PHYSICS PAPER 1: Energy

Facts: Energy stores and systems

1.System	An object or a group of objects
3. Kinetic energy store	In **moving** objects.
4. Thermal energy store	**In hot objects.** The **hotter** the object, the **more** energy in the store.
5. Chemical	Anything that can **release energy** by a **chemical reaction** (e.g. food and fuels).
6. Gravitational potential energy store	Any object **raised above ground level.**
7. Elastic	Anything that is **stretched or squashed.**
8. Electrostatic	Two **charges** that **attract or repel** each other.
9. Magnetic	Two **magnets** that **attract or repel** each other.
10. Nuclear energy store	Energy released from the **nucleus of an atom** during nuclear reactions.

Facts: Energy pathways

11. Mechanically	When a **force does work** on an object, energy is transferred **mechanically.**
12. Electrically	When a **moving charge does work**, energy is transferred **electrically.**
13. Heating	Energy is transferred **by heating** when a hot object passes its energy to a cooler object.
14. Radiation	When **waves do work**, energy is transferred **by radiation** (e.g. sound or light).

Facts: Changes in energy equations

15. Kinetic energy (J) =	0.5 x mass (kg) x velocity^2 (m/s)
16. Elastic potential energy (J) =	0.5 x spring constant (N/m) x extension2 (m)
17. Gravitational potential energy (J) =	mass (kg) x gravitational field strength (N/kg) x height (m)

Facts: Heat transfer

18. Specific Heat Capacity (SHC)	The energy required to raise the temperature of 1kg of a substance by 1^{o}C.
19. Change in thermal energy	Change in thermal energy (J) = mass (kg) x SHC (J/kg) x temperature change Δθ (^{o}C).

Facts: Work done and power

20. Work done	The amount of energy transferred. Measured in Joules (J).
21. Work done equation	Work done (J) = Force (N) x distance moved (m).
22. Power	The rate at which energy is transferred or rate at which work is done. Measured in Watts (W).

23. Power equations	energy (J) ÷ time (s)	work done (J) ÷ time (s)

Facts: Conservation of energy

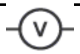
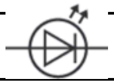
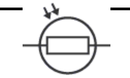
24. Conservation	Energy cannot be created or destroyed but it can be transferred, stored or dissipated.
25. Efficiency	How much energy is usefully transferred. Always between 0% and 100%.
26. Equations	Efficiency = useful energy output ÷ total energy input Efficiency = useful power output ÷ total power input
27. Dissipated	**Wasted energy** transferred into the **surroundings. Warms** it up.
28. Reducing wasted energy	Insulation and lubrication of moving parts with oil.

Facts: Energy resources

29. Uses	Transport, electricity generation and heating
30. 3 fossil fuels	Coal, oil and gas
31. Renewable	Can be replaced as it is used
32. Non-renewable	Cannot be replaced as it is used
33. Fossil fuels (non-renewable)	A: reliable, concentrated energy source
	D: non-renewable, gives out carbon dioxide (global warming)
34. Nuclear fuel (non–renewable)	A: reliable, no carbon dioxide given off
	D: non-renewable, expensive setup cost, produces radioactive nuclear waste, risk of meltdown
35. Bio-fuel (renewable)	A: carbon neutral - no net carbon emissions
	D: uses a lot of land, drives up food prices
36. Wind (renewable)	A: no carbon dioxide given off
	D: unreliable, noise pollution, eyesore
37. Hydroelectric (renewable)	A: no carbon dioxide given off
	D: expensive setup cost, unreliable, damages habitats
38. Geothermal (renewable)	A: no carbon dioxide given off, reliable
	D: geothermal energy only works in certain parts of the world
39. Tidal (renewable)	A: no carbon dioxide given off
	D: destroy the habitat, only works when tides go down
40. Solar (renewable)	A: no carbon dioxide given off
	D: unreliable (only works when its sunny)
41. Wave (renewable)	A: no carbon dioxide given off
	D: expensive setup cost, unreliable

Knowledge navigator: Electricity

Circuit symbols

1.Cell	Store of chemical energy	
2.Battery	2 or more cells in series	
3.Switch	Completes a circuit or breaks a circuit	
4.Filament lamp	Lights when current flows	
5.Ammeter	Measure current in amps (A)	
6.Voltmeter	Measure potential difference in volts (V)	
7.Diode	Current flows in one direction	
8.Light Emitting Diode	Emits light when current flows	
9.Light Dependent Resistor	Resistance decreases as light intensity increases.	
10.Fuse	Wire Melts and breaks when current is too high	
11.Resistor	Affects the size of current flowing	
12.Variable resistor	Allows current to be varied	
13.Thermistor	Resistance is dependent on temperature	

Circuits

14.Series (A circuit with one loop)	Current is the same in all components.
	Total potential difference is shared between all the components.
	Total resistance is the sum of each component's resistance.
15.Parallel (A circuit with 2 or more loops)	Total current is the sum of each component's current.
	Potential difference across all components is the same.
	Total resistance is less than the resistance value of the smallest individual resistor.
16.Ammeter	Placed in series in a circuit.
17.Voltmeter	Placed in parallel across a component.

Electric current

18.Current	Rate of flow of electrical charge
19.Charge	Charged particles experience a force in an electric field. e.g., electrons are negatively charged particles
20.Charge Equation	Charge = Current x time (C) (A) (s)

Resistance

21.Resistance	A measure of how hard it is for electricity to flow.
22.Thermistor	Resistance decreases as temperature increases.
23.LDR	Resistance decreases as light increases.
24.Resistance Equation	Voltage = Current X Resistance (V) (A) (Ω)

I-V Characteristics

25.Ohmic conductor	Provided the temperature remains constant, current is directly proportional to the potential difference across the resistor.
26.Filament lamp	As current increases, the resistance increases. The temperature increases as current flows.
27.Diode	Current flows when potential difference flows forward. Very high resistance in reverse direction.

3 Pin Plug

28.Live	Brown. Carries potential difference from mains supply (230V).
29.Neutral	Blue. Completes the circuit (0V).
30.Earth	Green and Yellow. Safety wire: Only carries current if there is a fault (0V).
31.Mains supply	Frequency 50Hz, 230V

Energy Transfer

32.Energy is transferred to a resistor when current flows through it and heats it up.

33.Power	Is the energy transferred per second, measured in Watts (W)
34.P = IV	Power = Current X Voltage
35.E = Pt	Energy = Power x Time
36.$P = I^2 X R$	Power = $(\text{Current})^2$ X Resistance

The National Grid

37.Distributes electricity generated in power stations around the UK

38.Alternating current	Potential difference changes direction e.g. generators and mains supply provide alternating currents.
39.Direct current	Potential difference remains in one direction e.g. batteries provide direct current.
40.Step up transformer	Increases voltage and reduces current.
41.Step down transformer	Decreases voltage and increase current.

Knowledge navigator: Particle model of matter

Facts: States of matter

1. States of matter	The three forms in which a substance can exist. These are **solid**, **liquid** and **gas**.		
2. Particles	A **small piece of matter** e.g. atoms, ions or molecules.		
3. Particle model	A **theory** that describes the **arrangement**, **movement** and **energy** of particles. This is used to explain the **physical properties** of solids, liquids and gases.		
	Arrangement	**Movement**	**Energy/Forces**
4. Solid particle model	**Very close**, all **touching** in a **regular** pattern.	**Vibrate** around a fixed position.	**Low** energy. **Strong forces** between particles.
5. Liquid particle model	**Close**, all **touching** but **randomly** arranged.	**Move** around each other	**Moderate** energy. **Moderate forces** between particles.
6. Gas particle model	**Far apart**, **not touching**, **randomly** arranged.	**Move quickly** in all directions.	**High** energy. **Weak forces** between particles.
7. Solid properties	1. A **fixed shape** and **cannot flow** because particles **cannot move** only vibrate. 2. **Cannot be compressed** (squashed) because there is **no space** between the particles because they are **close together**,		
8. Liquid properties	1. **Flow** and **take the shape of their container** because particles can **move** around. 2. **Cannot be compressed** (squashed) because there is **no space** between the particles because they are **close together.**		
9. Gas properties	1. **Flow** and **fill a container** because particles **move quickly** in all directions. 2. **Can be compressed** because there is **space between** the particles because they are **far apart**.		
10. Change of state	When a substance changes from one state to another e.g. solid to liquid.		
11. Melting	A **solid** turns into a **liquid** when **heated**. Internal energy increases.		
12. Evaporation	A **liquid** turns into a **gas** when **heated.** Internal energy increases.		
13. Condensation	A **gas** turns into a **liquid** when **cooled**. Internal energy decreases.		
14. Freezing	A **liquid** turns into a **solid** when **cooled**. Internal energy decreases.		
15. Melting Point	Temperature at which a substance melts when heated or when it freezes when cooled. (ice/ water = 0^{o}C)		
16. Boiling Point	Temperature at which a substance boils when heated or when it condenses when cooled. (water/ water vapour = 100^{o}C)		

Facts: Internal energy

17. Internal energy	Total kinetic energy and potential energy of all the particles.
18. Kinetic energy	The speed of the particles. It increases with higher temperatures.
19. Potential energy	How far apart the particles are which is linked to the forces between the particles.
20. Specific heat capacity	The amount of energy needed to raise the temperature of 1kg of a material by 1°C.
21. Specific latent heat of fusion	The amount of energy needed to change 1kg of a solid into 1kg of a liquid with no change in temperature.
22. Specific latent heat of vaporisation	The amount of energy needed to change 1kg of a liquid into 1kg of a gas with no change in temperature.

Facts: Density of materials

23. Density	Mass of a substance in a given volume
24. Volume of a cube	Length x width x height
25. Density equation	Density (kg/m^3 or (g/cm^3) = mass (kg or g) ÷ volume (m^3 or cm^3)

Facts: Measuring the density of a regular object

26. Mass	1. Check top pan balance reads zero 2. Place the object on the scale and record mass
27. Volume	1. Use a ruler to measure the length, width and height 2. Multiply the 3 numbers together (length x width x height)
28. Density	Once you have mass and volume, density = mass ÷ volume

Facts: Measuring the density of an irregular object

29. Mass	1. Check top pan balance reads zero. 2. Place the object on the scale and record mass.
30. Volume 	1. Fill displacement can with water to the spout. 2. Place the can at the end of a table holding a measuring cylinder under the spout. 3. Gently submerge the object into can and wait for the water to pour out of the spout. 4. Measure the water collected in the measuring cylinder – this the volume of the object. 5. Now you have mass and volume, so density = mass ÷ volume

Knowledge navigator: atomic structure

The Structure of the Atom	
1.Atoms	Contain protons, neutrons, and electrons
2.Radius of an atom	1 x 10^{-10} m
3.Radius of the nucleus	1 x 10^{-14} m
4.Nucleus	Contains protons and neutrons, and makes up most of the mass of an atom, positively charged
5.Proton	Found in the nucleus with a +1 charge and a mass of 1
6.Neutron	Found in the nucleus with a 0 charge and a mass of 1
7.Electron	Arranged in different energy levels around the nucleus with a -1 charge and a mass of 0.0005
8.Electron moves up an energy level	By absorbing electromagnetic radiation
9.Electron moves down an energy level	By emitting electromagnetic radiation
Mass number, atomic number and isotopes	
10.Atomic number (small)	= number of protons (same for each element)
11.Mass number (large)	= number of protons + neutrons
12.Number of electrons	= number of protons (for neutral atoms)
13.Isotopes	An atom of the same element with the same number of protons (atomic number stays the same) but different number of neutrons (mass number changes)
14.Positive ion	Atom that has lost an electron (or electrons)
15.Negative ion	Atom that has gained an electron (or electrons)
Development of the Atom	
16.Democritus	Solid sphere model - Atoms are tiny spheres
17.JJ Thomson – 1897	Discovered the electron, a negatively charged particle, and invented plum pudding model of the atom.
18.Plum pudding model – JJ Thomson – 1904	Electrons randomly scattered like the plums in a plum pudding. Positive charges spread throughout the atom.
19.Geiger and Marsden – 1909 – Alpha particle Experiment	Directed beam of alpha particles (He^{2+}) at a thin sheet of gold foil. Found some travelled through, some were deflected, some bounced back.
20.Rutherford – 1911	Used evidence that alpha particles deflected to suggest existence of a very small positively charged nucleus and that most of the atom was empty space
21.Niels Bohr - 1913 (Bohr model)	Modern model - electrons orbit the nucleus as specific distances from the nucleus
James Chadwick - 1932	Discovered the neutron inside the nucleus.

Alpha, Beta and Gamma Radiation		
22.Alpha particles	Helium nucleus with 2 protons and 2 neutrons. Mass 4 and charge +2. Blocked by paper, skin and 3cm+ of air.	
23.Beta particles	High energy electron emitted from unstable nucleus, stopped by few mm of aluminium foil.	
24.Gamma rays	Electromagnetic wave, stopped by several cm of lead.	
25.Uses of radiation	Alpha: Smoke alarms	
	Beta: Thickness control of paper, medical tracer	
	Gamma: Sterilising food, sterilising medical equipment, medical tracer, treat cancer	
26.Radioactive decay	Is a random process in which unstable nuclei give out radiation to become stable	
27.Ionising radiation	Can knock electrons off atoms, damage DNA and cause cancer. (Alpha is the most ionising, beta in the middle, gamma is the least)	
28.Penetrating	How far the radiation can travel (Gamma is the most penetrating, beta in the middle, alpha is the least)	
Half Life		
29.Background radiation	Radiation given out by natural and man-made sources that is around us all the time in the background	
30.Origins of background radiation	Cosmic rays from the sun and stars, rocks, hospitals, nuclear power stations and food and drink	
31.Activity (Bq)	Amount of radiation emitted by a radioactive source each second in counts per second or Becquerels (Bq)	
32.Half-life	Time it takes for the activity of radioactive nuclei to half	
33.Contamination	Unwanted presence of radioactive atoms inside an object or person.	
34.Irradiation	Process of exposing an object to nuclear radiation	
Nuclear Equations		
35.Alpha	Mass number decreases by 4 Proton number decreases by 2	${}^{4}_{2}\alpha$
36.Beta	Mass number stays the same Proton number increases by 1	${}^{0}_{-1}\beta$
37.Gamma	The atom is not changed by gamma radiation. Only the energy of the atom changes.	${}^{0}_{0}\gamma$