different for different materials.

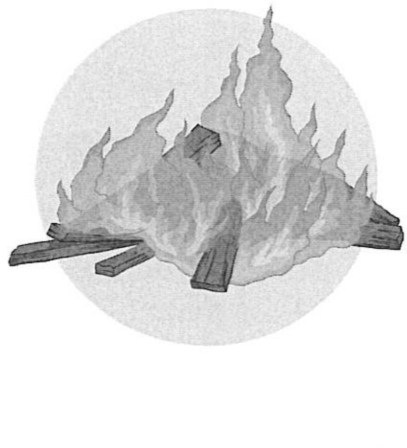
- solid ⟶ liquid - specific latent heat of **fusion**
- liquid ⟶ gas - specific latent heat of **vaporisation**

Specific Latent Heat Equation

The amount of energy needed/released when a substance of mass changes state.

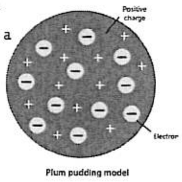
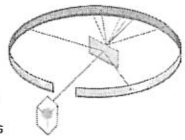
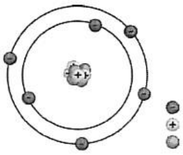
energy (E) = mass (m) × specific latent heat (L)

$E = mL$



Atomic Structure Knowledge Organiser – Foundation and Higher

Developing the Model of the Atom

Scientist	Time	Contribution
John Dalton	Start of 19th century	Atoms were first described as solid spheres.
JJ Thomson	1897	Thomson suggested the plum pudding model – the atom is a ball of charge with electrons scattered within it. 
Ernest Rutherford	1909	Alpha Scattering experiment – Rutherford discovered that the mass is concentrated at the centre and the nucleus is charged. Most of the mass is in the nucleus. Most atoms are empty space. 
Niels Bohr	Around 1911	Bohr theorised that the electrons were in shells orbiting the nucleus. 
James Chadwick	Around 1940	Chadwick discovered neutrons in the nucleus.

Isotopes

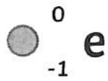
An isotope is an element with the same number of protons but a different number of neutrons. They have the same atomic number, but different mass numbers.

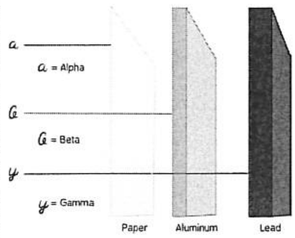
Isotope	Protons	Electrons	Neutrons
$^{1}_{1}H$	1	1	0
$^{2}_{1}H$	1	1	1
$^{3}_{1}H$	1	1	2

Some isotopes are unstable and, as a result, decay and give out radiation. Ionising radiation is radiation that can knock electrons off atoms. Just how ionising this radiation is, depends on how readily it can do that.

Beta

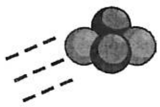
Beta radiation is a fast moving electron that can be stopped by a piece of aluminium. Beta radiation is emitted by an atom when a neutron splits into a proton and an electron.





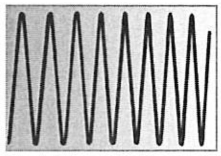
Alpha

Alpha radiation is an alpha particle emitted from the nucleus of a radioactive nuclei. It is made from two protons and two neutrons. They can't travel too far in the air and are the least penetrating – stopped by skin and paper. However, they are highly ionising because of their size.



Gamma

A gamma wave is a wave of radiation and is the most penetrating – stopped by thick lead and concrete.



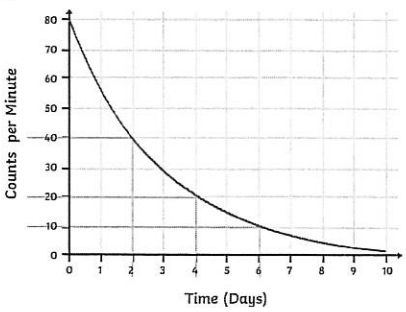
Half-life

The half-life is the time taken for the number of radioactive nuclei in an isotope to halve.

Radioactivity is a random process – you will not know which nuclei will decay. Radioactive decay is measured in becquerels Bq. 1 Bq is one decay per second.

Radioactive substances give out radiation from their nucleus.

A graph of half-life can be used to calculate the half-life of a material and will always have this shape:



Judging from the graph, the radioactive material has a half-life of two days.

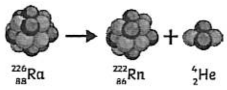
Irradiation

Irradiation occurs when materials are near a radioactive source. The source is sometimes placed inside a lead-lined box to avoid this.

People who work with radioactive sources will sometimes stand behind a lead barrier, be in a different room or use a remote-controlled arm when handling radioactive substances.

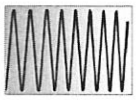
Alpha Decay Equations

An alpha particle is made of two protons and two neutrons. The atomic number goes down by two and its mass number decreases by four.



Gamma rays

There is no change to the nucleus when a radioactive source emits gamma radiation. It is the nucleus getting rid of excess energy.



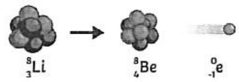
Contamination

When unwanted radioactive atoms get onto an object, it is possible for the radioactive particles to get inside the body.

Protective clothing should be worn when handling radioactive material.

Beta Decay Equations

A neutron turns into a proton and releases a an electron. The mass of the nucleus does not change but the number of protons increases.



Alpha radiation is more dangerous inside the body. It is highly ionising and able to cause a lot of damage. Outside the body it is less dangerous because it cannot penetrate the skin.

Beta radiation is less dangerous inside the body as some of the radiation is able to escape. Outside the body it is more dangerous as it can penetrate the skin.

Gamma radiation is the least dangerous inside the body as most will pass out and it is the least ionising. Gamma is more dangerous outside the body as it can penetrate the skin.

Q1.

Figure 1 shows a mobile phone with its battery removed.

Figure 1

A student measured the potential difference across the battery and then put the battery into the phone.

(a) What is the equation linking current (I), potential difference (V) and resistance (R)?

Tick (✓) **one** box.

- $I = V R$ ☐
- $R = I V$ ☐
- $V = I R$ ☐
- $V = I_2 R$ ☐

(1)

(b) The current in the electronic circuit in the mobile phone was 0.12 A.

The potential difference across the battery was 3.9 V.

Calculate the resistance of the electronic circuit in the mobile phone.

Resistance = ______________ Ω

(3)

(c) Write down the equation which links energy (E), power (P) and time (t).

(1)

(d) The battery was fully charged when it was put into the mobile phone.

The battery discharged when the mobile phone was switched on.

The average power output of the battery as it discharged was 0.46 watts.

The time taken to fully discharge the battery was 2500 minutes.

Calculate the energy transferred by the battery.

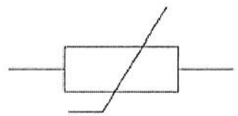
Energy transferred = ______________ J

(3)

The mobile phone includes a sensor to monitor the temperature of the battery.

Figure 2 shows the circuit symbol for a component used in the sensor.

Figure 2



(e) What component does the circuit symbol shown in **Figure 2** represent?

(1)

(f) The temperature of the component in **Figure 2** increases.

The potential difference across the component remains constant.

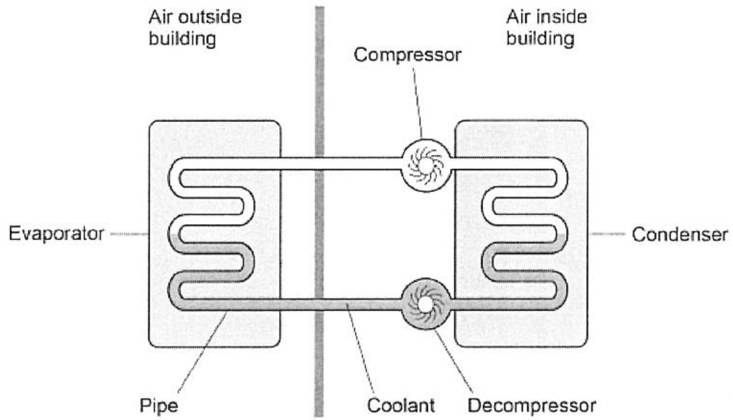
Explain what happens to the current in the component.

(2)
(Total 11 marks)

Q2.

An air source heat pump transfers energy from the air outside a building to increase the temperature of the air inside the building.

The figure below shows an air source heat pump.



The compressor is connected to the mains electricity supply.

The pipe in the heat pump contains a substance called coolant.

In the evaporator, energy is transferred from the air outside the building to the liquid coolant.

The temperature of the coolant increases and it evaporates.

(a) Explain what happens to the internal energy of the coolant as its temperature increases.

(2)

(b) What name is given to the energy needed to change the state of the liquid coolant?

(1)

(c) What happens to the mass of the coolant as it evaporates and becomes a vapour?

Tick (✓) **one** box.

Decreases ☐

Stays the same ☐

Increases ☐

(1)

(d) The compressor increases the density and temperature of the coolant vapour inside the pipe.

Explain why the pressure in the pipe increases.

(2)

(e) The condenser transfers energy from the coolant to the air in the building.

When the total energy input to the heat pump system is 1560 kJ the temperature of the air in the building increases from 11.6 °C to 22.1 °C.

The efficiency of the heat pump system is 87.5%.

The mass of the air inside the building is 125 kg.

Calculate the specific heat capacity of the air in the building.

Give your answer in standard form.

Specific heat capacity (standard form) = ______________ J/kg °C

(6)

(f) The air in the building gains 400 J for every 100 J of energy transferred from the mains electricity supply to the compressor.

An advertisement claims that the heat pump system has an efficiency of 400%.

Explain why the advertisement is **not** correct.

(3)

(Total 15 marks)

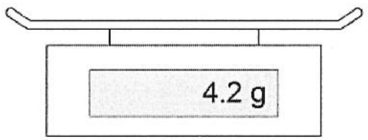
Q3.

A student determined the density of a cube made of bronze.

The student used a balance to measure the mass of the bronze cube.

Figure 1 shows the balance before the cube was added.

Figure 1



(a) What type of error is shown on the balance?

(1)

(b) How could the student get a correct value for the mass of the cube from the balance?

(1)

(c) The student measured the length of the bronze cube using Vernier callipers and then using a micrometer.

Table 1 shows the results.

Table 1

Equipment	Length in mm
Vernier callipers	20.1
Micrometer	20.14

Complete the sentence.

The results in **Table 1** show that the Vernier callipers and the micrometer have a different ________________.

(1)

The student wanted to determine the density of a bronze coin.

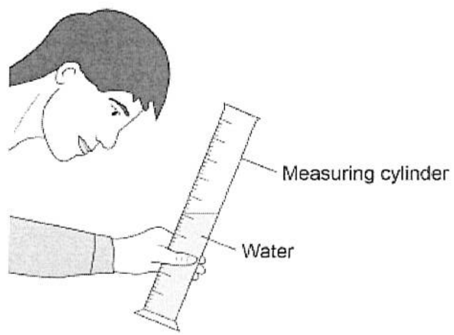
The student had several identical coins.

The volume of each coin was very small.

(d) The student added water to a measuring cylinder.

Figure 2 shows the student reading the volume of water in the measuring cylinder.

Figure 2



Give **two** changes the student should make to increase the accuracy of the volume measurement.

1 ____

____

2 ____

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(2)

(e) Describe how the student could use a displacement method to determine an accurate value for the volume of a single coin.

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(3)

(f) Old penny coins were made from a disc of bronze.

New penny coins are made from a disc of a different metal.

Figure 3 shows a disc of metal.

Figure 3

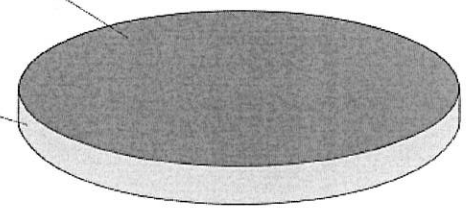

Table 2 shows information about the discs used to make each coin.

Table 2

Disc	Mass in g	Density in g/cm³	Thickness in cm
Old penny	3.6	8.9	0.16
New penny	3.6	**X**	0.17

The discs used to make the old and the new coins have the **same** cross-sectional area.

Calculate value **X** in **Table 2**.

Give your answer to 2 significant figures.

The volume of a disc can be calculated using the equation:

volume of a disc = cross-sectional area × thickness

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Density (2 significant figures) = ______________ g/cm^3

(5)

(Total 13 marks)

Q4.

Different radioactive isotopes emit different types of nuclear radiation.

A polonium-210 (Po) nucleus emits an alpha particle (α) and turns into a lead (Pb) nucleus.

This can be represented by the equation:

$$^{210}_{84}Po \longrightarrow ^{A}_{Z}Pb + \alpha$$

(a) What is the value of A in the equation?

Tick (✓) **one** box.

A = 206 ☐ A = 208 ☐ A = 210 ☐ A = 211 ☐

(1)

(b) What is the value of Z in the equation?

Tick (✓) **one** box.

Z = 80 ☐ Z = 82 ☐ Z = 85 ☐ Z = 86 ☐

(1)

(c) A strontium-89 nucleus (Sr) emits a beta particle (β) and turns into an yttrium nucleus (Y).

This can be represented by the equation:

$$^{89}_{38}Sr \longrightarrow {}^{A}_{Z}Y + \beta$$

What are the values of A and Z in the equation?

A = ____________________

Z = ____________________

(2)

(d) Gamma radiation is another type of nuclear radiation.

What does gamma radiation consist of?

Tick (✓) **one** box.

High energy neutrons	☐
Electromagnetic waves	☐
Particles with no charge	☐
Positively charged ions	☐

(1)

(e) Explain the differences between the properties of alpha, beta and gamma radiations.

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(6)

(Total 11 marks)

Q5.

A student modelled radioactive decay by rolling some dice in a tray.

Dice that landed on the number six were removed from the tray.

The removed dice represent nuclei that have decayed.

(a) Why is rolling dice a suitable model for radioactive decay?

____

____

(1)

(b) The student rolled 144 dice and removed all those that landed on the number six.

The student rolled the remaining dice and again removed all those that landed on the number six.

When the student had rolled the dice 20 times there were 9 dice left.

Calculate the most likely number of times that the student had rolled the dice before the number of dice had halved.

You should show how you work out your answer.

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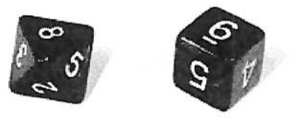
Answer = ______________ rolls of the dice

(3)

(c) The number of times the dice have to be rolled to halve the original number of dice in the tray represents the half-life.

The image below shows an eight-sided dice and a six-sided dice.



The student now used eight-sided dice to model radioactive decay. Dice that landed on the number six were again removed from the tray.

The half-life represented by rolling eight-sided dice is likely to be different from the half-life represented by rolling six-sided dice.

Explain how.

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(2)

(d) A teacher has two radioactive sources, **A** and **B**.

Source **A** has a longer half-life than source **B**.

What can be deduced about the nuclei in source **A** compared with the nuclei in source **B**?

Do **not** refer to isotopes in your answer.

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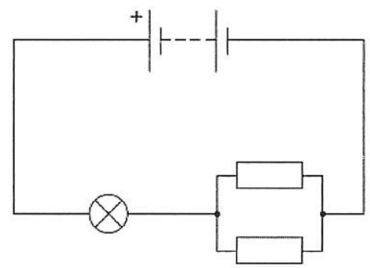
____

(1)
(Total 7 marks)

Q6.

Figure 1 shows a circuit that a student built.

Figure 1



(a) The lamp has a resistance of 10 Ω

Each resistor has a resistance of 10 Ω

What is the total resistance of the circuit?

Tick (✓) **one** box.

Between 20 and 30 Ω ☐

Exactly 20 Ω ☐

Exactly 30 Ω ☐

Less than 20 Ω ☐

(1)

(b) Explain your answer to part (a).

____

____

____

____

(2)

The student replaced one of the resistors with a thermistor.

(c) Draw the circuit symbol for a thermistor in the box below.

(1)

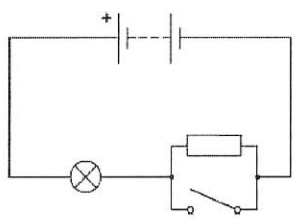
(d) The student increased the temperature of the thermistor.

Explain how the current in the thermistor changed.

(2)

(e) **Figure 2** shows another circuit the student built.

Figure 2



Explain how the potential difference across the resistor and the lamp will change when the switch is closed.

The resistor

The lamp

(4)
(Total 10 marks)

Q7.

Ice cream is made by cooling a mixture of liquid ingredients until they freeze.

(a) Which statement describes the motion of the particles in solid ice cream?

Tick (✓) **one** box.

They are stationary. ☐

They move freely. ☐

They vibrate about fixed positions. ☐

(1)

(b) How do the kinetic energy and the potential energy of the particles change as a liquid is cooled and frozen?

Tick (✓) **one** box.

Kinetic energy	Potential energy	
Decreases	Decreases	☐
Decreases	Does not change	☐
Does not change	Decreases	☐
Does not change	Does not change	☐

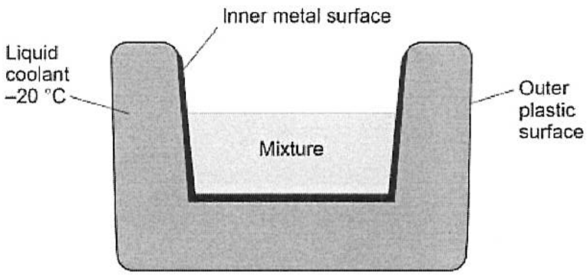
(1)

The diagram below shows a bowl used for making ice cream.

The walls of the bowl contain a liquid coolant.

The bowl is cooled to –20 °C before the mixture is put in the bowl.

The bowl causes the mixture to cool down and freeze.



(c) Explain why the different thermal conductivities of metal and plastic are important in the design of the bowl.

Metal ______________________________

Plastic ______________________________

(4)

(d) The liquid coolant has a freezing point below –20 °C

Explain **one** other property that the liquid coolant should have.

(2)

(e) The initial temperature of the mixture was +20 °C. The mixture froze at –1.5 °C.

A total of 165 kJ of internal energy was transferred from the mixture to cool and freeze it.

specific heat capacity of the mixture = 3500 J/kg °C

specific latent heat of fusion of the mixture = 255 000 J/kg

Calculate the mass of the mixture.

Give your answer to 2 significant figures.

Mass (2 significant figures) = ______________ kg

(6)

(Total 14 marks)

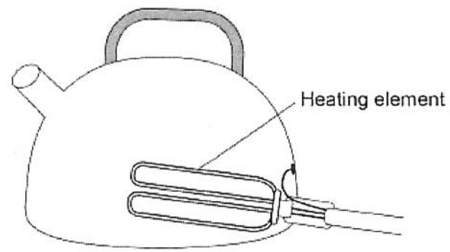
Q8.

A student investigated how the mass of water in an electric kettle affected the time taken for the water to reach boiling point.

The kettle switched off when the water reached boiling point.

Figure 1 shows the kettle.

Figure 1



(a) The heating element of the kettle was connected to the mains supply.

Explain why the temperature of the heating element increased.

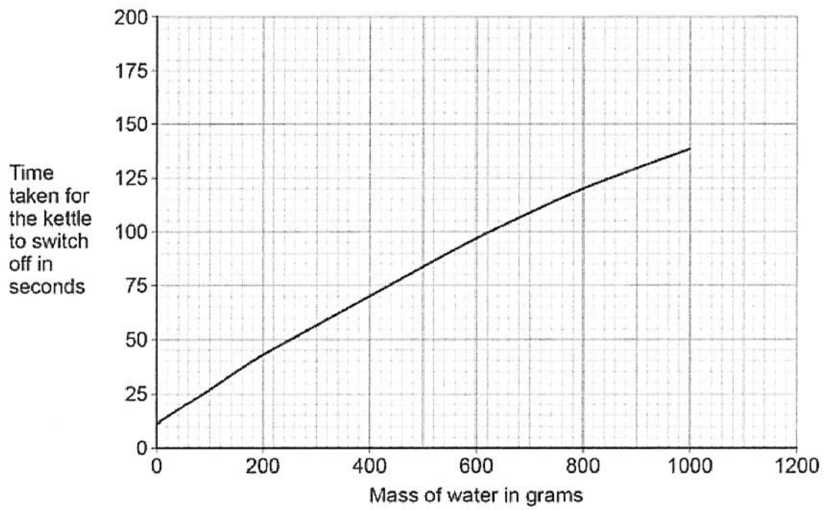
(2)

(b) Give **one** variable that the student should have controlled.

(1)

Figure 2 shows how the mass of water in the kettle affected the time taken for the kettle to switch off.

Figure 2



(c) Suggest why the line on **Figure 2** does **not** go through the origin.

(1)

(d) Suggest why the results give a non-linear pattern.

(1)

(e) The power of the kettle was 2.6 kW

The kettle took 120 seconds to heat 0.80 kg of water from 18 °C to 100 °C

Calculate the specific heat capacity of water using this information.

Give your answer to 2 significant figures.

Specific heat capacity = ____________ J/kg °C

(6)

(Total 11 marks)

Q9.

The photograph below shows a sailing boat crossing an ocean.

There is a wind turbine on the boat.

(a) The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

____

(1)

(b) The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

1 ____

____

2 ____

____

(2)

(c) Explain **one** environmental impact of using fossil fuels to generate electricity.

____

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(2)

(d) The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

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Speed = _______________ m/s

(4)

(e) As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

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____

____

Change in height = _______________ m

(3)

(Total 12 marks)

Q10.

A radioactive source emits alpha, beta and gamma radiation.

(a) An alpha particle is the same as a helium nucleus.

How many times bigger is the radius of a helium atom than the radius of an alpha particle?

Tick (✓) **one** box.

Less than 100 times bigger	☐
Exactly 5000 times bigger	☐
More than 10 000 times bigger	☐

(1)

(b) Alpha particles can ionise atoms in the air.

What happens to an atom when it is ionised by an alpha particle?

Tick (✓) **two** boxes.

A neutron in the atom becomes a proton.	☐
The atom becomes a positive ion.	☐
The atom gains a neutron.	☐
The atom gains a proton.	☐
The atom loses an electron.	☐

(2)

(c) A spark detector is a device that can be used to detect alpha radiation.

A spark detector works by alpha particles ionising atoms in the air near a wire mesh.

A large potential difference creates a spark when the air near the wire mesh is ionised.

Suggest why a spark detector **cannot** detect beta radiation.

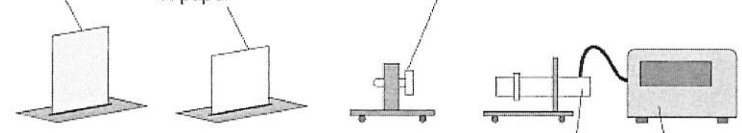
___

___

(1)

(d) A teacher wants to demonstrate that the radioactive source emits alpha, beta and gamma radiation.

The figure below shows the equipment the teacher has.



Describe a method the teacher could use.

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(6)
(Total 10 marks)