

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**A152/01**

**ADDITIONAL SCIENCE A**

Unit A152: Modules B5, C5, P5 (Foundation 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	6	
2	8	
3	6	
4	8	
5	6	
6	3	
7	3	
8	3	
9	6	
10	6	
11	3	
12	2	
TOTAL	60	

## TWENTY FIRST CENTURY SCIENCE DATA SHEET

### Qualitative analysis

#### Tests for ions with a positive charge

Ion	Test	Observation
calcium $\text{Ca}^{2+}$	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper $\text{Cu}^{2+}$	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) $\text{Fe}^{2+}$	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) $\text{Fe}^{3+}$	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc $\text{Zn}^{2+}$	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

#### Tests for ions with a negative charge

Ion	Test	Observation
carbonate $\text{CO}_3^{2-}$	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride $\text{Cl}^-$	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide $\text{Br}^-$	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide $\text{I}^-$	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate $\text{SO}_4^{2-}$	add dilute 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 This question is about cell division and the cell cycle.

(a) The statements **A** to **E** are about either mitosis or meiosis.

- A** produces cells identical to the parent cells
- B** produces cells with only half the number of chromosomes
- C** produces gametes
- D** produces cells with a full set of paired chromosomes
- E** is a process within the cell cycle

Put the letters **A**, **B**, **C**, **D** and **E** in the correct column of the table to show whether they refer to either **mitosis** or **meiosis**.

mitosis	meiosis

[2]

(b) Why is it important that a cell produced by meiosis contains half the number of chromosomes of the parent cell?

.....

.....

..... [2]

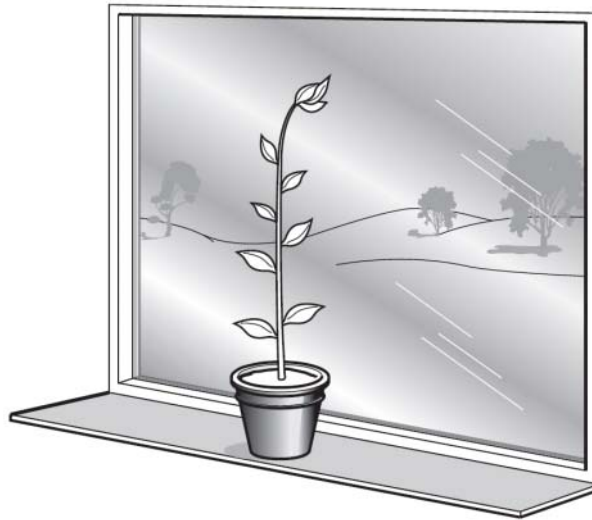
(c) Describe what happens to the cell organelles and the chromosomes during cell growth.

.....

..... [2]


[Total: 6]

2 Joe does an experiment to show the effect of light on the growth of a plant. He puts the plant next to a window.



(a) Explain

- what happens to the plant if it is kept next to the window
- how this will affect this plant's chance of survival.

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

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[6]

(b) Joe takes two cuttings from the plant.

He dips the cut stem surface of one of the cuttings in water, and dips the cut stem surface of the other cutting in a solution containing water, glucose and a plant hormone.

After 10 days, Joe looks to see whether roots have been produced at the cut stem of each cutting.

Here are his results.

	roots produced at cut stem
cutting dipped in solution containing water, glucose and a plant hormone	✓
cutting dipped in water only	✗

Joe concludes that the plant hormone had caused the plant stem cells to form root cells.

Use Joe's results to give one reason to **accept** his conclusion and one reason to **reject** his conclusion.

.....

.....

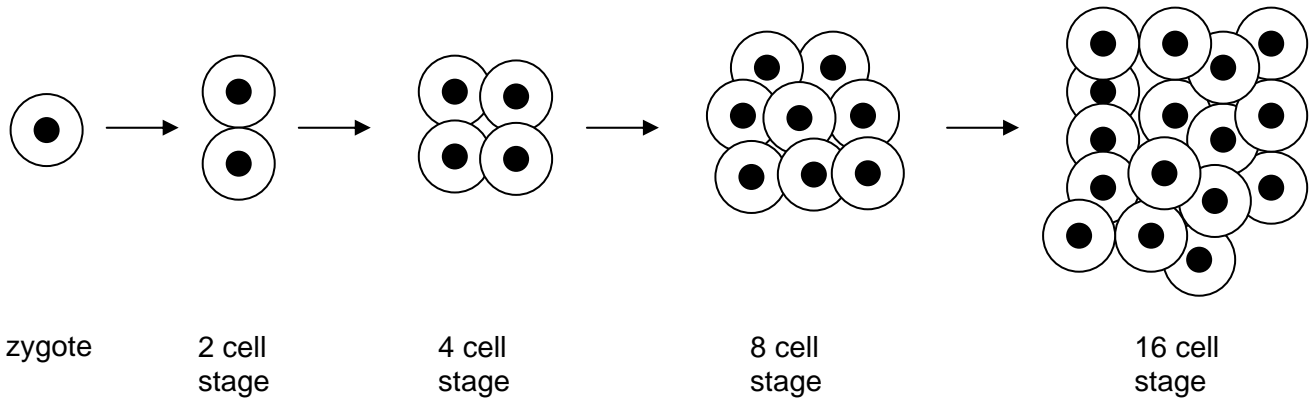
..... [2]

[Total: 8]

3 Embryos are formed by cell division in a fertilised egg cell (zygote).

- (a) It is possible to produce clones of animals. This is done by removing cells from a single embryo and growing them to form identical embryos.

The human embryo grows from a single cell (zygote), which divides to form a group of cells.



- (i) At which of these stages in humans is it **not** possible to use every cell to produce identical embryos?

..... cell stage [1]

- (ii) What happens to the cells at this stage that stops them from producing identical embryos?

Put a tick (✓) in the box next to the correct answer.

The cells ...

... start to specialise.

... start to break down.

... become too large to divide.

[1]

(b) A scientist investigates the growth rate of embryos.

She records the number of cells found in different embryos, **A** to **E**, over a 24-hour period following fertilisation.

embryo	number of cells in each embryo			
	6 hours	12 hours	18 hours	24 hours
<b>A</b>	2	8	64	128
<b>B</b>	4	16	32	64
<b>C</b>	2	8	16	32
<b>D</b>	4	16	16	32
<b>E</b>	2	8	32	128

(i) Use the results to explain why scientists seeking to produce clones cannot simply collect cells at a fixed length of time after fertilisation.

.....  
 ..... [1]

(ii) The results of the investigation can be studied to observe patterns of cell division and to make conclusions.

Describe **two** differences between the pattern of cell division shown by embryo **B** and the pattern shown by embryo **E** between hours 6 and 18 of the experiment.

.....  
 .....  
 .....  
 ..... [2]

(iii) The scientist concluded that the highest rates of cell division took place between the 6 hour and 12 hour period.

Identify **one** source of data in the results table that does not support the scientist's conclusion.

.....  
 ..... [1]

[Total: 6]



- 4 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
<b>highest value</b> ↓ <b>lowest value</b>	iron	gold	gold	gold	gold
	copper	copper	copper	aluminium	copper
	gold	aluminium	iron	copper	aluminium
	aluminium	iron	aluminium	iron	iron

- (a) 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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..... [6]

(b) The sentences below show some uses of gold.

Each use depends on a different property.

Draw straight lines to connect each **use** to the **property** that allows this use.

use	property
Car air bags have gold electrical contacts.	Gold is very unreactive.
Jewellery can be made by shaping gold wires.	Gold can be bent easily.
Some people have gold fillings in their teeth.	Gold is a good conductor.

[2]

[Total: 8]

- 5 Most electrical wiring is made from copper.  
Copper mining can cause environmental harm.  
The photograph shows a picture of a copper mine.



© istockphoto.com

A mining company wants to open a new copper mine.

Tests at the site for the new mine show that the company will be able to recover 40 g of copper metal from every kilogram of mined rock.

- (a) What percentage of the mined rock is copper?

answer = ..... % [1]

- (b) Copper is present in the rock as cuprite, a copper ore with the formula  $\text{Cu}_2\text{O}$ .

What is the percentage mass of copper in cuprite?

Relative atomic masses are given in the Periodic Table on the back page.

Show your working.

answer = ..... % [2]

- (c) Suggest why there is a difference between your answers for parts (a) and (b).

.....  
..... [1]

(d) Cuprite,  $\text{Cu}_2\text{O}$ , is an oxide of copper.

Suggest how copper could be extracted from cuprite.

..... [1]

(e) Mining causes problems to people who live near the mines.

Mining companies try to solve the problems so that they can continue to mine.

Draw straight lines to connect each **problem** with the best **solution to the problem**.

**problem**

heavy traffic on local roads

dust rises from the mine and travels over local houses

mining is very noisy

**solution to the problem**

mines are only allowed to operate during the day

lorries are only allowed to use main roads direct to the motorways

water sprayers are used around the mine

[1]

[Total: 6]

6 The table shows some information about five different chemicals.

The chemicals are shown by the letters **A**, **B**, **C**, **D** and **E**.

chemical	melting point in °C	boiling point in °C	does it conduct electricity when it is a solid?	does it conduct electricity when it is a liquid?
<b>A</b>	-95	69	no	no
<b>B</b>	1261	2239	no	yes
<b>C</b>	1240	2100	yes	yes
<b>D</b>	1650	2230	no	no
<b>E</b>	-138	0	no	no

(a) Silicon dioxide is a compound with a very high melting point and boiling point. It does not conduct electricity in either the solid or molten state.

Which chemical is most likely to be silicon dioxide?

Put a (ring) around the correct answer.

**A**      **B**      **C**      **D**      **E**

[1]

(b) Chemical **C** is a metal.

Which statement describes how the data in the table show this?

Put a tick (✓) in the box next to the correct answer.

Chemical **C** has a high melting point.

Chemical **C** has a high boiling point.

Chemical **C** conducts electricity when it is a solid.

Chemical **C** conducts electricity when it is a liquid.

[1]

(c) Which of the chemicals is an ionic compound?

Put a (ring) around the correct answer.

**A**      **B**      **C**      **D**      **E**

[1]

[Total: 3]

7 Diamond and graphite are two forms of carbon.

The table gives some information about diamond and graphite.

	melting point in °C	density in g/cm <sup>3</sup>	hardness	does it conduct electricity?
<b>diamond</b>	3823	3.51	very hard	no
<b>graphite</b>	3925	2.25	soft	yes

(a) Use ideas about the bonding in diamond and graphite to explain the difference in their electrical conductivity.

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 .....  
 ..... [2]

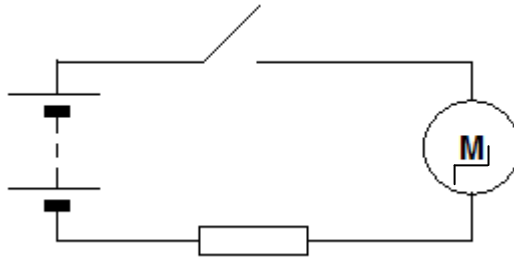
(b) Which form of carbon could be used in the middle of a pencil?

Use ideas about properties to explain why this form of carbon is suitable for this purpose.

.....  
 ..... [1]

[Total: 3]

8 Bill assembles this circuit.



Explain why the motor spins when Bill presses the switch.

.....

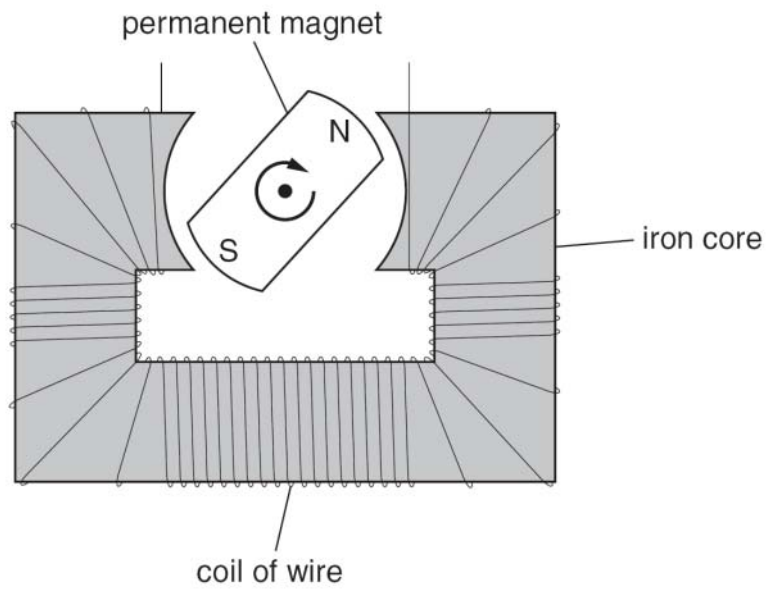
.....

.....

..... [3]

[Total: 3]

9 The diagram shows a simple generator.



Describe how a simple generator produces electricity.

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

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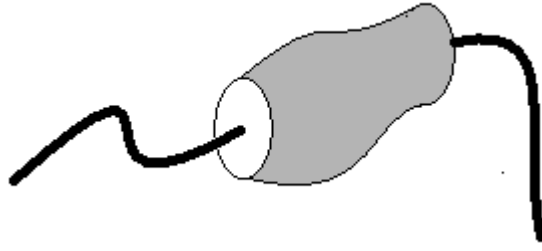
.....

.....

[6]  
[Total: 6]



10 Jeff and Rita investigate a component.



They connect it to three different batteries, measuring the current and voltage each time. Here are their 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.

.....

.....

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..... [2]

- (c) Rita knows that the resistance of many electrical components depends on their temperature. She thinks that this might explain the results.

Suggest what they could do to find out who is right.

.....

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.....

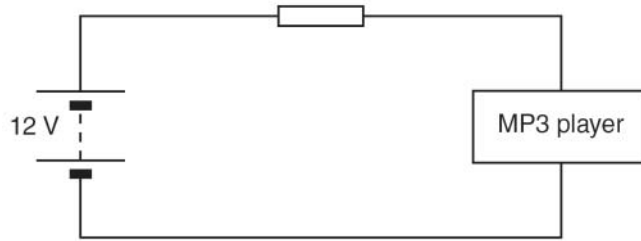
.....

..... [3]

[Total: 6]

11 Jo likes to listen to her MP3 player in the car.

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



- (a) When the MP3 player is switched on, the potential difference across it is 3.0 V and the current in it is 0.15 A.

Calculate the power of her MP3 player.

Include the unit of power in your answer.

answer = ..... [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?

Put a **ring** around the correct answer.

**3 V**

**9 V**

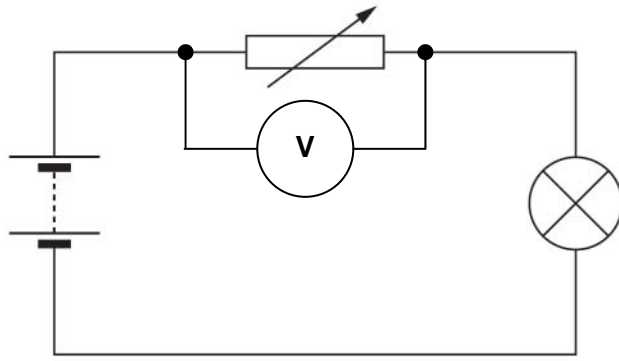
**12 V**

**15 V**

[1]

[Total: 3]

12 Sylvia sets up this circuit.



(a) Sylvia decides to measure the potential difference across the lamp.

Draw another component on the circuit diagram to show how she could do this.

[1]

(b) Sylvia finds that the potential difference across the lamp reads 4 V. Sylvia asks her friends what this means.

	<p><b>Alan</b></p> <p>It tells you about the energy lost by the charge on its way through the lamp.</p>	<p><b>Bess</b></p> <p>It's the rate at which charge passes through the lamp.</p>	
	<p><b>Carlo</b></p> <p>It tells you how much energy there is in the battery.</p>	<p><b>Davina</b></p> <p>It's the amount of charge in the lamp.</p>	

Who gives the correct explanation?

answer ..... [1]

[Total: 2]

[Paper Total: 60]

END OF QUESTION PAPER

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# Periodic Table

1	2											3	4	5	6	7	0			
		<b>Key</b> relative atomic mass <b>atomic symbol</b> name atomic (proton) number																	<b>1</b> <b>H</b> hydrogen 1	<b>4</b> <b>He</b> helium 2
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4											11 <b>B</b> boron 5	12 <b>C</b> carbon 6	14 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	19 <b>F</b> fluorine 9	20 <b>Ne</b> neon 10			
23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12											27 <b>Al</b> aluminium 13	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	40 <b>Ar</b> argon 18			
39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	45 <b>Sc</b> scandium 21	48 <b>Ti</b> titanium 22	51 <b>V</b> vanadium 23	52 <b>Cr</b> chromium 24	55 <b>Mn</b> manganese 25	56 <b>Fe</b> iron 26	59 <b>Co</b> cobalt 27	59 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65 <b>Zn</b> zinc 30	70 <b>Ga</b> gallium 31	73 <b>Ge</b> germanium 32	75 <b>As</b> arsenic 33	79 <b>Se</b> selenium 34	80 <b>Br</b> bromine 35	84 <b>Kr</b> krypton 36			
85 <b>Rb</b> rubidium 37	88 <b>Sr</b> strontium 38	89 <b>Y</b> yttrium 39	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	96 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46	108 <b>Ag</b> silver 47	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	119 <b>Sn</b> tin 50	122 <b>Sb</b> antimony 51	128 <b>Te</b> tellurium 52	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54			
133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78	197 <b>Au</b> gold 79	201 <b>Hg</b> mercury 80	204 <b>Tl</b> thallium 81	207 <b>Pb</b> lead 82	209 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86			
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 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  
ADDITIONAL SCIENCE A**

**A152/01**

Unit A152: Modules B5, C5, P5 (Foundation 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
<b>not/reject</b>	=	answers which are not worthy of credit
<b>ignore</b>	=	statements which are irrelevant – applies to neutral answers
<b>allow/accept</b>	=	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 <b>not</b> 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	
Manchester	
Paris	
Southampton	

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			✓			✓	✓	✓	✓	
Manchester	✓	x	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	x		✓		✓	✓		✓	
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)	<table border="1"> <thead> <tr> <th>mitosis</th> <th>Meiosis</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>B</td> </tr> <tr> <td>D</td> <td>C</td> </tr> <tr> <td>E</td> <td></td> </tr> </tbody> </table>	mitosis	Meiosis	A	B	D	C	E		[2]	one mark for each correct set of responses/ each box
mitosis	Meiosis											
A	B											
D	C											
E												
	(b)	so that the cell/gamete can fuse with/fertilise another gamete and produce a zygote/cell with the correct number of chromosomes	[2]									
	(c)	organelles increase in number chromosomes are copied	[2]									
		<b>Total</b>	<b>[6]</b>									

Question			Expected Answers	Marks	Additional Guidance
2	(a)		<p><b>[Level 3]</b> Answer correctly describes the directional growth of the plant towards the light (phototropism) and accounts for enhanced survival. 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><b>[Level 2]</b> Answer may correctly identify the outcome of the directional growth without an explanation of the differential growth at the shoot tip and/or the impact on survival. 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><b>[Level 1]</b> An incomplete answer, describing the outcome (directional growth) without giving correct details of the explanation. 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><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>plant grows towards the light - <b>ignore</b> references to the plant “bending” towards the light</li> <li>growth (rate) is , higher on the dark side / lower on the side facing the light source</li> <li>this directional growth is phototropism</li> <li>the plant obtains more light</li> <li>the plant can , photosynthesise more rapidly / make more food</li> <li>this causes the plant to grow more quickly</li> <li>the plant can compete better with other (nearby) plants / has an advantage</li> </ul>

Question		Expected Answers	Marks	Additional Guidance
2	(b)	roots grew in the solution containing the plant hormone = accept the solution also contained glucose/ do not know if the glucose caused the roots to grow = reject	[2]	OWTTE
<b>Total</b>			<b>[8]</b>	

3	(a)	(i)	16 (cell stage)	[1]	
		(ii)	(the cells) start to specialise	[1]	
	(b)	(i)	after 12 hours some embryos have passed the stage where cells are unspecialised / 8 cell stage	[1]	
		(ii)	<b>any two from:</b> there were three rounds of cell division in embryo <b>B</b> but four in embryo <b>E</b>  the rate of cell division in embryo <b>B</b> was , slower / half , (compared to embryo <b>E</b> ) between 12 and 18 hours  the rate of cell division was constant in embryo <b>E</b> (over the twelve hours) but , changed / decreased , in embryo <b>B</b>  the , average / mean , rate of cell division was slower in embryo <b>B</b> than in embryo <b>E</b>	[2]	
		(iii)	there were 3 rounds of cell division in embryo A between 12 and 18 hours (which is more than in the 6 to 12 hour period for any of the embryos)	[1]	OWTTE <b>accept</b> any other correct pattern which does not support the conclusion
<b>Total</b>				<b>[6]</b>	

Question	Expected answers	Marks	Additional guidance
4 (a) 	<p><b>[Level 3]</b> Choose 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 the 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><b>[Level 2]</b> 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><b>[Level 1]</b> Chooses a metal other than aluminium. Make 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><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• aluminium has lowest density so cable can span long distances</li> <li>• aluminium has good resistance to corrosion so cables will last a long time</li> <li>• aluminium has reasonable conductivity but this is a compromise</li> <li>• aluminium is quite cheap so lots of cables can be used for reasonable cost</li> <li>• gold has very good conductivity but is too heavy and is too expensive</li> <li>• iron is cheap but is too heavy and corrodes too easily</li> <li>• copper has good conductivity but is too heavy and too expensive</li> </ul>




Question		Expected answers	Marks	Additional guidance
4	(b)	<p style="text-align: center;">use</p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     Car air bags have gold electrical contacts.                 </div> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     very unreactive                 </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     Jewellery can be made by shaping gold wires.                 </div> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     easily bent                 </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     Some people have gold fillings in their teeth.                 </div> <div style="border: 1px solid black; padding: 5px; width: 45%;">                     good conductor                 </div> </div>	[2]	all correct = 2 1 correct = 1
<b>Total</b>			[8]	

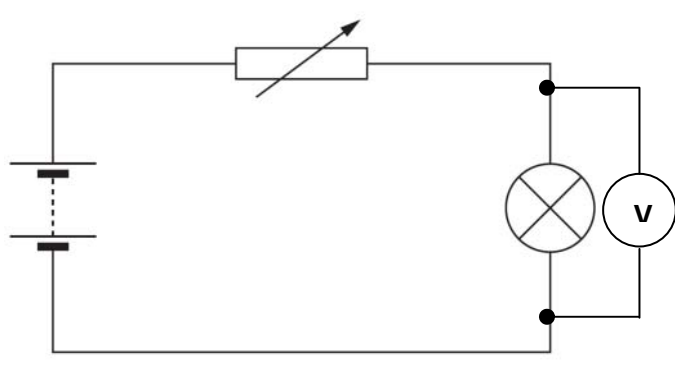
Question		Expected answers	Marks	Additional guidance
5	(a)	4	[1]	
	(b)	Formula mass of $\text{Cu}_2\text{O} = 63.5 + 63.5 + 16 = 143$ $\frac{63.5 + 63.5}{143} \times 100 = 88.8$	[2]	<b>accept</b> any answer correctly rounded from 88.81118881
	(c)	the mined rock will contain other minerals/impurities	[1]	<b>ignore</b> suggestions that the extraction or mining procedure will not recover all of the copper
	(d)	heat the cuprite with carbon	[1]	<b>accept</b> 'reduce the cuprite' without practical details
	(e)	<p><b>problem</b></p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">heavy traffic on local roads</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">mines are only allowed to operate during the day</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">dust rises from the mine and travels over local houses</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">lorries are only allowed to use main roads direct to the motorways</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">mining is very noisy</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">water sprayers are used around the mine</div> </div>	[1]	
<b>Total</b>			<b>[6]</b>	

Question		Expected answers	Marks	Additional guidance
6	(a)	D	[1]	
	(b)	C conducts when solid	[1]	
	(c)	B	[1]	
<b>Total</b>			<b>[3]</b>	




7	(a)	diamond has giant covalent structure with no free moving electrons  but graphite has layers with mobile electrons between them	[2]	
	(b)	graphite is soft so leaves marks on paper	[1]	
<b>Total</b>			<b>[3]</b>	

8		pressing the switch completes the circuit (1) which allows charges/electrons to move around the circuit / allows the battery to push charges/electrons around the circuit (1) and energy is transferred from the power supply/electrons/charges to the motor (1)	[3]	
<b>Total</b>			<b>[3]</b>	

Question	Expected answers	Marks	Additional guidance
9	<p> <b>[Level 3]</b> Includes all main details and some additional details. 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><b>[Level 2]</b> Includes some of the main details and some additional details. 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><b>[Level 1]</b> Includes at least one main detail and at least one additional detail. 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><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <p><i>main details</i></p> <ul style="list-style-type: none"> <li>• rotate magnet</li> <li>• to alter magnetism / magnetic field of iron / coil</li> <li>• voltage across / current in coil</li> </ul> <p><i>additional details</i></p> <ul style="list-style-type: none"> <li>• process is called (electromagnetic) induction</li> <li>• voltage keeps on changing / a.c. / not d.c.</li> <li>• current in components connected to ends of coil</li> <li>• work done turning magnet transfers to electrical energy</li> </ul> <p><b>accept</b> charge / electron flow for current</p> <p><b>reject</b> electricity / power as voltage / current / charge</p>
	<b>Total</b>	<b>[6]</b>	

Question		Expected answers	Marks	Additional guidance
10	(a)	1.8 A gives $6.7 \Omega$ , 0.70 A gives $4.0 \Omega$	[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]	<b>accept</b> resistance depends on current for (1)
	(c)	repeat the experiment with component kept at constant temperature checked with a thermometer	[3]	<b>accept</b> effective way of keeping temperature fixed
<b>Total</b>			<b>[6]</b>	
11	(a)	0.45 watts / W	[2]	
	(b)	<b>9 V</b>	[1]	
<b>Total</b>			<b>[3]</b>	
12	(a)	 <p>The diagram shows a circuit with a battery on the left, a variable resistor (rectangle with a diagonal arrow) on the top wire, a lamp (circle with an 'X') and a voltmeter (circle with a 'V') in parallel on the right, and a return wire at the bottom. Two black dots are placed at the junctions where the top wire meets the lamp and voltmeter branches.</p>	[1]	black dot at junction of conductors is ideal, but not necessary for the mark
	(b)	Alan	[1]	
<b>Total</b>			<b>[2]</b>	

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

Question	AO1	AO2	AO3	Total
1(a)	2			2
1(b)		2		2
1(c)	2			2
2(a) 	6			6
2(b)			2	2
3(a)(i)	1			1
3(a)(ii)	1			1
3(b)(i)			1	1
3(b)(ii)		2		2
3(b)(iii)			1	1
4(a) 		3	3	6
4(b)		2		2
5(a)		1		1
5(b)		2		2
5(c)		1		1
5(d)	1			1
5(e)		1		1
6(a)		1		1
6(b)		1		1
6(c)		1		1
7(a)	2			2
7(b)		1		1
8	3			3
9 	6			6
10(a)		1		1
10(b)		1	1	2
10(c)	1	2		3
11(a)	1	1		2
11(b)		1		1
12(a)		1		1
12(b)		1		1
<b>Totals</b>	<b>26</b>	<b>26</b>	<b>8</b>	<b>60</b>

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