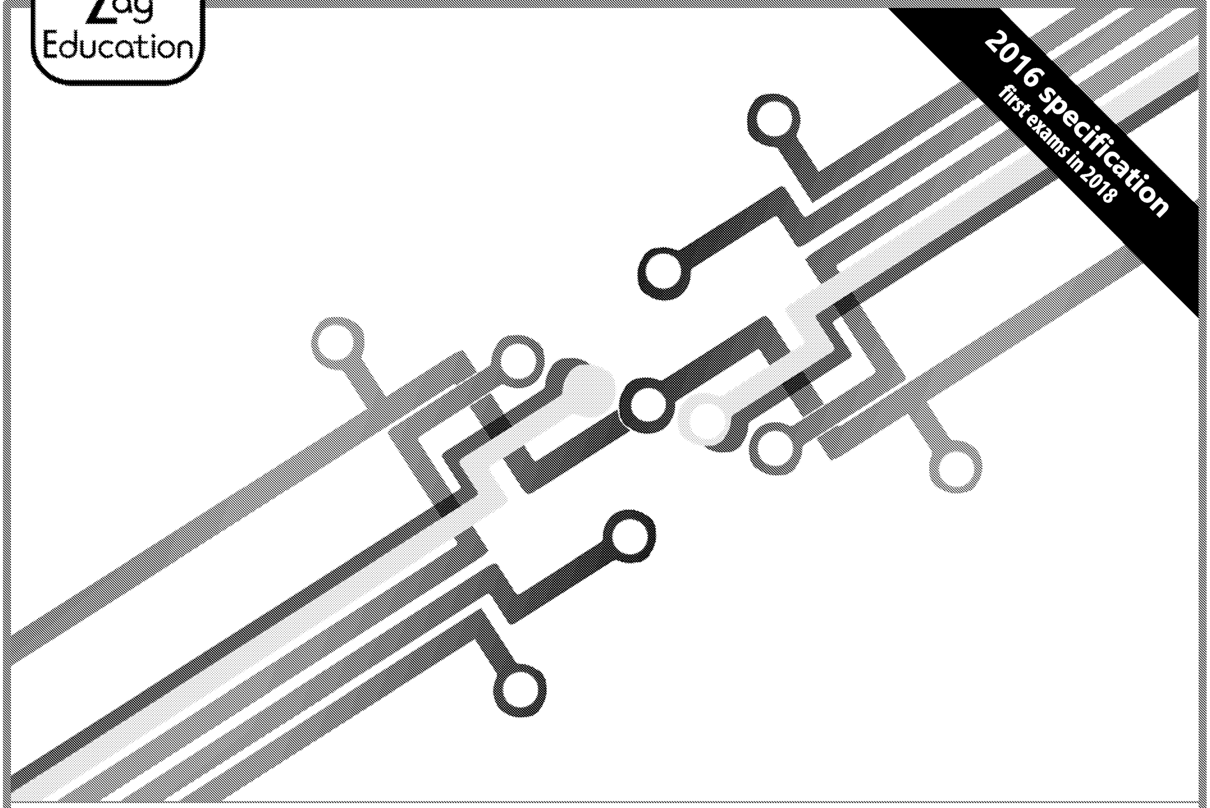
Combined Science

GCSE (9–1) | AQA | 8464



2016 specification
first exams in 2018

End-of-Topic A4 Quick-Mark Homeworks

for GCSE AQA Combined Science

Physics Topics 1–4

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POD 12919

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) Combined Science** course, **Physics Topics 1–4**.

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

The first half of the course is split into nine topics, eight of which are covered by at least 40 questions, with one shorter 20-question test for a total of over 410 questions.

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.

April 2025

Specification Reference Table

Homework	Title	Specification Reference
1	Energy Changes in a System	6.1.1
2	Transfers, Efficiency and Energy Resources	6.1.2–6.1.3
3	Current, Potential Difference and Resistance	6.2.1
4	Series, Parallel Circuits and Mains Electricity	6.2.2–6.2.3
5	Power and the National Grid	6.2.4
6	Changes of State	6.3.1–6.3.3
7	The Particle Model of a Gas	6.3.3
8	Atoms and Isotopes	6.4.1
9	Atoms and Nuclear Radiation	6.4.2

Topic 1 — 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 and why?
17. Why does a more powerful microwave heat up food faster than a less powerful microwave?

C

1. What happens to t speed is halved?
2. How is energy stor
3. What is the kinetic 2 kg travelling at a
4. Given that E_e = 1 / and e = 3.2 cm, cal
5. What are the units
6. A 450 g block is he temperature by 17 the specific heat ca
7. How much kinetic boat have if it weig
8. A plane has a mass 240 m/s. What is it
9. How long will an e and has a power ra
10. How much energy and a half minutes
11. If it takes 30 s for a of energy, what is
12. Why does the amo temperature of an
13. Describe how you thermal energy of
14. Describe how ener piano is pushed ou
15. Why do the tyres o been driven? Expla
16. Why is a 2 kW kett boiling a litre of wa
17. Explain what is me

Extension

1. How high will a projectile go if it travels vertically from the ground starting at 30 km
2. A javelin of mass 2 kg is thrown vertically to a height of 43.6 m. What is its maximum
3. What is the kinetic energy in kJ of a skydiver weighing 70 kg falling at a terminal veloc
4. A skydiver jumps out of a plane. Assuming no air resistance, how fast is the skydive
5. If a ball falls from a height of 2.0 m from rest, how fast will it be going before it hits
6. If the extension of a spring is doubled, by what factor does its elastic potential ener
7. What is the dependent variable when measuring the specific heat capacity of a ma
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[illegible] J / kg °C and $\Delta\theta$ = 37.5 °C, calcula
10. 500 J of thermal energy is used to heat [illegible] of copper (c = 385 J / kg °C). What is th
11. How fast can a remote-controlled car go if its power rating is 8 W, its mass is 600 g, maximum speed? Assume no dissipative forces.
12. A 2 kW motor runs for 3 min, and a 1.5 kW motor runs for 5 minutes. Which motor
13. Two identical kettles are filled with 1.2 l and 1.8 l of water. Explain why the 1.2 l ke
14. Why does the kinetic energy equation not allow negative values for kinetic energy
15. Describe how energy is stored before and after the explosion of a firework.
16. When a current flows down a wire, the wire heats up. Explain why this happens in t
17. What happens to the energy of a system when it is heated, and why?
18. If a rocket with its engines off in space has kinetic energy, why will it not slow dow

Topic 2 — Transfers, Efficiency and Ene

Fundamentals

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

C

1. Name one type o currently suitable
2. Which is more the a plastic rod?
3. Name one way by be reduced for a k
4. Name one factor t material, such as c
5. What is the main w wastes energy?
6. If a computer has a and an efficiency o
7. What is the efficie output power is 2
8. Which is the more nuclear or solar?
9. How is energy was
10. Name two renewa used to directly po
11. Explain what happ system when an e
12. You are building a make it as efficient
13. Why can't geother resource worldwid
14. What advantage d fossil fuels?
15. Why is coal a non-
16. Why is efficiency i 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. W
3. A radiator is made out of unpainted copper; name one thing that can be done to im
4. Which is the better insulator – a sheet of housing insulation or a vacuum?
5. A TV has a power input of 900 W and an efficiency of 70 %. What is its useful powe
6. The air at the top of a room is colder than the air at the bottom of the room – true
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
10. At what time of day is the demand for electricity at its lowest?
11. Name two renewable energy resources that could be used on Mars.
12. Explain why a balloon will pop when a [illegible] beam is directed at it for some time.
13. Why is burning fossil fuels bad for the environment?
14. If a light bulb is connected and aimed at a solar panel, will it stay on indefinitely?
15. Describe how energy is wasted in an operating fridge.
16. Why do scientists continue to develop new energy resources?
17. Where in the world is it best to build a solar farm, and why?
18. Why can't scientists and engineers just start using only renewable energy resource

Topic 3 — Current, Potential Difference

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.[illegible] A?
4. What is the word equation that gives 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 component with a resistance of 250 Ω and a 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 mA 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 bigge
2. A current varies be loop – true or false
3. The circuit symbol it – true or false?
4. The current at a p 2.3 A. After 3 s, ho
5. The potential diffe stays constant. Wh resistance is increa
6. What is the resista is 2.7 V and the cur
7. What is the curren connected to a 5 V
8. How much time el through a 2.0 kΩ r of 12 V?
9. What is the depen measuring the resi a potential differe
10. How much charge after 45 s if the po
11. How does a higher
12. How does an incre a thermistor?
13. Describe the circui
14. Describe how you through a compon
15. Explain what is me
16. Why must there b circuit for a curren
17. Describe a circuit t resistance of a com

Extension

1. A diode is connected the wrong way round in a circuit. What is the current flowing t
2. What is the potential difference across a 220 Ω resistor if 0.8 C of charge pass thro
3. How much charge has passed through a 400 Ω resistor after 30 s if the potential dif
4. The potential difference across an LED with a resistance of 100 Ω is 4.5 V. If it runs through it?
5. What is the potential difference across a 150 Ω resistor if 2.5 C of charge passes th
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
8. Describe the resistance of a diode connected in the reverse direction.
9. What is the resistance of a resistor if the potential difference across it is 2.7 V and 1.8
10. Name a variable that needs to be kept constant when investigating the I–V charact
11. What is the potential difference of a battery if a 30 mA current flows when it is con
12. Suggest a reason why the resistance of a wire starts to increase after the wire has b
13. Why does the current–potential difference graph for a filament lamp flatten for high potential differences?
14. Why is it useful to know the I–V graph of an electrical component?
15. Logic circuits output either a 1 (+5 V) or a 0 (0 V). Why are diodes useful in logic cir
16. Why does the resistance of a wire increase when the length of wire increases?

Topic 4 — Series, Parallel Circuits and M

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 ... in series or in parallel to a c... when used to measure its cur...
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 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 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 ... whether it works correctly?
15. Why a... connected using a parall...?
16. Describ... 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 total connected in paral one of the resisto
2. A 4 V battery and a to a 200 Ω resistor.
3. What is the total r and a 1 kΩ resistor
4. Two 100 Ω filamen a 9 V battery. Wha
5. Three 1 kΩ resistor current out of the current in one resi
6. What colour is the
7. What is the potent and neutral wire?
8. An AC power supp 1.5 V. What is its p
9. What happens if th electrical applianc
10. What is the potent in the UK?
11. Three 400 Ω resist connected in serie
12. Why is there an ea electrical applianc
13. A variable resistor battery and a lamp resistance have o
14. Describe what an
15. Explain why all thr an electrical plug.
16. Why must a voltm measure the poter
17. Explain what is me

Extension

1. Three wires, each carrying 0.1 A, join together in parallel to form a new wire. What
2. What is the resistance of a lamp connected to a 7 V battery if a resistor connected 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
4. The total resistance of two resistors connected in parallel is less than the resistance of
5. What is the potential difference across a 200 Ω resistor if it is connected in series wi
6. A 70 mA current flows through two 100 Ω resistors ... in series. What is the pote
7. The total current through two 30 Ω resist... in parallel is 75 mA. What is
8. A light bulb plugged into the m... resistance of 250 Ω. How much current pa
9. The total current thro... resistors connected in parallel is 90 mA. What is
10. What is ... neutral wire?
11. An ex... plugged into the mains has a resistance of 720 Ω. How much curre
12. What ... if the neutral wire becomes loose?
13. Why does adding more resistors in parallel to each other reduce the total resistanc
14. Why are wires colour-coded, and why is the earth wire striped in colour?
15. Why does current split at an intersection of a parallel circuit?
16. When testing lots of filament bulbs in one go, which type of circuit would you use,

Topic 5 — Power and the Natio

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 in total do they use in two minutes?
7. How much energy does a 700 W microwave use in 100 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. Describe the national grid.
11. Why is the power of an electrical appliance dependent on the current flowing through it?
12. Describe the change in energy store when a phone battery is charged using the mains.
13. Why is the power of an electrical appliance dependent on the potential difference?
14. What are step-up transformers used for, and why?

C

1. What is the pote takes 36 kJ of en
2. What is the resis 4 W and a curren
3. A 1200 W hairdr on for one minut
4. How much work flows through it of 2.3 V?
5. What is the curre difference acros
6. What is the pow resistance is 80
7. A transistor has does it take for 5 potential differen
8. How much charg plugged into the minutes?
9. What is the resis and has a power
10. How much energ supplied with 0.5
11. A 600 W microw 1.2 kW kettle is o more energy?
12. Each km of cable resistance of 0.1 20 km of cable if the cable?
13. Describe the ene connected to the

Extension

1. 1 kWh = 3.6 MJ. How much work, in kWh, is done by a transformer to transfer 90 k 20 kV? (Assume 100 % efficiency.)
2. Given that 1 mAh = 3.6 C, how long (in hours) does a 2000 mAh battery take to disch
3. 10 V is produced in a generator on a bike when a cyclist does 3 kJ of work on it. Ho
4. If the potential difference between two charged objects is kept at 17 kV and a spar energy is transferred?
5. How much work is done to transfer 200 mC of charge through a 330 Ω resistor in 14
6. The charge capacity of modern-day batteries is measured in mAh. What is 1 mAh i
7. Compare the decrease in potential difference by step-down transformers to the inc step-up transformers.
8. 50 C of charge passes through a 3 W bulb [illegible]. What is the potential difference a
9. How long does a 3000 mAh phone battery with a potential difference of 5 V take to supplied with 10 W of power?
10. 14 V is produced in a generator on a bike when a cyclist does 950 J of work. How m
11. By substituting P = I V into E = P t and using a previously learnt equation, derive the
12. Why is using the national grid an efficient way to transfer energy?
13. Assume that the National Grid has 7000 km of transmission cables that each have a Consider two-way transmission, so the total cable length is 14,000 km. Also assume the grid is 30 GW. If the average current transmitted across the grid is 1 kA, approxi supplied to the grid is lost as heat in the transmission cables?

Topic 6 — Changes of Sta

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 for measuring the diameter of a water bottle.
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 = 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 $\Delta E = m\,c\,\Delta\theta$, what is $\Delta\theta$ 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.

Ch

1. What is the density of a cu is 1.9 kg?
2. When water is boiled, the reduced – true or false?
3. If the total kinetic energy potential energy is 0.7 kJ,
4. Name the two changes of is placed into a hot frying
5. Water is frozen and melte closed system. What happ
6. When a gas is heated, des the particles.
7. What is the specific heat temperature increases by
8. An 850 g bar of gold is me thermal energy. What is t
9. In an experiment measuri would you use to determi
10. What is the temperature heated with 11.2 kJ of ene
11. What is the mass of a sub 1200 kJ / kg if it takes 350
12. Name a variable you need latent heat of water.
13. Explain how changes of st chemical changes.
14. Explain what internal ene
15. Describe the temperature the melting and boiling po energy input.
16. Why does snow take a lor
17. Describe what happens w
18. Explain how the higher ki in the structure of a gas.

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 kg / m^3 and a radius of 1.8 cm?
3. Name the two changes of state when a kettle is on and droplets appear on a nearb
4. Calculate the mass of an ice cube if it melts in a glass of water and releases 33 kJ o
5. Compare the 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 ene
8. Calculate the energy transfer when an 80 g ice cube melts in a glass of 0 °C water. (
9. A lead ball with a radius of 8.0 mm is heated with [illegible] kJ. What is its temperature ch (c_{lead} 129 = J / kg °C, ρ_{lead} = 11340 kg / m^3)
10. A 60 g ice cube at 0 °C is heated with [illegible] of energy. What is the final temperature c_{water} = 4180 J /kg °C)
11. Name one advantage of using a data logger instead of a thermometer to measure t
12. The latent heat of vaporisation is greater than the latent heat of fusion. Suggest a re
13. Give an equation describing internal energy.
14. Why do droplets appear on the outside of a cold glass of water?
15. In terms of particles, give a reason why a hovercraft experiences less friction than a
16. Explain why using steam to heat something is better than using hot water.
17. Explain the cooling effect of evaporation.
18. Describe how you could measure the density of a gold ring.

Topic 7 — The Particle Model o

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 of each particle – true or false?
5. Explain how the temperature of a gas is related to the motion of its particles.
6. Explain how a gas exerts a pressure on a container wall.
7. Why would heating a sealed balloon cause it to expand?
8. The temperature of a gas is related to the maximum kinetic energy of its particles – true or false?

C

1. What property o the temperature
2. A low-temperatu a high-temperatu
3. Denser gases exe
4. If the temperatu effect does doing
5. A pressure gauge sealed container Describe and exp of the gas.
6. If the kinetic ene increases, how d
7. The larger the vo temperature – tr

Extension

1. The particles of a gas collide more if the pressure of the gas is high – true or false?
2. If two gases at the same temperature are made up of particles with different mass
3. If the volume and mass of a gas are kept constant, but the pressure is decreased, w
4. Explain the change in pressure for a sealed gas at constant volume when the tempe
5. Balloons A and B contain the same gas at the same pressure, but balloon B has twic balloon A. Explain how the temperature of the gas in balloon A compares to the te

Topic 8 — Atoms and Isoto

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 equal in charge in the atom?
6. A sulphur atom has 16 protons and 16 neutrons; how many electrons does it have?
7. An atom of carbon has a mass number of 12 and an atomic number of 6. How many neutrons does it have?
8. An isotope of 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 in nm.
2. The radius of the n radius of the atom
3. If the radius of an what is the radius
4. An isotope of carb many more neutro
5. An ion of chromiu 24 neutrons. How
6. Plutonium has 150 its mass number?
7. Copper has 35 neu mass number, and
8. The discovery of th discovery of the nu
9. What is different b original element?
10. The number of wh the element of the
11. An electron drops type of radiation is
12. Explain why isotop not different charg of the same eleme
13. Describe how elec
14. Describe the nucle
15. In the Geiger–Mar did some of the α-
16. Explain why Ruthe plum pudding mod

Extension

1. What must be absorbed/emitted for the arrangement of electrons in an atom to ch
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 do
4. A nucleus contains 2 protons and is an isotope with one fewer neutron than the ele What is 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 t
8. The larger the drop in energy level of an electron, the larger the energy of the emit
9. Name the components of the plum pudding model.
10. How many subatomic particles are there in the nuclear model of the atom?
11. When Geiger and Marsden published their results, the scientific community will ha Why is this important?
12. Describe the changes Niels Bohr made to Rutherford's atomic model.
13. Describe what happens when an atom absorbs electromagnetic radiation.
14. Why was the proton introduced into the nuclear model of the atom?
15. Explain why a hydrogen atom (one proton and no neutrons) would cause the least

Topic 9 — 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 … t
6. What property of α-r… … es them the most da… rou… … uclear radiation to ing
7. For th… ear 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 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 'acti… ty'
16. Explain what happe… t … nt rate of a radioa… an… … one half-life, and w
17. Explai… y 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 object 1.9 × 10^{8} Bq. How m every second?
3. An α-particle can be what atom?
4. What is the half-life years its mass drops
5. Which types of nucle mass number?
6. Is γ radiation the mo α, β and γ radiation?
7. For the nuclear reac $^{X}_{3}Li \rightarrow {}^{9}_{Y}Be + {}^{0}_{-1}\beta$, wh
8. For the nuclear reac $^{X}_{6}C \rightarrow {}^{14}_{Y}N + {}^{0}_{-1}\beta$, wh
9. For the nuclear reac $^{244}_{94}Pu \rightarrow {}^{240}_{X}U + {}^{4}_{2}\alpha$
10. For the nuclear reac what is X?
11. Half-life is the time i decay – true or false
12. How much of 2 kg of 36 hours if its half-li
13. Name a reason scien working with radioa
14. Describe what a Geig
15. Describe why a lead radioactive substanc
16. If you were to inges type of nuclear radia
17. Explain what is mear radioactive substanc

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 decay process, how many protons are lost in the nucleus?
4. For the nuclear reaction equation $^{244}_{94}Pu \rightarrow {}^{236}_{90}Th + X\,{}^{4}_{2}\alpha$, what is X?
5. Name a type of nuclear radiation th… w… e suitable for detecting smo… om … re.
6. For the nuclear rea… … q… tion $^{244}_{94}P$… U … on, what is X?
7. The a… f a radioactive substance decreases as time goes on – true or false?
8. What is a β-particle?
9. Name a type of rad sterilising food or m harmful bacteria.
10. When a β-particle is changes into what?
11. If an α-particle and how many neutrons
12. Why are radioactive
13. Explain why isotope long half-lives.
14. Explain why the hal even though radioa
15. Why is it important research on radioac
16. Describe how the e mass and charge of

Fundamentals Tests

Topic 1 — Energy Changes in a Syst

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 ene
4	What type of energy d e s n object has if it is travelling at a constan
5	State e tored before and after an electric remote-controlled
6	The rature of a cup of tea drops from 80 °C to 35 °C. What is the te
7	Calculate the gravitational potential energy of a 5 kg weight raised 1.6 km
8	State the equation used to calculate the gravitational potential energy of
9	How much gravitational potential energy does a 25 g bouncy ball gain if it
10	What piece 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 material
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 ins
17	Why does a more powerful microwave heat u d f ster than a less pow

T 2 — Transfers, Efficiency and Energy R

1	Stat hange in energy stores when a ball is dropped from rest.
2	Are the following objects good insulators or good conductors? Oven glove
3	Name one way in which a coal-powered furnace wastes energy.
4	Why does a TV become warm after being on for a long time?
5	How is energy wasted by a jackhammer on a construction site?
6	State the equation for efficiency in terms of energy transfer.
7	What piece of apparatus would you use to measure the temperature of a
8	State the energy transfer in a tennis ball being hit by a racquet.
9	Name two types of non-renewable energy resource.
10	What is the efficiency of a transformer with a powe put of 100 kW and
11	What is a renewable energy resource?
12	Why is housing insulation line ver veneer?
13	Describe the energ ccurring for a bullet when a gun is fired.
14	Why us rround moving parts in a car engine?
15	Wh ant by 'dissipated energy'?
16	Why is using renewable energy resources more favourable than using non

Topic 3 — Current, Potential Difference and Resista

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 cur
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 component with a ... of 250 Ω and a cu
8	A charge of 80 C flows through a circuit in 20 s ... the current in the circuit.
9	A 1.2 mA current is applied throug ... esistor. What is the potential differenc
10	What is the current in a ... tor if 80 C of charge passes through it in one mi
11	Describe the ...–potential difference graph for a filament lamp.
12	What is the in...endent variable in an experiment measuring the resistance of wir 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, a

Topic 4 — Series and Parallel Circuits and Mains Elect

1	The potential difference across each component in a ser... it is the same – true
2	What equation would you use to find the tota... of two resistors connected
3	For components connected in para... ...es the potential difference across eac component compare?
4	Is an ammete... ...ec... series or in parallel to a component when used to meas
5	The potential ...nce across a 100 Ω resistor is 4 V. What is the potential differen 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 potential d 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 t
12	Describe what a direct potential difference is.
13	Why is an exposed live wire dangerous if an applian... ...ged into the mains?
14	How would you test an LED to find out wh... ...works correctly?
15	Why are house lights connected ...g a parallel circuit?
16	Describe the cir... ... a parallel circuit.
17	Why does the ...esistance increase when you add more resistors in series with e

Topic 5 — Power and the National G

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 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 [illegible] are switched on, how much energy in total d
7	How much energy does a 700 W microwave use in 100 s? Give your answe
8	How much energy does a 9.0 V battery lose if it discharges 200 C?
9	What do step-down transformers do?
10	Describe the national grid.
11	Why is the power of an electrical appliance dependent on the current flo
12	Describe the change in energy store when a phone battery is charged usi
13	Why is the power of an electrical appliance dependent on the potential d
14	What are step-up transformers used for, and why?

Topic 6 — Changes of State

1	What is the density of a 2.3 m^3 box if its mass is 6 kg
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 wat
4	The particles in a gas are more tightly packed than those in a solid – true c
5	What is the volume of a 2.5 kg tube of copper with a density of 8940 kg / r
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 lead if 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 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 obj
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 7 — 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 temperatu

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 e

5 Explain how the temperature of a gas is related to the motion of its partic

6 Explain how a gas exerts a pressure on a container wall.

7 Why would heating a sealed balloon cause it to expand?

8 The temperature of a gas is related to the maximum kinetic energy of its p

Topic 8 — 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 net

5 What particles are neutral in charge in the atom?

6 A sulphur atom has 16 protons and 16 neutrons; how many electrons doe

7 An atom of carbon has a mass number of 12 and an atomic number of 6. H
it have?

8 An isotope of uranium has a mass number of 235 and an atomic number o
it have?

9 A magnesium atom has 12 protons and 12 neutrons. What is its mass nu

10 What metal was used for the thin film in the Geiger–Marsden scattering e

11 What are atoms of the same element but which have a different number o

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 disprov

15 Describe what happens when an electron emits electromagnetic radiatio

Topic 9 — Atoms and Nuclear Radiati

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 ... them the most dangerous type of nuc

7 For the nuclear ... equation $^{19}_{8}O \rightarrow {}^{19}_{X}F + {}^{0}_{-1}\beta$, what is X?

8 Oth... α, β and γ radiation, name a type of nuclear radiation.

9 α-particles have the greatest ionising power compared to other forms of r 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 inv

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 thicknes

Answers

Topic 1 — Energy Changes in a System

Fundamentals

1. 0.0125 kg
2. As chemical energy
3. Joule, J
4. Kinetic energy
5. Before: ch[illegible]ca[illegible] [illegible]fter: kinetic energy
6. 80 – 35[illegible]
7. 5 × 9.8 × [illegible] = 78 kJ
8. $E_P = mgh$
9. 0.025 × 9.8 × 3 = 0.74 J
10. A thermometer
11. 1.2 × 185 × 35 = 7800 J or 7.8 kJ
12. 1 watt is equal 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 inciden[illegible] the food per second, causing it to heat [illegible]

Challenge

1. It is div[illegible] 4
2. As kine[illegible]y
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: it is stored as gravitational potentia[illegible] e[illegible]; after: it is stored as kinetic energy [illegible] it [illegible] the ground)
15. Kinetic energy of the [illegible] [illegible]sferred to thermal energy [illegible]
16. Becaus[illegible] is transferred twice as quickly
17. The amo[illegible] of energy required to raise the temperature of 1 kg of a substance by 1 °C

[E]xtension

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 moto
13. The mass of wate energy (and, the to boil
14. Velocity is square there is no such t
15. Before: it is store stored as therma
16. The current is ele wire to be stored
17. The temperature there is an increa system has some
18. For the rocket to the rocket to tra other forms

Topic 2 — Transfers, Efficiency and Energy Re

Fundamentals

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

Challenge

1. Hydroelectricity
2. A coppe
3. Painting the inside of the kettle a silver colour / building the kettle from thermally insulating materials / removing limescale from the heating element
4. The amount of material
5. Via thermal energy
6. 300 W
7. 76.6 % or 0.766
8. Nuclear
9. Through the conduction of its walls, windows and doors
10. Biofuel/solar
11. It stays the same because energy can neither be created nor destroyed
12. Build a large, light wheel / ensure the paddles have a large surface area
13. It requires thermal activity just below the surface of Earth's crust
14. It doesn't produce large amounts of CO_2 as fossil fuels do
15. There is a limited amount of coal buried underground and it takes millions of years to form
16. It is better for the environment and for the durability of the device (as it won't overwork itself)

Extension

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

Topic 3 — Current, Potential Difference and R

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 / 2[illegible] A
9. 1.2 mA [illegible] = 400 mV or 0.40 V
10. 80 / 60 = [illegible] A
11. The graph is curved at large values and linear in between
12. The diameter of the wire
13. A current won't flow if there is a break in the circuit, meaning no charge 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 [illegible] throughout a series circuit)
3. False (i[illegible] [illegible]ved 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, and then use a stop clock to time how long you want to measure the charge for. Then, use Q = I × t to find the charge that has passed through in that time.
15. Current that always flows in the same direction
16. A potential difference is created by an imbalance of charge carriers between two points. The energy stored by this imbal[illegible] [illegible] 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 / mat[e] wires used
11. 3.6 V
12. The duration of t[h] causes the wire t[o] resistance to inc[r]
13. The resistance in[c] depending on th[e] filament lamp
14. It can be used to building a circuit component well
15. They don't allow any output belo[w]
16. The longer the w[i] flows through, s[o] current meets

Topic 4 — Series, Parallel Circuits and Mains E

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
8. Brown
9. Alternating
10. Green and yellow stripes
11. 9 / (2 × 300) = 15 mA
12. A direct potential difference (dc supply) is one that is constant in direction (i.e. 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 receives 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 tw when the resistor 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 flo
11. 0.32 A
12. The circuit is now work
13. Adding more resis more paths for th though these path infinite (an infinit isn't there).
14. For easy identifica make it clearer w much if you mix u simply breaks the the earth wire (ve
15. A current is made which can only flo current splits at a depending on the
16. A parallel circuit determine which will still be on.

Topic 5 — Power and the National Grid

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
9. They de th domestic levels
10. The na id is a system of cables and transfor linking power stations to consumers
11. The higher the current, the more charges present, and, therefore (through E = Q V), the more energy in the system
12. It starts as electrical energy in the mains, before being transferred to chemical energy in the battery
13. The higher the potential difference, the more the charges will want to flow, so more energy is present in the system
14. 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. 470 C
9. 40 Ω
10. 110 kJ
11. The kett
12. 2 MW
13. Electrical energy from the mains is transformed into thermal energy in the water

Extension

1. 500 kWh
2. 2.5 hr
3. 300 C
4. 66 mJ
5. 0.94 J
6. 3.6 C
7. The decrease in p is greater than th step-up transforn
8. V = (P t) / Q = (3
9. 5400 s or 1.5 hou answer from Q5)
10. 68 C
11. E = P t = (I V) t, an E = (I t) V = Q V
12. The step-up trans the current decre The lower curren through heat loss
13. R = 14 000 km ×
P = I^2R = (1000 A)
Percentage loss =

Topic 6 — 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 [illegible] 6.7 °C
9. 191 600 [illegible] = 871 kJ / kg
10. 24 900 / (3.1 × 340) = 23.6 °C
11. A change of state from a solid to a liquid
12. It stays the same
13. A scientific model used to describe a system as being made of particles 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 reversed, whereas chemical changes cannot be reversed
14. The total energy of the system held by the particles in the system
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
4. 98.8 g
5. Gas particles mov
6. 5.4 × 10^3 kg / m^3
7. False; it is stored energy stays cons
8. 26.7 kJ
9. 32 °C
10. 39.7 °C
11. Higher resolutio
12. The particles mus potential energy
13. Internal energy = potential energy
14. Evaporated wate condenses to for
15. The particles of a spaced out than l easily, resulting i
16. The steam releas transferring more
17. Latent heat is nee Once this energy remaining liquid i
18. Measure the volu displacement me calculate the den

Topic 7 — 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. The faster the particles of a gas move, the more energy the gas has, and, therefore, the higher its temperature
6. 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.
7. 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.
8. False (temperature depends on the average kinetic energy of particles, not maximum)

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. The temperature increases
5. For a fixed volume of gas, a decrease in pressure means that a decrease in temperature has occurred
6. If the kinetic energy of 50 % of particles increases, the average kinetic energy – and, therefore, temperature – increases
7. False (temperature depends on the average kinetic energy of particles, not volume)

Extension

1. True (more collisions means a large force exerted on the container, resulting in higher pressures)
2. The lighter particles
3. It also decreases
4. Each particle has less energy due to the lower temperature; therefore, there are fewer collisions with the container wall, resulting in the lower pressure
5. The gas in balloon B has the same temperature as the gas in balloon A

Topic 8 — 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
10. Gold
11. Isotopes
12. Negatively charged particles embedded in a sphere of positive charge
13. An atom that has either 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 some 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 with
8. True (conservatio
9. The electron and
10. 3
11. To verify their re results are reliabl
12. He theorised elec based on their en
13. An electron orbit energy and jumps
14. Later experiment subdivided into p
15. The nucleus is sm has the least char the least

Topic 9 — Atoms and Nuclear Radiation

Fundamentals

1. +2
2. -1
3. 1 m
4. Unlimited
5. Becquerel, Bq
6. Short penetration depth / high ionising po…
7. 8 – (-1) = 9
8. Neutron radiation
9. True (they have the largest mass so they have the largest …
10. 24 – 0 = …
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 radia… and n… radiation
6. The lea…ng
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 penetrate lead
16. Gamma radiation because it can easily pass through the skin and 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 radiatio… depending on th…
13. Naturally occurri… half-lives quickly …
14. The half-life of a … of billions of dec… is lost
15. So other scientist… better understan…
16. The relative char… the nucleus stays…