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Examiners' Report
June 2022

GCSE Combined Science 1SC0 1PF

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Introduction

The questions were set to test knowledge, application and the candidates' ability to analyse information and ideas having been taught the topics which make up the specification.

The topics covered by the specification are:

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.

The assessment is through multiple choice questions, short answers, extended writing, calculations and analysis.

The paper also tested the skills acquired by candidates when completing practical work. The specification includes core practicals which should be included in the scheme of work and a number of suggested practicals which exemplify points in the specification to help candidates' understanding.

The work produced for the examination showed that most candidates were able to deal with calculations when given the equation to use. Most candidates showed the substitution so that even with an incorrect evaluation a mark could be obtained. It was pleasing to see that many candidates appreciate the need to give numerical values to fewer significant figures than may be shown on a calculator, although the difference between simply truncating a value and rounding up or down was often not understood.

Candidates coped well with obtaining information from simple graphs and were often able to provide a simple description of the relationship between the two variables but were less successful in reading precise values from a velocity-time graph.

Testing of practical skills showed that candidates were generally capable of producing a drawing of how to arrange equipment that could be used to obtain a cooling curve but were less successful in identifying the factors that needed to be controlled when comparing the insulating properties of two different substances.

The dangers arising from driving on a wet road were appreciated by most candidates but there was considerable confusion between stopping distance, braking distance and thinking distance.

Candidates found calculations involving radioactive half-life difficult and future candidates would possibly benefit from more practice on this frequently examined topic.

Question 1 (b)(i)

Most candidates knew that x-rays can be used to detect broken bones.

Question 1 (b)(ii)

Candidates were often unsure of the term thermal imaging and visible light was frequently offered as an (incorrect) answer.

Question 1 (b)(iii)

This and the following question could be answered by recognising that the wavelengths in the electromagnetic spectrum shown decreased from left to right.

In this case infrared has a shorter wavelength than microwaves.

Question 1 (b)(iv)

Gamma rays have a shorter wavelength than x-rays.

Question 2 (a)(i-ii)

Although the diagram clearly labelled the lines as being crests of the water wave, many candidates seem to have counted the number of complete gaps between P and Q to arrive at an incorrect answer of 11 rather than 12.

Nevertheless, provided working was shown, an incorrect answer to part (a)(i) could still score full credit for part (a)(ii).

2 This question is about waves.

(a) Figure 3 is a diagram of a **water wave** in a ripple tank.

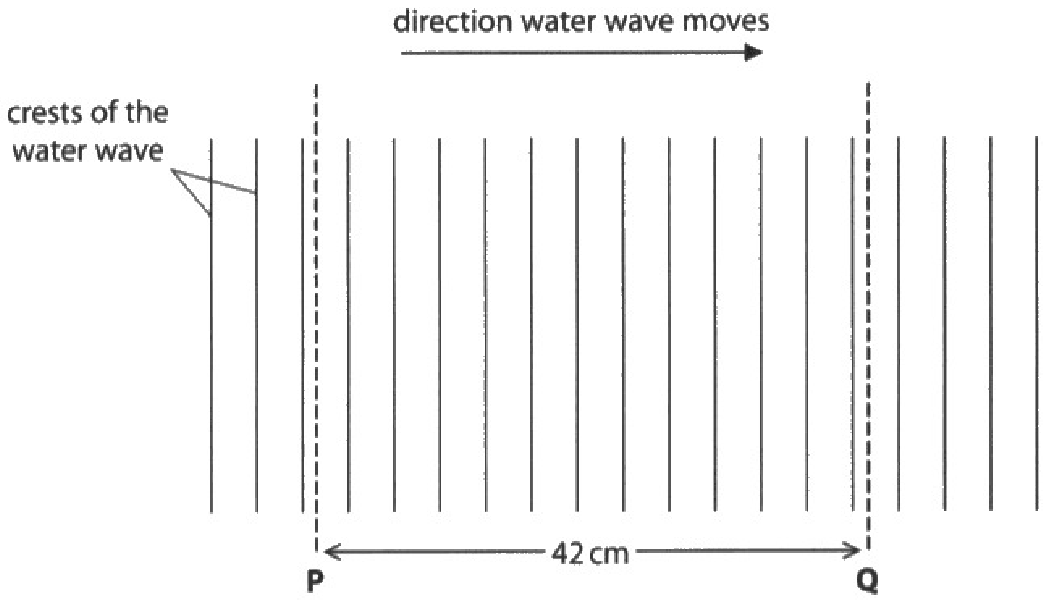

Figure 3

(i) State the number of crests of the wave between **P** and **Q**.

(1)

number of crests = 11

(ii) The distance between **P** and **Q** is 42 cm.

Calculate the wavelength of the water wave in Figure 3.

(2)

42 cm ÷ 11 = 3.81

wavelength = 3.81 cm

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Examiner Comments

Although the candidate has incorrectly counted the number of crests, this value was correctly used in the subsequent calculation and so scored full marks for part (a)(ii).

ResultsPlus
Examiner Tip

Always show your working. You may gain some credit even if your final answer is wrong.

Question 2 (a)(iii)

Wave speed can be determined either from distance and time or from wavelength (which has already been found) and frequency.

Candidates therefore needed to first describe either how to determine the time taken to travel through a measured distance or describe how to find the frequency and then state how the value(s) are used to find the speed of the wave.

Many candidates gave additional practical details such as making a video and analysing the images. These details were not essential, however.

(iii) Describe how a student could determine the wave speed of the water wave in Figure 3.

(3)

the student can ~~da~~ ~~[illegible]~~ do distance ÷ time. He can do this by recording how long a wave from point P would take to get to point Q. To be sure he ~~can~~ could time lapse it and check for accurate results. Then do 42cm ÷ how long it took.

ResultsPlus
Examiner Comments

The response gives a description of measuring the time taken for a crest to travel through a measured distance and then described how the measurements of distance and time are used to find the wave speed.

Full marks awarded.

Note that examiners would allow the use of "wave" rather than the more accurate "crest" or "wavefront" in this question.

(iii) Describe how a student could determine the wave speed of the water wave in Figure 3.

(3)

The student could count the number of waves passing in 20s and then divide it by 20 to get frequency and then calculate speed using frequency x wavelength

ResultsPlus
Examiner Comments

Here, the candidate has described how to find the frequency and then how that value is used, together with wavelength, to calculate speed.

Full marks awarded.

Question 2 (b)(ii)

Candidates were usually able to select and correctly use the equation linking wave speed, frequency and wavelength.

Question 3 (a)

This proved straightforward for many candidates, although a few did attempt an unnecessary conversion from kg to g.

Question 3 (b)

Although many candidates could select the correct equation to calculate kinetic energy, they were less successful in handling the squared term. Partial credit could be given for answers that showed the correct substitution of values that were subsequently incorrectly evaluated.

(b) A cyclist of mass 70 kg travels at a constant velocity of 8 m/s.

Calculate the kinetic energy of the cyclist.

(3)

Kinetic energy $= \frac{1}{2} \times \text{mass} \times (\text{speed})^2$

$= \frac{1}{2} \times 70 \times (8)^2$

$= 2240$

kinetic energy of the cyclist = 2240 J

ResultsPlus
Examiner Comments

A nicely laid out answer. It is always a good idea to give the equation in words or symbols before writing the values.

Question 3 (c)(i)

Candidates had to first locate an angle that was between two gird lines on the x axis and then correctly read the value on the y axis that was also between two grid lines.

Some tolerance was allowed and very many candidates gave an acceptable answer between 0.53 and 0.55.

Question 3 (c)(ii)

A candidate needed to correctly extend the curve up to 80 degrees and then read off the value.

A value between 0.42 and 0.48 indicated that the curve had indeed been correctly extended and would score full marks.

A value outside this range could still score a mark if the curve was extended to 80 degrees even if it was not sufficiently accurate.

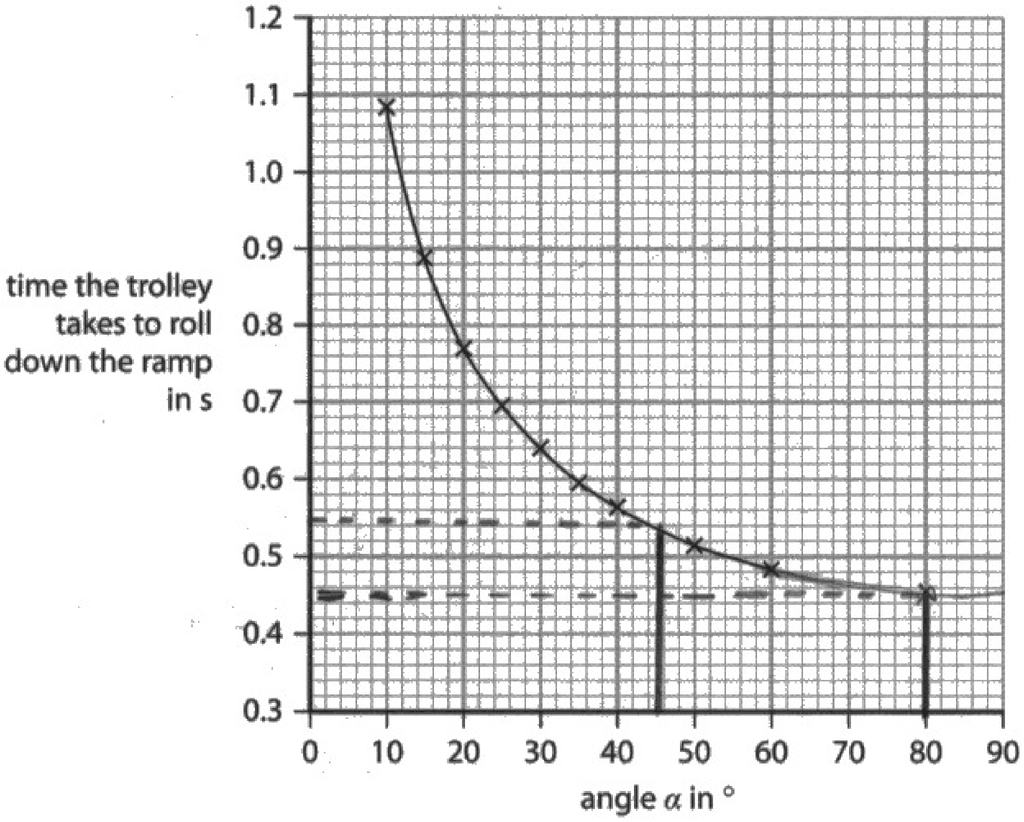

Figure 6

(i) Use the graph in Figure 6 to find the time the trolley takes to roll down the ramp when the angle $\alpha = 45°$.

(1)

time = 0.54 s

(ii) Use the graph in Figure 6 to estimate the time the trolley takes to roll down the ramp when the angle $\alpha = 80°$.

Show your working on the graph.

(2)

time = 0.44 s

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Examiner Comments

The value at 45 degrees has been correctly read.

The graph has been correctly extended and the value at 80 degree correctly read. Full marks awarded.

ResultsPlus
Examiner Tip

When reading from a graph it is always a good idea to draw lines from both axes to the line of the graph. This helps to make sure that you do not misread the values.

Question 3 (c)(iii)

Candidates are often familiar with using light gates to measure time in dynamics investigations. This question required them to refer to the data on the graph and provide a reason for using light gates rather than a stopwatch. Examiners were looking for an appreciation that the times being measured were comparable to human reaction times. Stronger candidates were able to use an idea of reaction time in their responses but a great many simply wrote about the greater accuracy of light gates without any reference to the graph or the times being measured.

(iii) The student had a choice of how to measure the time the trolley takes to roll down the ramp.

1. Use a hand-held stopwatch.

2. Use light gates at the top and bottom of the slope.

The student chose to use the light gates.

Explain why this was the correct choice.

You should refer to the data on the time axis of Figure 6 in your answer.

(2)

• because it is a very quick time to measure a persons reaction time would add on unneeded time.
• light gates are more accurate.

ResultsPlus
Examiner Comments

A mark for correctly identifying that a person's reaction time is significant here but there is no indication that the candidate has referred to the times shown in the graph.

There was no mark for simply stating that a light gate is more accurate.

1 mark out of 2.

A more complete answer that refers to the time axis of the graph.

(iii) The student had a choice of how to measure the time the trolley takes to roll down the ramp.

1. Use a hand-held stopwatch.
2. Use light gates at the top and bottom of the slope.

The student chose to use the light gates.

Explain why this was the correct choice.

You should refer to the data on the time axis of Figure 6 in your answer.

(2)

Because it is very difficult to get accurate time stamps at 0.4, 0.6 seconds as a human cannot react that fast.

ResultsPlus
Examiner Comments

This answer recognises that the time being measured is shown on the graph as being around 0.4 to 0.6 seconds.

It goes on to correctly state that a person's reaction time is significant in this case.

Scores both marks.

Question 4 (a)(i)

Most candidates were able to state one danger of radioactivity; most usually increasing the risk of cancer although the mark scheme also allowed for a variety of hazards. However a large number of candidates seemed to confuse radioactivity with chemical or electrical hazards.

(i) State **one** way that radioactivity can be dangerous to humans.

(1)

we can breath it in (the chemicals) and it can slow down the breathing.

ResultsPlus
Examiner Comments

This was a very common misconception. No marks awarded.

(i) State **one** way that radioactivity can be dangerous to humans.

(1)

this could harm humans bodies from the inside

ResultsPlus
Examiner Comments

There is some idea of a danger but this answer is too vague to score a mark.

(i) State **one** way that radioactivity can be dangerous to humans.

(1)

Can cause cancer

ResultsPlus
Examiner Comments

This was a very common and correct statement and scores the mark.

Question 4 (a)(ii)

Many candidates were able to recall that a Geiger counter could be used to measure radioactivity. Credit would also be given for mentioning a film-badge or a dosimeter. A large number of candidates, however, either left this blank or wrote vaguely about radiation detectors.

Question 4 (a)(iii)

Stronger candidates were able to recall at least one example of ionising radiation. Less well prepared candidates seemed to (incorrectly) choose parts of the electromagnetic spectrum that had been listed in the first question.

Question 4 (b)

Candidates were required to first identify that the lower number represented the atomic number and therefore the number of protons and the top number represented the mass number and therefore the number of nucleons. The number of neutrons could then be found by the difference between these two values. The most common confusion was between neutrons and nucleons.

Question 4 (c)(i-ii)

Half-life calculations proved very challenging for a great many candidates. Many attempted to take the mass and either multiply or divide by the number of days. Correct calculation required recognising that mass would be halved after each half-life period. Therefore after 18 days, (one half-life) there would be 260 g remaining. The second part required understanding that 54 days was 3 half-lives and there the mass would be halved and then halved again to produce 65 g remaining. Partial credit was given to candidates whose working demonstrated that 54 days was equivalent to 3 half-lives even if their use of this number was not quite correct.

(c) A sample of a radioactive isotope has a mass of 520 g.

The half-life of the radioactive isotope is 18 days.

(i) Calculate the mass of the original radioactive isotope remaining after 18 days.

(1)

520 ÷ 2 = 260

mass after 18 days ....260........ g

(ii) Calculate the mass of the original radioactive isotope remaining after 54 days.

(2)

520 ÷ 2 = 260 = 18days

260 ÷ 2 = 130 = 36days

130 ÷ 2 = 65 = 54 days

mass after 54 days ....65........ g

ResultsPlus
Examiner Comments

A nicely laid out and fully correct answer. The examiner had no hesitation in awarding full marks.

(ii) Calculate the mass of the original radioactive isotope remaining after 54 days.

(2)

$\frac{54}{18} = 3 \qquad \frac{260}{3} = 86.6$

mass after 54 days ....86.6........ g

ResultsPlus
Examiner Comments

The candidate scored full marks for part (c)(i) by giving a value of 260 g.

The response to part (c)(ii) clearly showed that there were three half-lives in 54 days but the candidate divided the previous answer by 3 rather than halving the original value 3 times.

This scored 1 out of 2 possible marks.

ResultsPlus
Examiner Tip

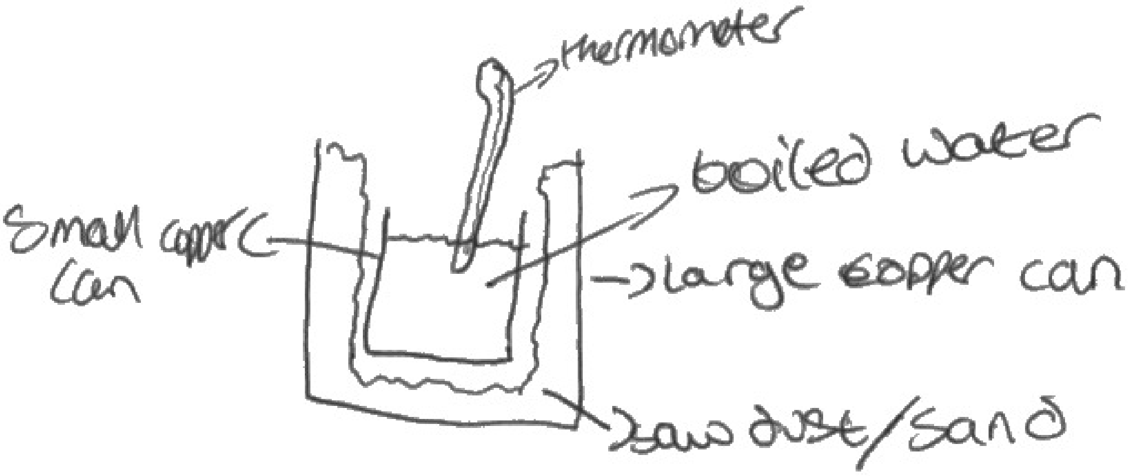
Half-life calculations are different to most other calculations. Make sure that you know how to do them.

Question 5 (b)(i)

Producing a clear diagram is an important scientific skill. Perfect draughtsmanship was neither expected nor required. However, labels were essential. Many candidates lost marks by not showing a thermometer placed in the water. Many candidates also seemed to think that the water and sand were mixed together and placed in one of the copper cylinders and then the investigation repeated with water and sawdust in the other copper cylinder. Nevertheless, many candidates had clearly either seen or performed a similar investigation and could produce an acceptable drawing.

(i) **Draw a labelled diagram to show how the student should set up the equipment to investigate which material is the better insulator.**

(3)



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Examiner Comments

Although this diagram would look better if a ruler had been used, it is perfectly clear and is labelled correctly.

It scored all three marks.

Question 5 (b)(ii)

Some candidates took the idea of control as relating to laboratory safety precautions. Nevertheless a great many showed some appreciation of the factors that needed to be kept constant during an investigation that compared two materials.

Most successful candidates could state that the volume of sand must be the same as the volume of sawdust, although examiners would accept "amount" or "mass" for volume in this case.

Most successful candidates also knew that mass of water must be the same in each case. Once again examiners would accept "amount" or "volume" in this case.

Candidates were less clear about temperature.

(ii) Give **three** factors that the student must control in this investigation.

(3)

1 the amount of sawdust / sand

2 The volume of water used

3 The Temperature of the water

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Examiner Comments

The temperature of the water will change during the investigation. It has to be clear that the starting temperature must be the same in both investigations.

A mark for factor 1 and a mark for factor 2. No marks for factor 3.

3 the same temperature water before the time starts

ResultsPlus
Examiner Comments

Here the candidate has clearly stated the importance of starting both investigations at the same temperature and scored the mark.

The candidate had also correctly identified the first two factors.

3 marks out of 3.

Similarly, candidates were often vague about time.

(ii) Give **three** factors that the student must control in this investigation.

(3)

1 volume of water.

2 mass of sand/sawdust.

3 time

ResultsPlus
Examiner Comments

Although the first two factors scored marks, the final factor, "time" in this case was not precise.

It needed to be clear that it was important to allow the cooling to last for the same amount of time in both investigations.

3 must control how long the investigation lasts for

ResultsPlus
Examiner Comments

The candidate scored both marks for the first two factors and also scored a mark for the third factor which clearly explained how the time should be controlled.

Question 5 (c)

Candidates should expect to be required to describe the relationship between two variables as shown on a graph, even if those variables may be unfamiliar quantities.

Here the candidate should recognise that as density increased, the thermal conductivity decreased and furthermore, that the relationship was not linear.

(c) Expanded polystyrene, used to insulate buildings, has different densities.

Figure 10 shows how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

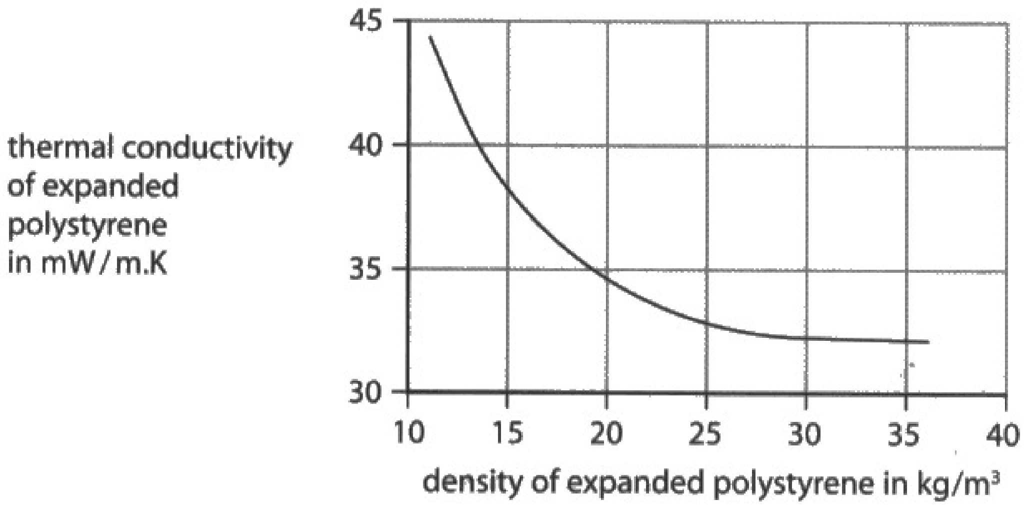

Figure 10

Using the graph in Figure 10, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

(2)

The thermal conductivity of expanded polystyrene decreases as the density increases.

ResultsPlus
Examiner Comments

The decrease in thermal conductivity was correctly linked to an increase in density. However the candidate failed to mention that it was not a straight line graph.

1 mark out of 2.

(c) Expanded polystyrene, used to insulate buildings, has different densities.

Figure 10 shows how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

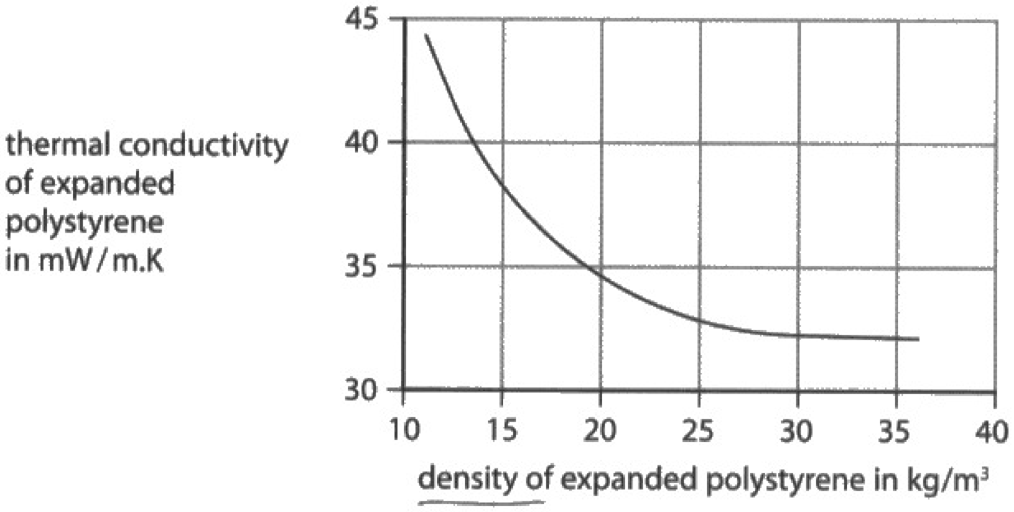

Figure 10

Using the graph in Figure 10, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

(2)

As the density of expanded polystyrene increases, the thermal conductivity decreases and then becomes constant.

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Examiner Comments

A mark for writing that as density increases so thermal conductivity decreases.

Another mark for describing the non-linear relationship in terms of the line levelling off or "becomes constant".

2 out of 2 marks.

Question 6 (a)(i)

Although most candidates appreciated that there were hazards associated with driving in wet weather, some struggled to give a coherent explanation. A good response would link the reduction in friction between tyres and road with an increase in the braking distance or making it more likely for the driver to lose control of the car.

There was, however, much confusion between thinking distance, braking distance and overall stopping distance.

6 (a) Figure 12 is a speed limit sign from a European motorway.

The speeds shown are in km/h (kilometres per hour).

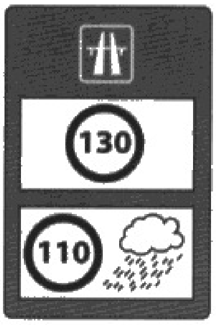

Figure 12

(i) The sign tells drivers to drive at a slower speed in wet weather.

Explain why it is safer for drivers to drive at a slower speed in wet weather.

(2)

wet weather can cause the wheels of the car to have less friction on the road, making it more likely to skid and crash.

ResultsPlus
Examiner Comments

An answer that correctly links the reduction of friction with the increased risk of losing control of the vehicle.

Full marks awarded.

6 (a) Figure 12 is a speed limit sign from a European motorway.

The speeds shown are in km/h (kilometres per hour).

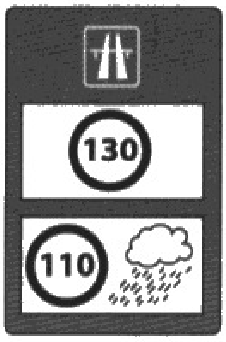

Figure 12

(i) The sign tells drivers to drive at a slower speed in wet weather.

Explain why it is safer for drivers to drive at a slower speed in wet weather.

(2)

Because roads will be slippy, and your stopping distance will ~~decrease~~ increase

ResultsPlus
Examiner Comments

A correct answer that links the reduction of friction with an increase in stopping distance.

Full marks awarded.

Question 6 (a)(ii)

This question assessed the ability of a candidate to convert between units of both time and distance.

Common errors were to convert m to km by multiplying by 100 instead of 1000 and to convert seconds into hours by multiplying by 60 rather than 3600.

Two successful approaches were seen.

Candidates could convert 130 km/h into m/s.

(ii) Show that a speed of 31 m/s is less than a speed of 130 km/h.

(2)

↓ x1000 (km→m)

130000 m/h

↓ ÷60 (h→min)

2166.67 m/min

↓ ÷60 again (min→s)

36.11

31 < 36.11

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Examiner Comments

The first step here was to convert km into m by multiplying by 1000 and then hours into seconds by two divisions of 60.

The resulting value of 36.1 is clearly more than 31 but the candidate did not need to state this to score full marks.

The alternative approach is to convert 31 m/s into km/h

(ii) Show that a speed of 31 m/s is less than a speed of 130 km/h.

(2)

31 m/s   130 km/h

×60

1860 m/m   130 km/h

×60

111600 m/h   130 km/h

÷1000

111.6 km/h < 130 km/h

ResultsPlus
Examiner Comments

The candidate has first converted m/s into m/h by two multiplications of 60.

Then a division by 1000 to convert m into km.

Once again, the value of 111.6 is clearly less than 130 and scores full marks.

Question 6 (a)(iii)

Candidates had to select and rearrange the equation linking speed, distance and time for the first two marks.

A common error was to rearrange incorrectly to produce a calculator value of 0.6739 rather than 1.4839.

The third mark was to express the result to 2 significant figures.

This was an independent mark and could be scored by a value that was incorrect but nevertheless was to 2 significant figures.

(iii)

> The driver's reaction time is the time between the driver seeing an emergency and starting to brake.

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time.

Give your answer to 2 significant figures.

(3)

46 ÷ 31 = 1.4838~~8~~70

1.48

driver's reaction time = 1.48 s

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Examiner Comments

The candidate had performed the correct substitution, rearrangement and evaluation to produce a calculator value of 1.48387 and scored the first two marks.

However this was then rounded to 2 decimal places rather than 2 significant figures.

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Examiner Tip

Remember 2 significant figures means there will be exactly two digits (plus zeros for numbers with three or more digits).

(iii)

> The driver's reaction time is the time between the driver seeing an emergency and starting to brake.

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time.

Give your answer to 2 significant figures.

(3)

time = distance/speed

S = 31m/s

D = 46m

T = ?

46/31 = 1.483870968

= 1.5

driver's reaction time = 1.5 s

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Examiner Comments

The calculator value of 1.48387 has been correctly rounded to 2 significant figures and scores all three marks.

Question 6 (b)

Examiners saw many excellent answers that clearly demonstrated a candidate's ability to interpret a velocity-time graph. Particularly creditworthy was recognising the difference in gradient on the two decreasing parts of the graph as indicating different rates of velocity change.

Weaker candidates were unclear about the difference between velocity and acceleration and would often write about the velocity and acceleration increasing or staying the same.

A common error was to see the horizontal part of the graph as being where the train was stationary, even though the first part had been correctly described in terms of increasing velocity.

Only a few candidates saw the train climbing and then descending a hill.

Candidates who could interpret a velocity-time graph usually correctly described at least three parts of the graph with accurate reading of the time axis.

*(b) Figure 13 is a velocity/time graph for a toy train on a straight track for 7 seconds.

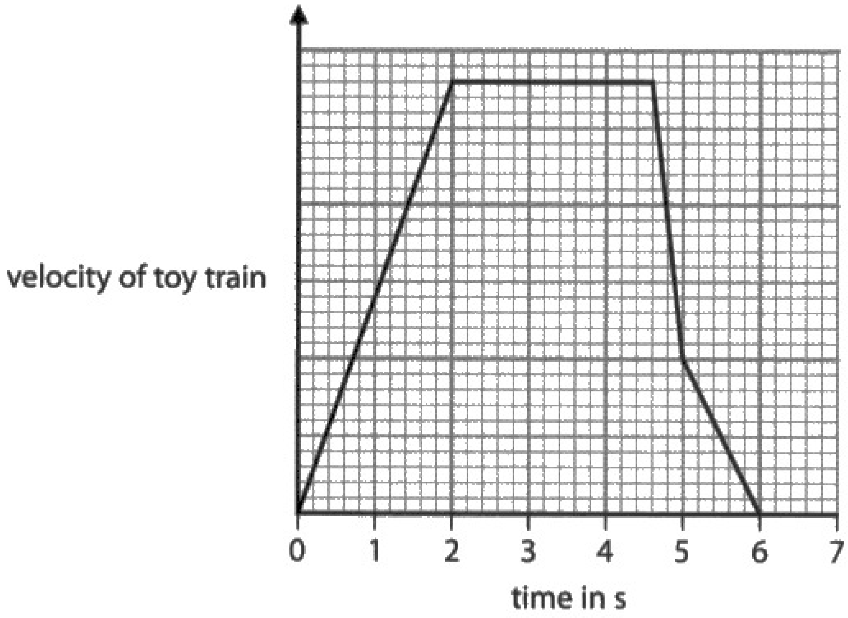

Figure 13

Using information from the graph, describe when and how the velocity and acceleration of the toy train change at different times during the 7 seconds shown on the graph.

(6)

- for the firs 2 seconds the train is accelarating
- when the train stops accelarating It stays at one speed for the next 2.6 seconds
- then the speed rapidly declines for 0.4 seconds ~~and~~
- ~~then~~ then it starts to decline slighty more gradually for the next second
- finally It comes to a stop after six seconds.

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Examiner Comments

Here all five parts of the graph have been accurately described and the examiner had no hesitation in awarding the full 6 marks.

It was quite common to see answers of this quality.

Candidates failed to score marks by either not reading the time axis accurately or by being unclear whether they were writing about velocity or acceleration.

*(b) Figure 13 is a velocity/time graph for a toy train on a straight track for 7 seconds.

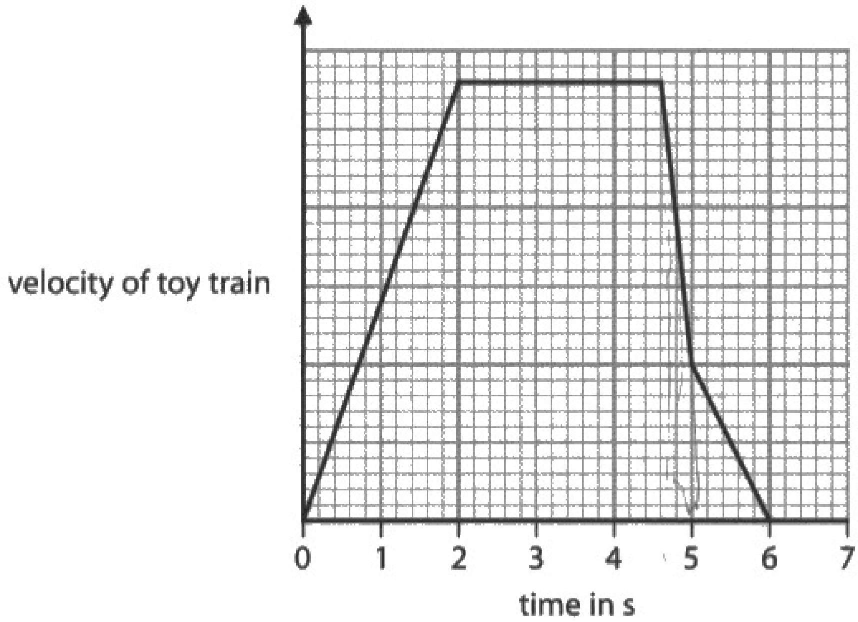

Figure 13

Using information from the graph, describe when and how the velocity and acceleration of the toy train change at different times during the 7 seconds shown on the graph.

(6)

The toy train got faster at the start till 2 then it went the same speed but nearer to 5 it went slower

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Examiner Comments

There is a description of the train getting faster and then travelling at the same speed.

There is one correct reference to data ("at the start till 2") but the other references were not precise enough. This was a typical level 2 response and scored 4 marks.

Paper Summary

Based on their performance on this paper, candidates should:

- always show your working for calculations.
- note that, if the question has two marks, then you need to make two points to get both marks.
- read all questions carefully and take note of the command words.
- practice drawing and labelling equipment being used in an investigation.
- plot points on graphs and practice drawing lines or curves of best fit accurately.
- revise how to carry out calculations involving radioactive half-life.
- make sure that you understand how to interpret both velocity-time graphs and distance-time graphs.

Grade boundaries

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