

Q1–10 · Atoms & matter

1. Describe Dalton's model of the atom. (2 marks)

Atoms are tiny, **solid spheres** that **cannot be divided** into anything smaller (they are indivisible).

2. Describe Thomson's model of the atom. (3 marks)

The **plum pudding model**.

The atom is a **ball of positive charge** with **electrons spread through it**.

3. Describe what was expected to happen in the gold foil experiment and what actually happened. How did this change the model of the atom? (4 marks)

Expected: the alpha particles would pass **straight through** the gold foil.

What happened: most did go straight through, but some were **deflected** and a few **bounced straight back**.

New model: Rutherford said the atom has a tiny, **positively charged nucleus** that contains **most of its mass**. Electrons orbit outside the nucleus, like planets around the Sun. Most of the atom is empty space.

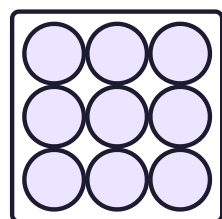
4. What is the Bohr model of the atom? (2 marks)

Electrons orbit the nucleus in **fixed energy levels**, called **shells**.

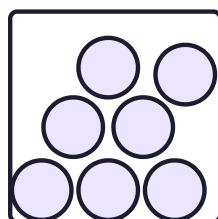
Bohr realised that orbiting electrons should spiral into the nucleus. Fixed energy levels explain why they don't.

5. Draw state diagrams for a solid, liquid and gas.

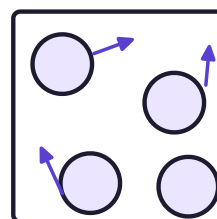
(3 marks)



Solid



Liquid



Gas

- **Solid:** particles touching, in a **regular pattern**.
- **Liquid:** particles touching, in a **random arrangement**.
- **Gas:** particles **far apart**, moving randomly.

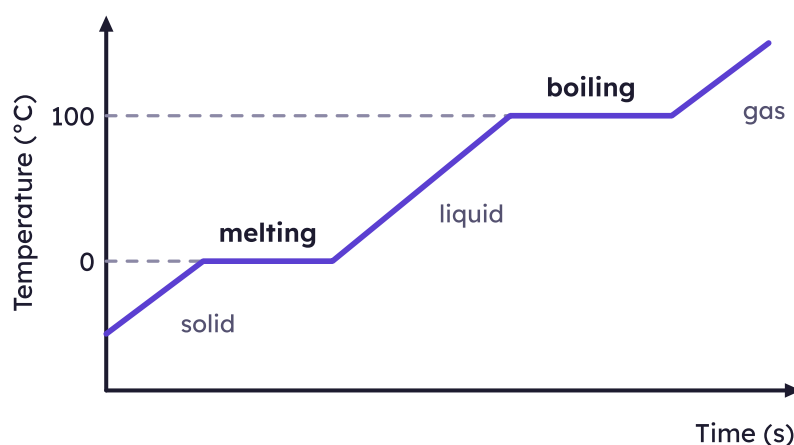
6. What is specific heat capacity?

(2 marks)

The **energy** needed to raise the temperature of **1 kg** of a substance by **1 °C**.

7. Draw a temperature against time graph for a piece of ice that is heated until it boils.

(5 marks)



The temperature **stays the same** while the ice is **melting** (0 °C) and while the water is **boiling** (100 °C).

8. Explain how a gas exerts pressure. (4 marks)

1. Gas particles **move randomly**.
2. The particles **collide with the walls** of the container.
3. This exerts a **force** on the walls, which have an area.
4. Pressure = force $\div$ area, so this creates **pressure**.

9. What happens to pressure as you ascend into the atmosphere and why? (4 marks)
What happens to pressure when you dive deeper into the ocean and why?

Going up: pressure **decreases**, because there are **fewer particles above you**.

Diving deeper: pressure **increases**, because there are **more particles above you**.

10. Explain how objects float. (3 marks)

The liquid pushes up on the object with a force called **upthrust**.

Upthrust happens because the liquid's **pressure** is bigger on the bottom of the object than on the top.

The object floats when the **upthrust is equal to its weight**.

Q11–20 · Forces & motion

11. What is the difference between a vector and a scalar? (3 marks)

A **vector** has **magnitude (size) and direction**.

A **scalar** has **magnitude only**.

12. List three vectors and three scalars.

(3 marks)

Vectors	Scalars
Force	Speed
Acceleration	Distance
Momentum	Time

Others: velocity and displacement are vectors. Mass and energy are scalars.

13. What is acceleration? How do you calculate acceleration?

(3 marks)

Acceleration is the **rate of change of velocity**.

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$a = \frac{v - u}{t}$$

14. What do the area and gradient of a velocity-time graph represent?

(2 marks)

Gradient = acceleration

Area under the graph = **displacement** (distance travelled)

15. Draw a free body diagram of a skydiver at various points of their descent (minimum three diagrams). (6 marks)

1. **Just jumped:** only weight acts, so the skydiver **accelerates**.
weight only

2. **Speeding up:** drag increases, but **weight > drag**, so they still accelerate.
weight > drag

3. **Terminal velocity:** **weight = drag**, so acceleration is zero and the speed is constant.
weight = drag

16. What is the law of conservation of momentum? (2 marks)

The **total momentum before** a collision **equals** the **total momentum after** the collision.

17. What is the difference between an elastic and inelastic collision? (2 marks)

Elastic: momentum **and** kinetic energy are conserved.

Inelastic: momentum is conserved, but kinetic energy is **not**.

18. Calculate the work done when an object is pushed 5 m with a force of 10 N. (1 mark)

work done = force $\times$ distance

$$W = 10 \times 5 = 50 \text{ J}$$

19. What is Hooke's law?

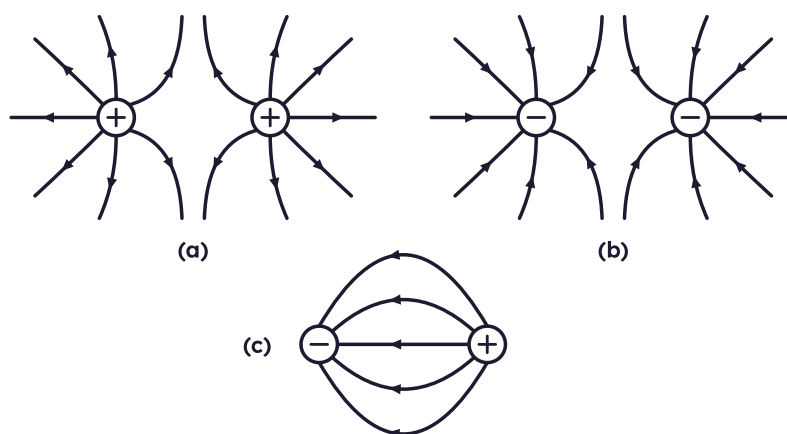
(2 marks)

The **extension** of a spring is **directly proportional** to the **force** applied (up to the limit of proportionality).

$$F = kx$$

20. Draw the electric field of (a) two positive charges (b) two negative charges and (c) one negative and one positive charge.

(3 marks)



Field lines point **away from positive** charges and **towards negative** charges. They never cross.

Q21–30 · Electricity & waves

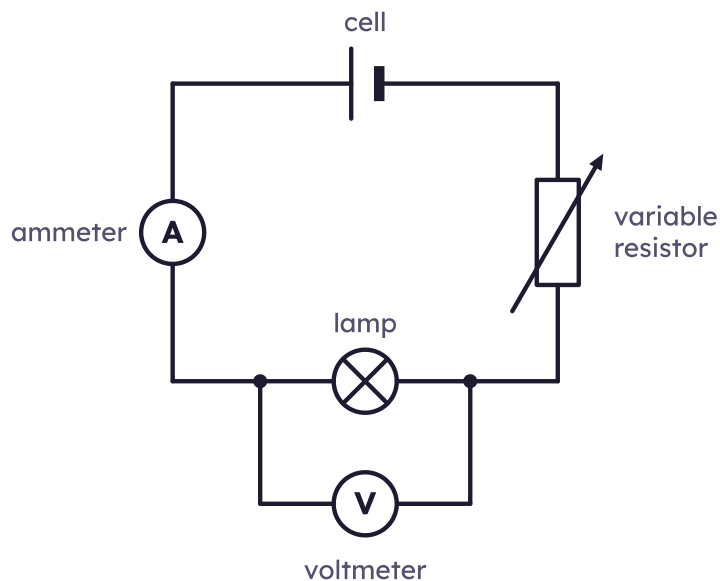
21. What is the difference between conventional current and electron flow? (2 marks)

Conventional current flows from **positive to negative**. This is what we draw on circuit diagrams.

Electrons flow from **negative to positive**.

22. Draw the circuit used to determine the resistance of a lamp.

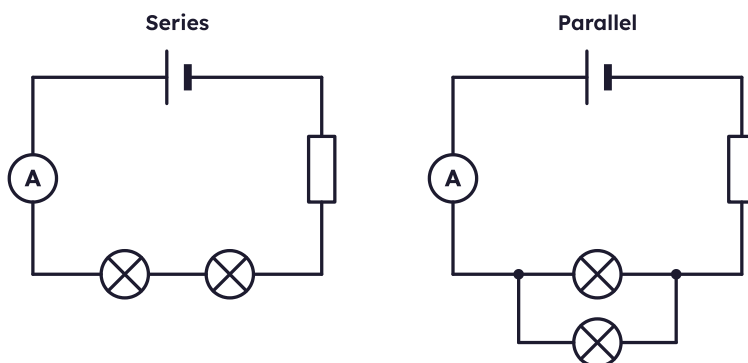
(5 marks)



- **Ammeter** in **series** with the lamp, to measure current.
- **Voltmeter** in **parallel** across the lamp, to measure potential difference.
- **Variable resistor** to change the current.

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

23. Draw a series circuit with a cell, resistor, ammeter and two lamps. Draw a parallel circuit with the same components. (3 marks)

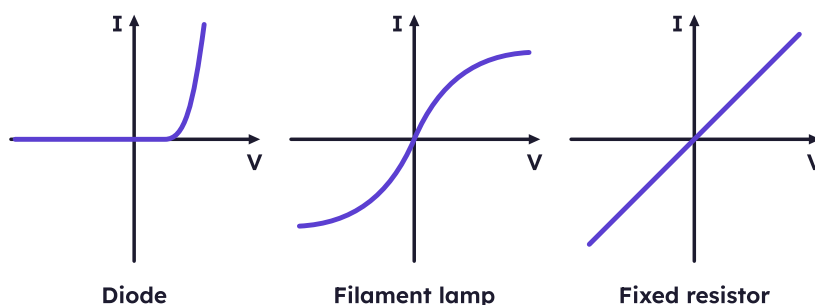


In **series**, everything is in one loop. In **parallel**, each lamp is on its own branch.

24. Why does the resistance of a filament lamp increase as it is used? (4 marks)

1. Current flows through the filament and it **gets hotter**.
2. The metal **ions vibrate more**.
3. Electrons **collide with the ions** more often.
4. So the **resistance increases**.

25. Draw the I-V characteristic of a diode, filament lamp and fixed resistor. (3 marks)



- **Diode:** no current in the reverse direction, then the current rises steeply.
- **Filament lamp:** an **S-shaped curve** through the origin.
- **Fixed resistor:** a **straight line** through the origin.

26. Describe how the magnetic field of a magnet shows the strength and direction of magnetic forces. (2 marks)

Strength: the **closer together** the field lines, the **stronger** the field.

Direction: the **arrows** on the field lines show the direction of the force. They always point **from north to south**.

27. What does the strength of the magnetic field around a wire depend on? (2 marks)

The **size of the current:** a bigger current gives a stronger field.

The **distance from the wire:** closer to the wire, the field is stronger.

28. State the law of reflection.

(2 marks)

The **angle of incidence** = the **angle of reflection**.

Both angles are measured from the normal.

29. State the equation for wave speed.

(2 marks)

wave speed = frequency × wavelength

$$v = f\lambda$$

30. What is the speed of an electromagnetic wave?

(1 mark)

3×10^8 m/s (300 000 000 m/s) in a vacuum.

Q31–40 · Radiation & nuclear

31. List the different types of electromagnetic wave.

(7 marks)

1. Radio waves
2. Microwaves
3. Infrared
4. Visible light
5. Ultraviolet (UV)
6. X-rays
7. Gamma rays

Memory trick: **R**aging **M**artians **I**nvasion **V**enus **U**sing **X**-ray **G**uns.

32. Which type of electromagnetic wave has the most energy? Explain why. (3 marks)

Gamma rays have the most energy.

The energy of a wave depends on its **frequency** ($E = hf$): the **higher the frequency**, the **more energy**.

Gamma rays have the **highest frequency**, so they have the most energy.

33. Describe what is inside the nucleus of an atom, and state the charge of the nucleus. (2 marks)

The nucleus contains **protons and neutrons**.

The nucleus is **positive**, because protons are positive and neutrons have no charge.

34. What is an isotope? (2 marks)

Atoms of the **same element** with the **same number of protons** but a **different number of neutrons**.

35. Describe the types of radiation that unstable nuclei emit. (4 marks)

- **Alpha (α) particles**
- **Beta (β) particles**
- **Gamma (γ) rays**
- **Neutrons**

36. Order the three types of ionising radiation in terms of (i) ionising power and then (ii) range. (4 marks)

(i) **Ionising power**, most to least:

alpha $\rightarrow$ beta $\rightarrow$ gamma

(ii) **Range**, longest to shortest:

gamma $\rightarrow$ beta $\rightarrow$ alpha

37. Describe in terms of particles what happens in alpha, beta and gamma decay. (3 marks)

Alpha: a **helium nucleus** (2 protons and 2 neutrons) is emitted.

Beta: a fast-moving **electron** is emitted from the nucleus.

Gamma: **electromagnetic radiation** is emitted.

38. Explain what is meant by half-life. (2 marks)

The **time** it takes for the **activity** of a radioactive substance to **halve**.

This is the same as the time it takes for half of the unstable nuclei to decay.

39. Describe the difference between contamination and irradiation. (2 marks)

Contamination: radioactive material gets **onto or into** an object, so the object now contains a radioactive source. *Example: swallowing a radioactive substance.*

Irradiation: an object is **exposed to radiation** but **does not become radioactive**.
Example: sterilising medical equipment with gamma rays.

40. What is nuclear fission? (3 marks)

Short answer: a **large nucleus splits** into two smaller nuclei and **releases energy**.

More detail: a large, unstable nucleus (such as uranium) absorbs a **neutron** and splits into two smaller nuclei. This releases **energy** and two or three more **neutrons**. These neutrons can make more nuclei split: a **chain reaction**.

Q41–50 · Energy & space

41. What is nuclear fusion? (3 marks)

Short answer: two **small nuclei join together** to form a larger nucleus and **release energy**.

More detail: the new nucleus has **less mass** than the two small nuclei added together. This “missing” mass has been converted into energy, which is released as radiation.

42. List the 8 types of energy store. (Bonus: give an example of each and the formula where applicable.) (8 marks)

Energy store	Example BONUS
Chemical	Food, fuel, batteries
Thermal	A hot cup of tea
Kinetic	A moving car $KE = \frac{1}{2}mv^2$
Gravitational potential	A book on a high shelf $GPE = mgh$
Elastic potential	A stretched spring $E = \frac{1}{2}kx^2$
Nuclear	Uranium in a power station
Electrostatic	Two charges pushing apart
Magnetic	Two magnets attracting

43. How is energy transferred? (4 marks)

1. **Mechanically** (a force moves something)
2. **Electrically** (a current flows)
3. **Heating by particles** (conduction and convection)
4. **Heating by radiation** (e.g. infrared)

44. Describe, in terms of energy stores, what happens when a car competes in a drag race. (Start of race: stationary. End of race: maximum speed.) (3 marks)

Energy store	Start of race	End of race
Chemical (fuel)	Full	Less
Kinetic	Empty	More
Thermal	Some	More

Energy is transferred **mechanically** from the **chemical** store of the fuel to the **kinetic** store of the car. Some is wasted to the **thermal** store of the surroundings.

45. Describe, in terms of energy stores, what happens when you throw a ball (3 marks) into the air until it stops momentarily at the top of its flight.

Energy store	Leaving your hand	Top of flight
Kinetic	Lots	Zero
Gravitational potential	Some	More
Thermal	Some	A little more

Energy is transferred **mechanically** from the **kinetic** store to the **gravitational potential** store. A little is wasted to the **thermal** store because of air resistance.

46. Why is electricity transported across the national grid at high voltages? (3 marks)

Energy is wasted heating the wires. The power lost depends on the current:

$$P_{\text{lost}} = I^2 R$$

A **higher voltage** means a **lower current**, so **less energy is wasted**. This makes the National Grid more **efficient**.

47. What is thermal conductivity? How does thermal conductivity of the walls of a house affect the rate of cooling? (4 marks)

Thermal conductivity is a measure of **how quickly energy is transferred** through a material by heating.

The **higher** the thermal conductivity of the walls, the **faster** the house cools down.

Walls with a low thermal conductivity (good insulation) keep a house warm for longer.

48. What factors affect thinking distance? What factors affect braking distance? What factors affect stopping distance? (3 marks)

Thinking distance: speed, tiredness, alcohol, drugs, distractions (e.g. a phone).

Braking distance: speed, mass of the vehicle, condition of the tyres and brakes, road and weather conditions (wet or icy).

Stopping distance = thinking distance + braking distance, so **all** of these affect it. **Speed** affects both.

49. How do seatbelts and airbags protect you in a car collision?

(3 marks)

Seatbelts and airbags **increase the time** it takes for you to stop.

This **reduces your deceleration**, so the **force on your body is smaller** ($F = ma$).

They also stop you hitting the dashboard, the windscreen or the seat in front.

50. Explain the evidence for the Big Bang model.

(3 marks)

1. **Red shift:** light from distant galaxies is shifted towards the red end of the spectrum. The further away a galaxy is, the faster it is moving away. This shows the **universe is expanding**.
2. **Cosmic microwave background (CMB) radiation:** the universe started very hot and dense. As it expanded, the radiation from then was stretched into **microwaves**. We detect this radiation **from every direction** in space, just as the Big Bang model predicts.