Qualification Accredited

OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

J249/02 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 2 series overview

This was the first paper 2 of the new style GCSE. The paper is designed to assess content from Topics P5 to P8 with assumed knowledge of Topics P1 to P4 and P9. Thus, this paper requires candidates to have knowledge and understanding of all the topics within the course.

There was no evidence to suggest that candidates were short of time in answering the paper. The majority of candidates answered all the multiple choice questions. All the structured questions were attempted although one or two sub-parts were omitted by a significant minority of candidates, in particular, Q17(c), Q23(c)(i), Q23(c)(iii) and Q23(d)(ii).

A number of questions required candidates to analyse information and ideas. For example, in Q17, data from a radioactivity experiment needed to be analysed to identify the types of radiation and in Q20, the data on stopping distances given in a table was used in all parts of the question. Similarly, in Q23, candidates needed to interpret a graph. Candidates should be encouraged to practise interpreting data both qualitatively and quantitatively from different sources.

There were a number of questions where candidates needed to carry out a numerical calculation. Candidates should be encouraged to write the recalled equation down as a first step, then identify the data to use and substitute the data into the equation, before calculating the answer. It is very important for candidates to write down what they are doing at each stage. They should remember to carefully consider the units of their data.

On this paper, there was one question, Q20(c), 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. Candidates should also ensure that they answer the question set.

There are a number of questions where an explanation was required. Candidates should be encouraged to use the number of answer lines and the marks for the particular sub-part as a guide to the length of their answers. Candidates should also ensure that they use appropriate technical physics terms correctly in their answers.

Section A overview

Section A of the paper has fifteen multiple choice questions, each worth one mark. Candidates should be given the opportunity to practise these type of questions under timed conditions. In particular, they should be encouraged not to spend too long on any particular question but also to read the whole question including all the possible options.

AfL Candidates should not be afraid to use the white space around the question to write done working and/or equations. This will assist with answering the question and to enable them to check their answer at the end of the examination. Annotating in the white space can also help the candidate to eliminate incorrect options as they read through the question.

Key:

AfL Guidance to offer for future teaching and learning practice.

Question 1

1 Some electromagnetic waves are used to scan a person in hospital.

Which statement is true about a scan that uses **electromagnetic** waves?

A Micro-waves are used to scan skin.

B Ultrasound waves are used to scan an unborn baby.

C Ultra-violet is used to scan for cancer.

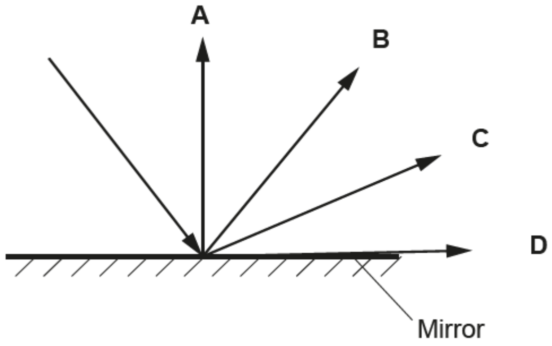
D X-rays are used to scan for broken bones.

Your answer [ ] **[1]**

This question was generally answered well. The common incorrect answer was B, where candidates thought that ultrasound was an electromagnetic wave.

Question 2

2 Which light ray shows the correct reflection from the plane (flat) mirror?



Your answer ☐ **[1]**

This question was generally answered well. Some candidate incorrectly selected either A the normal or C.

AfL With ray diagrams, candidates should always identify the normal, before working out further positions of the rays.

Question 3

3 Which statement is true about the **nucleus** of an atom?

A It contains neutrons and ions and has a negative charge.

B It contains neutrons and ions and has a neutral charge.

C It contains neutrons and protons and has a neutral charge.

D It contains neutrons and protons and has a positive charge.

Your answer ☐ **[1]**

Most candidates answered this question although a common misconception was that the nucleus was uncharged (option D).

Question 4

4 Estimate the typical cruising speed of a jet airliner.

A 25 m/s

B 250 m/s

C 2 500 m/s

D 25 000 m/s

Your answer ☐ **[1]**

This question assessed P8.1a which includes the abilities to recall typical speeds of other transportation systems. Many candidates chose 2500 m/s (equivalent to 9000 km/h), rather than 250 m/s, equivalent to 900 km/h (or about 560 mph). Candidates should have an idea of typical speeds of wind, sound as well as walking, running, cycling and other transportation systems such as trains.

Question 5

5 A student experiments with a model parachute and collects some results.

She drops the parachute from a height of 4 m three times and takes **three** results of the time taken.

The three results are:

3.25 s
3.00 s
3.08 s

What is the mean of the three results?

A 3.00 s

B 3.08 s

C 3.11 s

D 3.25 s

Your answer ☐ **[1]**

Question 6

6 A student wants to find out which heater produces the largest temperature rise.

Look at the results she collects and the calculations she makes.

Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)
A	18	28	20
B	18	36	16
C	18	44	26
D	18	51	23

Which heater has results that are correctly calculated?

Your answer ☐ **[1]**

Higher ability candidates added an extra column to the table to calculate the change in temperature. These candidates were also more likely to write down their workings, even for multiple choice questions. See exemplar 1

Exemplar 1

6 A student wants to find out which heater produces the largest temperature rise.

Look at the results she collects and the calculations she makes.

Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)	
A	18	28	20	10
B	18	36	16	18
C	18	44	26	26
D	18	51	23	33

Which heater has results that are correctly calculated?

Your answer C ✓

Question 7

7 Which row **A**, **B**, **C** or **D**, is true for electromagnetic waves?

	Transmission	Type	Movement in space
A	Transmit energy from absorber to source	Longitudinal	Travel through space at different velocities
B	Transmit energy from absorber to source	Transverse	Travel through space at different velocities
C	Transmit energy from source to absorber	Longitudinal	Travel through space where all have the same velocity
D	Transmit energy from source to absorber	Transverse	Travel through space where all have the same velocity

Your answer ☐ **[1]**

Candidates found this question difficult with only about a third of the candidates choosing the correct answer D. Candidates should know that electromagnetic waves are transverse and travel through space with the same velocity. The other three options were regularly chosen by the candidates.

Candidates should practice answering this type of questions which often test basic knowledge and understanding. One way of answering these questions is to look at one of the column headings for example transmission and rule out with small crosses A and B, then look at the next column and rule out A and C, which then means the correct answer should be D. In this question the third column could be used to check that D would still work again by placing a cross next to A and B.

Question 8

8 A vehicle has an input power from fuel of 20 kW and a useful output power of 6 kW.

Calculate the power it wastes.

A 3 kW

B 6 kW

C 14 kW

D 20 kW

Your answer ☐ **[1]**

Question 9

9 Which statement is **correct** about geostationary satellites?

A They are above the equator and they orbit the Earth in about 90 minutes at a high orbit.

B They are above the equator and they orbit the Earth in 24 hours at a high orbit.

C They are above the equator and they orbit the Earth in 24 hours at a low orbit.

D They are above the poles and they orbit the Earth in 24 hours at a low orbit.

Your answer ☐ **[1]**

This question assessed P8.3e and was answered correctly by around 40% of candidates. All three distractors were chosen with equal frequency.

Question 10

10 A student measures the time it takes for the sound from a firework to reach the observer.

She takes 3 measurements of the time taken for four different distances, **A**, **B**, **C** and **D**.

Distance	Time taken (s)		
	1st measurement	2nd measurement	3rd measurement
A	2.16	2.19	2.17
B	1.99	2.02	1.97
C	1.80	1.81	1.89
D	1.69	1.68	1.71

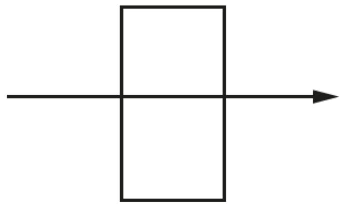
Which distance **A**, **B**, **C** or **D**, has the largest range of values?

Your answer ☐ **[1]**

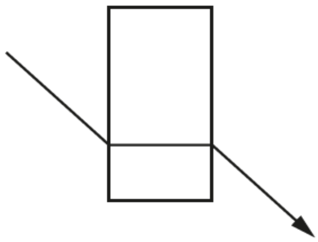
This question was answered correctly by most candidates and many had added a column to the table to determine the range for each of the four distances.

Question 11

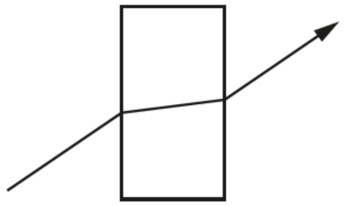
11 Look at the diagrams of a light ray as it passes from air through a glass block.



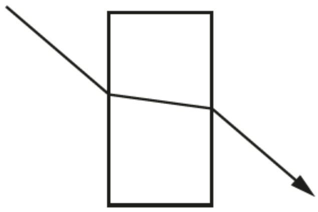
A



B



C



D

Which diagram shows an **incorrect** refraction?

Your answer **[1]**

Candidates found this question very challenging and the most common response was distractor A.

AfL

A better way for candidates to approach this question would be to consider refraction occurring with a change of speed and the effect across a wavefront. In diagram A, a change of speed would change the speed of all parts of the wavefront by the same amount so that the wavefront would continue to move 'in step'. Response B is the correct answer since it would not be possible to have an angle of refraction of 0° with an angle of incidence greater than 0°. Similarly, for the emergent ray it would not be possible to have an angle of refraction greater than 0° if the angle of incidence is 0°.

Question 12

12 A radio wave has a wavelength of 100 m. It has a speed of 3×10^8 m/s.

Use the equation: Wave speed = Frequency × Wavelength

Calculate the frequency of the wave.

A 3 MHz

B 30 MHz

C 300 MHz

D 3000 MHz

Your answer ☐ **[1]**

This was the most challenging question in Section A. The most common response was distractor D, where candidates multiplied the numbers together rather than dividing wave speed by wavelength.

AfL

For these type of questions candidates should be encouraged to insert the numbers into the equation. When they do this they will see that the equation needs to be rearranged. Alternatively, candidates could rearrange the equation so that the unknown quantity is on the left-hand side of the equal sign.

Question 13

13 Which equation shows a correct alpha decay?

A $^{241}_{95}\text{Am} \rightarrow ^{239}_{91}\text{Np} + ^{2}_{4}\text{He}$

B $^{241}_{95}\text{Am} \rightarrow ^{237}_{93}\text{Np} + ^{0}_{2}\text{He}$

C $^{241}_{95}\text{Am} \rightarrow ^{237}_{93}\text{Np} + ^{4}_{2}\text{He}$

D $^{241}_{95}\text{Am} \rightarrow ^{237}_{93}\text{Np} + ^{0}_{1}\text{He}$

Your answer ☐ **[1]**

Almost half of the candidates correctly recalled that an alpha particle had 2 protons and 2 neutrons and were able to show that they understood standard nuclear notation (conventional representation for nuclei).

Question 14

14 A wooden block has a mass of 2 kg and a specific heat capacity of 2000 J/kg °C.

Calculate the energy needed to raise its temperature by 6 °C.

Use the equation:

Change in thermal energy = Mass × Specific Heat Capacity × Change in Temperature

A 1 200 J

B 2 400 J

C 12 000 J

D 24 000 J

Your answer ☐ **[1]**

Question 15

15 A lorry has a mass of 3500 kg. It travels at a speed of 30 m/s.

Use the equation: Kinetic Energy = 0.5 × Mass × Speed^2

Calculate the kinetic energy of this lorry.

A 10 500 J

B 52 500 J

C 1 575 000 J

D 3 150 000 J

Your answer ☐ **[1]**

Q14 and Q15 where candidates were required to carry out a simple substitution into a given equation were generally answered well. The most common error was not squaring the speed in Q15 and choosing distractor B.

Section B overview

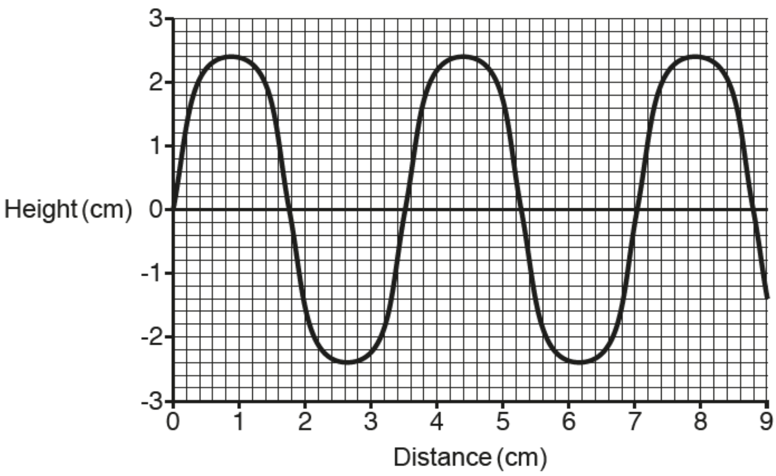
All the questions in this section were attempted.

Candidates should be encouraged to use the answer lines and marks as a guide to the length of their answers. Numerical calculation questions will typically contain marks for following the appropriate process (i.e. recalling the correct formula, rearranging the formula, using the correct units, intermediate calculations) and candidates should be encouraged to show their working so that they can access these marks. Most candidates did not show their workings and adopted a high risk strategy where, if the number they wrote down was incorrect, they could not be credited with any marks (for example Q20b).

There were a number of questions which required candidates to explain physics using their physics knowledge. In these questions candidates are expected to use technical scientific terms correctly.

Question 16(a)(i)

16 Look at the diagram of a water wave.



(a) **(i)** What is the **wavelength** of this wave?

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

One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response was 9 cm.

Question 16(a)(ii)

(ii) What is the **amplitude** of this wave?

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

Many candidates read the vertical axis incorrectly and gave values that were around 2.4 cm but not that specific value (for example 2.5 cm).

? **Misconception** A common incorrect answer was 4.8 cm, where candidates confused the peak to peak value with amplitude. Other candidates confused amplitude with the wavelength.

Question 16(a)(iii)

(iii) The wavelength of the wave is changed to 25 cm. Two waves are produced each second.

Use the equation: Wave speed = Frequency × Wavelength

Calculate the speed of the wave.

Answer = ...m/s **[2]**

Most candidates were credited with one mark for multiplying 2 by 25 to give an answer of 50. Fewer candidates appreciated that this was 50 cm/s while the unit on the answer line was m/s.

AfL

Encourage candidates to check the unit used on the answer line. This additional information can help them to understand the question and the equations they should use.

Question 16(b)(i)

(b) Water waves are transverse and sound waves are longitudinal.

(i) Describe how water particles move in a **transverse** water wave.

....

.... **[1]**

Question 16(b)(ii)

(ii) Describe how air particles move in a **longitudinal** sound wave.

....

.... **[1]**

Very few candidates were able to express a clear understanding of the motion of particles caused by the progress of a transverse water wave, Q16(b)(i), or a longitudinal sound wave, Q16(b)(ii). A number of candidates stated used ambiguous descriptions such as 'the particles would move side to side', which could apply to both transverse and longitudinal waves.

OCR support

The Waves in Matter transition guide (from KS3 to KS4) provides guidance on the teaching about waves.

http://www.ocr.org.uk/Images/318139-waves-in-matter-transition-guide.pdf

Question 16(c)(i)

(c) Look at the diagram of the electromagnetic spectrum.

Radio	Microwave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays

(i) Name a wave that has a longer wavelength than red light.

.... **[1]**

Question 16(c)(ii)

(ii) Name a wave that has a higher frequency than violet light.

.... **[1]**

Question 16(c)(iii)

(iii) State two **uses** of gamma-rays.

1. ....

2. ....

[2]

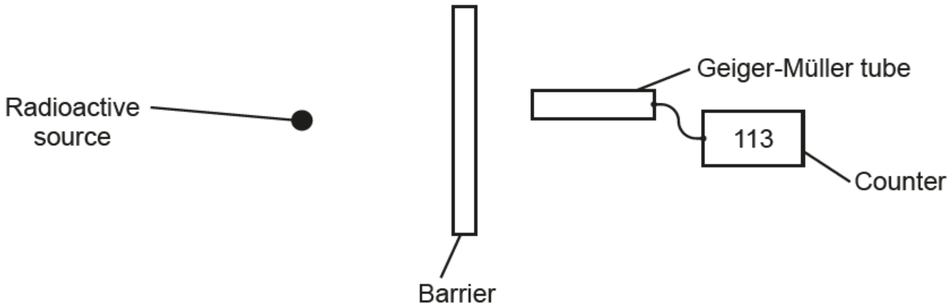
Candidates had a sounder understanding of the trend in frequency in the electromagnetic spectrum (part ii) than that for wavelength (part i). The most common misconception was by candidates who gave visible light as their response to both part i and part ii. Around half of the candidates knew that gamma-rays are used in the treatment of cancer but other uses, such as the irradiation of food or medical equipment, were known by far fewer.

To gain credit, candidates need to ensure that their answers are specific. A number of candidates stated that gamma-rays were used in chemotherapy. Some candidates stated that gamma-rays were used in scans, often with an implication of unborn babies. It was hoped that candidates would understand the use of gamma radiation as a tracer and for sterilising instruments.

Question 17(a)

17 A teacher demonstrates an experiment about radioactivity. He demonstrates how different types of radiation can be absorbed.

He puts different barriers between the source and the Geiger-Müller tube. He uses four different radioactive sources **A**, **B**, **C** and **D**.



(a) Suggest two safety **precautions** that the teacher should use when demonstrating this experiment.

1. ....

....

2. ....

.... **[2]**

Many candidates answered this question in general terms suggesting general laboratory rules rather than specific safety precautions relevant to the experiment. A large number of candidates suggested keeping a safe distance from the source. Some candidates were confused about whether the barrier was part of the experiment or a safety device.

Higher ability candidates gave relevant precautions including the use of tongs to hold the source (in effect adding some distance), using the sources for a short period of time (to minimise exposure) and storing the sources in lead lined boxes.

Question 17(b)(i)

(b) The teacher chooses source **A** and uses the Geiger-Müller tube to measure the count rate (counts per minute) for different barriers. He repeats the experiment with source **B**, source **C** and then source **D**.

Look at his results.

Source	Count rate using different barriers			
	Paper	Aluminium	Lead	No barrier
A	113	112	22	112
B	20	21	20	182
C	162	23	21	164
D	282	78	24	280

He also finds that the **average count rate** with **no** sources and **no** barriers is 20.

(i) Which source **A**, **B**, **C** or **D** emits **gamma** radiation only?

Explain your answer.

Source .... because ....

....

.... **[2]**

Question 17(b)(ii)

(ii) Which source **A**, **B**, **C** or **D** emits **alpha** radiation only?

Explain your answer.

Source .... because ....

....

.... **[2]**

Candidates were expected to the interpret information from the table. The first mark was credited for identifying the correct source. Candidates then needed to apply their understanding to explain why source A could be the only correct answer for part I (because there was no change in the count rate through paper and aluminium, but the radiation was absorbed by the lead). The most common misconception was to choose source D because it had the largest count rate. For part (ii), half of the candidates correctly identified source B but fewer explained their choice in terms of paper absorbing the radiation.

Question 17(b)(iii)

(iii) Which source **A**, **B**, **C** or **D** could emit both **beta and gamma** radiation?

Explain your answer.

Source .... because ....

....

.... **[2]**

One in four candidates identified the source correctly as D, but few justified their choice in terms of the count rate decreasing though the aluminium and then further decreasing after the lead.

Question 17(c)

(c) The teacher notices that the count rate behind the lead barrier ranges from 20 to 24.

Give **two** reasons why there are a wide range of results around 22 counts per minute.

1. ....

....

2. ....

....
[2]

Candidates found this question very challenging and fewer than 5% were credited with any marks. Many candidates responded in terms of the thickness of the lead barrier. It was expected that candidates would state that there was a range of results because of the random nature of radioactivity and that what was being measured was the background radiation.

Question 17(d)

(d) The teacher decides to repeat the experiment.

This time he records the number of counts for a much longer time interval for each source.

Explain why this is an improvement to the experiment.

....

....

.... **[2]**

A large number of candidates responded by repeated the stem of the question in their own words, many just stated that the time should be increased. A number of candidates stated that the experiment would be "more accurate" without any explanation and so did not gain any. This was a practical skills question, which also assessed candidates' understanding of Working Scientifically (Appendix 5e). Candidates were expected to understand that the longer recording time would give a larger number of counts and thus there would be less variation in count rate, or it would enable an average count rate to de determined. There were also marks available for stating that the teacher's observations would give more repeatable results.

AfL

Candidates should be encouraged to interpret the question paper as to the expected length of their answers. In this question there were three answer lines and two marks available, which indicated that at least two improvements needed to be explained and that a short three-word answer was unlikely to gain both marks.

Question 18(a)(i)

18 Look at the information about different electric motors.

Electric motor	Energy input per hour (J)	Useful energy output per hour (J)	Energy 'wasted' per hour (J)
A	72 000	60 000	
B	54 000	36 000	
C	18 000		3 000
D		48 000	12 000
E	54 000	48 000	

(a) (i) Calculate the energy input per hour in J for electric motor **D**.

Answer = ... J **[2]**

Question 18(a)(ii)

(ii) Which electric motor has the **lowest** 'wasted' energy in one hour?

.... **[1]**

Question 18(a)(iii)

(iii) Which electric motor has the **highest** 'wasted' energy in one hour?

.... **[1]**

Q18(a) parts (i), (ii) and (iii) were answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.

Question 18(a)(iv)

(iv) Describe how energy is 'wasted' in an electric motor.

....

.... **[1]**

A large number of candidates correctly stated that the motor would produce heat and/or sound or indicated that the energy was 'wasted' through friction. Some candidates wrote out all the energy transfers in an electric motor (e.g. "heat, sound and kinetic energy") which could not gain credit as it did not describe how energy is 'wasted'. Credit was given when it was clear that the 'waste' resulted from the transfer of the kinetic energy store of particles passed on to other particles or to the surroundings but not a vague transfer of 'kinetic energy to the atmosphere'.

Question 18(a)(v)

(v) Suggest how this 'wasted' energy can be reduced in an electric motor.

....

.... **[1]**

Candidates found this question extremely challenging. There were very few suggestions of specific improvements to the electric motor such as lubricating it or applying oil to the moving parts. Many candidates suggested general energy efficiency tips such as switching it off when it not in use, running the motor at a slower speed or putting insulation around the motor.

Question 18(b)

(b) Calculate the **%** efficiency of electric motor **E**.

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

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

Answer = ...% **[3]**

Two thirds of candidates were credited with some marks for this question. Candidates needed to use the equation provided and give their final answer as a percentage. Many candidates did not show any working so could only be credited with any marks if their final answer was correctly given as a percentage. There was a compensatory mark for showing 48000 divided by 54000 in a candidate's workings which almost every candidate could have accessed.

OCR support

The answer to two significant figures is 89%. Many candidates gave their final answer to two significant figures as 0.8/ 80% or 0.9/90% or 0.88 /88%. The Mathematical Skills Handbook provides support on the use of significant figures and other required mathematical skills.

http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf

Question 19(a)

19 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 greater than the speed of sound.

He decides to do an experiment to measure the speed of sound waves in air.

(a) Describe which measurements he needs to measure this speed.

....

....

.... **[2]**

Some candidates wrote a list of quantities that could be measured with no description: speed, distance, time, frequency and wavelength. These candidates could not be credited with any marks as they had not answered the question. Candidates were expected to describe how the distance that the sound would travel and the time for the sound to travel were needed to calculate the speed. Many candidates ignored the context for the question and referred to measuring the distance the ball travels.

Question 19(b)

(b) Which equation is used to calculate speed?

.... **[1]**

This question was answered well by candidates. Some candidates quoted the wave equation which was not appropriate to the experiment. A significant number of candidates incorrectly gave the correct equation as *speed = distance x time*. .

Question 19(c)

(c) Describe one way he could get valid results for this experiment.

....

.... **[1]**

Most candidates suggesting repeating the experiment and calculating an average. Some candidates suggested using different distances and then plotting a graph. Other candidates suggested increasing the distance to the observer.

Question 20(a)

20 **Fig. 20.1** shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

(a) Describe how the **thinking distance** changes when the speed doubles.

Use data from the table in your answer.

....

....

.... **[1]**

Around half the candidates stated that thinking distance also doubled and used data from the table to demonstrate their answer. Many of the candidates who did not gain credit stated that the thinking distance increases but without using the information from the question of the speed doubling. Other candidates did not answer the question set but explained factors that could affect thinking distance. A few candidates referred to the 'thinking time' doubling.

AfL

When investigating stopping distances, candidates should be encouraged to understand fully the terms thinking distance, braking distance, thinking time, braking time. Encourage candidates to underline the important parts of the question – in this case thinking distance (which was already emboldened) and speed doubles.

Question 20(b)

(b) Calculate the reaction time of the person driving the car.

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

10% of candidates recalled the speed equation and rearrange it as *reaction time* = *thinking distance* ÷ *speed*. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.

Question 20(c)*

(c)* Explain why the stopping distances are different for each speed in **Fig. 20.1**.

....

....

....

....

....

....

....

....

....

....

....

.... **[6]**

This question gave candidates the opportunity to apply their knowledge and understanding of stopping distances. The question is deliberately set to be open ended so that candidates had the opportunity of structuring their answers logically.

Higher ability candidates explained that the stopping distance was equal to the sum of the thinking distance and braking distance before stating that the stopping distances increased with speed. Often candidates demonstrated the change in stopping distance using the data from the table.

For the highest marks, candidates were expected to analyse the data quantitatively from the table. A few candidates used part (a) and stated that thinking distance doubled with speed and carried out a similar analysis for braking distance, stating that as speed doubled, braking distance quadrupled.

Common misconceptions included thinking time increasing with speed, drivers being under greater pressure at high speed, braking forces increasing with speed. Other candidates discussed factors that affected thinking distance and braking distance rather than using the data in the table.

Exemplar 2

(c)* Explain why the stopping distances are different for each speed in **Fig. 20.1**.

° When driving at 8 m/s the ~~ss stopping~~ thinking and braking distance are equal, 6 m, ~~thre~~ therefore the stopping is 6x2=12 m.
° When driving at 16 m/s the thinking distance double but it ~~t~~ takes longer to break as your going at a faster speed.
° Same applies to 32 m/s as it takes 90 m longer than 8 m/s to stop, meaning the stopping distance totals 120 m.

L2

[6]

This is a four mark, Level 2 response. The candidate has calculated the stopping distance for each speed and provided a limited analysis. They have made good use of mathematical expressions to show that stopping distance is equal to the product of thinking and breaking distance. The information presented is relevant, however there are limited links made between the bullet points. To progress to a Level 3 response the candidate could have added a short introduction and a final bullet point linking the analysis at each speed together in a summary sentence.

Exemplar 3

(c)* Explain why the stopping distances are different for each speed in **Fig. 20.1**.

At higher speeds the thinking and braking distance increase. If the ~~sp~~ speed doubles the thinking distance doubles and the braking distance quadrupals. ~~This~~ Which mean the stopping distances get larger. ~~The~~ The thinking distances increases because the car is travelling at a higher speed meaning it will travel further in that thinking time which stays the same. The braking distance increases massively with faster ~~tra~~ speeds. This is because ~~the~~ there is a higher velocity and a larger moment therefore it takes a lot more force and time to decelerate the car which **[6]** is shown in the graph. ~~Ath~~ This equates to a much ~~higher~~ a difference in stopping times because of these two factors, ~~What~~ caused by the different speeds.

L3

This is a six mark Level 3 response. This is very clear analysis of the data in the table that is linked together in a clear logical structured way. Although the candidate has not annotated their script (except in their response to Q20(a)) it is clear that they have processed the data in the table. They have described the complex mathematical relationships (for example 'if the speed doubles the thinking distance doubles and the breaking distance quadruples') although it would have been easier to present this conclusion numerically.

Question 21(a)

21 **(a)** A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm^2 in contact with the road.

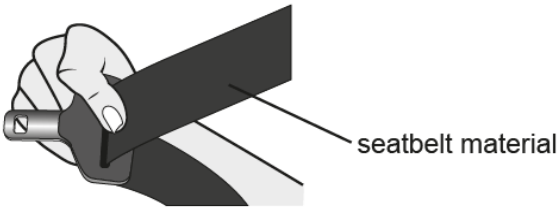
Calculate the pressure of the car on the road.

Answer = ... N/cm^2 **[3]**

Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm^2.

Question 21(b)

(b) Seatbelts in cars are made of a wide material that stretches in a crash.



(i) Explain why it is important that the material is **wide**.

....

.... **[1]**

Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.

AfL

The parts of a question form a story that develops a central theme. In Q21 part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in Q21(b)(i) and Q21(c) most candidates did not make the connection after they were asked to calculate pressure in Q21(a).

Question 21(b)(ii)

(ii) Explain why it is important that the material is **stretchy**.

....

.... **[1]**

Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.

Question 21(c)

(c) Children in cars use special seats with their own seatbelts.

The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children's seatbelts to be **narrower** than adult seatbelts?

....

....

.... **[2]**

Many candidates suggested that the narrower belts were needed because of child car seats are smaller.

Question 22(a)

22 This question is about force, mass and acceleration.

(a) A car starts from rest and accelerates at 3 m/s^2.

Use the equation: Acceleration = Change in velocity ÷ Time taken

Calculate the **velocity** of the car after 4 s.

Answer = ... m/s **[2]**

Higher ability candidates wrote out in a recognisable form that *change in velocity = acceleration x time = 3 x 4 = 12 (m/s).* A common misconception was to divide the acceleration by time taken (i.e. 3 ÷ 4 = 0.75). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.

Question 22(b)

(b) A roller coaster car moves down a slope with an acceleration of 5 m/s^2.

The force on the roller coaster car is 4000 N.

Calculate the **mass** of the roller coaster car.

Answer = ... kg **[3]**

Some candidates divided their calculated answer by 1000 so that there answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.

Question 23(a)(i)

23 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]**

Many candidates found it difficult to interrogate the stacked line graph and many candidates stated the total energy use in 1971 rather than the increase from 1971 to 2003. As the vertical scale on the graph was only marked at 1 billion tonne increments candidates were allowed to give an answer between 5.0 and 5.5 billion tonnes (oil equivalent).

Question 23(a)(ii)

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

.... **[1]**

Most candidates correctly identified oil as the greatest use. Other candidates suggested coal or renewables.

Question 23(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]**

Only around 10% of candidates were able to answer this question fully and most other candidates were not credited with any marks. Many candidates struggled to identify coal, oil and gas as fossil fuels. Those less able candidates that attempted to show their working were could be credited with a compensatory mark.

Question 23(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]**

Most candidates recognised that fossil fuels may run out or be in short supply or stating that they are non-renewable. However, fewer candidates went on to give specific scientific reasons for scientists concerns that were creditable. Most candidates gave generalised responses about fossil fuels damaging the environment or causing 'pollution'.

Question 23(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]**

Higher ability candidates said that there were not enough renewable energy resources and nuclear power stations would assist in meeting the demand for electricity, or help in preserving fossil fuels. Answers which gave detail about less damage to the environment were also credited, although a number of candidates thought that nuclear power stations would not cause any potential damage to the environment.

Question 23(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]**

One in six candidates did mention transformers. Step-up and step-down transformers are on specification knowledge (P8.2d) and candidates should know the difference that step-up transformers are used to increase the voltage distributed by power line.

Question 23(c)(ii)

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

.... **[1]**

This question required candidates to apply their understanding of the National Grid from P8.2e. Only the most able candidates recalled that the higher voltage reduces energy losses but does not eliminate them. Some candidates stated that higher voltages allowed more power to be produced.

Question 23(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]**

Only the most able candidates were able to answer this question explaining both the differences in the direction of the current flow and the polarity of the voltage.

?

Misconception Most candidates' knowledge and understanding of a.c. and d.c. electrical supply is quite vague, and often only understood in terms of 'different directions' but not how this relates to the flow of current nor to the polarity of the voltage.

Question 23(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]**

Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11×23 or $23 \div 11$, rather than $11^2 \times 23 = 2.78$ kW. .

Question 23(d)(ii)

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

....

.... **[1]**

Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

Question 23(d)(iii)

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

State a reason why.

....

.... **[1]**

Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.

AfL

It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.

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