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Examiners' report

GCSE

GATEWAY SCIENCE PHYSICS A

OCR Level 1/Level 2 GCSE (9-1) in Physics A (Gateway Science)

J249

For first teaching in 2016

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Contents

Introduction 4
Paper 1 series overview 5
Section A overview 6
Question 1 6
Question 2 7
Question 3 7
Question 4 8
Question 5 9
Question 6 10
Question 7 10
Question 8 11
Question 9 11
Question 10 12
Question 11 13
Question 12 14
Question 13 14
Question 14 15
Question 15 16
Section B overview 17
Question 16 (a) (i) 17
Question 16 (a) (ii) 18
Question 16 (b) (i) 18
Question 16 (b) (ii) 19
Question 16 (b) (iii) 19
Question 16 (b) (iv) 20
Question 16 (b) (v) 20
Question 17 (a) 21
Question 17 (b) 22
Question 17 (c) 22
Question 18 (a) 23
Question 18 (b) 24
Question 18 (c) (i) 24
Question 18 (c) (ii) 25
Question 18 (c) (iii) 25

Question 19 (a) (i) 25
Question 19 (a) (ii) 26
Question 19 (b) (i) 26
Question 19 (b) (ii) 27
Question 19 (b) (iii) 28
Question 19 (c) 28
Question 20 (a) 29
Question 20 (b) (i) 29
Question 20 (b) (ii) 30
Question 20 (b) (iii) 30
Question 20 (c) (i) 31
Question 20 (c) (ii) 31
Question 21 (a) 32
Question 21 (b)* 33
Question 22 (a) 34
Question 22 (b) (i) 35
Question 22 (b) (ii) 35
Question 23 (a) 36
Question 23 (b) (i) 37
Question 23 (b) (ii) 37
Question 23 (c) 38

Introduction

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

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

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

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

Paper 1 series overview

This is the second Foundation Tier paper for of GCSE (9-1): Physics A (Gateway Science). This paper is designed to assess content from Topics P5 to P8 as well as P9 and with assumed knowledge of Topics P1 to P4. Thus, this paper requires candidates to have knowledge and understanding of all the topics within the course. The last two questions overlap with the Higher tier paper.

There was no evidence to suggest that candidates were short of time in answering the paper.

A number of questions required candidates to analyse information and ideas. Candidates should be encouraged to practise interpreting data both qualitatively and quantitatively from different sources. There were also a number of questions where candidates needed to interpret graphs.

For numerical calculations, candidates should be encouraged to write the equation down as a first step. In other numerical questions candidates should identify the data to use and substitute the data into the equation, before calculating the answer. Candidates should also carefully consider the units of their data.

On this paper, there was one question, Question 21 (b), where candidates had the opportunity to demonstrate their knowledge and understanding of physics by constructing their own answer. It is important that candidates answer the question set in a logical way with clear explanations. They should use the bullet points as a guide. Candidates should also make sure that they answer the question set.

In questions where an explanation is required, candidates should be encouraged to use the number of answer lines and the marks for the particular sub-part mark as a guide to the length of their answers. Candidates should also make sure that they use appropriate physics terms correctly in their answers.

Candidates should also be able to describe experimental procedures including both the method of conducting an experiment and analysing the data. Candidates should have a good understanding of the language of measurement.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used the white space in multiple-choice questions for working • read all the options and eliminated incorrect responses in the multiple-choice questions • in numerical questions stated the equation used, rearranged the equation and substituted the data before writing the answer • structured answers logically • applied their knowledge and understanding to the question set • applied their practical skills to the context of the practical given in the question.	• could not give correct definitions • in numerical questions, often guessed the answer by multiplying the data together • did not describe experimental procedures with sufficient practical detail • did not use technical terms correctly in their answers • were not able to use unit prefixes • did not have a good knowledge or understanding of the language of measurement.

Section A overview

Section A of the paper has 15 multiple-choice questions, each worth 1 mark. Candidates should be encouraged not to spend too long on any question, but also to read the whole question including all the possible options.

In numerical questions, candidates should be encouraged to use the 'white' space around the question for equations and working. This should help them to answer the question and assist them with checking their answer.

In other questions, as candidates read the question, a useful technique is to use small crosses to eliminate incorrect options.

High scoring candidates often underlined or circled data or other important information or terms given in the question.

Question 1

1 Which statement describes how the Sun was formed?

A By the electromagnetic attraction of dust and gas

B By the gravitational attraction of dust and gas

C By the heating of gas in a large cloud of dust and gas

D By the nuclear fission of gas in a large cloud of dust and gas

Your answer ☐ **[1]**

This first question proved quite challenging with all the distractors selected. The common incorrect distractor was D perhaps indicating that candidates could not distinguish between the terms 'fission' and 'fusion'.

Assessment for learning

Candidates should also be encouraged to consider each of the four answers and put small crosses next to answers they have 'ruled out'.

Question 2

2 A hot drink is poured into a mug.

Which method would **not** help to keep the drink hot?

A Use a lid on the mug.

B Use a mug with a larger surface area.

C Use a mug with thicker sides.

D Wrap the mug with an insulating material.

Your answer ☐ **[1]**

The majority of candidates realised that the use of a mug with a larger surface area would allow a greater transfer of energy from the thermal energy store and thus the temperature of the hot drink would decrease.

Question 3

3 Which row explains how energy moves from object **X** to object **Y** by an **electromagnetic wave**?

	Object X	**Electromagnetic wave**	**Object Y**
A	absorbs energy	emits energy	transfers energy
B	absorbs energy	transfers energy	emits energy
C	emits energy	absorbs energy	transfers energy
D	emits energy	transfers energy	absorbs energy

Your answer ☐ **[1]**

High scoring candidates added small ticks or crosses to indicate correct and incorrect terms. All of the other three distractors were selected by candidates who did not gain credit.

Exemplar 1

	Object X	Electromagnetic wave	Object Y	
A	absorbs energy	emits energy	transfers energy	X
B	absorbs energy	transfers energy	emits energy	
C	emits energy	absorbs energy	transfers energy	X
D	emits energy	transfers energy	absorbs energy	

Your answer D **[1]**

This candidate has eliminated options A and C since the electromagnetic wave transfers energy. The candidate has marked an 'X' at the end of each of these rows. This then means that the candidate then can concentrate on selecting the correct answer from the two remaining options.

Question 4

4 A ball is lifted vertically from a height of 1.6 m to a height of 2.0 m.

The force used to lift the ball is 3.0 N.

What is the **work done** on the ball?

Use the equation: work done = force × distance

A 1.2 J

B 3.2 J

C 4.8 J

D 6.0 J

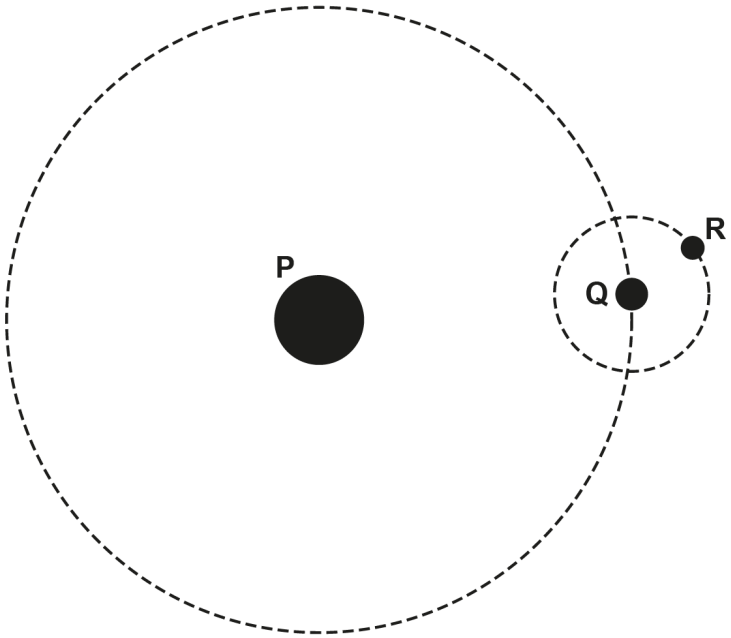
Your answer ☐ **[1]**

Most candidates correctly identified that the distance as 0.4 m and substituted the data into the equation. High performing candidates wrote their working in the white space next to the question.

Question 5

5 The diagram shows a model of the Sun, the Earth and the Moon.

The dashed lines show the orbits of object **Q** and object **R**.



Not to scale

Which row identifies each object?

	Object P	Object Q	Object R
A	the Earth	the Moon	the Sun
B	the Moon	the Earth	the Sun
C	the Sun	the Earth	the Moon
D	the Sun	the Moon	the Earth

Your answer ☐ **[1]**

The majority of the candidates correctly identified the orbits. A very small minority of candidates incorrectly started selected A.

Question 6

6 The isotope aluminium-27 has the symbol $^{27}_{13}Al$.

How many **neutrons** are in a nucleus of aluminium-27?

A 13

B 14

C 27

D 40

Your answer ☐ **[1]**

High performing candidates usually answered this question correctly. Lower performing candidates tended to select either A (the number of protons) or C (the number of protons plus (+) the number of neutrons, the mass number).

Question 7

7 What is the function of the **earth wire** in an electrical device?

A To complete the circuit

B To melt if the current is too high due to a fault

C To provide a low resistance path for the current if there is a fault

D To provide power to the device

Your answer ☐ **[1]**

The majority of the candidates were able to identify that the earth wire provided a low resistance path for the current if there is a fault. All the other distractors were chosen by candidates who did not select C.

Question 8

8 Which material will gamma radiation **not** easily penetrate?

A A sheet of paper

B A thick block of lead

C A thin sheet of aluminium

D Human skin

Your answer ☐ **[1]**

The majority of the candidates correctly selected B. The common incorrect distractor selector chosen was human skin D. High scoring candidates often used small crosses to indicate the options that they had eliminated.

Question 9

9 Redshift provides evidence for the Big-Bang model of the universe.

Which statement describes redshift of light from a galaxy that is moving away from the Earth?

A The observed speed of light on the Earth is greater than the speed of light emitted by the galaxy.

B The observed speed of light on the Earth is smaller than the speed of light emitted by the galaxy.

C The observed wavelength of light on the Earth is greater than the wavelength of light emitted by the galaxy.

D The observed wavelength of light on the Earth is smaller than the wavelength of light emitted by the galaxy.

Your answer ☐ **[1]**

Candidates across the mark range found describing the redshift of light challenging. Candidates who incorrectly selected A or B did not understand that the wavelength changes. Candidates who incorrectly selected D did not understand that the redshift means a longer wavelength.

Question 10

10 The table shows the speed of a person walking and the speed of an aeroplane flying.

Object	Speed (m/s)
Aeroplane	150
Person	1.5

What is the ratio of aeroplane's speed : person's speed?

A 1 : 10

B 1 : 100

C 10 : 1

D 100 : 1

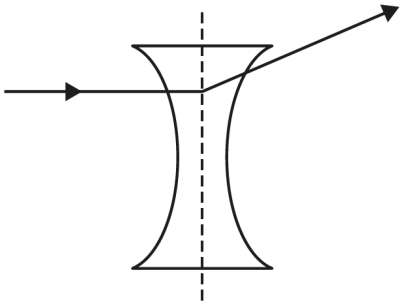
Your answer ☐ **[1]**

Most candidates selected the correct answer. A small minority of candidates realised that the factor was 100 and incorrectly selected B.

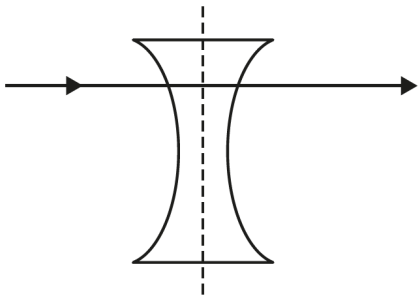
Question 11

11 Which diagram shows a ray of light passing through a **concave** lens?

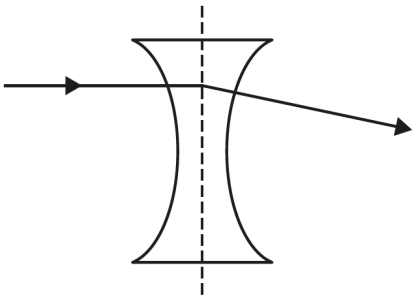
A



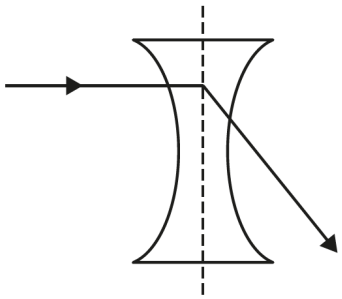
B



C



D



Your answer ☐ **[1]**

Candidates found this question challenging. The choice of responses would suggest that many candidates guess the answer. Candidates are expected to be able to use ray diagrams for convex and concave lenses.

Assessment for learning

Candidates are expected to be able to use ray diagrams to illustrate reflection, refraction and the similarities and differences between convex and concave lenses (qualitative only)

Candidates experiencing the path of a ray of light through convex and concave lenses during practical work may support this.

Question 12

12 Which value is a typical acceleration of a family car?

A $2.5\,m/s^2$

B $25\,m/s^2$

C $250\,m/s^2$

D $2500\,m/s^2$

Your answer ☐ **[1]**

Candidates found this question challenging. The common incorrect answer was B. This indicates that candidates were perhaps confused between acceleration and speed. A speed of 25 m / s corresponds to a speed of 90 km / h (56 mph).

Question 13

13 A league is an old unit of distance.

One league is approximately equal to 4800 m.

What is 4 leagues in metres?

A $1.92 \times 10^2\,m$

B $1.92 \times 10^3\,m$

C $1.92 \times 10^4\,m$

D $1.92 \times 10^5\,m$

Your answer ☐ **[1]**

This question was well-answered. A small minority incorrectly suggested B perhaps having difficulty in correctly converting their answer to standard form.

Question 14

14 An electromagnetic wave travels in a vacuum.

A second electromagnetic wave travelling in a vacuum has a smaller wavelength.

Which row describes how the frequency and velocity of the second electromagnetic wave compares with the frequency and velocity of the original wave?

	Frequency	Velocity
A	larger	equal
B	larger	larger
C	smaller	equal
D	smaller	larger

Your answer ☐ **[1]**

This question was challenging. Some high scoring candidates indicated small crosses to incorrect options.

Many candidates did not understand that all electromagnetic waves travel at the same speed in a vacuum. Candidate also needed to apply the equation: wave speed = frequency × wavelength.

Assessment for learning

Candidates are expected to have a basic understanding of electromagnetic waves.

In particular, candidates should be able to describe the main groupings of the electromagnetic spectrum and that these groupings range from long to short wavelengths and from low to high frequencies. The groupings to be included are radio, microwave, infrared, visible (red to violet), ultraviolet, X-rays and gamma rays.

Question 15

15 A sound wave travels from air to water. The speed of the sound wave is directly proportional to its wavelength.

The wavelength of the sound wave in air is 80 cm.

The speed of the sound wave increases by a factor of 4 when it enters the water.

What is the wavelength of the sound wave in the water?

A 20 cm

B 40 cm

C 160 cm

D 320 cm

Your answer ☐ **[1]**

The majority of candidates gained the correct answer. A small minority of candidates incorrectly selected A or B.

Section B overview

As candidates read a question, they should be encouraged to underline key information and data.

When answering explanation type questions, candidates' responses should relate to the question and include detailed knowledge and understanding. Vague answers do not gain credit. A guide to detail required is included in the mark box, e.g. [2] indicates two specific points should be made.

In numerical questions candidates should be encouraged to write down the equation they are using, substitute the numbers into the equation and then evaluate the answer.

Assessment for learning

In numerical questions candidates should be encouraged to use the following method:

- equation
- rearrange the equation
- substitute the data
- consider the units and any power of ten
- calculate the answer
- consider the whether the answer looks correct.

There are a number of questions which assess candidates' practical skills. Often these questions will require candidates to apply the skills they have developed during their practical course to different situations.

Question 16 (a) (i)

16 Energy sources are used to generate electricity.

(a) The list shows some energy sources.

coal	**hydroelectric**	**nuclear**
oil	**solar**	**tidal**	**wind**

(i) Write down the name of **one renewable** energy source from the list.

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

Almost all the candidates correctly identified a renewable source from the list provided.

Question 16 (a) (ii)

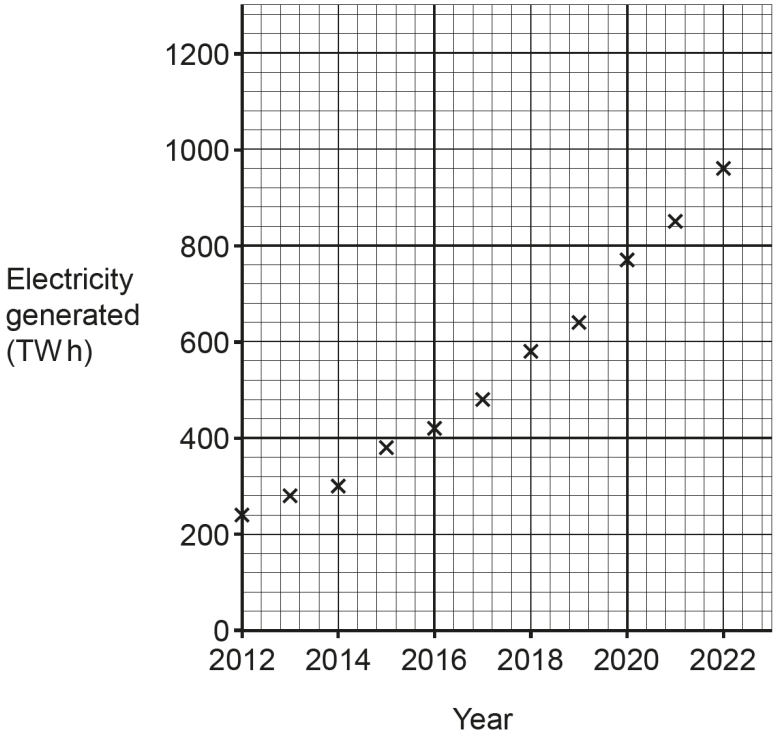
(ii) Write down the name of **one non-renewable** energy source from the list.

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

Almost all the candidates correctly identified a non-renewable source from the list provided.

Question 16 (b) (i)

(b) The graph shows the electricity generated by some renewable energy sources in the UK between 2012 and 2022.



(i) Draw a curve of best fit on the graph.

[1]

The majority of candidates were able to draw a curve of best fit. The common errors were either drawing a line that was too thick or drawing the line from cross to cross.

Assessment for learning

Candidates are expected to be able to draw straight lines of best fit and curved lines of best fit.

When analysing results from an experiment, candidates should be encouraged to plot graphs. They should draw lines of best fit through their data points. Candidates should understand that their line of best fit may not pass through every data point.

Question 16 (b) (ii)

(ii) Describe how the electricity generated by these renewable energy sources has changed between 2012 and 2022.

.....

.....

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

Most candidates correctly observed that the electricity generated had increased over time. Very few candidates described the change was at an increasing rate.

Candidates should be encouraged to give full descriptions in their answers. In this question there were 2 marks available which means that candidates should attempt to write two distinct points.

Question 16 (b) (iii)

(iii) Give **two** reasons why it is important that the trend shown on the graph continues.

1 .....

.....

2 .....

.....

[2]

This was a challenging question. Many answers were vague in terms of climate change and better for environment. Specific detail was needed to score marks.

Many candidates understood the need of reduce the use of non-renewables or explained this reason in terms on non-renewables running out.

A smaller minority of candidates gave a reason that the demand for electricity is increasing or in terms of greenhouse gases not being emitted so carbon emissions being reduced.

Question 16 (b) (iv)

(iv) Calculate the change in the electricity generated between 2012 and 2022.

Use the graph.

Change in electricity generated = ... TW h **[3]**

The majority of the candidates realised that this required reading off the graph in 2012 and 2022 and then subtracting the values. A number of errors were made with the read offs. The common mistakes was reading 220 instead of 240 and 880 instead of 960.

Candidates who made an error in the read offs could still gain some credit for clearly showing their working.

Question 16 (b) (v)

(v) Calculate the average change in the electricity generated by these renewable energy sources **per year** between 2012 and 2022.

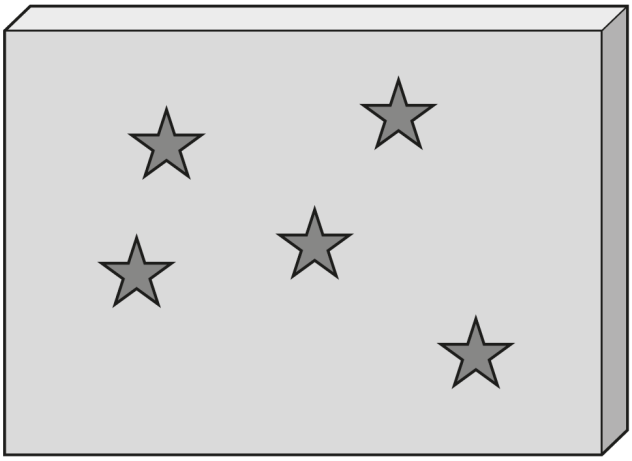
Average change per year = ... TW h / year **[2]**

Many candidates did not realise that they needed to divide their previous answer by 10. Some candidates re-did the previous calculations by working out the change each year – this was liable to cause mistakes.

Question 17 (a)

17 The diagram shows star shaped stickers attached to a wall.

The stickers can sometimes be seen in the dark because they emit electromagnetic waves and glow.



(a) Which region of the electromagnetic spectrum is emitted by the stickers so they can be seen in the dark?

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

Candidates found this question challenging. A number of candidates incorrectly stated ultraviolet.

Question 17 (b)

(b) A student thinks the stars look green when they glow.

Green light has a wavelength of 5.3×10^{-7} m and a speed of 3.0×10^{8} m/s.

Calculate the frequency of green light.

Use the equation: wave speed = frequency × wavelength

Frequency = ... Hz **[3]**

The majority of the candidates correctly rearranged the given equation and substituted the data. Many candidates found the powers of ten challenging.

Question 17 (c)

(c) The student observes that the stickers only glow in the dark after being exposed to light for a few hours.

Complete the sentences to explain the student's observation.

Use words from the list.

absorb	**emit**	**higher**	**lower**	**reflect**	**refract**

When light shines onto a sticker, atoms in the sticker ..... energy from the light.

When this happens, the electrons in the atoms move to a ..... energy level.

After some time, the electrons will move back to a ..... energy level.

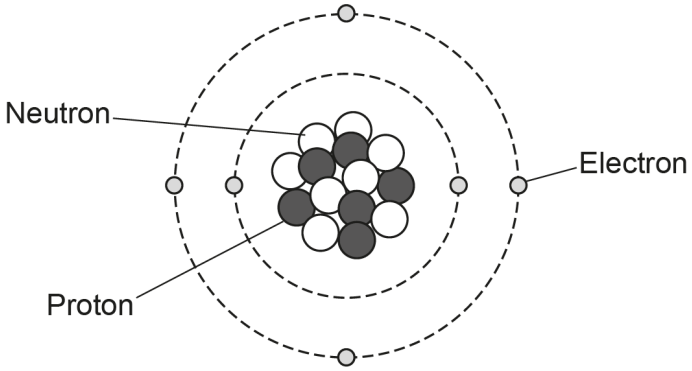
When this happens, the electrons ..... green light.

[3]

This question was generally well answered. Where mistakes occurred, it was often the use of the word 'reflect' for either absorb or emit.

Question 18 (a)

18 The diagram shows a radioactive atom of carbon-14.



(a) The carbon-14 atom has 6 protons and 8 neutrons in its nucleus.

Carbon-12 is a different isotope of carbon.

State **one** similarity and **one** difference between an atom of carbon-14 and an atom of carbon-12.

Similarity .....

.....

Difference .....

.....

[2]

This question tested the idea that atoms of the same element have in their nucleus the same number of protons but atoms of the same element but a different nuclear mass will have with a different number of neutrons.

A number of candidates wrote vague answers such as 'a different number of protons and neutrons' which did not gain credit. This statement did not make it clear that the number of protons was the same but the number of neutrons was different.

Question 18 (b)

(b) An atom of carbon-14 decays by emitting a negatively charged beta particle from the nucleus.

Describe the effect this has on the mass number and on the charge of the nucleus.

Mass number .....

Charge .....

[2]

Candidates found this question challenging.

Few candidates stated that the mass number stays the same.

Many candidates stated the charge was positive which is true for all nuclei. Few candidates stated that the positive charge increased.

Question 18 (c) (i)

(c) Technicians store carbon-14 as a gas in sealed metal containers.

(i) Explain how the sealed metal containers prevent the technicians from being **irradiated** by beta particles emitted from carbon-14.

.....

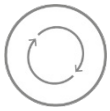
.....

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

Many candidates understood that the metal would stop the beta particles penetrating the container. Few candidates completed the explanation by stating that the beta particles did not reach the technician.

There were many vague answers regarding 'it' – it was not clear as to whether candidates were referring to the carbon-14 or the beta particles.

Assessment for learning



Candidates need to understand the difference between irradiation and contamination.

Candidates should understand that Irradiation does not cause radioactivity. Irradiation is when objects are exposed to alpha, beta or gamma radiation.

Candidates should understand that contamination is when a radioactive material or source is placed on an object or person.

Question 18 (c) (ii)

(ii) Explain how the sealed metal containers prevent the technicians from being **contaminated** by carbon-14.

.....

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

Few candidates were able to state that the sealed container prevented the technician coming into contact with the carbon-14.

Question 18 (c) (iii)

(iii) The technicians check the safety of the containers by measuring the count rate next to the container. The count rate is the number of counts of radiation per minute.

State the name of **two** pieces of equipment the technicians use to measure the count rate.

1 .....

2 .....

[2]

Candidates needed to understand that to determine a rate, a stopwatch or timer was needed. Some candidates correctly stated a Geiger-Muller tube. Other candidates gained credit by stating Geiger counter.

Question 19 (a) (i)

19 X-rays and infrared radiation are involved in the scanning of patients in hospitals.

(a) A radiographer uses X-rays to scan the inside of a patient's body.

(i) Describe **one** hazardous effect of X-rays on human tissue.

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

Most candidates stated that X-rays could causes cancer. Few candidates discussed the effect in terms of cell mutation.

Question 19 (a) (ii)

(ii) The radiographer stands behind a lead barrier while doing the scan.

Explain how the barrier will protect the radiographer.

.....

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

Many candidates did not answer this question in terms of X-rays but gave general answers in terms of radioactivity or named radiation such as gamma. It is important that candidates answer the question set.

Question 19 (b) (i)

(b) A hospital technician scans the infrared radiation emitted by a patient.

The technician:
- measures the peak wavelength of infrared radiation emitted by the patient
- repeats the measurement 3 times and records the results in **Table 19.1**.

Table 19.1

Measurement	Peak wavelength (μm)
1	9.36
2	9.42
3	9.40

(i) Calculate the mean peak wavelength using the data in **Table 19.1**.

Give your answer in **standard form** in **metres**.

Mean peak wavelength = ... m **[2]**

Most candidates correctly calculated the mean but did not covert μm to m.

Candidates should also consider significant figures. Since all the peak wavelengths were recorded to three significant figures, then two significant figures was not acceptable.

Assessment for learning

Candidates need to be able to covert between the unit prefixes.

Candidates should understand that 1 μm is the same as 1×10^{-6} m or 0.000 001 m.

Assessment for learning

Candidates need to consider significant figures in calculations.

When calculating the mean from repeated readings, candidates should write their answer to the same number of significant figures or one more.

For example, in thus question, the peak wavelengths were all recorded to three significant figures so the mean value should be recorded to three significant figures or four significant figures.

Question 19 (b) (ii)

(ii) Give **one** reason why the technician repeats the measurements.

.....

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

This was a challenging question. The majority of candidates incorrectly stated that 'it is more accurate'. Repeating the measurements enables anomalies / outliers to be identified.

OCR support

Candidates need to understand the language of measurement.

In particular candidates should be aware of meaning of accurate and precise.

The Language of Measurement guide is available on the OCR website and can be used for better understanding of measurements in physics.

Question 19 (b) (iii)

(iii) The technician scans a different patient and records the results as shown in **Table 19.2**.

Table 19.2

Measurement	Peak wavelength (μm)
1	9.43
2	9.41
3	8.25

What should the technician do with measurement 3 before calculating the mean peak wavelength in **Table 19.2**?

Explain your answer.

.....

.....

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

Many candidates stated they would repeat the measurement. High performing candidates often explained that measurement 3 was an outlier, that it should be ignored and the measurement should be repeated.

Question 19 (c)

(c) Describe **one** other practical use of infrared radiation.

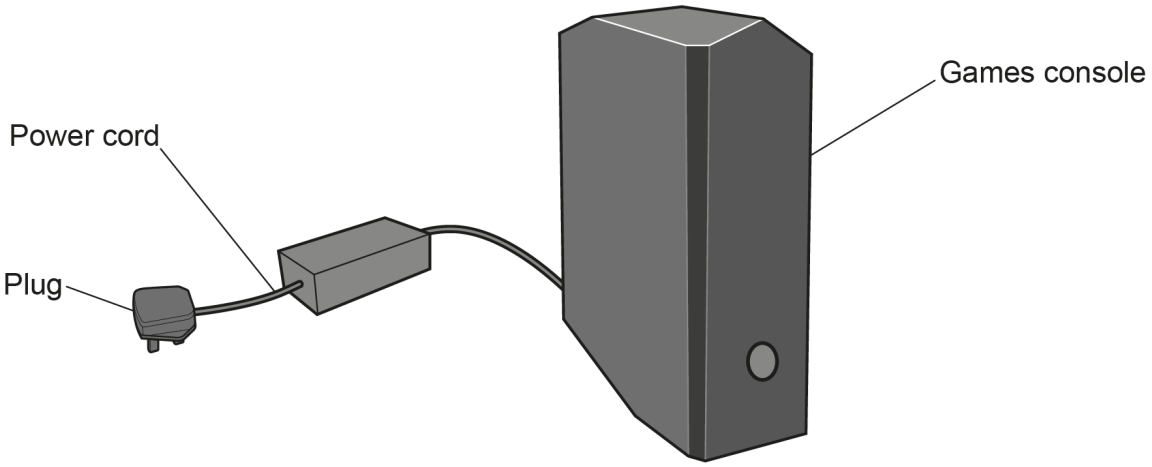
..... **[1]**

Many candidates did not relate the thermal properties of the practical use. A common misconception was 'night vision'. Night vision cameras work by magnifying visible light while thermal imaging cameras use infrared to detect temperature of the objects around it.

Question 20 (a)

20 The diagram shows a games console.

A games console is an electrical device used to play computer games.



(a) The games console is connected to the mains supply and switched on.

Describe how energy is **transferred** through the power cord to the games console.

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

Few candidates were able to describe the energy transferred by an electric current or electrically. Many answers stated 'through the wire or power cord'.

Question 20 (b) (i)

(b)

(i) The games console uses 4.2×10^5 J of energy per hour when a student is playing on it.

The actual energy input to the games console in one hour is 5.2×10^5 J.

Calculate the energy **wasted** by the games console in one hour of playing.

Energy wasted = ... J **[2]**

High performing candidates showed their working. Some low performing candidates ignored the 10^5.

Question 20 (b) (ii)

(ii) Explain why some energy is wasted when the student is playing on the games console.

.....

.....

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

Many candidates omitted to state that the energy is transferred to the thermal store. It was then expected that candidates would describe where this occurred, e.g. in the console / air or power cord and transformer. A common incorrect answer was that that energy was wasted since the game was not always played.

Question 20 (b) (iii)

(iii) Calculate the efficiency of the game console.

Use the equation: efficiency = $\frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

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

Efficiency = ... **[3]**

For this question candidates should be encouraged to show their working. The data should be substituted into the equation and answer evaluated and written down before the rounding occurs.

Exemplar 2

$$\frac{4.2 \times 10^5}{5.2 \times 10^5}$$

$$= 0.807692307\dot{7}$$

$$= 0.81$$

Efficiency = 0.81 **[3]**

This candidate's script clearly substitutes the data into the equation, calculates the answer and gives 0.8076 before correctly rounding the answer to two significant figures.

Question 20 (c) (i)

(c) The games console has a transformer built into the power cord.

The transformer needs to decrease the potential difference of the mains supply from 230 V to 12.1 V.

(i) State the type of transformer used in the games console.

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

A small majority of candidates correctly stated 'step-down'.

Assessment for learning

Candidates should understand the differences between step-down and step-up transformers.

Candidates should understand the differences in terms of the number of turns, potential difference and current.

Question 20 (c) (ii)

(ii) The current in the primary coil of the transformer is 0.51 A.

Calculate the current in the secondary coil of the transformer.

Assume the transformer is 100% efficient.

Use the Equation Sheet.

Current in secondary coil = ... A **[3]**

This was a very challenging question. Many candidates gave an answer of 0.51 A or 51 A.

The logical way to answer this question is to write down the equation from the equation sheet, then substitute the data into the equation. Then rearrange and calculate the answer.

Exemplar 3

potential difference in primary coil x current in primary coil = potential difference in secondary coil x current in secondary coil

Current in secondary coil = 9.69 A **[3]**

$\frac{V_P I_P}{V_S} = I_S$

~~0.51 x 100~~

$\frac{230 \times 0.51}{12.1} = 9.69A$

This candidate has written the equation from the equation sheet. There is then evidence of rearranging the equation before substituting in the data. The candidate has correctly calculated the answer and transferred it to the answer line.

Question 21 (a)

21 A nuclear power station uses fission to produce electricity.

(a) The total power output of the nuclear power station is 1.0 GW.

The average power output of **one** fission reaction is 3.2×10^{-11} W.

Calculate the number of fission reactions that occur per second.

Use the equation:

$$\text{number of fission reactions per second} = \frac{\text{total power output}}{\text{average power output per fission reaction}}$$

Number of fission reactions per second = ... **[3]**

The majority of the candidates could correctly substitute the data into the given equation and calculate an answer. Very few candidates understood the meaning of giga, G.

Assessment for learning

Candidates need to be able to covert between the unit prefixes.

Candidates should understand that 1 GW is the same as 1×10^9 W or 1 000 000 000 W.

Question 21 (b)*

(b)* Scientists think that nuclear **fusion** would be a better energy source than nuclear **fission**.

The table gives information about nuclear fission power stations and nuclear fusion power stations.

Type of power station	Fuel used	Average power output from power station (GW)	Where fuel is obtained from	Waste products
Nuclear fission	uranium	1.0	mined from underground	very radioactive with long half life
Nuclear fusion	hydrogen	more than 1.0 (predicted)	extracted from water	slightly radioactive with short half life

Explain why scientists think that nuclear **fusion** would be a better energy source than nuclear **fission**.

In your answer, write about

- differences between a fission reaction and a fusion reaction
- the benefits of nuclear fusion using the information in the table.

.....

.....

.....

.....

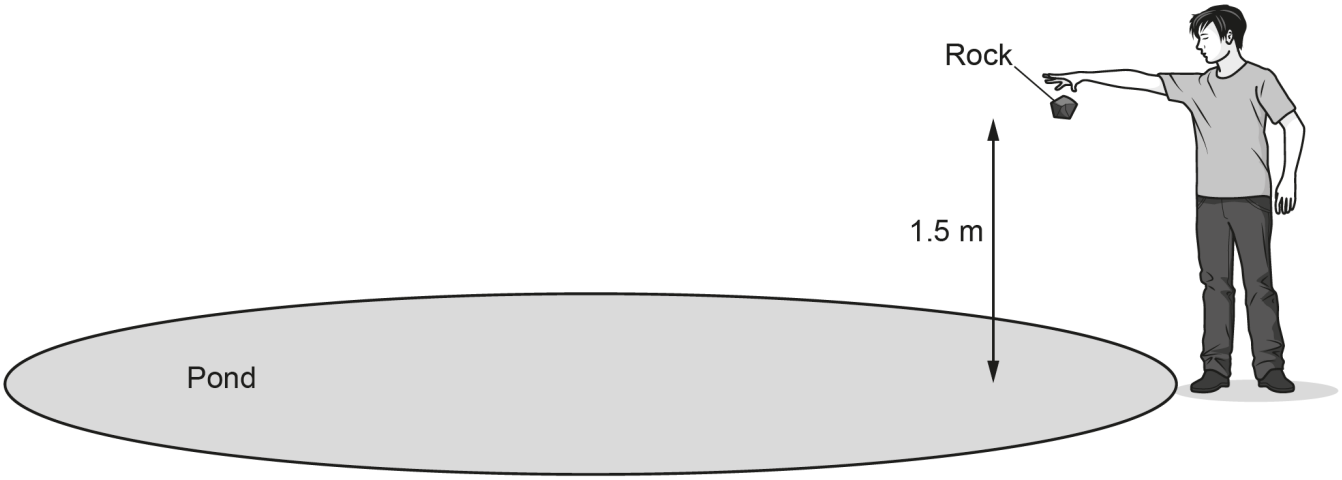
.....

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

The majority of the candidates were able to describe the information provided in the table. A small minority answered the question set by explaining the differences between the terms fission and fusion. Few candidates extended the description to gain full marks for the question.

Question 22 (a)

22 A student drops a rock into a pond from a height of 1.5 m.



(a) When the rock hits the water, it makes a sound. At the same time ripples form on the surface of the water.

The sound and the ripples are different types of waves.

Complete the table to describe the two waves.

	Type of wave	Direction of particle vibration
Sound	.....	Particles vibrate ..... to wave direction
Water ripples	.....	Particles vibrate ..... to wave direction

[4]

Many candidates were unable to correctly use the terms longitudinal and transverse and then complete the sentences to explain the particle vibration.

Assessment for learning

Candidates need to understand the two types of waves: longitudinal and transverse.

Candidates should understand that the vibrations of the particles in a longitudinal wave are parallel to the wave direction and the vibrations of the particles in a transverse wave are perpendicular to the wave direction.

Question 22 (b) (i)

(b) The student drops an identical rock from a height of 2.0 m.

The student notices that the ripples produced by this rock have a larger amplitude than the ripples produced by the first rock.

(i) Explain why the rock dropped from a greater height produces ripples with a larger amplitude.

.....

.....

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

Many candidates stated a greater force. This question was worth two marks so there was an expectation that candidates would describe energy changes. High performing candidates stated that gravitational store has increased due to the increased height of the rock, which means that there is a greater energy transfer to the kinetic store of the rock as it hits the water so the rock transfers more energy to the to the water.

Question 22 (b) (ii)

(ii) Describe how the student uses a metre ruler and a stop clock to determine the speed of the ripples.

.....

.....

.....

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

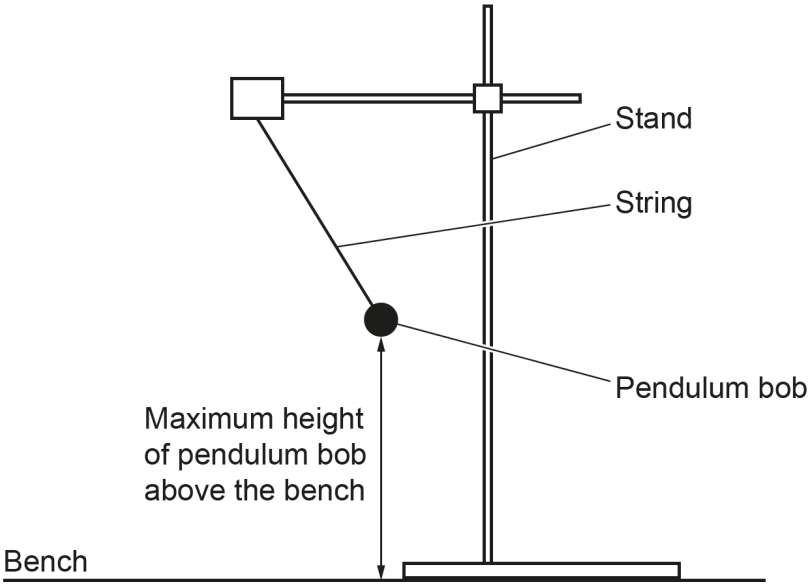
This question was designed to assess experimental technique. Many candidates did not answer the question set but explained how the average speed of the rock as it fell could be calculated.

Candidates should have been able to apply their practical skills from using ripple tanks.

High scoring candidates described how a distance a ripple travelled would be marked and measured and how the time would be measured for this distance and then stating the equation to calculate speed. A few candidates described a method for determining the wavelength and the frequency. It is expected that to determine frequency that candidates would describe measuring the time for a number of waves and then divide the number of waves by the time to calculate the frequency.

Question 23 (a)

23 The diagram shows a pendulum bob attached to a stand using string.



A student lifts the pendulum bob to the position shown on the diagram.

The student then releases the pendulum bob so that it swings freely.

(a) The student notices that the maximum height of the pendulum bob above the bench decreases after each swing.

Explain why the maximum height of the pendulum bob decreases after each swing.

.....

.....

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

Candidates found this question challenging. Few candidates stated that the air resistance or friction does work on the pendulum so that energy is transferred to the thermal store of the surroundings.

Many candidates stated that the pendulum loses energy which was too vague.

Question 23 (b) (i)

(b) The student holds a metre ruler behind the swinging pendulum bob and measures the maximum height of the pendulum bob above the bench.

(i) Give **two** reasons why the student's method might **not** give an **accurate** value for the maximum height of the pendulum bob.

1 .....

.....

2 .....

.....

[2]

A minority of candidates correctly identified that it would be difficult to read the ruler when the ball was at its maximum height.

Question 23 (b) (ii)

(ii) Describe **two** ways to improve the student's method to obtain a more accurate value of the maximum height of the pendulum bob at the end of each swing.

1 .....

.....

2 .....

.....

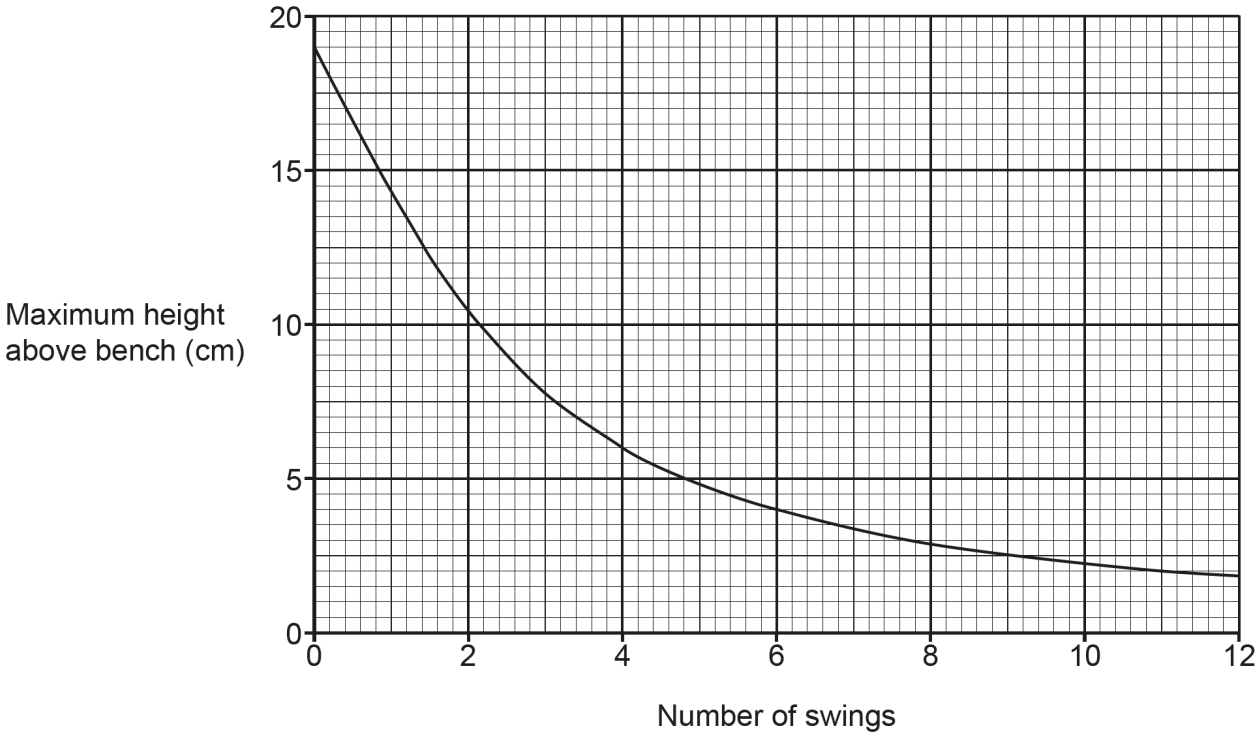
[2]

The common response of repeating the experiment did not gain credit since this would not increase the accuracy of the measurement of the maximum height.

To gain credit candidates needed to describe methods of improving the measurement of maximum height. For example, the use of a video with slow motion playback would assist in determining the position of the maximum height. Similarly fixing the rule in the approximate position or a large sheet of paper with a grid. It was also important that the ruler was vertical and not at an angle.

Question 23 (c)

(c) The graph shows how the maximum height of the pendulum bob above the bench changes as the pendulum bob swings.



The initial release height of the pendulum bob above the bench is 19 cm.

Determine the maximum height after 6 swings as a percentage of the initial release height.

Percentage of the initial release height = ... % **[3]**

Many candidates did not correctly read off the graph the height of the pendulum after 6 swings. Other candidates were unsure on how to calculate the percentage and did not use the initial release height of 19 cm.

High performing candidates often drew a line on the graph to indicate the read-off and then clearly showed their method for calculating the percentage.

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