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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

J249/01 Summer 2019 series

Version 1

Contents

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. 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 can be downloaded from OCR.

Paper 1 series overview

The number of candidates taking this component in 2019 had increased compared to 2018. The accessibility principles described in Exploring our question papers continue to be applied, particularly to questions in Section B. The final two questions in the component (Q22 and Q23) are overlap questions with the higher tier component J249/03. Although these questions targeted higher achieving candidates most candidates were credited with some marks including for attempting the calculation at the very end of the examination.

	**OCR support**	The Exploring our question papers, assessment guide explore our assessment approach and provides an outline and explanation of our accessibility principles. https://www.ocr.org.uk/Images/462559-exploring-our-question-papers-gateway-science.pdf

Section A overview

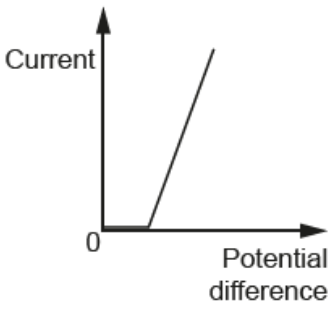
Very few of these multiple choice questions were left blank. Comments follow on five of the fifteen questions where there are points which could be of use to Centres.

Question 4

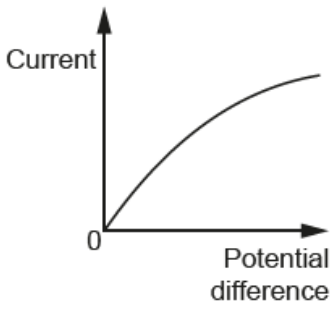
4 A student investigates how current and potential difference vary in different components.

Look at the graphs of her results.

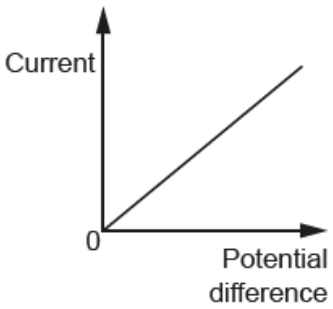
A



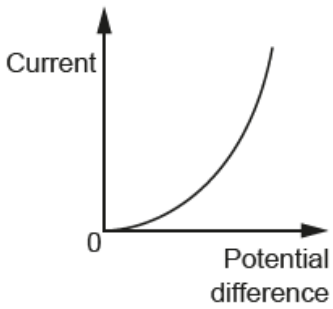
B



C



D



Which graph shows a filament lamp?

Your answer ☐ **[1]**

Candidates clearly recalled that the current-voltage graph for a filament lamp was non-linear and they then had to choose between options B and D. Option D, the graph for a thermistor, was chosen by many. Option C is the correct answer as the increased current heats the lamp filament, a hotter filament has an increased resistance and therefore a smaller current is observed than might be expected.

Question 6

6 Different states of matter have different densities.

Which of the following shows the states of matter in density order, starting with the lowest density?

A Solid – liquid – gas

B Solid – gas – liquid

C Gas – liquid – solid

D Liquid – gas – solid

Your answer ☐ **[1]**

Candidates knew the order in which the states needed to be put. Option C is the correct answer. Option D was a common misunderstanding where candidates had not placed the states of matter '…in density order, starting with the lowest density.'

Question 7

7 What conditions are needed for charge to flow?

A A source of potential difference and two lamps.

B A complete circuit and two lamps.

C A complete circuit and a source of potential difference.

D A complete circuit and a source of resistance.

Your answer ☐ **[1]**

The term 'source' was not clearly understood by some candidates. In this context a 'source of potential difference' is 'something which will give a voltage that pushes the flow of charge around the circuit.'

Question 12

12 A car travels at 72 km/h.

How fast is this in metres per second (m/s)?

A 1.2 m/s

B 20 m/s

C 120 m/s

D 1200 m/s

Your answer ☐ **[1]**

This involves two different unit conversions, km to m and h to s. Many successful candidates used the space to set out step-by-step intermediate calculations..

Question 15

15 Which one of the following uses of forces causes a rotation?

A Lowering a book vertically from a shelf

B Opening a door

C Lifting a book vertically onto a shelf

D Sitting in the centre of a see-saw

Your answer ☐ **[1]**

Option B was the correct answer. Option D was a common misconception, probably because the phrase 'see-saw' suggested rotation to many candidates.

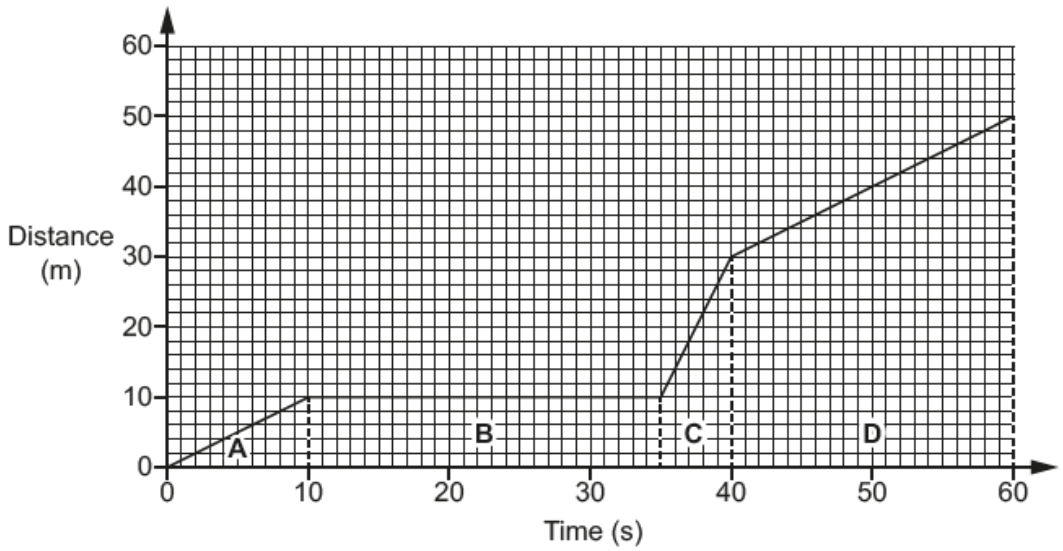
	**AfL**	Rather than focus on a single word like 'see-saw' in the stem of a question, it can be helpful for candidates to try and visualise each of the operations described. At the pivot a see-saw does not move. The book is moving down in A and up in C. However the door is rotating on its hinges.

Section B

Question 16 (a) (i), (ii) and (iii)

16 A student investigates motion graphs.

(a) Look at a distance-time graph for the movement of a dog in a park.



(i) How far did the dog move in the park?

Distance = ... m **[1]**

(ii) How long was the dog in the park?

Time = ... s **[1]**

(iii) Name a piece of apparatus the student could use to accurately measure the distance the dog moved.

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

16(a) was a gentle introduction to the structured questions in Section B and almost all candidates were awarded all three marks.

Question 16 (b) (i) and (ii)

(b) The distance-time graph has four sections: **A**, **B**, **C** and **D**.

(i) Which section of the graph shows the **greatest** speed?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

Explain your answer.

.....

.....

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

(ii) Which section of the graph shows **zero** speed?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

Explain your answer.

.....

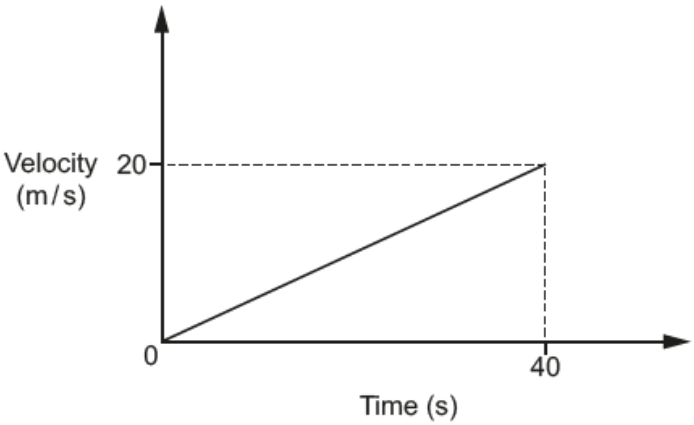
.....

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

16(b) provided the first questions where more than one mark was available, and this helped a number who could identify the important factor but had selected the wrong option A – D. In (i) a number calculated all four speeds (including 0) in order to identify C. Most candidates appreciated that it was the section with the highest gradient/steepness which they needed to identify.

Question 16 (c)

(c) The student draws a velocity-time graph for a boat accelerating.



Acceleration is the gradient of a velocity-time graph.

Calculate the acceleration of the boat.

Use the equation: acceleration = change in velocity ÷ time

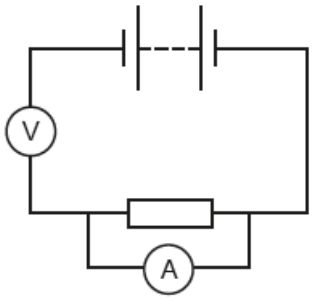
Acceleration = ... m/s^2 **[2]**

The equation for acceleration was given and it required no rearrangement. Most candidates were credited with both marks here.

Question 17 (a) (i)

17 A student sets up a circuit to find out the resistance of an unknown resistor. The student makes **three** mistakes in their circuit.

Look at the circuit diagram of their experiment.



(a) (i) Write down the **three** mistakes the student makes.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

Many candidates had problems with this circuit that were not relevant to the question. Some expected to see components (such as a filament bulb) which did not feature and others were unfamiliar with the symbol for a battery (two or more cells in series/two cells joined by a dotted line).

Exemplar 1 shows a candidate who identified the problems with the battery and the voltmeter and ammeter. Although the candidate has stated two separate points were on the same line for the third mistake, as what the candidate wrote made it clear exactly what they intended the second identified mistake was allowed by the examiner to gain full marks.

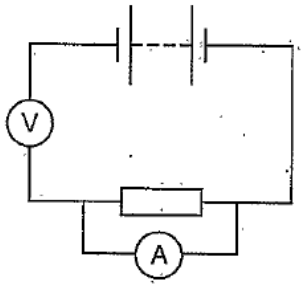
Exemplar 2 is typical of many candidate responses seen by examiners and gained no marks.

?	**Misconception**	Remember it is the apparatus and techniques in Topic P9 (Practical skills) that candidates are examined on not the specific practical activity that they experienced in their science classroom.

Exemplar 1

17 A student sets up a circuit to find out the resistance of an unknown resistor. The student makes **three** mistakes in their circuit.

Look at the circuit diagram of their experiment.



(a) (i) Write down the **three** mistakes the student makes.

1 The batteries are placed wrong the second one should be flipped.

2 The resistor is in the wrong place.

3 The ampeter and the voltmeter should be swapped.

[3]

Exemplar 2

1 they have used [redacted] two battenys

2 they haven't used any [redacted] bulbs

3

[3]

Question 17 (a) (ii)

(ii) For **one** of the mistakes identified in **(a)(i)** describe how the student can fix the error.

.....

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

Many candidates who had gained some marks in 17(a)(i) also answered this question successfully. Typical responses that were given the mark included 'turn one of the two batteries round' or 'swap the voltmeter and ammeter over'.

Question 17 (b)

(b) The student finds that the current is 20 mA when the potential difference is 4.0 V.

Calculate the **resistance** of the unknown resistor.

Include the **unit** for resistance in your answer.

Use the equation: resistance = potential difference ÷ current.

Resistance = ... Unit = ... **[4]**

In this question the unit mark was free-standing and so any valid unit combination was allowed. Both 0.20 kΩ and 0.2 mA/V are examples of responses which gained 4/4.

Because of the application of error-carried-forward, candidates losing the first mark by not converting mA to A did not lose subsequent marks, so for example 0.2 Ω with suitable workings could gain three of the four marks.

Question 17 (c)

(c) Calculate the **charge** that flows when a current of 2.5 A flows for 30 seconds.

Charge = ... C **[3]**

Although the concept of electrical charge is difficult for many GCSE candidates, and they were required to recall the equation the majority of candidates were credited with full marks here.

Question 18 (a)

18 A student has a spring, a ruler and a 2.0 N weight.

(a) Describe how the student can use this equipment to determine the **spring constant** of the spring.

.....

.....

.....

.....

.....

..... **[3]**

Only a few candidates stated how the spring constant should be calculated by referring to *spring constant = force exerted by the spring ÷ extension*. However as the mark scheme allowed for any of the four marking points to count towards the total many candidates gained all 3 marks without reference to the spring constant equation.

Exemplar 3 was a typical response and gained two marks. This candidate did realise a calculation was needed but decided it should be $E = ½ k x^2$. This energy equation (which was on the data sheet) was given in more candidate answers than the expected *force = extension x spring constant*.

Exemplar 3

18 A student has a spring, a ruler and a 2.0 N weight.

(a) Describe how the student can use this equipment to determine the **spring constant** of the spring.

the student can attach the spring to a stand and a clip, then put the weight on the end of the spring, measuring how far it extends. Then use the equation energy transfered in stretching = 0.5 × spring constant × (extension)² **[3]**

Question 18 (b)

(b) The 2.0 N weight has a surface area of 0.005 m^2.

Calculate the **pressure** when it is placed on a surface.

Use the equation: pressure = force normal to a surface ÷ area of that surface

Pressure = ... Pa **[2]**

Relatively few candidates had problems with dividing by 0.005.

Question 18 (c)

(c) Describe how to change the shape of an object.

Use the idea of forces in your answer.

.....

.....

.....

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

The key factors which were needed here were that more than once force is necessary, and that those forces must act in different directions. The 'multiple forces' idea was accepted to be implied by the use of some verbs, for example squash, twist, squeeze and crush. The 'opposite directions' mark could be gained by setting up a situation where the opposition was obvious, for example by. putting the object on a table and pushing down from above.

Question 18 (d)

(d) Describe the differences between elastic and plastic deformation.

.....

.....

.....

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

Around half of all candidates described plastic deformation and this almost always led on to a description of elastic deformation, or vice versa (a description elastic deformation leading into plastic deformation). Very few candidates only described one form of deformation.

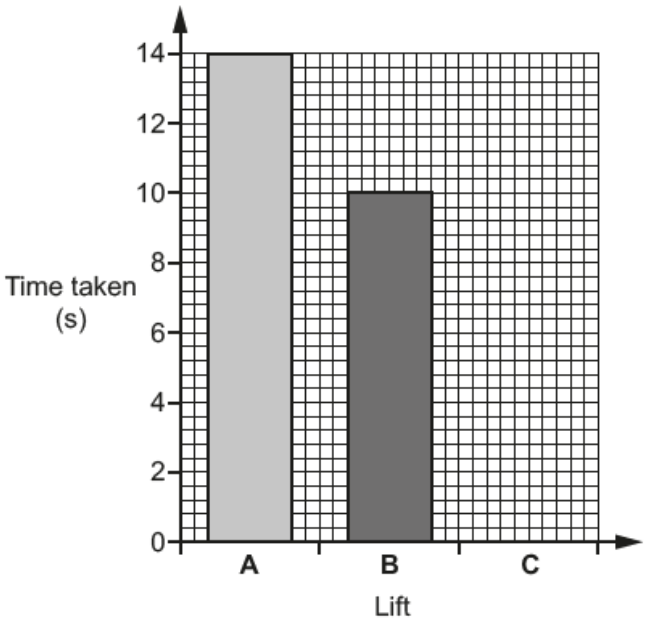
Question 19 (a) (i) and (ii)

19 A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(a) (i) Lift **C** takes 12 s to move between the two floors.

Draw a bar for lift **C** on the bar chart. **[1]**

(ii) Calculate the **mean** time of the three lift journeys.

Mean = ... s **[2]**

Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.

Question 19 (a) (iii)

(iii) Explain which lift uses the most power.

.....

.....

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

Many candidates identified lift B uses the most power correctly but did not provide an explanation of why it use the most power for the second mark. Some candidates clearly thought the highest bar in the bar chart indicated a greater height reached by the lift and so chose lift A.

Question 19 (b) (i)

(b) (i) One lift uses 50 000 J for a 12 s journey.

Calculate the power of the lift.

Give your answer to **1** decimal place.

Power = ... W **[4]**

(ii) When the lift is broken the stairs are used.

Calculate the work done when a 750 N person climbs a distance of 4 m.

Work done = ... J **[3]**

Part (i): required candidates to round their answer to one decimal place. Many candidates did the calculation well and gained 4/4, or 3/4 with incorrect rounding. Any calculation error in finding the power of the lift could still earn the candidate the last mark if their result was rounded correctly.

Part (ii) was done correctly by the majority of candidates. The stem of the question contained some data that they did not need to complete the calculation, which made this a more challenging task than it may appear to be.

Question 20 (a)

20 (a) Draw the magnetic field pattern between the North and South poles of the magnets.

Include arrows on your field lines.

[3]

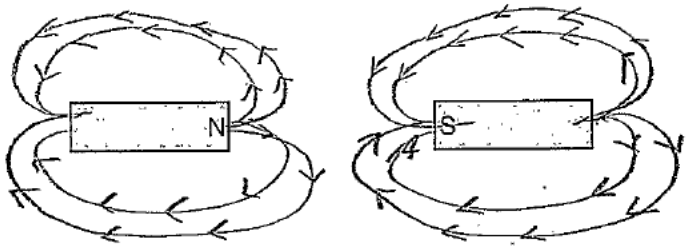
The question required candidates to sketch of the magnetic field 'between the North and South poles' and this was emphasised in the diagram by only labelling a single N and S. The three marks were given for: symmetrical(ish) convex cured lines joining the top and bottom of the adjacent poles, a straight line from the centre of the N to the centre of the S, and arrows on the lines going from N to S.

?	**Misconception**	A common misconception is for candidates to see one familiar thing in the stem of a question and assume that is what they are being asked to do. A number of candidates drew the 'standard' magnetic field around a bar magnet. Exemplar 4 is a response where the candidate has not understood the question. However, because they drew the field directions correctly they gained a consolation mark.

Exemplar 4

20 (a) Draw the magnetic field pattern between the North and South poles of the magnets.

Include arrows on your field lines.



[3]

Question 20 (b)

(b) Describe **one difference** between a permanent magnet and an induced magnet.

.....

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

Around half the candidates correctly identified that induced magnetism was temporary. A common misconception was to explain induced magnetism in terms of electromagnets.

Question 20 (c)

(c) A student investigates solenoids and writes the following:

Solenoids

Solenoids are coils of wire.

When a voltage flows through them a magnetic field is created.

The magnetic field can be increased by decreasing the number of turns or by increasing the current.

The student makes **two** mistakes.

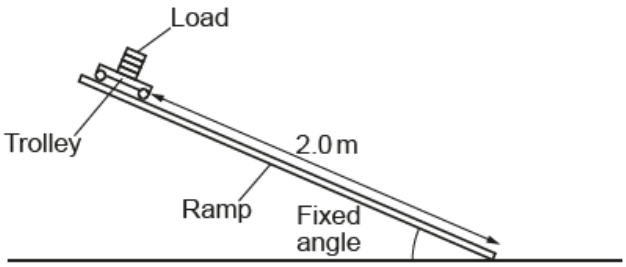
Put a (ring) around the **two** mistakes in the above box. **[2]**

Most candidates identified one error (for example voltage or decreasing), and some two. A number tried to ring entire sentences without identifying the individual errors in the sentences. This approach was an allowed approach for the second sentence (where the two errors are unambiguous), but not for the third sentence where if one statement is correct the other will be incorrect. The magnetic field will only increase if the number of turns increases, or if the number of turns is decreased then the magnetic field will decrease.

Question 21 (a)

21 A student investigates the average speed at which a trolley with different loads travels down a ramp.

Look at the diagram of her experiment.



She releases the trolley from a distance of 2.0 m from the bottom of the ramp.

The student uses a stop-clock to measure the time it takes to reach the bottom of the ramp.

She calculates the average speed. Look at her results.

Load (N)	Time taken (s)	Average speed (m/s)
20	2.3	0.87
40	2.4	0.83
60	2.3	0.87
80	2.4	0.83

(a)* Describe the trend shown by the results, identify problems with the experiment and describe any improvements that you would make to the experiment.

.....

.....

.....

..... **[6]**

Because there was no systematic pattern in the data this was a demanding level of response question for a foundation tier candidates.

Exemplar 5 is a candidate who scored Level 3, 6 marks for clearly identifying the absence of a trend and suggesting improvement to the experiment.

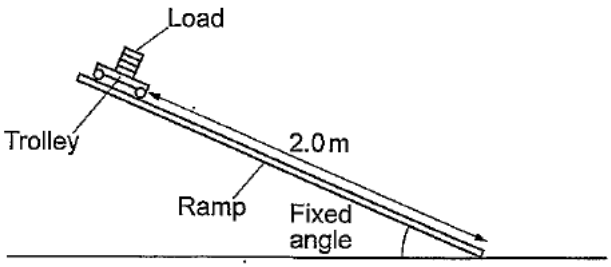
Exemplar 6 is a Level 2 response, gaining 4 marks as the candidate has identified that the times and speeds are essentially similar and suggested improvements to the procedure.

Exemplar 7 is a Level 1 response. The candidate makes reference to the data and makes a suggestion for doing a better experiment. This was judged to fit the Level 1 criteria exactly and was given 2 marks.

Exemplar 5

21 A student investigates the average speed at which a trolley with different loads travels down a ramp.

Look at the diagram of her experiment.



She releases the trolley from a distance of 2.0 m from the bottom of the ramp.

The student uses a stop-clock to measure the time it takes to reach the bottom of the ramp.

She calculates the average speed. Look at her results.

Load (N)	Time taken (s)	Average speed (m/s)
20	2.3	0.87
40	2.4	0.83
60	2.3	0.87
80	2.4	0.83

(a)* Describe the trend shown by the results, identify problems with the experiment and describe any improvements that you would make to the experiment.

There is no clear trend. When the speed is higher it takes less time to cover the distance. The problem is that the ramp is too short so time is not allowed for it to accelerate meaning that all speeds are extremely similar and a correlation is not shown between the load and speed. To improve she could make the ramp longer. She could experiment with different fixed angles in order to have a larger collection of results. If there was a bigger difference in the load, she may be able to see a clear trend. They are all too close in force. **[6]**

Exemplar 6

(a)* Describe the trend shown by the results, identify problems with the experiment and describe any improvements that you would make to the experiment.

Firstly, the table shows a trend, that the time taken at a similar average speed for example all the 230 have an average speed of 0.87m/s and 240 has also 0.87m/s.

The student could lean something up against the Ramp to make sure it stays in a fix angle, the student could also instead use a light gate and not a stop watch to reduce human error and time.

[6]

Exemplar 7

(a)* Describe the trend shown by the results, identify problems with the experiment and describe any improvements that you would make to the experiment.

- She could've done the experiment with the same load a few times to get a more accurate average speed.
- When the load was 40N and 80N it was slower than 20N and 60N but the average speed was ~~that~~ quicker.

Question 21 (b)

(b) For one experiment the trolley starts from rest and reaches a final speed of 2 m/s.

The ramp length is 2.0 m.

Calculate the acceleration of the trolley.

Acceleration = ... m/s^2 **[4]**

There were different possible approaches to the calculation: use of $v^2 = u^2 + 2as$ or finding the mean speed and hence t and using $a = (v-u)/t$. Both were seen. Many candidates just randomly multiplied or divided the numbers given, and two of these operations gave a response of 1 m/s^2.

Where candidates used incorrect physics in their response (e.g. acceleration = speed/distance = 2/2 = 1) then they only gained marks for those parts of their workings that were appropriate. For fairness candidates who only wrote '1' on the answer line with no workings shown were given the benefit of the doubt and awarded all 4 marks.

Question 22 (a) (i) and (ii)

22 A student puts an ice cube into a beaker. The mass of the ice cube is 40 g.

The ice cube melts.

(a) (i) Write down the mass of the water produced.

Mass = ... g **[1]**

(ii) Explain your answer to **(a)(i)**.

.....

.....

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

Question 22 (b)

(b) Describe **one** difference between a **physical change** and a **chemical change**.

.....

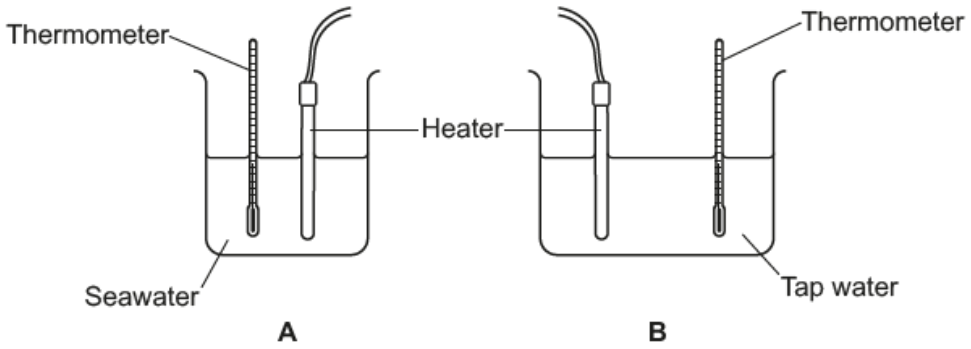
..... **[1]**

Question (a)(i) was correctly done by most candidates. Around half the candidates gained 2/2 in (a)(ii) where an explanation on the mass conservation in terms of particles was needed for the second mark (e.g. 'the same molecules are present'). . The most common misconception was that physical changes were hard to reverse but chemical changes were easy to reverse.

Question 22 (c) (i)

(c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water.

The student places a heater and a thermometer into two beakers, **A** and **B**.
Look at the diagram.



(i) There are 5 steps to the method for this experiment.

Complete the missing steps for this method.

Step 1 – Put seawater into beaker **A** and tap water into beaker **B**.

Step 2 – .....

Step 3 – .....

Step 4 – .....

Step 5 – Calculate the temperature change of beaker **A** and beaker **B**.

[3]

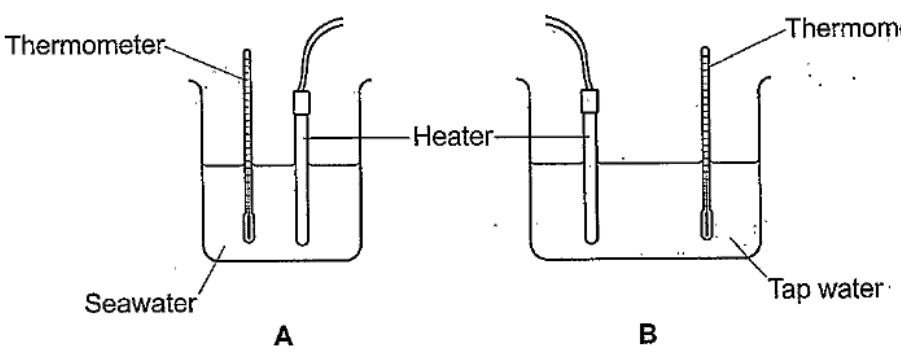
Many candidates did not read the stem to (c)(i) carefully. Exemplar 8 is a response where the quoted steps 2 and 3 are actually in the stems has having been done already. Fortunately, there were two reasonable suggestions on the 'Sep 4' answer line, so the candidate gained 2 marks.

?	**Misconception**	In practical skills questions many candidates want to describe the practical activity they did in the classroom rather than answering the question they have been given. It is important to read the stem to the question carefully, including any diagrams. In Exemplar 8 the candidate responses for Step 2 and Step 3of their method had already been done. Fortunately Step 4 contained two reasonable suggestions so the candidate was given 2 marks.

Exemplar 8

(c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water.

The student places a heater and a thermometer into two beakers, **A** and **B**.
Look at the diagram.



(i) There are 5 steps to the method for this experiment.

Complete the missing steps for this method.

Step 1 – Put seawater into beaker **A** and tap water into beaker **B**.

Step 2 – put the heaters in at the same time

Step 3 – put the thermometers in

Step 4 – take the temprature after a certain time

Step 5 – Calculate the temperature change of beaker **A** and beaker **B**.

[3]

Question 22 (c) (ii) and (iii)

(ii) Suggest **one** mistake the student made when choosing their equipment.

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

(iii) Suggest **two** improvements to the method followed.

1 .....

2 .....

[2]

Many candidate answers to (c)(ii) and (c)(iii) were linked, with the response to (c)(iii) correcting one of the errors in (c)(ii), and this appeared to be a good approach. Acceptable answers to (c)(iii) had to be related to the process in (c)(i), and not just a generic 'how to do a better experiment' comment.

Question 23 (a)

23 A TV has the label below on it.

OCR TV

Voltage: 230 V
Power: 65 W
Frequency: 50 Hz

(a) Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to **2** significant figures.

Current = ... A **[4]**

In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures.

Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is 65/4.5 = 14.4444 which (expressed to 2 s.f.) is 14, so earned second mark was given.

Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision.

Exemplar 9

23 A TV has the label below on it.

OCR TV

Voltage: 230 V
Power: 65 W
Frequency: 50 Hz

(a) Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to **2** significant figures.

65 230 Power / PD

230/50 = 4.5

65/4.5

Current = 14 A **[4]**

Question 23 (b)

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

Energy used = ... J **[4]**

This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.

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