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Tonbridge School 13+ Science

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TONBRIDGE SCHOOL

Scholarship Examination Sample Paper

Science I

Time allowed: 45 minutes

Answer all the Questions

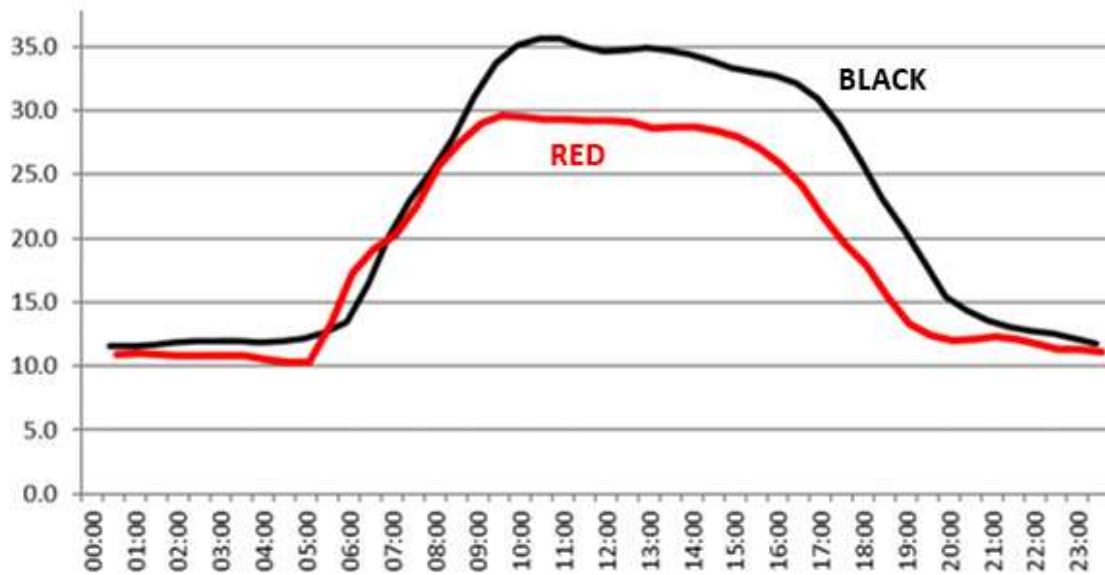
You may use a calculator

The entire paper is worth 40 marks and the number of marks for each question is shown in brackets.

1. Tonbridge School recently opened a state-of-the-art science centre. One of the considerations when designing a new building is the long-term energy usage of the building.



The below graph shows the electricity usage in the building on two typical school days:



Both lines were recorded during term time, but one was from May and the other was from November.

a) Which of the lines corresponds to the November reading? Explain your answer (3)

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b) Why does electricity demand increase during the day? (1)

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c) Why is electricity still being used at 01:00am? (1)

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d) Describe two measures that could be introduced to reduce electricity consumption in the new building? (2)

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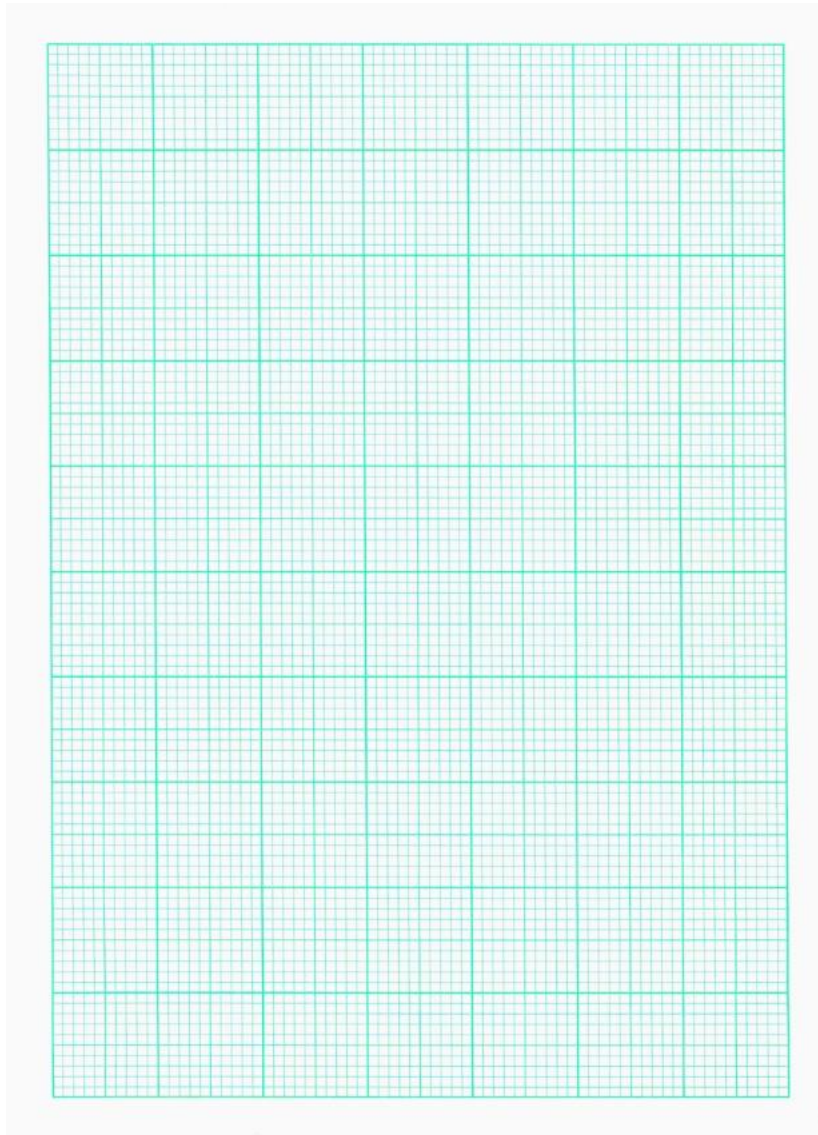
2. The building was officially opened by two NASA astronauts who worked with our students for a week.



The table below shows the height of one of the astronauts when he was on the International Space Station:

<u>Number of days in space</u>	<u>Height (inches)</u>
0	66
10	68
20	69
30	70
40	71
50	71
60	71

- a) Plot a **line graph** to show the relationship between “Number of Days in Space” (x-axis) against “Height” (y-axis) (5)



- b) Describe the relationship demonstrated by the graph: (3)

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c) Explain why this relationship exists when astronauts are on the International Space Station: (2)

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d) Estimate the astronaut's height after 70 days in space: (1)

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e) A standard classroom ruler has two scales the same length, 30cm and 12 inches. With this information, calculate the change in height of the astronaut between day 0 and day 60, **giving your answer in cm:** (3)

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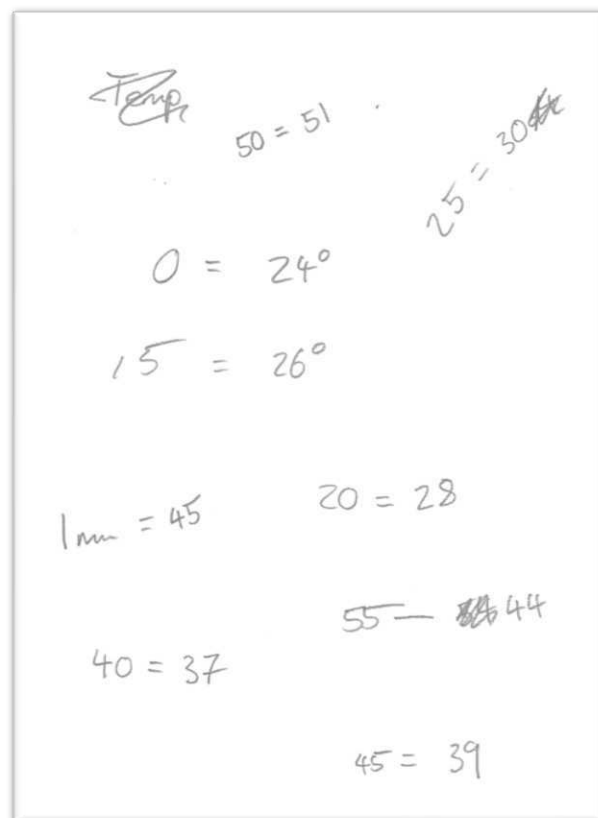
QUESTIONS CONTINUE OVERLEAF

3. The new science centre has enabled Tonbridgians to complete many interesting experiments during lessons.



Two students are working on an experiment in which they measure the temperature rise of a substance over a minute. Their initial results on scrap paper are included on the right:

- a) Copy these results into a table below, in a format suitable for a formal experimental report: (3)



b) Identify the anomalous result: (1)

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c) What could the students do to improve the reliability of the results (1)

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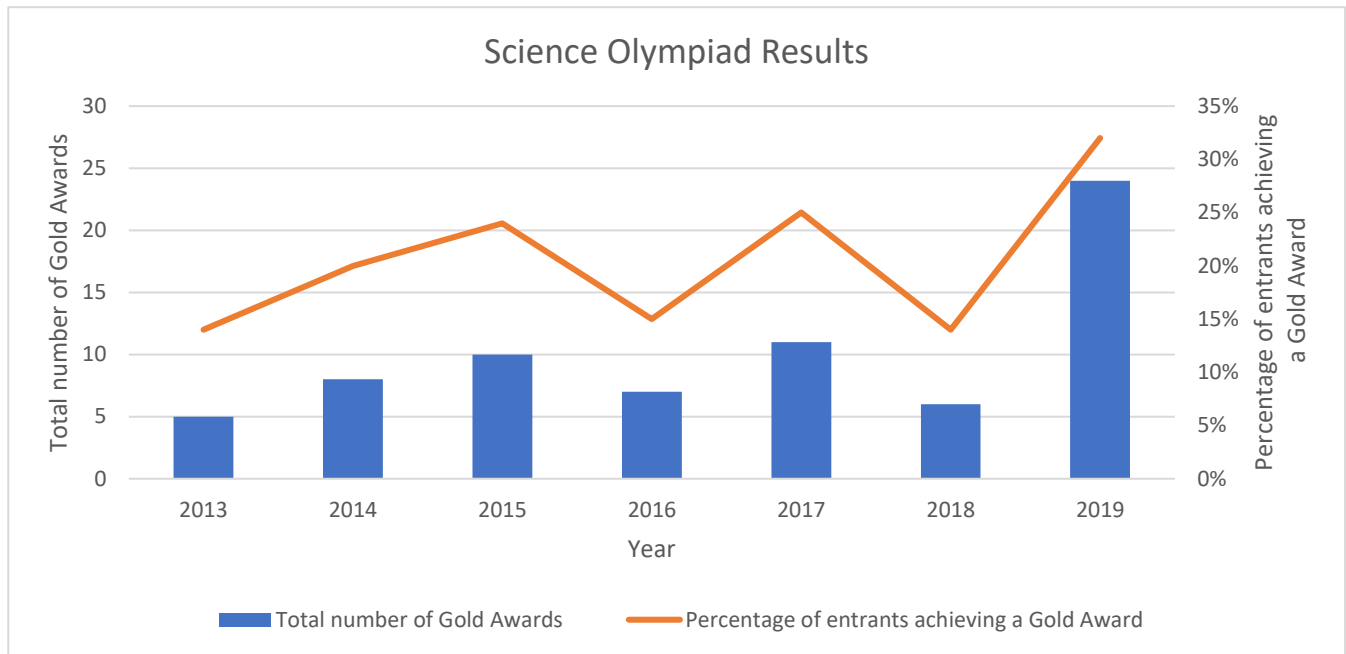
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d) How could the students make their results more precise: (1)

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4. The Barton Science Centre is a great space for students to prepare for extension competitions called Olympiads. The following graph shows both the number of gold awards achieved in recent Olympiads and the percentage of Tonbridgian entrants achieving gold awards:



The building opened at the start of 2019.

- a) How could the graph’s data help the Head of Science to suggest that the building has had a positive impact on the department’s Olympiad results? (4)

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- b) The Headmaster is cautious about making conclusions about the building's impact from the graph. Why might he be hesitant? (2)

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5. When working with the astronauts at the opening of the Barton Science Centre, our L6th students designed a variety of experiments to be taken up to the International Space Station (ISS) for completion in 2020 by current astronauts.



Outline an experiment to be carried out on the ISS to explore an area of science that you are interested in. You should consider:

- What would you investigate - what kind of experiment would be worth conducting on the ISS?
- What would the astronauts vary, measure and control etc?
- Feasibility - e.g. size of equipment to transport up to the ISS, safety, any additional resources needed?
- What could be done with the results?
- How would the experiment aid future research?

(7)

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[Space to draw a diagram if needed]

END OF PAPER 1

Paper Notes: 13+ Science Sample Paper (13+ Science Sample Paper)

Compiled by [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk) to help you get the most from this paper.

Overview

This is a **Science I** scholarship examination sample paper published by **Tonbridge School** for **13+ entrance** candidates (students seeking entry into Year 9). The paper is designed to stretch academically able pupils preparing for **scholarship level** assessment, rather than the standard entrance examination.

The paper is worth **40 marks** and allows **45 minutes** working time. Candidates may use a calculator. The questions are presented as free-response items requiring written explanations, data analysis, graph plotting, and creative experimental design. The context is built around the opening of Tonbridge's new science centre, the Barton Science Centre, and a visit from two NASA astronauts, making the paper contemporary and engaging.

The paper tests scientific literacy across multiple disciplines (physics, biology, data handling) and emphasises practical investigative skills, graph interpretation, experimental design, and the ability to apply scientific reasoning to real-world scenarios. It is well suited for high-attaining Year 8 pupils preparing for scholarship examinations at independent senior schools.

How this paper is organised

The paper contains **five main questions** subdivided into multiple parts, worth a total of **40 marks**. Question 1 (7 marks) focuses on electricity usage data presented in a dual-line graph, requiring interpretation, explanation, and practical energy-saving suggestions. Question 2 (14 marks) explores astronaut height changes in microgravity through table analysis, graph plotting, descriptive writing, scientific explanation, estimation, and a unit conversion calculation involving inches and centimetres.

Question 3 (6 marks) addresses experimental methodology, asking candidates to reformat rough data into a formal table, identify an anomalous result, and suggest improvements for reliability and precision. Question 4 (6 marks) presents a composite graph showing Olympiad performance over time and asks students to interpret trends, construct arguments, and critique the validity of causal claims.

Question 5 (7 marks) is an extended open-ended task requiring students to design a feasible experiment for the International Space Station, considering variables,

equipment, safety, and the broader scientific value of the proposed investigation. Candidates are given space to write and draw diagrams.

Topics covered

- Interpretation of line graphs showing electricity consumption over time, including comparison of two data sets and identification of seasonal variation
- Energy conservation in buildings, understanding demand patterns, and suggesting practical measures to reduce electricity usage
- Data presentation and graph plotting: constructing a line graph from tabular data with correct axes, labels, and scale
- Describing relationships in scientific data: recognising initial linear increase followed by plateau in biological measurements
- Microgravity effects on the human body, specifically spinal elongation in astronauts during extended spaceflight
- Unit conversion between imperial (inches) and metric (centimetres) systems using proportional reasoning
- Experimental technique: formatting raw data into formal tables suitable for scientific reporting
- Identifying anomalous results in a data set and understanding concepts of reliability and precision in experimental work
- Critical interpretation of trends in composite graphs with dual y-axes (total numbers versus percentages)
- Evaluating correlation versus causation, recognising limitations in drawing conclusions from observational data
- Open-ended experimental design for microgravity research, including feasibility, variables (independent, dependent, control), safety considerations, and the wider scientific context

How to use this paper for revision

- Practise reading composite graphs with two y-axes carefully; always check which line corresponds to which axis and pay attention to the units and scale on each side.
- When asked to explain a scientific phenomenon, structure your answer logically: state the observation, identify the underlying cause, and link it to the scientific principle involved.
- Revise unit conversion methods, particularly between metric and imperial systems; use the ruler relationship ($30\text{ cm} = 12\text{ inches}$) to build conversion factors rather than memorising formulae.
- For graph plotting, always use a ruler, label axes clearly with quantity and unit, choose sensible scales that use most of the grid, and plot points accurately before drawing a line of best fit.
- In experimental design questions, remember to address the key elements: what you will change (independent variable), what you will measure (dependent variable), what you will keep the same (control variables), and how you will ensure fair testing.
- When identifying anomalous results, look for values that do not fit the overall pattern or trend; explain why they stand out rather than simply stating which point is anomalous.
- For open-ended questions like Question 5, plan your answer before writing; jot down the experiment aim, method outline, and anticipated results to ensure a coherent response.

Common mistakes to avoid

- Confusing correlation with causation in data interpretation; just because two trends occur together (such as the building opening and improved Olympiad results) does not prove one caused the other without controlling for other factors.
- Plotting graphs without labelling axes or omitting units; examiners deduct marks for missing labels, incorrect scales, or failure to use the grid space efficiently.
- Providing vague explanations such as 'less gravity' without explaining the mechanism; for astronaut height increase, you must mention that the spine extends because intervertebral discs decompress in the absence of gravitational compression.
- Ignoring the anomalous data point in Question 3 (the 55-second reading of 44°C instead of the expected ~43°C) or failing to explain how to improve reliability by repeating measurements and calculating a mean.
- Misreading composite graphs by matching the wrong data series to the wrong axis; always trace each line back to its corresponding y-axis before making comparisons.
- In experimental design, describing what you would observe rather than how you would conduct the experiment; focus on method, apparatus, and control of variables rather than expected outcomes.

Exam technique

Work through the paper in order, but be aware that **Question 5** carries 7 marks and requires sustained writing and planning; if time is tight, allocate at least 8 to 10 minutes to this question. Read each part of a question carefully before answering; many parts build on earlier answers, so an error in part (a) may affect subsequent parts. For graph questions, use the grid space provided generously and plot points accurately with a sharp pencil; neat, clear presentation earns credit.

When explanations are required, write in full sentences and structure your reasoning clearly. For example, in explaining astronaut height increase, first describe the phenomenon (the spine lengthens), then explain the cause (absence of gravitational compression allows discs to expand), and finally relate it to the conditions (microgravity environment). Avoid one-word answers unless the question explicitly asks for identification only.

In the extended experimental design question, plan before you write. Jot down the independent variable, dependent variable, control variables, apparatus, and a brief method outline. Consider feasibility seriously; proposing an experiment requiring tonnes of equipment or hazardous materials will not score well. Aim for a concise,

realistic investigation that exploits the unique microgravity environment of the ISS. Leave a couple of minutes at the end to review your answers, checking units, labels, and clarity of explanations.

What to revise alongside this paper

Students preparing for this paper should revise the principles of **energy transfer and efficiency**, including renewable energy sources, insulation, and building design.

Understanding **gravitational forces** and how they affect the human body will support answers on astronaut physiology. Graph skills are central; practise constructing and interpreting line graphs, scatter graphs, and bar charts, paying particular attention to scaling, labelling, and reading composite graphs with dual axes.

Investigative skills underpin much of the paper. Revise how to design fair tests, identify and control variables, recognise sources of error, and suggest improvements to experimental reliability and precision. Familiarity with **data handling** techniques, including calculating means, identifying trends, and spotting anomalies, is essential.

Broader reading on space science, particularly life aboard the International Space Station, will enrich answers to Questions 2 and 5. Explore how microgravity affects physiology, materials science, and chemical reactions. For stretch, investigate real experiments conducted on the ISS to inspire your own experimental proposal.

Key terms

Electricity consumption, Seasonal variation, Energy efficiency, Line graph, Anomalous result, Reliability, Precision, Independent variable, Dependent variable, Control variable, Microgravity, Spinal elongation, Unit conversion, Correlation versus causation, Experimental design

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Name:

School:



TONBRIDGE SCHOOL

Scholarship Examination Sample Paper

Science II – Biology, Chemistry and Physics

Time allowed: 1 hour 15 minutes

Please write your name at the top of each of the subject specific sections, as indicated.

Answer all the Questions.

You may use a calculator.

The entire paper is worth 60 marks and the number of marks for each question is shown in brackets.

1. One of the characteristics of living organisms is that they reproduce. Many organisms use a process called sexual reproduction in order to produce offspring. During this process two cells, one from each parent, combine.

a. What name is given to the specialised cells produced by each parent? (1)

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b. Each gender produces specialised sex cells. Complete the table below using the key terms given. (3)

Sessile Small Few Many Mobile Large

Feature of Sex Cell	Male Sex Cell	Female Sex Cell
Size		
Number		
Mobility		

c. Once the sex cells have fused in mammals a baby may grow. In order for the baby to grow it will need to undertake a process called respiration. In the space below write a word equation for this process. (2)

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- d. In humans the raw materials for this process come from the mother's body and the waste material is excreted by the mother. In birds this is not the case. Would you expect an egg to get heavier, lighter or stay the same mass as the chick grows?

Please explain your answer.

(3)

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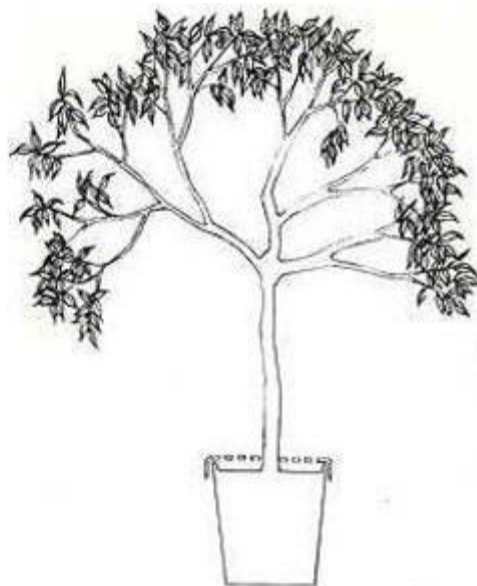
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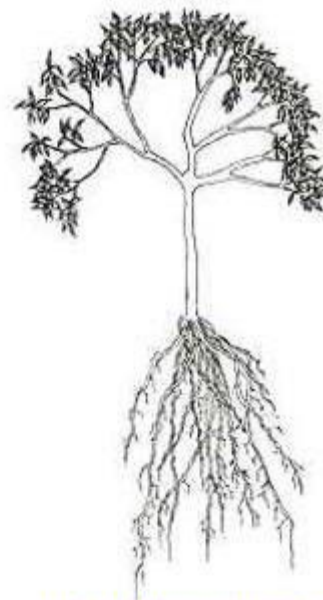
2. Jan Baptist van Helmont was a Belgian scientist. He studied plants. At the time it was thought that plants grew heavier by consuming material in the soil. van Helmont decided to design an experiment to test this.



Van Helmont's tree when he planted it



Van Helmont's tree after five years



Van Helmont's tree after five years, out of its pot to show the roots

- a. Fill in the table below to show the mass of the plant at the start and end of the experiment. (1)

	Mass of Soil (kg)	Mass of Plant and Soil (kg)	Mass of Plant (kg)
Start	90.0	92.2	
5 years later	89.5	166.1	

- b. To what extent do the results of this experiment conflict with the thinking of the time? (1)

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- c. van Helmont concluded that the gain in mass of the plant must come from the water he had given it whilst it grew. Use your knowledge of Chemistry to dispute his conclusion (2)

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- d. Science requires empirical proof of a hypothesis. Design an experiment to test van Helmont's hypothesis that a plant gains mass from the water given to it. Consider in your experiment which variables you will change, which you will measure and which you will keep constant.

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3. An adaptation is a feature of an organism or its behaviour that helps an organism to survive and reproduce. Outline your favourite adaptation, this can be taken from any organism, and explain how it helps the organism survive and reproduce.

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Biology Total Marks 20

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1. This question is about Particle Theory. A student places 20.0cm^3 of water into a measuring cylinder that is sitting on a top pan balance. She finds the mass to be 20g. She places it in a freezer overnight and finds that the resulting ice has a volume of 21.7cm^3 .

a. Name the process in which water is converted to ice. (1)

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b. Explain why the volume has increased. (1)

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c. Predict the mass of ice in the measuring cylinder. Explain your answer. (2)

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2. Magnesium is reacted with oxygen in an open beaker. There is a bright white light and the white solid is formed.



a. Is this change chemical or physical? Explain your answer. (2)

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b. What happens to the mass of the beaker and solid? Tick your answer (1)

- Increases
- Decreases
- Stays the Same

c. Explain your answer. (1)

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The experiment is repeated with the magnesium in a **sealed** container.

d. What happens to the mass of the sealed container? Tick your answer (1)

- Increases
- Decreases
- Stays the Same

e. Explain your answer. (1)

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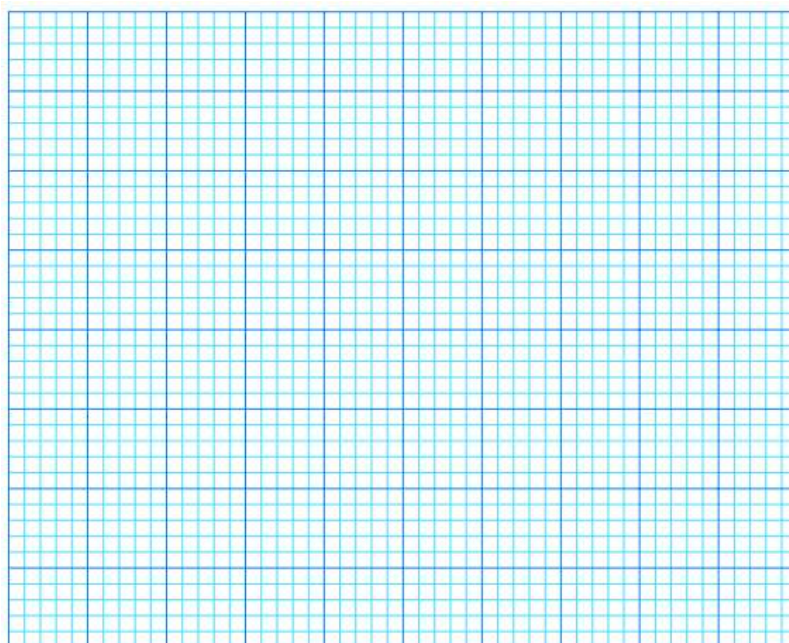
f. Which of the following processes is endothermic? Tick your answer (1)

- Deposition
- Condensation
- Freezing

3. This question is all about metal displacement reactions. The table below shows the temperature change when metals are added to a solution of Copper (II) Sulphate, CuSO_4 .

Metal	Tin	Calcium	Zinc	Magnesium
Temperature Change / $^{\circ}\text{C}$	4	32	21	27

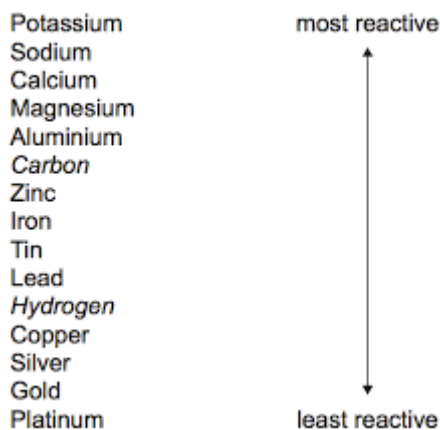
- a. Plot a suitable graph for this data. You should choose an appropriate scale and label the axes. (4)



- b. In each case, a solid is produced in the reaction. Predict the colour of this solid. (1)

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A reactivity series is shown below;



- c. Predict the temperature change when Iron is reacted with Copper (II) Sulphate. (1)

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When metal, M, is put into water, bubbles of gas given off and the metal eventually disappears. The resulting solution has pH14.

- d. Suggest a possible identity for metal M (1)

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Gold has a number of uses in the modern world:

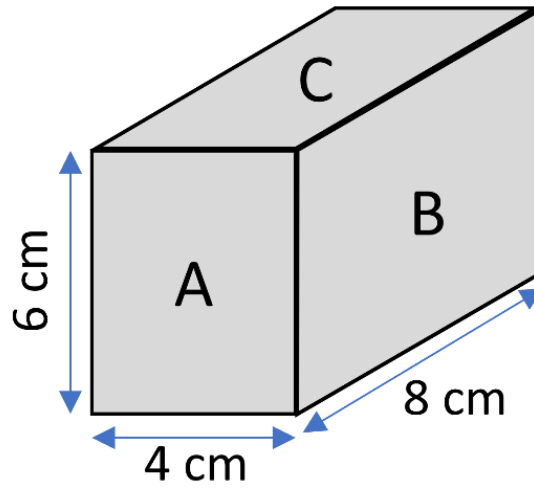
- e. Give a use of Gold metal (1)

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- f. Explain, in terms of its chemical or physical properties, why it is suitable for that use. (1)

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Chemistry Total Marks 20



1. A cuboid has side lengths 4.0cm, 6.0cm and 8.0cm.

a. Calculate the volume of the cuboid (2)

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b. The cuboid has a density of 5.0g/cm^3 . Calculate the mass of the cuboid (3)

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- c. The cube is placed with one side on the floor. Which side will produce the largest pressure? (1)

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[Ignore any effects of air resistance during the following question]

2. A ball has a long piece of tape attached to it which runs through a machine that marks dots on the paper every 0.1s. The ball is dropped and hits the floor. The first dot is made when the ball is released, and the last dot being made when it hits the floor.

- a. Using the scale 1cm = 10cm, calculate the height from which the ball was dropped (2)

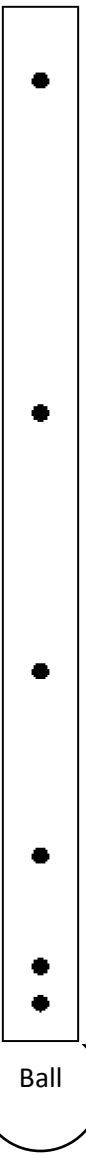
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- b. How long did it take for the ball to hit the floor? (2)

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- c. Hence calculate the average speed of the ball: (3)

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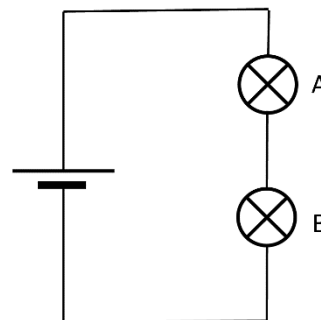
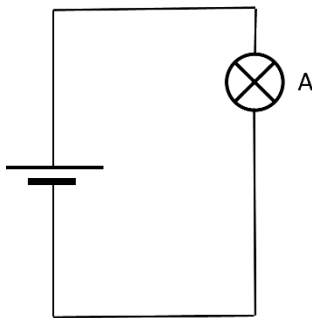
d. When was the ball travelling at the average speed? (1)

- At half the distance between its release height and the floor
- At half the time through its flight
- Throughout its journey
- It never was travelling at exactly its average speed

e. A second heavier ball was also dropped at the same time. The time it took for the second ball to fall to the ground was: (1)

- Less than the lighter ball
- The same as the lighter ball
- Longer than the lighter ball

3. A simple circuit is made with a bulb (labelled A) and a cell. The brightness of bulb A is recorded. A second, identical bulb (labelled B) is added to the circuit so that the two bulbs are in line. The brightness of the bulbs A & B is again recorded and compared to the first result:



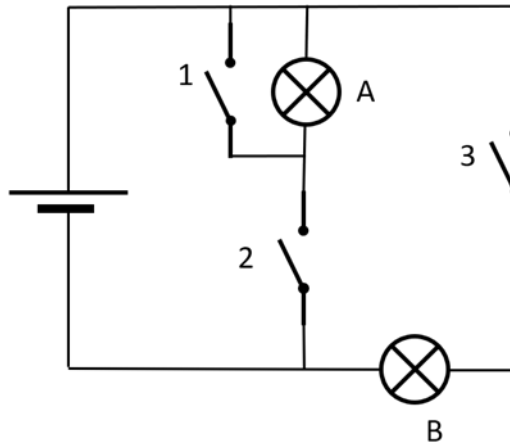
a. In the second circuit, how does the brightness of bulb A compare with that of B? (1)

- A is Brighter
- They are the same
- A is dimmer

b. Which of the following statements is true: (1)

- Bulb A got dimmer when bulb B was added
- Bulb A stayed the same brightness even after bulb B was added
- Bulb A got brighter after bulb B was added

A new circuit is made with bulbs A and B, as well as three switches. The diagram below shows the configuration. The three switches can be open and closed and the bulbs may light up:



c. Complete the table below. The first row is completed for you: (5)

<u>Switch 1</u>	<u>Switch 2</u>	<u>Switch 3</u>	<u>Bulb A</u>	<u>Bulb B</u>
open	open	closed	off	on
closed	closed	open		
open	closed	closed		
open	closed	open		
closed	open	closed		
closed	closed	closed		

Physics Total Marks 20

END OF PAPER 2

Paper Notes: 13+ Science Sample Paper (13+ Science Sample Paper)

Compiled by [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk) to help you get the most from this paper.

Overview

This is a **13+ scholarship sample paper** published by **Tonbridge School** in Kent, designed for candidates applying for entry into Year 9. It assesses all three core sciences in an integrated format under the heading **Science II**, covering **Biology, Chemistry and Physics** in equal measure.

The paper is worth **60 marks** in total and candidates are given **1 hour 15 minutes** to complete it. Each science section carries **20 marks**, and questions range from short factual recalls to extended written responses and graph plotting. Calculators are permitted throughout.

This paper suits students preparing for the Tonbridge 13+ scholarship exams who have covered the first two years of senior school science or accelerated Year 8 material. It expects fluent recall of foundational concepts, the ability to analyse data, design simple experiments, and apply knowledge across disciplinary boundaries. The inclusion of historical experiments (van Helmont) and conceptual reasoning (bird eggs, metal reactivity) make this a test of scientific literacy, not just rote learning.

How this paper is organised

The paper opens with an instruction to write your name at the top of each subject section. Biology comes first (questions 1–3, **20 marks**), followed by Chemistry (questions 1–3, **20 marks**), and then Physics (questions 1–3, **20 marks**). Each discipline occupies its own set of pages, clearly labelled.

In Biology, question 1 covers sexual reproduction and respiration (9 marks total), question 2 examines the van Helmont willow tree experiment and experimental design (8 marks), and question 3 is an open-ended question on adaptations (3 marks). Chemistry question 1 addresses particle theory and state changes (4 marks), question 2 explores mass conservation in open and sealed systems (8 marks), and question 3 involves metal displacement, reactivity series interpretation, and a graph (8 marks).

Physics question 1 tests density and pressure calculations for a cuboid (6 marks), question 2 analyses a falling ball using a ticker-tape diagram (9 marks), and question 3 examines series circuits and switch logic (7 marks). The final page is a blank sheet for rough work.

Topics covered

- Sexual reproduction in animals: specialist gametes, their size, number and mobility; fertilisation and development
- Aerobic respiration in mammals: word equations for the process, supply of reactants and removal of waste products
- Mass and energy changes in bird embryos: conservation of mass in closed systems, gas exchange through eggshells
- Historical scientific experiments: van Helmont's willow tree investigation, mass measurement, and interpretation of results
- Experimental design and variables: identifying independent, dependent and control variables; forming hypotheses and testing them empirically
- Particle theory and state changes: freezing water, volume expansion, conservation of mass, endothermic and exothermic processes
- Chemical reactions and mass conservation: open versus closed containers, why mass appears to change in open systems, role of gases
- Reactivity series of metals: displacement reactions, temperature changes as evidence of reactivity, predicting outcomes with less reactive metals
- Density, mass and volume calculations: using the formula $\text{density} = \text{mass} / \text{volume}$ with cuboids, converting units correctly
- Motion and speed: interpreting ticker-tape diagrams, calculating average speed, understanding acceleration under gravity
- Series electrical circuits: brightness of bulbs in series, current and voltage distribution, logic tables for switches controlling multiple bulbs

How to use this paper for revision

- Revise word equations for key biological processes (respiration, photosynthesis) and be ready to write them from memory without chemical symbols.
- Practise calculating density, mass and volume using the triangle method; always write out the formula, substitute values, then solve step by step.
- Learn the reactivity series of metals from potassium down to platinum; use mnemonics like 'Please Send Charlie's Monkeys...' to fix the order.
- When designing experiments, always state what you will change (independent variable), what you will measure (dependent variable), and what you will keep the same (control variables).
- For ticker-tape or dot-diagram questions, count the intervals carefully and use the given time scale (here 0.1 s per dot) to find total time, then apply $\text{speed} = \text{distance} \div \text{time}$.
- Draw clear, labelled circuit diagrams in pencil; trace the current path for each switch configuration to predict which bulbs will light.
- Remember that ice has a larger volume than the same mass of water because particles arrange in a more open lattice structure when frozen.

Common mistakes to avoid

- Writing 'oxygen' or 'air' as a product of respiration instead of carbon dioxide; respiration consumes oxygen and glucose, producing carbon dioxide and water.
- Assuming a bird's egg gets heavier as the chick grows, forgetting that oxygen enters and carbon dioxide leaves through the shell, so mass decreases slightly.
- Stating that mass increases in an open beaker when magnesium burns, overlooking that the product (magnesium oxide) includes oxygen from the air which was not originally weighed.
- Mixing up endothermic and exothermic processes; deposition, condensation and freezing all release energy (exothermic), whereas melting, evaporation and sublimation absorb energy.
- Plotting temperature on the x-axis and metal on the y-axis; continuous variables (temperature change) belong on the y-axis, categories (metal names) on the x-axis.
- Forgetting to convert cubic centimetres to other units if required, or leaving density in g/cm^3 when the question asks for kg/m^3 ; always check units in the question.

Exam technique

Start by reading the instructions at the top of each section and noting the total marks available. Aim to spend roughly **25 minutes per science section**, leaving a few minutes at the end to review. Tackle the shorter, factual questions first to build confidence and bank easy marks, then move to multi-step calculations and extended writing.

For calculation questions (density, speed, volume), always write the formula, show substitution with units, and box your final answer. If a question says 'explain your answer', one-word responses will not earn full marks; write at least one clear sentence linking your reasoning to the science. Use the space provided as a guide to how much detail is expected.

In the circuit-logic table, trace the path from the battery through each combination of switches methodically. If you are unsure whether a bulb will light, draw a simplified diagram on scrap paper. For the graph in Chemistry question 3a, use a ruler, label both axes with quantities and units, choose a sensible scale that fills most of the grid, and plot all four points accurately before deciding whether to join them with a line or leave them as a bar chart.

What to revise alongside this paper

Students should consolidate their understanding of **photosynthesis** alongside respiration, focusing on how the two processes are linked in plants. Revise the full reactivity series and practise writing balanced symbol equations for displacement reactions, including those involving acids (a natural extension from metal–salt displacements).

In Physics, deepen your grasp of **Newton's laws of motion**, particularly the relationship between force, mass and acceleration, and how gravity accelerates all objects equally in a vacuum. Parallel and series circuits should be compared side by side, with attention to how current and voltage behave differently in each configuration.

For Chemistry, explore the kinetic particle model in more detail, explaining changes of state, diffusion and gas pressure. Understanding **conservation of mass in chemical reactions** will also prepare you for balancing equations and stoichiometry at GCSE level.

Key terms

Gametes, Fertilisation, Aerobic respiration, Hypothesis, Independent variable, Dependent variable, Control variable, Particle theory, Endothermic, Exothermic, Conservation of mass, Reactivity series, Displacement reaction, Density, Volume, Mass, Pressure, Average speed, Acceleration, Series circuit, Current, Ticker-tape diagram

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