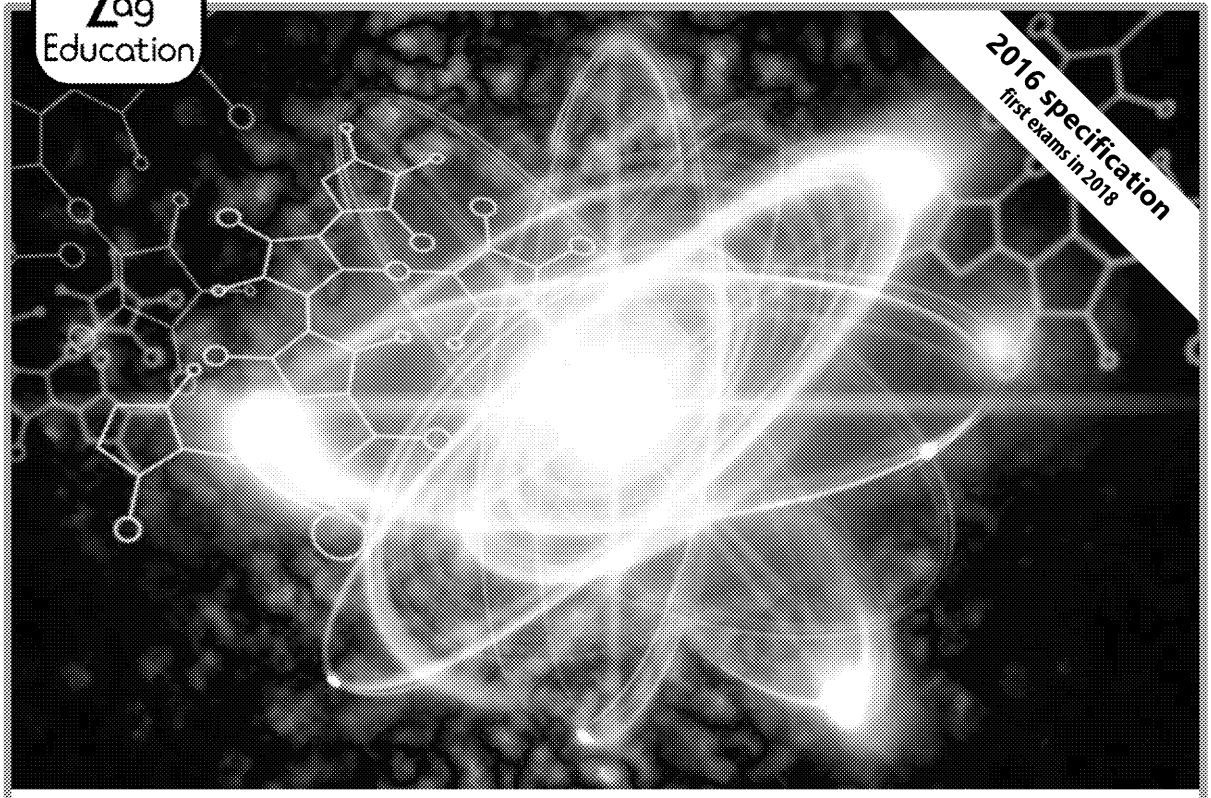
Zig Zag Education

Physics GCSE (9–1) | AQA | 8463



End-of-Topic A4 Quick-Mark Homeworks

For GCSE AQA Physics

Topics 1–4

zigzageducation.co.uk

POD 9783

Contents

Teacher's Introduction

These End-of-Topic Quick-Mark Homeworks are designed to test and consolidate students' knowledge of the **AQA GCSE (9–1) Physics** course, **Topics 1–4**.

The first half of the course is split into 10 topics, each covered by over 50 questions, for a total of over 500 questions.

Remember!
Always check the exam board website for new information, including changes to the specification and sample assessment material.

The questions increase in difficulty across each homework, with an extension section at the bottom of each homework. The **Fundamentals** section on each homework is targeted at students aiming for grade 4–5. The **Challenge** section is targeted at students aiming for grade 6. The **Extension** section is targeted at students aiming for grade 7 and above. All Higher-tier-only content is in the extension section, so the main body of the homework is suitable for students completing Foundation-tier exams.

All of the topics are in the same order as in the specification.

Maths questions and some shorter-answer questions may contain working or explanation that is not required in the answer so that students can more easily understand and follow difficult answers.

The homeworks are intended to be used at the end of each topic, but they can also be used at the end of the course to aid revision. Alternatively, you may choose to use them as tests in class or for students to work through by themselves or in pairs to test their understanding of the course material.

The first set of fundamentals questions for each homework are presented in the second section for use with weaker students who may struggle with the full homework. These can be cut down the middle to use one test at a time or test two topics at a time.

Answers are presented at the back of the resource, enabling students to check their answers, or teachers to mark students' work, quickly and easily.

I hope you find this resource useful in your teaching.

August 2019

Topic 1A — Energy Changes in a

Fundamentals

1. The mass of an object is 12.5 g. What is the object's mass in kg?
2. How is energy stored in a battery?
3. What is the standard unit of energy?
4. What type of energy do we say an object has if it is travelling at a constant velocity?
5. State how energy is stored before and after an electric remote-controlled boat starts to move.
6. The temperature of a cup of tea drops from 80 °C to 35 °C. What is the temperature change?
7. Calculate the gravitational potential energy of a 5 kg weight raised 1.6 km above the ground.
8. State the equation used to calculate the gravitational potential energy of an object.
9. How much gravitational potential energy does a 25 g bouncy ball gain if it is raised by 3 m?
10. What piece of apparatus could be used to measure the temperature change of a copper block?
11. Given that $\Delta E = m\ c\ \Delta\theta$, where m = 1.2 kg, c = 185 J / kg °C and $\Delta\theta$ = 35 °C, calculate ΔE.
12. Define the watt, W, the unit of power.
13. Describe how you could measure the change in temperature of a material.
14. Describe the energy transfer that occurs when a kettle is used to boil water.
15. Explain what is meant by elastic potential energy.
16. How many times should you repeat a temperature measurement of an insulated material? Why?
17. Why does a more powerful microwave heat up food faster than a less powerful microwave?

C

1. What happens to speed is halved?
2. How is energy sto
3. What is the kinet 2 kg travelling at
4. Given that E_e = 1 and e = 3.2 cm, ca
5. What are the uni
6. A 450 g block is h temperature by 1 the specific heat
7. How much kineti boat have if it we
8. A plane has a ma 240 m/s. What is
9. How long will an and has a power
10. How much energy and a half minute
11. If it takes 30 s for of energy, what is
12. Why does the am temperature of a
13. Describe how you thermal energy o
14. Describe how ene piano is pushed o
15. Why do the tyres been driven? Exp
16. Why is a 2 kW ke boiling a litre of w
17. Explain what is m

Extension

1. How high will a projectile go if it travels vertically from the ground starting at 30 km/h?
2. A javelin of mass 2 kg is thrown vertically to a height of 43.6 m. What is its maximum gravitational potential energy?
3. What is the kinetic energy in kJ of a skydiver weighing 70 kg falling at a terminal velocity of 55 m/s?
4. A skydiver jumps out of a plane. Assuming no air resistance, how fast is the skydiver travelling after falling 2 km?
5. If a ball falls from a height of 2.0 m from rest, how fast will it be going before it hits the ground?
6. If the extension of a spring is doubled, by what factor does its elastic potential energy increase?
7. What is the dependent variable when measuring the specific heat capacity of a material?
8. What do we call an object or a group of objects when dealing with energy changes?
9. Given that $\Delta E = m\ c\ \Delta\theta$, where m = 22 mg, c = 84.1 J / kg °C and $\Delta\theta$ = 37.5 °C, calculate ΔE.
10. 500 J of thermal e (c = 385 J / kg °C)
11. How fast can a re rating is 8 W, its m reach maximum s
12. A 2 kW motor run runs for 5 minute
13. Two identical ket water. Explain wh
14. Why does the kin negative values fo
15. Describe how ene explosion of a fire
16. When a current f Explain why this h
17. What happens to heated, and why?
18. If a rocket with its energy, why will i

Topic 1B — Efficiency and Energy

Fundamentals

1. State the change in energy stores when a ball is dropped from rest.
2. Three beakers are wrapped in three different materials in a thermal insulator experiment. What is the independent variable?
3. Are the following objects good insulators or good conductors? Oven gloves. Metal tongs.
4. Name one way in which a coal-powered furnace wastes energy.
5. Why does a TV become warm after being on for a long time?
6. How is energy wasted by a [illegible] on a construction site?
7. State [illegible] for efficiency in terms of energy transf[illegible]
8. What piece of apparatus would you use to measure the temperature of a rod of material?
9. State the energy transfer in a tennis ball being hit by a racquet.
10. Name two types of non-renewable energy resource.
11. What is the efficiency of a transformer with a power input of 100 kW and power output of 80 kW?
12. What is a renewable energy resource?
13. Why is housing insulation lined with a silver veneer?
14. Describe the energy transfer occurring for a bullet when a gun is fired.
15. Why is oil used to surround moving parts in a car engine?
16. What is meant by 'dissipated energy'?
17. Why is using renewable energy resources more favourable than using non-renewable energy resources?

C

1. Name one type o[illegible] currently suitable
2. Which is more th[illegible] a plastic rod?
3. In an experiment [illegible] materials as therm[illegible] dependent variab[illegible]
4. Name one way by [illegible] be reduced for a [illegible]
5. Name one factor [illegible] material, such as [illegible]
6. What is the main [illegible] energy?
7. If a computer has [illegible] and an efficiency [illegible]
8. What is the effici[illegible] output power is 2[illegible]
9. Which is the mor[illegible] nuclear or solar?
10. How is energy wa[illegible]
11. Name two renew[illegible] used to directly p[illegible]
12. Explain what hap[illegible] system when an [illegible]
13. You are building [illegible] make it as efficien[illegible]
14. Why can't geothe[illegible] resource worldwi[illegible]
15. What advantage [illegible] fuels?
16. Why is coal a non[illegible]
17. Why is efficiency [illegible] electronic device?

Extension

1. Name one advantage of wind energy as an energy resource.
2. A campfire has a total input energy of 2.7 kJ and a useful energy output of 850 J. What is its efficiency as a [illegible]
3. A radiator is made out of unpainted copp[illegible] thing that can be done to improv[illegible] efficiency.
4. Which is the better insul[illegible] a sheet of housing insulation or a vacuum?
5. A TV [illegible] input of 900 W and an efficiency of 70 %. What [illegible] useful power output?
6. The air at the top of a room is colder than the air at the bottom of the room – true or false?
7. How can a sailing boat be improved so it catches the wind more efficiently?
8. Which is a more reliable energy resource – wind, tidal or solar?
9. A robot has a total input energy of 1.4 kJ and a useful energy output of 780 J. What is its efficiency as a decimal?
10. At what time [illegible] at its lowest?
11. Name two ren[illegible] be used on M[illegible]
12. Explain why a [illegible] is directed at it[illegible]
13. Why is burning [illegible] environment?
14. If a light bulb [illegible] panel, will it st[illegible]
15. Describe how [illegible] fridge.
16. Why must scie[illegible] energy resour[illegible]
17. Where in the [illegible] and why?
18. Why can't scie[illegible] only renewab[illegible]

Topic 2A — Current, Potential Differenc

Fundamentals

1. What is the standard unit of charge?
2. An LED emits light when supplied with a current – true or false?
3. How much charge passes through a filament lamp if it is left on for 90 s and the current is 1.5 A?
4. What is the word equation that defines current in terms of charge and time?
5. What does the resistance of a thermistor depend on?
6. State Ohm's law in any form.
7. What is the potential difference of a lamp with a resistance of 250 Ω and current of 100 mA?
8. A charge of 80 C flows through a circuit in 20 s. Calculate the current in the circuit.
9. A 1.2 V current is applied through a 330 Ω resistor. What is the potential difference across the resistor?
10. What is the current in a 200 Ω resistor if 80 C of charge passes through it in one minute?
11. Describe the current–potential difference graph for a filament lamp.
12. What is the independent variable in an experiment measuring the resistance of wires with different diameters?
13. Why must a circuit be closed for the components in it to work?
14. Explain what is meant by an ohmic component.
15. Explain how an LDR can be used to solve a real-world problem.
16. Describe the current–potential difference graph for a diode.
17. Would the resistance of a wire increase or decrease if its diameter was increased, and why?

C

1. Which is the bigg
2. A current varies b
loop – true or fals
3. The circuit symbo
it – true or false?
4. The current at a p
2.3 A. After 3 s, h
5. The potential diff
stays constant. W
resistance is incre
6. What is the resista
is 2.7 V and the cu
7. What is the curre
connected to a 5 V
8. How much time e
through a 2.0 kΩ
of 12 V?
9. What is the depe
measuring the re
a potential differe
10. How much charge
after 45 s if the po
11. How does a highe
12. How does an incr
thermistor?
13. Describe the circu
14. Describe how you
through a compo
15. Explain what is m
16. Why must there b
circuit for a curre
17. Describe a circuit
resistance of a co

Extension

1. A diode is connected the wrong way round in a circuit. What is the current flowing through the circuit?
2. What is the potential difference across a 220 Ω resistor if 0.8 C of charge pass through it in 35 s?
3. How much charge has passed through a 400 Ω resistor after 30 s if the potential difference across it is 2 V?
4. The potential difference across an LED with a resistor of 100 Ω is 4.5 V. If it runs for 30 s, how much charge passes through it?
5. What is the potential difference across a 150 Ω resistor if 2.5 C of charge passes through it in 75 s?
6. What circuit component could you use to detect when water is boiling in a kettle?
7. For a filament bulb, does a higher potential difference mean the bulb is dimmer or brighter?
8. Describe the resistance of a diode connected in the reverse direction.
9. What is the resistance difference across it through it in 50 s?
10. Name a variable that investigating the I–V
11. What is the potential current flows when
12. Suggest a reason why increase after the w
13. Why does the curre for a filament lamp differences?
14. Why is it useful to k component?
15. Logic circuits outpu are diodes useful in
16. Why does the resist length of wire incre

Topic 2B — Series, Parallel Circuits and A

Fundamentals

1. The potential difference across each component in a series circuit is the same – true or false?
2. What equation would you use to find the total resistance of two resistors connected in series?
3. For components connected in parallel, how does the potential difference across each component compare?
4. Is an ammeter connected in series or in parallel to a component when used to measure its current?
5. The potential difference across a 100 Ω resistor is 4 V. What is the potential difference across a 200 Ω resistor connected in parallel with it?
6. What [illegible] of the domestic electric supply in the UK?
7. Two 450 Ω resistors are connected in series to a 9 V battery. What is the potential difference across one resistor?
8. What colour is the live wire in a three-core cable?
9. Is the mains electricity supply direct or alternating?
10. What colour is the earth wire in a three-pin plug?
11. Two 300 Ω resistors are connected in series to a 9 V battery. What is the current in the circuit?
12. Describe what a direct potential difference is.
13. Why is an exposed live wire dangerous if an appliance is plugged into the mains?
14. How would you test an LED to find out whether it works correctly?
15. Why are house lights connected using a parallel circuit?
16. Describe the circuit diagram of a parallel circuit.
17. Why does the total resistance increase when you add more resistors in series with each other?

C

1. Describe the tota… connected in para… one of the resisto…
2. A 4 V battery and … to a 200 Ω resisto…
3. What is the total … and a 1 kΩ resisto…
4. Two 100 Ω filame… a 9 V battery. Wh…
5. Three 1 kΩ resisto… current out of the … current in one re…
6. What colour is the…
7. What is the poten… and neutral wire?
8. An AC power sup… 1.5 V. What is its …
9. What happens if t… appliance?
10. What is the poten… in the UK?
11. Three 400 Ω resis… connected in serie…
12. Why is there an e… electrical applian…
13. A variable resisto… battery and a lam… resistance have o…
14. Describe what an …
15. Explain why all th… an electrical plug…
16. Why must a voltm… measure the pote…
17. Explain what is m…

Extension

1. Three wires, each carrying 0.1 A, join together in parallel to form a new wire. What is the current in this new wire?
2. What is the resistance of a lamp connected to a 7 V battery if a resistor connected in series has a potential difference of 3 V and a current of 70 mA?
3. A 100 Ω resistor and a 330 Ω resistor are connected in series to a 9 V battery. What is the current in each resistor?
4. The total resistance of two resistors connected in parallel is less than the resistance of the smallest resistor – true or false?
5. What is the potential difference across a 200 Ω resistor if it is connected in series with a 50 Ω resistor and a 5 V battery?
6. A 70 mA current flows through two 100 Ω resistors connected in series. What is the potential difference of the power supply?
7. The total current through two 30 Ω resistors connected in parallel is 75 mA. What is the current through each resistor?
8. A light bulb plugged into the mains has a resistance of 250 Ω. How much current passes through it?
9. The total cu… connected in… current thro…
10. What is the …
11. An extractor … resistance o… through it?
12. What happe… loose?
13. Why does a… each other r… circuit?
14. Why are wir… earth wire s…
15. Why does c… parallel circu…
16. When testing … which type o…

Topic 2C — Power, the National Grid and

Fundamentals

1. State the equation for power in terms of potential difference and current.
2. What is the power rating of a thermistor if a potential difference of 3 V is measured when 0.3 A passes through it?
3. What is the potential difference across a 0.7 W LED if the current through it is 0.15 A?
4. If a 100 W device is switched on for 45 s, how much energy does it use?
5. What is the power rating of a microwave if it is plugged into the mains (230 V) and the current is 3.3 A?
6. If a 3 W bulb and a 2 W bulb are switched on, how much energy do they use in two minutes?
7. How much energy does a 700 W microwave use in 120 s? Give your answer in kJ.
8. How much energy does a 9.0 V battery lose if it discharges 200 C?
9. What do step-down transformers do?
10. Two objects of opposite charge are placed near each other. Is the force between them attractive or repulsive?
11. When an object gains electrons, does it become positively charged or negatively charged?
12. Describe the national grid.
13. Why is the power of an electrical appliance dependent on the current flowing through it?
14. Describe the change in energy store when a phone battery is charged using the mains.
15. Describe how static electricity is produced.
16. Why is the power of an electrical appliance dependent on the potential difference?
17. What are step-up transformers used for, and why?

Cl

1. What is the potential d
36 kJ of energy to disch
2. What is the resistance
and a current of 250 m
3. A 1200 W hairdryer an
one minute. Which use
4. How much work is don
through it and it has a
5. What is the current in
difference across it is 3
6. What is the power rati
is 80 Ω and the current
7. A transistor has a powe
take for 50 µC of charg
difference is 5 V?
8. Describe the change in
when they are brought
9. Name two examples o
electricity.
10. How much charge does
into the mains (230 V)
11. If a positively charged
spheres are brought cl
would happen?
12. How can you tell if two
together are like-charg
13. Name one way to reduc
charged with static ele
14. Why are sparks produc
objects are brought ne
15. Explain what is meant
16. Describe how rubbing
the rod and the cloth t
17. Describe the electric fi
spheres in close proxim

Extension

1. 1 kWh = 3.6 MJ. How much work, in kWh, is done by a transformer to transfer 90 kC if its potential difference is 20 kV? (Assume 100 % efficiency.)
2. Given that 1 mAh = 3.6 C, how long (in hours) does a 2000 mAh battery take to discharge at a constant current of 0.[illegible] A?
3. 10 V is produced in a generator on a bike when a cyclist does 3 kJ of work on it. How much charge flows?
4. If the potential difference between two charged objects is kept at 17 kV and a charge of 2.9 µC is seen, how much energy is transferred?
5. How much work is done to transfer 200 mC of charge through a 330 Ω resistor in 14 s? (Hint: first calculate the current.)
6. What do the electric field lines look like for a negatively charged sphere?
7. The charge capacity of modern-day batteries is measured in mAh. What is 1 mAh in coulombs?
8. Compare the decrease in potential difference by step-down transformers to the increase in potential difference by step-up transformers.
9. 50 C of charge passes through a 3 W bulb in 35 s. What is the potential difference across the bulb?
10. How long do
potential dif
0 % to 100 %
11. 14 V is produ
cyclist does
flows?
12. By substituti
previously le
E = Q V.
13. Two metal s
connected to
spheres attra
14. Explain how
be dangerou
15. How is an el
16. Explain why
charged pain
17. Why is using
transfer ene
18. Why do obje
material for

Topic 3A — Changes of St

Fundamentals

1. What is the density of a 2.3 m^3 box if its mass is 650 g?
2. What is the density of a cube with sides 2 m if its mass is 4 kg?
3. Name the change of state when an indoor ice rink is made from liquid water.
4. The particles in a gas are more tightly packed than those in a solid – true or false?
5. What is the volume of a 2.5 kg tube of copper with a density of 8940 kg / m^3?
6. Name a piece of apparatus suitable fo… measuring the diameter of … wire.
7. Condensation is an … for boiling – true …
8. Given … = m c Δθ, what is Δθ when m = 2 kg, c = … J / kg °C and ΔE = 20 J?
9. Given that E = m L, what is the latent heat of lead if 220 kg of lead changes state after being heated with 191.6 MJ?
10. Given that ΔE = m c Δθ, what is Δθ when m = 3.1 kg, c = 340 J / kg °C and ΔE = 24.9 kJ?
11. What is the effect of latent heat of fusion?
12. What happens to the temperature when a change of state occurs?
13. Explain what is meant by the particle model.
14. Describe how you would measure the volume of an irregularly shaped object.
15. Explain what is meant by the conservation of mass for a system of particles.
16. Explain what latent heat is.
17. Explain the difference between evaporation and boiling.
18. Explain the difference between melting and sublimation.

Cl…

1. What is the density of a … 1.9 kg?
2. When water is boiled, … is reduced – true or fal…
3. If the total kinetic ener… potential energy is 0.7 …
4. Name the two changes … cube is placed into a ho…
5. … ater is frozen and me… closed system. What ha…
6. When a gas is heated, … particles.
7. What is the specific hea… temperature increases …
8. An 850 g bar of gold is … thermal energy. What …
9. In an experiment measu… would you use to deter…
10. What is the temperatu… heated with 11.2 kJ of …
11. What is the mass of a s… 1200 kJ / kg if it takes 3…
12. Name a variable you n… latent heat of water.
13. Explain how changes o… changes.
14. Explain what internal e…
15. Describe the temperat… the melting and boiling … energy input.
16. Why does snow take a …
17. Describe what happens …
18. Explain how the higher … results in the structure …

Extension

1. What is the density of a sphere with a mass of 2.2 g and a radius of 2.3 cm?
2. What is the mass of a sphere with a density of 375 k… and a radius of 1.8 cm?
3. Name the two changes of state wh… is on and droplets appear on a near… ind…
4. Calculate the mass … ice cube if it melts in a glass of water … 5 kJ of energy. (L_{water} = 334 kJ / kg)
5. Comp… motion of particles in a gas and in a liquid.
6. The mass of Earth is 6.0 × 10^{24} kg and its radius is 6400 km. What is its density?
7. At the temperature when a change of state occurs, added energy is stored as kinetic energy of the particles – true or false?
8. Calculate the energy transfer when an 80 g ice cube melts in a glass of 0 °C water. ($L_{ice/water}$ = 334 kJ / kg)
9. A lead ball with a radius of 8.0 mm is heated with 0.1 kJ. What is its temperature change? (c_{lead} 129 = J / kg °C, ρ_{lead} = 11340 kg / m^3)
10. A 60 g ice cu… energy. Wha… water? ($L_{ice/w…}$
11. Name one ad… instead of a t… heat of wate…
12. The latent he… latent heat of …
13. Give a word e…
14. Why do drop… glass of wate…
15. In terms of p… hovercraft ex…
16. Explain why … better than u…
17. Explain the c…
18. Describe how … gold ring.

Topic 3B — The Particle Model

Fundamentals

1. The arrangement of molecules in a gas is very ordered – true or false?
2. Describe the effect on the average speed of particles when the temperature of a gas increases.
3. What happens to the pressure of a gas being heated in a sealed box?
4. The temperature of a gas is dependent on the potential energy between each particle – true or false?
5. Describe the relationship between pressure and volume at a constant temperature.
6. If a gas is described by $PV = 2.8 \times 10^5$ Pa m^3 and $P = 7.$ Pa, what is its volume?
7. What is the standard unit of pressure?
8. What is the volume change, in m^3, when the volume of a gas changes from 25 cm^3 to 134 cm^3?
9. If a gas at a constant temperature has the relationship $P V = 3.4 \times 10^4$ Pa m^3 and its volume is 2.5 m^3, what is its pressure?
10. A gas at constant temperature and mass has its volume tripled. By what factor has its pressure decreased?
11. For Boyle's law, P V = constant. To hold true, what properties of a gas must stay constant?
12. Explain how the temperature of a gas is related to the motion of its particles.
13. Explain how increasing the volume of a gas decreases the pressure.
14. Explain how a gas exerts a pressure on a container wall.
15. Why does an unsealed balloon fly away when it is released?
16. Why would heating a sealed balloon cause it to expand?

1. What property o
the temperatur
2. A low-temperat
a high-temperat
3. Denser gases ex
4. A gas undergoes
$V_1 = 0.8$ m^3 and
5. A fixed mass of g
$p_1 = 1.3 \times 10^5$ Pa
What is V_2?
6. A gas undergoes
$p_2 = 2.4 \times 10^5$ Pa
7. A fixed mass of g
$p_1 = 0.9 \times 10^5$ Pa
What is p_2?
8. If the temperatu
effect does doin
9. A piston compre
What happens t
10. Do particles wit
temperature, ex
container wall?
11. Describe the an
wall due to its p
12. Why would pres
cause it to pop?
13. What happens t
bicycle pump is
14. Before a bicycle
a bicycle pump
increase.
15. Explain why the
the volume dec
16. If an amount of g
happens to the

Extension

1. A gas undergoes a change where $p_1 = 1.9 \times 10^5$ Pa, $p_2 = 2.6 \times 10^5$ Pa and $V_2 = 14952$ cm^3. What was V_1 in
2. A gas undergoes a change where $p_1 = 0.8 \times 10^5$ Pa, $p_2 = 4.2 \times 10^5$ Pa and $V_2 = 2.7$ cm^3. Wh V_1?
3. The volume of a coolant ga a fi s increased at a constant temperat n happens to its pressure?
4. If you e balloon, the temperature of the air ins balloon increases – true or false?
5. The pa les of a gas collide more if the pressure of the gas is high – true or false?
6. If two gases at the same temperature are made up of particles with different masses, which particles move faster?
7. If the pressure, volume and mass of a gas are constant, describe its temperature.
8. A gas is compressed in a piston. Describe what happens to the gas.
9. If the volume ar
but the pressure
temperature?
10. Two gases have
one gas has par
exerts more pre
11. Explain what ha
on a fully inflate
12. Describe how ch
used to operate
13. Describe how ai
they breathe in
14. Explain the cha
constant volum
decreased.
15. Describe how th
engine causes t

Topic 4A — Atoms and Isot

Fundamentals

1. The radius of a nucleus is 1×10^{-14} m. Write this in femtometres, fm.
2. What is the approximate radius of an atom?
3. Where would you find the protons in an atom?
4. If the number of electrons and protons in an atom is equal, there is no net charge – true or false?
5. What particles are neutral in charge in the atom?
6. A sulphur atom has 16 protons and 16 neut[illegible] how many electrons does it have?
7. An atom of carbon has a m[illegible] nu[illegible]r of 12 and an atomic number [illegible] many neutrons does i[illegible]
8. An iso[illegible] uranium has a mass number of 235 and an atomic number of 92. How many neutrons does it have?
9. A magnesium atom has 12 protons and 12 neutrons. What is its mass number?
10. What metal was used for the thin film in the Geiger–Marsden scattering experiment?
11. What are atoms of the same element but which have a different number of neutrons called?
12. Describe the previously accepted plum pudding model.
13. Explain what is meant by an ion.
14. Why did the Geiger–Marsden experiment and Rutherford's model disprove the plum pudding model?
15. Describe what happens when an electron emits electromagnetic radiation.

C

1. The radius of a ca[illegible] nm.
2. The radius of the [illegible] radius of the ato[illegible]
3. If the radius of ar[illegible] what is the radius
4. An isotope of car[illegible] many more neutr[illegible]
5. An ion of chromiu[illegible] 24 neutrons. How[illegible]
6. Plutonium has 15[illegible] its mass number?
7. Copper has 35 ne[illegible] mass number, an[illegible]
8. The discovery of [illegible] discovery of the n[illegible]
9. What is different [illegible] element?
10. The number of w[illegible] the element of th[illegible]
11. An electron drops [illegible] type of radiation [illegible]
12. Explain why isotop[illegible] not different char[illegible] of the same elem[illegible]
13. Describe how ele[illegible]
14. Describe the nucl[illegible]
15. In the Geiger–Ma[illegible] did some of the α-[illegible]
16. Explain why Ruth[illegible] plum pudding mo[illegible]

Extension

1. What must be absorbed/emitted for the arrangement of electrons in an atom to change?
2. Most of the volume of an atom is empty space – true or false?
3. Tritium is an isotope of hydrogen with a mass number of 3. How many neutrons does it have?
4. A nucleus contains 2 protons and is an isotope with one fewer neutron than the element's most common isotope. What is the its mass number?
5. What did James Chadwick's experiments prove the existence of?
6. What does the atomic number represent?
7. The energy levels Bohr suggested were only a theory. Why were they accepted as true?
8. The larger the drop in energy level of an electron, the larger the energy of the emitted radiation – true or false?
9. Name the com[illegible] model.
10. How many sub[illegible] nuclear model[illegible]
11. When Geiger a[illegible] the scientific c[illegible] experiment. W[illegible]
12. Describe the d[illegible] Rutherford's a[illegible]
13. Describe what [illegible] electromagnet[illegible]
14. Why was the p[illegible] model of the a[illegible]
15. Explain why a [illegible] neutrons) wou[illegible] deflected α-pa[illegible]

Topic 4B — Atoms and Nuclear R

Fundamentals

1. What is the relative charge of an α-particle?
2. What is the relative charge of a β-particle?
3. Approximately what is the range of a β-particle in the air?
4. What is the range of a γ-particle in the air?
5. What is the standard unit for activity?
6. What property of α-particles makes them the most dangerous type of nuclear radiation to ingest?
7. For the nuclear reaction equation $^{19}_{8}O \rightarrow {}^{19}_{X}F + {}^{0}_{-1}\beta$, what is X?
8. Other than α, β and γ radi[illegible], name a type of nuclear radiation.
9. α-par[illegible] have the greatest ionising power compa[illegible] other forms of nuclear radiation – true or false?
10. For the nuclear reaction equation $^{24}_{11}Na \rightarrow {}^{X}_{12}Mg + {}^{0}_{-1}\beta$, what is X?
11. Give a word to describe the nature of radioactive decay of a single atom.
12. The emission of β radiation causes a change in the mass of the nucleus involved – true or false?
13. What is γ radiation?
14. Explain what is meant by radioactive contamination.
15. Explain what is meant by 'activity'.
16. Explain what happens to the count rate of a radioactive sample after one half-life, and why.
17. Explain why α-particles wouldn't be very good for monitoring the thickness of metal sheets in a factory.

C

1. Do stable nuclei or u
2. A radioactive objec 1.9×10^{8} Bq. How m second?
3. An α-particle can b atom?
4. What is the half-life years its mass drops
5. Which types of nuc mass number?
6. Is γ radiation the m α, β and γ radiation?
7. For the nuclear rea $^{X}_{3}Li \rightarrow {}^{9}_{Y}Be + {}^{0}_{-1}\beta$, w
8. For the nuclear rea $^{X}_{6}C \rightarrow {}^{14}_{Y}N + {}^{0}_{-1}\beta$, w
9. For the nuclear rea $^{244}_{94}Pu \rightarrow {}^{240}_{X}U + {}^{4}_{2}$
10. For the nuclear rea what is X?
11. Half-life is the time decay – true or fals
12. How much of 2 kg o 36 hours if its half-l
13. Name a reason scie working with radio
14. Describe what a Ge
15. Describe why a lea substances.
16. If you were to inges type of nuclear rad
17. Explain what is mea radioactive substan

Extension

1. If the half-life of californium-251 is 900 years, how much of 1 g is left after 4500 years?
2. If the half-life of uranium-235 is 700 million years, how much of 1 kg is left after 2.1×10^{9} years?
3. When an α-particle is emitted during a deca process, how many protons are lost from the nucleus?
4. For the nuclear rea[illegible]tion $^{244}_{94}Pu \rightarrow {}^{X}_{90}Th + {}^{4}_{2}\alpha$, what is X?
5. Name a type of nuclear radiation that would be suitable for detecting smoke from a fire.
6. For the nuclear reaction equation $^{244}_{94}Pu \rightarrow {}^{X}_{92}U + {}^{4}_{2}\alpha + {}^{1}_{0}n$, what is X?
7. The activity of a radioactive substance decreases as time goes on – true or false?
8. What is a β-particle?
9. Name a type of ra sterilising food or bacteria.
10. When a β-particle changes into what?
11. If an α-particle and how many neutron
12. Why are radioacti
13. Explain why isotop long half-lives.
14. Explain why the ha even though radio
15. Why is it importan research on radioa
16. Describe how the mass and charge o

Topic 4C — Fusion, Fission and Radioac

Fundamentals

1. Are nuclear power stations a man-made or natural source of background radiation?
2. A radiation dose is measured in sieverts (Sv). How many sieverts is 1 mSv?
3. Are the two nuclear products from fission similar or different in mass?
4. The level of background radiation can vary between locations – true or false?
5. The average person in Cornwall is exposed to 6.9 mSv of radiation each year. Name a natural source of radiation that would cause this.
6. Name a variable that can cause the level of background radiation to change.
7. What is the name of the process when the neutron emitted from the fission of an isotope cause another atom to fission?
8. The larger the dose of radiation, the greater the risk of cancer – true or false?
9. Apart from the kinetic energy of the products of fission, how is energy released?
10. Where does fusion naturally occur?
11. Fusion can only release energy for light elements – true or false?
12. What is nuclear fission?
13. Why must radioactive isotopes used in medical imaging have short half-lives?
14. Describe how a radioactive tracer can be used to detect a blockage in the body.
15. Describe radiotherapy.
16. Why does the radiation in radiotherapy also kill the healthy cells?
17. Why is fusion a more desirable energy resource than fission?

C

1. What is the process
changes the structu
2. Radiation can cause
treat cancer – true
3. What type of nucle
its energy?
4. Name a variable th
radiation to change
5. A dose of 10 Sv wo
How many 30 mSv
6. Name a man-made
7. Name a natural sou
8. Nuclear industry em
radiation dose of 20
dose per day?
9. Only some of the p
energy – true or fal
10. Gamma rays are pr
fission – true or fal
11. Name something th
undergoes fission.
12. Why would uraniu
radioactive tracer?
13. Why would Iodine-
radioactive tracer?
14. Explain how a chai
15. Explain how medica
works.
16. Chernobyl is the sit
station. Why is it st
17. The Manhattan Pro
bombs. Why did th
chain reaction?

Extension

1. Changes in the blood can be seen after a dose of 100 mSv. How many 0.005 mSv dental X-rays would cause this?
2. The average radon dose in the UK is 1.3 mSv / year. How much is a Briton irradiated with each day?
3. How does the mass of the resultant nucleus from fusion compare to the combined mass of the two initial nuclei?
4. The risk of developing cancer due to background radiation never is true or false?
5. A chain reaction starts with 1 neutron and releases 2 neutrons each time; after five iterations, how many neutrons are there?
6. In a chain reaction starting with 1 neutron and releasing 3 neutrons each time, after six iterations how many neutrons are there?
7. Name a property needed from a radioactive material used as a battery to power a space probe in outer space.
8. Apart from the products from uranium fission, name something that makes up nuclear waste.
9. A fission bomb a
mass of fuel are
in explosions, in
10. What type of fis
need?
11. Radon gas cont
background rad
12. Apart from the
name a man-ma
13. Describe how y
organ using rad
14. Before the 193
paint because t
people stop usi
15. Brachytherapy
source into a tu
cancer?
16. Why are the co
occur?

Fundamentals Tests

Topic 1A — Energy Changes in a Sys

1	The mass of an object is 12.5 g. What is the object's mass in kg?
2	How is energy stored in a battery?
3	What is the standard unit of energy?
4	What type of energy do we say an object has if it is travelling at a constan
5	State how energy is stored before and after an electri remote-controlled
6	The temperature of a cup of tea drops fro 3 to 35 °C. What is the te
7	Calculate the gravitational poten rgy of a 5 kg weight raised 1.6 km
8	State the equation us to calculate the gravitational potential energy of
9	How h potential energy does a 25 g bouncy ball gain if i
10	Wh of apparatus could be used to measure the temperature chan
11	Given that $\Delta E = m\ c\ \Delta\theta$, where m = 1.2 kg, c = 185 J / kg °C and $\Delta\theta$ = 35 °C,
12	Define the watt, W, the unit of power.
13	Describe how you could measure the change in temperature of a materia
14	Describe the energy transfer that occurs when a kettle is used to boil wat
15	Explain what is meant by elastic potential energy.
16	How many times should you repeat a temperature measurement of an in
17	Why does a more powerful microwave heat up food faster than a less po

Topic 1B — Efficiency and Energy Resc

1	State the change in energy stores when a ball is dropped from rest.
2	Three beakers are wrapped in three different materials in a thermal insu independent variable?
3	Are the following objects good insulators or good conductors? Oven glov
4	Name one way in which a coal-powered furnace wastes energy.
5	Why does a TV become warm after being on for a long time?
6	How is energy wasted by a jackhammer on a construction site?
7	State the equation for efficiency in terms of e tr nsfer.
8	What piece of apparatus would y to easure the temperature of a
9	State the energy transf n a ns ball being hit by a racquet.
10	Name two t on renewable energy resource.
11	Wh e efficiency of a transformer with a power input of 100 kW and
12	What is a renewable energy resource?
13	Why is housing insulation lined with a silver veneer?
14	Describe the energy transfer occurring for a bullet when a gun is fired.
15	Why is oil used to surround moving parts in a car engine?
16	What is meant by 'dissipated energy'?
17	Why is using renewable energy resources more favourable than using no

Topic 2A — Current, Potential Difference and

1	What is the standard unit of charge?
2	An LED emits light when supplied with a current – true or false?
3	How much charge passes through a filament lamp if it is left on for 90 s a
4	What is the word equation that defines current in terms of charge and ti
5	What does the resistance of a thermistor depend on?
6	State Ohm's law in any form.
7	What is the potential difference of a component with a resistance of 250
8	A charge of 80 C flows through a circuit in 20 s. Calculate the current in th
9	A 1.2 mA current is applied through a 330 Ω resistor. What is the potenti
10	What is the current in a 200 [illegible] is [illegible] 80 C of charge passes through it
11	Describe the curr[illegible]ar difference graph for a filament lamp.
12	Wh[illegible]e [illegible]ependent variable in an experiment measuring the resista diam
13	Why must a circuit be closed for the components in it to work?
14	Explain what is meant by an ohmic component.
15	Explain how an LDR can be used to solve a real-world problem.
16	Describe the current–potential difference graph for a diode.
17	Would the resistance of a wire increase or decrease if its diameter was in

Topic 2B — Series and Parallel Circuits and Ma

1	The potential difference across each component in a series circuit is the s
2	What equation would you use to find the total resistance of two resistors
3	For components connected in parallel, how does the potential difference compare?
4	Is an ammeter connected in series or in parallel to a component when us
5	The potential difference across a 100 Ω resistor is 4 V. What is the poten resistor connected in parallel with it?
6	What is the frequency of the domestic electric supply in the UK?
7	Two 450 Ω resistors are connected in series to a 9 V battery. What is the resistor?
8	What colour is the live wire in a three-[illegible] co[illegible]?
9	Is the mains electricity su[illegible] [illegible] alternating?
10	What colour is th[illegible] in a three-pin plug?
11	Tw[illegible] [illegible] stors are connected in series to a 9 V battery. What is the
12	Desc[illegible] what a direct potential difference is.
13	Why is an exposed live wire dangerous if an appliance is plugged into the
14	How would you test an LED to find out whether it works correctly?
15	Why are house lights connected using a parallel circuit?
16	Describe the circuit diagram of a parallel circuit.
17	Why does the total resistance increase when you add more resistors in se

Topic 2C — Power, the National Grid and Stat

1	State the equation for power in terms of potential difference and curren
2	What is the power rating of a thermistor if a potential difference of 3 V is through it?
3	What is the potential difference across a 0.7 W LED if the current through
4	If a 100 W device is switched on for 45 s, how much energy does it use?
5	What is the power rating of a microwave if it is plugged into the mains (23
6	If a 3 W bulb and a 2 W bulb are switched on, how much energy in total d
7	How much energy does a 700 W microwave use in 2 s? Give your answ
8	How much energy does a 9.0 V battery lose if it discharges 200 C?
9	What do step-down transformers do?
10	Two objects of equal charge are placed near each other. Is the force be repulsive?
11	When an object gains electrons, does it become positively charged or neg
12	Describe the national grid.
13	Why is the power of an electrical appliance dependent on the current flow
14	Describe the change in energy store when a phone battery is charged usi
15	Describe how static electricity is produced.
16	Why is the power of an electrical appliance dependent on the potential d
17	What are step-up transformers used for, and why?

Topic 3A — Changes of State

1	What is the density of a 2.3 m^3 box if its mass is 650 g?
2	What is the density of a cube with sides 2 m if its mass is 4 kg?
3	Name the change of state when an indoor ice rink is made from liquid wa
4	The particles in a gas are more tightly packed than those in a solid – true o
5	What is the volume of a 2.5 kg tube of copper with a density of 8940 kg /
6	Name a piece of apparatus suitable for measuring the diameter of a wate
7	Condensation is another name for boiling – true or false?
8	Given that $\Delta E = m\ c\ \Delta\theta$, what is $\Delta\theta$ when m = 2 kg, c = 1.5 J / kg °C and ΔE
9	Given that E = m L, what is the latent heat of a 220 kg of lead change 191.6 MJ?
10	Given that $\Delta E = m\ c\ \Delta\theta$, what is $\Delta\theta$ when m = 3.1 kg, c = 340 J / kg °C and Δ
11	What is the latent heat of fusion?
12	What happens to the temperature when a change of state occurs?
13	Explain what is meant by the particle model.
14	Describe how you would measure the volume of an irregularly shaped ob
15	Explain what is meant by the conservation of mass for a system of particle
16	Explain what latent heat is.
17	Explain the difference between evaporation and boiling.
18	Explain the difference between melting and sublimation.

Topic 3B — The Particle Model of a G

1	The arrangement of molecules in a gas is very ordered – true or false?
2	Describe the effect on the average speed of particles when the temperat
3	What happens to the pressure of a gas being heated in a sealed box?
4	The temperature of a gas is dependent on the potential energy between
5	Describe the relationship between pressure and volume at a constant te
6	If a gas is described by P V = 2.8×10^5 Pa m^3 and P = 7.0×10^4 Pa, what is
7	What is the standard unit of pressure?
8	What is the volume change, in m^3, when the v of a gas changes fro
9	If a gas at a constant temperature h he relationship P V = 3.4×10^4 Pa what is its pressure?
10	A gas at constant e p ure and mass has its volume tripled. By what f dec d?
11	For law, P V = constant. To hold true, what properties of a gas mu
12	Explain how the temperature of a gas is related to the motion of its parti
13	Explain how increasing the volume of a gas decreases the pressure.
14	Explain how a gas exerts a pressure on a container wall.
15	Why does an unsealed balloon fly away when it is released?
16	Why would heating a sealed balloon cause it to expand?

Topic 4A — Atoms and Isotopes

1	The radius of a nucleus is 1×10^{-14} m. Write this in femtometres, fm.
2	What is the approximate radius of an atom?
3	Where would you find the protons in an atom?
4	If the number of electrons and protons in an atom is equal, there is no ne
5	What particles are neutral in charge in the atom?
6	A sulphur atom has 16 protons and 16 neutrons; how many electrons do
7	An atom of carbon has a mass number of 12 and an atomic number of 6. have?
8	An isotope of uranium has a mass number of 235 and an atomic number it have?
9	A magnesium atom has 12 proto 12 utrons. What is its mass nu
10	What metal was used f ne h m in the Geiger–Marsden scattering
11	What ar ato the same element but which have a different number
12	Des e previously accepted plum pudding model.
13	Explain what is meant by an ion.
14	Why did the Geiger–Marsden experiment and Rutherford's model dispro
15	Describe what happens when an electron emits electromagnetic radiatio

Topic 4B — Atoms and Nuclear Radia

1	What is the relative charge of an α-particle?
2	What is the relative charge of a β-particle?
3	Approximately what is the range of a β-particle in the air?
4	What is the range of a γ-particle in the air?
5	What is the standard unit for activity?
6	What property of α-particles makes them the most dangerous type of nu
7	For the nuclear reaction equation $^{19}_{8}O \rightarrow {}^{19}_{X}F + {}^{0}_{-1}\beta$, what is X?
8	Other than α, β and γ radiation, name a type of nuclear radiation.
9	α-particles have the greatest ionising power compared to other forms of false?
10	For the nuclear reaction equation $^{24}_{11}Na \rightarrow {}^{X}_{12}Mg + {}^{0}_{-1}\beta$, what is X?
11	Give a word to describe the nature of radioactive decay of a single atom.
12	The emission of β radiation causes a change in the mass of the nucleus in
13	What is γ radiation?
14	Explain what is meant by radioactive contamination.
15	Explain what is meant by 'activity'.
16	Explain what happens to the count rate of a radioactive sample after one
17	Explain why α-particles wouldn't be very good for monitoring the thickne

Topic 4C — Fusion, Fission and Radioactive

1	Are nuclear power stations a man-made or natural source of background
2	A radiation dose is measured in sieverts (Sv). How many sieverts is 1 mSv?
3	Are the two nuclear products from fission similar or different in mass?
4	The level of background radiation can vary between locations – true or fa
5	The average person in Cornwall is exposed to 6.9 mSv of radiation each y radiation that would cause this.
6	Name a variable that can cause the level of background radiation to chan
7	What is the name of the process when the neutrons emitted from the fis another atom to fission?
8	The larger the dose of radiation, the great risk of cancer – true or fa
9	Apart from the kinetic energy of the products of fission, how is energy re
10	Where does fusion naturally occur?
11	Fusion can release energy for light elements – true or false?
12	What is nuclear fission?
13	Why must radioactive isotopes used in medical imaging have short half-li
14	Describe how a radioactive tracer can be used to detect a blockage in the
15	Describe radiotherapy.
16	Why does the radiation in radiotherapy also kill the healthy cells?
17	Why is fusion a more desirable energy resource than fission?

Answers

Topic 1A — Energy Changes in a System

Fundamentals

1. 0.0125 kg
2. As chemical energy
3. Joule, J
4. Kinetic energy
5. Before: chemical energy; after: kinetic energy
6. 80 – 35 = 45 °C
7. 5 × 9.8 × 1600 = 78 kJ
8. $E_P = mgh$
9. 0.025 × 9.8 × 3 = 0.74 J
10. A thermometer
11. 1.2 × 1[illegible] = [illegible] or 7.8 kJ
12. 1 watt i[illegible]to the energy transfer of 1 joule per second
13. Use a thermometer to measure the temperature of the material before and after the change, then calculate the difference
14. The energy is transferred electrically to thermal energy
15. Elastic potential energy is the way energy is stored in a compressed or stretched spring
16. At least three times; to ensure the measurement is reliable
17. More power means more energy is incident on the food per second, causing it to heat more quickly

Challenge

1. It is divided by 4
2. As kinetic energy
3. 9 J
4. 7.2×10^{-4} or 0.72 mJ
5. Joules per kilogram per degree Celsius, J / kg °C
6. 390 J / kg °C
7. 9.1 J
8. 1.7 GJ
9. 5400 s or 1.5 hours
10. 3750 J
11. 2 kW
12. The higher the mass, the more material there is that must be raised by 1 °C; therefore, more energy is needed
13. Measure the temperature change and the mass of the object, then use the specific heat equation
14. Before: [illegible]re it has gravitational potential energy; after: it [illegible]d as kinetic energy (until it hits the ground)
15. Kinetic energy of the car is transferred to thermal energy in the tyres
16. Because energy is transferred twice as quickly
17. The amount of energy required to raise the temperature of 1 kg of a substance by 1 °C

Extension

1. 3.54 m
2. 855 J
3. 252 kJ
4. 44.3 m/s
5. 6.3 m/s
6. By a factor of 4
7. Temperature
8. A system
9. 69.4 J
10. 16.2 °C
11. 20 m/s
12. The 1.5 kW mot[illegible]
13. The mass of wat[illegible] energy (and, the[illegible] boil
14. Velocity is squar[illegible] there is no such t[illegible]
15. Before: it is stor[illegible] stored as therm[illegible]
16. The current is el[illegible] wire to be store[illegible]
17. The temperatur[illegible] there is an increa[illegible] system has som[illegible]
18. For the rocket to [illegible] the rocket to tra[illegible] other forms

Topic 1B — Efficiency and Energy Resources

Fundamentals

1. Gravitational potential energy → Kinetic energy
2. The types of material
3. Oven gloves are good insulators; metal tongs are good conductors
4. Carried away by light and sound to be dissipated and stored as thermal energy
5. Energy is transferred by the current to the TV (a thermal energy store)
6. The kinetic energy is dissipated mechanically and eventually stored as thermal energy
7. Efficiency = Useful output energy transfer / Total input energy transfer
8. Thermometer
9. Kinetic energy (rac[illegible] → Elastic potential energy → Kinetic [illegible] (te[illegible]ball) + Sound energy
10. Coal/oi[illegible]clear
11. 80 / 100 = 80 % or 0.8
12. A renewable energy resource is one that is being (or can be) replenished as it is used
13. The silver veneer reflects any infrared radiation, reducing heat loss by radiation
14. Chemical energy is transferred to kinetic energy and thermal energy
15. Oil acts as a lubricant to prevent the engine wasting energy through heat or sound
16. Energy that becomes unrecoverable (and, therefore, is wasted) during an energy transfer
17. They are a more long-term solution and don't produce greenhouse gases so are better for the environment

Challenge

1. Hydroelectricity
2. A copper rod
3. The temperature of the substance the materials are insulating
4. Painting the inside of the kettle a silver colour / building the kettle from thermally insulating materials / removing limescale from the heating element
5. The amount of material
6. Via thermal energy
7. 300 W
8. 76.6 % or 0.766
9. Nuclear
10. Through the conduction of its wa[illegible] do[illegible] and doors
11. Biofuel/solar
12. It stays [illegible]e [illegible]cause energy can neither be created [illegible]troyed
13. Build a large, light wheel / ensure the paddles have a large surface area
14. It requires thermal activity just below the surface of Earth's crust
15. It doesn't produce large amounts of CO_2 as fossil fuels do
16. There is a limited amount of coal buried underground and it takes millions of years to form
17. It is better for the environment and for the durability of the device (as it won't overwork itself)

Extension

1. It is renewable / i[illegible]
2. 0.32
3. Paint the inside o[illegible] radiator away fro[illegible]
4. A vacuum
5. 630 W
6. False (hot gases r[illegible] are less dense)
7. Larger sail (bigge[illegible]
8. Tidal energy
9. 0.56
10. Night-time
11. Solar/geotherma[illegible]
12. The laser beam t[illegible] stored as therma[illegible] becomes too hot [illegible]
13. Burning fossil fue[illegible] greenhouse gas, w[illegible] change
14. No; light from the[illegible] panel, and the bu[illegible] energy as heat
15. Heat conducts in[illegible] pump has to wor[illegible] energy)
16. To ensure we hav[illegible] future demand (o[illegible] run out). Also, m[illegible] environmental ef[illegible]
17. Near the equator[illegible] entire year) and i[illegible]
18. They alone don't [illegible] decision – such d[illegible] businesspeople, a[illegible]

Topic 2A — Current, Potential Difference and

Fundamentals

1. Coulomb, C
2. True (a current means charges flow through the LED which do work)
3. 1.5 × 90 = 140 C
4. Current = Charge / Time
5. Temperature
6. V = I R (or, Potential difference = Current × Resistance)
7. 250 × 100 = 25 V
8. 80 C / 20 s = 4 A
9. 1.2 mA × 330 Ω = 400 mV or 0.40 V
10. 80 / 60 = 1.33 A
11. The graph is curved at large values [illegible] between
12. The diameter of the [illegible]
13. A curre[illegible]t t[illegible] there is a break in the circuit, meanin[illegible]rge will reach the components
14. An ohmic component is one which obeys Ohm's law, i.e. its current–potential difference graph is linear
15. Any suitable application, e.g. using an LDR to turn on street lights when it's dark enough in the evening
16. For negative potential differences, no current flows; for positive potential differences, a diode is ohmic (linear graph)
17. As the diameter increases, so does the resistance (because resistance is proportional to the amount of material)

Challenge

1. A battery
2. False (current is the same throughout a series circuit)
3. False (it is a cross centred within a circle)
4. 6.9 C
5. The current must decrease
6. 135 Ω
7. 5 mA
8. 210 s
9. The current through the component
10. 0.51 C
11. It causes a lower resistance
12. Its resistance decreases
13. A rectangular box (like the ordinary resistor) with an arrow diagonally crossing through it
14. Measure the current passing through it, an[illegible]ter. use a stop clock to time how long [illegible] an[illegible] measure the charge for. Th[illegible]se Q = I × t to find the charge that ha[illegible]th[illegible]ough in that time.
15. Curren[illegible]wa[illegible]flows in the same direction
16. A poten[illegible]erence is created by an imbalance of charge carriers between two points. The energy stored by this imbalance allows charge carriers to flow
17. Ammeter in series, voltmeter in parallel, both connected to a cell

Extension

1. 0 A
2. 5.0 V
3. 0.15 C
4. 1.4 C
5. 5.0 V
6. A thermistor
7. Brighter
8. Very high
9. 75 Ω
10. The length / ma[illegible] wires used
11. 3.6 V
12. The duration of [illegible] causes the wire [illegible] resistance to inc[illegible]
13. The resistance i[illegible] depending on th[illegible] filament lamp
14. It can be used to[illegible] building a circuit[illegible] component well
15. They don't allow[illegible] any output belo[illegible]
16. The longer the w[illegible] flows through, s[illegible] meets

Topic 2B — Series and Parallel Circuits and M

Fundamentals

1. False (it is only the same for components connected in parallel)
2. $R_T = R_1 + R_2$
3. The potential difference across each component is the same
4. Connected in series
5. Also 4 V
6. 50 Hz
7. 9 / 2 = 4.5 V
8. Brown
9. Alternating
10. Green and yellow stripes
11. 9 / (2 × 300) = 15 mA
12. A direct potential difference (a DC supply) is one that is constant in direction (it remains either positive or negative)
13. If you were to touch the live wire you would receive an electric shock, which could be fatal. An exposed live wire could also come into contact with something else, resulting in high currents which could start a fire.
14. Connect the LED in series to a DC power supply and resistor, and turn on the supply. Swap round the connections of the LED and repeat.
15. You can choose which light/s you want on/off; you aren't required to have all the lights on at any one time. Also, if one bulb blows, the rest of the lights are still usable.
16. A parallel circuit is made up of several series circuits joined together at intersections
17. There is only one path for the charge to flow through, and so it must pass through each resistor; therefore, every resistor affects the current

Challenge

1. The total resistance is less
2. 35 mA
3. 1660 Ω or 1.66 kΩ
4. 45 mA
5. 2.2 A
6. Blue
7. 0 V
8. 3 V
9. The earth wire safely discharges the appliance from any excess charge
10. 230 V
11. 1250 Ω
12. If there is a fault in the appliance, any unwanted charge can be safely discharged
13. The larger the resistance of the variable resistor, the lower the potential difference across the lamp, meaning the lamp dims
14. An alternating potential difference is one that reverses every time period (i.e. it flips between positive and negative)
15. This ensures that the wires can't come loose and come into contact with each other
16. The potential difference across components connected in parallel is the same, so a measurement can be reliably taken
17. An alternating current changes direction every time period, i.e. it flips from positive to negative

Extension

1. 0.3 A
2. 57.1 Ω
3. $I_{100} = I_{330} =$ 21 mA
4. True (there are t when the resisto less resistance)
5. 4 V
6. 14 V
7. 37.5 mA
8. 0.92 A
9. 30 mA
10. The neutral wire current would fl
11. 0.32 A
12. The circuit is now work
13. Adding more res more paths for t though these pa infinite (an infini isn't there).
14. For easy identific make it clearer w much if you mix simply breaks th the earth wire (w
15. A current is mad which can only fl current splits at depending on th
16. A parallel circuit determine which will still be on.

Topic 2C — Power, the National Grid and Stat

Fundamentals

1. P = V I (or power = potential difference × current)
2. P = I V = 3.0 × 0.3 = 0.9 W
3. V = P / I = 0.7 / 0.15 = 4.67 V
4. E = P t = 100 × 45 = 4500 J or 4.5 kJ
5. P = I V = 3.3 × 230 = 760 W
6. E = P t = (3 + 2) × 120 = 600 J
7. 700 × 100 = 70 kJ
8. 9.0 × 200 = 1800 J or 1.8 kJ
9. They decrease the p.d. to domestic levels
10. Attractive
11. Negatively charged
12. The national grid is a system of cable[illegible] and transformers linking power st[illegible]ons to consumers
13. The higher the current, [illegible] charges present, and, therefor[illegible]ug[illegible]), the more energy in the system
14. It starts [illegible]trical energy in the mains, before being tra[illegible]rred to chemical energy in the battery
15. When two insulating materials are rubbed against each other, charges transfer from one material to the other, creating an imbalance. This imbalance is known as static electricity.
16. The higher the potential difference, the more the charges will want to flow, so more energy is present in the system
17. They increase the p.d. of the power which in turn decreases the current (P = I V must stay balanced). A smaller current means less wasted energy as heat.

Challenge

1. 12 V
2. 64 Ω
3. The 1200 W hairdryer
4. 11.5 J
5. 167 mA
6. 97 W
7. 25 ms
8. It gets stronger
9. Attraction and repulsion of two charged objects
10. 470 C
11. The two negative spheres would stick to the positive sphere, but on opposite sides
12. Like-charged objects will repel; oppositely charged objects will attract
13. Grounding the object to earth / reducing friction of object with other objects
14. The electrons are attracted to the positively charged object. When the gap is small enough (or the p.d. is large enough) the electrons jump across it, ionising the air as they do. This ionised air glows and we see it as a spark.
15. Static cling is the build-up of charge which won't move, usually caused by two insulating materials rubbing against each other
16. The negative charges of the acetate rod are rubbed off onto the cloth so it becomes positively charged. The cloth now has an excess of negative charges so is negatively charged. The opposite charges attract.
17. The field lines will point radially outwards except for those between the spheres which will looked squashed and be pressed up against each other. Field lines never cross one another.

Extension

1. 500 kWh
2. 2.5 hr
3. 300 C
4. 66 mJ
5. 0.94 J
6. The lines and ar[illegible] the sphere
7. 3.6 C
8. The decrease in [illegible] greater than the [illegible] transformers
9. V = (P t) / Q = (3 ×
10. 5400 s or 1.5 ho[illegible] answer from Q5)
11. 68 C
12. E = P t = (I V) t, a[illegible] E = (I t) V = Q V
13. They attract
14. If a high enough [illegible] produced. This c[illegible]
15. An electric field i[illegible] imbalance of cha[illegible] object
16. The charged pai[illegible] attracted to the [illegible] an even coat of [illegible]
17. The step-up tran[illegible] the current decr[illegible] lower current m[illegible] heat loss in the c[illegible]
18. To ensure the ch[illegible] object. If the obj[illegible] would dissipate [illegible]

Topic 3A — Changes of State

Fundamentals

1. 0.65 / 2.3 = 0.283 kg / m^3
2. 4 / 2^3 = 0.5 kg / m^3
3. Freezing
4. False (gases are less dense than solids, hence their particles are further apart)
5. 2.5 / 8940 = 2.80 × 10^{-4} m^3
6. Vernier calipers
7. False (condensation is when a gas transitions to a liquid, the opposite of boiling)
8. 20 / (2 × 1.5) = 6.7 °C
9. 191 600 / 220 = 871 kJ / kg
10. 24 900 / (3.1 × 340) = 23.6 °C
11. A change of state from a sol[illegible] a liquid
12. It stays the same
13. A scien[illegible] de[illegible] to describe a system as being made o[illegible]es that interact via collisions and potentials
14. Place the object into a tank of water with a known volume. Then, measure the new volume of the water and calculate the difference.
15. The conservation of mass says when a system changes state (e.g. from a liquid to a gas), mass is conserved
16. Latent heat is the energy needed for a substance to change state with no temperature change
17. A liquid can evaporate at any temperature but only on its surface, whereas a liquid can boil from anywhere in its volume but only beyond its boiling point
18. Melting is when a solid changes to a liquid, whereas sublimation is when a solid changes to a gas

Challenge

1. 560 kg / m^3
2. False (in a closed system the mass will always stay constant)
3. 1.9 kJ
4. Melting and boiling
5. Stays constant
6. They move faster
7. 2000 J / kg °C
8. 2.5 kJ / kg
9. A digital balance (compare before and after)
10. 7.00 °C
11. 0.29 kg
12. The heat loss from the beaker
13. Changes of state can be r[illegible]d, whereas chemical changes cannot b[illegible]d
14. The tot[illegible]y [illegible] the system held by the particles in the sy[illegible]
15. At the melting point the graph is horizontal, then it's linear up until the boiling point where it is again horizontal
16. The energy supplied by the Sun needs to overcome the latent heat of water before it changes state
17. The particles arrange into structures resulting in an increase in density
18. Each particle is moving faster on average than in other states, so particles collide more and, therefore, are further apart

Extension

1. 43 kg / m^3
2. 9.16 g
3. Boiling and cond[illegible]
4. 98.8 g
5. Gas particles mo[illegible]
6. 5.4 × 10^3 kg / m^3
7. False; it is stored energy stays co[illegible]
8. 26.7 kJ
9. 32 °C
10. 39.7 °C
11. Higher resolutio[illegible]
12. The particles mu[illegible] potential energy
13. Internal energy = potential energy
14. Evaporated wat[illegible] condenses to fo[illegible]
15. The particles of a[illegible] spaced out than [illegible] easily, resulting i[illegible]
16. The steam relea[illegible] transferring mor[illegible]
17. Latent heat is ne[illegible] this energy has b[illegible] liquid is cooler.
18. Measure the vol[illegible] displacement m[illegible] calculate the de[illegible]

Topic 3B — The Particle Model of a Gas

Fundamentals

1. False (gas particles are in constant random motion)
2. Speed increases
3. It increases
4. False (it is dependent on the average kinetic energy of the particles)
5. They are inversely proportional
6. $(2.8 \times 10^5) / (7.0 \times 10^4) = 4.0\ m^3$
7. Pascal, Pa
8. $134 - 25 = 109\ cm^3 = 1.09 \times 10^{-4}\ m^3$
9. 1.36×10^4 Pa
10. 3
11. Temperature and mass
12. The faster the particles of a gas move, the more energy the gas has, and, therefore, the higher its temperature
13. Increasing the volume means the particles travel further before colliding with the walls; therefore, the pressure is lower
14. Gas particles collide with the wall, exerting a small perpendicular force on the wall. The force due to lots of particles is observed as pressure.
15. The pressure of the gas inside the balloon causes the gas to escape out of the hole, and, due to Newton's third law, the balloon flies away
16. Increasing the temperature of the gas inside the balloon causes the pressure to increase. As the rubber balloon is stretchy, the increase in pressure will cause the balloon to expand.

Challenge

1. Their average kinetic energy
2. True (temperature and pressure for a gas are directly proportional)
3. True (the more tightly packed the gas particles are, the higher the number of collisions, i.e. pressure)
4. $0.1\ m^3$
5. $0.61\ m^3$
6. $p_1 = 6.7 \times 10^5$ Pa
7. 4.6×10^5 Pa
8. The temperature increases
9. It increases
10. Larger
11. Perpendicular to the wall
12. Pressing on the bubble causes a decrease in its volume which increases the pressure inside the bubble, up to the point where the bubble can take no more
13. The temperature increases because work has been done on the gas to get it into the tyre
14. The pump pushes new air into the tyre. As there are now more particles, the pressure in the tyre increases, which, in turn, causes the tyre to stretch and increase in volume.
15. The smaller volume means the particles don't travel as far between collisions. The kinetic energy of the particles is constant, so they must collide with the walls more.
16. The volume has halved but so has the amount of gas; therefore, the pressure would be the same as before

Extension

1. $0.0205\ m^3$
2. $14.2\ cm^3$
3. It decreases
4. True (doing work
   internal energy a
5. True (more collis
   the container, re
6. The lighter parti
7. Constant
8. The pressure, in
   increase
9. It also decreases
10. The gas with the
11. The pressure in t
    bursts. The pump
    gas, so the temp
12. Increasing the vo
    reduces the pres
13. The volume of a
    breathe in, decre
    The lower pressu
    pressure outside
    inwards.
14. Each particle has
    temperature; the
    with the contain
    pressure
15. The explosion in
    which means the
    increasing the p

Topic 4A — Atoms and Isotopes

Fundamentals

1. 10 fm
2. 1×10^{-10} m
3. In the nucleus
4. True (each electron and proton has equal and opposite charge which cancels the other's effect)
5. Neutrons
6. 16
7. 12 – 6 = 6
8. 235 – 92 = 143
9. 12 + 12 = 24
10. Gold
11. Isotopes
12. Negatively charged particles embedded in a sphere of positive charge
13. An atom that has lost or gained an electron to become charged
14. Some α-particles were scattered at large angles, not predicted by the plum pudding model
15. The electron will move closer to the nucleus, to a lower energy level

Challenge

1. 0.09 nm
2. 1 / 10 000
3. 1.3×10^{-14} m
4. 2
5. 22
6. 244
7. The mass number is 64 and it has 29 electrons
8. False (the discovery of the proton came nine years after the nuclear model)
9. The number of electrons
10. The proton
11. Electromagnetic radiation (accept photon)
12. Isotopes have a varying number of neutrons which contribute a lot to the mass of an atom, but not to its charge
13. Electrons are arranged in different energy levels orbiting around the nucleus
14. A nucleus made up of positive protons and neutral neutrons orbited by negative electrons in orbital shells
15. The nucleus of the atom was heavier and like-charged compared to the α-particles, so α were reflected
16. The repeatable Geiger-Marsden experiment showed that the majority of the mass of an atom is concentrated at the atom's centre and is positively charged

Extension

1. Electromagnetic
2. True (the majority concentrated at
3. 2
4. 3
5. The neutron
6. The number of p
7. They agreed wit
8. True (conservatio
9. The electron and
10. 3
11. To verify their re results are reliab
12. He theorised elec based on their e
13. An electron orbi energy and jump
14. Later experiment subdivided into p
15. The nucleus is sm has the least cha least

Topic 4B — Atoms and Nuclear Radiation

Fundamentals

1. +2
2. -1
3. 1 m
4. Unlimited
5. Becquerel, Bq
6. Short penetration depth / high ionising power
7. 8 – (-1) = 9
8. Neutron radiation
9. True (they have the highest mass so they have the largest energy)
10. 24 – 0 = 24
11. Random/unpredictable
12. False (β radiation has an extremely small mass so doesn't affect the mass of the nucleus)
13. High-energy electromagnetic (EM) radiation
14. When a substance is exposed or subjected to the unwanted presence of radioactive atoms
15. The activity of a radioactive substance is the rate at which its radioactive nuclei decay
16. Its count rate is halved because there is now half the number of unstable nuclei that can decay
17. α-particles wouldn't be able to penetrate the metal; therefore, a detector wouldn't be able to tell whether the metal thickness was varying

Challenge

1. Unstable nuclei
2. 1.9×10^8 /s
3. Helium
4. 3 years
5. α radiation and neutron radiation
6. The least ionising
7. X = 9 and Y = 4
8. X = 14 and Y = 7
9. 92
10. 234
11. False (it is the time it takes for half a radioactive sample to decay; the decay of a single nucleus is unpredictable)
12. 0.25 kg
13. To reduce the risk of radioactive contamination / to reduce the amount of irradiation on their bodies
14. It monitors the count rate of radioactive substances
15. No type of nuclear radiation (except neutrons, but they are harmless) can pass through lead
16. Gamma radiation has a high energy and can easily pass through the skin as it has no charge, so it's unlikely to ionise anything
17. Irradiation is when a substance is subjected to nuclear radiation from a radioactive substance

Extension

1. 0.0313 g
2. 0.125 kg
3. 2
4. 2
5. α radiation
6. 239
7. True (the activity each half-life)
8. An electron
9. γ radiation
10. A proton
11. 3
12. Nuclear radiation depending on the
13. Naturally occurring half-lives quickly
14. The half-life of a of billions of dec lost
15. So other scientist better understa
16. The relative cha the nucleus stay

Topic 4C — Fusion, Fission and Radioactive Er

Fundamentals

1. Man-made source
2. 0.001 Sv
3. Similar
4. True (it depends on many factors, including level of radon gas or proximity to nuclear waste)
5. Radon gas / radiation from ores in the ground
6. Location/occupation
7. A chain reaction
8. True (a large dose means more ionising radiation that can cause cells to mutate, leading to cancer)
9. Via γ radiation
10. In stars
11. True (it can occur for heavi[illegible] but more energy is needed th[illegible])
12. The spli[illegible] and unstable nucleus
13. So they [illegible]ay in the body causing damage after the imaging has been done
14. A detector monitoring the radiation from the tracer will see the tracer stop
15. The use of nuclear radiation to destroy or control unwanted tissue
16. The radiation doesn't distinguish between the atoms of healthy cells and those of cancerous cells
17. Its waste product isn't radioactive / its fuel, hydrogen, is very common / its energy output per mass input ratio is high

Challenge

1. Mutation
2. False (radiation can ionise any atom and so destroy any cell, even if it is cancerous)
3. Fusion
4. Occupation/location
5. 333
6. Nuclear waste from power stations / nuclear fallout / nuclear accidents
7. Cosmic rays from space / radon gas / plants / radioactive soil and rocks
8. 5.48×10^{-5} Sv
9. False (all the products of fission have kinetic energy)
10. True (they are part of the by-products along with the daughter atoms and more neutrons)
11. Two or three neutrons / gamma rays / two smaller nuc[illegible]
12. Its long half-life means it would stay in the [illegible], radiating ionising α-particles [illegible]en it naturally decays
13. Its short half-life me[illegible] would quickly decay, and it emits γ [illegible]on [illegible] decays
14. A neutr[illegible]es a heavy nucleus to split, releasing more ne[illegible]ons and two new nuclei. The new neutrons then go on to split more nuclei, and so on.
15. Radioactive tracers are deposited into a region of the body. They emit either β or γ radiation which can then be detected outside the body
16. Both the fuel and the waste from the accident have a long half-life, so the site is still radioactive after 30 years
17. An uncontrolled chain reaction quickly sweeps through the fissile material resulting in a mass emission of energy, i.e. an explosion

Extension

1. 20 000
2. 3.56×10^{-6} Sv
3. Its mass is great[illegible]
4. False (if this wer[illegible] more common t[illegible]
5. 32
6. 729
7. Long half-life
8. Radioactive con[illegible] reactor
9. The fusion bomb[illegible] explosion is larg[illegible]
10. An uncontrolled [illegible]
11. Natural radiation[illegible] rays / contamina[illegible]
12. Fallout from nuc[illegible] accidents / medi[illegible]
13. By depositing a [illegible] life into the orga[illegible] detecting the ra[illegible]
14. It was discovere[illegible] and radium is da[illegible] cancer
15. The high dose o[illegible] only the cancero[illegible] healthy cells
16. The Sun's large m[illegible] pressure and te[illegible] which lets fusion[illegible]