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Examiners' Report June 2018

GCSE Physics 1PH0 1F

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June 2018
Publications Code 1PH0_1F_1806_ER

Introduction

This was the first examination of paper 1, at Foundation Level, for the new specification. Questions were set to test students' knowledge, application and understanding from the seven topics in the specification:

- Topic 1 – Key concepts of physics
- Topic 2 – Motion and forces
- Topic 3 – Conservation of energy
- Topic 4 – Waves
- Topic 5 – Light and the electromagnetic spectrum
- Topic 6 – Radioactivity
- Topic 7 – Astronomy

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. Within the question paper, a variety of question types were included, such as objective questions, short answer questions worth one or two marks each and longer questions worth three or four marks each. There was a new emphasis, too, in the inclusion of questions designed at targeting students' knowledge and understanding of practical work. This included assessing their fundamental knowledge of practicals specified in the specification, together with further application, especially where they were asked to propose improvements to a procedure. One assessment of this skill featured in the six-mark question 9c. The two six-mark questions were used additionally to test students' quality of using evidence within their written communication.

Students coped well with most questions and did particularly well in the questions asking for calculations using equations. Students' knowledge of practical work, in contrast, was not so secure.

Successful candidates were:

- well-acquainted with the content of the specification
- skilled as a result of having been engaged with practical work during their course
- competent in quantitative work, especially in using equations
- well-focused in their comprehension of the question-at-hand
- willing to apply physics principles to the novel situations presented to them

Less successful candidates:

- had gaps in their conceptual knowledge of the topics of this paper
- had gaps in their procedural knowledge, relating to their practical work
- misread and/or misunderstood the symbols used in equations

- did not focus sufficiently on what the question was asking
- found difficulty in applying their knowledge to new situations

This report will provide exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come from responses which highlight successes and misconceptions, with the aim of aiding future teaching of these topics.

Question 1 (b)

Most students realised that the spring balance, measuring in newtons, was measuring **weight**. Some gave 'mass' as their answer however.

Question 1 (c)

A large majority of students multiplied mass and acceleration to yield the correct numerical answer. Approximately one half of the students succeeded with the unit mark.

A small number squared the acceleration and some converted kilograms to grams.

(c) A toy car has a mass of 0.10 kg.
The toy car accelerates at 2.0 m/s².

Calculate the force producing this acceleration.
State the unit.

Use the equation

$F = m \times a$

0.10 x 2.0 = 0.2 **(3)**

Mass = 0.10kg
Acceleration = 2.0m/s

force = 0.2 unit = N

ResultsPlus
Examiner Comments

Reasonably well set out by the student to communicate what is being calculated; this is important in case of slip-ups, so that intermediate marks might then be accessed.

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Examiner Tip

Work in SI units on most occasions - kilograms, metres and seconds.

Show your working, like this student did, to enable intermediate marks to be given in case you make a calculator error.

Question 1 (d)

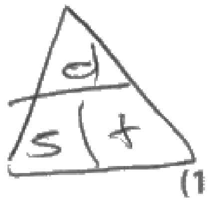
A large majority of students knew of the key difference between scalars and vectors, and so chose appropriately in this completion exercise, obtaining full marks.

Question 2 (a) (i)

Most answers quoted an equation correctly although a few gave the triangle for speed, distance and time. Since an equation was asked for, a triangular representation did not suffice here.

2 (a) A sound wave in air travels a distance of 220 m in a time of 0.70 s.

(i) State the equation linking speed, distance and time.



(1)

Speed = distance ÷ time

ResultsPlus
Examiner Comments

The statement of the equation got the mark.

(Equation aids - triangles - are ignored)

ResultsPlus
Examiner Tip

Triangles may be used as aids, but if the equation is asked for that must be provided to get the mark.

2 (a) A sound wave in air travels a distance of 220 m in a time of 0.70 s.

(i) State the equation linking speed, distance and time. **(1)**

Distance = speed × time

ResultsPlus
Examiner Comments

This is also a correct equation, linking the variables.

Question 2 (a) (ii)

Most students succeeded in substituting into a correct equation from (i), gaining full marks. One mark was allowed for an error carried forward, for substitution into the previous (incorrect) equation.

2 (a) A sound wave in air travels a distance of 220 m in a time of 0.70 s.

(i) State the equation linking speed, distance and time.

(1)

Speed = $\frac{\text{Distance}}{\text{time}}$

(ii) Calculate the speed of the sound wave in air.

(2)

$\frac{220}{0.7} = 314.\dot{2}8571\dot{4}$

wave speed = 314 m/s

ResultsPlus
Examiner Comments

This answer shows a correct substitution and evaluation, commendably showing the working in a clear manner.

ResultsPlus
Examiner Tip

In this question you didn't have to round off to be awarded the mark, but it is good practice and good training for where rounding off / significant figures is needed.

2 (a) A sound wave in air travels a distance of 220 m in a time of 0.70 s.

(i) State the equation linking speed, distance and time.

(1)

220 x 0.70 = 154 distance x time = speed

(ii) Calculate the speed of the sound wave in air.

(2)

220 x 0.70 = 154

wave speed = 154 m/s

ResultsPlus
Examiner Comments

For this part of the question a compensatory error-carried-forward mark is given for a correct substitution into a previously seen incorrect equation -- from part (i).

Question 2 (b)

This question was generally not well answered. The idea of obtaining greater accuracy through measuring across a number of wavelengths/intervals and then dividing by the number of those intervals was only proposed by a very small minority of students. The most frequently seen correct answer was to take a photograph and measure on the image. Alternatively one mark could be obtained by clearly explaining the use of a more accurate device, for example stating, as one student did *'use a ruler that would give a more precise measurement, like a ruler in mm.'*

(b) Figure 2 shows water waves spreading out from a source.

A student measures the wavelength of the waves.

He uses a ruler to measure the distance from one crest to the next crest.

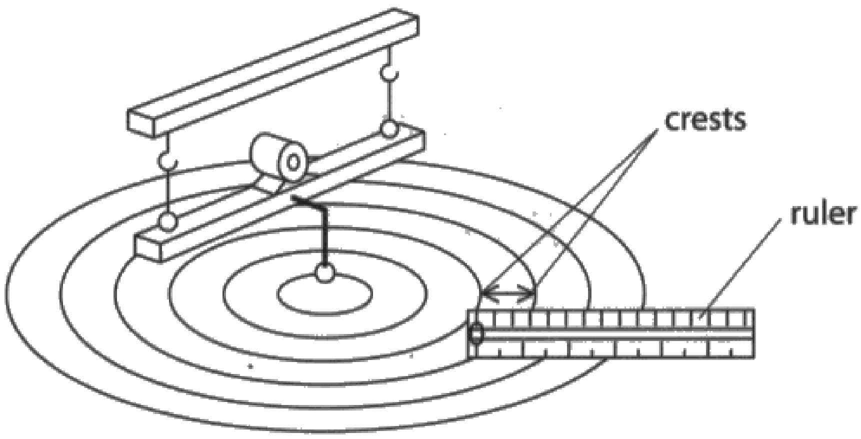


Figure 2

Explain how to improve the student's method for measuring the wavelength.

(2)

Ruler is not really accurate, use something that can measure smaller quantities.

ResultsPlus
Examiner Comments

The question seeks for improvements to the method of measurement. In the mark scheme second column (additional guidance) mark point 1 may be satisfied by 'use a more accurate device (finer divisions)'. This answer is clearly equivalent to that. Examiners use their professional judgement to decide upon equivalence. Equivalences are not always as clear cut as this one.

ResultsPlus
Examiner Tip

When you see the words 'Explain **how to...**' it is vital you engage with practical ideas. Imagine yourself in a laboratory - what would you do? Think and write about experimental ideas and do not neglect to talk about what you would measure, and with what.

(b) Figure 2 shows water waves spreading out from a source.

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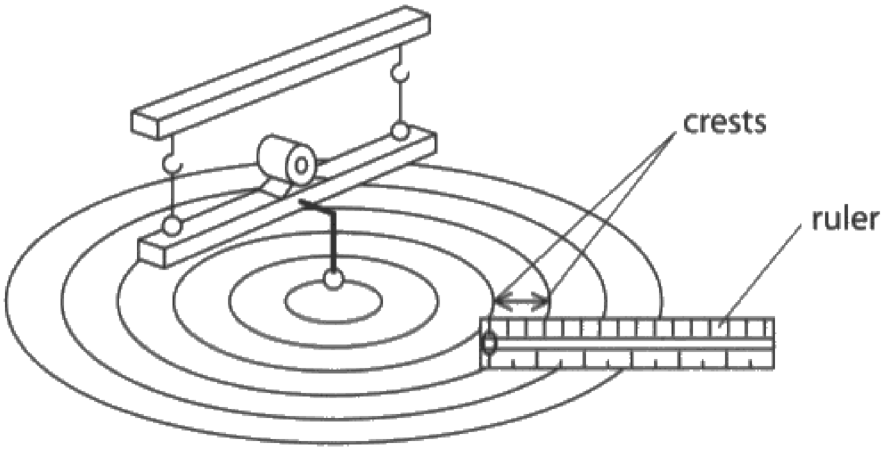


Figure 2

Explain how to improve the student's method for measuring the wavelength.

(2)

Take a picture using a camera with a flash (put the ruler up against the waves before hand). By doing this the waves won't be moving, making it easier to measure.

ResultsPlus
Examiner Comments

Another common approach involved an appropriate use of a camera, also covered in the additional marking guidance. This also earned one mark. Notice the clarity with which this student has spelt out what they would do.

Question 2 (c)

This question showed a lack of fundamental knowledge among candidates of longitudinal and transverse waves. A majority of students were unable to score any marks on this item. There was hardly any reference to particles moving on the waves, but some students were awarded marks through the mark scheme allowing explanations in terms of 'back and forth' or 'up and down', providing those statements were in the right context. Very few candidates linked the movement of the particles to the direction of the wave.

Section 4 of the specification (4.5) requires that students know about 'the difference between longitudinal and transverse waves'. It should come as no surprise that this is asked about in examinations, even in terms of a definition. That definition applies equally well to sound, electromagnetic, seismic and water waves.

(c) Sound waves are longitudinal waves.

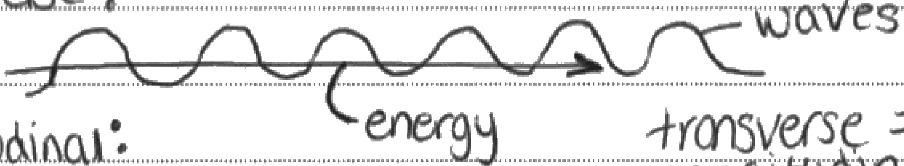
Water waves are transverse waves.

Describe the difference between longitudinal waves and transverse waves.

(3)

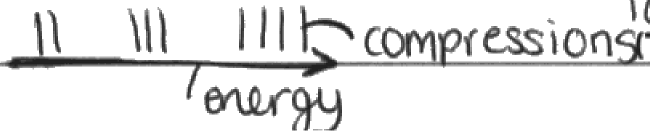
transverse waves have vibrations that move up and down and the energy is transferred across the waves. Longitudinal waves' Energy moves across the wave but in compressions when the particles are vibrating with eachother.

transverse:



longitudinal:

transverse = waves (sea)
longitudinal = sound



(Total for Question 2 = 8 marks)

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Examiner Comments

This student clearly knows what the differences between longitudinal and transverse waves are. The final mark point is for establishing the connection between direction of travel with direction of vibrations. This student has not established that very clearly in their writing but their diagram, which is taken into account, clearly conveys that understanding. 3 marks given.

ResultsPlus
Examiner Tip

One picture is worth a thousand words.

Don't let the lines drawn under an answer put you off drawing helpful diagrams when they clarify things. The examiner will also know then you are on the right wavelength.

Question 3 (a) (i)

Most students scored the full 2 marks, being able to plot accurately (to within one square's tolerance).

(The point 20,37 was often plotted too low though usually within the ± 1 small square.)

3 (a) A copper can, painted black, contains boiling water at 100 °C.

The can is left to cool and a measurement of the water temperature is taken every 5 minutes

Figure 3 shows the measurements.

time in minutes	temperature in °C
0	100
5	74
10	60
15	56
20	37
25	30
30	25

Figure 3

(i) Two points, shaded in the table, have not been plotted.

Plot these two points on the graph, in Figure 4.

(2)

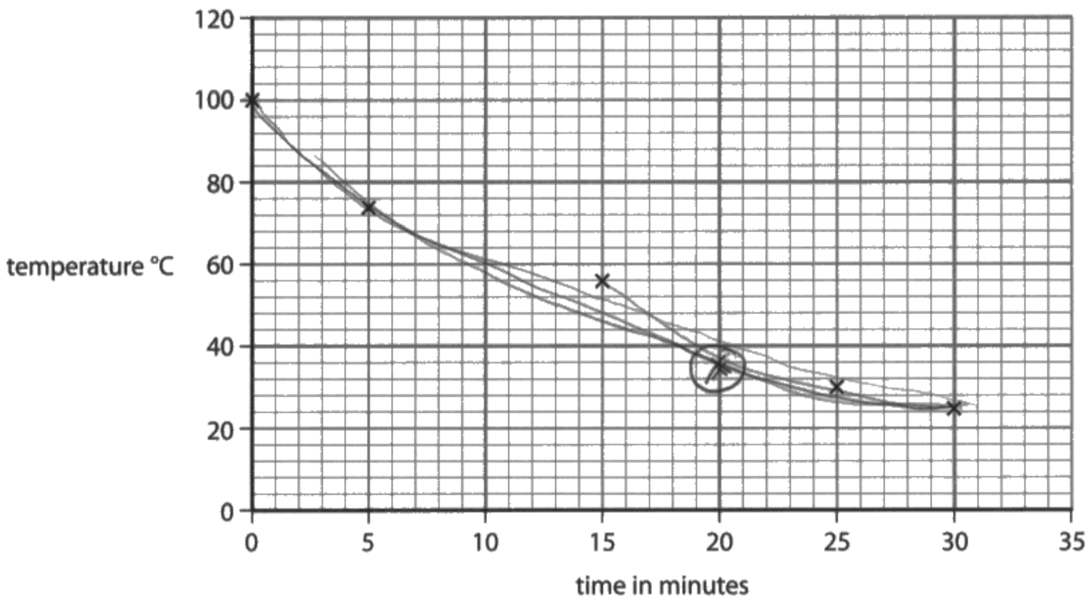

Figure 4

(ii) One of the points on the graph in Figure 4 is anomalous.

Circle the anomalous point.

(1)

(iii) Draw the best fit curve on the graph in Figure 4.

(1)

ResultsPlus
Examiner Comments

This scored one mark, as the student had omitted to plot a point at 10, 60.

3 (a) A copper can, painted black, contains boiling water at 100 °C.

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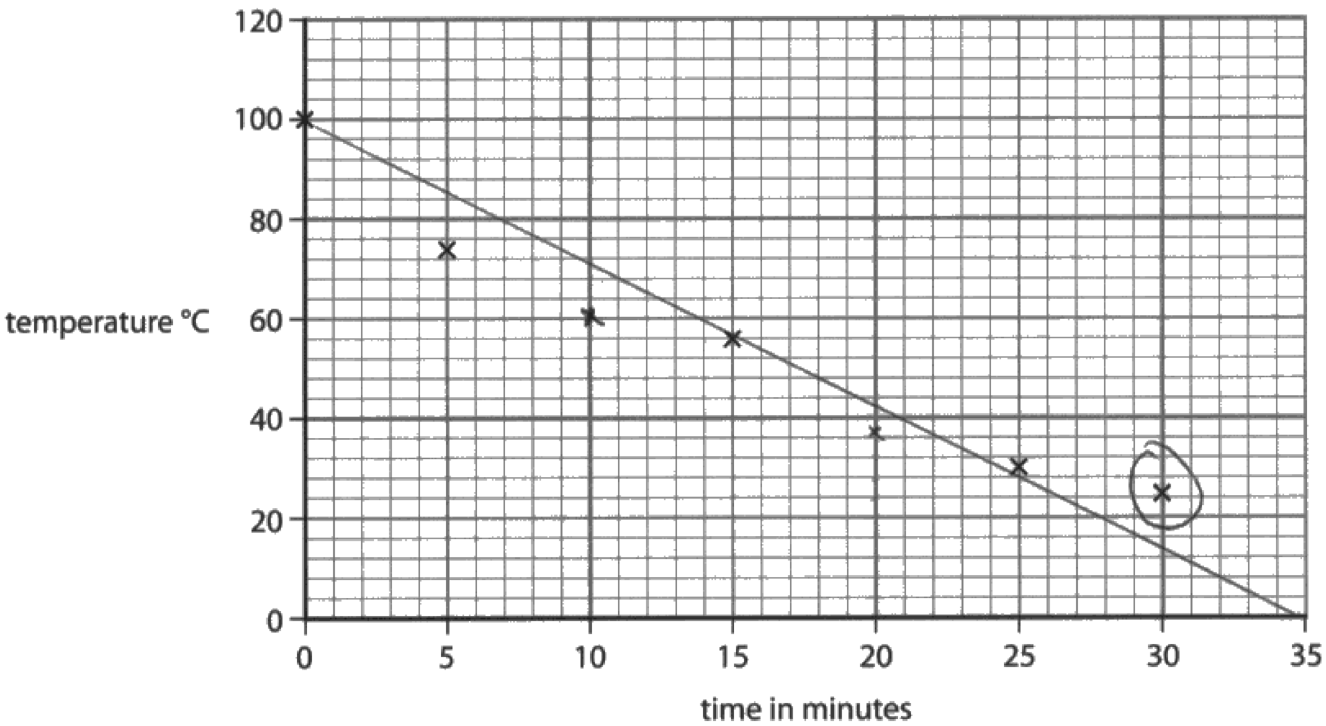

Figure 4

(ii) One of the points on the graph in Figure 4 is anomalous.

Circle the anomalous point.

(1)

(iii) Draw the best fit curve on the graph in Figure 4.

(1)

ResultsPlus
Examiner Comments

3ai awards marks just for plotting in this part of the question. This student has plotted both the required plots accurately.

ResultsPlus
Examiner Tip

It is important to inspect the graph scale carefully to avoid misplotting. In this case one square on the y-axis represented 4°C. Many students misinterpreted that, but were within one square of the correct point, so were allowed the mark. You might not always be so lucky so please work out in your mind what one small square represents, before plotting, to avoid mistakes.

Question 3 (a) (ii)

Approximately two thirds of students succeeded in identifying the middle point as being the anomalous one, lying above the imagined best fit curve.

Question 3 (a) (iii)

A half of all students drew an apt best fit curve. Somestudents drew a straight line while others included the anomalous point or joined dot to dot. Tramlining, lines crossed out or rubbed out very poorly were also seen.

Plot these two points on the graph, in Figure 4.

(2)

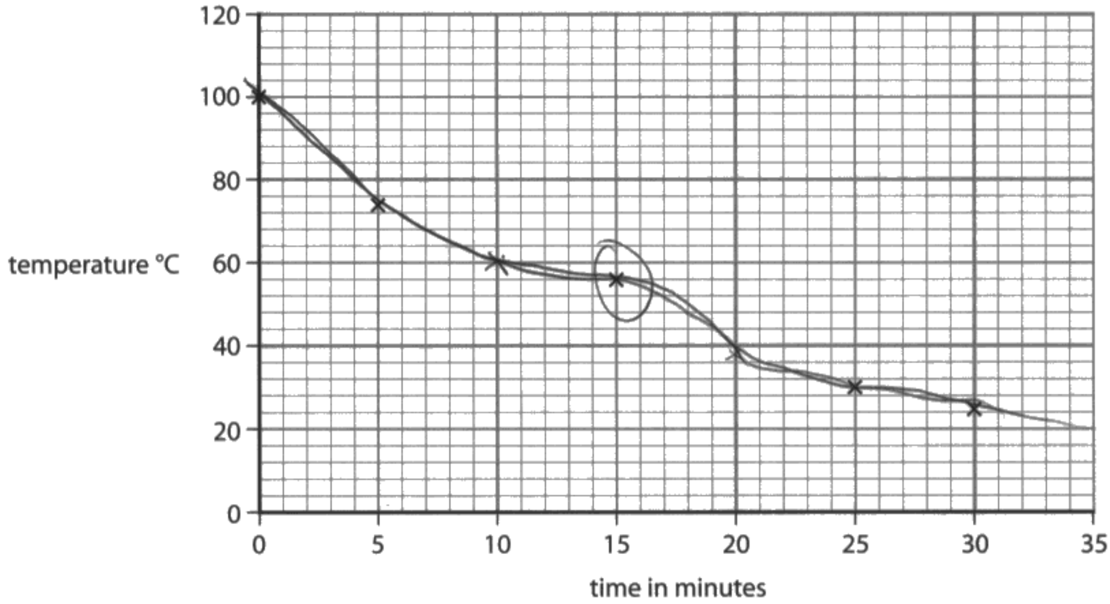

Figure 4

(ii) One of the points on the graph in Figure 4 is anomalous.

Circle the anomalous point.

(1)

(iii) Draw the best fit curve on the graph in Figure 4.

(1)

ResultsPlus
Examiner Comments

This student scored 0 marks for curve drawing. They have not taken into account the anomaly by ignoring it in their curve drawing, and they have produced multiple lines - tramlining, which should be avoided.

ResultsPlus
Examiner Tip

When you are asked to draw best fit lines and curves ignore any anomalous points; they may be circled to show your recognition of that. Aim to draw one continuous line/curve, with points either on, close to or balanced about that line.

Plot these two points on the graph, in Figure 4.

(2)

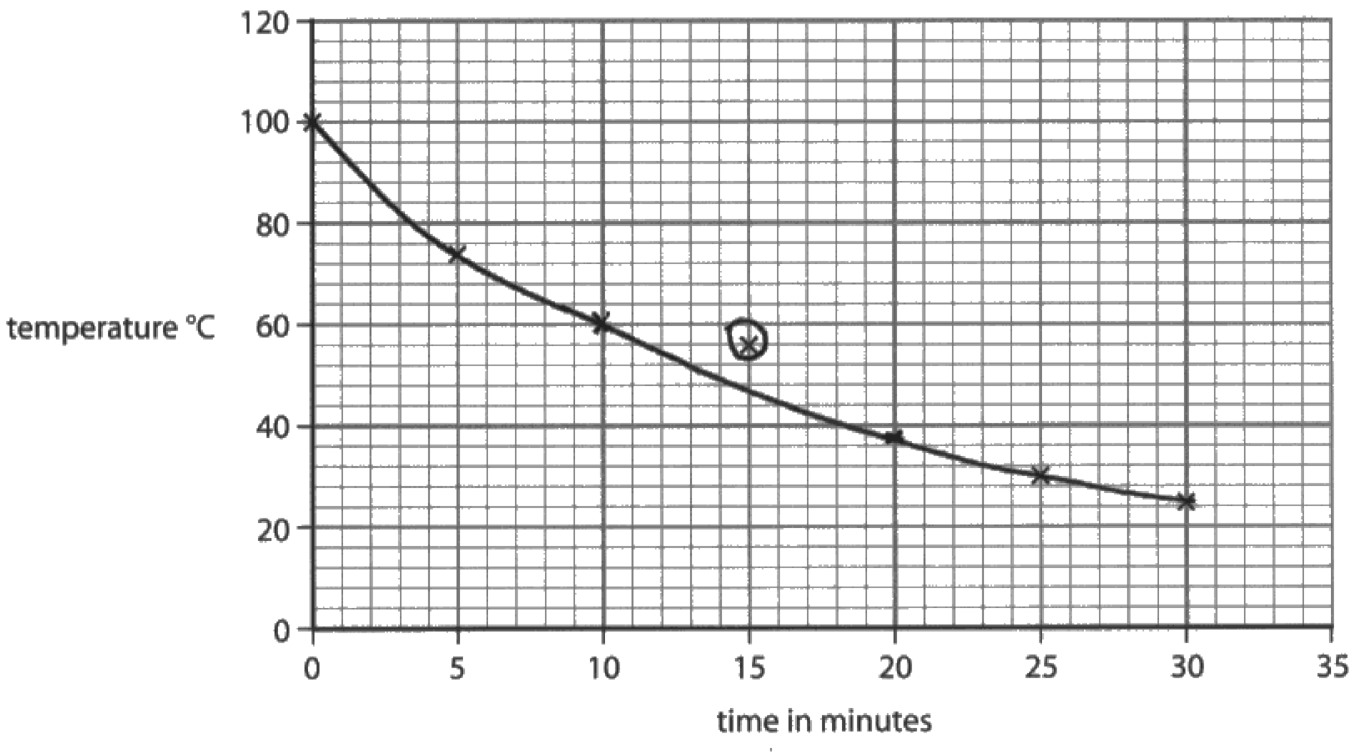

Figure 4

(ii) One of the points on the graph in Figure 4 is anomalous.

Circle the anomalous point.

(1)

(iii) Draw the best fit curve on the graph in Figure 4.

(1)

ResultsPlus
Examiner Comments

This student has done a very decent job in drawing a best fit curve.

ResultsPlus
Examiner Tip

Drawing best fit curves takes practice. With growing confidence you should be able to draw a smooth curve in one sweep of your hand, not necessarily going through every single plotted point exactly. Avoid tramlining, avoid joining point to point and avoid drawing straight lines where curvature is evident.

Question 3 (a) (iv)

Most students gave the opposite answer to the correct one, saying erroneously that the silver can would cool at a faster rate. Very few students seemed to understand that a silver surface is a poorer radiator of heat. Some suggested that the black can would be warmer as it absorbed heat, whilst others thought the question was about conduction.

Question 3 (b) (i)

A good majority estimated the peak wavelengths well, scoring two marks.

When the answers went awry it was mostly as a result of over-complicating the matter via mistaken calculations, as in the example below.

(b) Figure 5 is a graph showing the intensity–wavelength curves for two hot objects, L and M.

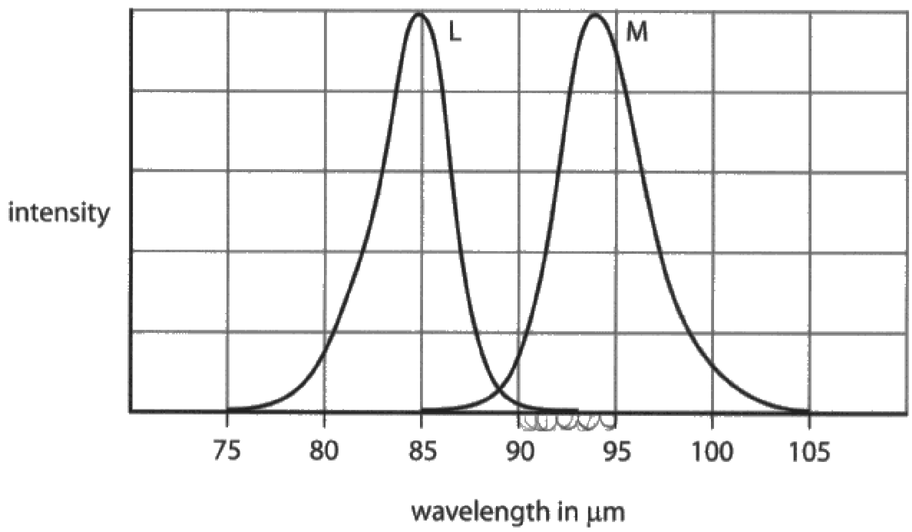

Figure 5

(i) Estimate the wavelength where the intensity is at a maximum for each of the objects.

93 - 75 **(2)**

wavelength at maximum intensity for object L = ...18...... µm

105 - 85

wavelength at maximum intensity for object M = ...20...... µm

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Examiner Comments

This is an example of where a student misinterprets the question and makes it overly complicated. 0 marks given.

Question 3 (b) (ii)

The vast majority of students got this the wrong way round, believing the answer to be 'M' because it had the longer wavelength.

Question 4 (a) (i)

This question was not answered well.Incorrect answers included 'chemically', 'in the centre of the wheel', and 'in a battery'.

With the rejection of energy language featuring 'types' and 'forms' in the new GCSE specifications this question is not so easy to pose. It was hoped that the requirement to **state** would lead students to name the energy store. This did not turn out to be the case.

Question 4 (a) (ii)

A majority of students stated correctly that making the flywheel spin faster would increase the amount of energy stored.

Question 4 (b) (i)

The vast majority of students scored 2 out of 2 on this, multiplying the 3 figures together correctly.

Question 4 (b) (ii)

Two thirds of students made the correct calculation here too, including squaring the speed. Where they went awry it was invariably because they didn't square the speed. Nevertheless, in this Foundation paper, they were still able to be credited up to 2 marks out of the 3 even if they didn't square the speed.

Question 4 (c)

This question discriminated quite well for the higher mark boundaries on this paper. The ability to describe practical set ups will undoubtedly develop. Some spoke of measuring a distance (not over the whole slope though, note). Many did identify the use of a stop-watch or a light gate for timing how long it took, going on to say how the result would be calculated.

(c) Describe how her speed at the bottom of the slope could be determined.

(3)

you could pick 2 points at the bottom of the slope where you want to measure the speed, you ~~to~~ then measure the distance ~~you~~ using a tape measure and time how long it takes to get from one point to another, and

(Total for Question 4 = 10 marks)

use the equation speed = $\frac{\text{Distance}}{\text{time}}$

or you could use light gates.

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Examiner Comments

This is a comprehensive to-the-point answer, well deserving of the three marks.

ResultsPlus
Examiner Tip

Spell it out like this student - What do I measure? With what? What do I then have to do to get the result? Think 'Could someone else follow my method and then be able to do it to get a precise result?'

(c) Describe how her speed at the bottom of the slope could be determined.

(3)

You could have a speed camera at the bottom which would detect her speed as she went past.

ResultsPlus Examiner Comments

This is credited with one mark on the mark scheme.

ResultsPlus Examiner Tip

It's worth paying regard to the number of marks available. It is likely that one basic statement about an experimental procedure will earn one mark.

Question 5 (a)

A pleasing majority got this correct. When two particles were named, usually protons and electrons, the mark was negated; ambiguously stated answers are not credited.

Question 5 (b) (i)

Only about a third of students scored marks on this one. Answers describing fusion as 'fusing' particles together were not credited since they were then only restating the question stem; more explanation was required, as in the example below.

(b) (i) Describe the difference between a fusion reaction and a fission reaction.

(2)

fusion is the joining of two particles and fission is the splitting of them. Fusion bonds two particles together and fission destroys a bond and creates two seperate atoms.

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Examiner Comments

This is a very clear coherent answer. Try to aim for such clarity yourself.

Question 5 (c) (i)

The vast majority were able to substitute into the simple ratio asked for and to calculate a correct answer.

Question 5 (c) (ii)

This question discriminated well. A half of all students were able to get one mark with a fifth making two good points and getting two marks. Few if any referred to the figures given in the previous question. 'More energy produced' was seen occasionally and credited. Many students seemed to think that fusion was a faster reaction.

(ii) State **two** advantages of using a fusion reactor rather than burning oil in a power station.

(2)

1 It won't produce any harmful gases that contribute to global warming.

2 There's more energy in a fusion reactor than in oil.

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Examiner Comments

These relatively basic statements score on mark points 2 and 1 respectively.

(ii) State **two** advantages of using a fusion reactor rather than burning oil in a power station.

(2)

1 A fusion reactor releases more energy than burning oil in a power station.

2 Less time is taken to get energy using a fusion reactor.

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Examiner Comments

The 'more energy' statement gets the mark. The unjustified comment about time taken is ignored.

Question 5 (c) (iii)

Most students did poorly on this question. A few were able to correctly answer that achieving a high temperature would be a difficulty to overcome, but very few managed to make a reference to the high pressure involved.

A few common incorrect answers were:

- references to the radioactive waste and radioactive emissions from a fusion reactor

- references to needing 'a lot of space' to build a reactor 'big enough' for fusion to happen
- references to the expense related to setting up a fusion reactor – how expensive research is, how expensive the materials are, how expensive fusion reactors would be to maintain.
- reference to dangers e.g. explosions

(iii) State **two** of the difficulties that need to be overcome to produce a fusion reactor.

(2)

1 ~~Immense pressure needed to~~ Extremly high pressure is needed to force the atoms together and to stop them from hitting the side of the reactor.

2 Extreme heat around 6000 °C

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Examiner Comments

A well-focused clearly expressed response worthy of 2 marks.

ResultsPlus
Examiner Tip

This student doesn't just minimally say 'high pressure . . . high temperature'. If you have knowledge like this and can explain it concisely it helps a lot in making the marks secure. It is part of your communicating to the examiner that you do understand some particular idea.

(iii) State **two** of the difficulties that need to be overcome to produce a fusion reactor.

(2)

1 need to have high temperatures

2 need a chamber that can handle the ~~reactor~~ reaction, won't blow up.

ResultsPlus
Examiner Comments

This earns 1 mark for the high temperature aspect. The second comment is representative of a kind of speculative hopeful response that is not creditworthy.

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Examiner Tip

Compare this answer with the previous one. Make it your aim to show mastery in a topic of knowledge.

Question 6 (a)

A clear majority of students got 2 marks on this question, often quoting coal and oil as the non-renewable sources. A significant number of students gave ‘fossil fuels’ as one answer, whilst then naming a particular fossil fuel as the other; this limited them to one mark.

Question 6 (b) (i) - (iii)

The work on the pie chart was largely very successful. Bioenergy was correctly identified as giving the greatest amount of renewable energy, with students often going on to explain why in terms of an area or percentage in the chart. Most identified wind as giving 20% of the energy too. Hydro/wave/tidal and 'other' were, on a few occasions, chosen wrongly for this latter answer.

Question 6 (c)

Most candidates were able to identify two predicted changes correctly. Some students were less successful in their descriptions of effects, e.g. using terms such as ‘less pollution’ without qualifying it as less CO_2 emissions or resulting in a reduction in global warming. There appeared to be a lack of understanding of the term ‘natural gas’. Answers were seen such as it would lead to more ‘natural gases in the atmosphere’.

(c) Figure 10 shows all the energy sources used in Canada in 2014 and a prediction for 2040.

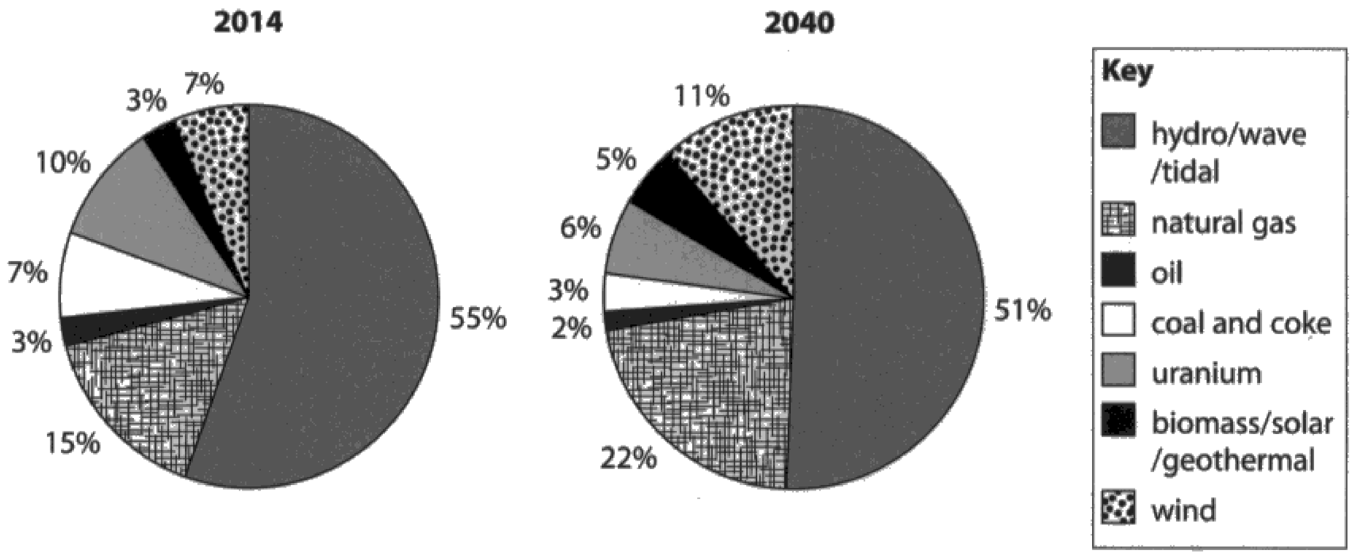

Figure 10

Discuss the effects on the environment of **two** predicted changes between 2014 and 2040.

(4)

change 1 using less coal and coke

effect on the environment will put less carbon dioxide in the air (CO^2 contributes to the greenhouse effect which leads to global warming)

change 2 using more wind power

effect on the environment won't be using up as much non-renewable resources - it is more natural

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Examiner Comments

This response earned the full 4 marks. The idea of conserving non-renewables was credited in the last 'effect on the environment'.

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Examiner Tip

Try to be as specific as possible e.g. in talking about impacts upon global warming as a results of the considered change. Vague responses such as 'less pollution' are not specific enough.

(c) Figure 10 shows all the energy sources used in Canada in 2014 and a prediction for 2040.

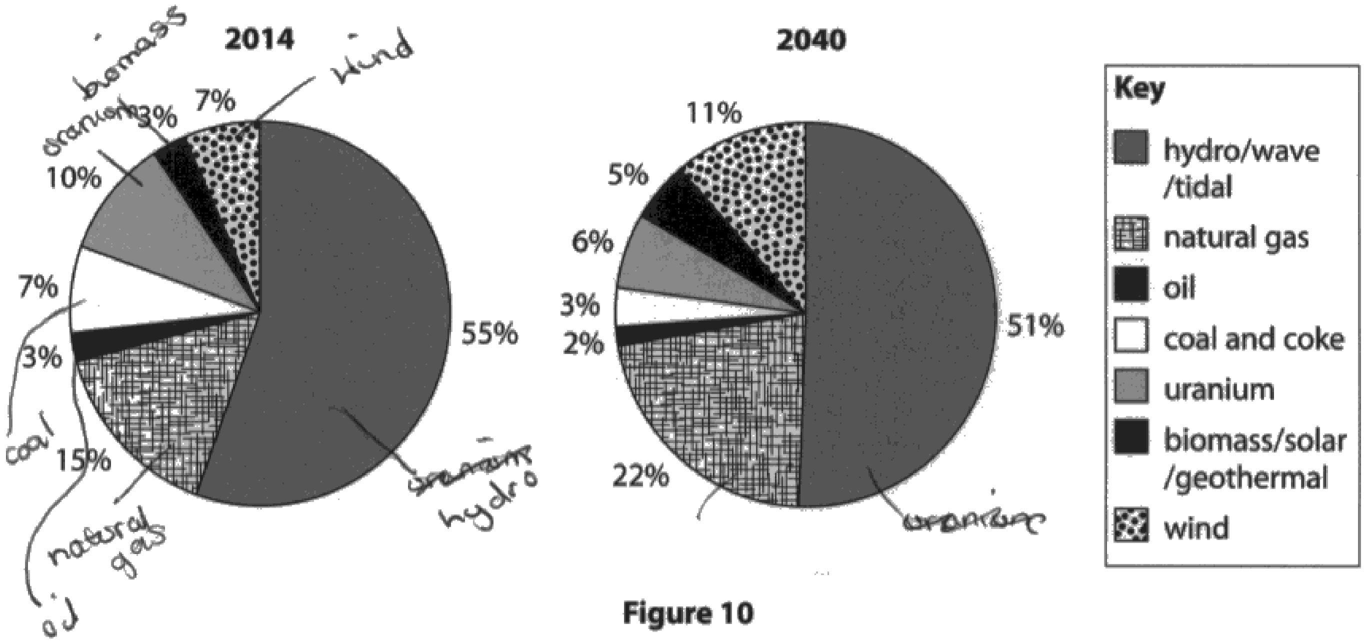

Figure 10

Discuss the effects on the environment of **two** predicted changes between 2014 and 2040.

(4)

change 1 less coal and coak

effect on the environment decreasing air pollution

change 2 increase natural gas

effect on the environment decreasing greenhouse gases.

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Examiner Comments

Only two marks obtained here. The association of more natural gas use with less greenhouse gases shows a fundamental misconception.

ResultsPlus
Examiner Tip

Go beyond the term 'natural' in your thinking here. Don't just think natural = good. Natural gas usage puts carbon dioxide into the atmosphere. CO_2 is a major greenhouse gas, contributing to global warming.

Question 6 (d)

This was poorly answered by most students. Many understood that heat was being produced but did not associate this with friction. Suggestions included slowing the rotor blades, changing the gear box and insulating it. The idea of lubricating with oil to reduce friction was seen only infrequently, but in those answers both marking points were usually attained.

(d) Figure 11 shows a wind turbine.

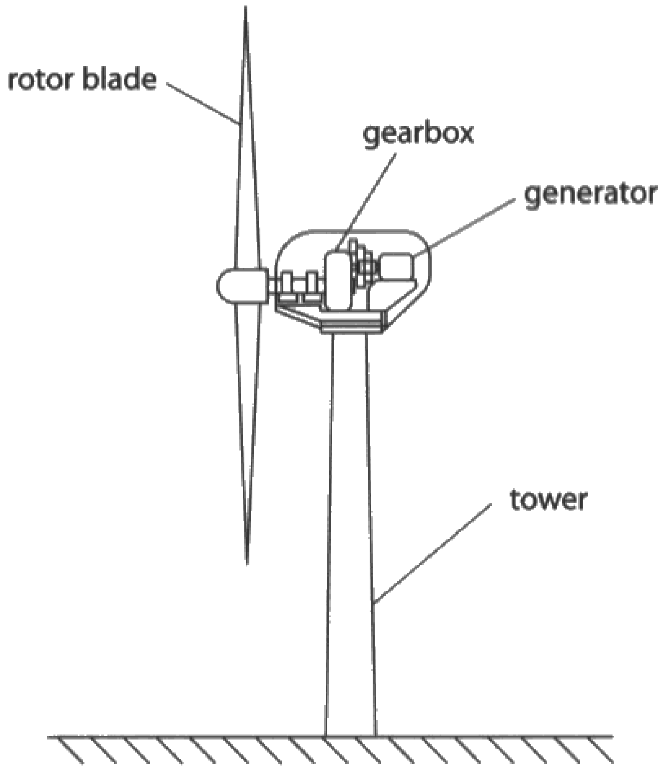

Figure 11

Explain how unwanted energy transfers could be reduced in the gear box.

(2)

Un wanted energy transfers could be reduced by Putting oil in the gear box to reduce the effects of friction.

ResultsPlus
Examiner Comments

A clear well-targeted response getting 2 marks.

ResultsPlus
Examiner Tip

You don't need to over-complicate an answer when the answer is straightforward like this. A direct succinct answer like this is commendable.

Question 7 (b)

Answers to this question discriminated well between candidates. There were many correct answers, but a significant number of them did not finally round off to 2 significant figures, as the question asked for. Only 1 mark was achieved when the student did not convert the focal length into metres and then did not round off appropriately as well.

(b) Calculate the power of a lens of focal length 17 cm.

Use the equation

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

Give the answer to 2 significant figures.

(3)

$$\text{power} = \frac{1}{17 \div 100} \rightarrow \frac{1}{0.17} \qquad \text{power} = \frac{1}{0.17}$$

$$\text{power} = 5.88$$

power = 5.88 dioptres

ResultsPlus
Examiner Comments

This is a well communicated answer, clearly showing the working involved including the conversion from cm to m. The only thing lacking is the rounding off to 2dp at the end.

(b) Calculate the power of a lens of focal length 17 cm.

Use the equation

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

Give the answer to 2 significant figures.

(3)

17 ÷ 100

= 0.17 m

$\frac{1}{0.17}$ = 5.8823529...

= 5.88

= 5.9

power = 5.9 dioptres

ResultsPlus
Examiner Comments

This represent full marks, well executed altogether.

ResultsPlus
Examiner Tip

Show all your working like this (as in the previous clip) will help the examiner to give you intermediate marks if you accidentally slip up with a calculation, which we all do from time to time.

Question 7 (c)

Almost a half of students obtained no marks in this question. In doing so those students were often just repeating the information given in the question. For level 1 answers there was often some mention of telescopes or satellite technology. Sometimes a telescope was confused with a microscope. In some answers at this level a discussion of red-shift and the universe expanding was given some credit. Higher level attainment involved understanding the significance of observations of Jupiter's moons. Few students stated how the observations of those moons led to the acceptance of the heliocentric model of the solar system. A small minority talked of modern space exploration and how it validates the heliocentric model.

Discuss how evidence has changed our views of the universe.

(6)

Because this shows that is not able to have the sun and the moon at the same time. This would also mean that there would be an eclipse at least twice a year and this has changed ~~the~~ because the moon.

ResultsPlus
Examiner Comments

A significant number of responses were seen where the logic produced defied reason. No marks could be credited in such cases.

Discuss how evidence has changed our views of the universe.

(6)

We believed everthing ~~revolved~~ orbited Earth because looking out of a ~~telescope~~ about 2,000 years ago didn't show much: ~~except~~ Back then you could see some planets that appeared to be ~~go~~ moving around the Earth and you could obviously see the sun, without the telescope, moving down, then back up every day, so people theorised and believed ~~t~~ everything was moving around the Earth. Copernicus in 1543 used a telescope and he observed moons around other planets like Jupiter. He concluded that if there ~~is~~ are moons orbiting another planet, ~~the t~~ everthing is not ~~ob~~ orbiting around Earth, ~~but and~~ Jupiter was facing towards the sun so Copernicus again concluded everthing revolves around the Sun.

(Total for Question 7 = 11 marks)

ResultsPlus

Examiner Comments

This is clearly a level 3 answer exemplifying all that is good about *a well-developed structure which is clear, coherent and logical* (A01 descriptor for a level 3 explanation). Answers do not have to be perfect to obtain maximum marks. Examiners are urged to think that there is room above the 6 mark ceiling for more detail/development. The fact that it was Galileo who made those observations and not Copernicus is not seen as a detraction. 6-markers are not micro-marked in a critical way, rather we are always looking for the good communication of relevant science that exists in a student's response.

ResultsPlus
Examiner Tip

Look at the way this student tells a clear and relevant story in what they have written. That is the hallmark of good understanding which will always impress the examiner and earn high marks. Answering exam questions is always a test of communicating ability but the 6-markers more than most.

Discuss how evidence has changed our views of the universe.

(6)

Telescope have shown planets and stars and the formation of them that have allowed us to map the universe Satellites have allowed to get pictures of the planets and how they moved it also collects data and the orbitary force carries the satellite around the Solar System this shows data from different stages of the orbit showing that the sun and moon orbits earth

ResultsPlus
Examiner Comments

This is clearly not at the same level as the previous answer but the student still marshals an argument well referring to observations via telescopes and to the use of satellite technology. A clear level 2 showing a *clear structure which is mostly clear, coherent and logical,* worth 4 marks.

Discuss how evidence has changed our views of the universe.

(6)

Back in the days, ~~befo~~ people thought every planet including the sun orbitted the Earth; geocentric. Later in the 16th telescopes were made and scientists found out it was a heliocentric model; the Earth and planets orbitted the Sun. When people thought it was a geocentric model it's because they could only see with a naked eye.

ResultsPlus
Examiner Comments

This is a level 1 answer - *an explanation with some structure and coherence*. The *understanding of scientific ideas lacks detail* (A01 descriptor). The student clearly understands the role of the telescope informing the developing models.

Question 8 (a) (ii)

This question was generally answered well, with students able to select coordinates and carry out the calculation. A minority entered the values the wrong way around, confusing angle Y and angle X.

(ii) Figure 16 is a graph of the student's results.

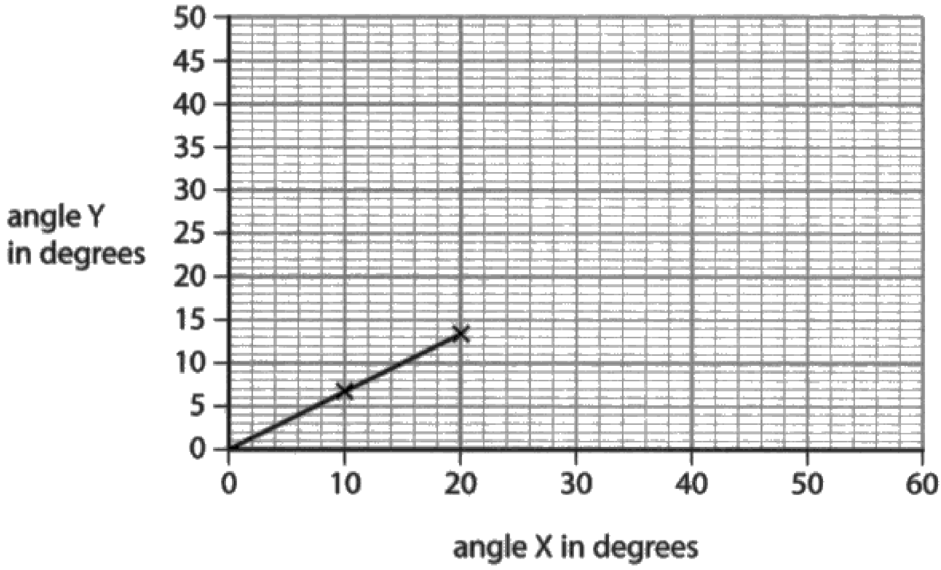

Figure 16

Use the graph to calculate a value for

$$\frac{\text{angle Y}}{\text{angle X}}$$

(2)

$$\frac{13}{20}$$

$\frac{\text{angle Y}}{\text{angle X}}$ = 0·65

ResultsPlus
Examiner Comments

Values of angle X = 20° and angle Y = 13° are used to good effect, showing the working clearly. Full marks obtained.

Question 8 (a) (iii)

Many students were able to score at least one mark on this question by suggesting the need for more data or repeating the experiment. Many suggested completing/extending the graph; they understood that more observations were required but they did not state this directly. Some students suggested measuring more angles, but not many stated that the angles should be bigger than 20°.

(iii) The student concludes that angle Y is directly proportional to angle X.

Explain what the student must do to test this conclusion in more detail.

(3)

She must investigate what happens to angle Y when angle X is greater than 20°. The student does not have enough results to prove her conclusion. She needs to take more readings.

ResultsPlus
Examiner Comments

This matches all three mark points on the mark scheme. The $> 20^{o}$ reference was lacking in many otherwise good answers.

Question 8 (b)

Answers to this question were variable. Some candidates coped well with dealing with powers of ten, but others had to change numbers to written-out decimal number versions and then they slipped up on decimal places.It was clear that some candidates were making calculator errors for the division. The unit of frequency was not very well known.

(b) The speed of light is 3.0×10^8 m/s.

The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

State the unit.

Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

0.0000010

3.0×10^8 (300000000) (3)

$$\frac{3.0 \times 10^8}{5.8 \times 10^{-7}} = 5.172$$

frequency = 5.172 unit m/s

ResultsPlus
Examiner Comments

This student gains one mark only for substitution. Then they go astray with wrong powers of 10 and giving incorrect units.

ResultsPlus
Examiner Tip

Students need to work on their ability to handle powers of ten on their calculators.

(b) The speed of light is 3.0×10^8 m/s.

The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

State the unit.

Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

$$\frac{3.0 \times 10^8}{5.8 \times 10^{-7}} = \frac{300000000}{0.00000058}$$

(3)

frequency = 5.17×10^{14} unit Hz

ResultsPlus
Examiner Comments

This student gets all three marks available, including the unit mark.

ResultsPlus
Examiner Tip

It is worthwhile learning to master powers of ten on your calculator. Then there should be no need to write out the decimal numbers with copious 0s. Doing it that way increases the chances of making a mistake.

Question 8 (c) (i)

A half of all students succeeded with this, mostly citing red as having a longer wavelength than yellow. Sometimes red and blue were put the wrong way around for (i) and (ii).

Question 8 (c) (ii)

This was not quite as successfully done as (i); the most common correct answer given here was blue. A small minority gave green or violet (equally correct).

Question 9 (a)

A half of all students didn't achieve any marks with this question. However, some students had clearly watched their teacher carry out radioactivity experiments, or maybe had seen video clips, and were knowledgeable. The control of variables was not well addressed by most students. Some achievement was obtained by saying that the two rocks were put (separately) near the GM tube. The need for distances to the GM tube to be maintained was not often stated. The idea of control of time was seen occasionally but background radiation was rarely considered.

9 Figure 17 shows a Geiger-Müller (GM) tube used for measuring radioactivity.

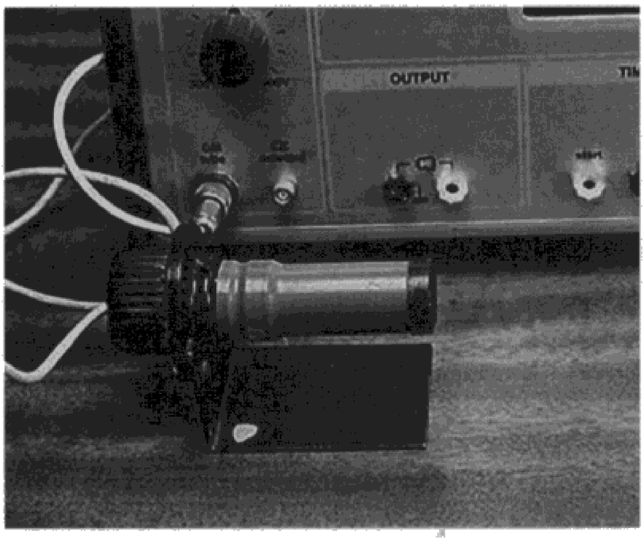

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Figure 17

(a) Describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks.

(4)

by putting the rocks (one-by-one) infront of the Gm and seeing what blocks it with different objects/materials.

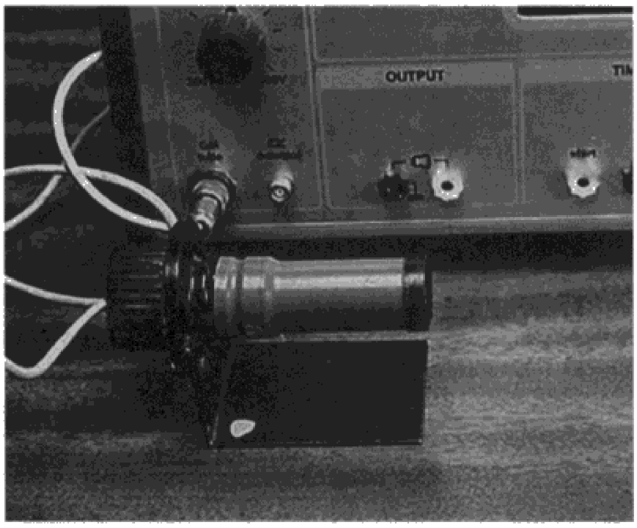
(absorbers)

~~[illegible]~~

ResultsPlus
Examiner Comments

This answer scores 2 marks for stating 'put in front of' and then for indicating some measurement - 'see what blocks it' - 'one by one' (idea of separately). Some benefit of doubt was applied in giving the mark point 2.

9 Figure 17 shows a Geiger-Müller (GM) tube used for measuring radioactivity.



©Andrew Lambert Science Photo Library

Figure 17

(a) Describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks.

(4)

place the Geiger - Müller tube 10cm away from the radioactive rock, ~~count~~ and count the amount of radiation and switch the rocks over and repeat the process (measure background radiation before hand*) Place ~~and~~ sheet of paper 5cm from each object in the middle and count the amount of radiation continue to do this with wood and alluminium to see what rock can penetrate which barrier.

* and minus the background radiation ~~from~~ answer from your final answer.

ResultsPlus
Examiner Comments

This student's answer is easy to follow and credit was given for each of mark points 1, 2, 4 and 5 from the mark scheme. There was no quibbling over the distance chosen from a marking point of view. This student easily obtained the 3 marks maximum available. The extra comments about further interposing of absorbers didn't affect what had been achieved.

ResultsPlus
Examiner Tip

Have regard for the number of marks available. Make sure you stick to answering the question and don't go off on some tangent. If there was contradiction involved you could lose a mark.

Question 9 (b)

Successful candidates realised the count rate halved every 6 hours, and so carefully plotted count rates of 40, 20 and 10 cpm after 6, 12 and 18 minutes respectively. Unfortunately, quite a number of students plotted the results going up at the major gridlines of 5, 10 and 15 from the x-axis. This resulted in all the plots being out by clearly more than 1 small square on the grid. Most candidates did not join their points to show the curve. Where they did that could earn a compensatory mark if their plotting of points was not accurate.

(b) A hospital uses a radioactive isotope with a half-life of 6 hours.

A technician measures a count rate of 80 counts per minute (cpm) from this isotope.

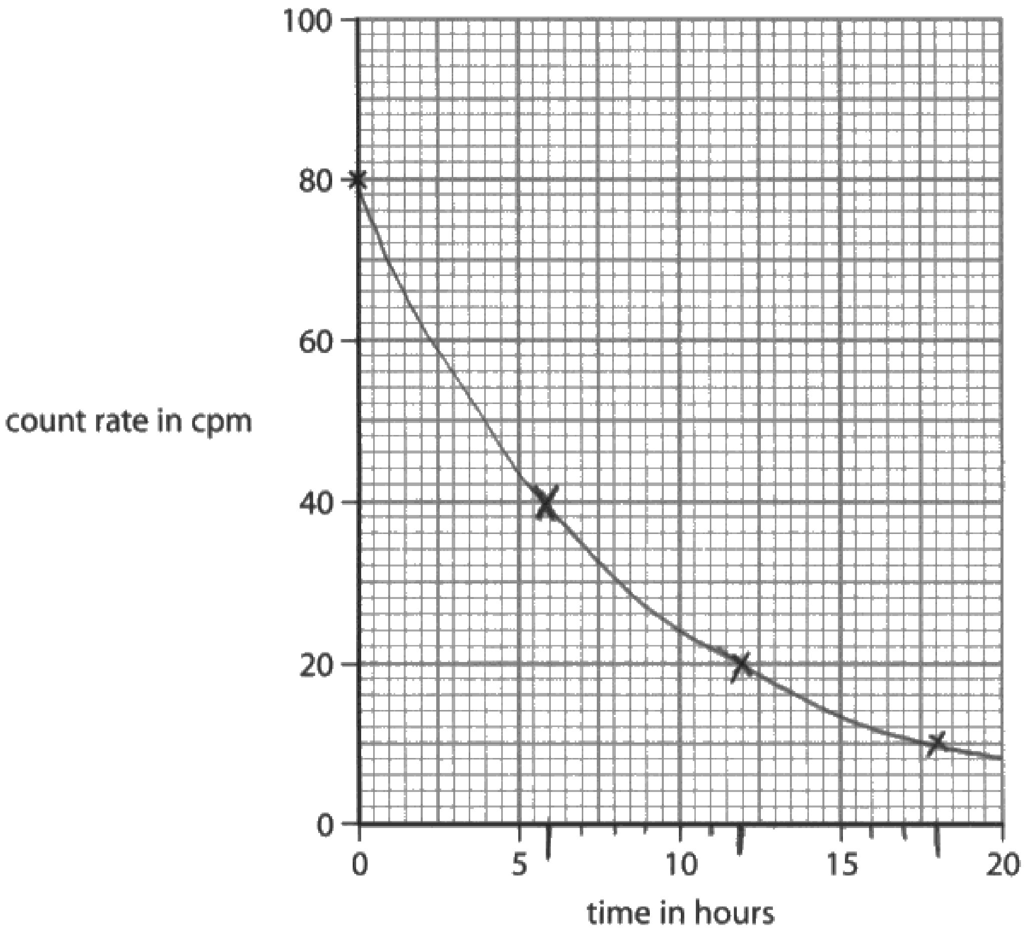


Figure 18

Complete the graph on Figure 18, as accurately as possible, to show how the count-rate from this isotope will change from the time of the first measurement.

The first point is already drawn in Figure 18.

(3)

ResultsPlus
Examiner Comments

Full marks obtained. All points plotted correctly, earning all three mark points.

ResultsPlus
Examiner Tip

Plot points on graphs carefully. Be aware of the +/- 1 small square tolerance often applied.

(b) A hospital uses a radioactive isotope with a half-life of 6 hours.

A technician measures a count rate of 80 counts per minute (cpm) from this isotope.

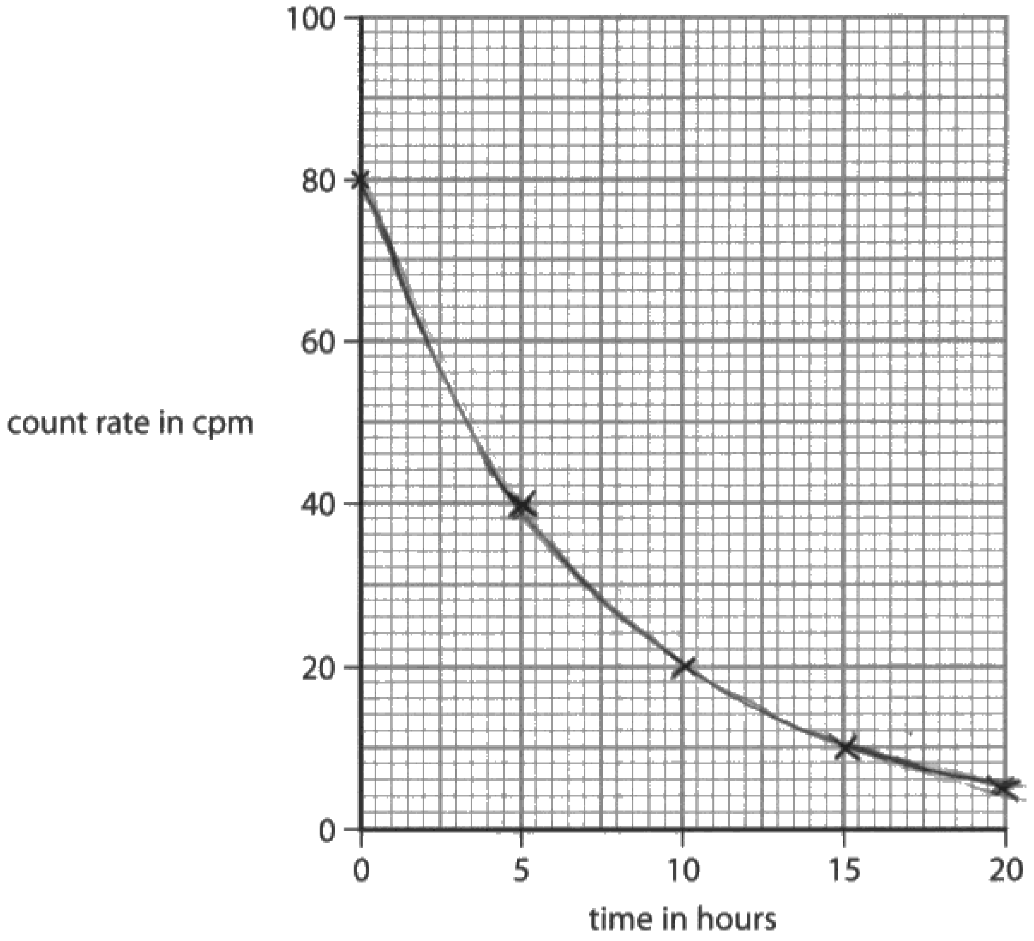


Figure 18

Complete the graph on Figure 18, as accurately as possible, to show how the count-rate from this isotope will change from the time of the first measurement.

The first point is already drawn in Figure 18.

(3)

ResultsPlus
Examiner Comments

This response includes the mistake of going up at the x-axis major gridlines when the values of 6, 12 and 18 hours were the ones that should have been used. By drawing the curved line, with a decreasing gradient throughout, the student has earned one mark.

Question 9 (c)

There was better achievement with this 6-marker than with the earlier cosmological question. In some answers the candidates were unable to name any type of radiation and therefore limited themselves to 2 marks. Many candidates were able to name more than one type of radiation. Some answers repeated what the student had learnt in school about the penetrative and ionising features of the radiations, without referring sufficiently to the evidence provided in the question. The best answers not only stated clearly the penetrative power of the three radiations but also used evidence from the table, quoting values and carrying out calculations on the data provided.

*(c) A radioactive rock is placed near to the front of a Geiger-Müller (GM) tube.

A radioactivity count-rate is first made in air.

The count-rate is measured again with each of three different absorbers between the rock and the GM tube.

Figure 19 shows the count-rates measured.

absorber	count-rate in counts per minute
3 cm of air	1272
thin sheet of paper	931
3 mm thick sheet of aluminium	328
2 cm thick sheet of lead	21

Figure 19

A scientist has an idea that the rock emits three different types of radiation.

Explain how the data in this table supports the scientist's idea.

(6)

Each time the scientist changes the absorber the count rate per minute change. When he uses 3cm of air the count rates per minute are extremely high but when he uses thin sheet of paper, 3mm thick sheet of aluminium and 2cm thick sheet of lead the count rate per minute decreases massively. This tells us that the different materials used give off different radiations.

ResultsPlus
Examiner Comments

This student makes a valiant effort at using the data. Unfortunately they don't refer to the types of radiation involved limiting themselves to a level 1 answer. 2 marks given.

ResultsPlus
Examiner Tip

Draw on your physics knowledge and understanding of concepts in answering the 6 markers. Ask yourself 'What **physics** ideas are involved?'

*(c) A radioactive rock is placed near to the front of a Geiger-Müller (GM) tube.

A radioactivity count-rate is first made in air.

The count-rate is measured again with each of three different absorbers between the rock and the GM tube.

Figure 19 shows the count-rates measured.

absorber	count-rate in counts per minute
3 cm of air	1272
thin sheet of paper	931
3 mm thick sheet of aluminium	328
2 cm thick sheet of lead	21

Figure 19

A scientist has an idea that the rock emits three different types of radiation.

Explain how the data in this table supports the scientist's idea.

(6)

The data supports this idea because there ~~are 931~~ the count rate ~~wh~~ through paper is 931 which means alpha has been stopped by the paper. Then it is 328 which means beta radiation has been stopped by aluminium. Then the count is 21 so gamma radiation has been stopped by the lead.

ResultsPlus Examiner Comments

This is a level 2 response, engaging with data and recalling types of radiation, but just quoting numbers without explaining reductions.

ResultsPlus
Examiner Tip

Level 3 answers require judgements supported by evidence. Try not to just quote numbers but to **do something with them** e.g. here notice the **significant reductions** in count rates as the absorbers are put in. Those **reductions** point to alpha, beta and gamma being absorbed successively.

Can you see the progression of answers from the previous two answers to a higher Level 3 one here?

*(c) A radioactive rock is placed near to the front of a Geiger-Müller (GM) tube.

A radioactivity count-rate is first made in air.

The count-rate is measured again with each of three different absorbers between the rock and the GM tube.

Figure 19 shows the count-rates measured.

absorber	count-rate in counts per minute	
3 cm of air	1272	→ Nothing is blocked
thin sheet of paper	931	A
3 mm thick sheet of aluminium	328	B
2 cm thick sheet of lead	21	G

Figure 19

A scientist has an idea that the rock emits three different types of radiation.

Explain how the data in this table supports the scientist's idea.

(6)

When there is only air to absorb the radiation Alpha, Beta and Gamā rays Pass through therefore the CPM is much greater. When a thin sheet of Paper is Placed In between only Beta and Gama rays can Pass through lowering the CPM further. when the 3mm Sheet of alUminium is Placed inbetween only Gamma rays can Pass through lowering the CPM even further but when the lead Is Placed In between, NO Rays can Pass through so the GM tube does not detect high levels of radiation.

(Total for Question 9 = 13 marks)

ResultsPlus
Examiner Comments

This student answers well as they clearly and coherently lay down an argument, drawing on evidence and showing great expertise in communicating their answer well.

ResultsPlus
Examiner Tip

Study the data/evidence, noting differences in your mind. Recall the physics - here it's as easy as a, b, c: i.e. alpha, beta and gamma. Tell the story from the data, bringing the physics ideas together with the evidence provided.

Question 10 (b) (i)

In all the sections of question 10 there seemed to be a general lack of understanding of the meaning of the terms: universe, a galaxy, a star, a planet and Earth. In many papers some parts of question 10 were left blank.

For 10(b)(i) the vast majority of students did well, with most citing 'gravity' as their correct response.

Question 10 (b) (ii)

Plenty of correct answers were seen to this part, but quite a number of students failed to pick up the mark for an arrow pointing **towards to the centre of the Earth**. Sometimes the arrow pointed in the wrong direction or followed the line of the orbit.

(b) Figure 20 shows a satellite orbiting the Earth.

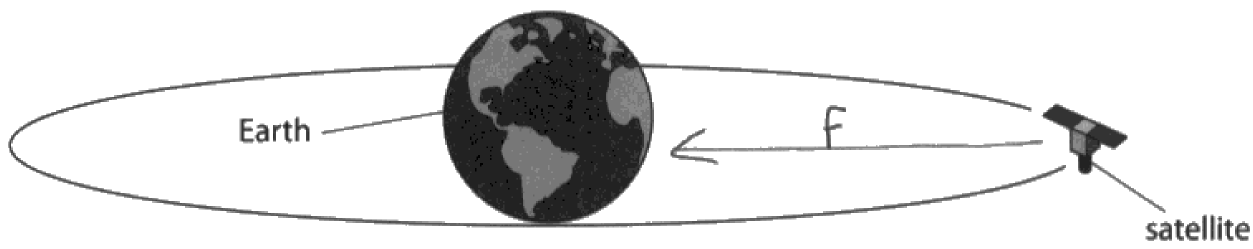


Figure 20

(i) State the name of the force that keeps the satellite in orbit around the Earth.

(1)

[illegible] gravity

(ii) Draw an arrow on Figure 20 to show the direction of the force acting on the satellite, that keeps the satellite in orbit around the Earth.

Label this arrow 'F'.

(1)

ResultsPlus
Examiner Comments

This is what it should look like - a clearly drawn unambiguous arrow pointing towards the centre of the earth.

(b) Figure 20 shows a satellite orbiting the Earth.

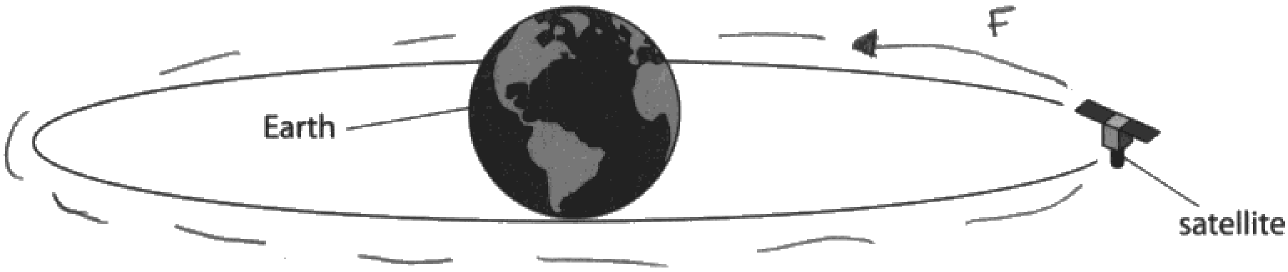


Figure 20

(i) State the name of the force that keeps the satellite in orbit around the Earth.

(1)

....

(ii) Draw an arrow on Figure 20 to show the direction of the force acting on the satellite, that keeps the satellite in orbit around the Earth.

Label this arrow 'F'.

(1)

ResultsPlus
Examiner Comments

This answer is incorrect, following the orbit.

ResultsPlus
Examiner Tip

Forces must always be shown in **one direction only**. Using a ruler helps.

Question 10 (c) (i)

Very few candidates understood the concept of red-shift when answering this question. While marks were picked up, those were mainly for hitting key words rather than for expressing the concept of red-shift well. Some students thought that galaxies and stars further away from us emit red light, rather than the correct idea that the light they emitted was being stretched towards the red end of the spectrum.

(c) Satellites are used to gather data about the origin of the Universe.

The Big Bang theory is a theory about the origin of the Universe.

Evidence for the Big Bang theory is provided by red-shift and CMB radiation.

(i) Describe what is meant by red-shift.

(2)

Red shift is when something is moving away it bends light towards the red side of visible light So if its red shifted its moving away e.g galaxies are mostly redshifted

ResultsPlus
Examiner Comments

Full 2 marks obtained here. 'Bends towards the red' is judged to be near enough to 'moves towards the red end' (mark scheme). In this part some generosity was applied about the object moving away. This student's association with galaxies is correct though.

Question 10 (c) (ii)

A minority of students were able to correctly reference the expanding universe or the 'explosion' at the start of the universe. Very few were able to gain the second mark by referring to 'galaxies moving away'. Many students incorrectly used 'planet' or 'object' instead of galaxy or star. A few candidates thought that red-shift was the cause of the Big Bang.

(ii) Explain how red-shift provides evidence for the Big Bang theory.

(2)

because When the different galexys apper red it means that they are constantly moving away from us, Proving that the universe is constantly expanding.

ResultsPlus
Examiner Comments

Marks are given for the expanding universe comment and the comment that it is galaxies moving away (from us). In this part 'objects' or 'planets' moving away was not accepted.

ResultsPlus
Examiner Tip

Think of the universe as galaxies (galaxy = billions of stars) drawn on a balloon's surface. The balloon is inflated resulting in the galaxies moving away from each other.

Question 10 (c) (iii)

This question was not answered well.Some of the incorrect answers seen were ‘mass’, ‘measure’, ‘molecular’, ‘moving’, ‘medium’ and ‘micro’.

Question 10 (c) (iv)

The concept of CMB was not understood on the whole. Many students wrongly associated this radiation with the atmosphere. It was also wrongly attributed to being emitted from other objects found in space. Some students merely repeated the stem of the question writing ‘radiation in the background ‘, getting no marks. Answers referring to radiation from space/the universe were accepted.

(iv) State what is meant by ‘cosmic background radiation’.

(1)

radiation that is left behind from The Big Bang and the creation of the earth.

ResultsPlus
Examiner Comments

CMB = radiation from all over the universe, which did come from the Big Bang, so 1 mark obtained.

Question 10 (c) (v)

This was left blank by quite a number of students. However there were a significant number who knew that the Big Bang theory suggests that the Universe started with an ‘explosion’. Less well known was that this initial expansion produced radiation and that the formation of the Earth took place much later. There was further confusion about the terminology, as ‘Earth’ was used by some students instead of the ‘Universe’.

(v) Explain how the presence of CMB radiation provides evidence for the Big Bang theory.

(2)

CMB radiation provides evidence for the Big Bang Theory, because ~~Then~~ if there was an explosion radiation would've been released and this is where CMB radiation is from.

(Total for Question 10 = 11 marks)

ResultsPlus
Examiner Comments

Both mark points are seen in this response.

Initial explosion idea (1) followed by 'released from this' (1).

ResultsPlus
Examiner Tip

Students showed weaknesses in their understanding of cosmology.

Effective revision should focus first on areas of weakness eliminating them by focused active revision, e.g. producing a powerpoint/flash card on a topic and using that to explain to someone else.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Candidates did well on questions which provided equations for them and involved straightforward substitutions. They did less well on handling powers of ten and on the units involved. A focus needs to be made on the use of metres, kilograms and seconds, as well as derived units e.g. that for frequency, the Hertz, which proved to be not very well known in this paper.

- Candidatesmostly did well when it came to graphical interpretations including pie charts and the results of a refraction experiment. They were not so successful at creating their own graphical interpretation of half-life ideas. Candidates should spend significant time, in their course, engaging with graphical interpretations to develop their understanding in this area.

- Candidates' explanations were of very variable quality especially when it came to energy vocabulary and understanding of cosmology and the development of cosmological models, including the Copernican revolution and the evidence for the Big Bang. Candidates need opportunities to develop their understanding in these areas.

- Candidates need to engage more in explanations that involve energy stores and energy transfers. That engagement needs to be made throughout the course, taking opportunities to explore language that can convey meanings better; this examination has revealed weaknesses in that area.

- A lack of comprehension concerning command words was noticed especially with 'Describe how' questions, which required experimental descriptions. For instance, how to find the speed of the skier at the bottom of the slope proved to be elusive for most students. It was clear from the practically-based questions that candidates have a long way to go through their content coverage and in terms of their exam techniques to achieve greater competence in this area. In examinations candidates should respond to the command words 'Describe how a candidate could show. . .' by describing experimental procedures. They should not digress on to theoretical explanations in that regard.

- The 6 mark question on radioactivity revealed that most candidates are aware of alpha, beta and gamma radiations. However their skills in analysis tabular data often left much to be desired. Candidates need to be skilled in being able to match observations with theories and to be able to discuss evidence in a more focused way, especially noticing differences and comparisons across data. Some more data comprehension/analyses exercise might help here.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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