



GCSE (9-1)

**Examiners' report** 

# TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/08 Summer 2022 series



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# Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

#### Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our <u>website</u>.

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# Paper 8 series overview

The paper was generally well answered, with very few questions missed out by candidates. This was pleasing to see and is much more positive than in previous series. The standard of the candidates' responses was perhaps more directed and improved by the advanced notice information provided before the examinations taking place in this series.

Candidates generally performed well on AO1.

Physics aspects of the paper were areas where candidates struggled to express their ideas clearly.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:								
<ul> <li>Could balance symbol equations.</li> <li>Carry out percentage calculations.</li> <li>Describe the relationship between momentum and stopping distance with relation to calculations of changes in momentum.</li> <li>Demonstrate a knowledge of circuit symbols and constructing circuits correctly.</li> <li>Explained the process of electrolysis of an ionic substance.</li> <li>Could write decay reactions for alpha particles.</li> </ul>	<ul> <li>Could not suggest suitable improvements to electrical circuits or electrolysis equipment.</li> <li>Struggled to draw a suitable graph including a line of best fit.</li> <li>Evaluate data about the BRCA 1 and 2 alleles and the impact on the choices available for carriers of the allele.</li> <li>Demonstrate a knowledge of nanoparticles and their risks.</li> </ul>								

#### Question 1 (a)

- 1 Sundip observed her teacher reacting five different metals with water and dilute hydrochloric acid.
  - (a) Suggest **one** safety precaution the teacher should have taken when demonstrating these reactions.

......[1]

Almost all candidates scored this mark for giving a suitable safety precaution.

#### Question 1 (b) (i)

(b) The table shows Sundip's observations.

Metal	Reaction with water	Reaction with dilute hydrochloric acid						
Α	lots of bubbles and fizzing	fizzing and caught fire						
В	no reaction	no reaction						
С	no reaction	a few bubbles formed						
D	caught fire	explosion						
E	one bubble formed	lots of bubbles formed						

(i) Write the letters of the metals in the boxes to show the correct order of reactivity.

The first one has been done for you.

least reactive		 most reactive
В		
		[3]

Almost all candidates could evaluate the correct order or reactivity of the elements listed in the table based on the observations.

#### Question 1 (b) (ii)

(ii) Sundip predicts that the bubbles given off by these reactions are hydrogen.

To test for this she blows out a splint and places it at the top of the test tube used for each reaction.

Will this test show whether the gas is hydrogen? Explain your answer.

A large number of candidates scored at least 1 mark by recognising that this was not the test for hydrogen but in fact it was the test for oxygen. Ideally the test for hydrogen (a lit splint) and the positive result of the 'squeaky pop' would be given. In future when quoting a test for a gas candidates should include the test to be carried out and the positive result of that test.

#### Question 1 (c)

(c) Sodium (Na) is a metal that reacts vigorously with hydrochloric acid (HC1) to give off hydrogen (H<sub>2</sub>).

Complete the balanced symbol equation for the reaction of sodium with hydrochloric acid.

..... Na + ..... HC $l \rightarrow$  .... NaC $l + H_2$ 

Almost all candidates could correctly balance the equation.

[3]

#### Question 2 (a) (i)

2 The diagram shows a food web from a garden.



(a) (i) Which two organisms from the list below are secondary consumers in the food web diagram?

Tick (✓) **two** boxes. Greenfly Hedgehog Lettuce Owl Rabbit Spider

[1]

The majority of candidates could identify the hedgehog and spider as secondary consumers from the diagram.

#### Question 2 (a) (ii)

(ii) How many organisms are there in the longest food chain in the food web diagram?

The most common incorrect answer was 4, perhaps the producer was missed when counting the length of the food chains.

#### Question 2 (a) (iii)

(iii) A disease reduced the number of caterpillars in the garden. What could happen to the number of snails in the garden? Explain your answer.

The majority of candidates could identify the changes in the number of snails and give an explanation for this.

#### Question 2 (b)

(b) One food chain from the garden food web is

grass  $\rightarrow$  grasshopper  $\rightarrow$  vole  $\rightarrow$  fox

On average the transfer of biomass between organisms is 10% efficient.

The biomass of grass in the vole's food chain is 37.5 kg.

Calculate the expected biomass of **voles** in the food chain.

Expected biomass of voles = ..... kg [2]

The majority of candidates scored 1 mark for the calculation of 10% of 37.5kg. Fewer candidates could then go onto calculate 10% of this value.

## Question 3 (a) (i)

3 (a) James is looking at cells taken from the root tips of broad beans under a light microscope.

The cells are shown in the image.



(i) James counts 76 cells in the image.

Calculate the percentage of cells undergoing mitosis in James' image.

Percentage = .....% [3]

The majority of candidates could identify 6 cells undergoing mitosis from the diagram and then calculate this value as a percentage. Where candidates scored 2 rather than 3 marks, it tended to be for correctly calculating a percentage from a miscounted number of cells undergoing mitosis.

#### Question 3 (a) (ii)

(ii) Suggest why James is looking at the cells in the root tips of the broad bean roots.

[1]

Lots of candidates discussed the tips of the root being the place where mitosis takes place. Unfortunately they had been told this in the stem of the question. It is the candidates realising that the root tips will show growth that scored the mark.

#### Question 3 (a) (iii)

(iii) Mitosis is the process of producing new cells so the broad bean plant can grow.

Draw **one** line from each word to its correct description about mitosis and growth.



A large number of candidates scored 2 or 3 marks here with the errors mainly being made with meristems and interphase.

[3]

#### Question 3 (b)

(b) Meiosis is another form of cell division.

Complete the sentences to explain the role of meiosis.

Use the words and numbers.

You can use each word and each number once, more than once or not at all.

cells	gamete	es gene	s nucl	eus	23
	once	tissues	twice	46	
Meiosis is a process wher	e the cells	divide			
The cells produced are ca	lled		In humai	ns these	e cells have
chro	mosomes ii	n preparation	for fertilisa	tion.	

Most candidates could identify gametes as the cells produced in meiosis. Where errors dis occur, it was the selection of meiosis being a one stage, rather than 2 stage process or the selection of the number 46 rather than 23 for the number of chromosomes being present in the gamete.

#### Question 4\*

4\* The picture shows a goods lorry.



When the lorry is empty, it has a mass of  $1.45 \times 10^4$  kg.

The lorry can carry a maximum load of  $2.95 \times 10^4$  kg.

The lorry is travelling at a velocity of 25 m/s on a motorway.

Explain why the stopping distance of the lorry is different when the lorry is empty compared to when it is fully loaded.

Include calculations in your answer.

Use the equation

momentum (kg m/s) = mass (kg) × velocity (m/s)

and ideas about change in momentum in your answer.

[6]

The information given to the candidates in the stem of the question was on the whole incorrectly interpreted. The values given were for the mass of the unloaded or empty lorry and the maximum load the lorry could carry. When calculating momentum using mass, a significant number of candidates simply used the maximum load of the lorry rather than adding in the mass of the lorry to the maximum load before attempting to calculate the momentum. In this situation the candidates had a value of 737,500 kg m/s rather than the expected 1,100,000 kg m/s. This was seen from a large number of candidates who processed the data. It was however pleasing to see that almost all students could correctly calculate the momentum of the empty lorry.

Where the discussion of stopping distance took place, it was pleasing to see the range of information that could be recalled about stopping distances. Some candidates related the stopping distance to its two components of thinking and braking distance and the factors affecting these. Other candidates could relate the stopping distance to the change in momentum and hence the longer time taken to stop for the same braking force in the fully loaded and empty lorries.

Candidates found linking their ideas and judgements about stopping distance to their ideas and calculations of momentum more difficult. As a result a large number of Level 2 answers were given.

#### Exemplar 1



Empty = 1.45×104 Max=2.95×104 b Velocity = 25m/s

When the lorry is empty, it has a mass of  $1.45 \times 10^4$  kg.

The lorry can carry a maximum load of 2.95 × 10<sup>4</sup> kg.

The lorry is travelling at a velocity of 25 m/s on a motorway.

Explain why the stopping distance of the lorry is different when the lorry is empty compared to when it is fully loaded.

Include calculations in your answer.

Use the equation

momentum (kg m/s) = mass (kg) × velocity (m/s)

and ideas about change in momentum in your answer.

Kance,

This candidate has given a clear and concise response. They have incorrectly calculated the momentum of the fully loaded lorry, as they have missed out the addition of the mass of the vehicle itself. This has only limited the achievement of full marks rather than stopping progress through the levels. The candidate has a well-developed and logical response which relates the momentum to the stopping distance and the time taken to stop the lorry. They have also linked in the idea of a force required to stop the lorry when in motion. This is a Level 3 response and the candidate scores 5 marks.

#### Exemplar 2

When the lorny is empty, it has amaller man than
when its full. This effects its momentum.
Empty lorn mom = mxv
$=(1.45 \times 10^{4}) \times (25)$
= 362500 kg m/s
Full Lorny mom = mxv
$= (2.95 \times 10^4) \times (25)$
= 737 500 kgm/s
The momentum changes when there is more max in
the lorns 21 it usu more force to get cround
= (2.95 × 104) × (25) = 737 500 kgm/s The momentum changes when there is more mass in the lorny 21 it use more force to get around

This candidate has given a Level 1 response and scores 2 marks. There is no discussion of the stopping distance and how that relates to the momentum. They have simply attempted to calculate the momentum of the vehicle. This does not meet the requirements of a Level 2 response as it has no discussion to link to the calculation. The calculation itself lacks the addition of the mass of the lorry for the fully loaded vehicle so is incorrect.

## Question 5 (a) (i)

**5** (a) (i) Draw lines to connect each electrical component to its correct symbol.



Most candidates could identify the circuit symbols for the components given. Thermistor and variable resistor were the errors made when candidates did not score full marks.

#### Question 5 (a) (ii)

(ii) Sarah is planning to make a series circuit to investigate the effect of changing the temperature of a thermistor on the current and potential difference in the circuit.

The diagram shows the circuit Sarah plans to use.



Describe two improvements she needs to make to the circuit to get valid results.

1																																																						
	•••	••	•••	•••	••	•••	•••	•••	•••	•••	•••	•••	•••	••	•••	••	•••	•••	•••	•••	••	•••	•••	•••	•••	•••	•••	•••	•••	•••	•••	••	•••	•••	•••		•••	•••	•••	•••	•••	•••	•••	•••	•••	•••		•••	•••	•••	•••	•••	•••	•••
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																																																					[	2]

A small number of candidates scored 1 or 2 marks on this question. The errors in the circuit drawing were not identified but rather others suggested such as changing the ammeter position. Where candidates did offer mark worthy responses, their communication was often weak. The term 'parallel' was rarely used to describe the correct position the voltmeter should be placed. Alternative wording such as 'around' or 'across' were given marks when used in the correct context. Some candidates drew a voltmeter correctly positioned in the diagram as an acceptable alternative.

#### **Misconception**



Connecting voltmeters into circuits. Voltmeters should be connected in parallel across or around the component for which you are trying to find the potential difference. These meters do not work when connected in series, as part of the circuit.

#### Question 5 (a) (iii)

Sarah's results at a constant room temperature can be seen in the table.

Potential difference (V)	Current (mA)
0.5	1.4
0.9	2.2
1.6	3.4
2.1	4.3
3.1	7.1
3.8	8.4
4.5	10.9

(iii) Plot Sarah's results from the table **and** draw a line of best fit. The first two have been plotted for you.



Candidates generally plotted points accurately, with the majority of candidates scoring 2 or 3 marks. In the case where the line of best fit was drawn there were several errors seen. Candidates extrapolated the graph beyond the points, in some cases off the graph paper at the top. This was ignored in this instance but is not good practice. Lines of best fit should be drawn with points evenly distributed either side of the line.

[3]

#### Question 5 (b)

(b) Sarah repeated the experiment at different temperatures. She heated the thermistor in a water bath to increase the temperature.

Which of these graphs shows how the resistance of the thermistor changes as the temperature increases?





[1]

Only a small number of candidates could identify the correct graph. Where candidates made the wrong selection, it was A or D that was chosen, showing an increase in the temperature with an increase in resistance, rather than a decrease in resistance with an increase in temperature.

#### Question 6 (a) (i)

6 (a) Amir is planning an electrolysis investigation.

Tick (✓) **two** boxes.

(i) Which two substances could be separated by electrolysis?

Diamond	
Graphite	
Lead bromide	
Potassium chloride	
Silicon dioxide	

[2]

Most candidates scored 2 marks here. Where only 1 mark was scored it was usually the omission of lead bromide. Silicon dioxide was often incorrectly chosen.

#### Question 6 (a) (ii)

(ii) Amir uses a sodium chloride solution and wants to collect the gases given off at the electrodes. The diagram shows the equipment he plans to use.



This question guided candidates to make improvements to the apparatus to allow gases to be collected. A number of candidates identified errors with the test tubes but struggled to articulate their responses. Suggestions were made to use gas syringes, but that didn't solve the problem of the gas not being collected inside the tubes to allow it to be captured rather than escape into the atmosphere. The subtlety of having the solution covering the bottom of the tubes was also something that evaded candidates. Candidates also discussed changing the electrodes but made no effort to explain how or why this was to be carried out. As a result of this only a small number of candidates were given both marks on this question.

#### Question 6 (a) (iii)

(iii) Name the gas formed at each electrode during the electrolysis of sodium chloride solution.

Anode ..... Cathode ..... [2]

Candidates struggled to identify hydrogen as the gas produced at the cathode. There were a wide variety of chemicals given here, some were not even in the starting solution. Oxygen was given marks as an alternative at the anode and this was seen on a number of occasions. A mark was also given to the candidates that could identify the two correct gases produced but that had mixed up the electrodes. The identification of the gases produced was given some marks (in this instance) rather than them being specifically produced at the correct electrode.

#### Question 6 (b)

(b) During the electrolysis of a molten ionic compound the reaction taking place at each of the electrodes is either oxidation or reduction.

Write the balanced half equation for the reduction reaction in the electrolysis of **molten** sodium chloride.

2Na<sup>+</sup> + ..... → .....

A very small number of candidates could complete this half equation. Chlorine was regularly seen as part of the equation rather than just sodium and the appropriate number of electrons. Where the correct entities were identified the balancing was often lacking.

[2]

## Question 7 (a) (i)

7 Scientists have discovered that breast cancer can be inherited. They have identified two alleles that can increase the risk of developing breast cancer. These two alleles are BRCA1 and BRCA2.

The table shows results from studies of women in five different countries looking at the link between BRCA alleles and breast cancer.

Country	Proportion of women with BRCA1 allele (%)	Proportion of women with BRCA alleles who developed breast cancer (%)	
Australia	54.5	45.5	55.4
Finland	49.5	50.5	56.3
Iceland	0.0	100.0	82.2
Italy	59.9	40.1	58.7
UK	56.1	43.9	48.9

(a) (i) There were 1212 women in the Australian study.

Calculate the number of women with BRCA alleles in the Australian study who developed breast cancer.

Use the data in the table.

Number of women ......[2]

The majority of candidates scored 2 marks and could calculate the number of women in Australia with the BRCA allele that went on to develop cancer. There does, however, need to be an appreciation for this to be a whole number. The value comes out to 671.448 and should be rounded to the nearest whole number when describing people. The full value of 671.448 was not penalised and was given 2 marks.

#### Question 7 (a) (ii)

(ii) Which country has the highest proportion of women with cancer in the study?

......[1]

Almost all candidates could identify Iceland as the country with the highest proportion of women with cancer in the study.

## Question 7 (a) (iii)

(iii) A student looks at the data and draws the conclusion that roughly the same percentage of women have the BRCA1 allele as those who have the BRCA2 allele.

Explain why the student is not correct.

[3]

There were 3 marks available for this question but a significant number of candidates gave only one point, which generally scored. The most common explanation given was the results from Iceland showing that 0% of women had the BRCA 1 allele and 100% BRCA 2. This demonstrated that the student was not correct but candidates stopped there rather than analysing the data further. Some candidates made superficial comments about the data, giving conclusions using sweeping statements from only a few countries with unknown data sizes. It was pleasing however, to see that a small number of high achieving candidates recognised the need for further information about the data sets such as size of the sample and that this was from a limited number of countries before making conclusions.

#### Question 7 (b)

(b) Genetic testing can be used to determine if someone has inherited BRCA alleles.

Suggest **two** ways that genetic testing for BRCA alleles can be used to reduce the incidence of breast cancer.

[2]

A large number of candidates misunderstood the question here. The question was asking how the information could be used to reduce the number of breast cancer cases. That is not what the majority of candidates discussed. Responses tended to be focused around identifying the allele rather than what could be done with the results to effect lifestyle changes, possible preventative surgery or decisions made about family planning. For those candidates that did interpret the question correctly many sensible arguments about how to use the information were put forward.

# Question 7 (c) (i)

(c) Some students are talking about genetic testing.



(i) Which student is discussing the reliability of genetic testing?

......[1]

The majority of candidates could identify Beth as the person talking about genetic testing, although a small number of candidates selected Nina.

# Question 7 (c) (ii)

(ii) Which student is talking about a medical risk of genetic testing?

......[1]

Almost all candidates could identify Jamal as the person discussing risk.

### Question 8 (a) (i)

8 The table shows some information about four nanoparticles.

Nanoparticle	Formula	Diameter (nm)	Surface area to volume ratio	Use
Silicon dioxide	SiO <sub>2</sub>	70	0.09	Added to plastics
Titanium dioxide	TiO <sub>2</sub>	20	0.30	Used in sunscreens
Silver oxide	Ag <sub>2</sub> O	15	0.40	Used as an industrial catalyst
Gold	Au	50	0.12	Used to deliver drugs to cells

- (a) Gold nanoparticles can be assumed to be spheres.
  - (i) Calculate the surface area of a gold nanoparticle.

Use information from the table and the equation:

surface area of a sphere =  $4\pi r^2$ 

Use π = 3.14

Give the correct **unit** for your answer.

Surface area of a gold nanoparticle = ..... unit = ..... [3]

Most candidates scored 2 or 3 marks on this question. Where candidates scored 2 marks, they often missed the step of dividing the diameter by 2 to get the radius of the particle before squaring and multiplying by  $4\pi$ . Candidates were given the value of  $\pi$  but some used the button on their calculator. This gave a slightly different calculated value but was given full marks.

There were a number of instances where candidates correctly calculated the value but gave incorrect units. The most common incorrect unit was nm<sup>3</sup> rather than nm<sup>2</sup>.

#### Question 8 (a) (ii)

(ii) Which statement would be a reason to use gold nanoparticles to deliver drugs to cells in the human body?

Tick (✔) <b>one</b> box.
Gold is very valuable
Gold has the smallest diameter
Gold is very unreactive
Gold only contains one element

[1]

A large number of candidates could identify gold as being unreactive.

#### Question 8 (b)

(b) Explain why silver oxide nanoparticles make an effective catalyst.

Use information from the table to support your answer.

A large number of candidates could identify the silver oxide having a larger surface area to volume ratio. Far fewer candidates could relate this to the explanation of why the reaction might be faster.

## Question 8 (c)

(c) Suggest why titanium dioxide nanoparticles might be a risk to marine ecosystems. Use information from the table and your own knowledge to support your answer.

[4]

Candidates struggled to interpret the data and link this to their ideas about nanoparticles. This was a difficult question and required the use of a combination of biological and chemical knowledge to score well. The more articulate responses generally linked the very small nature of the particles being present in the wearer of the sun cream as they entered the water. This gave an appropriate method of getting the nanoparticles into the food chain and then remaining there. It was pleasing to see some candidates discussing ideas about bioaccumulation in their responses. For those candidates that did not score, it was often down to their lack of good communication skills and poor choice of language when trying to explain their reasons. An example of this might be 'sunscreen used at the beach'. This was not sufficient to explain how the nanoparticles got into the water.

#### Question 9 (a)

9 The table gives some information about three radioactive isotopes.

Element	lsotope	Half life	Type of emission
Carbon	<sup>14</sup> <sub>6</sub> C	5.73 × 10 <sup>3</sup> years	β
Phosphorus	<sup>32</sup> 15	1.43 × 10 <sup>1</sup> days	β
Uranium	<sup>234</sup> 92	2.45 × 10 <sup>5</sup> years	α

(a) Complete the nuclear equation for the decay of the uranium isotope into an isotope of thorium (Th).

$$^{234}_{92}$$
U  $\rightarrow$  Th + .....

[3]

A large number of candidates scored zero on this question. Random numbers appeared in place of the mass number and the atomic number rather than simply subtracting 4 from the mass number of Uranium and 2 from the atomic number of Uranium. For those who did score marks, they recognised the decay was an alpha particle from the table of information given and could correctly write the symbol as either  $\alpha$  or as a nucleus of a helium atom (He including appropriate numbers).

## Question 9 (b) (i)

(b) (i) A woolly mammoth was discovered in a melting glacier.

The net decline of  ${}^{14}_{6}$ C emission of the mammoth was recorded as 1/4.

Calculate how long ago the woolly mammoth died.

Use information from the table.

..... years ago [3]

Only high achieving candidates scored marks on this question. A small number of candidates could identify that 2 half-lives had taken place to get to this number but then they struggled to appreciate that this was a multiplication rather than divide calculation. The most commonly seen incorrect response was 1432 years. Candidates had taken the half-life value and divided by 2 twice, rather than double the half-life to give the total number of years that had passed and hence calculate how long ago the woolly mammoth died.

#### Question 9 (b) (ii)

(ii) Suggest one reason why the value calculated in (b)(i) is likely to be inaccurate.

.....[1]

Very few candidates could give a reason why the value was likely to be inaccurate. For those that did score, the reason they give was due to the random nature of the decay.

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