Pearson Edexcel

GCSE (9-1) Sciences

Support for Tier Entry decisions.

GCSE 9-1 Science: Support for Tier Entry decisions

Background

9–1 grading scale

GCSE Sciences are now awarded based on the new 9-1 grading scale, which sees greater differentiation, particularly at the top end (grade 9) as shown in the diagram below. Where there was previously two grades at the top end, A and A*, there are now three grades – 7, 8 and 9. There is also slightly less differentiation at the lower end, with grades D, E, F and G replaced by grades 1, 2 and 3.

New grading structure	Old grading structure
9	A*
8	A
7	
6	B
5	
4	C
3	D
	E
2	F
1	G
U	U

Source: GCSE 9 to 1 grades: a brief guide for parents, The Ofqual Blog, 02 March 2018

In GCSE Sciences, all the papers are tiered. There has been a shift upwards in where the grades sit in the tiers, compared to the legacy qualifications. This has meant that the Higher Tier paper now goes down to grade 4 (previously to grade D) and the Foundation-Tier paper goes up to grade 5 (previously a C), with an overlap of grades 4 and 5 across both tiers. The overlap in grades allows us to write questions that are the same across both tiers and which, therefore, appear in both Foundation Tier and Higher Tier papers. There is more detail about this later in this guidance document.

Here are the grade ranges for the tiers in Combined Science and Separate Science:

	Foundation Tier grades	Higher Tier grades
GCSE Combined Science	1-1 to 5-5	4-4 to 9-9
GCSE Biology/Chemistry/Physics	1 to 5	4 to 9

Allowed grades for Higher Tier

A grade 3-3 was an exception for the 2018 Combined Science Higher Tier papers. Ofqual did not award the 3-3 grade for summer 2019 papers and they will not do this going forward. The full announcement can be viewed on the Ofqual Blog Teachers will be able to draw from their experience of tier entry in the previous GCSE series to select the most appropriate tier for their candidates.

GCSE Combined Science: Higher Tier or Foundation Tier?

We understand that choosing a tier of entry for your students can be challenging, especially the first award after we have been through a reform of the qualification with structural changes to the sciences, the removal of coursework and moving to a double award GCSE.

This guidance document aims to support you in making informed decisions around tier entry in GCSE Combined and Separate Sciences. We will take you through:

- how we design our Higher Tier and Foundation Tier papers; so you can decide which style is best suited for your students
- differences in maths requirements at Foundation Tier
- other factors to consider when deciding on tier entry
- overlap questions that you can use with your borderline students to help make your decision
- FAQs.

Structure of Higher Tier and Foundation Tier papers

One of the aspects to consider when making tier entry is an understanding about how our papers (Foundation Tier and Higher Tier) are designed.

Demand

The demand refers to the cognitive processes/steps a learner needs to go through in order to answer a question successfully. These steps take into consideration more than

just the difficulty of the question. Around half of the question items in the Foundation Tier are targeted at low demand processes and around half are targeted at medium demand processes. Around half of items at Higher Tier will be targeted at medium demand processes and around half are targeted at high demand processes. You can gauge student performance on these questions through mock exam papers or by using exam-style questions in lessons.

Ramping

The ramping in our papers is designed to help students persevere through the paper. Foundation Tier papers will generally start with lower demand questions to help students build their confidence in answering questions at the beginning of the paper. They will then need to persevere through to the medium demand questions towards the second half of the paper.

Higher Tier papers will generally start with medium demand questions, and move on to higher-demand questions in the second half of the paper.

Students who are at the lower end of Higher Tier may find that there are fewer questions overall that they can access, as the medium demand questions will tend to be nearer the beginning of the paper.

Low-attaining/low-ability students may be able to pick up more marks in the Foundation Tier paper compared to Higher Tier paper as the Higher Tier paper starts at medium demand.

Differences in Maths requirements for Foundation Tier and Higher Tier papers

As per Ofqual requirements for all awarding bodies, the assessment of Maths skills in our papers is:

- Combined Science 20%
- Biology 10%
- Chemistry 20%
- Physics 30%

Remember that not all Maths in the papers will be at the level required to meet the Ofqual requirements; however, the Maths is assessed to meet the DfE requirements. Sometimes you may have simple addition, subtraction or multiplication items, for example, and these should be mapped to the appropriate Maths skills, but cannot be counted towards the Maths marks as the Maths skills are set at too low a level for foundation and higher tiers.

It is important to note that the level of Maths assessed by our Foundation Tier papers will be at least at the level of KS3 Maths and at Higher Tier, at least at the level of Foundation Tier GCSE Mathematics. Within our specifications, all content for higher tier, including the required Maths skills, are emboldened.

It is worth reviewing how your students are performing on these common Maths skills across Maths and Science, and also the tier entry decisions made for students in GCSE Maths. More information for delivering Maths skills in Science can be found in our Guide to Maths for Scientists, which can be found here.

Physics equations

Candidates will be asked to recall equations at both Higher Tier and Foundation Tier Physics and Combined Sciences papers, such that all equations will need to be sampled over the lifetime of the qualifications. However, it is worth understanding that within our Foundation Tier papers (ranging from grade 1 to 5) it is expected that candidates could be given equations, or be given the terms of an equation or asked to recall the full equations, depending on the complexity of the equation. Within our Higher Tier papers, candidates will be expected to recall equations, with limited scaffolding, for more complex equations.

Mock exams

Using our additional sample assessment material, along with the notional grade boundaries published for each paper this summer, can give you a close indication of your student's performance in an exam paper. There is a bank of exam-style questions within our ExamWizard tool for you to use with your students.

Question styles

To ensure that the Foundation Tier and Higher Tier papers are appropriate for the candidates taking them, there are certain key differences between the two tiers. For example, in Foundation papers we may use more scaffolding within questions.

There will be certain question types, such as words in a box, sentence completion, or line matching, which will only appear in the Foundation Tier paper.

Extended open response questions

Based on previous exams, many candidates found these question types challenging, particularly those at Foundation Tier. This type of question accounts for 10% of marks within the combined paper at Higher and Foundation Tier. They can also be used to differentiate between student ability as the extended open response in the Foundation Tier is targeted at grades 1 to 5. The extended open response question in the Higher Tier is targeted from grades 4 to 9, to stretch the most able students.

Using overlap questions

Twenty-seven per cent of marks will overlap between Foundation Higher Tier papers (these will be questions at medium demand). You can use these questions to assess how your students perform and to help you make decisions about tier entry. As these questions are at medium demand and targeting grades 4 and 5, they will tend to be at the start of the Higher Tier paper and towards the end of the Foundation Tier paper.

We have collated some overlap questions across the Combined and Separate Sciences for you to use with your students, with some covering Maths and practical techniques, so you can see how your students respond to these types of questions. These questions can be found towards the end of this document.

Other factors to consider when deciding on tier entry

Predicted grades

One of the most widely used tools to help make decisions on tier entry is the use of predicted grades. These grades can come from packages, such as the Fischer Family

Trust data. Those students predicted to attain grades 6 or above for GCSE Science should be aiming towards Higher Tier. However, you will need to factor in other aspects (some of which are outlined below) to inform your decision.

Prior attainment

KS2 data for Maths and English could also be used to indicate performance for GCSE Science. If a student has achieved level 5 or 6 at KS2 for English and Maths, then it is likely that their predicted grades will be higher for GCSE Science and, therefore, Higher Tier would provide them with the opportunity to achieve those top-end grades. Again, this information should be used in conjunction with other quantitative and qualitative measures.

We have useful analysis tools and exam materials to help support you with any intervention work that you may undertake to help your students' progress. For example, using our ResultsPlus service, you can upload raw marks to ResultsPlus from any mock papers undertaken by your students. ResultsPlus will analyse the results in terms of performance against assessment objectives, Maths and specification content, so that you can tailor your intervention to your students and focus on key areas.

Our free Access to Scripts and examiner commentary provides student answers, enabling you to review how particular types of questions have been answered by your students tip and from the examiner for the particular question.

Progression

If your student is likely to progress to, or has aspirations for level 3 study in A level Biology/Chemistry/Physics, please speak to the post-16 providers in your area about their specific requirements for each subject. It may be the case that some post-16 providers require students to attain grade 6 at GCSE within all three disciplines to progress to A level study. If grade 6 is a requirement, then this can only be achieved in the higher-tier papers.

Attendance

Poor attendance can be linked to poor performance, particularly if candidates do not attend lessons and have not, therefore, acquired the knowledge, understanding and skills in particular areas of the specification. They will be disadvantaged in the exam and will therefore be likely to struggle with a more challenging paper at higher tier.

Temperament

Science concepts are challenging for some students and not all students engage in a way that demonstrates resilience and perseverance in the subject and assessments. It is important to maintain a dialogue with your student and their parents about their progress, engagement and aspirations in Science and, therefore, the student's suitability to be entered for the Higher Foundation Tier paper. This should be considered alongside other measures.

Exam entries for Summer 2020

You will need to enter your students for GCSE Science exams by **21st February**.

However, you may find that you have more data from mock exams or class tests later in the spring term, on which to base your decision about a student's progress, which may warrant a change in their tier entry. Therefore, we will allow changes to be made up until **21st April**, after this date fees will apply.

For any further queries please contact our dedicated Science Subject Advisor, Irine Muhiuddin.

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FAQs

1) **Will there be a grade 3-3 awarded for Summer 2020 Combined Science higher paper?**
   A grade 3-3 was an exception for the 2018 Combined Science Higher Tier papers. Ofqual have now announced that there will be no awarding of the 3-3 grade for summer 2019 papers onwards. The full announcement can be viewed on The Ofqual blog. Teachers will be able to draw from their experience of tier entry in previous exams to select the most appropriate tier for their candidates.

2) **Can a candidate resit the GCSE Combined Science (Double Award) at the Foundation level the following year?**
   Yes. Remember that a candidate who wishes to resit, they must resit all papers for the qualification at the same tier.

3) **Do you consider a grade 4-3 a good pass? Does it count in accountability measures?**
   The DfE have confirmed that a grade 4 is a standard pass and grade 5 is a strong pass. For Combined Science this means that it would equate to a grade 4-4 being a standard pass. Remember that for Progress 8 measures, the two grades attained by a student in Combined Science are averaged, so a grade 4-3 would be averaged to a 3.5 and count towards two slots in the accountability measures. The two grades are not split into a grade 4 and a grade 3.
   For more information about what counts for progress measures please visit: https://www.gov.uk/government/publications/gcse-9-to-1-grading-justine-greenings-letter https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734601/Secondary_accountability_measures_August_2018.pdf

   Secondary accountability measures guidance

4) **Can I mix tier entries for Combined Science and for separate Science**

   Combined Science

   Combined Science Students can sit Foundation or Higher tier, but they must choose **all** foundation or **all** higher. There is no mixing and matching of tiers in Combined Science.

   Separate Science

   For Separate Science Students can sit Foundation or Higher in each GCSE, but they can't mix tiers between papers 1 and 2. For example they can take F tier in

Biology (paper 1 and 2) and H tier in Chemistry (paper 1 and 2) and Physics (paper 1 and 2).

Overlap questions to use with your students

The overlap questions and marks schemes from page 17 onward in this document are taken from additional sample assessment material 2017.

Below is a reference to overlap questions found in our June 2018 exam papers.

Overlap Question reference June 2018

Biology

Biology Paper 1	1BIO/1H	1BIO/1F	
	Higher	Foundation	Marks
	2a	8b	2
	2b	8c	2
	2ci	8di	3
	2cii	8dii	2
	3ai	9ai	2
	3aii	9aii	2
	3aiii	9aiii	3
	4ai	10ai	1
	4aii	10aii	2
	4aiii	10aiii	2
	4aiv	10aiv	1
	4bi	10bi	2
	4bii	10bii	2
	4biii	10biii	1
		Total	27

Biology Paper 2	1BIO/2H	1BIO/2F	
	Higher	Foundation	Marks
	2ai	8ai	1
	2aii	8aii	2
	2aiii	8aiii	2
	2bi	8bii	3
	2bii	8bii	1
	3ai	9ai	1
	3aii	9aii	2
	3bi	9bi	1
	3bii	9bii	3
	4ai	10ai	2
	4aii	10aii	2
	4aiii	10aiii	3
	4bi	10bi	2
	4bii	10bii	2
			27

Chemistry

Chemistry Paper 1	1CH0/ 1H	1CH0/1F	
	Higher	Foundation	Marks
	2ai	8ci	2
	2aii	8cii	2
	2b	8d	2
	2c	2e	3
	3ai	9ai	1
	3aii	9aii	3
	3b	9b	2
	3c	9c	1
	4ai	10ai	2
	4aii	10aii	1
	4b	10b	4
	4ci	10ci	2

	4cii	10cii	2
			27

Chemistry Paper 2	1CH0/2H	1CH0/2F	
	Higher	Foundation	Marks
	2ai	8ai	1
	2aii	8aii	1
	2b	8b	2
	2ci	8ci	2
	2cii	8cii	2
	2d	8d	1
	3a	9a	3
	3b	9b	3
	3c	9ci	1
	4ai	10ai	1
	4aii	10aii	2
	4aii	10aiii	2
	4b	10b	3
	4ci	10ci	2
	4cii	10cii	1
			27

Physics

Physics Paper 1	1PH0/ 1H	11PH0/1F	
	Higher	Foundation	Marks
	2ai	8ai	1
	2aii	8aii	2
	2aiii	8aiii	3
	2b	8b	3
	3a	9a	4
	3b	9b	3
	4a	10a	1
	4bi	10bi	1
	4bii	10bii	1
	4ci	10ci	2
	4cii	10cii	2
	4ciii	10ciii	1
	4civ	10civ	1
	4cv	10cv	2
			27

Physics Paper 2	1PH0/ 2H	1PH0/2F	
	Higher	Foundation	Marks
	2ai	8ai	4
	2aii	8aii	2
	2b	8b	1
	2c	8c	2
	3a	9a	2
	3b	9b	2
	3c	9c	3
	4ai	10ai	3
	4aii	10aii	3
	4b	10b	1
	4ci	10ci	2
	4cii	10cii	2

			27

Combined Science Biology

Combined Science Biology 1	1SC0/1BH	1SC0/1BF	
	Higher	Foundation	Marks
	1a	5b	2
	1b	5c	2
	1ci	5di	3
	1cii	5dii	2
	2ai	6ai	2
	2aii	6aii	2
	2aiii	6aiii	3
			16

Combined Science Biology 2	1SC0/2BH	1SC0/2BF	
	Higher	Foundation	Marks
	1ai	5ai	1
	1aii	5aii	2
	1aiii	5aiii	2
	1bi	5bi	3
	1bii	5bii	1
	2ai	6ai	1
	2aii	6aii	2
	2bi	6bi	1
	2bii	6bii	3
			16

Combined Science Chemistry

Combined Science Chemistry 1	1SC0/1CH	1SC0/1CF	
	Higher	Foundation	Marks
	1ai	5b	2
	1aii	5cii	2
	1b	5d	2
	1c	5e	3
	2ai	6ai	1
	2aii	6aii	3
	2b	6b	2
	2c	6c	1
			16

Combined Science Chemistry 2	1SC0/2CH	1SC0/2CF	
	Higher	Foundation	Marks
	2ai	5ai	1
	2aii	5aii	1
	2b	5b	2
	2ci	5ci	2
	2cii	5cii	2
	2d	5d	1
	3a	6a	3
	3b	6b	3
	3c	6ci	1
			16

Combined Science Physics

Combined Science Physics 1	1SC0/1PH	1SC0/1PF	
	Higher	Foundation	Marks
	1ai	5ai	1
	1aii	5aii	2
	1aiii	5aiii	3
	1b	5b	3
	2a	6a	4
	2b	6b	3
			16

Combined Science Physics 2	1SC0/2PH	1SC0/2PF	
	Higher	Foundation	Marks
	1ai	5ai	4
	1aii	5aii	2
	1b	5b	1
	1c	5c	2
	2a	6a	2
	2b	6b	2
	2c	6c	3
			16

Additional sample assessment material 2017

Combined Science

Combined Science: Paper 1 Biology

5 In 2014, nearly 155 000 people died from cardiovascular disease in the UK.

(a) Give the reason why cardiovascular disease is a non-communicable disease.

(1)

.....

.....

.....

(c) Drugs have been developed to treat people with cardiovascular disease.

Developing drugs involves many stages.
One stage involves testing a drug on other mammals before testing it on humans.

Give **one** disadvantage of using other mammals for drug testing.

(1)

.....

.....

(d) Figure 6 shows information about the BMI and the lifestyle of two males, P and Q, who have the same height and age.

male	BMI	physical exercise in hours per week	percentage of total daily intake of nutrients		
			carbohydrate	protein	fat
P	24	7	50	20	30
Q	29	2	50	15	35

Figure 6

(i) Which measurements are used to calculate BMI?

(1)

- ☐ **A** waist and hip
- ☐ **B** hip and mass
- ☐ **C** height and mass
- ☐ **D** waist and height

(ii) Explain which male has a greater risk of developing cardiovascular disease.

(3)

(e) Figure 7 shows the use of a stent to treat cardiovascular disease.

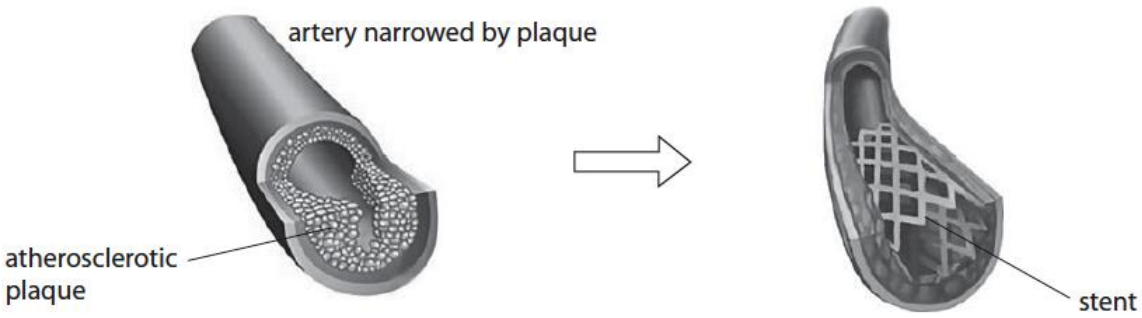


Figure 7

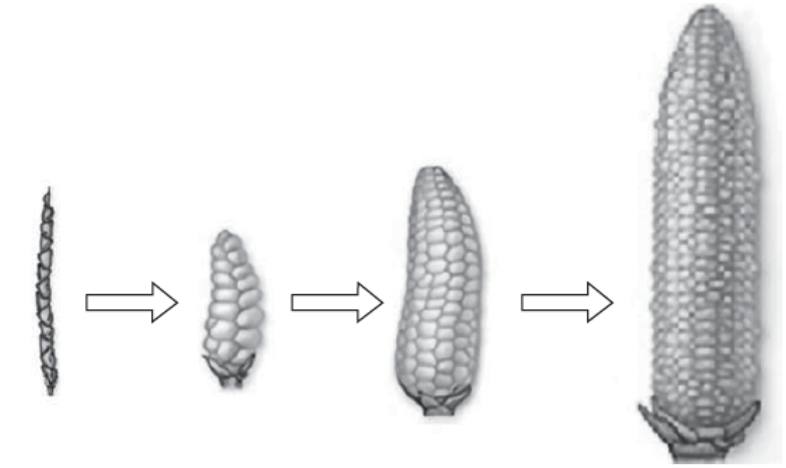
Explain how a stent works to treat cardiovascular disease.

(3)

6 Corn is one of the world's most important crop plants.

Native Americans grew an early form of corn called teosinte.
Modern corn has been developed by selective breeding of teosinte plants.

Figure 8 shows some stages in the development of modern corn.



teosinte modern corn

Figure 8

(a) Give reasons why native Americans selectively bred teosinte.

(2)

.....

.....

.....

.....

(b) Describe how selective breeding has produced modern corn.

(3)

.....

.....

.....

.....

.....

.....

(c) Genetic engineering can also be used to produce a new variety of modern corn.

Describe how the genome of this new variety of corn is different from the genome of corn that has not been genetically engineered.

(2)

.....

.....

.....

.....

Combined Science: Paper 1 Biology- Markscheme

Question number	Answer	Mark
5(a)	cannot be transferred from one person to another	(1)

Question number	Answer	Additional guidance	Mark
5(c)	Any one from: • mammals may be harmed • drugs may affect other mammals in a different way(1)	other mammals systems work in a different way from humans	(1)

Question number	Answer	Mark
5(d) (i)	C	(1)

Question number	Answer	Mark
5(d) (ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via reasoning (2 marks): • male Q (1) • higher BMI / less exercise / higher fat intake (1) • so more risk of fatty deposits / plaques in arteries / atherosclerosis / restricted blood flow to heart (1)	(3)

Question number	Answer	Mark
5(e)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (2 marks): • stent inserted into blood vessel and is expanded (1) • stent opens /widens blood vessel (1) • greater blood flow (through blood vessel) (1) • more oxygen delivered to body organ (1)	(3)

Question number	Answer	Additional guidance	Mark
6(a)	• to produce more food (1) • to improve quality of food (1)	bigger plants , produce more kernels, more sweet/juicy, pest resistant,	(2)

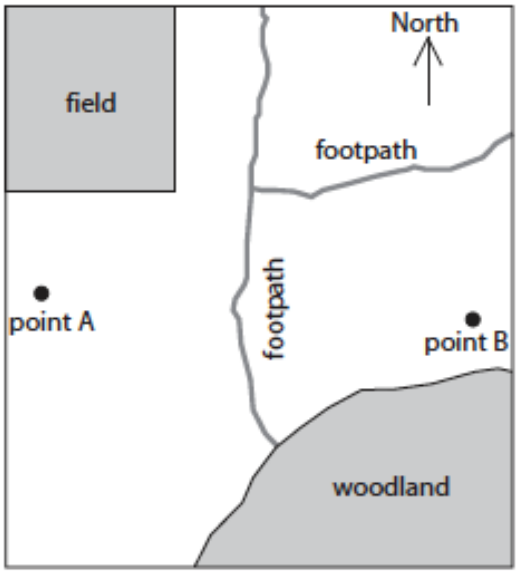
Question number	Answer	Additional guidance	Mark
6(b)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • best characteristics/named characteristic chosen (1) • parents bred together (1) • offspring produced showing some of the best characteristics are selected (1) • selection and breeding process repeated (1)	accept reference to pollination / fertilisation	(3)

Question number	Answer	Mark
6(c)	An answer that provides a description by making reference to: • an extra/new gene (1) • present in the DNA/chromosome (1)	(2)

Combined Science: Paper 2 Biology

5 (a) A student investigated the distribution of poppy plants in a park.

Figure 8 shows a sketch of the park and a diagram of a poppy plant.



poppy plant

Figure 8

The student placed a 1 m² quadrat at 10 metre intervals between point A and point B and recorded the number of poppy plants in each quadrat.

(i) Name the technique the student used to study the distribution of poppy plants.

(1)

.....

Figure 9 shows the number of poppy plants at 10 metre intervals from point A to point B.

distance from point A in metres	number of poppy plants in the 1 m² quadrat
0 (point A)	12
10	10
20	11
30	8
40 (point B)	6

Figure 9

(ii) Explain the effect of the woodland on the distribution of poppy plants.

(3)

(iii) Devise a plan, that uses a quadrat, to estimate the number of poppy plants in the field.

(3)

(b) The woodland is a protected conservation area.

Explain why this woodland increases the biodiversity of the park.

(2)

6 Figure 11 shows a peak flow meter.

A peak flow meter is used to measure the rate at which air is blown out of the lungs.

Figure 11

To use a peak flow meter a person takes a deep breath and exhales the air as hard and as fast as possible into the peak flow meter.

People with asthma can have a reduced peak flow.

A student investigated the peak flow of five people with asthma and five people without asthma.

All the people were male and the same age.

(a) Give **two** other factors the student should control when selecting the people for this investigation.

(2)

1 .....

.....

2 .....

.....

(b) The mean peak flow for people without asthma was 630 dm^3 per minute.

The mean peak flow for people with asthma was 480 dm^3 per minute.

Use the mean peak flow values to calculate the percentage decrease in peak flow for the people with asthma.

(2)

.....%

(c) Explain the effect of reduced airflow in the lungs on aerobic respiration.

(3)

.....

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.....

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.....

.....

Combined Science: Paper 2 Biology markscheme

Question number	Answer	Mark
5(a)(i)	(belt) transect	(1)

Question number	Answer	Mark
5(a)(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • number of poppy plants decreases (closer to the woodland) (1) and • trees block light (1) • light is needed for photosynthesis (1) or • competition (with other species/trees) (1) • for resources/named resource (1)	(3)

Question number	Answer	Mark
5(a)(iii)	An answer that combines the following points to provide a plan: • **randomly** place the quadrat several times (1) • record the number of poppy plants in each quadrat (1) • method for scaling up the area sampled to the total area of the field (1)	(3)

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): woodland provides a different type of habitat (1) allows different {animal/plant} species to live in the park (1)	accept the idea that human intervention is controlled accept specific example e.g. nesting site for birds	(2)

Question number	Answer	Additional Guidance	Mark
6(a)	Any two from: • weight (1) • height (1) • fitness (1) • other medical conditions (1) • drug intake / medication (1)	accept other valid factors when selecting the people	(2)

Question number	Answer	Additional Guidance	Mark
6(b)	Subtraction 630 - 480 = 150 (1) Evaluation (150 ÷ 630) x 100 = 24 (%)	accept 23.8 award full marks for correct numerical answer without working	(2)

Question number	Answer	Additional Guidance	Mark
6(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning / justification – application of understanding (2 marks): • less aerobic respiration (1) • because there is reduced oxygen entering the lungs (1) • which reduces oxygen supplied to the blood/to the cells (1)	accept reduced removal of carbon dioxide from the blood / less energy released (1)	(3)

Combined Science: Paper 1 Chemistry

4 (c) Hydrogen sulphide, H_2S, is a simple molecular, covalent compound.

(i) A hydrogen atom has one electron in its outer shell.
A sulfur atom has six electrons in its outer shell.

Which of the following is the dot and cross diagram of a molecule of hydrogen sulfide?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(ii) Which row in Figure 5 shows the properties of a simple molecular, covalent compound such as hydrogen sulfide?

(1)

	melting point	boiling point	conduction of electricity
☒ **A**	high	high	poor conductor
☒ **B**	high	high	good conductor only when liquid
☒ **C**	low	low	poor conductor
☒ **D**	high	high	good conductor

Figure 5

(d) A compound of sulfur was analysed to determine its empirical formula.

(i) State the meaning of the term **empirical formula**.

(1)

.....

.....

(ii) A compound of sulfur and fluorine contains 4.8 g of sulfur and 17.1 g of fluorine.

Calculate the empirical formula of this compound.

You must show your working.
(relative atomic masses: F = 19, S = 32)

(3)

empirical formula = ...

5 (a) Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.
The solid calcium carbonate is added until some remains at the bottom of the beaker.

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

6 Figure 6 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

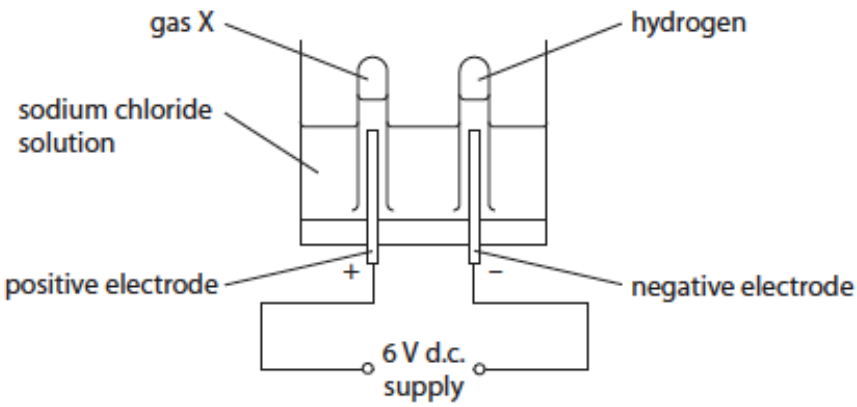


Figure 6

(c) Gases are produced at both electrodes.

(i) State the name of the yellow-green gas X formed at the positive electrode.

(1)

.....

(ii) Describe the test to show that the gas formed at the negative electrode is hydrogen.

(2)

.....

.....

.....

(d) Explain why sodium chloride solution can conduct electricity.

(2)

.....

.....

.....

.....

Combined Science: Paper 1 Chemistry mark scheme

Question number	Answer	Mark
4(c)(i)	B 	(1)

Question number	Answer			Mark
4(c)(ii)	C	low	low	poor conductor	(1)

Question number	Answer	Mark
4(d)(i)	(formula showing) simplest ratio of atoms (of each element in a substance)	(1)

Question number	Answer	Additional guidance	Mark
4(d)(ii)	no. S atoms : no. F atoms = $\frac{4.8}{32}$ (0.15) : $\frac{17.1}{19}$ (0.9) (1) = $\frac{0.15}{0.15}$ (1) : $\frac{0.9}{0.15}$ (6) (1) empirical formula SF_6 (1)	correct formula with no working scores 1	(3)

Question Number	Answer	Mark
5(a)(ii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) • to react all the (nitric) acid in the solution (1) • so that the calcium nitrate solution is pure (1)	(2)

Question Number	Answer	Mark
5(a)(iii)	$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$ (3) left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)	(3)

Question Number	Answer	Mark
6(c)(i)	chlorine (1)	(1)

Question Number	Answer	Mark
6(c)(ii)	A description to include • lighted splint / ignite gas (1) • gas burns / (squeaky) pop (if air is present) (1)	(2)

Question Number	Answer	Mark
6(d)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark): • sodium and chloride ions present (1) • these ions can move (in solution) (1)	(2)

Combined Science: Paper 2 Chemistry

5 (a) Sodium has an atomic number of 11.

Which line in the table shows the correct numbers of protons, neutrons and electrons in a positively charged sodium ion, Na^+?

(1)

	number of		
	protons	**neutrons**	**electrons**
☐ **A**	10	12	11
☐ **B**	10	11	10
☐ **C**	11	10	11
☐ **D**	11	12	10

(b) Fluorine has an electronic configuration 2.7.

Fluorine gas exists as diatomic molecules.
In each molecule of fluorine, the two fluorine atoms are joined by a covalent bond.

Draw a dot and cross diagram to show the electrons in a molecule of fluorine, F_2.

Show outer electrons only.

(2)

(c) Sodium reacts with fluorine to form sodium fluoride, NaF.

Complete the balanced equation for this reaction.

(2)

2Na + ... → .....NaF

(d) Sodium fluoride is an ionic compound.

(i) Describe how a sodium atom and a fluorine atom interact to form a sodium ion, Na^+, and a fluoride ion, F^-.

(2)

(ii) Explain why sodium fluoride is able to conduct electricity when it is molten but not when it is solid.

(2)

6 (a) A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.

The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.

The graph in Figure 8 shows the results obtained by the student.

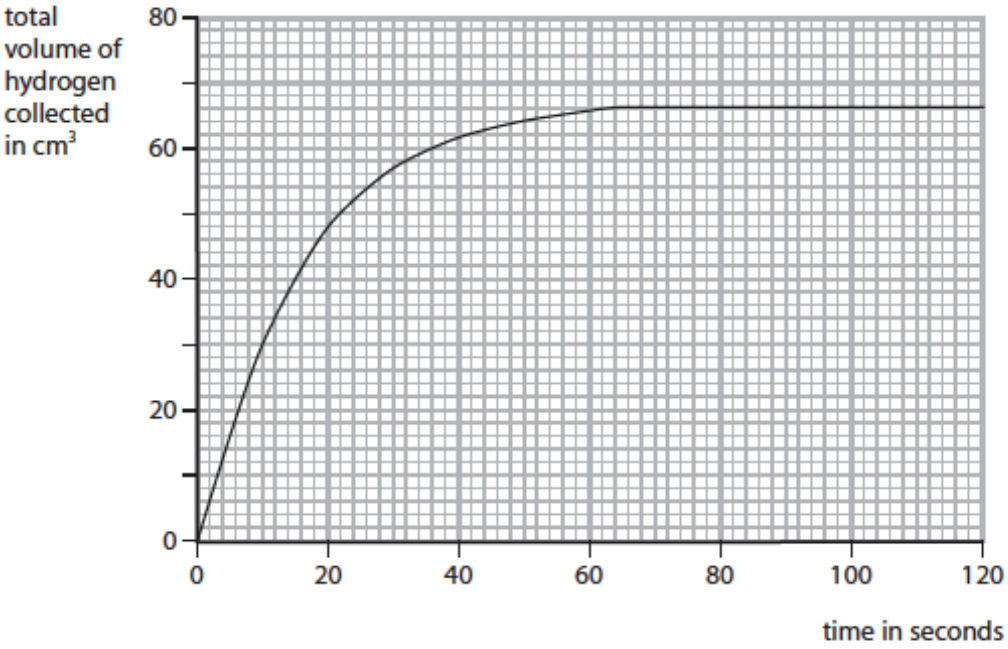


Figure 8

(i) Using the graph, give the time in seconds at which the reaction stopped.

(1)

..... s

(ii) Give the reason why the reaction stopped.

(1)

.....

.....

(iii) Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second.

(2)

.....

.....

.....

average rate of reaction = ... $cm^3 s^{-1}$

(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same.
This change caused the reaction to take place more quickly.

On the graph in Figure 8, sketch a line to show the results you would expect in this experiment.

(2)

(v) The rate of the reaction can be changed by adding a solid catalyst to the reaction mixture.

Which line in the table shows how the final volume of hydrogen produced and the mass of the catalyst change?

(1)

	change in final volume of hydrogen	change in mass of catalyst
☐ **A**	increases	no change
☐ **B**	no change	decreases
☐ **C**	no change	no change
☐ **D**	increases	decreases

Combined Science: Paper 2 Chemistry mark scheme

Question number	Answer	Mark
5(a)	**D** 11, 12, 10	(1)

Question number	Answer	Additional guidance	Mark
5(b)	• {1 pair of/two} electrons shared between two fluorine atoms (1) • rest of structure correct (1)	ignore inner shells	(2)

Question number	Answer	Mark
5(c)	2 Na + F_2 → **2** NaF (2) F_2 (1) 2 (1)	(2)

Question number	Answer	Mark
5(d)(i)	An answer that provides a description by making reference to: • one electron (transferred) (1) • transferred from sodium to fluorine (1)	(2)

Question number	Answer	Mark
5(d)(ii)	An explanation that combines identification - understanding (1 mark) and reasoning/justification - understanding (1 mark): • (both solid and molten) contained charged particles/ions (1) • (ions) free to move in molten but not in solid (1)	(2)

Question number	Answer	Mark
6(a)(i)	value in the range 64 - 66 (s)	(1)

Question number	Answer	Mark
6(a)(ii)	all magnesium is used up	(1)

Question number	Answer	Additional guidance	Mark
6(a)(iii)	volume of hydrogen = 48 (1) rate = $\frac{48}{20}$ (1) = 2.4 ($cm^3 s^{-1}$)	2.4 only (2) incorrect volume/20 1 mark only	(2)

Question number	Answer	Mark
6(a)(iv)	curved line to the left of curve (1) same final volume (which is the maximum volume) (1)	(2)

Question number	Answer	Mark
6(a)(v)	C no change, no change	(1)

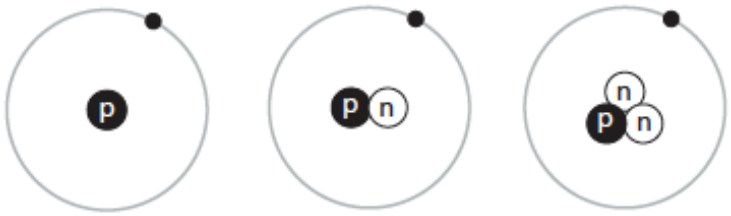
Combined Science: Paper 1 Physics

4 (a) What is the approximate size of a hydrogen atom?

(1)

- ☒ **A** 10^{-3} m
- ☒ **B** 10^{-10} m
- ☒ **C** 10^{-19} m
- ☒ **D** 10^{-31} m

(b) Figure 5 is a diagram of three atoms.



$^{1}_{1}H$ hydrogen $^{2}_{1}H$ deuterium $^{3}_{1}H$ tritium

Figure 5

Give reasons why these atoms are isotopes.

(2)

.....

.....

.....

.....

(c) Some isotopes are unstable.
They emit β^- particles when they decay.

Explain how a nucleus changes when a β^- particle is emitted.

(2)

.....

.....

.....

.....

(d) Other unstable isotopes emit alpha particles.

Which of these describes an alpha particle?

(1)

☐ **A** a hydrogen nucleus

☐ **B** a hydrogen atom

☐ **C** a helium nucleus

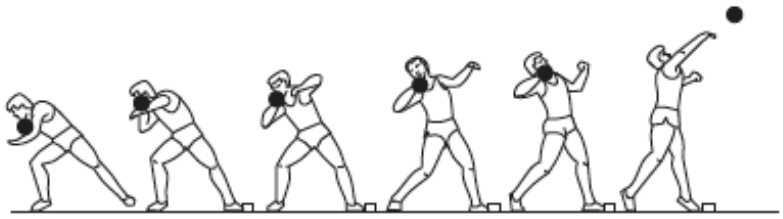
☐ **D** a helium atom

5 Shot-put is an Olympic event.
The shot is a heavy ball.
An athlete throws the shot as far as possible.

A sports scientist analyses an athlete's throw to help improve performance.

(b) The scientist takes pictures of the athlete every 0.1 s during one throw.

Figure 7 shows the pictures of one throw.



start of throw
(shot at rest)

just after the
release of the shot

Figure 7

(i) Estimate the amount of time during the throw when the shot is in the athlete's hand.

(1)

time = ... s

(ii) Explain how the scientist could improve this method of analysing the throw.

(2)

.....

.....

.....

.....

.....

(iii) The average acceleration of the shot while in the athlete's hand is 20.6 m/s^2.
The mass of the shot is 7.26 kg.

Calculate the average force that the athlete applies to the shot during the throw.

(2)

force = ... N

(iv) In another throw, the shot is in the athlete's hand for 0.48 s.
The average acceleration during this time is 23 m/s^2.

Calculate the velocity of the shot as it leaves the athlete's hand.

(3)

velocity = ... m/s

(c) In one throw, the shot continues to rise by another 1.3 m after it leaves the athlete's hand.
The mass of the shot is 7.26 kg.

(i) Calculate the amount of gravitational potential energy gained by the shot.

(2)

gravitational potential energy gained = ... J

Combined Science: Paper 1 Physics mark scheme

Question number	Answer	Mark
4(a)	B 10^{-10} m	(1)

Question number	Answer	Mark
4(b)	one from • same atomic number (1) • same number of protons (1) • same element (1) and one from • different numbers of neutrons (1) • different mass numbers (1)	(2)

Question number	Answer	Additional guidance	Mark
4(c)	An explanation that combines understanding (1 mark) and reasoning (1 mark) linking: • number of neutrons decreases by one (1) • number of protons increases by one.(1)	a neutron becomes a proton plus an electron for (2) marks	(2)

Question number	Answer	Mark
4(d)	C a helium nucleus	(1)

Question number	Answer	Additional guidance	Mark
5(b)(i)	0.45 (s) (1)	Allow any value ≥ 0.4 and ≤ 0.5	(1)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An explanation that combines improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark) • take pictures more frequently (1) • in order to determine exact time of the release. (1)	other responses may be acceptable	(2)

Question number	Answer	Additional guidance	Mark
5(b)(iii)	Substitution (1) F = 7.26 x 20.6 Evaluation (1) 150 (N)	 Accept 149.6 (N) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
5(b)(iv)	Rearrangement (1) v = a x t Substitution (1) v = 23 x 0.48 Evaluation (1) 11 (m/s)	 Accept 11.04(m/s) full marks will be awarded for correct numerical answer without working	(3)

Question number	Answer	Additional guidance	Mark
5(c)(i)	Substitution (1) PE = 7.26 x 10 x 1.3 Answer (1) 94.4 (J)		(2)

Combined Science: Paper 2 Physics

5 (a) Some forces act at a distance.

One example is the gravitational attraction between the Moon and the Earth.

Describe an example of another type of force acting at a distance, where the force is **not** gravitational.

(2)

.....

.....

.....

.....

(b) A rock falls off the top of a cliff of height *h*.

Figure 8 shows the rock falling.

The Earth exerts a force of 150 N on the rock.

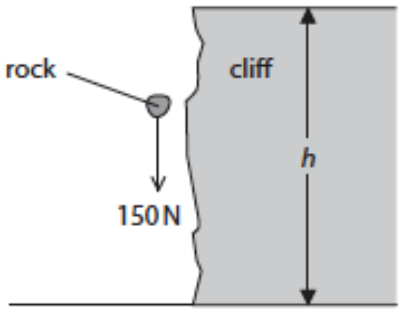


Figure 8

The work done by this force when the rock falls from the top to the bottom of the cliff is 2700 J.

(i) Calculate the height, *h*, of the cliff.

(2)

h = ... m

(ii) State the value of the kinetic energy of the rock just before it hits the ground.

(1)

kinetic energy = ... J

(iii) The mass of the rock in Figure 8 is 15 kg.

Calculate the velocity of the rock just before it reaches the bottom of the cliff.

(2)

velocity = ... m/s

(c) An electric motor is used to lift a box.

Figure 9 shows how the efficiency of the electric motor changes as the mass of the box increases.

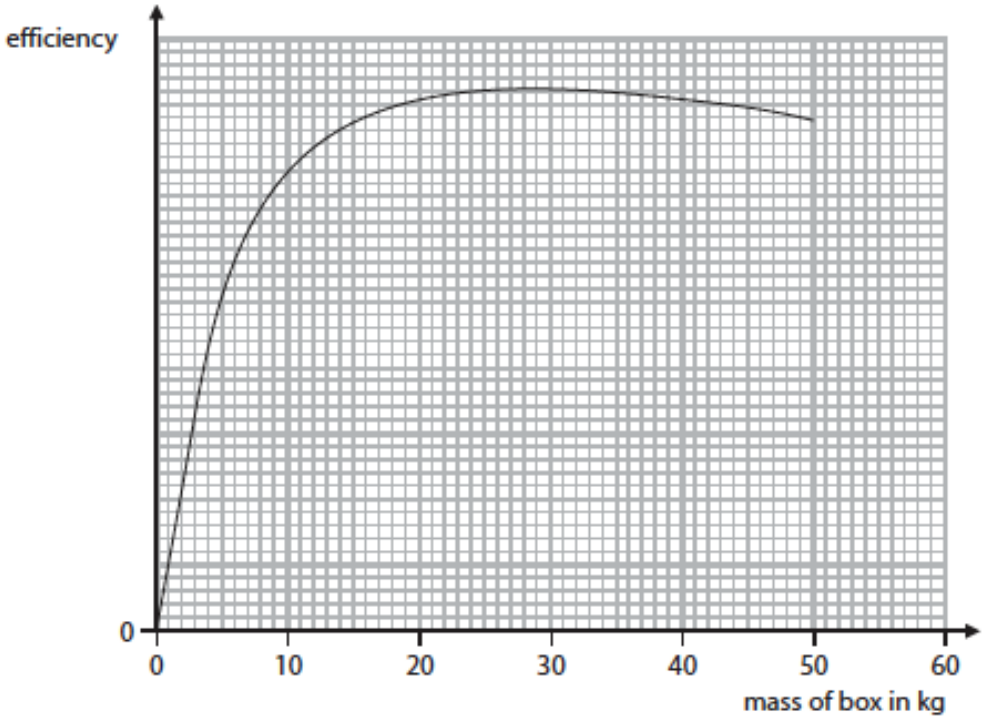


Figure 9

Describe how the efficiency of the electric motor depends on the mass of the box lifted.

(2)

.....

.....

.....

.....

(Total for Question 5 = 9 marks)

6 (a) An electric heater is connected to a 230 V supply.

The power supplied to the heater is 2.6 kW.

Calculate the current in the heater.

(3)

current = ... A

(b) A car headlamp has a power rating of 55 W when the current in the headlamp is 4.4 A.

(i) State the equation relating power, current and resistance.

(1)

(ii) Calculate the resistance of the headlamp.

(3)

resistance = ... Ω

Combined Science: Paper 2 Physics mark scheme

Question number	Answer	Additional guidance	Mark
5 (a)	An answer that combines the following points of understanding to provide a logical description: named force (acting at a distance) (1) situation (1)	 e.g. magnetic force between two (magnetic) poles	(2)

Question number	Answer	Additional guidance	Mark
5 (b)(i)	rearrangement of work = force × distance (1) d = W ÷ F substitution and evaluation (1) 18 (m)	 d = 2700 ÷ 150 Award full marks for correct answer without working	(2)

Question number	Answer	Mark
5 (b)(ii)	2700 (J)	(1)

Question number	Answer	Additional guidance	Mark
5 (b)(iii)	rearrangement of KE = ½ mv^2 (1) v = √(2 × KE ÷ m) substitution and evaluation (1) 19 (m/s)	 v = √(2 × 2700 ÷ 15) v^2 = (2 × 2700 ÷ 15) allow answers that round to 19 award full marks for correct answer without working allow alternative route using $v^2 - u^2 = 2ax$ for full marks	(2)

Question number	Answer	Additional guidance	Mark
5 (c)	An answer that combines points of interpretation/evaluation to provide a logical description: efficiency increases (at first) (1) to maximum efficiency (for mass of about 25 kg) (1)	 e.g. decreases for larger masses	(2)

Question number	Answer	Additional guidance	Mark
6 (a)	substitution into P = V × I (1) 2600 = 230 × I rearrangement (1) I = P ÷ V evaluation (1) 11 (A)	Substitution and re-arrangement in either order I = 2600 ÷ 230 for 2 marks allow answers that round to 11 award full marks for correct answer without working allow I = 2.6 ÷ 230 for 1 mark allow 0.011 (A) for 2 marks max if no other marks scored, award 1 mark for 2.6 kW = 2600 W	(3)

Question number	Answer	Mark
6 (b)(i)	either power = (current)^2 × resistance or P = I^2 × R	(1)

Question number	Answer	Additional guidance	Mark
6 (b)(ii)	substitution into $P = I^2 \times R$ (1) $55 = 4.4^2 \times R$ rearrangement (1) $R = P \div I^2$ evaluation (1) 2.8 (Ω)	Substitution and re-arrangement in either order $R = 55 \div 4.4^2$ for 2 marks allow answers that round to 2.8 award full marks for correct answer without working allow alternative route $V = P \div I = 55 \div 4.4$ then $R = V \div I = 12.5 \div 4.4$	**(3)**

Separate Science: Biology

Separate Science: Biology Paper 1

8 In 2014, nearly 155 000 people died from cardiovascular disease in the UK.

(a) Give the reason why cardiovascular disease is a non-communicable disease.

(1)

.....

.....

.....

(c) Drugs have been developed to treat people with cardiovascular disease.

Developing drugs involves many stages.
One stage involves testing a drug on other mammals before testing it on humans.

Give **one** disadvantage of using other mammals for drug testing.

(1)

.....

.....

(d) Figure 8 shows information about the BMI and the lifestyle of two males, P and Q, who have the same height and age.

male	BMI	physical exercise in hours per week	percentage of total daily intake of nutrients		
			carbohydrate	protein	fat
P	24	7	50	20	30
Q	29	2	50	15	35

Figure 8

(i) Which measurements are used to calculate BMI?

(1)

- ☒ **A** waist and hip
- ☒ **B** hip and mass
- ☒ **C** height and mass
- ☒ **D** waist and height

(ii) Explain which male has a greater risk of developing cardiovascular disease.

(3)

(e) Figure 9 shows the use of a stent to treat cardiovascular disease.

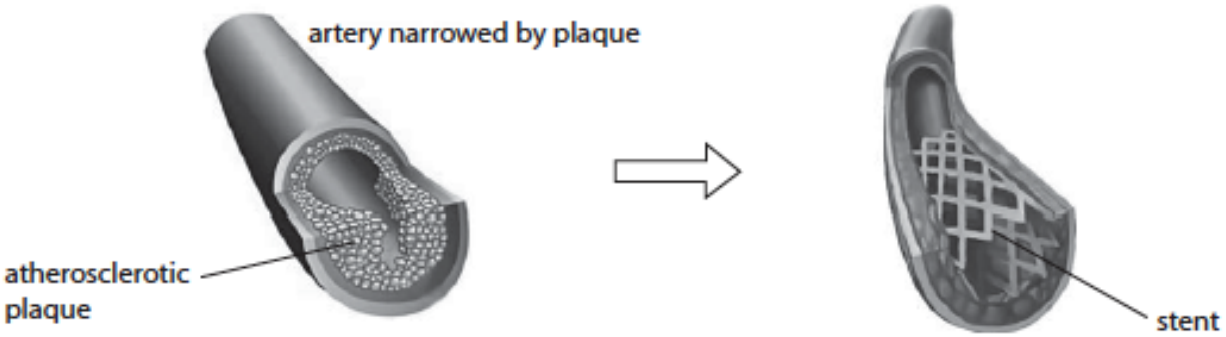


Figure 9

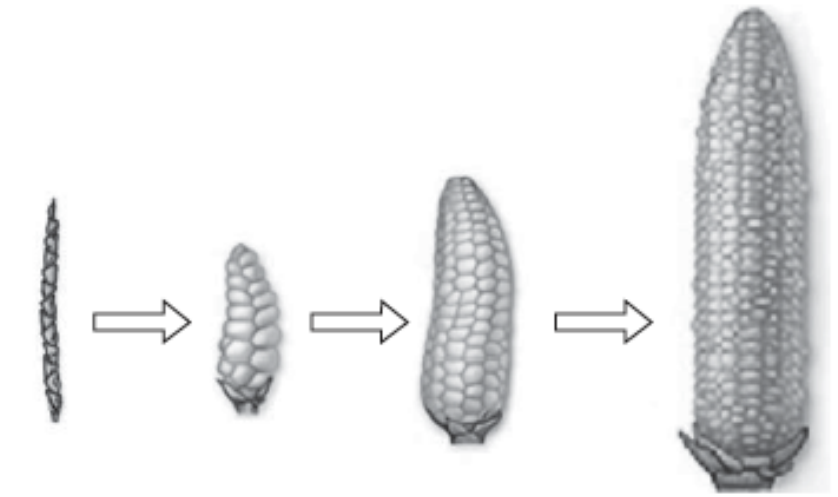
Explain how a stent works to treat cardiovascular disease.

(3)

9 Corn is one of the world's most important crop plants.

Native Americans grew an early form of corn called teosinte.
Modern corn has been developed by selective breeding of teosinte plants.

Figure 10 shows some stages in the development of modern corn.



teosinte modern corn

Figure 10

(a) Give reasons why native Americans selectively bred teosinte.

(2)

.....

.....

.....

.....

(b) Describe how selective breeding has produced modern corn.

(3)

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.....

.....

(c) Genetic engineering can also be used to produce a new variety of modern corn.

Describe how the genome of this new variety of corn is different from the genome of corn that has not been genetically engineered.

(2)

10 Short-sightedness, also known as myopia, is a common eye defect.

Figure 11 shows a section through the human eye with light rays from a distant object.

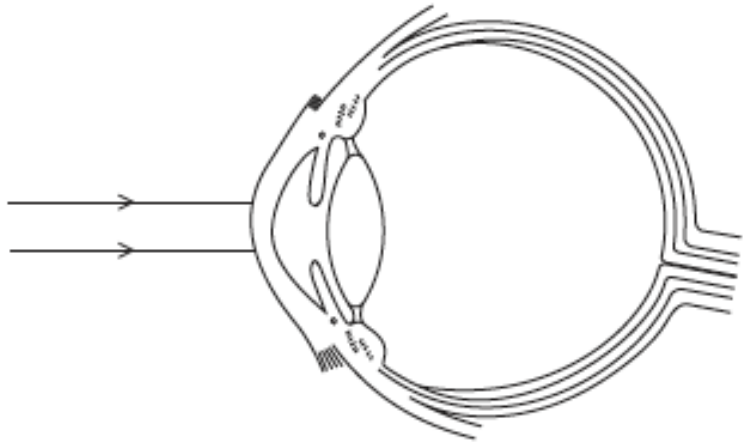


Figure 11

(a) (i) Complete the diagram to show the light rays for this individual who is short-sighted.

(2)

(ii) Explain how laser technology can be used to correct short-sightedness.

(2)

(iii) Which structure controls the amount of light entering the eye?

(1)

- ☒ **A** cornea
- ☒ **B** iris
- ☒ **C** retina
- ☒ **D** lens

(b) In an investigation, scientists asked three volunteers to look at a computer screen which changes from red to green.

Each volunteer was given a drink containing an amount of caffeine.

The volunteers hit a button with their index finger each time the screen changed colour.

Their reaction times were measured.

The results are shown in Figure 12.

	reaction time in seconds			
volunteer	**repeat 1**	**repeat 2**	**repeat 3**	**mean**
volunteer 1 – 100 mg caffeine	0.45	0.52	0.50	0.49
volunteer 2 – 300 mg caffeine	0.22	0.16	0.24	0.21
volunteer 3 – 600 mg caffeine	0.19	0.19	0.22	0.20

Figure 12

(i) Describe the effect of concentration of caffeine on the reaction times of these volunteers.

(2)

.....

.....

.....

.....

Separate Science: Biology Paper 1 mark scheme

Question number	Answer	Mark
8(a)	cannot be transferred from one person to another	(1)

Question number	Answer	Additional guidance	Mark
8(c)	Any one from: • mammals may be harmed • drugs may affect other mammals in a different way(1)	other mammals systems work in a different way from humans	(1)

Question number	Answer	Additional guidance	Mark
8(d) (i)	C		(1)

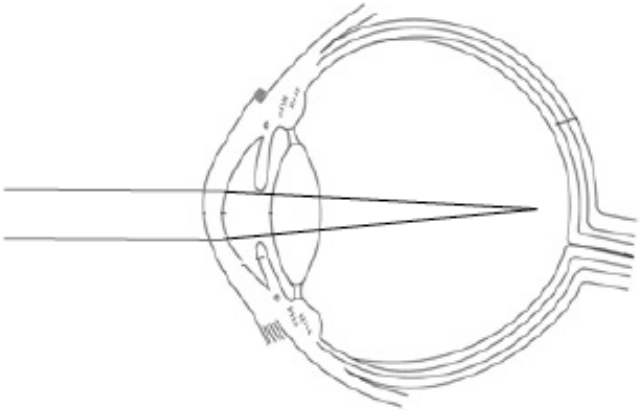
Question number	Indicative content	Mark
8(d) (ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via reasoning (2 marks): • male Q (1) • higher BMI / less exercise / higher fat intake (1) • so more risk of fatty deposits / plaques in arteries / atherosclerosis / restricted blood flow to heart (1)	(3)

Question number	Answer	Mark
8(e)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (2 marks): • stent inserted into blood vessel and is expanded (1) • stent opens /widens blood vessel (1) • greater blood flow (through blood vessel) (1) • more oxygen delivered to body organ (1)	(3)

Question number	Answer	Additional guidance	Mark
9(a)	• to produce more food (1) • to improve quality of food (1)	bigger plants , produce more kernels, more sweet/juicy, pest resistant,	(2)

Question number	Answer	Additional guidance	Mark
9(b)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • best characteristics/named characteristic chosen (1) • parents bred together (1) • offspring produced showing some of the best characteristics are selected (1) • selection and breeding process repeated (1)	accept reference to pollination / fertilisation	(3)

Question number	Answer	Mark
9(c)	An answer that provides a description by making reference to: • an extra/new gene (1) • present in the DNA/chromosome (1)	(2)

Question number	Answer	Mark
10(a)(i)	 the rays converging (1) rays meeting at a point before the retina (1)	(2)

Question number	Answer	Mark
10(a)(ii)	An explanation that combines application of knowledge (1 marks) and reasoning/justification – application of understanding (1 mark): • laser used to reshape the cornea/lens (1) • so that light rays are refracted on to the retina (1)	(2)

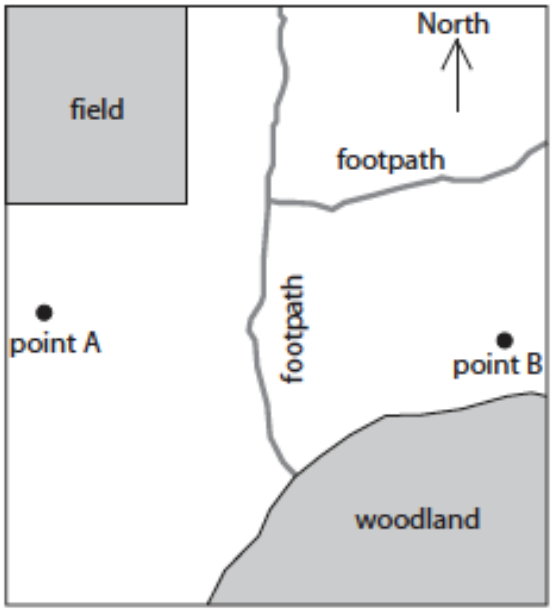
Question number	Answer	Mark
10(a)(iii)	B	(1)

Question number	Answer	Mark
10(bi)	A description that combines analysis via a judgement (1 mark) to reach a conclusion (1 mark): • as the caffeine dosage increases from 100mg to 300mg mean reaction time decreases (1) • little / no further effect on reaction time above 300mg dosage (1)	(2)

Separate Science: Biology Paper 2

8 (a) A student investigated the distribution of poppy plants in a park.

Figure 12 shows a sketch of the park and a diagram of a poppy plant.



poppy plant

Figure 12

The student placed a 1 m^2 quadrat at 10 metre intervals between point A and point B and recorded the number of poppy plants in each quadrat.

(i) Name the technique the student used to study the distribution of poppy plants.

(1)

.....

Figure 13 shows the number of poppy plants at 10 metre intervals from point A to point B.

distance from point A in metres	number of poppy plants in the 1 m² quadrat
0 (point A)	12
10	10
20	11
30	8
40 (point B)	6

Figure 13

(ii) Explain the effect of the woodland on the distribution of poppy plants.

(3)

(iii) Devise a plan, that uses a quadrat, to estimate the number of poppy plants in the field.

(3)

(b) The woodland is a protected conservation area.

Explain why this woodland increases the biodiversity of the park.

(2)

9 Figure 15 shows a peak flow meter.

A peak flow meter is used to measure the rate at which air is blown out of the lungs.

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Figure 15

To use a peak flow meter a person takes a deep breath and exhales the air as hard and as fast as possible into the peak flow meter.

People with asthma can have a reduced peak flow.

A student investigated the peak flow of five people with asthma and five people without asthma.

All the people were male and the same age.

(a) Give **two** other factors the student should control when selecting the people for this investigation.

(2)

1 .....

.....

2 .....

.....

(b) The mean peak flow for people without asthma was 630 dm^3 per minute.

The mean peak flow for people with asthma was 480 dm^3 per minute.

Use the mean peak flow values to calculate the percentage decrease in peak flow for the people with asthma.

(2)

.....%

(c) Explain the effect of reduced airflow in the lungs on aerobic respiration.

(3)

.....

.....

.....

.....

.....

.....

10 (a) Tuna are carnivorous fish.

In the wild, tuna eat smaller fish called mackerel.

Mackerel eat sand eels.

Sand eels eat microscopic plant life called phytoplankton.

Sketch a pyramid of biomass for this food chain and label each level with the name of the organism.

(2)

(b) Some young tuna are kept in fish farms.

The tuna in fish farms are fed more food than they would normally catch in the wild, so they grow quickly.

When a tuna reaches 35 kg it is removed from the fish farm and sold as food.

Figure 16 shows the effect of feeding tuna different protein diets.

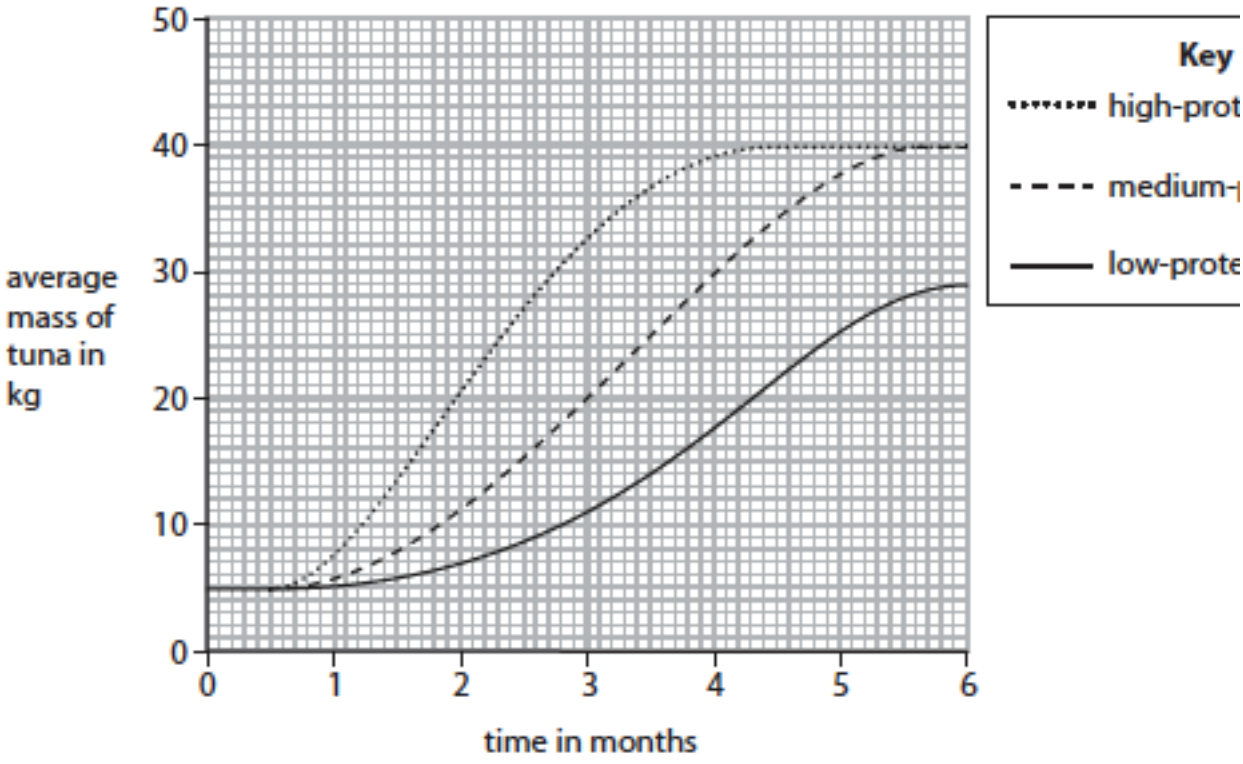


Figure 16

State and explain which diet would be given to the tuna so they can be sold in the shortest possible time.

.....

.....

(c) Some tuna living in the wild can grow larger than 350 kg.

When a tuna eats 1 kg of mackerel the tuna gains 60 g in mass.

Calculate the mass of mackerel a tuna would have to eat to increase its mass by 300 kg.

(2)

.....kg

(d) (i) Explain why fish farmers keep the fish confined in netted areas.

(2)

.....

.....

.....

.....

(ii) Give **one** reason why there is an increase in the number of fish farms in the world today.

(1)

.....

.....

Separate Science: Biology Paper 2 mark scheme

Question number	Answer	Mark
8(a)(i)	(belt) transect	(1)

Question number	Answer	Mark
8(a)(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • number of poppy plants decreases (closer to the woodland) (1) and • trees block light (1) • light is needed for photosynthesis (1) or • competition (with other species/trees) (1) • for resources/named resource (1)	(3)

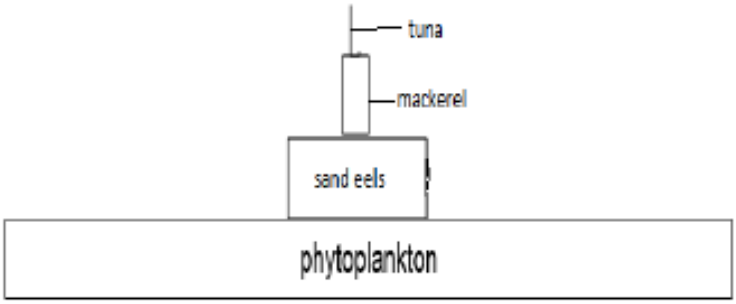
Question number	Answer	Mark
8(a)(iii)	An answer that combines the following points to provide a plan: • **randomly** place the quadrat several times (1) • record the number of poppy plants in each quadrat (1) • method for scaling up the area sampled to the total area of the field (1)	(3)

Question number	Answer	Additional guidance	Mark
8(b)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • woodland provides a different type of habitat (1) • allows different {animal/plant} species to live in the park (1)	accept the idea that human intervention is controlled accept specific example e.g. nesting site for birds	(2)

Question number	Answer	Additional guidance	Mark
9(a)	Any two from: • weight (1) • height (1) • fitness (1) • other medical conditions (1) • drug intake / medication (1)	accept other valid factors when selecting the people	(2)

Question number	Answer	Additional guidance	Mark
9(b)	Subtraction 630 - 480 = 150 (1) Evaluation (150 ÷ 630) x 100 = 24 (%)	 accept 23.8 award full marks for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
9(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning / justification – application of understanding (2 marks): • less aerobic respiration (1) • because there is reduced oxygen entering the lungs (1) • which reduces oxygen supplied to the blood/to the cells (1)	 accept reduced removal of carbon dioxide from the blood / less energy released (1)	(3)

Question Number	Answer	Mark
10(a)	correct shape (exact widths not required) (1) – ignore pyramid drawn as a triangle correct labels (1)  	(2)

Question Number	Answer	Mark
10(b)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (3 marks): • high-protein diet (1) • because the tuna reach 35kg in approximately three months (1) • whereas the medium-protein diet the tuna take four and a half months to reach this mass (1) • on the low-protein diet the tuna do not reach 35kg (1)	(4)

Question Number	Answer	Additional guidance	Mark
10(c)	conversion 60 ÷ 1000 =0.06 (1) evaluation 300 ÷ 0.06 = 5000 (kg)	accept alternative methods of calculation award full marks for correct numerical answer without working	(2)

Question Number	Answer	Additional guidance	Mark
10(d)(i)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • to restrict movement (1) • so less energy is lost (1) OR • to prevent predators entering (1) • so fish not harmed / higher yield (1)	accept other relevant explanations	(2)

Question Number	Answer	Additional guidance	Mark
10(d)(ii)	increasing world population / humans eating a high protein diet / increase preference for fish protein	accept other relevant reasons	(1)

Separate Science: Chemistry

Separate Science: Chemistry Paper 1

6 (c) Hydrogen sulphide, H_2S, is a simple molecular, covalent compound.

(i) A hydrogen atom has one electron in its outer shell.
A sulfur atom has six electrons in its outer shell.

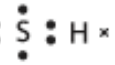
Which of the following is the dot and cross diagram of a molecule of hydrogen sulfide?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(ii) Which row in Figure 6 shows the properties of a simple molecular, covalent compound such as hydrogen sulfide?

(1)

	melting point	boiling point	conduction of electricity
☒ **A**	high	high	poor conductor
☒ **B**	high	high	good conductor only when liquid
☒ **C**	low	low	poor conductor
☒ **D**	high	high	good conductor

Figure 6

(d) A compound of sulfur was analysed to determine its empirical formula.

(i) State the meaning of the term **empirical formula**.

(1)

.....

.....

(ii) A compound of sulfur and fluorine contains 4.8 g of sulfur and 17.1 g of fluorine.

Calculate the empirical formula of this compound.

You must show your working.
(Relative atomic masses: F = 19, S = 32)

(3)

.....

.....

.....

.....

.....

.....

empirical formula = ...

7 (a) A Bunsen burner has a base and a chimney as shown in Figure 7.

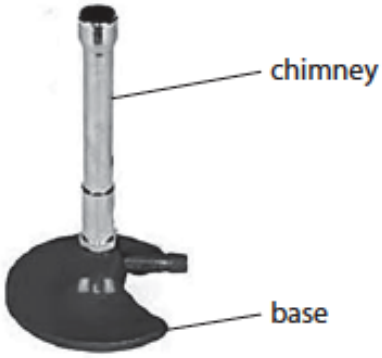


Figure 7

The base can be made of steel.

Explain why steel is a suitable material for the base.
Do not consider cost.

(2)

.....

.....

.....

(c) An alloy of aluminium contains aluminium and copper.
This alloy is stronger than pure aluminium.

Figure 10 shows the structures of pure aluminium and this alloy.

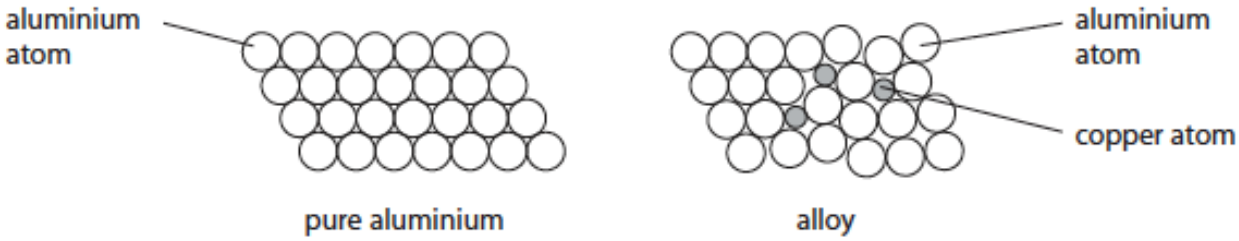


Figure 10

Explain, in terms of these structures, how the presence of copper atoms in the alloy results in the alloy being stronger than pure aluminium.

(3)

8 (b) The compound ammonium chloride is used as a fertiliser.

Starting with a dilute solution of ammonia, describe how you could prepare a pure solution of ammonium chloride in the laboratory.

(3)

(d) In an experiment to prepare some ammonium chloride crystals, it is calculated that the maximum mass of ammonium chloride produced from the mass of ammonia used should be 24.60 g.

In the experiment, the actual yield was 17.73 g.

Calculate the percentage yield, giving your answer to **three** significant figures.

(3)

percentage yield = ...

9 (a) Calculate nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.
The solid calcium carbonate is added until some remains at the bottom of the beaker.

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

10 (c) Gases are produced at both electrodes.

(i) State the name of the yellow-green gas X formed at the positive electrode.

(1)

.....

(ii) Describe the test to show that the gas formed at the negative electrode is hydrogen.

(2)

.....

.....

.....

(d) Explain why sodium chloride solution can conduct electricity.

(2)

.....

.....

.....

.....

Separate Science: Chemistry Paper 1 mark scheme

Question number	Answer	Mark
6(c)(i)	B 	(1)

Question number	Answer				Mark
6(c)(ii)	C	low	low	poor conductor	(1)

Question number	Answer	Mark
6(d)(i)	(formula showing) simplest ratio of atoms (of each element in a substance)	(1)

Question number	Answer	Additional guidance	Mark
6(d)(ii)	no. S atoms : no. F atoms $= \frac{4.8}{32}$ (0.15) : $\frac{17.1}{19}$ (0.9) (1) $= \frac{0.15}{0.15}$ (1) : $\frac{0.9}{0.15}$ (6) (1) empirical formula SF_6 (1)	correct formula with no working scores 1	(3)

Question Number	Answer	Mark
7(a)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) • high density (1) • (so that) Bunsen does not tip over (1)	(2)

Question Number	Answer	Additional guidance	Mark
7(c)	An explanation linking any three of ALUMINIUM/ PURE METAL • atoms/ions/ particles all the same size (1) • {atoms/ions/layers/sheets/rows} {slide/slip/move} over each other easily (1) ALLOY • added atoms are different size/ {atoms/ions} in an alloy have different sizes (1) • layers disrupted and cannot easily slide over each other (1)	marks can be obtained from **labels** on diagrams <u>that equate to the marking points</u> **Ignore** different shape	(3)

Question Number	Answer	Mark
8(b)	An answer that combines three of the following points of application of knowledge and understanding to provide a logical description • add some ammonia solution/ hydrochloric acid (to a beaker/flask) (1) • add an indicator (1) • add the other reagent until the indicator just changes colour (1) • repeat using same volumes but without indicator (to obtain pure solution) (1)	(3)

Question Number	Answer	Mark
8(d)	• 17.73/24.60 (0.7207) (1) • (17.73/24.60) x 100 (72.07) (1) • = 72.1% (1)	(3)

Question Number	Answer	Mark
9(a)(ii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) • to react all the (nitric) acid in the solution (1) • so that the calcium nitrate solution is pure (1)	(2)

Question Number	Answer	Mark
9(a)(iii)	$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$ (3) left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)	(3)

Question Number	Answer	Mark
10(c)(i)	chlorine (1)	(1)

Question Number	Answer	Mark
10(c)(ii)	A description to include • lighted splint / ignite gas (1) • gas burns / (squeaky) pop (if air is present) (1)	(2)

Question Number	Answer	Mark
10(d)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark): • sodium and chloride ions present (1) • these ions can move (in solution) (1)	(2)

Separate Science: Chemistry Paper 2

8 (a) Sodium has an atomic number of 11.

Which line in the table shows the correct numbers of protons, neutrons and electrons in a positively charged sodium ion, Na^+?

(1)

	number of		
	protons	**neutrons**	**electrons**
☒ **A**	10	12	11
☒ **B**	10	11	10
☒ **C**	11	10	11
☒ **D**	11	12	10

(b) Fluorine has an electronic configuration 2.7.

Fluorine gas exists as diatomic molecules.
In each molecule of fluorine, the two fluorine atoms are joined by a covalent bond.

Draw a dot and cross diagram to show the electrons in a molecule of fluorine, F_2.

Show outer electrons only.

(2)

(c) Sodium reacts with fluorine to form sodium fluoride, NaF.

Complete the balanced equation for this reaction.

(2)

2Na + ... → .....NaF

(d) Sodium fluoride is an ionic compound.

(i) Describe how a sodium atom and a fluorine atom interact to form a sodium ion, Na^+, and a fluoride ion, F^-.

(2)

(ii) Explain why sodium fluoride is able to conduct electricity when it is molten but not when it is solid.

(2)

9 (a) A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.

The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.

The graph in Figure 10 shows the results obtained by the student.

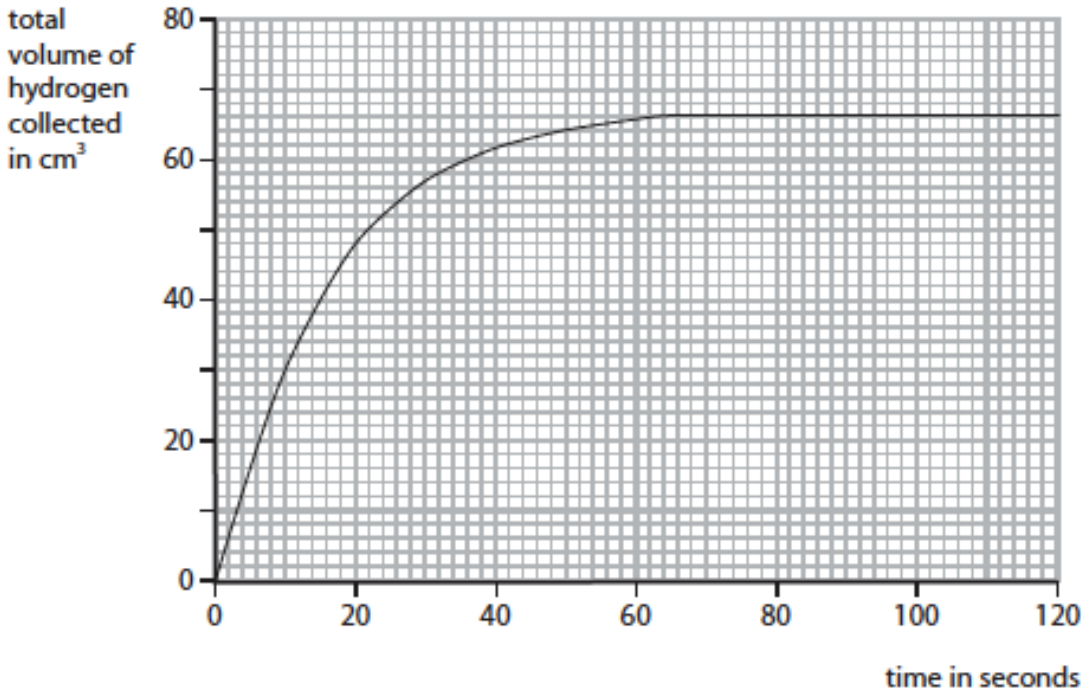


Figure 10

(i) Using the graph, give the time in seconds at which the reaction stopped.

(1)

..... s

(ii) Give the reason why the reaction stopped.

(1)

.....

.....

(iii) Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second.

(2)

.....

.....

.....

average rate of reaction = ... $cm^3 s^{-1}$

(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same.
This change caused the reaction to take place more quickly.

On the graph in Figure 10, sketch a line to show the results you would expect in this experiment.

(2)

(v) The rate of the reaction can be changed by adding a solid catalyst to the reaction mixture.

Which line in the table shows how the final volume of hydrogen produced and the mass of the catalyst change?

(1)

	change in final volume of hydrogen	change in mass of catalyst
☒ **A**	increases	no change
☒ **B**	no change	decreases
☒ **C**	no change	no change
☒ **D**	increases	decreases

10 Sodium sulfate is tested to show the ions present in it.

(a) (i) Describe how to carry out a flame test on solid sodium sulfate.

(3)

(ii) State what colour would be seen in the flame.

(1)

(b) The sodium sulfate is dissolved in water to make a solution.

Describe how to show that sulfate ions are present in this solution.

(3)

(c) An experiment is carried out to find the concentration of sodium sulfate in another sodium sulfate solution.

The method used is

determine the mass of an empty evaporating basin

place 50 cm^3 of the solution in the evaporating basin

evaporate the water from the solution to leave just the solid

determine the mass of the evaporating basin containing dry, solid sodium sulfate.

The results are

mass of evaporating basin = 111.23 g

mass of evaporating basin + solid sodium sulfate = 114.78 g

Calculate the concentration of the sodium sulfate solution in g dm^{-3}.

(4)

.....

.....

.....

.....

.....

.....

concentration ..... g dm^{-3}

Separate Science: Chemistry Paper 2 mark scheme

Question number	Answer	Mark
8(a)	D 11, 12, 10	(1)

Question number	Answer	Additional guidance	Mark
8(b)	• {1 pair of/two} electrons shared between two fluorine atoms (1) • rest of structure correct (1)	ignore inner shells	(2)

Question number	Answer	Additional guidance	Mark
8(c)	2 Na + F_2 → 2 NaF (2) F_2 (1) 2 (1)		(2)

Question number	Answer	Mark
8(d)(i)	An answer that provides a description by making reference to: • one electron (transferred) (1) • transferred from sodium to fluorine (1)	(2)

Question number	Answer	Mark
8(d)(ii)	An explanation that combines identification - understanding (1 mark) and reasoning/justification - understanding (1 mark): • (both solid and molten) contained charged particles/ions (1) • (ions) free to move in molten but not in solid (1)	(2)

Question number	Answer	Mark
9(a)(i)	value in the range 64 - 66 (s)	(1)

Question number	Answer	Mark
9(a)(ii)	all magnesium is used up	(1)

Question number	Answer	Additional guidance	Mark
9(a)(iii)	volume of hydrogen = 48 (1) rate = $\frac{48}{20}$ (1) = 2.4 ($cm^3\ s^{-1}$)	2.4 only (2) incorrect volume/20 1 mark only	(2)

Question number	Answer	Mark
9(a)(iv)	curved line to the left of curve (1) same final volume (which is the maximum volume) (1)	(2)

Question number	Answer	Mark
9(a)(v)	C no change, no change	(1)

Question number	Answer	Mark
10(a)(i)	An answer that provides a description by making reference to: • dip clean wire into hydrochloric acid (1) • dip wire into solid (1) • put wire in a {roaring/blue/non-luminous} flame (1)	(3)

Question number	Answer	Additional guidance	Mark
10(a)(ii)	yellow		(1)

Question number	Answer	Additional guidance	Mark
10(b)	An answer that provides a description by making reference to: • add (dilute) hydrochloric acid (1) • add barium chloride solution (1) • white precipitate forms (1)	3rd marking point consequential on 2nd marking point	(3)

Question number	Answer	Additional guidance	Mark
10(c)	114.78 - 111.23 (1) = 3.55 50 cm^3 solution contain = 3.55g sodium sulfate(1) 1000 cm^3 solution contains = $\frac{3.55 \times 1000\ g}{50}$ (1) concentration = 71 g dm^{-3} (1)	allow full marks for correct answer with no working	(4)

Separate Science: Physics

Separate Science: Physics Paper 1

6 (a) What is the approximate size of a hydrogen atom?

(1)

- ☐ **A** 10^{-3} m
- ☐ **B** 10^{-10} m
- ☐ **C** 10^{-19} m
- ☐ **D** 10^{-31} m

(b) Figure 7 is a diagram of three atoms.

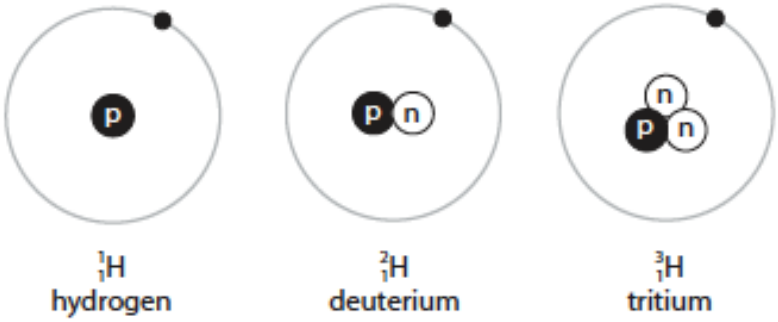


Figure 7

Give reasons why these atoms are isotopes.

(2)

.....

.....

.....

.....

(c) Some isotopes are unstable.
They emit β^- particles when they decay.

Explain how a nucleus changes when a β^- particle is emitted.

(2)

(d) Other unstable isotopes emit alpha particles.

Which of these describes an alpha particle?

(1)

- ☐ **A** a hydrogen nucleus
- ☐ **B** a hydrogen atom
- ☐ **C** a helium nucleus
- ☐ **D** a helium atom

7 (b) A student looks through a blue filter at a green leaf on a white background.

Describe the colours that the student sees.

(2)

(c) Figure 9 shows an image taken at night using a camera that is sensitive to infrared radiation.

Figure 9

Radiation with shorter wavelengths shows as brighter areas in this image.

Explain why the people can be seen against the background in this image.

(2)

.....

.....

.....

.....

(d) A student investigates how light is reflected from a plane mirror.

Figure 10 shows part of the student's investigation.

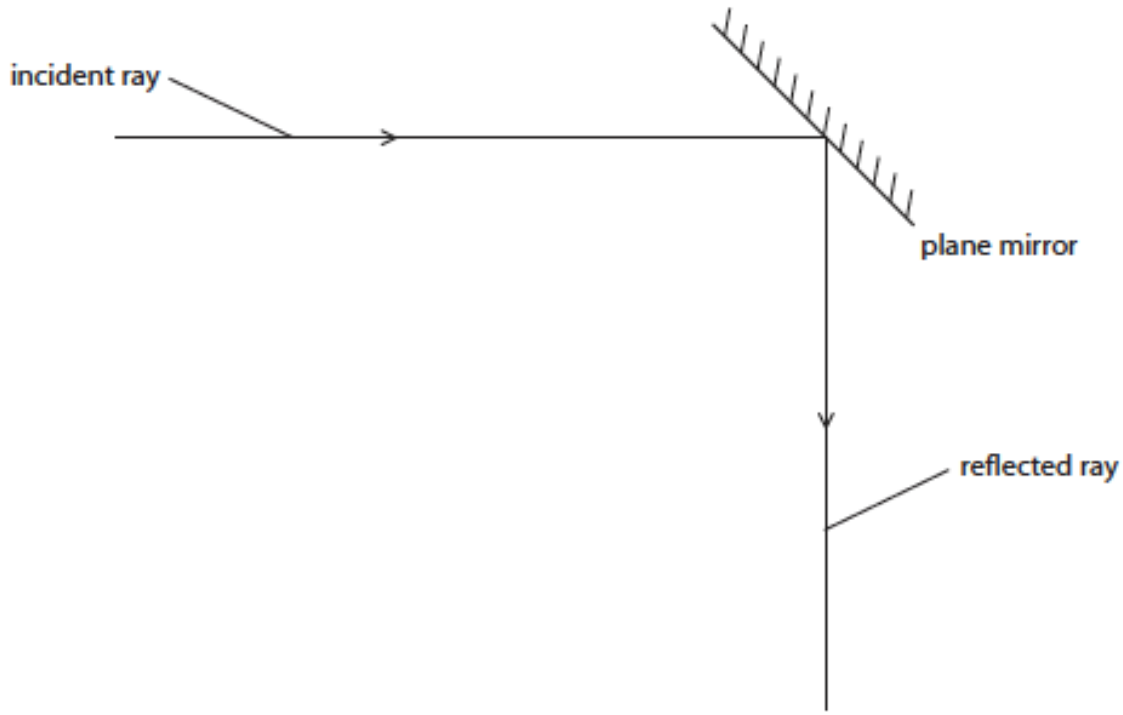


Figure 10

(i) Complete the diagram to show

- the normal
- the angle of incidence (*i*) and the angle of reflection (*r*).

(2)

(ii) Figure 11 shows a ray of light travelling through a 45° glass prism.

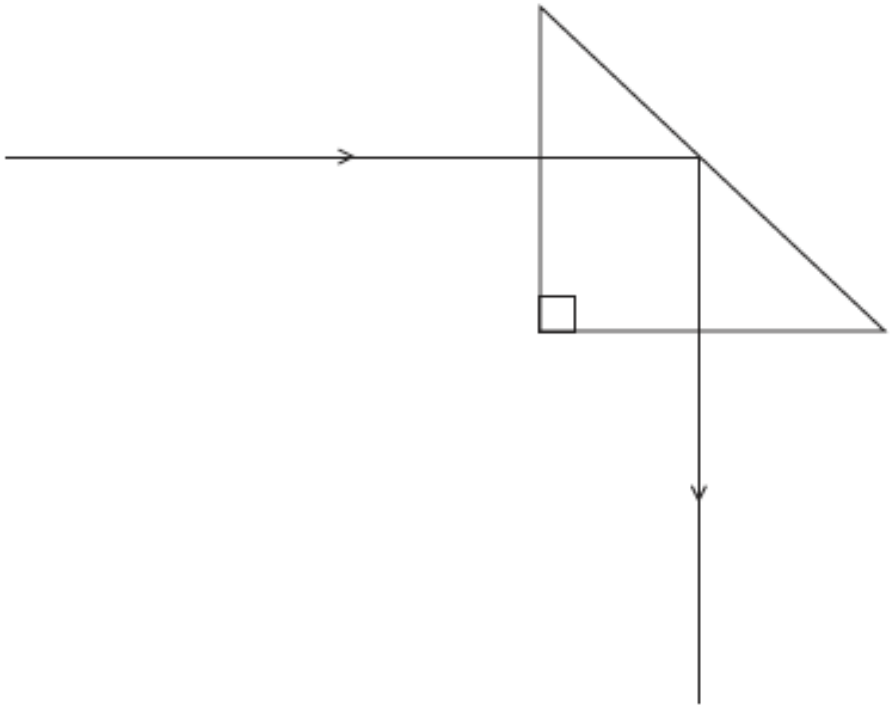


Figure 11

State what can be deduced from this diagram about the value of the critical angle for glass.

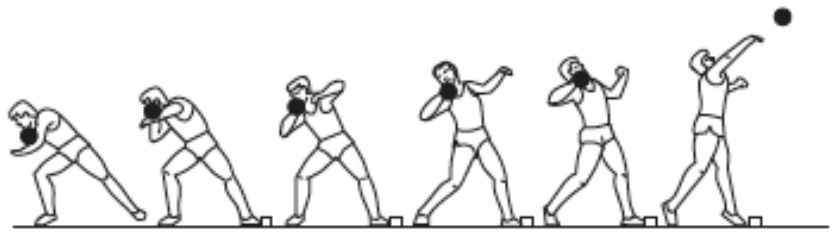
(1)

.....

.....

(b) The scientist takes pictures of the athlete every 0.1 s during one throw.

Figure 13 shows the pictures of one throw.



start of throw (shot at rest)

just after the release of the shot

Figure 13

(i) Estimate the amount of time during the throw when the shot is in the athlete's hand.

(1)

time = ... s

(ii) Explain how the scientist could improve this method of analysing the throw.

(2)

.....

.....

.....

.....

.....

(iii) The average acceleration of the shot while in the athlete's hand is 20.6 m/s^2.
The mass of the shot is 7.26 kg.

Calculate the average force that the athlete applies to the shot during the throw.

(2)

force = ... N

(iv) In another throw, the shot is in the athlete's hand for 0.48 s.
The average acceleration during this time is 23 m/s^2.

Calculate the velocity of the shot as it leaves the athlete's hand.

(3)

velocity = ... m/s

(c) In one throw, the shot continues to rise by another 1.3 m after it leaves the athlete's hand.
The mass of the shot is 7.26 kg.

(i) Calculate the amount of gravitational potential energy gained by the shot.

(2)

gravitational potential energy gained = ... J

9 (a) Which of the following particles is absorbed and emitted during a nuclear fission reaction?

(1)

- ☒ **A** electron
- ☒ **B** neutron
- ☒ **C** positron
- ☒ **D** proton

(b) Explain the use of a moderator in a nuclear reactor.

(3)

Separate Science: Physics Paper 1 mark scheme

Question number	Answer	Mark
6(a)	B 10^{-10} m	(1)

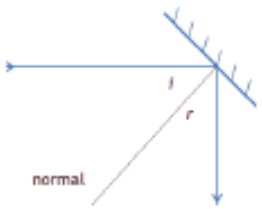
Question number	Answer	Mark
6(b)	one from • same atomic number (1) • same number of protons (1) • same element (1) and one from • different numbers of neutrons (1) • different mass numbers (1)	(2)

Question number	Answer	Additional guidance	Mark
6(c)	An explanation that combines understanding (1 mark) and reasoning (1 mark) linking: • number of neutrons decreases by one (1) • number of protons increases by one.(1)	a neutron becomes a proton plus an electron for (2) marks	(2)

Question number	Answer	Mark
6(d)	C a helium nucleus	(1)

Question number	Answer	Mark
7(b)	An answer that provides a description by making reference to: leaf appears black (1) background appears blue (1)	(2)

Question number	Answer	Additional guidance	Mark
7(c)	An explanation that combines application of knowledge (1 mark) and reasoning (1 mark) linking: (faces of) people are at a higher temperature than the background (1) therefore they emit more (infrared) at shorter wavelengths than background (1)	accept higher frequency / higher intensity	**(2)**

Question number	Answer	Additional guidance	Mark
7(d) (i)	normal drawn correctly (1) angles of incidence and reflection shown correctly (1)		**(2)**

Question number	Answer	Additional guidance	Mark
7(d) (ii)	The critical angle must be less than 45° (1)		**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	0.45 (s) (1)	Allow any value ≥ 0.4 and ≤ 0.5	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation that combines improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark) • take pictures more frequently (1) • in order to determine exact time of the release. (1)	other responses may be acceptable	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	Substitution (1) F = 7.26 x 20.6 Evaluation (1) 150 (N)	 Accept 149.6 (N) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
8(b)(iv)	Rearrangement (1) v = a x t Substitution (1) v = 23 x 0.48 Evaluation (1) 11 (m/s)	 Accept 11.04(m/s) full marks will be awarded for correct numerical answer without working	(3)

Question number	Answer	Additional guidance	Mark
8(c)(i)	Substitution (1) PE = 7.26 x 10 x 1.3 Answer (1) 94.4 (J)		(2)

Question number	Answer	Mark
9(a)	B neutron	(1)

Question number	Answer	Additional guidance	Mark
9(b)	An explanation that combines understanding (1 mark) and reasoning/justification - understanding (2 marks): • slows down neutrons (1) • increase chance of collision / fission (1) • maintain the reaction rate (1)	 to allow capture by nucleus increase the reaction rate	**(3)**

Separate Science Physics: Paper 2

8 (a) Some forces act at a distance.

One example is the gravitational attraction between the Moon and the Earth.

Describe an example of another type of force acting at a distance, where the force is **not** gravitational.

(2)

.....

.....

.....

.....

(b) A rock falls off the top of a cliff of height *h*.

Figure 13 shows the rock falling.

The Earth exerts a force of 150 N on the rock.

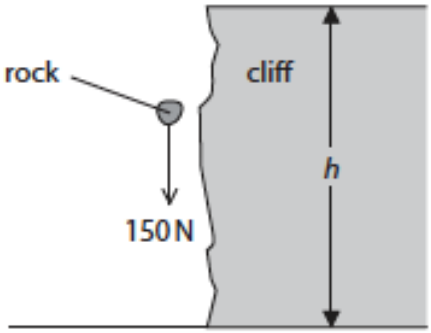


Figure 13

The work done by this force when the rock falls from the top to the bottom of the cliff is 2700 J.

(i) Calculate the height, *h*, of the cliff.

(2)

h = ... m

(ii) State the value of the kinetic energy of the rock just before it hits the ground.

(1)

kinetic energy = ... J

(iii) The mass of the rock in Figure 13 is 15 kg.

Calculate the velocity of the rock just before it reaches the bottom of the cliff.

(2)

velocity = ... m/s

(c) An electric motor is used to lift a box.

Figure 14 shows how the efficiency of the electric motor changes as the mass of the box increases.

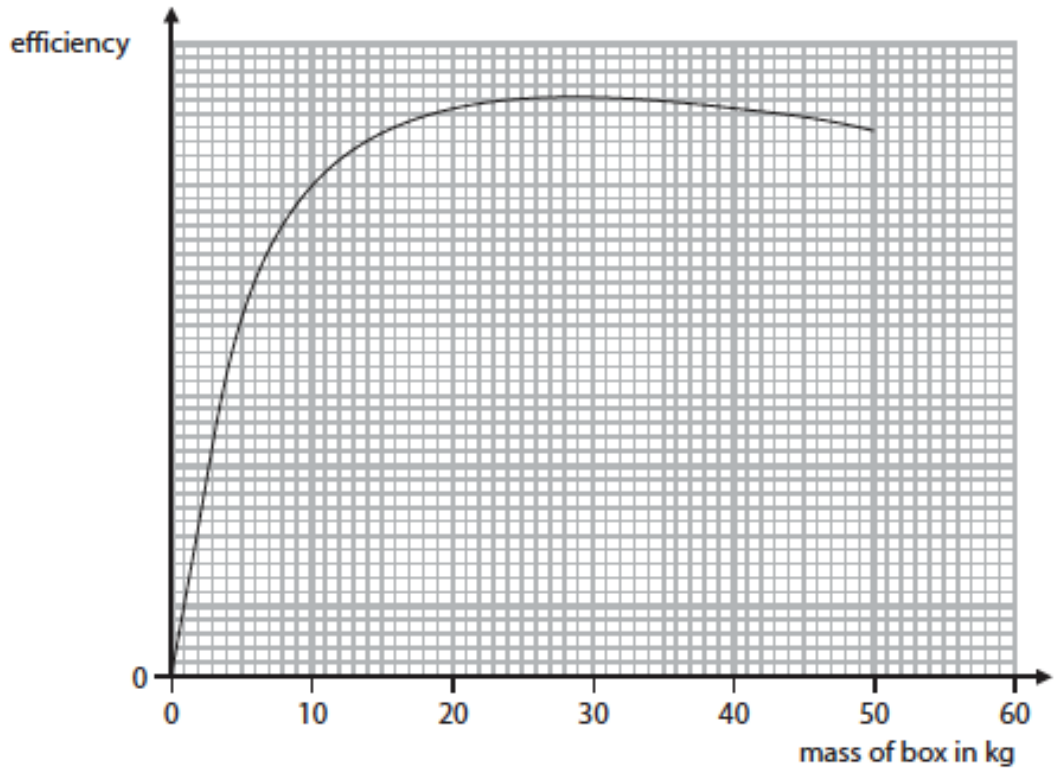


Figure 14

Describe how the efficiency of the electric motor depends on the mass of the box lifted.

(2)

9 (a) An electric heater is connected to a 230V supply.

The power supplied to the heater is 2.6 kW.

Calculate the current in the heater.

(3)

current = ... A

(b) A car headlamp has a power rating of 55 W when the current in the headlamp is 4.4 A.

(i) State the equation relating power, current and resistance.

(1)

(ii) Calculate the resistance of the headlamp.

(3)

resistance = ... Ω

10 (a) Figure 15 shows a metal chair being sprayed with paint.

The paint droplets come from a gun with an electric charge.

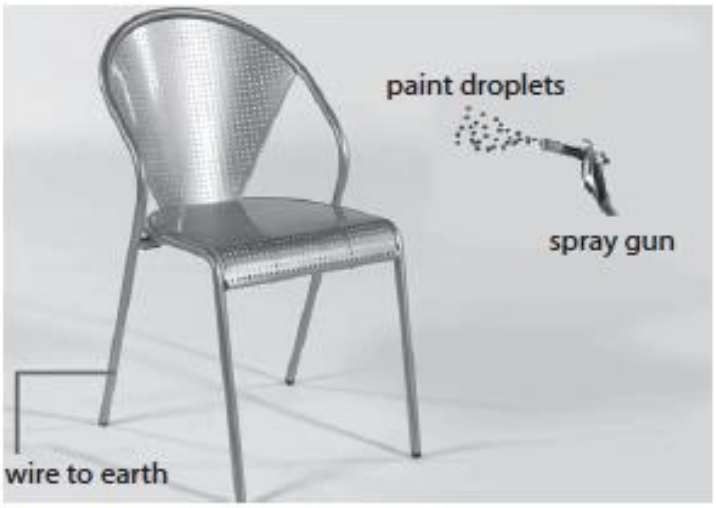


Figure 15

Inside the spray gun, electrons move along a charged wire towards the nozzle to charge the paint.

The charged paint droplets are sprayed from the nozzle.

The chair is connected to earth.

Which row of the table shows the correct combination of the charges as the charged paint droplets get near to the chair?

(1)

		paint droplets	chair
☒	**A**	negative	negative
☒	**B**	negative	positive
☒	**C**	positive	negative
☒	**D**	positive	positive

(b) Glass is an insulator.

A student rubs a piece of glass with some silk.

The glass becomes positively charged.

(i) Explain how rubbing silk charges the glass.

(2)

(ii) The silk is also charged when it rubs against the glass.

Describe the charge on the silk.

(2)

(c) (i) Describe **one** situation where separation of electric charge can create a spark.

(2)

(ii) In a spark, the total charge of 0.22 μC (microcoulombs) flows in 2 ms (milliseconds).

Calculate the average current in that time.

(4)

average current = ... A

Separate Science Physics: Paper 2 mark scheme

Question number	Answer	Additional guidance	Mark
8 (a)	An answer that combines the following points of understanding to provide a logical description: named force (acting at a distance) (1) situation (1)	 e.g. magnetic force between two (magnetic) poles	(2)

Question number	Answer	Additional guidance	Mark
8 (b)(i)	rearrangement of work = force × distance (1) d = W ÷ F substitution and evaluation (1) 18 (m)	 d = 2700 ÷ 150 Award full marks for correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
8 (b)(ii)	2700 (J)		(1)

Question number	Answer	Additional guidance	Mark
8 (b)(iii)	rearrangement of KE = ½ mv^2 (1) v = √(2 × KE ÷ m) substitution and evaluation (1) 19 (m/s)	 v = √(2 × 2700 ÷ 15) v^2 = (2 × 2700 ÷ 15) allow answers that round to 19 award full marks for correct answer without working allow alternative route using v^2 - u^2 = 2ax for full marks	(2)

Question number	Answer	Additional guidance	Mark
8 (c)	An answer that combines points of interpretation/evaluation to provide a logical description: efficiency increases (at first) (1) to maximum efficiency (for mass of about 25 kg) (1)	 e.g. decreases for larger masses	(2)

Question number	Answer	Additional guidance	Mark
9(a)	substitution into P = V × I (1) 2600 = 230 × I rearrangement (1) I = P ÷ V evaluation (1) 11 (A)	Substitution and re-arrangement in either order I = 2600 ÷ 230 for 2 marks allow answers that round to 11 award full marks for correct answer without working allow I = 2.6 ÷ 230 for 1 mark allow 0.011 (A) for 2 marks max if no other marks scored, award 1 mark for 2.6 kW = 2600 W	(3)

Question number	Answer	Mark
9(b)(i)	either power = (current)^2 × resistance or P = I^2 × R	(1)

Question number	Answer	Additional guidance	Mark
9(b)(ii)	substitution into $P = I^2 \times R$ (1) $55 = 4.4^2 \times R$ rearrangement (1) $R = P \div I^2$ evaluation (1) 2.8 (Ω)	Substitution and re-arrangement in either order $R = 55 \div 4.4^2$ for 2 marks allow answers that round to 2.8 award full marks for correct answer without working allow alternative route $V = P \div I = 55 \div 4.4$ then $R = V \div I = 12.5 \div 4.4$	(3)

Question number	Answer	Mark
10 (a)	B negative | positive	(1)

Question number	Answer	Additional guidance	Mark
10 (b)(i)	An explanation that combines identification - understanding (1 mark) and reasoning - understanding (1 mark): charges move (1) because of friction (1)	 (negative) electrons transfer glass loses electrons	(2)

Question number	Answer	Mark
10 (b)(ii)	An explanation that combines identification understanding (1 mark) and reasoning - understanding (1 mark): (negative) electrons are rubbed off the glass (on to the silk) (1) giving the silk a negative charge (1)	(2)

Question number	Answer	Additional guidance	Mark
10 (c)(i)	An answer that combines the following points of understanding to provide a logical description: the situation which caused the charge separation (1) where the spark travelled {from/to} (1)	examples when refuelling, spark between end of {fuel/pipe} and vehicle =2 spark {between/from /to} person comb/clothes/metal handle and, when combing hair/removing clothing/opening door = 2 lightning flash, between cloud and cloud/plane/ground, =2 ignore between plug and socket/jump leads	(2)

Question number	Answer	Additional guidance	Mark
10(c)(ii)	unit conversion (1) $0.22\ \mu C = 0.22 \times 10^{-6}$ C and $2\ ms = 2 \times 10^{-3}$ s substitution (1) 0.22×10^{-6} = current $\times$ 2×10^{-3} s rearrangement (1) current = $0.22 \times 10^{-6} / 2 \times 10^{-3}$ evaluation (1) 1.1×10^{-4} (A)	Substitution and re-arrangement in either order both needed ecf award full marks for correct answer without working power of ten error only loses one mark, if the rest is correct	(4)