



Examiners' Report **June 2024**

GCSE Physics 1PH0 1F

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Introduction

Questions were set to test candidates' knowledge, application and understanding from these 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.

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, calculations and short answer questions worth one or two marks each and longer questions worth three or four marks each.

The inclusion of questions designed at targeting candidates' knowledge and understanding of practical work continued. This included assessing their fundamental knowledge of practicals specified in the specification, together with further application.

One of the six-mark questions tested knowledge and understanding of the Solar System. The other six-mark question tested candidates recall of the determination of speed of a trolley down an inclined ramp.

Question 1 (a)

It was well known that electromagnetic waves are transverse. It was less well known that, in a vacuum, they all travel at the same speed. Wavelength and frequency were frequently confused.

Question 1 (b)

Candidates were generally familiar with the properties and uses of different types of electromagnetic waves. The most common error was to fail to recognise ultraviolet as being both a cause of skin cancer and used to detect forged banknotes with many candidates assigning these statements to x-rays.

Question 2 (a)

Most candidates could apply their understanding of the absorption and transmission of different colours of light to reason that the flag would appear as shown when illuminated by blue light.

Question 2 (b)

It was widely known that the image of an object produced on a screen by a convex lens was smaller than the object itself. Candidates were less familiar with the terms real and virtual with many describing the opposite of virtual in this context as non-virtual.

Question 2 (d)

This question tested understanding of the difference between specular and diffuse reflection and some candidates accurately used both terms. It was sufficient, however, to describe the differences in the images being due to the water droplets reflecting rays in different directions.

Examiners would accept the word light for rays in this context.

(d) Figure 7 shows light reflecting from two mirrors in a bathroom.

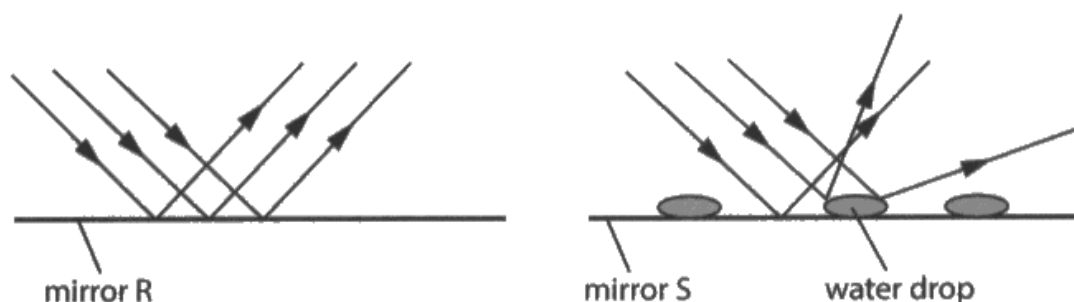


Figure 7

Mirror R has a dry surface.

Mirror S has lots of small drops of water on the surface.

A person looks into each mirror.

Explain the difference between the image seen in mirror R and the image seen in mirror S.

(2)

In mirror R the image would be clear and would show a reflected image. mirror S's reflected image would be distorted and will not show an exact reflection



The question asked for an explanation. This answer gave a description of the difference and scored one mark only.



If the question asks you to explain, then you should start with a description of what is happening and then continue with why it is happening.

Mirror R would have a clear image as the rays are still parallel after ~~being~~ being reflected whereas, mirror S would have an unclear image as the water drops reflect the light in different directions.

(Total for Question 2 = 7 marks)



An answer worthy of both marks. The differences in the images were described and explained.

Question 3 (b)(i)

This was intended to be a reasonably straightforward calculation that required candidates to find 46% of 10 billion. The answer line made it clear that an answer in terms of billions of years was required.

(b) The inward and outward forces in stars like the Sun stay balanced for 10 billion years.

(i) In the Sun, these forces have been balanced for 46% of this time.

Calculate for how many billions of years these forces have been balanced in the Sun.

(2)

$$1,000,000,000 \div 10 = 100,000,000$$

$$100,000,000 \times 4 = 400,000,000$$

$$1,000,000,000 \div 100 = 10,000,000$$

$$10,000,000 \times 6 = 60,000,000 \quad \text{time} = \dots\dots\dots 0.46 \dots\dots\dots \text{billion years}$$

$$400,000,000 + 60,000,000 = 460,000,000$$

0.46



ResultsPlus
Examiner Comments

It was common to see conversions from billions of years to years and then back to billions. This led many candidates to miscount the number of zeros somewhere in their steps. Examiners would give partial credit for this.



ResultsPlus
Examiner Tip

Check the answer line before you do a calculation. It will often tell you the units that are expected.

$$\frac{46}{100} \times 10 \text{ Billion} = 4.6$$

time = 4.6 billion years



ResultsPlus
Examiner Comments

A much simpler approach was simply to find 46% of 10 as demonstrated here.



ResultsPlus
Examiner Tip

This response scored the full two marks.

Question 3 (b)(ii)

Candidates were generally unfamiliar with the life cycle of a star such as the Sun. It was very common to see answers that described the event of the Sun exploding.

Better candidates were confident in describing how a star such as the Sun will change over time.

(ii) Describe what will happen to the Sun when the inward and outward forces become unbalanced.

(2)

It will start to expand and become a red giant. The sun will start to cool down. There will be lots of reactions.



ResultsPlus
Examiner Comments

There is a mark for expand and another mark for red giant.

It is also correct that the sun will cool down.

The sun would ~~into~~ start expanding⁽²⁾ because the outward forces would overpower the inward force.



ResultsPlus
Examiner Comments

A partly correct answer that scored one mark

balance will be lost and the sun would
explode due to the change in matter and
temperature



ResultsPlus
Examiner Comments

A very common incorrect answer.

Question 3 (c)

Candidates at this level still seem to confuse nuclear fusion and fission. There were also many responses in terms of collisions (which could simply be rebounding)

In nuclear fusion the particles in the sun fuse together at a constant rate. -



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Examiner Comments

There is a mark for the idea of fusing together, but "particles" is too vague for another mark.

(c) Nuclear fusion reactions take place in the Sun.

Describe what happens in a nuclear fusion reaction.

~~atoms~~ atoms colliding together (2)



ResultsPlus
Examiner Comments

Examiners would accept "atoms" even though it is the nuclei of atoms that are involved in nuclear fusion.

However, "colliding" is not the same as joining together or fusing.

(c) Nuclear fusion reactions take place in the Sun.

Describe what happens in a nuclear fusion reaction.

(2)

Nuclear fusion ~~takes place when~~ is when two nuclei join together to create one big nucleus.



ResultsPlus
Examiner Comments

This is clearer with a concise response that scored both marks.

Question 3 (d)

This question tested candidates' appreciation of scientific thinking. They had to recall the conditions necessary for nuclear fusion and then explain why a claim that fusion could take place in a laboratory test tube was not accepted by most scientists.

Examiners would give marks for comparing the conditions necessary for nuclear fusion with the conditions likely to exist in a laboratory. Examiners would also give credit for the idea that scientific claims needed to be confirmed by other scientists before becoming accepted, but such responses were rarely seen.

(d) In 1989, two scientists claimed that they could produce a nuclear fusion reaction in their laboratory.

They said their reaction could take place at room temperature in a test tube.

Explain why other scientists did not believe them.

(2)
It can't be done in a test tube as the heat is greater than room temp. It should be mostly above room temperature. At that insane temperature glass can't withstand the heat.



This answer has the idea of the very high temperature required linked to the idea that this would be impossible to achieve in a laboratory test tube.

(d) In 1989, two scientists claimed that they could produce a nuclear fusion reaction in their laboratory.

They said their reaction could take place at room temperature in a test tube.

Explain why other scientists did not believe them.

(2)

For a nuclear fusion reaction to happen there need to be a lot of pressure in a small space and extremely high temperatures.



Two marks for describing both the very high pressure and the very high temperature required for nuclear fusion

Question 4 (a)(ii)

This question tested knowledge of reaction time and how it may be affected. Examiners saw many correct responses that gave a factor that would increase reaction time. Common answers included distractions, tiredness and consuming alcohol

(ii) State **one** factor that might increase a driver's reaction time.

(1)

Being on a phone call while driving



Being on the phone distracts the driver and increases the time taken to react to an emergency. This response scores the mark.

Some candidates seemed to have misunderstood the question and gave a factor that would **improve** reaction time; in other words, to react more quickly.

A good amount of sleep so driver is more
~~awake~~ and prepared mentally.



Tiredness makes a driver react more slowly and therefore increase reaction time.

This answer is describing something that might make the driver more alert and therefore decrease the reaction time. It scored zero.



Double check that you are answering the question.

Many candidates wrote about changes to the vehicle or the road. These do not affect the reactions of the driver

Better tires, e.g. more grip



ResultsPlus
Examiner Comments

Better tires may allow the car to stop more quickly by reducing the breaking distance. They will not increase the driver's reaction time.

Candidates also often wrote about factors that may alter when a driver detects a hazard but do not affect how quickly the driver reacts after detecting that hazard.

The weather being clear so the driver can see further
and stop the car quicker



ResultsPlus
Examiner Comments

Responses like this did not score.

Question 4 (a)(iii)

In this question, the area under the velocity-time graph had to be evaluated in order to find the distance travelled. Candidates were given the equation to use.

- (iii) Calculate the distance travelled between when the driver applies the brakes and when the car comes to rest in Figure 9.

Use the equation

distance = area under the sloping line of the graph in Figure 9

$$\frac{b \times h}{2} = \frac{22 \times 3}{2} = 33$$

(3)

distance = 33 m



ResultsPlus
Examiner Comments

Examiners saw many well laid out and correct answers that scored all three marks.



ResultsPlus
Examiner Tip

It is always a good idea to write the equation first and then put in the values before calculating the answer.

Some candidates clearly knew how to find the area but, took the time to be 4 seconds without accounting for the 1st second of thinking time. Provided the rest of the working was clear, this could score two marks.

$$a = \frac{1}{2} \times b \times h$$

(3)

$$\begin{aligned} 0.5 \times 4 \times 22 \\ = 2 \times 22 \\ = 44 \end{aligned}$$

distance = 44 m



ResultsPlus
Examiner Comments

The correct equation was used but the time was 3 seconds not 4. Examiners could give 2 out of 3 marks for this answer.

Answers that showed that suitable values had been selected could still score one mark.

$$\begin{aligned} \text{Distance} &= 22 \text{ m/s} \times 3 \text{ s} \\ &= 66 \text{ m} \end{aligned}$$

distance = 66 m



The values of 22 and 3 must have come from correct reading of the graph and therefore scored 1 mark.

Unfortunately, the equation was incorrect and scored no further marks.

Question 4 (b)

Most candidates appreciated that the reaction time of a computer would be much less than the reaction time of a person. Others correctly reasoned that a computer would not be affected by those factors that affected a person.

(b) The stopping distance of a car is the thinking distance plus the braking distance.

A car has a device that can detect an obstacle in the road ahead.

The device is linked to a computer that can apply the brakes.

It is claimed that, in an emergency, the computer-controlled car will have a shorter stopping distance than if the car is controlled by a human driver.

Explain why this claim could be true.

(2)

the reaction time for
a computer is quicker
than a humans reaction
time.



ResultsPlus
Examiner Comments

This answer gives a partial explanation and describes a shorter "thinking time" but does not fully explain why the stopping distance is shorter. It scored 1 mark from a possible 2 marks.



ResultsPlus
Examiner Tip

Make sure you know the difference between thinking time (or distance), braking time (or distance) and overall stopping time (or distance).

Better candidates went on to correctly explain that this would mean that a computer-controlled car would travel a shorter distance before the brakes were applied or have a short "thinking distance"

Human reaction times are often slower than computers. Because there is no/lower thinking distance with computers.



A good explanation that scored 2 marks

Question 4 (c)(i-ii)

The requirement to reduce speed on wet roads was usually correctly linked to reduced friction between tyres and the wet road. Credit was not given for answers that simply referred to accidents or crashes without mentioning why these may occur.

(c) A different car has a device that can detect rain.

This device is linked to a computer that can change the speed of the car.

In wet weather, the computer changes the speed of the car.

(i) State the change in speed that the computer should make when the road is wet.

(1)

slower speed.

(ii) Give a reason why this change in speed is necessary when the road is wet.

(1)

so it prevents it from crashing



ResultsPlus
Examiner Comments

There is a mark for slower speed but prevents it from crashing is insufficient for the second mark.

Slow down/decrease speed.

(ii) Give a reason why this change in speed is necessary when the road is wet.

(1)

So your car doesn't slip on the wet surface which can cause you to crash.



ResultsPlus
Examiner Comments

This response correctly links a wet road with the possibility of slipping (due to reduced friction) and so scores both marks.

Question 5 (c)

The question required candidates to rearrange the equation that had been given to them, substitute the given values into the equation and finally evaluate it. Examiners saw very many correct answers with the rearrangement and substitution carried out in either order.

(c) The speed of a sound wave in air is 330 m/s.

The wavelength of this wave is 0.75 m.

Calculate the frequency of this wave.

Use the equation

$$v = f \times \lambda$$

(3)

$$330 = f \times 0.75$$

$$\frac{330}{0.75} = 440$$

frequency = 440 Hz



ResultsPlus
Examiner Comments

Correct values have been substituted into the equation and then rearranged before calculating the correct answer. Full marks.

An answer of 247.5 may have been the result of a correct substitution followed by an incorrect rearrangement or vice-versa.

(3)

$$330 \times 0.75$$

frequency = 247.5 Hz



ResultsPlus
Examiner Comments

Since 1 of the 3 possible marks was intended to be low demand, any answer that rounded to 250 was given a mark in this question; even if the working was not clear or was absent.

Question 5 (e)(i)

The question required candidates to devise a practical investigation by applying the formula for wave speed to a situation that was probably novel. The equation booklet gives two equations for wave speed. The most suitable equation in this case is wave speed = distance \div time.

Examiners were looking for a description of measuring a relevant distance that a wave travels, measuring the associated time for it to travel that distance and then use the appropriate equation to determine the speed of a wave.

Many candidates gave clear descriptions of measuring a relevant distance and associated time and scored 3 marks.

(e) Ripples travel out from the centre of a small circular pond to its edge.

(i) Describe how a student could determine the wave speed of the ripples.

(3)
- record the distance of the edge of the pond to the centre.
- Then record the time taken for the ripple to go from the middle to edge.
- Divide the time off the distance.



In this particular example the descriptions of the measurements were clear and scored the first two marks. Unfortunately, the equation was the wrong way round and so missed the third mark.

There were also many candidates who chose to use wave speed=frequency x wavelength. Determination of frequency could be done by counting the number of waves in a given time. However, direct measurement of wavelength of ripples in a pond would be very difficult and was very rarely clearly described. Candidates that chose this method would usually score only 1 or 2 of the available marks.

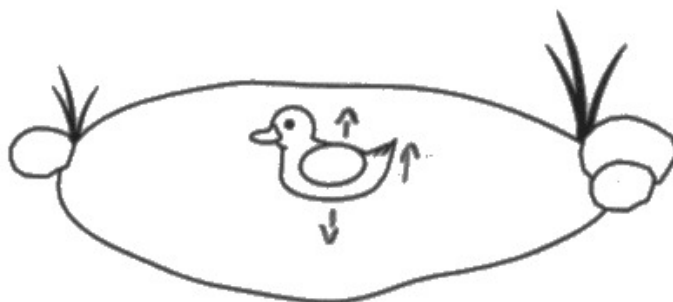
the students could count the amount of ripples in a minute with a stop watch. Then take a picture of a ripple and with a ruler calculate the wavelength. Apply the information to the equation $v = f \times \lambda$



Measuring a picture of the waves with a ruler would not provide a value of the wavelength. This response scored 2 marks only.

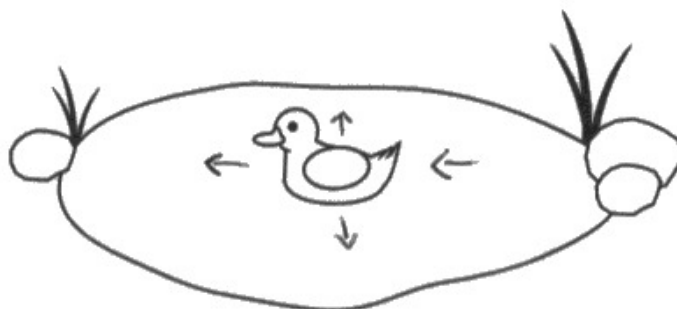
Question 5 (e)(ii)

A very large number of candidates drew arrows that, incorrectly, implied that the duck moved horizontally as a result of the waves passing under it.



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Examiner Comments

Up and down arrows only scored the mark.



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Examiner Comments

The arrows imply that the duck moves across the water. This is incorrect and scored no marks.

Question 6 (c)(i)

Candidates were very familiar with the precautions necessary when investigating radioactivity. It was pleasing to see very few incorrect responses relating to general laboratory safety such as wearing goggles and tying back long hair.

Question 6 (c)(ii)

The random nature of radioactive decay means that measurements of the activity of a radioactive source will not always have the same value. Candidates identified this variation by analysing the data and expressed this in different, acceptable ways.

The teacher tells the class that radioactive decay is random.

State how the data in Figure 13 supports this statement.

All of the measurements are different (1)



A simple correct answer that scored the mark.

Measurements increased then decreased in different numbers (1)



A mark was given for writing about the numbers increasing and decreasing.

The activity in Bq is random and has no set difference.



This response simply repeated the information given in the question. It does not state how the data shows the decay is random and did not score the mark.

Question 6 (c)(iii)

Most candidates were able to calculate the mean of the four numbers.

Question 6 (d)(i)

The question required candidates to interpret the graph and draw a conclusion.

Examiners saw many examples of a correct interpretation with answers such as “when the detector is moved away then the reading becomes lower”.

As the radiation detector moves further away the mean detector reading decreases.



A correct description of the graph scores 1 mark. However, it does not go on to explain why the radiation must be alpha and not beta or gamma. Those types of radiation would also decrease with distance but would not fall to zero in such a short distance.

Many candidates recalled the properties of alpha radiation.

because alpha particles can only travel a couple of cm while gamma and beta can travel a lot ~~far~~ further



An answer that correctly compares alpha with gamma and beta for 1 mark. It does not refer to the graph, however, and so does not score a second mark.



Make sure that you actually refer to the graph where the question asks you to explain how a graph shows something.

Examiners were looking for a link between the graph and how it showed that the radiation must therefore be alpha.

alpha particles do not travel far as they have low penetration, therefore as the detector is moved further from the source, the reading becomes lower and lower.



An answer that links a description of the graph with how it shows that the radiation must be alpha. Full marks.

Question 6 (d)(ii)

The detector reading does not fall to zero because there is background radiation. Surprisingly few candidates answered in these terms with many writing that alpha radiation from the source was still being detected.

- (ii) Give a reason why the mean detector reading in Figure 14 does not fall to zero in this experiment.

(1)

Because of Background
radiation



A short and correct answer that scored the mark.

because Alpha is still present.



This answer implies that there was still alpha radiation reaching the detector from the source. In fact, the alpha radiation had been absorbed by the air. The readings must be due to radiation that was not from the source. No marks here.

Question 7 (a)(ii)

Examiners were looking for an explanation that included the fact that the direction of the satellite is constantly changing as it orbits. Therefore, its velocity is changing. This is acceleration. Alternatively, candidates could state that there is a resultant force on the satellite (because, by Newton's 2nd law, this will cause an object to accelerate).

The satellite is constantly changing direction which is a form of acceleration.



Writing about a change in direction scores 1 mark.

Because it is always changing direction to be able to orbit the earth, which means that there is always a change in velocity which is why it has to accelerate to keep its constant speed.



A change in direction linked to a change in velocity scores 2 marks

Many candidates seemed to misinterpret the question and described the forces keeping the satellite in orbit rather than explain why moving in an orbit means accelerating.

a satellite will travel at a constant speed around the earth due to ~~gr~~ the earth's gravitational field keeping it in place.



This response tries to explain why the satellite stays in orbit. It does not explain why it is accelerating.

No marks.

Question 7 (b)

The Earth's atmosphere scatters and absorbs light from distant objects and therefore, in order to get a clear image, some telescopes are located outside the Earth's atmosphere.

The question did not mention the Earth's atmosphere therefore any response that recognised that being above the Earth's surface and put it outside the atmosphere was worthy of at least one mark.

A very large number of candidates wrote, incorrectly, about it being nearer to the stars being observed. This slightly shorter distance is insignificant compared to the vast distance to even the nearest star.

A mark was given for the idea of being able to get a clear image.

- (b) The Hubble Space Telescope is an artificial satellite in orbit about 500 km above the Earth's surface.

This telescope is used to observe the light from very distant objects in the Universe.

Explain why the Hubble Space Telescope must be high above the Earth's surface to make its observations.

(2)

So it can get clearer
Images



Scores 1 mark

A mark was given for the idea that light pollution should be avoided.

- (b) The Hubble Space Telescope is an artificial satellite in orbit about 500 km above the Earth's surface.

This telescope is used to observe the light from very distant objects in the Universe.

Explain why the Hubble Space Telescope must be high above the Earth's surface to make its observations.

(2)

So there's no light pollution in its way



This scores 1 mark

A mark was given for a reference to the telescope being above the atmosphere.

- (b) The Hubble Space Telescope is an artificial satellite in orbit about 500 km above the Earth's surface.

This telescope is used to observe the light from very distant objects in the Universe.

Explain why the Hubble Space Telescope must be high above the Earth's surface to make its observations.

(2)

It must be above the clouds and earths atmosphere to have a clear image. No earth surface is above the atmosphere.



This gets a mark for a clear image and a mark for being above the atmosphere.

Question 7 (c)

This question assessed the ability to interpret graphical information; in this case the question showed a scatter graph with a linear relationship between height above the Earth and time to orbit.

A mark was given for a simple description of the height above the Earth's surface increasing with the time taken to orbit.

(c) There are many other artificial satellites in orbit around the Earth.

Figure 16 shows the time taken to complete one orbit for satellites at different heights above the Earth's surface.

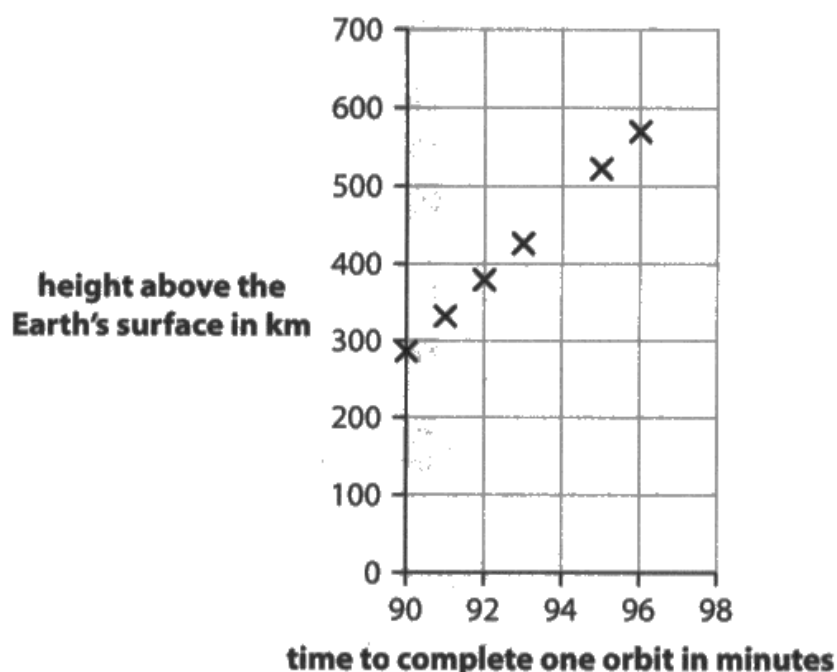


Figure 16

Describe the relationship shown in Figure 16.

(2)

As height increases, the time taken to complete orbit increases as well.



This scored 1 mark.

This mark could also be scored for describing a positive correlation (between the two variables).

A second mark was given for a detailed description that included the fact that the relationship was linear.

Although the relationship is not directly proportional (because the line, if drawn, does not pass through the origin) examiners would give a mark for this at this level.

(c) There are many other artificial satellites in orbit around the Earth.

Figure 16 shows the time taken to complete one orbit for satellites at different heights above the Earth's surface.

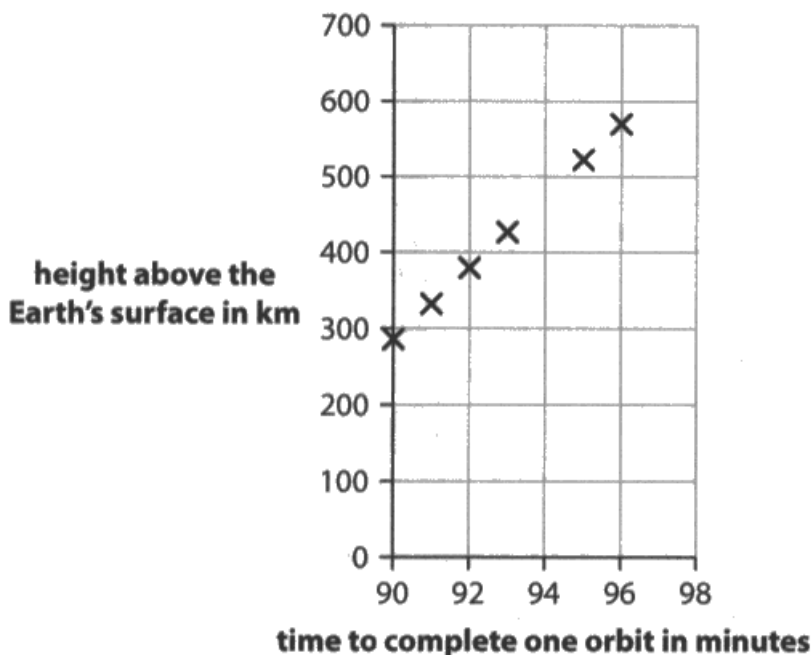


Figure 16

Describe the relationship shown in Figure 16.

(2)

The relationship is a linear relationship in figure 16. As the time to complete one orbit in minutes increases, the height above the Earth's surface increases.



This scored the second mark as well as the first mark.

Question 7 (d)

This question asked candidates to compare an old diagram of the Solar System that had objects orbiting the Earth with its currently accepted structure.

Examiners were looking for detailed descriptions that compared both the objects in the Solar System and how those objects are arranged.

There was space for candidates to draw their own diagram.

A clear diagram could help a candidate give a level 3 answer.

*d) A long time ago, many people thought that the objects seen in the sky were arranged as shown in Figure 17.

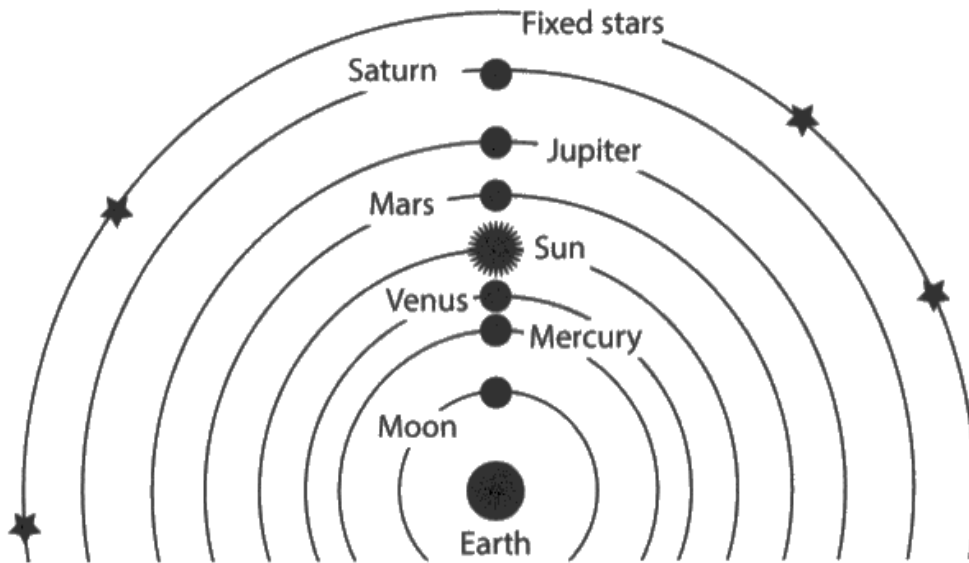


Figure 17

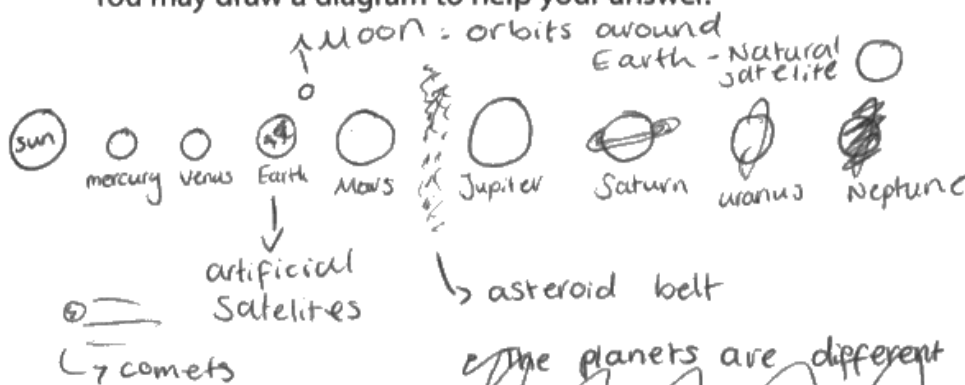
Compare the arrangement shown in Figure 17 with what we now know about the Solar System.

Your answer should refer to

- the objects that are in the Solar System
- how these objects are arranged.

You may draw a diagram to help your answer.

(6)



The planets are different compared to the geocentric model because the planets now orbit around the sun, and not Earth.

The planets are now different compared to the geocentric model because the geocentric model shows every planet orbiting around Earth, but now everything every planet orbits around the sun.

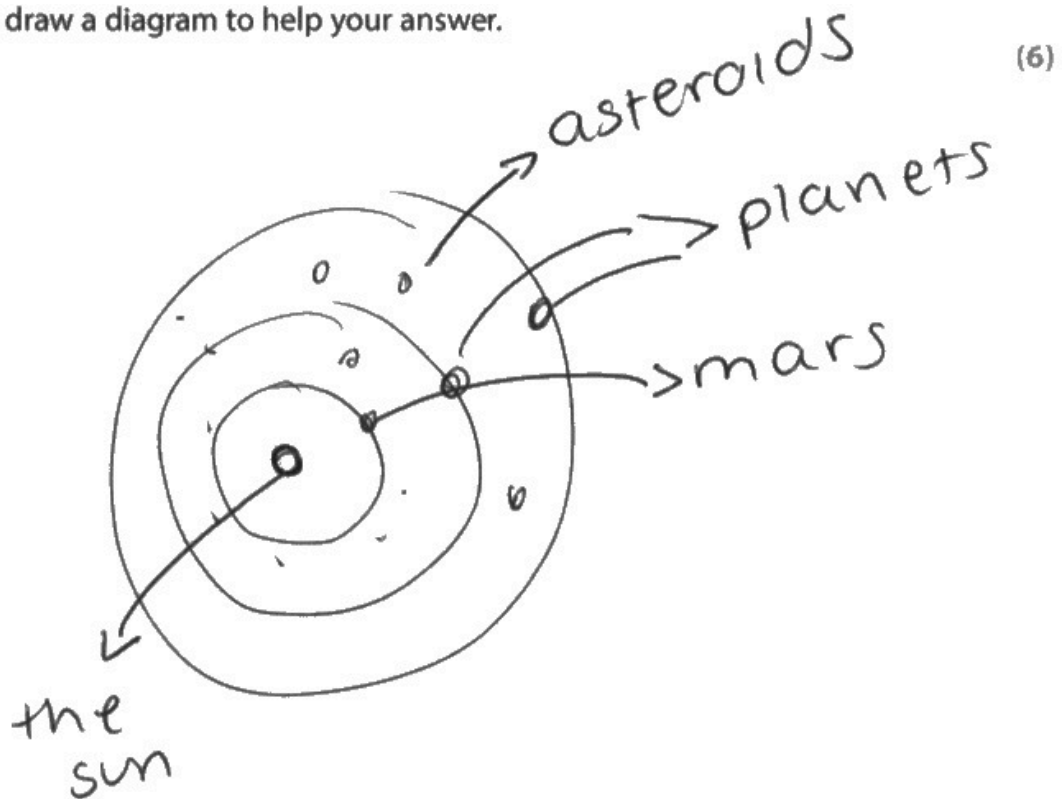


The well drawn diagram shows the Sun in the centre with the planets in the correct order. The Moon is orbiting the Earth. Additional objects, including Neptune, Uranus, asteroids and comets are named and shown in the correct place. The writing correctly summarises the information shown in the diagram.

Taken together, this detailed comparison of the objects and their arrangement demonstrates accurate and relevant physics understanding with detailed and fully developed scientific ideas. It is a level 3 response worthy of the full 6 marks.

A level 2 response would typically give comparisons of both the objects and their arrangement but those comparisons lacked detail and may have contained inaccuracies.

You may draw a diagram to help your answer.



The arrangement shown in Figure 17 show that the planets were all lined up together and they used to think that the earth was in the centre of the solar system.

whereas in the modern one the sun is at the centre of the solar system, and now that they have better technology there are satellite systems and asteroids.

They have also found out that not all planets have the same orbits.

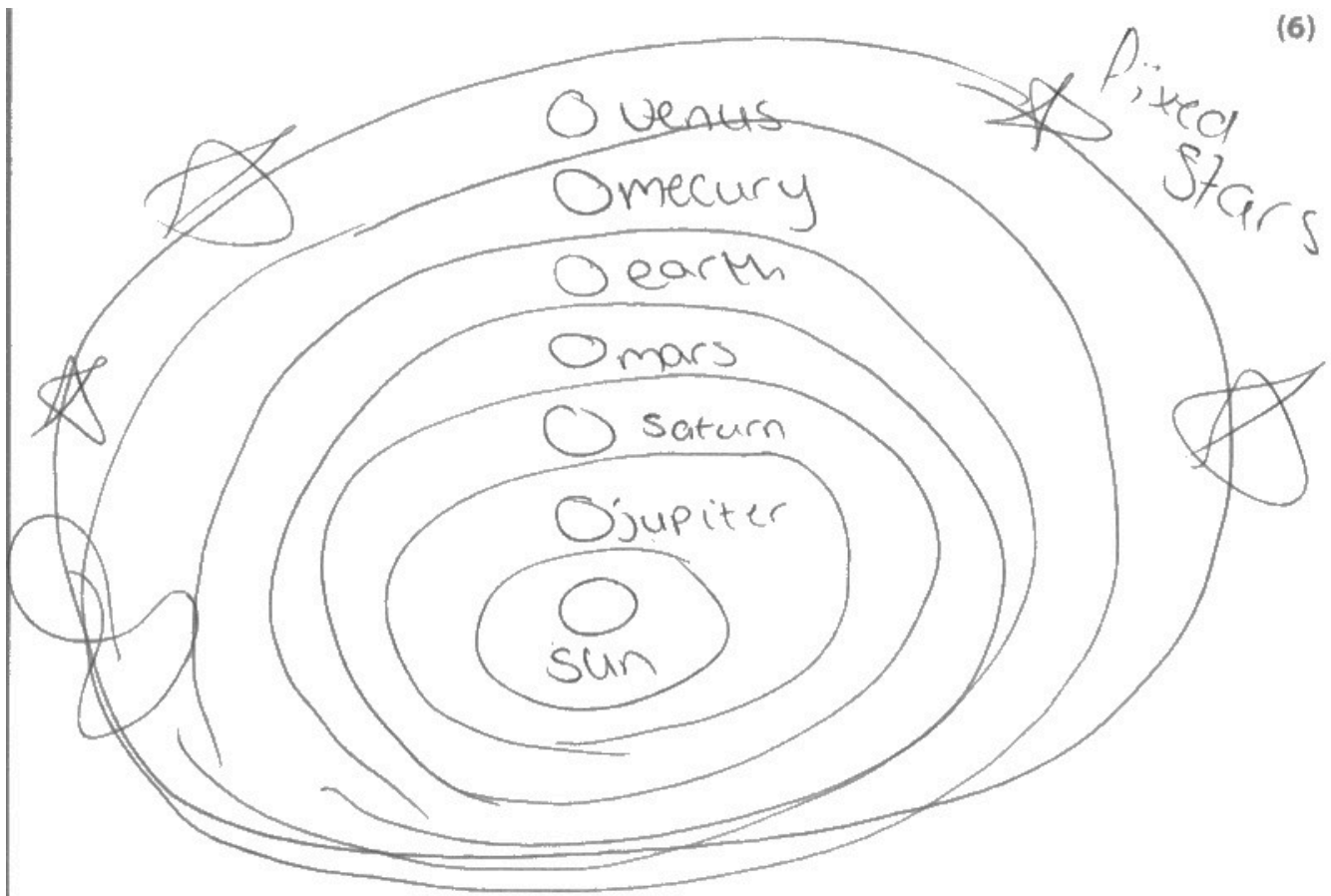


The diagram shows the Sun in the centre, a planet, Mars and additional objects, the asteroids. However, the arrangement of those objects around the Sun are not accurate. This is a partially complete comparison of objects and arrangement.

The writing describes the Earth no longer being in the centre and makes it clear that the Sun is in the centre which is also a simple comparison.

Taken together this shows some relevant physics understanding that includes some inaccuracies and is a level 2 response scoring 4 marks.

A level 1 answer typically gave isolated facts about objects and/or arrangement, but the comparisons included many inaccuracies and lacked detail.



All of the planets in the solar system all orbit around the sun and not the earth as if all the planets orbited around the sun you would be able to see the closest ones without a telescope and there would be little to no light on earth.



The diagram shows the Sun in the centre with planets orbiting around it. However, the order of those planets is incorrect. It also shows the stars still orbiting the Sun. No additional objects are mentioned, and the Moon is missing.

The writing includes a statement that the Earth is not at the centre.

Taken together this response shows elements of physics understanding, some of which is inaccurate and lacks detail of scientific ideas.

This is a level 1 response scoring 2 marks.

Question 8 (a)

This question also appeared towards the start of the higher paper and was aimed at grade 4 and 5 candidates.

It required substitution into the equation that was given followed by a rearrangement in order to calculate the height.

It was pleasing to find that very many candidates were able to do this calculation.

Since substitution and rearrangement could be done in either order partial credit was given for a correct substitution followed by an incorrect rearrangement or vice versa.

(a) The person rides the skateboard down the ramp from P to Q.

The gravitational potential energy of the person decreases by 980 J.

The mass of the person is 35 kg.

Calculate h , the height of the ramp.

Use $g = 10 \text{ N/kg}$.

Use the equation

$$\text{change in gravitational potential energy} = m \times g \times h \quad (2)$$

$$h = \frac{\text{GPE}}{m \times g} = \frac{980}{35 \times 10}$$

$$h = \dots 280 \dots \text{m}$$



This showed a correct rearrangement and substitution and scored 1 mark.

The evaluation was incorrect, however, and did not score the second mark.

change in gravitational potential energy

change in gravitational potential energy = $m \times g \times h$

$$980 = 35 \times 10 \times h$$

$$\Rightarrow h = \frac{980}{35 \times 10} = \frac{980}{350} = 2.8$$

$$h = \dots\dots\dots 980 \dots\dots\dots \text{m}$$

$$h = 980$$



ResultsPlus
Examiner Comments

The candidate has substituted the correct values into the equation and so scored 1 mark.

The rearrangement and evaluation was incorrect and so the second mark could not be awarded.

Examiners would also, on this occasion, give credit for an incorrect rearrangement with the given values substituted into this provided that the rearranged equation was shown.

$$h = \frac{m \times g}{\text{gravitational potential energy}}$$
$$h = \frac{35 \times 10}{980} = 0.3571428$$

$$h = 0.3571428 \dots \text{ m}$$



ResultsPlus
Examiner Comments

Here the candidate has started by writing an incorrect rearrangement of the equation.

However, the correct values have been substituted into this and so can score 1 mark even though an incorrect final answer meant that a second mark was not awarded.



ResultsPlus
Examiner Tip

Always show your working, including rearranging the equation and substituting with the values given in the question.

You may still score a mark even though your answer is not fully correct.

Question 8 (b)

This was a slightly more difficult question that required substitution into the equation given and an evaluation that required finding the square root.

Better candidates were able to score all three marks.

Better candidates were able to score all three marks.



$$v^2 = \frac{2 \times 950}{35}$$

$$v^2 = \frac{380}{7}$$

$$v = \sqrt{\frac{380}{7}} = 7.37$$

velocity = 7.37 m/s



ResultsPlus
Examiner Comments

A well laid out answer that scored full marks.

Many candidates showed substitution into the equation and evaluation of v^2

$$\text{velocity} = \frac{2 \times 950}{35} = 54.28571429$$

$$\text{velocity} = \underline{54.3} \text{ m/s}$$



A mark for correct substitution and another mark for evaluation that rounds to 54.3.

The candidate should have then found the square root of this number to score the final mark.

Question 8 (c)(i)

In this question the arrow represents energy that was not transferred from gravitational potential energy to an increase in kinetic energy but instead was dissipated to the surroundings.

Candidates were clearly familiar with interpreting this type of diagram and correctly identified it as thermal energy or, more commonly as wasted energy. The mark scheme also accepted energy transferred due to friction or transferred to the surroundings.

Question 8 (c)(iii)

Very many candidates were able to use the equation to calculate efficiency by dividing the useful energy transferred (950 J) by the total energy supplied (980 J) to arrive at an answer of 97% or 0.97.

The most common difficulty seemed to be how to express the result. It could either be as a simple fraction ie 0.97 or as a percentage ie 97%.

Many candidates seemed to confuse the two.

(iii) Calculate the efficiency of the system represented in Figure 19.

(2)

$$\text{Efficiency} = \frac{\text{useful energy transferred}}{\text{total energy supplied}}$$

$$\begin{aligned} \text{Efficiency} &= \frac{950}{980} \\ &= \cancel{0.969} \\ &= 0.97 \end{aligned}$$

$$\text{efficiency} = \underline{0.97\%}$$



ResultsPlus
Examiner Comments

The correct answer here is 0.97.



ResultsPlus
Examiner Tip

Make sure you understand when and how to use the % sign.

(iii) Calculate the efficiency of the system represented in Figure 19.

(2)

$$100 \times \frac{\text{useful}}{\text{total}} = \text{efficiency}$$

$$\frac{950}{980} = 0.9693\dots$$
$$\times 100 = 96.938\dots$$
$$96.94$$

$$\text{efficiency} = \underline{\underline{96.94}}$$



ResultsPlus
Examiner Comments

The fraction has been multiplied by 100. This makes it into a percentage and so needs the % sign.

A mark was also lost in cases where the value given on a calculator of 0.96938 was truncated to 0.96 rather than rounded to 0.97.

(iii) Calculate the efficiency of the system represented in Figure 19.

(2)

$$950 \div 980 = 0.9693877551$$

$$\text{efficiency} = 0.96$$



ResultsPlus
Examiner Comments

The correct rounding is 0.97 and not 0.96



ResultsPlus
Examiner Tip

Make sure you know how to round the answer shown on a calculator correctly.

Question 8 (d)

This question was essentially about ways of reducing the energy losses when going down the slope. Acceptable answers included ways of reducing friction or air resistance. However, credit would be given for a way of increasing the kinetic energy such as applying an extra force at the start.

Answers that required changes to the ramp would mean that points P and/or Q were no longer the same and these answers did not score.

(d) The person would like to start from P again but have a greater velocity at Q.

Suggest **two** ways that this can be achieved.

(2)

- 1 have a run up by stepping back further
- 2 go at a higher height



Having a run up would mean no longer starting at P.

Changing the height of the slope would alter the position of P.

Neither of these suggestions would answer the question and scored no marks.

(d) The person would like to start from P again but have a greater velocity at Q.

Suggest **two** ways that this can be achieved.

(2)

- 1 reduce the ~~fr~~ friction on the skateboard by adding a lubricant.
- 2 the person can also start at a higher point on the ramp.



ResultsPlus
Examiner Comments

There is a mark for reducing friction.

There is no mark for starting at a different position.

Question 9 (a)(i)

Most candidates were able to read the graph at the point where the two lines crossed to find the distance that L has run.

Some tolerance was given so that values between 64 and 68 were acceptable.

Some candidates seemed to have misinterpreted the question and found the remaining distance that L has still to run to give an answer between 32 and 36. Examiners gave full credit for this which still required correctly reading the graph.

Question 9 (a)(ii)

The velocity is calculated by finding the slope of the graph. A mark was given for identifying suitable values from the graph and a second mark was awarded for a correct calculation using those values. Very many candidates gave the expected answer of 6.6 m/s for full marks.

The grid lines on the time axis were a little unusual. Each small square represented 0.4 s. Examiners would give partial credit for a slightly incorrect time that was correctly used in the calculation.

(ii) Calculate the velocity of L when running the 100 m race.

(2)

$$\frac{100}{14.4}$$

velocity = 6.94 m/s



ResultsPlus
Examiner Comments

Time value for time on the graph is 15.2 not 14.4. This scored 1 mark out of 2.

Question 9 (b)(i)

This equation linking time, change in velocity and acceleration was given and candidates were required to substitute the values given before calculating the answer.

The biggest challenge for many candidates was to find the change in velocity which was $10 - 6.2 = 3.8$ m/s and many simply used the first value for velocity that appeared in the question (6.2 m/s).

(b) A motorcycle is travelling at a velocity of 6.2 m/s.

The motorcycle accelerates at 2.5 m/s^2 until its velocity is 10 m/s.

(i) Calculate the time taken for this acceleration.

Use the equation

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}} \quad (2)$$

$$6.2 \div 2.5 = 2.48$$

time taken = 2.48 s



ResultsPlus
Examiner Comments

The change in velocity is from 6.2 to 10 m/s. This answer did not score any marks.

A few candidates made an unnecessary conversion between seconds and minutes.

(b) A motorcycle is travelling at a velocity of 6.2 m/s.

The motorcycle accelerates at 2.5 m/s² until its velocity is 10 m/s.

(i) Calculate the time taken for this acceleration.

Use the equation

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}} \quad (2)$$

$$10 - 6.2 = 3.8$$

$$\frac{3.8}{2.5} = 1.52 = 112\text{s}$$

time taken =112..... s



ResultsPlus
Examiner Comments

This would have been a perfect answer, but it was spoiled by converting the time; in this case by multiplying by 60.

It scored 1 out of 2.

Question 9 (b)(ii)

This question, along with part(a) appeared on the higher paper as well. It was intended to allow the more capable candidates to demonstrate their ability to handle more complex equations. The equation linking initial velocity, final velocity, acceleration and distance was given. Candidates had to substitute for the values given and then rearrange the equation to find the distance of 11m.

This provided several challenges including identifying that the final velocity was zero and squaring the initial velocity before rearranging. Better candidates managed this difficult question.

Partial credit was given for an answer that rounded to 1.1 which would be obtained if the initial velocity was not squared but the subsequent rearrangement was correct.

(ii) The motor cycle now decelerates (slows down) from 10 m/s to a stop.

The deceleration is at a constant rate of 4.4 m/s².

Calculate the distance the motorcycle travels as it slows down to a stop.

Use the equation

$$v^2 - u^2 = 2 \times a \times x$$

$$4.4 \times 2 = 8.8^{(2)}$$

on 15 $10 \text{ m/s} = 10$

$$\cancel{0^2 - 10^2} = -100$$

distance = 1.1 m

$$\frac{10}{\frac{100}{8.8}} = 1.1 \text{ m}$$



This scored 1 of the available marks.

Partial credit was also given for the mathematical step of rearranging the equation even if incorrect values were substituted into that equation.

$$\frac{v^2 - u^2}{2 \times a} = x$$

$$\frac{v^2 - u^2}{2 \times 4.4}$$

$$\frac{(10)^2 - (6.2)^2}{2 \times 4.4} = 6.7$$

distance = 7 m



ResultsPlus
Examiner Comments

1 mark for rearranging the equation.

Both the change in velocity to 0 from 10 and the acceleration had negative values (because the motorcycle was slowing down). The resulting distance would be positive. However, examiners condoned errors arising from treating either or both values as positive.

$$0^2 - 10^2 = 2 \times 4.4 \text{ m/s}^2 \times x$$

$$0^2 - 10^2 = -100$$

$$\text{distance} = \dots -11.36 \dots \text{ m}$$

$$\begin{aligned} -100 &= 2 \times 8.8 \times 4.4 \text{ m/s}^2 \\ &= 38.72 \end{aligned}$$

$$x = 2.58$$

$$x = -11.36$$



ResultsPlus
Examiner Comments

A perfectly acceptable response that scored full marks.

Question 9 (c)

This question required candidates to devise an investigation based on a core practical involving a trolley descending a ramp.

Examiners were looking for detailed descriptions of measuring the distance between the points X and Y, measuring the time taken to travel from X to Y, using these values to calculate the speed and finally repeating the investigation with the end of the ramp at different heights.

There was often some confusion between the investigation specified in the question and investigations that candidates had carried out that involved the trolley being accelerated by a force provided by a string attached to the trolley and passing over a pulley to a hanging weight. Examiners would not penalise this provided that the descriptions of obtaining and processing the measurements were correct.

Many excellent level 3 responses were seen, and they usually scored 6 marks.

Student needs the following equipment:

meter ruler, stopwatch / stopclock or light gates

if but latter is optional.

First student must measure distance from X to Y on

the ramp. Then also measure the height

of the ramp, all using a meter ruler.

Then student must place trolley at X and time

how long it takes to reach Y using the

stopwatch. Then calculate the speed

using the formula $\text{Speed} = \text{distance} \div \text{time}$.

An alternative way of measuring speed is

using the light gates at points X and Y.

~~Student should repeat several times to get an accurate result.~~

Student should repeat several times to get

an accurate result. Then, student should

Change the height of the ramp by making it
~~shorter~~ shorter or higher. Then, repeat
the same steps for each height.

As student obtains their results,
put it into a table to analyse their results.

Also, student should make sure that the
points of x and y do not change throughout.



ResultsPlus
Examiner Comments

It is clear exactly what measurements are being made and how the results should be processed. This scored 6 marks.

Level 2 answers typically did not give detail about which distance and/or time was being measured.

A student will need a stopwatch to measure the time it takes for the trolley to go down the ramp. However to get a more accurate measurement of time taken the student could use light gates. The student needs a metre ruler to be able to measure the distance of the ramp (which is the distance travelled). They will also need a ruler to measure the height of the ramp. To calculate the mass of the trolley + see how much pressure it applies to the ramp it will need to be measured using a ~~metre~~ or a weighing scales.



This scored 4 marks. It was not clear exactly which distance and times were being measured.

Level 1 responses often showed recall of apparatus to be used but failed to go on to describe how they would be used.

*(c) A student has a trolley and a ramp, as shown in Figure 21.

The height, H , of one end of the ramp can be adjusted.

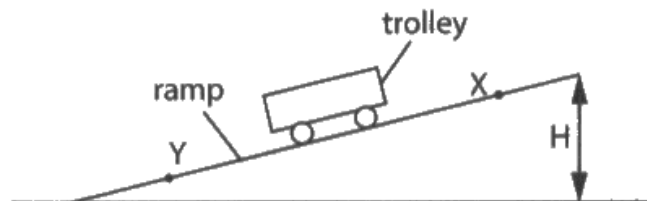


Figure 21

The student investigates how the average speed of the trolley between X and Y depends on the height, H , of the ramp.

Describe

- the additional equipment that the student needs
- how that equipment is used to obtain the measurements needed.

(6)

Equipment needed:

- Trolley
- Ramp
- Ruler
- Stop watch / timer
- Camera / phone



The necessary apparatus was recalled. This scored 2 marks.

Question 10 (b)(i)

This was a difficult question that also appeared on the higher paper. Only the better candidates were expected to be able to score marks. These were usually given for writing about a gamma ray being produced and detected. Examiners saw no description of electron – positron annihilation and only rare appreciation that two gamma rays were emitted in opposite directions.

Question 10 (b)(ii)

Only the best candidates reasoned that the isotope would start to decay immediately that it was produced and so had to be used quickly before its activity decreased so much that it would not be useful. Most wrote about the need to inject the isotope near to the suspected tumour.

Question 10 (c)

This was another difficult question. Only a few of the better candidates were able to give an acceptable difference between irradiation and contamination

Question 10 (d)(i)

Candidates had more success with this question, and many could use the graph to determine a half-life of between 110 and 130 hours.

A mark was given for showing how to use the graph.

(d) Figure 23 shows the decay curves of two different isotopes, Q and P.

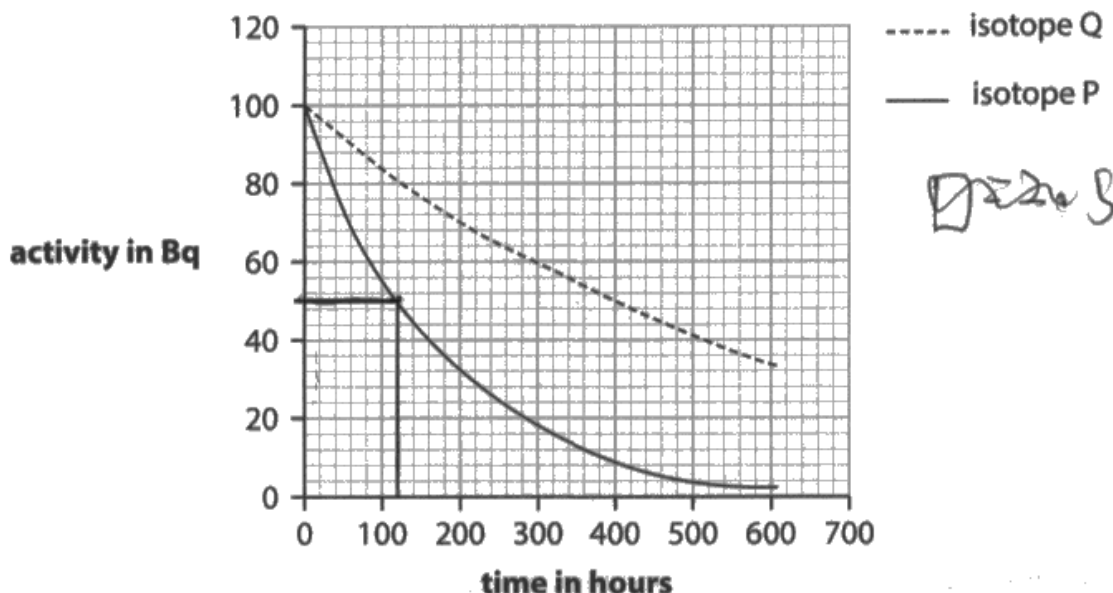


Figure 23

(i) Use the graph in Figure 23 to determine the half-life of isotope P.

(2)

half-life of isotope P = 100 hours



The candidate has found the point on the graph where the activity has fallen from 100 Bq to half that amount (50 Bq). This scores a mark. Unfortunately, the time has not been read correctly. It should be 120 hours and not 100 hours. 1 mark out of 2.



When using a half-life graph always draw a line from the axis to the graph where the activity has fallen to half its original value. This shows the examiner that you know what you are doing.

Question 10 (d)(ii)

Examiners saw very many answers that correctly drew information from the graph to suggest that either isotope Q remained more active for longer than isotope P or, more simply, that isotope Q had a longer half-life.

because it radioactivity take more time
so decrease than isotope P



A good answer that scores the mark

its half life is longer, meaning it will
be exposing you to radiation for a lot
longer

(Total for Question 10 = 11 marks)



Another good response that scores the mark for "half-life is longer"
even without the rest of the answer

Paper Summary

Based on their performance on this paper, candidates should:

- make sure that they have a sound knowledge of the fundamental ideas in all the topics
- get used to the idea of applying their knowledge to new situations by attempting questions in previous examination papers
- draw a labelled diagram to help their answer, especially when invited to so in the question
- note that when suggesting a practical procedure, to make sure they are relevant to the context of the question
- make sure that where a question involves a calculation, they write down the equation they are using (if not given in the question) and show each step in their working
- make sure that they are confident in using percentages and pay close attention to the units expected
- use the marks at the side of a question as a guide to the form and content of their answer.

Grade boundaries

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

<https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html>

