Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

J249/04 Summer 2018 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 J249/04 series overview

J249/04 is one of the two Higher Tier papers for the new GCSE (9-1) Physics A (Gateway Science).

It covers the topics:

- P5 Waves in matter
- P6 Radioactivity
- P7 Energy
- P8 Global challenges
- P9 Practical skills

Candidate performance overview

Candidates who did well on the paper generally did the following.

- Recalled and applied or manipulated equations.
- Underlined key words.
- Answered questions in depth e.g. speed of sound experiment and Level of Response questions.

Candidates who did less well on this paper generally did the following.

- Found it difficult to recall and apply or manipulate equations.
- Lacked the necessary knowledge to describe an appropriate speed of sound experiment in sufficient detail.
- Did not know the meaning of unit prefixes.

There was no evidence that any time constraints has led to candidates underperforming.

Section A overview

Section A is a new addition to the GCSE Physics examination and consists of 15 Multiple Choice Questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

Almost all candidates attempted all of the questions.

Most successful questions	*Least successful questions*
• Calculating the range of values Question 2 • Average time Question 9 • Efficiency Question 10 • Potential energy Question 11	• Beta radiation Question 4 • Satellite orbits Question 12 • Estimating force Question 14 • Refraction through a prism Question 15

Candidates who did well on this section generally did the following.

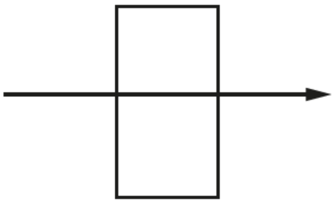
- Underlined keywords.
- Wrote equations and / or calculations next to the relevant questions.
- Worked through the distractors methodically e.g. by crossing out and dismissing incorrect distractors.

Key:

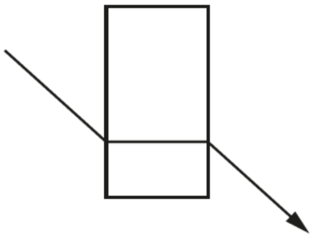
AfL Guidance to offer for future teaching and learning practice.

Question 3

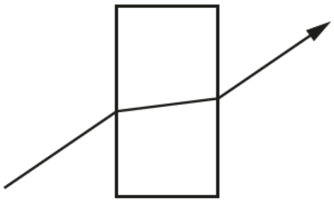
3 Look at the diagrams of a light ray as it passes from air through a glass block.



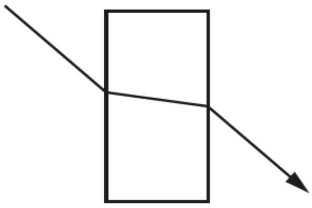
A



B



C



D

Which diagram shows an **incorrect** refraction?

Your answer ☐ **[1]**

Candidates found this question challenging and many candidates selected distractor A as their answer.

Key

Misconception Candidates knew that the ray should enter and leave the block in the same direction (options A and B). However, the ray is also refracted as it enters the glass block and this is independent of the angle of incidence. Therefore option B is the only correct answer.

Question 4

4 Beta radiation is used to check the thickness of thin aluminium foil at a factory.

Why is beta radiation used?

A All electromagnetic radiation is reflected by aluminium foil.

B Beta radiation will **not** pass through aluminium foil.

C Beta radiation will partially pass through aluminium foil.

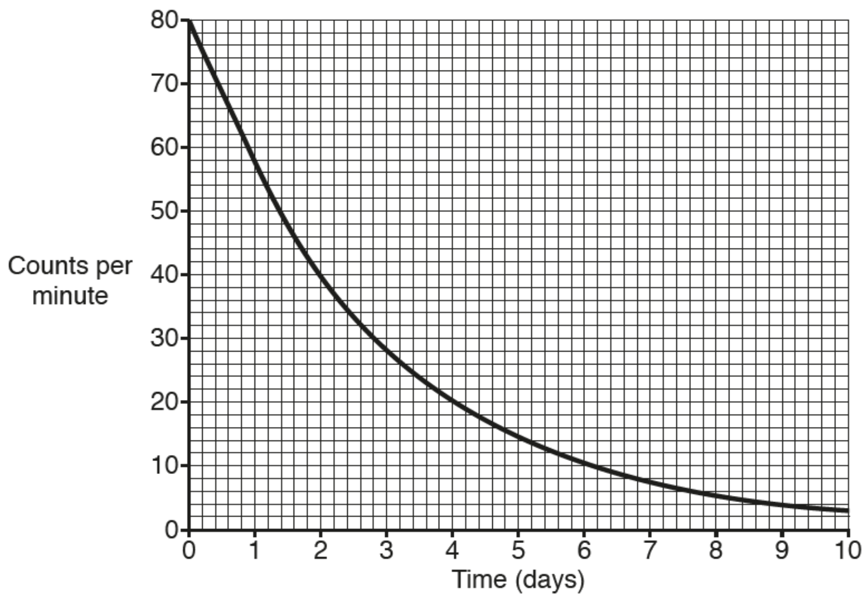
D Beta radiation is reflected by aluminium foil.

Your answer ☐ **[1]**

Many candidates chose distractor B as they had the misconception that beta radiation will not pass through aluminium foil. While an aluminium plate will stop beta radiation, thin aluminium foil will not be an effective screen for all the beta radiation.

Question 5

5 A teacher measures the radiation from a radioactive source for 10 days.



What is the half-life of this radioactive source?

A 1 day

B 2 days

C 4 days

D 5 days

Your answer ☐ **[1]**

This question required candidates to use their knowledge of half-life to interpret the graph. The majority of candidates were able to work out the half-life of the source using the graph.

Question 6

6 An alpha particle collides with an atom to produce a positive ion.

What happens to the atom for it to become a positive ion?

A It loses an electron from inside the nucleus.

B It loses an electron from outside the nucleus.

C It loses a neutron from inside the nucleus.

D It loses a proton from outside the nucleus.

Your answer ☐ **[1]**

Most candidates successfully applied their knowledge of ionisation to identify what happens to the atom for it to become a positive ion.

Question 7

7 A car accelerates from 0 to 60 mph (miles per hour) in about 9 seconds.

Use the relationship: 1 m/s = 2.24 mph

Estimate the acceleration for this car in m/s^2.

A 1 m/s^2

B 3 m/s^2

C 7 m/s^2

D 15 m/s^2

Your answer ☐ **[1]**

This question required candidates to recall and apply the equation: *acceleration = change in velocity ÷ time* as well as use the relationship provided to convert m/s into mph. Most candidates were able to do this successfully.

Question 10

10 A gas fire, used to heat a room, has an input energy transfer of 180 000 J per minute.

The fire has an efficiency of 0.8.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Calculate the useful output energy transfer per minute.

A 600 J

B 2400 J

C 36 000 J

D 144 000 J

Your answer ☐ **[1]**

Question 11

11 A pump lifts 500 kg of water to a water tank at the top of a building.

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

Use the equation: Potential energy = Mass × Height × Gravitational field strength

Calculate the height of the water tank.

A 4.8 m

B 48 m

C 240 m

D 480 m

Your answer ☐ **[1]**

Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below.

Exemplar 1

11 A pump lifts 500 kg of water to a water tank at the top of a building.

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

Use the equation: Potential energy = Mass × Height × Gravitational field strength

Calculate the height of the water tank.

$$\frac{240000}{500 \times 10}$$

A 4.8 m

B 48 m

C 240 m

D 480 m

Your answer: B **[1]**

Question 12

12 An artificial satellite is kept in its low polar orbit by a gravity force from a planet.

The satellite is moved to a higher orbit above the planet.

Which statement is correct about the satellite in this higher orbit?

A The force of gravity is greater and its speed decreases.

B The force of gravity is greater and its speed increases.

C The force of gravity is less and its speed decreases.

D The force of gravity is less and its speed increases.

Your answer ☐ **[1]**

Most candidates demonstrated a good knowledge about the orbits of artificial satellites at different heights (P8.3f and P8.3g). Most other candidates correctly identified that the force of gravity would be less when the satellite is moved to a higher orbit, but also predicted that the speed would increase (distractor D).

Question 14

14 An adult on a bicycle travels at 8 m/s on a level road. She sees a hazard and applies her brakes using full force.

Estimate the force of the brakes.

A 5 N

B 50 N

C 500 N

D 5000 N

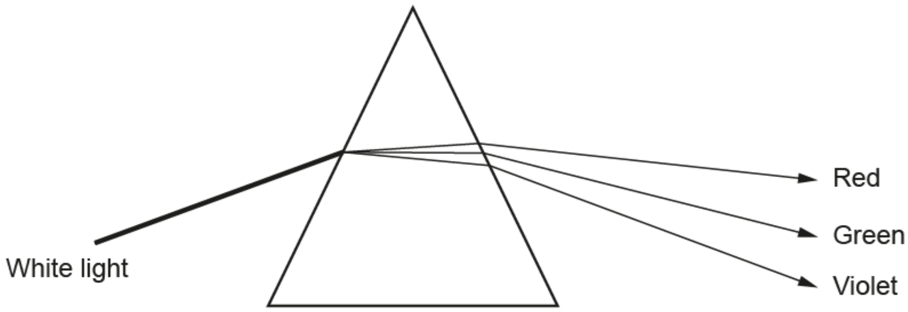
Your answer **[1]**

Many candidates struggled to estimate the force of the brakes, often incorrectly choosing distractor B. Those candidates who correctly choose distractor C were often seen to write down their estimated values of the mass and acceleration.

AfL Candidates would benefit from being provided with opportunities to estimate, the speed, accelerations and forces involved for everyday road transport.

Question 15

15 Look at the diagram of white light as it passes through a prism.



A spectrum of colours is seen. It ranges from red to violet.

Why does the **violet** light refract **more** than the red light?

A Violet light changes frequency more than red light.

B Violet light has the largest change in speed.

C Violet light has the smallest change in speed.

D Violet light increases its speed in the glass prism.

Your answer **[1]**

Higher ability candidates were able to correctly apply their knowledge of refraction through a prism (option B). Most lower ability candidates chose one of the distractors and were unable to explain why violet light is refracted more than red light.

Section B overview

Section B consisted of short, 1 mark, questions as well as questions requiring longer answer and the Level of Response question. It covered all of the AOs and many questions needed candidates to use mathematical skills.

Most successful questions	*Least successful questions*
• Wind turbines Question 16(d)(ii) and (iii) • UV rays and sun protection factor Question 18(b) and (c)(i) • Isotopes Question 19d • Decay equations Question 19e	• Calculating power output Question 16(d)(i) • Describing water waves Question 17aiii • Calculations about EM waves using unit prefixes Question 18a(i) and (ii) • Defining contamination and irradiation Question 19a

Candidates who did well on this section generally did the following.

- Underlined key words.
- Recalled equations and wrote down all of their calculations.
- Worked methodically in order to describe each step of a suitable speed of sound experiment.
- Could convert unit prefixes to a power of 10.

Candidates who did less well on this section generally did the following.

- Struggled to recall the correct equations for power output and reaction time.
- Did not know the meaning of unit prefixes.
- Only wrote the answers to questions involving equations, no calculations were shown.
- Gave responses that lacked depth e.g. LoR question and speed of sound experiment.

Question 16(a)(i)

16 The graph shows how the World's energy use has changed from the year 1971 to the year 2003.

It also shows the amount of different energy sources used.

Item removed due to third party copyright restrictions

(a) (i) Approximately how much did the total World's energy use increase from the year 1971 to the year 2003?

Answer = ... billion tonnes (oil equivalent) **[1]**

Question 16(a)(ii)

(ii) Which energy source had the **greatest** use in the year 2003?

.... **[1]**

Q16(a)(i) and (ii) assessed AO3 and required candidates to use estimated values from the graph. The majority of candidates were able to do this successfully.

Question 16(a)(iii)

(iii) The total energy use in the year 2003 was 10.6 billion tonnes (oil equivalent).

Approximately what percentage of this amount was due to fossil fuel use?

Answer = ...% **[2]**

This question required candidates to use estimated values from the graph to work out the amount of energy use due to fossil fuels and then convert their answer into a percentage of the total energy use.

The question discriminated well as the lower ability candidates struggled to identify the proportion due to fossil fuel use. Many did not take into account all three of the fossil fuels which resulted in percentages that were much smaller than the expected answer.

The higher ability candidates, who did identify the amount of energy use due to fossil fuels, were able to calculate the percentage correctly.

Question 16(b)(i)

(b) Scientists are researching the World's energy use for the future.

The graph shows some of their research.

Item removed due to third party copyright restrictions

(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1. ....

....

2. ....

.... **[2]**

This question assessed AO3 and the majority of candidates gained at least 1 mark, usually for the idea that fossil fuels are not renewable. A significant number of candidates did not gain the second mark as their responses included statements about pollution that were too vague e.g. 'harmful emissions' or 'bad for the environment'.

Exemplar 2

1. Fossil fuels are non-renewable and will eventually run out
2. Fossil fuels release lots of pollution, which causes damage to people and the planet **[2]**

This response was credited with 1 mark for stating that fossil fuels are renewable. The second mark was not achieved as the candidate's statement that 'fossil fuels release lots of pollution' is not specific enough. To gain the second mark, the candidate should have referred to an appropriate scientific reason, for example more CO_2 or more greenhouse gases.

Question 16(b)(ii)

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

....

....

.... **[2]**

Although many candidates achieved 1 or 2 marks, a significant proportion did not gain any credit. Some candidates had the misconception that nuclear power is renewable. Others gave vague suggestions about 'damage to the environment'. Only the highest ability candidates usually gained full credit.

AfL

Candidates should be aware that in a Physics exam what they write will be assessed as a specific scientific response. Where candidates use unnamed, vague statements about 'pollution' or 'damage to the environment' these are unlikely to gain credit. For example graffiti, fly tipping and loud music are examples of pollution that are unlikely to be caused a power station.

Question 16(c)(i)

(c) Power stations in the UK generate electricity at 25 kV a.c.

The voltage is then increased to 400 kV a.c. and distributed by power lines.

(i) Write down the full name of the device used to **increase** the voltage.

.... **[1]**

The majority of candidates correctly identified a step-up transformer. However, many lower ability candidates had less secure knowledge and suggested an inappropriate electrical device such as a voltmeter.

Question 16(c)(ii)

(ii) Why is it important to increase the voltage in these power lines?

.... **[1]**

This question is a direct assessment of on specification knowledge (P8.2d and P8.2e) that is in both separate Physics and Combined Science. However candidates across the ability range found it challenging and a minority of candidates correctly answered this lower demand question.

Misconception Candidates have many misconceptions about transformers and why the voltage needs be increased. They referred to many incorrect ideas such as to make the energy move faster / further, to transfer enough power to homes and to reduce the resistance. Some candidates suggested that high voltages are used in the National Grid as this reduces energy losses during transmission to zero.

OCR support There is a KS3–KS4 Transition Guide (J249) and a KS4–KS5 Transition Guide (H557) that offer support on teaching about generation of and distribution of the domestic electrical supply:

http://www.ocr.org.uk/Images/324646-electricity-ks3-ks4-transition-guide.pdf

http://www.ocr.org.uk/Images/309732-generating-electricity-transition-guide.pdf

Question 16(c)(iii)

(iii) The high voltages across the power lines are reduced to 230 V a.c. for use in the home.

A phone charger changes the 230 V a.c. to a 5 V d.c.

Explain the difference between d.c. and a.c.

....

....

.... **[2]**

Most candidates gained at least 1 mark, usually for identifying a.c. as alternating current. Common misconceptions for d.c. included 'd.c. is constant' or 'd.c. goes straight to the device'.

Question 16(d)(i)

(d) A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

(i) The domestic wind turbine has an electrical resistance of 23 Ω.

It generates a current of 11 A on a windy day.

Calculate the **power** output in kW of the turbine on this day.

Answer = ... kW **[4]**

This question required candidates to recall the equation: *power* = *current*^{2} *x resistance* before converting their answers into kW. Out of the candidates who gained credit, most were credited with all four marks. A few candidates were only credited with one mark for converting the power output in W into kW. A significant number of candidates used an incorrect equation for power, most commonly using *current* rather than *current*^{2}

AfL

When a physics question requires candidates to apply their mathematical skills they should always write down how they are answering the question. Using brief notes is and writing down intermediate calculations helps the examiner to see what the candidate is doing. A single finger error will result in many candidates receiving no credit because they only write down their final answer. Marks may be available for each stage of the process, using the correct equation, rearranging the equation, substituting in correct values. Choosing to access these compensatory marks by showing workings is good examination technique.

Question 16(d)(ii)

(ii) Suggest why the manufacturer gives a range for the power rating of the wind turbine.

....

.... **[1]**

Question 16(d)(iii)

(iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

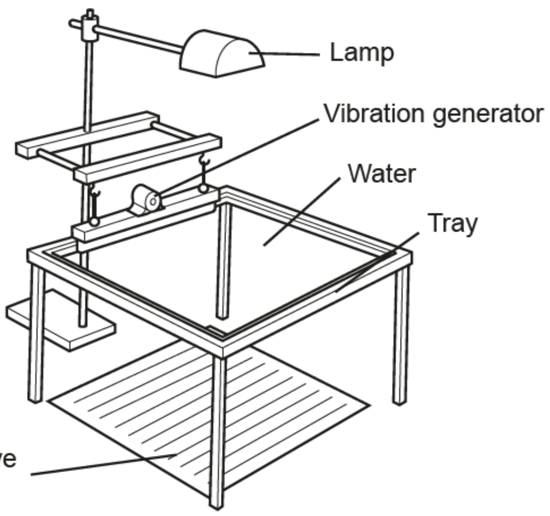
....

.... **[1]**

Most candidates gained full credit for Q16(d)(ii) and (d)(iii). Those who did not gain credit often provided non-specific generalised reasons about the weather or the wind turbine 'breaking'.

Question 17(a)(i)

17 A teacher uses water waves in a ripple tank to demonstrate **transverse** waves.



She makes measurements of the water waves.

(a) The frequency of the water waves is 0.5 Hz.

(i) Calculate the number of water waves produced in 5 seconds.

Answer = ... **[1]**

Most candidates were able to calculate the number of waves produced. The most common error made was to divide the time by the frequency instead of multiplying the time by the frequency.

Question 17(a)(ii)

(ii) The teacher **increases** the frequency of the water waves.

Describe what happens to the speed **and** the wavelength of the water waves.

....

....

.... **[2]**

Most candidates correctly stated that the wavelength would decrease. The majority of candidates stating that wave speed would also increase while only the highest ability candidates knew that that wave speed would be unchanged.

Question 17(a)(iii)

(iii) A student tries to describe water waves in the sea.

'The water waves move up and down. The water particles move all the way across the surface of the sea. This means that water moves in the direction of the waves.'

Part of his explanation is **incorrect**.

Write an improved and correct description about water waves in the sea.

....

....

.... **[2]**

Candidates found this question very challenging and many misinterpreted what they were being asked to do. Most candidates did not identify that the second and third statements about water wave were incorrect and many merely rewrote the student's original statement. The most common mark gained was for the idea of the water moving perpendicular to the direction of the wave motion. Only the highest ability candidates gained full credit.

Question 17(b)

(b) A student watches a ball game on the school field.

The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is much greater than the speed of sound.

Describe an experiment which measures the speed of **sound** in air.

In your answer describe the measurements, calculations and procedures needed to gather **accurate** and **reliable** results.

You may draw a diagram as part of your answer.

.... **[5]**

This question assessed AO1, AO2 and AO3 and discriminated well between the lower and higher ability candidates. Many correct experiments were suggested, for example practical improvements to the ball being hit by a bat making use of echoes, microphones and oscilloscope, as well as less practical suggestions in a school setting involving the use of fireworks and explosions. Some candidates made vague references to 'using a computer' that could not be credited.

Most candidates realised that it was necessary to measure a time, but did not clearly specify what time they should measure. Almost every candidate gained some credit, many for stating the correct equation to calculate speed or for the idea of taking multiple readings and then using the average value.

Exemplar 2

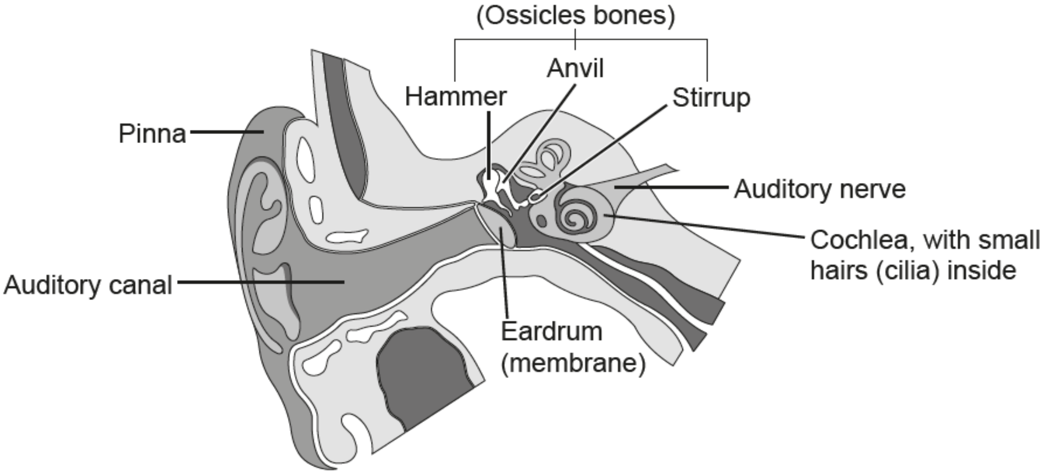
Two students with a stop clock and measuring tape could shout to each other over a distance of around 200 metres (which they would measure out using a measuring tape). One student could then use some sort of body language (eg putting his thumbs up) to show that he's going to shout and to start the stop watch. As soon as the other student hears him he would stop the stopwatch. They could repeat this several times and swap roles, to get more accurate results **[5]** and decrease the chances of human error. They could then find an average time and do Distance ÷ time to find an average speed.

This candidate gained full credit. The response included:

- a suitable experiment
- an appropriate time and distance measured
- an equation to calculate the speed
- the improvement of repeating and averaging the readings in order to improve accuracy and reduce the effect of operator error on their observations.

Question 17(c)

(c) Look at the diagram of a human ear.



Sound wave disturbances, outside the ear, transfer energy to the small hairs (cilia) inside the cochlea.

The cochlea then sends nerve impulses along the auditory nerve to the brain.

Explain how sound wave disturbances in the air outside the ear transfer to the small hairs (cilia) inside the cochlea.

.... **[3]**

Most candidates gained at least 1 mark for either the eardrum, ossicles or cilia vibrating. Good responses were able to mention all 3 of these vibrations. Candidates who achieved zero or 1 mark, did not use the word 'vibrate', merely listing the parts of the ear that the sound travelled through.

Question 18(a)(i)

18 Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 μm				

(a) The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

[2]

This question assessed AO1 and AO3 and required candidates to recall and use the equation: *wave speed = frequency x wavelength* as well as convert 30 GHz into Hertz and 1 cm into metres. Most candidates struggled with the meaning of the prefixes and converting the units. Because many of these candidates did not write down the equation or their workings they could not be credited for any of the compensatory marks available in the mark scheme. A number of candidates used data from the table for radio or infra-red waves. Although they could not gain full marks they were credited with 1 mark for correct use of the equation.

Question 18(a)(ii)

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

Answer = ... nm **[3]**

This question required candidates to convert the prefix Tera into a power of ten, recall and rearrange the equation: *wave speed = frequency x wavelength* to calculate the wavelength of ultra-violet, and then convert their answer into nanometres.

Only the higher ability candidates gained full credit. The majority of candidates did not score any marks. Those candidates, who did gain credit, were credited with a one mark for correctly rearranged equation or for the correct application of the equation (i.e. 3×10^8 divided by any frequency from the table).

OCR support Candidates would benefit from greater familiarity with the standard metric prefixes (WS1.4d). The Mathematical Skills Handbook provides additional support on the use of prefixes and powers of ten for orders of magnitude: http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf

Question 18(b)

(b) Ultra-violet waves can damage human skin.

Describe the damage caused to human skin by ultra-violet waves.

....

.... **[1]**

The majority of candidates achieved 1 mark. Of those candidates who did not gain credit, most had stated that ultra-violet waves cause 'burns' rather than cause sunburn.

Question 18(c)(i)

(c) Sun cream can be used to protect skin from ultra-violet waves. Sun creams have different sun protection factors (SPF).

Look at the information about a bottle of sun cream.

> This sun cream has a SPF of 10.
>
> If used sensibly it can allow you up to 10 × longer in the Sun without increasing the risk from ultra-violet waves.

(i) A doctor says 'adults should not sunbathe for more than 20 minutes in the midday sunshine when **not** using sun cream'.

If an adult used sun cream with SPF 6, how long could they safely sunbathe for?

Answer = ... minutes **[1]**

Almost every candidate answered this question correctly.

Question 18(c)(ii)

(ii) The doctor says that children should always use at least SPF 50 sun cream.

Suggest reasons why.

....

....

....

.... **[2]**

Most candidates were credited with one mark for the idea that children have more sensitive skins. Around a quarter of candidates were credited with both marks, frequently because they recognised that children spend more time in the sun.

Question 18(d)*

(d)* Ultrasound and X-rays are used to scan patients in hospital.

Look at the information about these two different waves.

Name	Frequency	Wavelength	Type	Description
Ultrasound	≥ 2 MHz	≤ 1.6×10^{-4} m	Longitudinal	Pressure sound wave
X-rays	≥ 3×10^{16} Hz	≤ 10 nm	Transverse	Electromagnetic wave

Ultrasound and X-rays are used to scan different parts of the patient.

Explain how ultrasound and X-rays are used and evaluate the risks and benefits of using these two different waves to scan patients in hospital.

Use the information in the table in your answer.

.... **[6]**

This Level of Response question assessed all three Assessment Objectives and provided an opportunity for candidates to demonstrate Grade 9 performance. Most candidates gained some credit for their written responses. The majority demonstrated a good knowledge of X-rays in particular and two thirds of the candidates demonstrated Level 2 or Level 3 performance. Many excellent responses at Level 3 included detailed explanations of absorption of X-rays by bones, reflection of ultrasound for soft tissues, and a detailed evaluation of the risks and benefits of the two different waves.

? Most responses successfully identified the risks / benefits of X-rays but a common misconception was that ultrasound could also cause cell mutations or harm (to the baby).

? **Misconception** Most candidates successfully identified the risks and benefits of X-rays but a significant number of candidates mistakenly believed that ultrasound could also cause cell mutations or harm to the baby.

Exemplar 4

18. (d) Ultrasound waves are used to look at a live image of soft tissues within the body such as a foetus by measuring the time it takes for the wave to return when it reflects at the border of a membrane. This process is beneficial as it can produce a live feed of the inside of the body and also it is completely harmless as it is only a sound wave as it is above 2MHz a human can't hear it and so it doesn't affect our hearing. However, it can only produce a black and white image and it can only detect soft tissues so X-rays are used. X-rays are high energy Electromagnetic waves that potentially pose a large risk of ionisation and cancer in patients so exposure is limited and the technicians and doctors are protected by a lead wall to absorb any radiation as the high frequency of $\geq 3\times10^{16}$Hz means it is high energy and could penetrate through thin materials. The X-rays are passed through the body and where there is bone they are absorbed and so do not reach the filmbehind the person and so these parts stay white and the X-ray that reach it turn the film black to leave and image of bones which is usefu to see broken bones but is expensive compared to ultra sound and also produces a black and white image but most impotantly is dangerous and so needs to be llimited where as ultrasound is harmless.

This is a six mark, Level 3 answer. The candidate included a detailed explanation of how both X-rays and ultrasound are used to scan patients. There is also a detailed evaluation of risks / benefits of both waves, which includes the use of some data from the table.

Question 19(a)

19 Nuclear radiation, such as gamma, is used to irradiate some fresh food to increase its 'shelf-life' and make it last longer.

Fresh herbs and spices are dried and irradiated with gamma rays.

(a) Explain the difference between nuclear **irradiation** and nuclear **contamination**.

....

....

.... **[2]**

Only a small number of candidates were unable to explain the difference between irradiation and contamination. A common misconception was candidates that confused the terms 'radiation' and 'radioactive source' in their explanation.

Question 19(b)

(b) Explain how the gamma rays can increase the 'shelf-life' of herbs and spices to make them last longer.

....

....

.... **[2]**

A complete explanation linking the bacteria being killed by gamma rays to the slowing down of the decay of the food was only given by higher ability candidates**.** Many candidates did not know that gamma rays kill bacteria. A common misconception was that gamma rays 'give energy to the food'.

Question 19(c)

(c) Some people are worried about eating irradiated food.

Write down two **concerns** they may have about irradiated food.

1. ....

....

2. ....

....
[2]

The majority of candidates gained one mark for sating the concern that the food may become radioactive or cause cancer. It was rare for a second valid concern to be given by a candidate.

Question 19(d)(i)

(d) Carbon is a common element. Carbon has two different isotopes called carbon-12 and carbon-14. Both of these isotopes have six protons in the nucleus.

(i) Carbon-14 is radioactive and carbon-12 is **not** radioactive.

Explain why some isotopes are radioactive.

....

.... **[1]**

Just over half of the candidates correctly explained that some isotopes are radioactive because the nuclei are unstable or have too many neutrons. Common incorrect responses referred to 'more neutrons' or ideas about numbers of electrons or protons.

Question 19(d)(ii)

(ii) Describe how the nucleus of carbon-12 is different to the nucleus of carbon-14.

....

.... **[1]**

The majority of candidates successfully stated that there are a different number of neutrons in carbon-12 and carbon-14.

Question 19(e)(i)

(e) Decay equations are used to show the type of emission from different radioactive elements.

(i) Complete the decay equation for **alpha** emission.

$$^{230}_{92}U \rightarrow {}^{4}_{2}He + {}^{.....}_{.....}Th$$ **[2]**

Question 19(e)(ii)

(ii) Complete the decay equation for **beta** emission.

$$^{214}_{83}Bi \rightarrow {}^{.....}_{.....}\beta + {}^{214}_{84}Po$$ **[2]**

Question 19(e)(iii)

(iii) Complete the decay equation for **gamma** emission.

$$^{235}_{.....}U \rightarrow {}^{0}_{0}\gamma + {}^{.....}_{92}U$$ **[2]**

Almost all candidates were able to complete all three decay equations. Of the small number who could not complete the equation the most common error was stating the atomic number of beta as +1 rather than -1.

Question 20(a)

20 A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	24
E	8	5	6
F	32	30	120

(a) Most of the drivers tested the car on a dry day, on a level road.

Which driver tested the car on an **icy** road?

Driver .... tested the car on an **icy** road. **[1]**

Almost all candidates were able to answer this correctly.

Question 20(b)

(b) Which driver has the **quickest** reaction time?

Driver .... has the **quickest** reaction time.

Calculate their reaction time.

Answer = ... s **[3]**

Most candidates were able to identify that driver E had the quickest reaction time. Only the higher ability candidates were then able to correctly calculate the reaction time. Calculations were sometimes shown and a common error made by candidates when calculating the reaction time was to use (*thinking distance + braking distance*) ÷ *speed*.

Question 20(c)

(c) Give **two** drivers that have the **same** reaction time.

Drivers .... have the **same** reaction time.

Explain your answer.

....

....

.... **[2]**

This question required candidates to identify two drivers from A, C and D and explain why their reaction times are the same. Over half of the candidates correctly identified two of the drivers. Most of these candidates proceeded to explain why, usually by calculating the reaction time of 0.75 s.

A significant number of candidates did not gain any credit. A common error candidates made was to choose drivers A and E or B and D due to their braking distances being almost the same.

Question 20(d)

(d) Driver **C** travels at 32 m/s on the road and then stops. The car has a mass of 1200 kg.

(i) Show that the **kinetic energy** stored by the car at 32 m/s is 614 000 J.

[2]

We have adjusted the mark scheme to allow for a typo within this question.

Question 20(d)(ii)

(ii) Describe what happens to the kinetic energy of the car as it brakes and stops.

....

....

....

.... **[2]**

The majority of candidates knew that the kinetic energy store would decrease or be transferred and so were credited with one mark. Fewer candidates gained the second mark as although they referred to heat or thermal energy they did not specify that the energy was transferred to the brakes or surroundings (i.e. into a thermal energy store).

Question 20(e)

(e) Driver **B** travels at 16 m/s on the road. The thinking distance is 13 m and the braking distance is 24 m.

Driver **B** now drives the car **uphill** at the same speed on the same road.

How will driving the car **uphill** affect thinking, braking and stopping distances?

The reaction time will stay the same.

Complete the sentences.

The **thinking distance** will ....

The **braking distance** will ....

The **stopping distance** will ....

[2]

Higher ability candidates generally were credited with full marks for this question. However a third of the candidates did not provide any creditable response. .

AfL

These 'thought experiment' type questions can be used as short starter activities to help students develop the habit of thinking about science. Candidates can also be encouraged to quickly sketch out the question. This can help candidates to visualise how the forces acting on the car have changed from moving along the flat road to moving uphill at a constant speed.

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