Topic P1 — Energy

Page 175 — Energy Stores and Systems

1.1 An object or a group of objects. ***[1 mark]***

1.2 Energy is transferred from: apple's gravitational potential energy store / apple's kinetic energy store ***[1 mark]***
Energy is transferred to: apple's kinetic energy store / thermal energy store of the apple and surroundings (as the apple hits the ground) ***[1 mark]***

1.3 E.g. work being done by the current in the circuit ***[1 mark]***.

2 Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief explanation of one of the energy transfers, with no mention of the forces doing the work. ***[1 to 2 marks]***
Level 2: There is a clear description of the energy transfers that take place, as well as the forces that are doing the work. ***[3 to 4 marks]***
Here are some points your answer may include:
Gravitational force does work on the bike.
This causes energy to be transferred from the gravitational potential energy store of the bicycle to its kinetic energy store.
Friction force does work between the brake pads and the wheels.
This causes energy to be transferred from the bicycle's kinetic energy store to the thermal energy store of the brake pads.

Page 176 — Kinetic and Potential Energy Stores

1 $E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 20 \times 0.01^2$ ***[1 mark]*** = **0.001 J** ***[1 mark]***

2 Energy lost from the g.p.e. store = energy gained in the kinetic energy store ***[1 mark]***
$E_p = mgh = 0.1 \times 9.8 \times 0.45 = 0.441$ J ***[1 mark]***
$E_k = \frac{1}{2}mv^2$
So $v = \sqrt{(2 \times E) \div m}$
$= \sqrt{(2 \times 0.441) \div 0.1}$ ***[1 mark]***
$= 2.969...$ ***[1 mark]*** = **3 m/s (to 1 s.f.)** ***[1 mark]***

3.1 $E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 144 \times 0.10^2$ ***[1 mark]*** = 0.72 J
It is assumed that all of the energy stored in the elastic potential energy store of the elastic band is transferred to the kinetic energy store of the ball bearing ($E_e = E_k$)
so energy = **0.72 J** ***[1 mark]***

3.2 Speed of child A's ball bearing:
$E_k = \frac{1}{2}mv^2 = 0.72$ J
so $v^2 = (2 \times 0.72) \div 0.0100 = 144$ ***[1 mark]***
$v = 12$ m/s so child B's ball bearing speed is:
2×12 m/s = 24 m/s ***[1 mark]***
$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.0100 \times 24^2 = 2.88$ J ***[1 mark]***
$E_e = \frac{1}{2}ke^2 = 2.88$ J
so $k = (2 \times 2.88) \div 0.10^2$ ***[1 mark]***
$= 576 =$ **580 N/m (to 2 s.f.)** ***[1 mark]***

Page 177 — Specific Heat Capacity

Warm-up
The energy needed to raise 1 kg of a substance by 1 °C.

1.1 $\Delta E = mc\Delta\theta$ so $c = \Delta E \div m\Delta\theta$ ***[1 mark]***
$= 15\,000 \div (0.3 \times 25)$ ***[1 mark]***
Specific heat capacity = **2000** ***[1 mark]***

1.2 The current flowing through the immersion heater does work ***[1 mark]***, transferring energy electrically ***[1 mark]*** to the thermal energy store of the immersion heater ***[1 mark]***. It is then transferred from the thermal energy store of the immersion heater to the thermal energy store of the liquid ***[1 mark]***.

Pages 178-179 — Conservation of Energy and Power

Warm-up
Power is the **rate of** energy transfer or **work done**.
It is measured in **watts**.

1 E.g. energy transferred to a less useful energy store ***[1 mark]***.

2.1 Energy can be created.
Energy can be destroyed.
[1 mark for both correct answers, otherwise no marks if more than two boxes have been ticked]

2.2 Useful energy store: e.g. kinetic energy store (of razor) ***[1 mark]***
Wasted energy store: e.g. thermal energy store (of shaver or surroundings) ***[1 mark]***

2.3 E.g. it would reduce the battery life of the battery / it would make the battery go flat quicker / it would mean the battery must be recharged more often ***[1 mark]***.

3.1 $P = W \div t$ ***[1 mark]***

3.2 $W = Pt = 35 \times 600$ ***[1 mark]*** = **21 000 J** ***[1 mark]***

3.3 $P = E \div t$
so $t = E \div P = 16\,800 \div 35$ ***[1 mark]*** = **480 s** ***[1 mark]***

4.1 It will decrease the time ***[1 mark]*** because more energy is being transferred to the kinetic energy store of the car per second ***[1 mark]*** so the car speeds up more quickly ***[1 mark]***.

4.2 The same amount of energy is needed to accelerate the car with both engines. The energy transferred by the old engine:
$P = E \div t$, so $E = P \times t = 32\,000 \times 9.0 = 288\,000$ J ***[1 mark]***
The time taken for the new engine to transfer the same amount of energy is:
$P = E \div t$, so $t = E \div P = 288\,000 \div 62\,000$
$= 4.645...$ ***[1 mark]***
= 4.6 s (to 2 s.f.) ***[1 mark]***

Pages 180-181 — Reducing Unwanted Energy Transfers

1.1 through the roof ***[1 mark]***

1.2 E.g. install loft insulation (to reduce convection) ***[1 mark]***

1.3 E.g. use draught excluders (to reduce convection) / install double glazing (to reduce conduction) / hang thick curtains (to reduce convection) / reduce the temperature difference between inside and outside the home ***[1 mark for each sensible suggestion]***

2 D ***[1 mark]***. The lower the rate of energy transfer through the brick, the more energy-efficient the house will be ***[1 mark]***.
D has a lower thermal conductivity value, so the rate of energy transfer through it will be lower ***[1 mark]***. It's also thicker (than brand B), which also reduces the rate of energy transfer through it ***[1 mark]***.

3 Doing work against friction causes energy to be dissipated/ wasted (usually to thermal energy stores) ***[1 mark]***. After lubricating the axle, the frictional forces acting on it were reduced ***[1 mark]***. This means that less energy is dissipated as the handle (and axle) is turned and so more energy is transferred to the kinetic energy store of the handle (and axle) and the bucket ***[1 mark]***.

4 Best: C Second best: B Worst: A ***[1 mark]***
The thicker a sample is, the slower the rate of energy transfer through it ***[1 mark]*** so sample B will be a better insulator than sample A ***[1 mark]***. Air has a lower thermal conductivity than glass (so it transfers energy at a slower rate than glass does) ***[1 mark]*** so even though samples B and C are the same thickness, sample C is a better insulator than sample B ***[1 mark]***.

Page 182 — Efficiency

1.1 Efficiency = Useful output energy transfer ÷ Total input energy transfer ***[1 mark]***

1.2 Efficiency = $16\,000 \div 20\,000$ ***[1 mark]***
= 0.8 ***[1 mark]***
You'd also get the mark for giving the efficiency as a percentage (80%).

2 Efficiency = 75% = 0.75
Efficiency = Useful power output ÷ Total power input
So Total power input = Useful power output ÷ Efficiency ***[1 mark]***
$= 57 \div 0.75$ ***[1 mark]*** = **76 W** ***[1 mark]***

3.1 Useful output power of the air blower:
Efficiency = Useful power output ÷ Total power input
so Useful power output = Efficiency × Total power input
$= 0.62 \times 533$ ***[1 mark]***
$= 330.46$ W ***[1 mark]***
Useful power output of the turbine:
Efficiency = 13% = 0.13
Total power input = Useful power of air blower

Useful power output = Efficiency × Total power input
= 0.13 × 330.46 *[1 mark]*
= 42.9598
= **43 W (to 2 s.f.)** *[1 mark]*

3.2 E.g. adding more sails (so there is a larger surface area for the air to hit) / increasing the size of the sails (so there is a larger surface area for the air to hit) / adding a lubricant to the moving parts of the turbine (to reduce friction) / changing the angle of the sails so they get hit by more wind *[2 marks — 1 mark for each sensible suggestion]*

Pages 183-184 — Energy Resources and Their Uses

Warm-up
Renewable — bio-fuel, solar, tidal, geothermal, wave power, hydroelectricity, wind
Non-renewable — oil, coal, gas, nuclear fuel

1 E.g. a non-renewable energy resource will one day run out *[1 mark]* but a renewable energy resource can be replenished as it is used *[1 mark]*.

2.1 coal, oil, (natural) gas *[1 mark]*

2.2 E.g. generating electricity / burning coal on fires / using gas central heating / using a gas fire / coal in steam trains *[2 marks — 1 for each correct answer]*

2.3 Bio-fuels are solids, liquids or gases that are produced from plant products or from animal waste *[1 mark]*.

2.4 E.g. because fossil fuels will eventually run out / because fossil fuels harm the environment *[1 mark for any correct answer]*.

3 E.g. during winter, there are fewer hours of daylight, but the weather is usually more windy *[1 mark]*, so wind turbines will be able to generate more electricity during winter *[1 mark]*. However, during the summer, there will be more daylight hours and the weather will be less windy *[1 mark]*, so solar panels will be more favourable *[1 mark]*. By installing both, the university will have a more reliable electricity supply throughout the year *[1 mark]*.

4.1 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief description of the reliability or environmental impact of one of the energy resources. *[1 to 2 marks]*
Level 2: There is a clear and detailed description of the reliability and environmental impacts of both energy resources, as well as some similarities between them. *[3 to 4 marks]*
Here are some points your answer may include:
Both energy resources are reliable.
Tides come in and out at known times.
Except in times of drought, there is always water available for a hydroelectric power plant to work.
Hydroelectric power plants require the flooding of valleys, which causes a loss of habitat for any animals living there.
The plants in the valley die during the flood and rot, which releases gases that contribute to global warming.
Using tides to generate electricity creates no pollution, but tidal barrages do alter the habitat of nearby animals.

4.2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation of an advantage or a disadvantage of fossil fuels. *[1 to 2 marks]*
Level 2: There is some explanation of both advantages and disadvantages of fossil fuels. *[3 to 4 marks]*
Level 3: There is a clear and detailed explanation of the advantages and disadvantages of using fossil fuels. *[5 to 6 marks]*
Here are some points your answer may include:
Advantages:
Fossil fuels are reliable.
They are extracted at a fast enough rate that there are always some in stock.
Power plants can respond quickly to peaks in demand.
Running costs of fossil fuel power plants aren't that expensive compared to other energy resources.
Fuel extraction costs are also low.
Disadvantages:
Fossil fuels are slowly running out / they are a non-renewable energy resource.
Burning fossil fuels releases carbon dioxide into the atmosphere.
Carbon dioxide in the atmosphere contributes to global warming.
Burning coal and oil also releases sulfur dioxide, which causes acid rain.
Acid rain can damage soil and trees. This can damage or destroy the habitats of animals.
Coal mining can spoil the view by damaging the landscape.
Oil spillages kill sea life and birds and mammals that live near to the sea.

Page 185 — Trends in Energy Resource Use

1.1 35 + 23 + 5 = 63 %
[2 marks for correct answer, otherwise 1 mark for reading all three values correctly from the graph]

1.2 E.g. the country is using a larger percentage renewable energy resources to generate electricity in 2015 than they were the previous year / overall, they are using a smaller percentage of fossil fuels to generate their electricity in 2015 than they were in 2014 *[1 mark]*.

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation why the UK is using more renewable energy resources. *[1 to 2 marks]*
Level 2: There is some explanation of why the UK is using more renewable energy resources and the factors that restrict the increase in their use. *[3 to 4 marks]*
Level 3: There is a clear and detailed explanation of why the UK is using more renewable energy resources and the factors that restrict the increase in their use. *[5 to 6 marks]*
Here are some points your answer may include:
Reasons the UK is using more renewable energy resources:
We understand more about the negative effects that fossil fuels have on the environment, so more people want to use renewable energy resources that have less of an impact on the environment.
Fossil fuel reserves will run out, so we have to find an alternative for them.
Pressure from the public and other countries has lead to government targets for the use of renewable energy resources. This can lead to increased government funding for renewable energy resources.
Pressure from the public and the global community/other countries has also lead to private companies creating more environmentally-friendly products that use renewable energy resources.
Factors that limit the use of renewable energy resources:
Building new power plants to replace existing fossil fuel powered ones costs money.
Some renewable energy resources are less reliable than fossil fuels.
Research into improving renewable energy resources costs money and will take time.
Personal products that use renewable energy resources, like hybrid cars, are generally more expensive than similar ones that use fossil fuels.

Topic P2 — Electricity

Page 186 — Current and Circuit Symbols

Warm-up
A — cell, B — switch, C — filament lamp, D — fuse.

1.1 There is no source of potential difference *[1 mark]*

1.2 Current is the rate of flow of **charge** *[1 mark]*.

2.1 0.5 A *[1 mark]*

Remember that the current is the same at any point in a single closed circuit loop.

2.2 $Q = I \times t$ *[1 mark]*

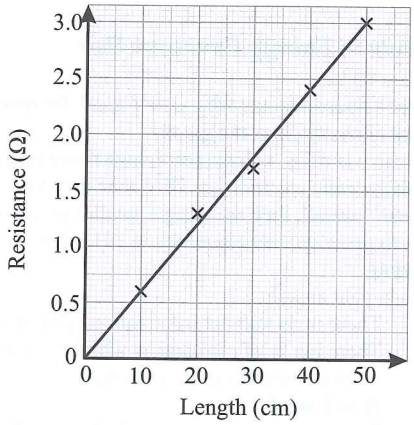
2.3 $t = 2 \times 60 = 120$ s
Charge = 0.5 × 120 *[1 mark]*
= **60** *[1 mark]* **C** *[1 mark]*

Page 187 — Resistance and V = IR

1 $V = I \times R$
$V = 3 \times 6$ *[1 mark]* = **18 V** *[1 mark]*

2.1 She could have varied the length of the wire between the crocodile clips *[1 mark]* and divided the reading on the voltmeter by the reading on the ammeter to find the resistance for each length *[1 mark]*.

2.2



[1 mark for resistance on vertical axis and length on horizontal axis, 1 mark for appropriate values labelled on both axes, 1 mark for correctly plotted points, 1 mark for suitable line of best fit.]

2.3 The resistance is proportional to the length *[1 mark]*. This is shown by the graph being a straight line through the origin *[1 mark]*.

Pages 188-189 — Resistance and I-V Characteristics

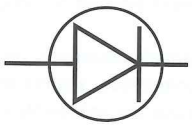
1.1 C *[1 mark]*

At a constant temperature, the relationship between pd and current is linear — when this is true, the resistor is said to be ohmic.

1.2 I-V characteristic *[1 mark]*

1.3 A resistor at a constant temperature is an example of an **ohmic** conductor. It is also an example of a **linear** component. *[1 mark for each correct answer]*

2.1



[1 mark]

2.2 A diode only lets current flow through it in one direction *[1 mark]*.

2.3 The student put the diode/power supply in the circuit the other way around *[1 mark]*. The resistance of a diode is very large when current goes through it one way and very small when current goes through in the opposite direction *[1 mark]*.

3.1 It is used to alter the current *[1 mark]* so the potential difference can be measured for each current *[1 mark]*.

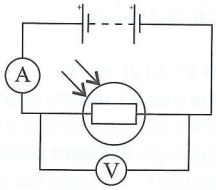
3.2 At 3 A the pd is 12 V *[1 mark]*
$V = I \times R$
$R = V \div I$ *[1 mark]* = 12 ÷ 3 *[1 mark]* = **4 Ω** *[1 mark]*

3.3 The resistance increases as the current increases *[1 mark]*. This is because the increase in current causes the temperature to rise *[1 mark]*.

3.4 A resistor is ohmic when the relationship between current and potential difference is linear *[1 mark]*. The graph is linear until approximately 3.5 V, so the resistor is ohmic in this range *[1 mark]*.

Page 190 — Circuit Devices

1.1



[1 mark for correct LDR symbol, 1 mark for LDR, ammeter and power supply in series, 1 mark for voltmeter in parallel across LDR.]

1.2 It decreases *[1 mark]*

1.3 E.g. automatic night lights / burglar detectors *[1 mark]*

2 As the temperature increases, the resistance of the thermistor decreases *[1 mark]*. This means the current in the circuit increases *[1 mark]*. As the current increases, the brightness of the light increases *[1 mark]*. When the cooker's surface is cold, the resistance is high and the current is too small to light the bulb *[1 mark]*.

Page 191 — Series Circuits

1 A *[1 mark]*.

In a series circuit, there should only be one closed loop of wire.

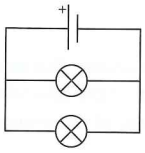
2.1 10 + 30 = **40 Ω** *[1 mark]*

2.2 $V = I \times R$
$V = 75 \times 10^{-3} \times 30$ *[1 mark]* = **2.25 V** *[1 mark]*

3 The potential difference across the 8 Ω resistor is:
6 – 2 = 4 V *[1 mark]*
$V = I \times R$, so the current through the 8 Ω resistor is:
$I = V \div R = 4 \div 8$ *[1 mark]* = 0.5 A *[1 mark]*
This is the same as the current through R, so the resistance of R is: $R = V \div I = 2 \div 0.5$ *[1 mark]* = **4 Ω** *[1 mark]*

Page 192 — Parallel Circuits

1



[1 mark]

2.1 6 V *[1 mark]*

Potential difference is the same across all components in parallel.

2.2 $V = IR$ so $I = V \div R$ *[1 mark]*
A_1: $I = V \div R = 6 \div 4$ *[1 mark]* = **1.5 A** *[1 mark]*
A_2: $I = V \div R = 6 \div 12$ *[1 mark]* = **0.5 A** *[1 mark]*

2.3 The current from the supply splits into 1.5 A and 0.5 A.
So A_3 reads 1.5 + 0.5 = **2 A** *[1 mark]*

3 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: There is a brief explanation about the effect of adding resistors in series or parallel. *[1 to 2 marks]*

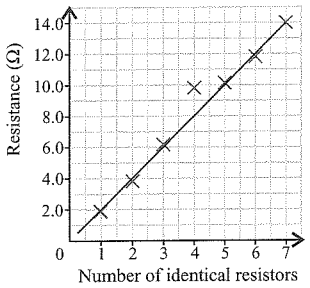
Level 2: There is a comparison between adding resistors in series and parallel and an explanation of their effects. *[3 to 4 marks]*

Level 3: A logical and detailed comparison is given, explaining why adding resistors in series increases the total resistance but adding them in parallel reduces it. *[5 to 6 marks]*

Here are some points your answer may include:
In series, resistors share the potential difference from the power source.
The more resistors that are in series, the lower the potential difference for each one, and so the lower the current for each one.
Current is the same all around a series circuit, so adding a resistor will decrease the current for the whole circuit.
A decrease in total current means an increase in total resistance.
In parallel, all resistors have the same potential difference as the source.
Adding another resistor in parallel (forming another circuit loop) increases the current flowing in the circuit, as there are more paths for the current to flow through.
An increase in total current means a decrease in total resistance (because $V = IR$).

Page 193 — Investigating Resistance

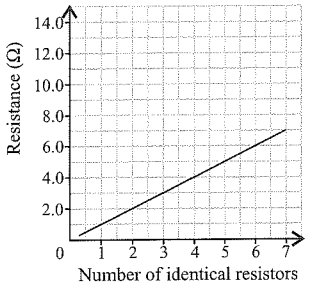
1.1



Resistance = **8.0 Ω**

[1 mark for a straight line of best fit that excludes the point plotted for 4 resistors, 1 mark for correct prediction of resistance]

1.2



[1 mark for a straight line of best fit with a positive gradient, 1 mark for the gradient of the line being half of the gradient of the line drawn in 1.1]

2 How to grade your answer:

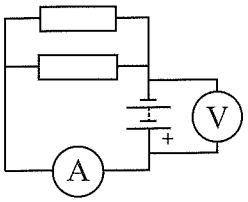
Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of the techniques used to measure resistance of the circuit. The steps mentioned are not in a logical order.
[1 to 2 marks]

Level 2: There is a good description of the techniques used to measure resistance of the circuit. Most steps are given in a logical order and they could be followed to produced valid results.
A correct circuit diagram may be included.
[3 to 4 marks]

Level 3: A logical and detailed description is given, fully describing the method for investigating the effect of adding resistors in parallel. The method could easily be followed to produce valid results.
A correct circuit diagram may be included.
[5 to 6 marks]

Here are some points your answer may include:
Connect a battery or cell in series with an ammeter and a fixed resistor.
Measure the source potential difference using the voltmeter.
Measure the current through the circuit using the ammeter.
Calculate the resistance of the circuit using $R = V \div I$.
Connect a second identical resistor in parallel with the first resistor.
Do not connect the second resistor across the ammeter.
Measure the current and use this to calculate the resistance of the circuit.
Repeat this for several identical resistors.
Plot a graph of number of identical resistors against overall resistance of the circuit.
A correct circuit diagram, similar to:



So long as you draw a correct diagram with at least two resistors in parallel, you would get the marks. You could also draw your circuit with several resistors in parallel, all separated with switches.

Page 194 — Electricity in the Home

Warm-up
The live wire is **brown** and is at a potential difference of **230** V.
The earth wire is **green and yellow** and is at a potential difference of **0** V.

1.1 230 V ***[1 mark]***
50 Hz ***[1 mark]***

1.2 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief explanation of the function of the live and neutral wires and some attempt at explaining why the toaster would not work.
[1 to 2 marks]

Level 2: There is a good explanation of the function of the live and neutral wires and why the fault would not allow a current to flow through the toaster.
[3 to 4 marks]

Here are some points your answer may include:
The purpose of the neutral wire is to complete the circuit.
Current flows into the toaster via the live wire, through the toaster, and out of the device by the neutral wire.
The fault means that a closed loop/low-resistance path has been formed between the live and neutral wire before the current in the live wire has reached the toaster.
So no (or very little) current will flow through the toaster.
This means that the toaster will not work.

2.1 To stop an electric current from flowing out of the live wire and potentially causing an electric shock (i.e. for safety) ***[1 mark]***. To make it easy to identify the live wire ***[1 mark]***.

2.2 The man has an electric potential of 0 V ***[1 mark]*** and the wire has an electric potential (of 230 V) so a potential difference exists between them ***[1 mark]***. This causes a current to flow through the man ***[1 mark]***.

2.3 Yes ***[1 mark]***. Although there is no current flowing when it is switched off, there is still a potential difference ***[1 mark]***, so touching the live wire in the socket could cause a current to flow through you to the Earth ***[1 mark]***.

Page 195 — Power of Electrical Appliances

1 The **power** of an appliance is the energy transferred **per second**. Energy is transferred because the **current** does work against the appliance's resistance. ***[1 mark for each correct]***

2.1 $E = P \times t$ ***[1 mark]***

2.2 $E = 50 \times 20$ ***[1 mark]*** = **1000 J** ***[1 mark]***

2.3 The power of the car is higher ***[1 mark]***. So more energy is transferred away from the chemical energy store of the battery per second ***[1 mark]***.

3.1 Energy is transferred electrically from the power source ***[1 mark]*** to the thermal energy store of the water ***[1 mark]*** and the kinetic energy store of the motor ***[1 mark]***.

3.2 Work done = power × time ($E = P \times t$)
Work done = 400 × 60 ***[1 mark]*** = **24 000 J** ***[1 mark]***

3.3 Time of economy mode = 160 × 60 = 9600 s
Energy transferred in economy mode
= power × time = 400 × 9600 = 3 840 000 J ***[1 mark]***
Time of standard mode = 125 × 60 = 7500 s
Energy transferred in standard mode = 600 × 7500
= 4 500 000 J ***[1 mark]***
Energy saved = 4 500 000 – 3 840 000 ***[1 mark]***
= **660 000 J** ***[1 mark]***

Page 196 — More on Power

Warm-up
A power source supplies **energy** to a charge. When a charge passes through a component with **resistance**, it does **work**, so the charge's energy **decreases**.

1.1 $E = V \times Q$ ***[1 mark]***

1.2 $E = 6 \times 2$ ***[1 mark]*** = **12 J** ***[1 mark]***

1.3 Multiplying the potential difference by the current gives the power ***[1 mark]***. In 1.2 the energy was transferred by the two coulombs of charge in one second ***[1 mark]***. This is the same as the power ***[1 mark]***.

2.1 $P = I \times V$
so $I = P \div V = 75 \div 230$ ***[1 mark]*** = 0.3260...
= **0.33 A (to 2 s.f.)** ***[1 mark]***

2.2 $P = I^2 \times R$
so $R = P \div I^2 = 2.5 \div 0.50^2$ ***[1 mark]*** = **10 Ω** ***[1 mark]***

Page 197 — The National Grid

1.1 Potential Difference ***[1 mark]***, Current ***[1 mark]***
1.2 A step-up transformer increases the potential difference, a step-down transformer decreases it ***[1 mark]***.
2.1 Transformer A = step-up transformer ***[1 mark]***
Transformer B = step-down transformer ***[1 mark]***
2.2 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief explanation of the function of the step-up transformer and how this results in smaller energy losses. ***[1 to 2 marks]***
Level 2: There is a good explanation of the function of the step-up transformer and how reducing the energy lost increases the efficiency of the national grid. ***[3 to 4 marks]***
Here are some points your answer may include:
Transformer A increases the potential difference.
This decreases the current at a given power.
This decrease in current decreases energy lost to the thermal energy stores of the cables and surroundings.
Efficiency is useful output energy transfer ÷ total input energy transfer, so reducing the energy lost to thermal stores makes the transmission of electricity more efficient.
2.3 The potential difference across the power cables is very high and too large for domestic devices ***[1 mark]***. Transformer B reduces the potential difference to lower, usable levels ***[1 mark]***.

Topic P3 — Particle Model of Matter

Pages 198-199 — The Particle Model and Motion in Gases

Warm-up
From left to right: liquid, solid, gas
1 When the temperature of a gas increases, the average energy in the **kinetic** energy stores of the gas molecules increases. This **increases** the **average** speed of the gas molecules. If the gas is kept at a constant volume, increasing the temperature **increases** the pressure.
[3 marks for all correct, otherwise 1 mark for two correct or 2 marks for three correct]
2.1 There would be more air particles in the same volume ***[1 mark]***, so the particles would collide with the tyre walls (and each other) more often ***[1 mark]***. This would mean the pressure would increase ***[1 mark]***.
2.2 On a hot day, the air particles in the tyre would have more energy in their kinetic energy stores ***[1 mark]***, so they would move faster and hit the tyre walls more often ***[1 mark]***.
As the particles are moving faster, they also have a larger momentum, so the force each particle exerts on the tyre walls is larger ***[1 mark]***. Hitting the tyre walls with a greater force and more often creates a higher pressure ***[1 mark]***.
3 A ***[1 mark]***
The volume of each container is the same (0.04 m^3 = 40 000 cm^3). A fixed mass and volume of a gas has a lower pressure at a lower temperature.
4 The large lid will pop off first ***[1 mark]***. As the temperature of the gas increases, the particles have more energy in their kinetic energy stores. The momentum of the particles increases, so the force they exert on a unit area of the container walls increases ***[1 mark]***. The particles also hit the walls more often, which also increases the force acting on a unit area ***[1 mark]***. As the large lid as a larger area, the total force acting on it at any temperature will be higher than the total force acting on the smaller lid ***[1 mark]***. So the force required to remove one of the lids will be reached by the larger lid first ***[1 mark]***.

Pages 200-201 — Density of Materials

1.1 $\rho = m \div v$ ***[1 mark]***
1.2 $\rho = 10\,000 \div 0.5$ ***[1 mark]*** = **20 000 kg/m³** ***[1 mark]***
1.3 The density is the same for the whole block,
so $\rho = 20\,000$ kg/m³
$\rho = m \div v$
so $m = \rho \times v = 20\,000 \times 0.02$ ***[1 mark]*** = **400 kg** ***[1 mark]***
2 Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description of the set-up of apparatus. There is no mention of how to measure volume or how to calculate density. ***[1 to 2 marks]***
Level 2: There is a detailed explanation of the set-up of apparatus, with a description of the measurements needed to be taken and how these are used to find the density. ***[3 to 4 marks]***
Here are some points your answer may include:
Place the empty beaker on the mass balance.
Zero the mass balance before putting acetic acid in the beaker.
Pour some acetic acid into the beaker.
Write down the mass of the acid shown on the mass balance.
Read the volume of the acid from the scale on the beaker.
Use the equation density = mass ÷ volume to calculate the density of the acetic acid.
3.1 First measure the mass of the object using a mass balance ***[1 mark]***. Then submerge the object in the water and measure the volume of water displaced ***[1 mark]***.
The volume of the displaced water in the measuring cylinder is equal to the volume of the object ***[1 mark]***.
Use density = mass ÷ volume to calculate the density of the object ***[1 mark]***.
3.2 $\rho = m \div v$
1 ml of water = 1 cm^3 ***[1 mark]***
A: $\rho = 5.7 \div 0.30 = 19$ g/cm³. So A is gold. ***[1 mark]***
B: $\rho = 2.7 \div 0.60 = 4.5$ g/cm³. So B is titanium. ***[1 mark]***
C: $\rho = 3.0 \div 0.30 = 10$ g/cm³. So C is silver. ***[1 mark]***
4 Volume of empty aluminium can
= volume displaced by full can – volume of cola
= 337 – 332 = 5 ml ***[1 mark]***
5 ml = 5 cm^3 ***[1 mark]***
$\rho = m \div v = 13.5 \div 5$ ***[1 mark]*** = **2.7 g/cm³** ***[1 mark]***

Page 202 — Internal Energy and Changes of State

1 When a system is heated, the internal energy of the system **increases**. This either increases the **temperature** of the system or causes a change of state. During a change of state the temperature and **mass** of the substance remain constant.
[2 marks for all correct, otherwise 1 mark for two correct]
2.1 Gas to liquid: condensing
Liquid to gas: evaporating/boiling
[1 mark for both correct]
2.2 E.g. a change where you don't end up with a new substance / you end up with the same substance in a different form ***[1 mark]***.
3.1 E.g. the energy stored in a system by its particles. / The sum of the energy in the particles' kinetic and potential energy stores ***[1 mark]***.
3.2 Any two from: mass, specific heat capacity, total energy transferred to the system ***[2 marks]***
4 10 g ***[1 mark]*** E.g. because when a substance changes state, its mass doesn't change. So the mass of the water vapour equals the mass of the water originally in the test tube minus the mass of water left at the end ***[1 mark]***.

Page 203 — Specific Latent Heat

1.1 The amount of energy required to change the state of one kilogram of a substance with no change in temperature ***[1 mark]***.
1.2 $E = mL$ so $L = E \div m$ ***[1 mark]***
$L = 1.13 \div 0.5$ ***[1 mark]*** = **2.26 MJ/kg** ***[1 mark]***
2.1 The substance is melting ***[1 mark]***.
2.2 As the substance is heated, its internal energy increases ***[1 mark]***. As the substance melts (during 3-8 minutes), all of this energy is used to break apart intermolecular bonds ***[1 mark]*** so there is no increase in the substance's temperature as it changes state ***[1 mark]***.
2.3 Melting point = –7 °C ***[1 mark]***
Boiling point = 58 °C ***[1 mark]***

Topic P4 — Atomic Structure

Pages 204-205 — Developing the Model of the Atom

Warm-up

1×10^{-10} m

10 000

1.1 Our current model shows that the atom can be broken up (into protons, neutrons and electrons) ***[1 mark]***.

1.2 The plum pudding model ***[1 mark]***. This was where an atom was thought to be a sphere of positive charge, with electrons spread throughout it ***[1 mark]***.

1.3 The neutron ***[1 mark]***.

2.1 An electron can move into a higher energy level / further from the nucleus, by absorbing EM radiation ***[1 mark]***, and move into a lower energy level / closer to the nucleus, by emitting EM radiation ***[1 mark]***.

2.2 ion ***[1 mark]***

2.3 Positive (or +1) ***[1 mark]***

An atom is neutral. Losing an electron takes away negative charge, so the remaining ion is positive.

3 Level 0: There is no relevant information. ***[No marks]***

Level 1: There is only one correct discovery mentioned with a brief description of the observation that led to it. ***[1 to 2 marks]***

Level 2: Two correct discoveries are given with a detailed description of how observations led to them. ***[3 to 4 marks]***

Here are some points your answer may include:

Discovery: The atom is mostly made up of empty space / most of the atom's mass is concentrated at the centre in a tiny nucleus.

Observation: Most of the alpha particles fired at the thin gold foil passed straight through.

Discovery: The atom has a positively charged central nucleus.

Observation: Some of the positive alpha particles were deflected back towards the emitter, so they were repelled by the nucleus.

4.1 Proton: (+)1 ***[1 mark]***

Neutron: 0 ***[1 mark]***

4.2 The protons and neutrons are in the central nucleus ***[1 mark]*** and the electrons surround the nucleus (arranged in shells) ***[1 mark]***.

4.3 26 electrons ***[1 mark]***. Atoms are neutral ***[1 mark]***. Protons and electrons have equal but opposite charges. For these charges to cancel, there must be the same number of each ***[1 mark]***.

Pages 206-207 — Isotopes and Nuclear Radiation

Warm-up

Gamma — weakly ionising, alpha — strongly ionising, beta — moderately ionising.

1.1 radioactive decay ***[1 mark]***

1.2 Atoms with the same number of protons ***[1 mark]*** but different numbers of neutrons (in their nucleus) ***[1 mark]***.

1.3 An atom losing (or gaining) at least one electron ***[1 mark]***.

1.4 Alpha decay ***[1 mark]***

2 E.g. Alpha particles have a small range in air and will be stopped by a thin sheet of material ***[1 mark]***. So the alpha radiation inside the detector cannot escape the detector ***[1 mark]***.

3.1 23 ***[1 mark]***

Remember that the mass number is the little number in the top-left. It's the total number of protons and neutrons in the nucleus.

3.2 23 – 11 = 12 neutrons ***[1 mark]***

The number of neutrons is the difference between the mass number and the atomic number.

3.3 $^{24}_{11}$Na ***[1 mark]***

An isotope has the same number of protons (so the same atomic number), but a different number of neutrons (so a different mass number).

3.4 The atomic number of the neon isotope is lower, so there are fewer protons in the neon isotope ***[1 mark]***. So the charge on the neon isotope's nucleus is lower than the charge on the sodium isotope's nucleus ***[1 mark]***.

4 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief explanation of the method of locating the leak and of the radiation used. ***[1 to 2 marks]***

Level 2: There is some explanation of the method of locating the leak and of the radiation used. ***[3 to 4 marks]***

Level 3: There is a clear and detailed explanation of the method of locating the leak and of the radiation used. ***[5 to 6 marks]***

Here are some points your answer may include:

The isotope travels along the pipe.

If there is no leak, the radiation doesn't escape the pipe/not much radiation can escape the pipe/some of the radiation is blocked by the pipe.

If there is a leak, the isotope escapes the pipe and some/more radiation can reach the detector.

This causes the count-rate to increase.

An increase in count-rate indicates a leak.

The isotope could be beta-emitting because beta radiation would be blocked by the pipe but would not be blocked by the small amount of ground above the pipe.

OR The isotope could be gamma-emitting because it can escape the pipe and reach the detector, and more gamma radiation would get to the detector if there was a leak.

Page 208 — Nuclear Equations

1.1 It increases the positive charge on the nucleus / makes the nucleus 'more positive' ***[1 mark]***.

1.2 The atomic number increases ***[1 mark]*** but the mass number stays the same ***[1 mark]***. This is because emitting an electron (beta decay) involves a neutron turning into a proton ***[1 mark]***.

Remember that a neutron turns into a proton in order to increase the positive charge on the nucleus. (Because emitting the electron has taken away some negative charge.)

1.3 No effect ***[1 mark]***

When an electron moves to a lower energy level, it loses energy in the form of an EM wave, which doesn't change the charge or mass of the nucleus.

2.1 The atomic numbers on each side are not equal ***[1 mark]***.

2.2 $^{0}_{-1}$e ***[1 mark]***

The other particle must be an electron (a beta particle), as this will balance the equation.

2.3 $^{226}_{88}\text{Ra} \longrightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$

[3 marks in total — 1 mark for each correct symbol]

You know that the mass number of the radium is 226 (that's what 'radium-226' means). You also know that an alpha particle is $^{4}_{2}$He, so you can find the mass and atomic numbers of radon by balancing the equation.

2.4 Rn-222 has 222 – 86 = 136 neutrons ***[1 mark]***

2 alpha decays = 2 × 2 = 4 neutrons released ***[1 mark]***

136 – 4 = **132** ***[1 mark]***

Pages 209-210 — Half-life

1.1 E.g. the time taken for the count-rate of a sample to halve ***[1 mark]***.

1.2 75 seconds ***[1 mark]***

The initial count-rate is 60 cps. Half of this is 30 cps, which corresponds to 75 seconds on the time axis.

1.3 After 1 half-life, there will be 800 ÷ 2 = 400 undecayed nuclei remaining. After 2 half-lives, there will be 400 ÷ 2 = 200 undecayed nuclei remaining.

So 800 – 200 = **600** nuclei will have decayed.

[2 marks for correct answer, otherwise 1 mark for calculating the number of decayed/undecayed nuclei after one half-life]

1.4 After 2 half-lives, there are 200 undecayed nuclei.

The ratio is 200:800,

which simplifies to **1:4** ***[1 mark]***

You don't even need the numbers to work out this ratio. For any radioactive isotope, after two half lives, the initial number of undecayed nuclei will have halved and then halved again. It will be one quarter of the original number, so the ratio is always 1:4.

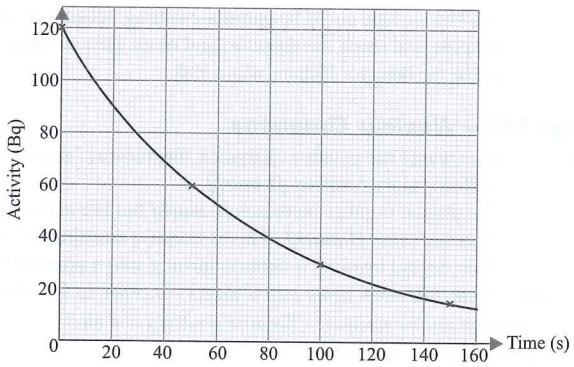
2 Isotope 1, because more nuclei will decay per second ***[1 mark]***.

3.1 It takes a total of 2 hours and 30 minutes for the activity to halve from 8800 Bq to 4400 Bq,

so its half-life = (2 × 60) + 30 = **150 minutes** ***[1 mark]***

3.2 Check how many half-lives pass during 6 hours and 15 minutes:
6 hours and 15 minutes = (6 × 60) + 15 = 375 minutes
375 ÷ 150 = 2.5 half-lives
The activity can only be worked out if a whole number of half-lives have passed, so calculate how many half-lives have passed from the time when activity = 6222 Bq:
1 hour 15 minutes = 60 + 15 = 75 minutes
375 – 75 = 300 minutes
300 ÷ 150 = 2 half-lives.
So now you can calculate the activity after 2 half-lives, with an initial activity of 6222 Bq:
After 1 half-life, the activity will be 6222 ÷ 2 = 3111 Bq
After 2 half-lives, the activity will be 3111 ÷ 2 = 1555.5 Bq
1555.5 = **1600 Bq (to 2 s.f.)**
[2 marks for correct answer, otherwise 1 mark for finding how many half-lives will have passed between 1 hour and 15 minutes and 6 hours and 15 minutes]

4.1



[3 marks in total — 2 marks for all points plotted correctly, otherwise 1 mark for three points plotted correctly, 1 mark for smooth curve.]

Start the graph at 120 Bq. After 50 s, this will have halved to 60 Bq. After another 50 s (i.e. 100 s altogether), it will have halved again, to 30 Bq. Plot these points, then join them up with a nice smooth curve.

4.2 70 Bq (accept between 68 Bq and 72 Bq)
[1 mark for correct value from your graph]

4.3 After 200 s, 15 ÷ 2 = 7.5 Bq
After 250 s, 7.5 ÷ 2 = **3.75 Bq** ***[1 mark]***
E.g. radioactive decay is random ***[1 mark]*** and the effect of randomness on the activity will be greater for lower activities ***[1 mark]***.

Page 211 — Irradiation and Contamination

1 Any two from: e.g. using shielding / working in a different room to the radioactive source / using remote-controlled arms to handle sources / wearing protective suits ***[2 marks]***

2.1 Contamination is when unwanted radioactive particles get onto an object ***[1 mark]***. Irradiation is when an object is exposed to radiation ***[1 mark]***.

2.2 Any two from: e.g. wearing protective gloves / using tongs / wearing a protective suit or mask ***[2 marks]***.

3 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief explanation of the dangers of contamination or radiation. ***[1 to 2 marks]***
Level 2: There is some explanation of the dangers and risks of contamination and radiation. ***[3 to 4 marks]***
Level 3: There is a clear and detailed explanation of the dangers and risks of contamination and radiation, used to justify the conclusion that the clockmaker should be more concerned about contamination. ***[5 to 6 marks]***
Here are some points your answer may include:
Alpha particles are strongly ionising.
Alpha particles are stopped by skin or thin paper.
Being irradiated won't make the clockmaker radioactive.
But irradiation may do some damage to his skin.
However, the radiation cannot penetrate his body and cause damage to his tissue or organs.
If the clockmaker's hands get contaminated with radium-226, he will be exposed to more alpha particles, close to his skin.Or he may accidentally ingest (eat) some.
Or if particles of the radium get into the air, he could breathe them in.
The radium will then decay whilst inside his body.
This means that the alpha particles can do lots of damage to nearby tissue or organs.
So he should be more concerned about contamination.

Topic P5 — Forces

Page 212 — Contact and Non-Contact Forces

Warm-up
Scalar — mass, time, temperature
Vector — acceleration, weight, force

1 Vector quantities have both magnitude and direction. ***[1 mark]***

2 Contact force: e.g. friction / tension / normal contact force / air resistance ***[1 mark]***
Non-contact force: e.g. weight / gravitational force ***[1 mark]***

3.1

[1 mark for correct arrow length, 1 mark for correct direction]

3.2 Both arrows need to be longer (to indicate the stronger interaction) ***[1 mark]***.
The arrows need to be the same size as each other ***[1 mark]***.

Page 213 — Weight, Mass and Gravity

1 **Mass** is the amount of matter in an object. **Weight** is a force due to gravity. Mass is measured **kilograms** whilst weight is measured in **newtons**. The weight of an object is **directly** proportional to its mass. ***[3 marks for all correct, 2 marks for 3-4 correct, 1 mark for 1-2 correct]***

2 A point at which you can assume the whole mass of an object is concentrated. / The point from which the weight of an object can be assumed to act. ***[1 mark]***

3.1 $W = mg$ ***[1 mark]***

3.2 $W = 350 \times 9.8$ ***[1 mark]*** = **3430 N** ***[1 mark]***

3.3 New mass = 350 – 209 = 141 kg ***[1 mark]***
$W = mg = 141 \times 3.8$ ***[1 mark]*** = 535.8
= **536 N (to 3 s.f.)** ***[1 mark]***

Page 214 — Resultant Forces and Work Done

1 C ***[1 mark]***

The resultant force is the sum of the two forces acting on each runner, taking into account the direction. For runner C, the resultant force is 130 N – 100 N = 30 N.

2.1 $W = Fs = 50 \times 15$ ***[1 mark]*** = **750** ***[1 mark]***
Unit: **J** or **Nm** ***[1 mark]***

2.2 The temperature of the suitcase increases ***[1 mark]*** because doing work causes some energy to be transferred to the thermal energy store of the suitcase ***[1 mark]***.

3.1 100 N ***[1 mark]***

As the ladder isn't moving, the resultant force is zero, and so the weight of the ladder is equal to the normal contact force acting on the ladder.

3.2

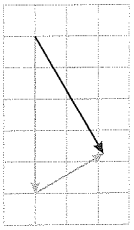
[1 mark for correct arrow length (same as 30 N arrow length), 1 mark for correct direction]

Page 215 — Calculating Forces

Warm-up
Horizontal component = 4 N
Vertical component = 3 N

1.1 1 cm = 100 N ***[1 mark]***

1.2



Magnitude = **430 N**
[1 mark for correct construction of resultant force, 1 mark for correct magnitude]

Page 216 — Forces and Elasticity

1.1 Elastic deformation is when an object returns to its original size after the deforming force is removed ***[1 mark]***. Inelastic deformation is when an object has been deformed such that it cannot return to its original size or shape after the deforming force is removed ***[1 mark]***.

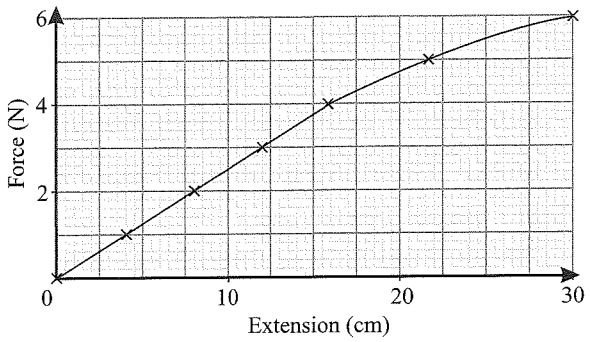
1.2 Compressing, bending ***[1 mark for both correct]***

2.1 $F = ke$ so $k = F \div e$
$e = 20$ cm $= 0.2$ m
so $k = 250 \div 0.2$ ***[1 mark]*** = **1250** ***[1 mark]***
Unit = **N/m** ***[1 mark]***

2.2 E.g. Agree — the extension will be 40 cm, because force is proportional to extension, so doubling the force doubles the extension ***[1 mark]***, assuming that the spring hasn't gone past its limit of proportionality ***[1 mark]***.

Page 217 — Investigating Springs

1.1



[1 mark for points plotted correctly, 1 mark for line of best fit showing linear relationship at the start, 1 mark for curved line of best fit towards the end of the graph]

1.2 Spring constant = Force ÷ Extension
= gradient of the linear section of the graph
$k = 3 \div 0.12 =$ **25 N/m**
[2 marks for correct answer between 24 and 26 N/m, otherwise 1 mark for correct calculation]

2 Work done on spring = energy stored in the spring's elastic potential energy store
$E = \frac{1}{2}ke^2 = \frac{1}{2} \times 25 \times 0.08^2$ ***[1 mark]*** = **0.08 J** ***[1 mark]***

Pages 218-219 — Distance, Displacement, Speed and Velocity

Warm-up
Displacement and **velocity** are both **vector** quantities. This means they have both a size and a direction. Speed and **distance** are both **scalar** quantities. They do not depend on direction.

1.1 7 m ***[1 mark]***

1.2 12 m ***[1 mark]***

1.3

[1 mark for arrow of correct length in the correct direction]

1.4 2 m ***[1 mark]***

2 330 m/s ***[1 mark]***

3 Any three from: fitness / age / distance travelled / terrain
[3 marks — 1 mark for each correct answer]

4 No — velocity is speed in a given direction ***[1 mark]***. The satellite travels at a constant speed, but is always changing direction so its velocity is always changing ***[1 mark]***.

5.1 $s = vt$ ***[1 mark]***

5.2 Typical walking speed = 1.5 m/s (accept 1-2 m/s) ***[1 mark]***
$t = s \div v = 6000 \div 1.5$ ***[1 mark]***
= **4000 s** (accept 3000-6000 s) ***[1 mark]***

5.3 Typical cycling speed = 6 m/s (accept 5-7 m/s) ***[1 mark]***
$s = vt$ so $t = s \div v = 6000 \div 6$ ***[1 mark]*** = 1000 s ***[1 mark]***
4000 – 1000 = **3000 s** (accept 1800-5200) ***[1 mark]***

5.4 $t = 20 \times 60 = 1200$ s ***[1 mark]***
$s = vt$ so $v = s \div t = 9600 \div 1200$ ***[1 mark]*** = **8 m/s** ***[1 mark]***

6 Speed of sound = $331 + (0.6 \times -60) = 295$ m/s ***[1 mark]***
Jet speed = $0.80 \times 295 = 236$ m/s ***[1 mark]***
$s = vt$
$= 236 \times 5.0 \times 10^4$ ***[1 mark]***
= 11 800 000 m = **11 800 km** ***[1 mark]***

Page 220 — Acceleration

Warm-up
A sprinter starting a race — 1.5 m/s^2
A falling object — 10 m/s^2
A bullet shot from a gun — 2×10^5 m/s^2

1 The object is slowing down ***[1 mark]***.

2.1 $a = \Delta v \div t$ ***[1 mark]***

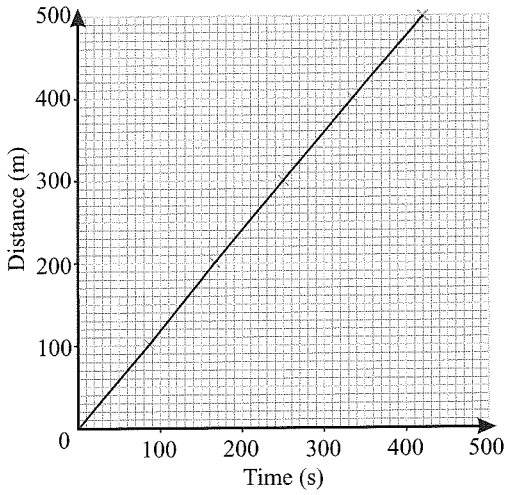
2.2 $a = \Delta v \div t = 4 \div 1$ ***[1 mark]*** = **4 m/s^2** ***[1 mark]***

3 $a = \Delta v \div t$
$t = \Delta v \div a$ ***[1 mark]*** $= 20 \div 2.5$ ***[1 mark]*** = **8 s** ***[1 mark]***

4 $v^2 - u^2 = 2as$ so
$a = (v^2 - u^2) \div 2s = (18^2 - 32^2) \div (2 \times 365)$ ***[1 mark]***
$= -0.9589...$
So deceleration = 1.0 m/s^2 (to 2 s.f.) ***[1 mark]***

Pages 221-223 — Distance-Time and Velocity-Time Graphs

1.1



[3 marks for graph plotted correctly, otherwise 1 mark for three points correct, 1 mark for suitable straight lines connecting the points]

1.2 360 m (accept between 350 m and 370 m) ***[1 mark]***

1.3 210 s (accept between 200 s and 220 s) ***[1 mark]***

1.4 E.g. refer to the same point on the boat / make sure that the timings are measured from exactly level with the posts / make sure timings are made close to the posts to avoid parallax / use a stopwatch instead of a watch ***[1 mark for any correct answer]***

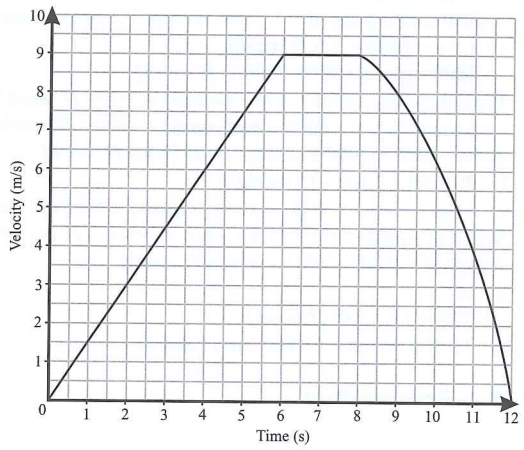
2.1 12 minutes ***[1 mark]***

2.2 Accelerating ***[1 mark]***

3.1 $v = \Delta s \div t$ = gradient of line
Speed = $(92 - 20) \div (6 - 3) = 72 \div 3 =$ **24 m/s**
(accept between 23 m/s and 25 m/s)
[3 marks for correct answer, otherwise 1 mark for realising speed is the gradient of the line, 1 mark for correct calculation]

3.2 Speed = gradient of a tangent to the line
$v = \Delta s \div \Delta t = (16 - 0) \div (3 - 1) = 16 \div 2 =$ **8 m/s**
(accept between 6 m/s and 10 m/s)
[3 marks for correct answer, otherwise 1 mark for a correct tangent to the line, 1 mark for correct calculation]

4.1



[1 mark for correct shape of graph, 1 mark for graph ending at 0 m/s]

4.2 $a = \Delta v \div t$ = gradient of the line
Acceleration = $(9 - 0) \div (6 - 0) =$ **1.5 m/s²**
[2 marks for correct answer, otherwise 1 mark for correct calculation]

4.3 $s = vt$ = area under the line *[1 mark]*
0-6 s: area = $\frac{1}{2}bh = \frac{1}{2} \times 6 \times 9 = 27$ m *[1 mark]*
6-8 s: area = $bh = 2 \times 9 = 18$ m *[1 mark]*
Total distance in 8 s = 27 + 18 = **45 m** *[1 mark]*

4.4 1 square is worth 0.5 s on the x-axis (time)
1 square is worth 0.5 m/s on the y-axis (velocity)
[1 mark for both correct]
$s = vt = 0.5 \times 0.5 = 0.25$ m *[1 mark]*
Squares under the line between 8 s and 12 s = 91 *[1 mark]*
$91 \times 0.25 = 22.75$ m *[1 mark]*
Total distance = 45 + 22.75 = 67.75 = **68 m** *[1 mark]*
(accept between 63 and 72 m)

Page 224 — Terminal Velocity

1 The resultant vertical force on an object falling at its terminal velocity is zero.
Terminal velocity is the maximum velocity an object can fall at. *[1 mark for both correct]*

2 The drag from the water acting on the fish is increasing. *[1 mark]*

3.1 As both objects fall, they accelerate due to gravity *[1 mark]*. As their velocities increase, so does the air resistance acting on them *[1 mark]*. The air resistance acts in the opposite direction to the acceleration, reducing the resultant forces acting on each object. Eventually the resultant forces on the objects are zero and they fall at constant velocities *[1 mark]*.

3.2 The book has a larger surface area than the ball, so experiences more air resistance *[1 mark]*. This means that the resultant force on the book reaches zero sooner, and so it has a lower terminal velocity *[1 mark]*.

Pages 225-226 — Newton's First and Second Laws

1 If the resultant force on a stationary object is zero, the object will remain stationary *[1 mark]*.

2 Newton's Second Law states that the acceleration of an object is **directly** proportional to the **resultant** force acing on the object and **inversely** proportional to the **mass** of the object.
[3 marks for all correct, 2 marks for 2-3 correct, 1 mark for one correct]

3.1 E.g. friction *[1 mark]*, air resistance / drag *[1 mark for either]*

3.2 Resultant force on an object at a constant velocity is zero.
so 5000 = 3850 + second force
Second force = 5000 – 3850 = **1150 N**
[1 mark for correct answer]

4.1 $F = ma$ *[1 mark]*

4.2 $F = 5.0 \times 9.8$ *[1 mark]* = **49 N** *[1 mark]*

5 $a = \Delta v \div t$
$a = 24 \div 9.2$ *[1 mark]* = 2.6... m/s² *[1 mark]*
$F = ma$
$F = 1450 \times 2.6...$ *[1 mark]* = 3782.6...
= **3800 N (to 2 s.f.)** *[1 mark]*

6 Typical speed of a lorry is 25 m/s
(accept 20-30 m/s) *[1 mark]*
$v^2 - u^2 = 2as$
$a = (v^2 - u^2) \div 2s = (0^2 - 25^2) \div (2 \times 50)$ *[1 mark]*
$= -625 \div 100 = -6.25$ m/s² (accept 4-9 m/s²) *[1 mark]*
$F = ma = 7520 \times -6.25$ *[1 mark]*
= **(–) 47 000 N** (accept 30 100-67 700 N) *[1 mark]*

Page 227 — Inertia and Newton's Third Law

Warm-up
When two objects interact, they exert equal and opposite forces on each other.

1.1 320 N *[1 mark]*

1.2 Normal contact force *[1 mark]*

1.3 640 N *[1 mark]*

Weight is the force exerted by the Earth on the gymnast (because of the gymnast and the Earth interacting). An equal but opposite force acts on the Earth because of the gymnast.

2.1 The tendency to continue in the same state of motion *[1 mark]*

2.2 E.g. how difficult it is to change the velocity of an object / ratio of force over acceleration / $m = F \div a$
[1 mark for any correct definition]

Page 228 — Investigating Motion

1.1 E.g. as force increases, so does acceleration / acceleration is proportional to force
[1 mark for any correct conclusion]

1.2 $F = ma$ *[1 mark]*

1.3 At a force of 4.0 N, the acceleration is 2.25 m/s²
So $m = F \div a$ *[1 mark]* = $4.0 \div 2.25$ *[1 mark]*
= 1.77... = **1.8 kg** *[1 mark]*

You'll still get the marks if you took readings from a different part of the graph, so long as you get the correct final answer.

2 To test the effect of varying the mass of the trolley, the force on the trolley has to remain constant *[1 mark]*. Adding masses to the trolley increases both the force on and mass of the trolley, so the effect of varying the mass cannot be found *[1 mark]*.

Page 229 — Stopping Distances

1.1 The distance travelled during the driver's reaction time *[1 mark]*

1.2 The distance travelled under the braking force of the vehicle *[1 mark]*

2 Stopping distance = thinking distance + braking distance
12 + 24 = **36 m** *[1 mark]*

3 Work is done by friction between the brakes and the wheels *[1 mark]*. This causes energy to be transferred to the thermal energy stores of the brakes, so they increase in temperature *[1 mark]*.

4 Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation of why good brakes and tyres are important. *[1 to 2 marks]*
Level 2: There is an explanation of why good brakes and tyres are important with some explanation as to the safety implications of poor brakes or tyres. *[3 to 4 marks]*
Level 3: A logical and detailed explanation is given which includes at least 2 examples of explaining the importance of having the tyres and brakes in good condition, at least 2 safety implications and at least 1 effect on stopping distance. *[5 to 6 marks]*

Here are some points your answer may include:
A good tread depth on tyres removes water.
This means there is a large amount of grip (friction) between the road and the tyres.
This decreases the braking (and so stopping) distance in wet conditions.
It also means the car will be less likely to skid in wet conditions.
Brakes that are in good condition allow a larger braking force to be applied.
This means that the braking distance of the car is shorter.
Brakes that are in good condition are also less likely to overheat under a large braking force.
So the car is less likely to go out of control or cause a crash.

Pages 230-231 — Reaction Times

1 0.2 - 0.9 s *[1 mark]*

2 Any three from: tiredness / alcohol / drugs / distractions *[3 marks — 1 mark for each correct answer]*

3.1 E.g. clicking a mouse when a computer screen changes colour *[1 mark]*

3.2 Student A: (7.0 + 7.1 + 6.9) ÷ 3 = **7.0 cm** *[1 mark]*
Student B: (8.4 + 8.2 + 8.3) ÷ 3 = **8.3 cm** *[1 mark]*

3.3 Student A, because the average distance fallen by the ruler was less for Student A than Student B *[1 mark]*.

3.4 E.g. use the same ruler, always have the same person dropping the ruler. *[2 marks — 1 mark for each correct answer]*

3.5 Their reaction times will get longer *[1 mark]*.

4 Hold a ruler between the open forefinger and thumb of the person being tested *[1 mark]*. Align their finger to the zero line of the ruler, then drop the ruler without warning *[1 mark]* and have the test subject close their thumb and finger to catch the ruler *[1 mark]*. The distance the ruler falls can be read from the ruler *[1 mark]*. The time taken for it to fall can be calculated, as the acceleration (due to gravity) is constant. This is the reaction time of the test subject *[1 mark]*.

5 Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation of how the man's reaction time may be affected and at least one mention of an implication this has for safety. *[1 to 2 marks]*
Level 2: There is an explanation of how the man's reaction time may be affected and the implications this has for safety. *[3 to 4 marks]*
Here are some points your answer may include:
Listening to loud music may mean that the driver is distracted. This may increase his reaction time.
An increased reaction time means an increased thinking distance.
Driving quicker also increases the distance the car travels during the man's reaction time.
All of these things increase stopping distance, which means the man may not be able to stop in time to avoid hitting a hazard.
He may be unable to see an upcoming hazard because it is dark.
Driving late at night might mean that the man is tired.
He may not be able to hear an upcoming hazard because of the loud music.
This reduces the stopping distance required to avoid hitting a hazard and may lead to the driver having a collision.

6 $v^2 - u^2 = 2as$
$v^2 = 0 + (2 \times 9.8 \times 0.45)$ *[1 mark]* = 8.82
$v = 2.969...$ m/s *[1 mark]*
$a = \Delta v \div t$
$t = \Delta v \div a = 2.969... \div 9.8$ *[1 mark]*
$= 0.303...$ = **0.30 s (to 2 s.f.)** *[1 mark]*

Page 232 — Momentum

Warm-up
1: Momentum is a property of...
2: ...moving objects.
3: It is a...
4: ...vector quantity and is equal to...
5: ...mass × velocity.

1.1 $p = mv$ *[1 mark]*

1.2 $m = p \div v$ *[1 mark]* = 5500 ÷ 25 *[1 mark]* = **220 kg** *[1 mark]*

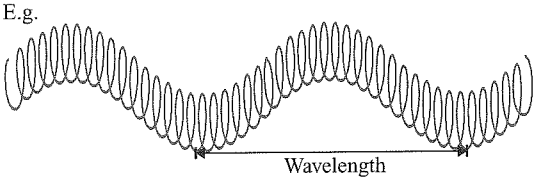
2 In Figure 1, the total momentum of the system is equal to the mass of the moving ball multiplied by its velocity *[1 mark]*. As it hits the line of balls, it transfers this momentum to them and comes to a stop. All of this momentum is transferred along the line of balls to the ball at the end of the line, which is why the middle balls don't move *[1 mark]*. This final ball has the same momentum as the first ball, causing it to move with the same velocity (because all of the balls have the same mass) that the moving ball in Figure 1 had *[1 mark]*. In Figure 2, the total momentum of the system is equal to the total momentum in Figure 1 *[1 mark]*.

Topic P6 — Waves

Page 233 — Transverse and Longitudinal Waves

1.1 Wave A is a **transverse** wave and wave B is a **longitudinal** wave. *[1 mark]*

1.2 E.g.



[1 mark for correctly labelled wavelength]

1.3 Amplitude is the maximum displacement of a point on a wave from its undisturbed position *[1 mark]*.

1.4 E.g. ripples on the surface of water / light / any other electromagnetic wave *[1 mark]*

2.1 Horizontal arrow drawn pointing away from the loudspeaker *[1 mark]*

2.2 $T = 1 \div f = 1 \div 200$ *[1 mark]* = **0.005 s** *[1 mark]*

2.3 In longitudinal waves, the oscillations/vibrations are parallel to the wave's direction of energy transfer *[1 mark]*, but in transverse waves, the oscillations/vibrations are perpendicular/at right angles to the wave's direction of energy transfer *[1 mark]*.

Page 234 — Experiments with Waves

1.1 E.g. the student could use a strobe light *[1 mark]*. When the frequency of the strobe light matches that of the wave, the wave fronts will appear stationary (and the student can then measure the stationary wave) *[1 mark]*.

1.2 There are 9 wavelengths in the distance of 18 cm.
Therefore, wavelength = 18 cm ÷ 9 = 2 cm *[1 mark]*
$v = f\lambda = 12 \times 0.02$ *[1 mark]*
= **0.24 m/s** *[1 mark]*

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: A simple method to find the speed of waves on a string is partly outlined. *[1 to 2 marks]*
Level 2: A method to find the speed of waves on a string is outlined in some detail. *[3 to 4 marks]*
Level 3: A method to find the speed of waves on a string using suitable apparatus is fully explained in detail. *[5 to 6 marks]*
Here are some points your answer may include:
Connect a string over a pulley to a vibration transducer. Connect a signal generator to the vibration transducer and switch it on.
Adjust the frequency of the signal generator to produce clear waves on the string.
For as many half-wavelengths on the string as you can, measure the distance they cover.
Divide this by the number of half-wavelengths to find the average half-wavelength of the waves on the string.
Double this value to find the wavelength, λ, and note down the frequency of the frequency generator, f.
Use the formula $v = f\lambda$ to calculate the speed of the waves on the string, v.
To get more accurate results the experiment can be repeated for different frequencies and a mean value calculated.

Page 235 — Wave Behaviour and Electromagnetic Waves

Warm-up
wave is reflected — it bounces back off the material
wave is absorbed — it transfers all energy to the material
wave is transmitted — it passes through the material unaffected

1.1 All waves in the electromagnetic spectrum are **transverse**. *[1 mark]*. All electromagnetic waves travel at the same speed in **a vacuum**. *[1 mark]*

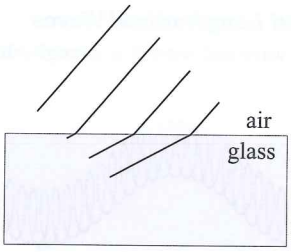
1.2 microwaves *[1 mark]*

1.3 E.g. energy is transferred from the thermal energy store of a toaster's heating element *[1 mark]* by (infrared) radiation to the thermal energy store of bread inside the toaster *[1 mark]*.

2 Some of the light is reflected back *[1 mark]* and some of the light is transmitted through the lens *[1 mark]*.

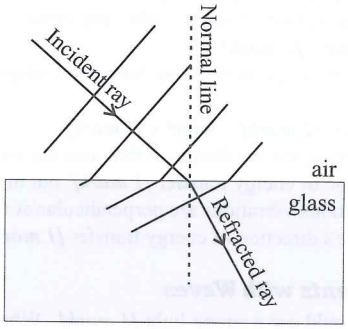
Page 236 — Refraction

1.1



[1 mark for wave fronts bending in the correct direction, 1 mark for wave fronts inside the glass being joined up with those in the air.]

1.2



[1 mark for incident ray drawn and labelled correctly, 1 mark for normal line drawn and labelled correctly, 1 mark for refracted ray drawn and labelled correctly.]

2.1 The ray bends towards the normal as it crosses the boundary *[1 mark]*.

2.2 The light ray would bend away from the normal *[1 mark]* because it would speed up / because light travels slower in glass than in a vacuum *[1 mark]*.

Page 237 — Radio Waves

Warm-up

True, True, False, True.

1 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: A simple method of generating radio waves is described. *[1 to 2 marks]*

Level 2: A method of generating radio waves and how these waves generate an electrical signal in a distant TV aerial is described. *[3 to 4 marks]*

Here are some points your answer may include:

An alternating current flows in the circuit the transmitter is connected to.

Alternating currents are made up of oscillating charges/electrons.

As the electrons oscillate in the transmitter, they produce oscillating electric and magnetic fields/radio waves.

Radio waves are transmitted to and then absorbed by the distant TV aerial.

The energy carried by the waves is transferred to the electrons in the material of the receiver.

This causes electrons in the receiver aerial to oscillate.

This generates an alternating current/an electrical signal.

This alternating current has the same frequency as the original current used to generate the radio wave.

2 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: There is a brief explanation of the differences between radio wave types used for broadcasting *[1 to 2 marks]*

Level 2: There is some explanation of the differences between radio wave types used for broadcasting, including their different ranges and how this affects which broadcast can be heard. *[3 to 4 marks]*

Level 3: There is a clear and detailed explanation of the differences between radio wave types used for broadcasting, including their different ranges and how this affects which broadcast can be heard. *[5 to 6 marks]*

Here are some points your answer may include:

FM radio is transmitted using very short wavelength radio waves.

These radio waves can only be received while the receiver is in direct sight of the transmitter.

This is because these wavelengths are easily absorbed by obstacles, e.g. buildings, and cannot diffract.

Therefore, the signal cannot be received in France.

Long-wave radio waves can be transmitted over long distances.

This is because long-wave radio waves diffract around the curved surface of the Earth.

Long-wave radio waves can also diffract around obstacles such as mountains.

Hence the signal can be received in France.

Page 238 — EM Waves and Their Uses

1.1 The microwaves are absorbed by water molecules in the potato *[1 mark]*. This transfers energy to the water molecules, causing the water in the potato to heat up *[1 mark]*. The water molecules transfer the energy they have absorbed to the rest of the molecules in the potato, cooking it *[1 mark]*.

1.2 The glass plate does not absorb any microwaves *[1 mark]* as it does not contain any water molecules, and so it is only heated by (conduction from) the potato *[1 mark]*.

1.3 infrared *[1 mark]*

2 It is dark so there is very little visible light for a normal camera to pick up *[1 mark]*. The person trying to hide is warmer than the surroundings and so emits more infrared radiation *[1 mark]*. This makes the person stand out from the surroundings if observed through infrared radiation *[1 mark]*.

Page 239 — More Uses of EM Waves

Warm-up

UV Rays: A, C, D

Visible Light: B, C

X-rays: E, F

Gamma Rays: F

1.1 E.g. the patient is injected with a gamma-emitting source *[1 mark]*. Gamma radiation is detected outside of the body, which is used to follow the source's progress around the patient's body *[1 mark]*.

1.2 E.g. they can pass out of the patient's body / they can be detected outside of the patient's body *[1 mark]*.

1.3 X-rays are directed at the patient. The X-rays are absorbed by bones *[1 mark]*, but transmitted by less dense body material, such as flesh *[1 mark]*. A screen behind the patient detects the X-rays and a negative image is formed with brighter areas where fewer X-rays are detected *[1 mark]*.

1.4 E.g. wear lead aprons / stand behind lead screens / leave the room whilst treatment is taking place *[1 mark]*.

Page 240 — Investigating Infrared Radiation

1.1 Matte black *[1 mark]*

1.2 Shiny white *[1 mark]*

1.3 E.g. use a radiation detector to measure the emitted radiation / use a ruler to make sure he measures the radiation emitted from each side from the same distance *[1 mark for any sensible suggestion]*

2 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: There is a brief description of the apparatus used to investigate the absorption of different surfaces. *[1 to 2 marks]*

Level 2: There is some description of a method and apparatus to investigate the absorption of different surfaces. At least one method to ensure the experiment is a fair test is mentioned. *[3 to 4 marks]*

Level 3: There is a clear and detailed description of a method and apparatus to investigate the absorption of different surfaces. At least two methods to ensure the experiment is a fair test are mentioned.
[5 to 6 marks]

Here are some points your answer may include:
Use two metal plates of the same material, but with different surfaces on one side (the front of the plate) — e.g. one shiny, one matte or one black, one white.
The plates should be the same size and thickness / identical in all other ways to make it a fair test.
On the back of each plate, a ball bearing is attached with candle wax.
The ball bearings should be identical to make the experiment a fair test.
The amount of wax used to attach each ball bearing should be the same, to ensure the test is fair.
The front of the plates are then faced towards a lit bunsen burner.
The distance between each plate and the bunsen burner should be the same to ensure the experiment is a fair test.
The time taken for the wax to melt and the ball bearing to fall is measured for both plates using a stopwatch.
The stopwatch should be stopped at the same point for each plate (e.g. the ball bearing starting to fall, or hitting the table/floor) for it to be a fair test.
The times taken for each ball bearing can then be compared to see which surface is better at absorbing radiation.
The faster the time, the better the surface is at absorbing radiation.

Page 241 — Dangers of Electromagnetic Waves

1.1 X-rays and gamma rays transfer so much energy to living cells that they can knock off electrons (ionise atoms) ***[1 mark]***. This can cause mutation of genes, leading to cancer ***[1 mark]***.

1.2 Any two from: sunburn / premature aging / blindness / (increased risk of) skin cancer ***[2 marks]***

2.1 Compare risk of chest scan to risk of head scan,
$10\,000 \div 2500 = 4$
Risk is 4 times greater, so dose is 4 times greater ***[1 mark]***.
Dose = $2 \times 4 =$ **8 mSv** ***[1 mark]***

2.2 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: The risks and benefits are identified but no comparison is made about whether one outweighs the other. ***[1 to 2 marks]***
Level 2: There is some discussion about balancing the benefits with the risks. ***[3 to 4 marks]***
Level 3: There is a detailed explanation of the benefits and risks, and an informed explanation of why the procedure may go ahead. ***[5 to 6 marks]***

Here are some points your answer may include:
The radiation dose is large, so the risk of developing cancer from the procedure is higher than in some other procedures.
However, the procedure might better inform a decision on future treatment.
So future treatment may be more effective.
The benefit of treating the condition needs to be compared with the risk of the procedure (and any subsequent treatment).
An assessment needs to be made about the risk of dying (or poor quality of life) from the underlying condition and the potential benefits for treatment.
Other less risky procedures might lead to similar benefits and these need to be considered.
If the benefits outweigh the risks considerably, then it is worth carrying on with the procedure.

Topic P7 — Magnetism and Electromagnetism

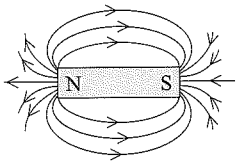
Pages 242-243 — Permanent and Induced Magnets

Warm-up
non-contact

1.1 A region in which a magnet or magnetic material will experience a force ***[1 mark]***.

1.2 Any two of e.g. iron/steel/nickel/cobalt ***[2 marks]***

1.3



[2 marks in total — 1 mark for correct shape, 1 mark for arrows pointing from north to south]

1.4 The correct statements are:
The closer together the magnetic field lines, the stronger the magnetic field ***[1 mark]***.
Magnetic field lines point from the north pole to the south pole of a magnet ***[1 mark]***.

2.1 The block of cobalt becomes an induced magnet when it is placed in the magnetic field of the bar magnet ***[1 mark]***, which causes a force of attraction between the paperclip and the cobalt ***[1 mark]***

2.2 When the bar magnet is removed, the cobalt will quickly demagnetise ***[1 mark]***, so the paperclip will become unstuck ***[1 mark]***.

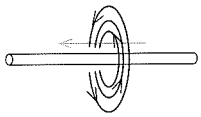
3.1 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description of how the compass should be used. ***[1 to 2 marks]***
Level 2: There is a good description of the method used to determine the magnetic field, including the effect on a compass when placed in a magnetic field. ***[3 to 4 marks]***

Here are some points your answer may include:
The needle of a compass points in the direction of the magnetic field it is in.
Put the magnet on a sheet of paper.
Move the compass along the field lines of the horseshoe magnet.
Mark the direction of the compass needle at each point.
Join up the marks to create a diagram of the magnetic field lines.

3.2 E.g. it would point (to geographic) north ***[1 mark]*** because it is aligning itself with the magnetic field of the Earth ***[1 mark]***.

Page 244 — Electromagnetism

1.1



[2 marks in total — 1 mark for correct shape, 1 mark for correct direction]

You can work this out using the right-hand thumb rule — point your right thumb in the direction of the current and your curled fingers will show the direction of the field lines. Bingo.

1.2 The direction of the field will also be reversed ***[1 mark]***.

1.3 Increase the current ***[1 mark]***.

2.1 E.g. put a block of iron in the middle of the solenoid ***[1 mark]***.

2.2 Repelled ***[1 mark]***, because the direction of the current means that the left-hand end of the solenoid acts as a north pole ***[1 mark]***, and like poles repel ***[1 mark]***.

Page 245 — The Motor Effect

1 $F = BIl$, so $B = F \div Il$
$B = 1.2 \div (0.4 \times 0.75)$ ***[1 mark]***
$= 1.2 \div 0.3 =$ **4 T**
[1 mark for correct value, 1 mark for correct unit]

2 A ***[1 mark]***

The force acting on the wire is at a maximum when the wire is perpendicular to the magnetic field between the magnets (O°) and is zero when the wire is parallel to the magnetic field (90°).

Page 246 — Electric Motors

1 It will move towards you, out of the paper ***[1 mark]***.

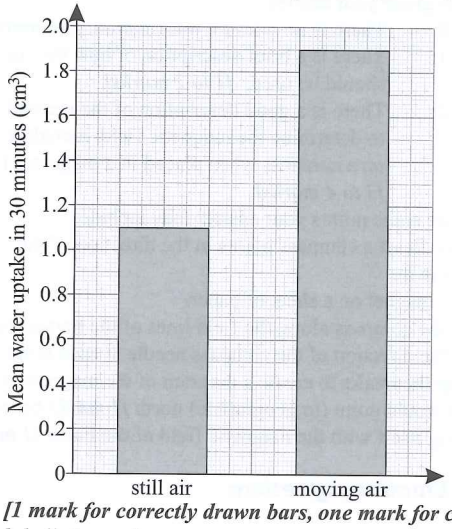
Use Fleming's left-hand rule here. Point your first finger in the direction of the field (i.e. from the north pole to the south pole of the magnets). Point your second finger in the direction of the current (shown in the diagram). Your thumb will then show the direction of motion of the wire.

2.1 clockwise *[1 mark]*
2.2 E.g. the interacting magnetic fields (of the coil and the magnets) causes a force on each arm of the coil *[1 mark]* in the opposite direction (which causes the coil to rotate) *[1 mark]*.
2.3 E.g. swap the contacts every half turn (e.g. using a split-ring commutator) to reverse the direction of the current *[1 mark]*. This swaps the direction of the forces for each arm and keeps the direction of rotation constant *[1 mark]*.

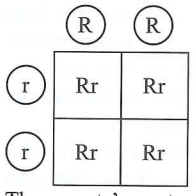
Mixed Questions

Pages 247-252 — Biology Mixed Questions

1.1 E.g. producing bile / converting lactic acid to glucose / storing glucose as glycogen / breaking down amino acids *[1 mark]*
1.2 Enzymes speed up chemical reactions in living organisms. *[1 mark]*
1.3 pH 9 *[1 mark]*
1.4 The enzyme will not work *[1 mark]* because the acid will change the shape of its active site/denature the enzyme *[1 mark]* and the substrate will no longer fit *[1 mark]*.
1.5 Alcohol is a risk factor for lung cancer. *[1 mark]*
2.1 To stop the loss of water by evaporation *[1 mark]*.
2.2



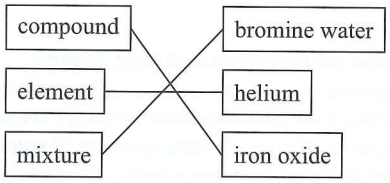
[1 mark for correctly drawn bars, one mark for correctly labelled axes.]
2.3 The greater the air flow around the plant, the greater the transpiration rate *[1 mark]*.
2.4 E.g. increasing air flow carries more water vapour away from the plant / reduces the concentration of water vapour outside the leaves *[1 mark]*. This increases the rate of diffusion of water from the leaf cells from an area of higher water concentration to an area of lower water concentration *[1 mark]*.
2.5 $1.2 - 0.8 = \mathbf{0.4\ cm^3}$ *[1 mark]*
The range is the difference between the highest and lowest values.
2.6 30 minutes ÷ 60 = 0.5 hours
$1.9 \div 0.5 = \mathbf{3.8\ cm^3/hour}$ *[2 marks for correct answer, otherwise 1 mark for correct working.]*
3.1 mitochondria *[1 mark]*
3.2 glucose + oxygen → carbon dioxide + water *[1 mark for both reactants correct, 1 mark for both products correct.]*
3.3 Glucose is combined with nitrate ions *[1 mark]* to make amino acids *[1 mark]*, which are then joined together to make proteins *[1 mark]*.
4.1 The hormone is secreted directly into the blood *[1 mark]*. It is then carried in the blood to the target organ *[1 mark]*.
4.2 C *[1 mark]*
4.3 B *[1 mark]*
4.4 It stimulates ovulation / the release of an egg from an ovary *[1 mark]*.
4.5 ovaries *[1 mark]*
4.6 A constantly high level of oestrogen inhibits the production of FSH *[1 mark]*, so there are no mature eggs for fertilisation to take place *[1 mark]*.
5.1 oxygen *[1 mark]*
5.2 light intensity *[1 mark]*
5.3 Tube 1 *[1 mark]*
5.4 Tube 1 shows that in the dark, the algae are producing more carbon dioxide than they take in *[1 mark]*. The concentration of carbon dioxide is high because the cells are respiring, but not photosynthesising (as there's no light for photosynthesis to take place) *[1 mark]*. Tube 2 shows that in the light, the algae are taking up more carbon dioxide than they produce *[1 mark]*. The concentration of carbon dioxide has reduced because the cells are photosynthesising faster than they are respiring *[1 mark]*.
5.5 Any two from: e.g. the temperature of the boiling tubes / the volume of hydrogencarbonate indicator / the concentration of hydrogencarbonate indicator / the number of beads in each tube / the concentration of algal cells in each bead *[2 marks]*.
5.6 Light intensity *[1 mark]* because the rate of photosynthesis is increasing as the light intensity increases *[1 mark]*.
5.7 carbon dioxide concentration *[1 mark]*
6.1 RR *[1 mark]*
6.2 round seed shape *[1 mark]*
6.3



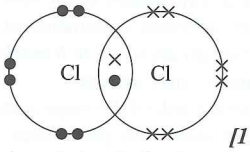
[1 mark]
The parents' genotypes were **RR** *[1 mark]* and **rr** *[1 mark]*.

Pages 253-259 — Chemistry Mixed Questions

1.1



[2 marks if all three correct, otherwise 1 mark if 1 correct]
1.2 Mixtures with a precise purpose *[1 mark]* that are made by following a formula / a recipe *[1 mark]*.
2.1 Dissolve the rock salt in water and filter *[1 mark]*.
2.2 It contains two elements/more than one element in fixed proportions *[1 mark]* held together by chemical bonds *[1 mark]*.
2.3 ionic *[1 mark]*
3.1 Group: 6 *[1 mark]*
Explanation: There are 6 electrons in the outer shell *[1 mark]*.
3.2 2– ions *[1 mark]*, as oxygen atoms need to gain two electrons to get a full outer shell *[1 mark]*.
3.3 Oxidation *[1 mark]*
4.1



[1 mark for shared pair of electrons, 1 mark for six further electrons in the outer shell of each chlorine atom]
4.2 E.g. atoms with the same number of protons / of the same element / with the same atomic number *[1 mark]* with different numbers of neutrons / different mass numbers *[1 mark]*.
4.3 Hold a piece of damp litmus paper in the unknown gas *[1 mark]*. It will be bleached white in the presence of chlorine *[1 mark]*.
4.4 Chlorine is more reactive than iodine *[1 mark]*, so would displace iodine from sodium iodide solution / the solution would go from colourless to brown *[1 mark]*.
5.1 endothermic *[1 mark]*
5.2 higher *[1 mark]*
5.3 It takes more energy to break the bonds in the reactants than is released when the bonds in the products form *[1 mark]*, so overall energy is taken in from the surroundings *[1 mark]*.
5.4 E.g. in a sports injury pack *[1 mark]*.
6.1 alkanes *[1 mark]*
6.2 (fractional) distillation *[1 mark]*
6.3 cracking *[1 mark]*
6.4 Decane *[1 mark]*, because the molecules are bigger *[1 mark]*, so will have stronger intermolecular forces / more energy is needed to break the forces between the molecules *[1 mark]*.

Answers

6.5 $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ ***[1 mark for correct reactants and products, 1 mark for balancing]***

7.1 The electrons in the outer shell ***[1 mark]*** of the metal atoms are delocalised ***[1 mark]***. There is strong electrostatic attraction between the positive metal ions and the shared negative electrons ***[1 mark]***.

7.2 Iron: solid ***[1 mark]***. Silver: liquid ***[1 mark]***

7.3 Iron ***[1 mark]***, because it has a higher melting/boiling point ***[1 mark]***, so more energy is needed to break the bonds ***[1 mark]***.

8.1 Copper is lower in the reactivity series/less reactive than carbon ***[1 mark]***, so can be extracted by reduction using carbon ***[1 mark]***.

8.2 Bacteria are used to convert copper compounds in the ore into soluble copper compounds ***[1 mark]***. This produces a leachate that contains copper ions ***[1 mark]*** which can be extracted by electrolysis/displacement with iron ***[1 mark]***.

8.3 The atoms in copper form layers which slide over each other, so it can be drawn out into wires ***[1 mark]***. Copper contains delocalised electrons which are free to move and carry an electric charge ***[1 mark]***.

8.4 The tin atoms in bronze distort the structure of the copper ***[1 mark]***. This means the layers can no longer slide over each other ***[1 mark]***, so bronze is harder than copper ***[1 mark]***.

9.1 It described atoms as having a tiny, positively charged nucleus at the centre ***[1 mark]***, surrounded by a cloud of electrons ***[1 mark]***.

9.2 Atoms consist of a small nucleus ***[1 mark]*** which contains the protons and neutrons ***[1 mark]***. The electrons orbit the nucleus in fixed energy levels/shells ***[1 mark]***.

10.1 The particles in a gas expand to fill any container they're in ***[1 mark]***. So the particles of carbon dioxide formed will expand out of the unsealed reaction vessel ***[1 mark]***, causing the mass of substance inside the reaction vessel to decrease ***[1 mark]***.

10.2 E.g. add a set volume and concentration of hydrochloric acid to the reaction vessel ***[1 mark]***. Add a set volume and concentration of sodium carbonate solution ***[1 mark]***, connect the reaction flask to a gas syringe ***[1 mark]*** and start the stop-watch ***[1 mark]***. Record the volume of gas collected at regular intervals until the reaction is finished ***[1 mark]***. Repeat the experiment, keeping everything the same except for the concentration of acid ***[1 mark]***.

10.3 Change in volume = 12.0 cm^3

$$\text{Mean rate of reaction} = \frac{\text{amount of product formed}}{\text{time}} = \frac{12.0}{30}$$

= **0.40 cm^3/s** ***[2 marks for correct answer, otherwise 1 mark for using the correct equation to calculate rate]***

11.1 Any two from: e.g. it dissolved in oceans / photosynthesis / trapped in rocks and fossil fuels ***[2 marks — 1 mark for each correct answer]***

11.2 E.g. methane ***[1 mark]***. It is increasing due to more agriculture / waste production ***[1 mark]***.

11.3 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There are a few examples of other pollutant gases, but little discussion of how they are made or what their impacts could be. ***[1 to 2 marks]***

Level 2: There are a number of examples of other pollutant gases, with some discussion of how they are made and what their impacts could be. ***[3 to 4 marks]***

Level 3: There are a number of examples of other pollutant gases, with a detailed discussion of how they are made and what their impacts could be. ***[5 to 6 marks]***

Here are some points your answer may include:

Other pollutant gases include carbon monoxide, sulfur dioxide and nitrogen oxides.

Carbon monoxide is produced when fuels undergo incomplete combustion.

Carbon monoxide can cause fainting, coma or even death.

Sulfur dioxide is produced when fuels that contain sulfur impurities are burned.

Sulfur dioxide can mix with water in clouds to produce sulfuric acid, so cause acid rain.

Sulfur dioxide can cause respiratory problems.

Nitrogen oxides are produced when nitrogen and oxygen from the air react/combine due to the heat of burning.

Nitrogen oxides can mix with water in clouds to produce nitric acid, so cause acid rain.

Nitrogen oxides can cause respiratory problems.

12.1 $M_r(LiOH) = A_r(Li) + A_r(O) + A_r(H) = 7 + 16 + 1 =$ **24** ***[1 mark]***

12.2 Number of moles = mass ÷ molar mass = 1.75 ÷ 7 = **0.25 mol** ***[2 marks for correct answer, otherwise 1 mark for using the correct equation to calculate moles]***

12.3 From the reaction equation, 0.50 mol Li forms 0.50 mol LiOH. Mass of LiOH = number of moles × molar mass = 0.50 × 24 = **12 g** ***[3 marks for correct answer, otherwise 1 mark for number of moles of LiOH produced, 1 mark for using the correct equation to calculate mass]***

13.1 Zinc is more reactive than hydrogen ***[1 mark]***. This means zinc forms positive ions more easily than hydrogen ***[1 mark]***.

13.2 Reduction ***[1 mark]***, because the hydrogen ions gain electrons ***[1 mark]***.

13.3 $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ ***[1 mark for correct reactants and products, 1 mark for balancing]***

If you had '$-4e^-$' on the left hand side of the equation instead of '$+4e^-$' on the right, you still get the marks.

14.1 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of the similarities and differences between lithium and sodium, but no explanation of these observations. ***[1 to 2 marks]***

Level 2: There is a detailed comparison of the similarities and differences between lithium and sodium, and some explanation of the observations. ***[3 to 4 marks]***

Level 3: There is a detailed comparison of the similarities and differences between lithium and sodium, and a good explanation of the observations. ***[5 to 6 marks]***

Here are some points your answer may include:

Both react to form positive, 1+ ions.

Both elements are in Group 1, so have one electron in their outer shell.

Not much energy is needed to remove this one outer electron and give the elements a full outer shell of electrons.

Both react with acid.

Sodium reacts more vigorously with acid than lithium.

Sodium is lower down in the group, so the outer electron in sodium is further away from the nucleus than the outer electron in lithium.

The attraction between the outer electron and the nucleus of sodium is less than the attraction between the outer electron and the nucleus in lithium.

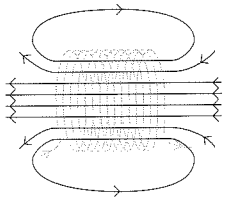
Less energy is needed to remove the outer electron of sodium, making it more reactive than lithium.

14.2 Any answer in the range 80–160 °C ***[1 mark]***

Pages 260-266 — Physics Mixed Questions

1.1 E.g. a permanent magnet produces its own magnetic field ***[1 mark]***. An induced magnet is a material that on becomes magnetic when it is put in a magnetic field ***[1 mark]***.

1.2



[1 mark for field lines pointing in the correct direction, 1 mark for drawing straight, parallel field lines inside the coil, 1 mark for drawing the field outside the coil]

2.1 Radioactive decay is where a nucleus releases radiation to become more **stable**. It is a **random** process, which means you **cannot** predict which individual nucleus in a sample will decay next. ***[2 marks for all correct, otherwise 1 mark for two correct]***

2.2 E.g. The rate of decay of a source of unstable nuclei/a radioactive source ***[1 mark]***.

It is measured in becquerels/Bq ***[1 mark]***.

2.3 E.g. the time taken for the activity of a sample to halve *[1 mark]*.

3.1 three-core cable *[1 mark]*

3.2 Live — **brown** — **230** *[1 mark]*
Neutral — blue — **0** *[1 mark]*
Earth — green and yellow — 0 *[1 mark]*

3.3 Energy is transferred **electrically** from the mains supply to the **kinetic** energy store of the fan's blades. *[1 mark for each correct answer]*

3.4 Energy transferred = Power × Time = 30 × (30 × 60) *[1 mark]*
= **54 000 J** *[1 mark]*

4.1 C *[1 mark]*

4.2 $V = IR$ *[1 mark]*

4.3 $R = V \div I = 240 \div 1.2$ *[1 mark]* = **200 Ω** *[1 mark]*

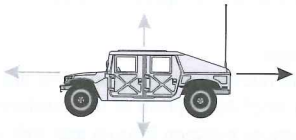
5.1 water ripples, gamma rays *[1 mark for both correct]*

5.2 $T = 1 \div f = 1 \div 40$ *[1 mark]* = 0.025 s
0.025 × 1000 *[1 mark]* = **25 ms** *[1 mark]*

5.3 $v = f\lambda$ *[1 mark]*

5.4 $v = 40 \times 0.6$ *[1 mark]* = **24 m/s** *[1 mark]*

6.1



[1 mark for an arrow in the right direction, 1 mark for it being the same length as the driving force arrow]

6.2 $s = vt$ *[1 mark]*

6.3 $s = 5.0 \times 30$ *[1 mark]* = **150 m** *[1 mark]*

6.4 $E_k = \frac{1}{2}mv^2$
$E_k = \frac{1}{2} \times 0.50 \times 5.0^2$ *[1 mark]* = **6.25 J** *[1 mark]*

6.5 Efficiency = Useful output energy transfer
÷ Total input energy transfer *[1 mark]*

6.6 0.65 = Useful output energy transfer ÷ 1200
Useful output energy transfer = 0.65 × 1200 *[1 mark]*
= **780 J** *[1 mark]*

7.1 increasing acceleration *[1 mark]*
steady speed *[1 mark]*
constant acceleration *[1 mark]*

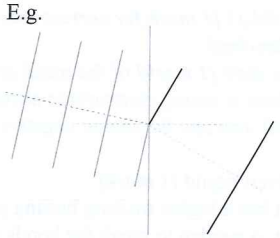
7.2 Acceleration = gradient of the graph *[1 mark]*
Acceleration = $\Delta v \div \Delta t = (7 - 4) \div (7 - 5)$ *[1 mark]*
= 3 ÷ 2 = **1.5 m/s²** *[1 mark]*

7.3 $F = ma$
So $a = F \div m$ *[1 mark]* = (–)440 ÷ 83 *[1 mark]*
= (–)5.30... m/s²
So deceleration = **5.3 m/s²** *[1 mark]*

Remember, force is a vector quantity. It's negative here because it's acting in the opposite direction to the motion of the cyclist. That's what gives you a negative acceleration (deceleration).

7.4 Distance travelled whilst reacting (thinking distance):
Assume a 0.5 s reaction time (accept 0.2-0.9 s) *[1 mark]*
From the graph, the cyclist's speed is 7 m/s, so:
$s = vt = 7 \times 0.5 = 3.5$ m (accept 1.4-6.3 m) *[1 mark]*
Distance travelled whilst braking (braking distance):
$v^2 - u^2 = 2as$
$u = 7$ m/s, $v = 0$, $a = -5.3$ m/s
$s = (v^2 - u^2) \div 2a = (0^2 - 7^2) \div (2 \times -5.3)$ *[1 mark]*
$= -49 \div -10.6 = 4.62...$ m *[1 mark]*
Stopping distance = thinking distance + braking distance
= 3.5 + 4.62... = 8.12... m = 8.1 m
(accept 6.0-11.0 m)
Stopping distance is less than 12 m, so the cyclist won't hit the car *[1 mark]*.

8.1 E.g.



[1 mark for wave fronts correctly changing direction, 1 mark for wave fronts being spaced further apart]

8.2 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

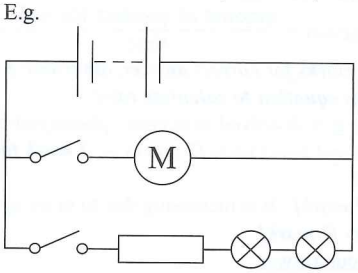
Level 1: There is a brief description of how the speed of different parts of the wave front change between air and diamond. *[1 to 2 marks]*

Level 2: There is a good description of how different parts of a wave front travel at different speeds when crossing a boundary. There is some description of how this results in refraction. *[3 to 4 marks]*

Level 3: There is a detailed explanation of how the difference in speed for different parts of a wave front results in a difference in distance travelled. There is a clear description of how this results in refraction when crossing a boundary at an angle. *[5 to 6 marks]*

Here are some points your answer may include:
Light travels faster in air than it does in diamond.
When the light ray crosses the boundary between diamond and air at an angle, it means different parts of the wave front cross the boundary at different times.
The parts of the wave front that have crossed the boundary travel faster than the rest of the wave front that is still travelling through the diamond.
Distance = speed ÷ time.
So in the time it takes the entire wave front to cross over the boundary, the parts of the wave front that have spent more of that time travelling through air have travelled further.
This difference in distance travelled between points along the wave front causes the ray to bend (refract) away from the normal.

9.1 E.g.



[2 marks for all circuit symbols correctly drawn, otherwise 1 mark for 4 symbols correctly drawn. 1 mark for filament lamps and resistor in series with each other, 1 mark for motor in parallel with other components, 1 mark for correct placement of switches]

9.2 $E = QV$ and $Q = It$ so $E = VIt$ *[1 mark]*
$E = 6.0 \times 70.0 \times 10^{-3} \times (15 \times 60)$ *[1 mark]* = 378 J
$\Delta E = mc\Delta\theta = 0.0250 \times 120 \times 6$ *[1 mark]* = 18 J
378 – 18 *[1 mark]* = **360 J** *[1 mark]*

9.3 E.g. he could lubricate the parts within the motor *[1 mark]*. This would reduce friction and the amount of energy being wasted/ dissipated to the thermal energy store of the motor *[1 mark]*.

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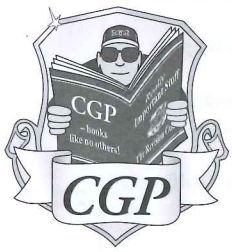

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