

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A152/02

ADDITIONAL SCIENCE A

Unit A152: Modules B5, C5, P5 (Higher Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:

None

Duration: 1 hour

Other Materials Required:

- Pencil
- Ruler (cm/mm)

Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- A list of qualitative tests for ions is printed on page **2**.
- A list of physics equations is printed on page **3**.
- The Periodic Table is printed on the back page.
- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The number of marks for each question is given in brackets [] at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **24** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	Mark
1	4	
2	11	
3	6	
4	2	
5	6	
6	6	
7	3	
8	2	
9	6	
10	3	
11	3	
12	2	
13	6	
TOTAL	60	

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative Analysis

Tests for positively charged ions

ion	test	observation
calcium Ca ²⁺	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu ²⁺	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe ²⁺	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe ³⁺	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn ²⁺	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide

Tests for negatively charged ions

ion	test	observation
carbonate CO ₃ ²⁻	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl ⁻	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br ⁻	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I ⁻	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO ₄ ²⁻	add dilute nitric acid, then add barium chloride or barium nitrate	a white precipitate forms

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Sustainable Energy

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

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

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved in the direction of the force}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

Answer **all** the questions.

1 Human enzymes can be made by genetically modifying yeast cells.

- Human DNA is inserted into the yeast cells.
- The **modified** yeast cells now have the ability to synthesise human enzymes.

(a) Complete the sentences about the production of human enzymes by modified yeast cells.
Choose words from this list.

amino acids

bases

fatty acids

proteins

sugars

The modified yeast cells can code for the production of the human enzymes because their DNA now contains the correct sequence of

The human enzymes produced will have the correct number and sequence of

[1]

(b) The modified yeast cells go through the cell cycle and reproduce to form a culture.

The two main parts of the cell cycle are cell growth and mitosis.

Which statements about the cell cycle are true?

Put ticks (✓) in the boxes next to the correct statements.

The nucleus divides during cell growth.

The chromosomes are copied to form new strands of DNA.

The number of organelles in each cell decreases as the cell grows.

The copies of each chromosome stay together when the cells divide during mitosis.

The number of chromosomes doubles in each cell before the cell divides.

[1]

(c) **Meiosis** is another type of cell division that takes place in humans.

Use ideas about chromosomes to explain how cells made by meiosis are different from those made by mitosis, and why this is important.

.....

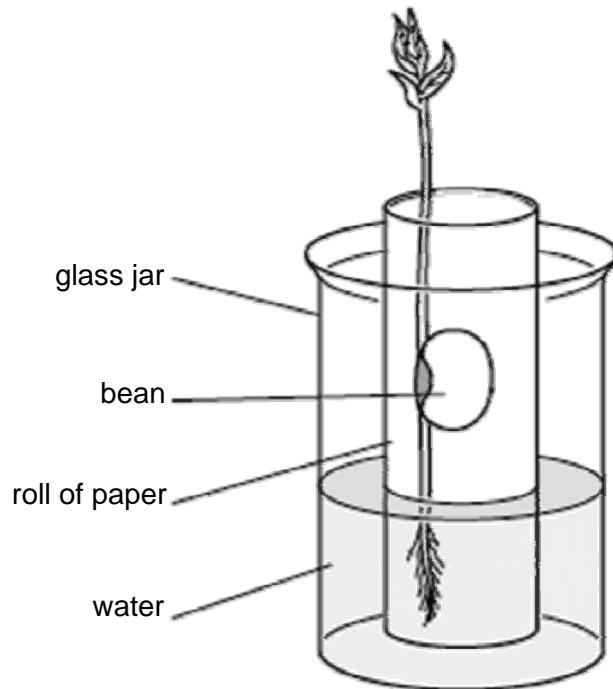
.....

.....

..... [2]

[Total: 4]

- 2 Joe does an experiment to show the effect of light on the growth of a bean seedling. He sets up the experiment as shown in the diagram.



- (a) Some parts of the seedling contain meristems.

Explain why these meristems are important to the seedling.

.....

.....


.....

..... [2]

(b) Joe puts the glass jar containing the bean seedling next to a window.

After several days he notices that the tip of the seedling stem has grown towards the window.

Explain how the seedling stem grows towards the light coming through the window.

 *The quality of written communication will be assessed in your answer to this question.*

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.....

[6]

(c) Explain how phototropism increases a plant's chance of survival under natural conditions.

Complete the sentences.

Use words from the list.

carbon dioxide

competitive

destructive

light

oxygen

parasitic

photosynthesis

reproduction

respiration

water

Phototropism allows plants to obtain more

The plants can carry out more quickly.

This allows the plants to be more

[1]

(d) A team of plant scientists predicted that a chemical they had produced would make plant roots grow.

The team tested their prediction by growing plants with and without the chemical then measuring root growth.

They found that there was **agreement** between the data and their prediction. The scientists concluded that this proved the chemical made roots grow.

Write down whether you agree or disagree with this conclusion, and explain why.

.....

.....

.....

..... [2]

[Total: 11]

- 3 A scientist is trying to produce specialised cells from adult stem cells. She hopes to use the specialised cells to replace damaged tissues in the human body.

She divides a sample of identical adult stem cells into two different solutions of chemicals. She wants to find out whether the chemicals affect the rate of cell division of the stem cells.

She counts the number of live cells present in each solution every six hours over a 24-hour period.

Here are her results.

solution	number of live cells to the nearest thousand			
	6 hours	12 hours	18 hours	24 hours
A	4000	16 000	16 000	32 000
B	2000	8000	32 000	128 000

- (a) The scientist concludes that the **rate** of cell division increased steadily between 6 and 24 hours in solution **B**.

Is this conclusion correct? Justify your answer.

.....

.....

..... [1]

- (b) The scientist also concludes that there was no cell division in solution **A** between hours 12 and 18 of the experiment.

(i) Suggest **two** reasons why this conclusion may **not** be correct.

.....

.....

..... [2]

- (ii) The scientist realises that a fault in the incubator for solution **A** caused the temperature to vary between hours 12 and 18 of the experiment.

Suggest how this could account for the results between hours 12 and 18.

.....

.....

..... [2]

- (c) The scientist needs to make the stem cells specialise so that she can use them to replace damaged tissues in the body.

One way to make the cells specialise is to expose them to certain chemicals.

What is the first thing that must happen in a cell before it can form a specific tissue type?

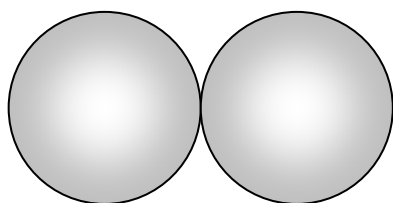
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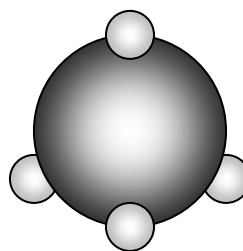
..... [1]

[Total: 6]

4 These diagrams show the arrangement of atoms in a molecule of oxygen and a molecule of methane.



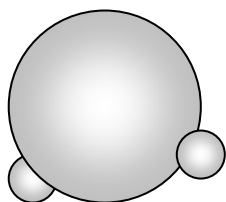
oxygen



methane

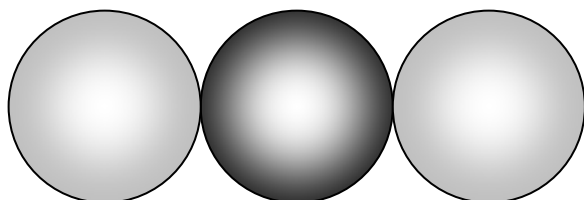


What is the name and formula of each of the following molecules?



name

formula.....



name

formula.....

[2]

[Total: 2]

- 5 The table shows some properties of a number of metals. For each property the metals are listed from highest value to lowest value.


	melting point	electrical conductivity	density	resistance to corrosion	cost per tonne
highest value ↓	iron	gold	gold	gold	gold
	copper	copper	copper	aluminium	copper
lowest value	gold	aluminium	iron	copper	aluminium
	aluminium	iron	aluminium	iron	iron

Electricity is distributed around the country along metal transmission lines.

These lines are hung from pylons.

Which metal would be the best choice for the electrical transmission lines?

Explain fully the reasons for your choice.

 The quality of written communication will be assessed in your answer to this question.

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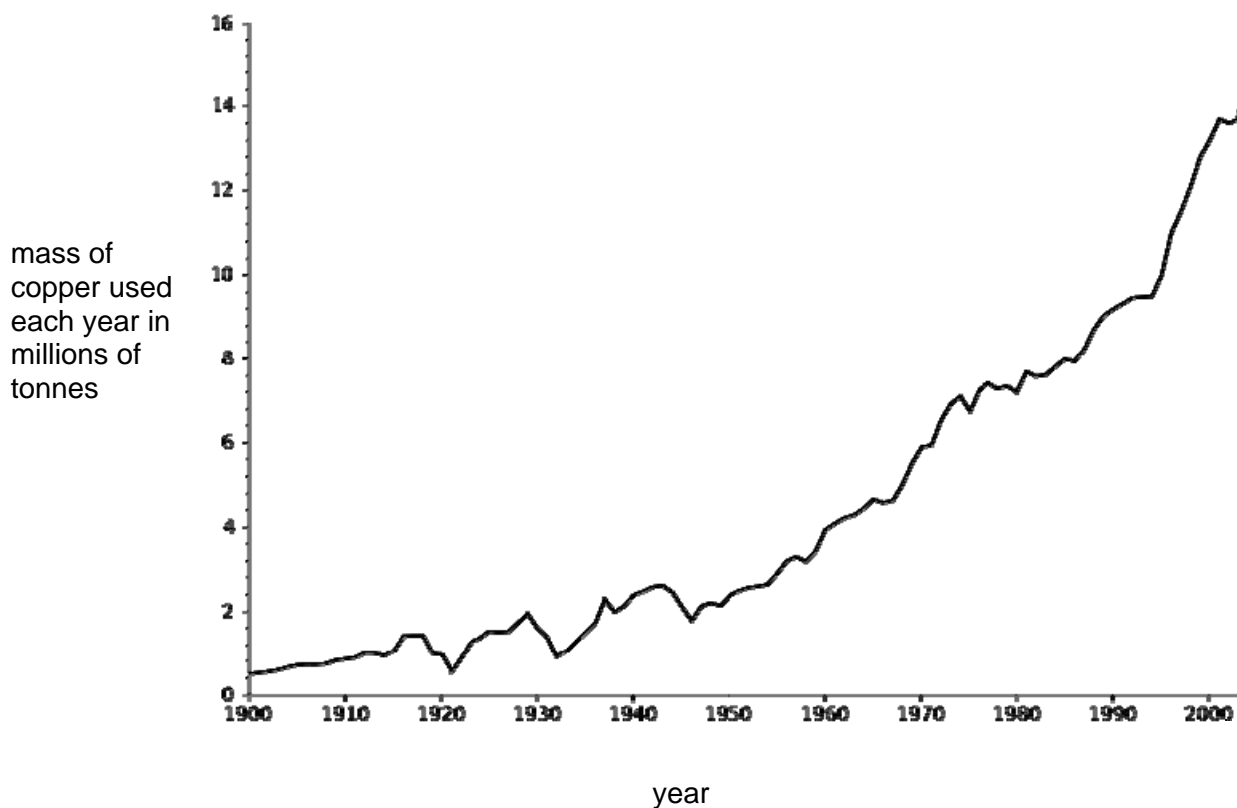
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..... [6]

[Total: 6]

6 The graph shows the mass of copper used each year during the last century.



Copper is a fairly common metal. It accounts for approximately 0.007 % of the Earth's crust.

(a) (i) Use your knowledge of copper extraction and the graph to predict whether we will be able to produce enough copper to meet demand in the future.

Explain your answer.

.....

.....

.....

..... [2]

(ii) Suggest how it might be possible to reduce the mass of copper that we need to extract each year.

.....

..... [1]

(b) Copper is obtained by mining copper ores from the ground.

A mining company can recover 40 g of copper ore from every kilogram of mined rock.

The ore they recover is called cuprite, and has the formula Cu_2O .

(i) What is the maximum amount of copper **metal** the company will be able to recover from a kilogram of mined rock?

answer = g [2]

(ii) Complete the sentences to explain how copper metal can be extracted from cuprite.

Cuprite ore is with carbon.

Copper is during the reaction because

it loses

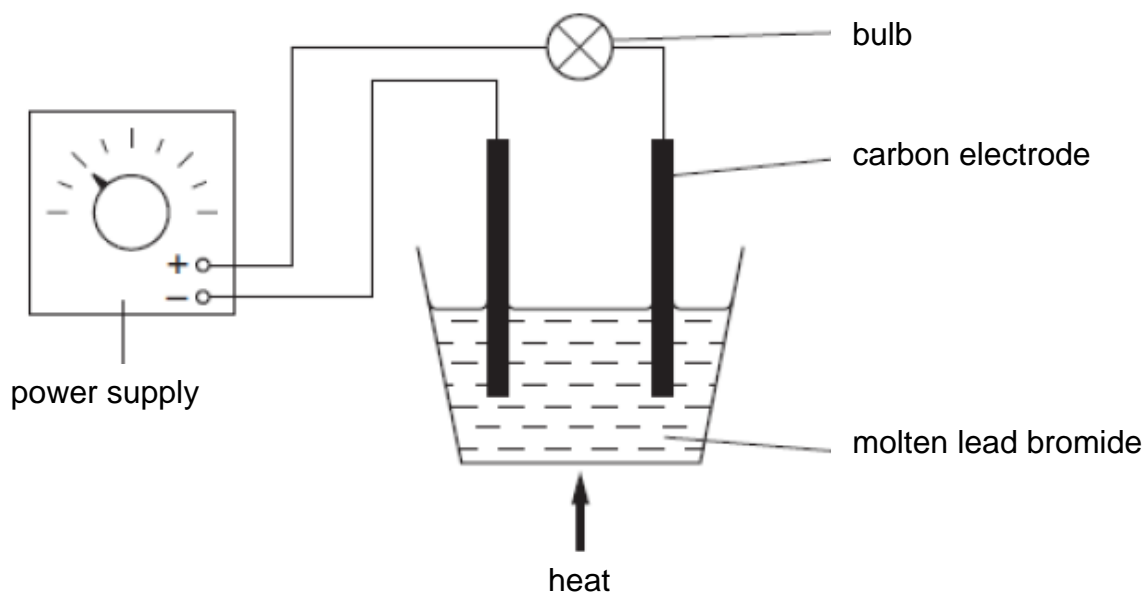
Carbon is during the reaction because

it gains

[1]

[Total: 6]

- 7 John does an experiment.
He passes electricity through molten lead bromide.
The diagram shows how he sets up his experiment.



- (a) Lead bromide is an ionic compound.

What will form at each electrode when John turns on the power supply?

.....

.....

.....

..... [2]

- (b) John finds out that atoms of sodium metal can be made from sodium chloride by electrolysis of molten sodium chloride.

Complete the equation to show what happens when a sodium ion forms a sodium atom.



[Total: 3]

8 Silicon dioxide is a giant molecular compound.

The atoms in silicon dioxide are held together by covalent bonds.

Which statements about the bonding in silicon dioxide are correct?

Put ticks (✓) in the boxes next to the **two** correct answers.

Electrons are gained or lost to form a full outer shell.

Electrons are shared between atoms.

The nucleus of each bonded atom attracts electrons.

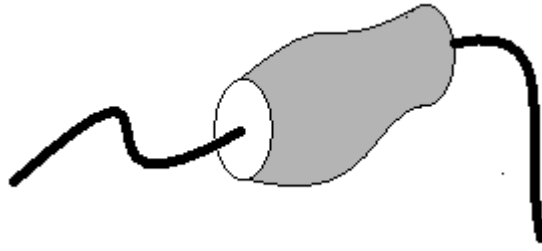
Charged ions are attracted towards one another.

The nuclei of the atoms attract each other.

[2]

[Total: 2]

9 Jeff investigates a new component.



He connects it to three different batteries, measuring the current and voltage each time.

Here are his results.

voltage in volts	current in amps	resistance in ohms
2.8	0.70	
5.9	1.2	4.9
12	1.8	

(a) Complete the table by filling in the two missing values for resistance. [1]

(b) Jeff says that any changes in the resistance are caused by changes in the current.

Explain whether Jeff's explanation is supported by the results.

.....

.....

.....

..... [2]

(c) Jeff decides to take some more measurements to test his idea.

He asks his colleagues for advice



Alan
Repeat the experiment many times with the same batteries.

Bess
Repeat the experiment with a wider range of voltages.



Carlos
Do the experiment again with the component at a constant temperature.

Davina
Plot the results on a graph to find the outliers.



Who has the best advice?

answer [1]

(d) After taking more measurements, Jeff decides that there is enough evidence to say that the resistance of the component depends on its current.

Explain what he needs to do before publishing his theory.

.....

.....

.....

.....

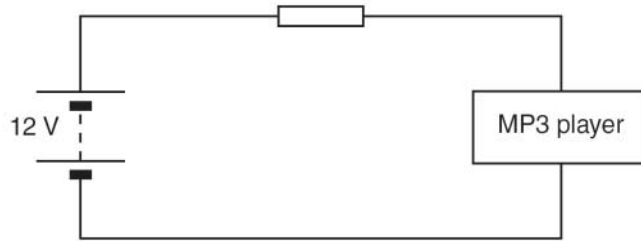
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[2]

[Total: 6]

10 Jo likes to listen to her MP3 player.

She uses this circuit to connect her MP3 player to a 12 V battery.



(a) Here are some data about the MP3 player.

electrical property	value
operating power	0.45 W
working voltage	3.0 V
current	

Complete the table by filling in the empty box.

[2]

(b) The battery supplies a potential difference of 12 V for the circuit.

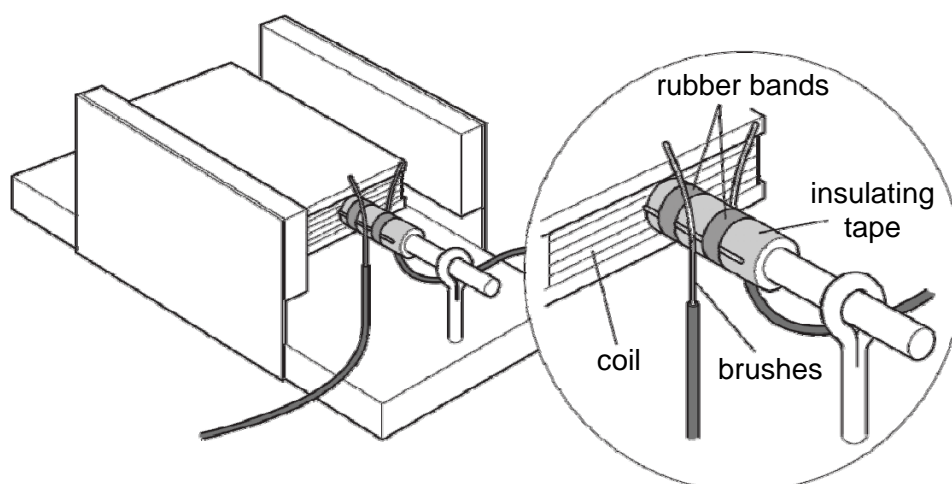
The potential difference across the MP3 player is only 3 V.

What is the potential difference across the resistor?

potential difference = V [1]

[Total: 3]

11 Here is a diagram of a simple electric motor.



The motor is made of a coil of wire that is suspended between a pair of magnets.

The coil starts off in a horizontal position, as shown in the diagram.

The close-up shows the electrical contacts (labelled 'brushes').

When a potential difference is applied to the brushes, the coil rotates.

Select 3 statements from the list below which, when taken together, help to explain how this motor works.

- A When the coil rotates it generates a potential difference.
- B When the coil is connected to the brushes there will be a current flowing in the coil.
- C The current in the coil exerts a force on the magnets which makes the coil move.
- D A voltage will produce a current in the wire when there is a complete circuit.
- E A current-carrying conductor will always experience a force.
- F The resistance of the wire in the coil reduces the current passing through it.

answer and and [3]

[Total: 3]

12 A generator is made using a magnet which spins near a coil of wire.

The generator produces a changing voltage.

(a) Which of the following words describes this process?

Put a ring around the correct answer.

deduction

formation

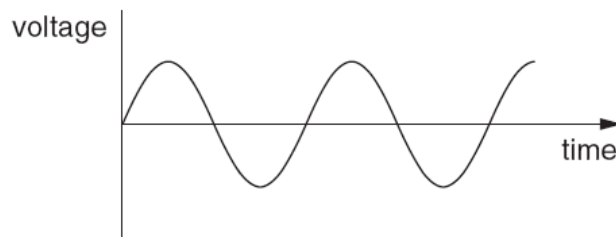
induction

reduction

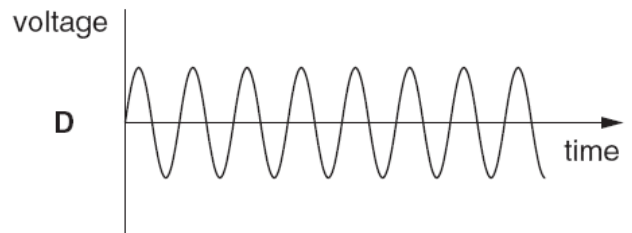
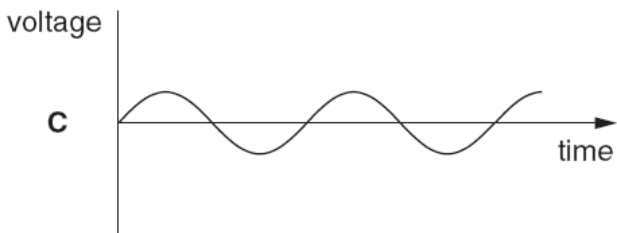
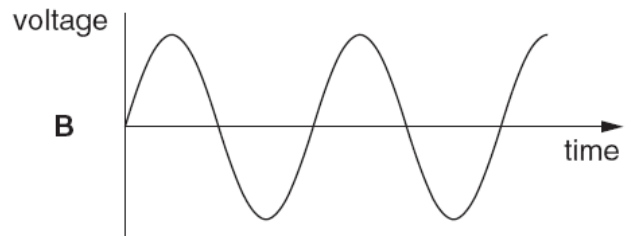
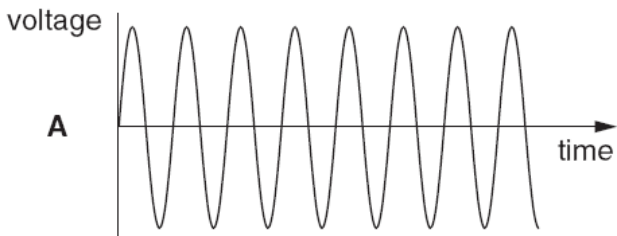
transformation

[1]

(b) The graph shows how the voltage produced by the generator changes with time when the magnet spins at a particular speed.



The following graphs all have the same scales as the graph above.



Which graph shows what happens when the magnet is spun round **faster**?

answer [1]

[Total: 2]

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Periodic Table

1	2											3	4	5	6	7	0												
		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Key relative atomic mass atomic symbol <small>name</small> atomic (proton) number </div>																										<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 1 H hydrogen 1 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 4 He helium 2 </div>
7 Li <small>lithium</small> 3	9 Be <small>beryllium</small> 4											11 B <small>boron</small> 5	12 C <small>carbon</small> 6	14 N <small>nitrogen</small> 7	16 O <small>oxygen</small> 8	19 F <small>fluorine</small> 9	20 Ne <small>neon</small> 10												
23 Na <small>sodium</small> 11	24 Mg <small>magnesium</small> 12											27 Al <small>aluminium</small> 13	28 Si <small>silicon</small> 14	31 P <small>phosphorus</small> 15	32 S <small>sulfur</small> 16	35.5 Cl <small>chlorine</small> 17	40 Ar <small>argon</small> 18												
39 K <small>potassium</small> 19	40 Ca <small>calcium</small> 20	45 Sc <small>scandium</small> 21	48 Ti <small>titanium</small> 22	51 V <small>vanadium</small> 23	52 Cr <small>chromium</small> 24	55 Mn <small>manganese</small> 25	56 Fe <small>iron</small> 26	59 Co <small>cobalt</small> 27	59 Ni <small>nickel</small> 28	63.5 Cu <small>copper</small> 29	65 Zn <small>zinc</small> 30	70 Ga <small>gallium</small> 31	73 Ge <small>germanium</small> 32	75 As <small>arsenic</small> 33	79 Se <small>selenium</small> 34	80 Br <small>bromine</small> 35	84 Kr <small>krypton</small> 36												
85 Rb <small>rubidium</small> 37	88 Sr <small>strontium</small> 38	89 Y <small>yttrium</small> 39	91 Zr <small>zirconium</small> 40	93 Nb <small>niobium</small> 41	96 Mo <small>molybdenum</small> 42	[98] Tc <small>technetium</small> 43	101 Ru <small>ruthenium</small> 44	103 Rh <small>rhodium</small> 45	106 Pd <small>palladium</small> 46	108 Ag <small>silver</small> 47	112 Cd <small>cadmium</small> 48	115 In <small>indium</small> 49	119 Sn <small>tin</small> 50	122 Sb <small>antimony</small> 51	128 Te <small>tellurium</small> 52	127 I <small>iodine</small> 53	131 Xe <small>xenon</small> 54												
133 Cs <small>caesium</small> 55	137 Ba <small>barium</small> 56	139 La* <small>lanthanum</small> 57	178 Hf <small>hafnium</small> 72	181 Ta <small>tantalum</small> 73	184 W <small>tungsten</small> 74	186 Re <small>rhenium</small> 75	190 Os <small>osmium</small> 76	192 Ir <small>iridium</small> 77	195 Pt <small>platinum</small> 78	197 Au <small>gold</small> 79	201 Hg <small>mercury</small> 80	204 Tl <small>thallium</small> 81	207 Pb <small>lead</small> 82	209 Bi <small>bismuth</small> 83	[209] Po <small>polonium</small> 84	[210] At <small>astatine</small> 85	[222] Rn <small>radon</small> 86												
[223] Fr <small>francium</small> 87	[226] Ra <small>radium</small> 88	[227] Ac* <small>actinium</small> 89	[261] Rf <small>rutherfordium</small> 104	[262] Db <small>dubnium</small> 105	[266] Sg <small>seaborgium</small> 106	[264] Bh <small>bohrium</small> 107	[277] Hs <small>hassium</small> 108	[268] Mt <small>meitnerium</small> 109	[271] Ds <small>darmstadtium</small> 110	[272] Rg <small>roentgenium</small> 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated																		

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A152/02

ADDITIONAL SCIENCE A

Unit A152: Modules B5, C5, P5 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant – applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)

work done = 0 marks

work done lifting = 1 mark

change in potential energy = 0 marks

gravitational potential energy = 1 mark

5. Annotations:
The following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt not given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

Eg

For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 0 marks.

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth one mark.

Put ticks (✓) in the two correct boxes.

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth one mark.

8. The list principle:
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:
Always check the additional guidance.
If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.
If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.
Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

Eg If a question requires candidates to identify a city in England, then in the boxes


Edinburgh	<input type="checkbox"/>
Manchester	<input type="checkbox"/>
Paris	<input type="checkbox"/>
Southampton	<input type="checkbox"/>

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

Edinburgh	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Manchester	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Paris	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Southampton	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Score:	2	2	1	1	1	1	0	0	0	NR

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:
- Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
 - Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
 - *For a general correlation between quality of science and QWC:* determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
 - *For high-level science but very poor QWC:* the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
 - *For very poor or totally irrelevant science but perfect QWC:* credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.


Question		Expected answers	Marks	Additional guidance
1	(a)	bases amino acids	[1]	must be in correct order
	(b)	<p>The nucleus divides during cell growth. <input type="checkbox"/></p> <p>The chromosomes are copied to form new strands of DNA. <input checked="" type="checkbox"/></p> <p>The numbers of organelles in each cell decreases as the cell grows. <input type="checkbox"/></p> <p>The copies of each chromosome stay together when the cells divide during <input type="checkbox"/></p> <p>The number of chromosomes doubles in each cell before the cell divides. <input checked="" type="checkbox"/></p>	[1]	both required for the mark
	(c)	<p>cells made by meiosis contain half the number of chromosomes of the parent cell but cells made by mitosis have same number of chromosomes</p> <p>this is important because meiosis produces gametes, which fuse with other gametes during fertilisation to make a cell/zygote with the correct number of chromosomes</p>	[2]	accept 'meiosis produces variation' for 1 mark
		Total	[4]	

Question		Expected Answers	Marks	Additional Guidance
2	(a)	<p>cells in meristems are the only cells in the seedling that divide (by mitosis)</p> <p>and allow the seedling to grow/elongate by producing new cells</p>	[2]	
	(b)	<p> [Level 3] Answer correctly describes the production, distribution and effect of auxin at the shoot tip under conditions of directional light. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] Answer may correctly identify some aspects of auxin activity at the shoot tip under conditions of directional light but may not make the correct links between events. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Answer refers to phototropism and/or diffusion of auxin, but without describing the details correctly. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <ul style="list-style-type: none"> • auxin produced by the tip of the stem • auxin diffuses down into the lower tissues of the stem • (strong) directional light causes the auxin to diffuse towards the dark side of the stem • auxin promotes cell division/growth • higher auxin concentration on the darker side of the stem increases the division/growth rate on this side • more/faster division/growth on the darker side produces a stem that is curved towards the directional light source • this is phototropism <p>ignore references to the shoot “bending” towards the light without this being linked to growth</p> <p>reject references to light destroying/breaking down auxin</p>

Question		Expected Answers	Marks	Additional Guidance
2	(c)	light photosynthesis competitive	[1]	all three correct responses = 1 mark responses must be in the correct order
	(d)	<i>disagree because:</i> observations/data that agree with prediction <u>increase</u> <u>confidence</u> in the explanation but this does not <u>prove</u> that the explanation is correct	[2]	OWTTE
Total			[11]	

Question		Expected Answers	Marks	Additional Guidance
3	(a)	<i>the conclusion is not correct because:</i> the rate of cell division is constant between 6 and 24 hours / there are two rounds of division between each time point	[1]	no mark for saying the conclusion is not correct, only for saying why
	(b)	(i) recording to the nearest thousand made the cell count appear the same even though different numbers of cells were present / there may have been a counting error (1) cells were dividing but an equal number of cells died as were formed (1)	[2]	
		(ii) cells may only divide at a specific temperature / within a certain temperature range but would be able to survive (without dividing) even if the temperature was higher or lower than this	[2]	
	(c)	inactive genes (in the nucleus) need to be reactivated/switched on	[1]	
Total			[6]	

Question	Expected answers	Marks	Additional guidance
4	water; H ₂ O carbon dioxide; CO ₂	[2]	Any two names/formula correct for 1 mark
Total		[2]	

5		<p>[Level 3] Chooses aluminium and uses its properties to explain suitability. Uses properties of other metals to explain their lack of suitability. Refers to compromise of properties for purpose. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] Chooses aluminium and uses its properties to explain suitability. Makes some reference to properties of other metals but does not explain their lack of suitability. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Chooses a metal other than aluminium. Makes some relevant comments about its suitability. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <ul style="list-style-type: none"> aluminium has lowest density so cable can span long distances aluminium has good resistance to corrosion so cables will last a long time aluminium has reasonable conductivity but this is a compromise aluminium is quite cheap so lots of cables can be used for reasonable cost gold has very good conductivity but is too heavy and is too expensive iron is cheap but is too heavy and corrodes too easily copper has good conductivity but is too heavy and too expensive
Total		[6]		

Question		Expected answers	Marks	Additional guidance
6	(a)	(i)	[2]	
		<p>may not be able to meet future demand (no mark) because: graph suggests increased demand for copper in the future / use of copper continues to increase (1)</p> <p>only a small proportion of the copper in the Earth's crust is close enough to the surface to be mined economically (1)</p>		
		(ii)	[1]	
	(b)	(i)	[2]	
$\frac{63.5 + 63.5}{63.5 + 63.5 + 16} \times 40$ $= 35.5$				
		(ii)	[1]	<p>all correct for the mark</p> <p>reject "reacted" / "mixed" / "treated" etc.</p>
Total			[6]	

7	(a)	lead and bromine form	[2]	
		lead forms at the negative electrode and bromine forms at the positive		
	(b)	e ⁻ and Na	[1]	both required for one mark
Total			[3]	


Question	Expected answers	Marks	Additional guidance
8	<p style="text-align: right;"><input type="checkbox"/></p> <p>Electrons are shared between atoms. <input checked="" type="checkbox"/></p> <p>The nucleus of each bonded atom ... <input checked="" type="checkbox"/></p> <p style="text-align: right;"><input type="checkbox"/></p> <p style="text-align: right;"><input type="checkbox"/></p>	[2]	
Total		[2]	


9	(a)	0.70 A gives 4.0 Ω , 1.8 A gives 6.7 Ω	[1]	
	(b)	the results show that resistance increases with increasing current / there is a correlation between resistance and current but this (correlation) does not prove Jeff's explanation (without a causal link)	[2]	accept resistance depends on current for (1)
	(c)	Carlos	[1]	
	(d)	he needs to think of a causal link / mechanism which links cause and effect and have the experiment repeated by other scientists	[2]	
Total		[6]		




Question		Expected answers	Marks	Additional guidance
10	(a)	0.15 A or amps	[2]	award (1) for evidence of using $I = P/V$ if no units shown
	(b)	9 V	[1]	
Total			[3]	

11		B C D	[3]	in any order
Total			[3]	

12	(a)	induction	[1]	
	(b)	A	[1]	
Total			[2]	

Question	Expected answers	Marks	Additional guidance
13 	<p>[Level 3] Includes all of the relevant points. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] Includes most of the relevant points. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Includes some of the relevant points. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <ul style="list-style-type: none"> • wires / components contain mobile charges / electrons • pressing the switch completes the circuit • which allows charges/electrons to move around the circuit / allows the battery to push charges/electrons around the circuit • in a continuous loop • energy is transferred from the power supply/electrons/charges to the lamp • as electrons collide with ions in the lamp filament • the filament gets hot • lamp gets hot enough to emit light <p>accept battery does work on electrons / charge</p>
	Total	[6]	

Assessment Objectives (AO) Grid
(includes quality of written communication )

Question	AO1	AO2	AO3	Total
1(a)	1			1
1(b)	1			1
1(c)	1	1		2
2(a)	1	1		2
2(b) 	5	1		6
2(c)	1			1
2(d)			2	2
3(a)			1	1
3(b)(i)		1	1	2
3(b)(ii)		1	1	2
3(c)		1		1
4	1	1		2
5 		3	3	6
6(a)(i)			2	2
6(a)(ii)		1		1
6(b)(i)		2		2
6(b)(ii)	1			1
7(a)		2		2
7(b)	1			1
8	2			2
9(a)		1		1
9(b)		1	1	2
9(c)	1			1
9(d)	2			2
10(a)	1	1		2
10(b)		1		1
11	2	1		3
12(a)	1			1
12(b)		1		1
13 	6			6
Totals	28	21	11	60

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