Pearson
Edexcel

Examiners' Report
June 2024

GCSE Combined Science 1SC0 1PH

ResultsPlus

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus. Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2024

Publications Code 1SC0_1PH_2406_ER

Introduction

This was the seventh year of examining this specification, being paper 3 of combined science at higher level. Questions were set to test candidates' knowledge, application and understanding from six 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 two multiple choice questions, short answer questions worth one or two marks each and longer questions worth three or four marks each. Items were set assessing candidates' knowledge of practical procedures, namely Qu5(c) and (d), the latter being of three separate parts concerning radioactivity. The standard of answers on these practical items was variable with some candidates showing good procedural knowledge, whilst for others there was a clear lack of familiarity shown, especially with the how to measure the background radiation, beyond knowing that a GM tube was used.

Candidates continued to do well with most calculation questions, although some didn't cope well with significant figures.

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 pitfalls, with the aim of aiding future teaching of these topics.

Question 1 (a)

Most candidates scored full marks on this.

It did involve rearranging the formula; most had no trouble doing this.

(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 $g = 10$ N/kg.

Use the equation

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

(2)

GPE = m×g×h

980 = 35×10×h

$h = \frac{980}{35 \times 10}$

$= \frac{980}{350}$

= 2.8

h = 2.8 m

ResultsPlus Examiner Comments

A full complete answer, well set out by the candidate.

(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 $g = 10$ N/kg.

Use the equation

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

(2)

$H = \frac{m \times g}{\text{change in GPE}}$ $H = \frac{35 \times 10}{980}$

$H = 0.36$ m

h = 0.36 m

ResultsPlus
Examiner Comments

Here we see a wrongly rearranged formula. Nevertheless, the candidate scored one mark for a correct substitution of values into the incorrectly rearranged equation.

ResultsPlus
Examiner Tip

Showing the working carefully enables the award of intermediate marks.

(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 N/kg.

Use the equation

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

(2)

$\frac{980}{35} = 28$

~~28×10=280~~

h = 28 m

ResultsPlus
Examiner Comments

The value of 'g' is omitted. This means no intermediate marks could be awarded.

Question 1 (b)

Candidates invariably find questions involving v^2 more demanding than ones without a power.

Nevertheless, this question was well answered by most candidates. Most achieved full marks.

(b) The kinetic energy, KE, of the person at Q is 950 J.

The mass of the person is 35 kg.

Calculate the velocity of the person at Q.

Use the equation

$$v^2 = \frac{2 \times KE}{m}$$

(3)

$$\frac{2 \times 950}{35} = 54.3^2$$

$$\sqrt{54.3}$$

$$= 7.4$$

velocity = 7.4 m/s

ResultsPlus
Examiner Comments

Full marks are seen, with clear communication of the calculation involved.

(b) The kinetic energy, KE, of the person at Q is 950 J.

The mass of the person is 35 kg.

Calculate the velocity of the person at Q.

Use the equation

$$v^2 = \frac{2 \times KE}{m}$$

(3)

$$\frac{2 \times 950}{35} = \frac{1900}{35} = 54.2$$

velocity = 54.2 m/s

ResultsPlus
Examiner Comments

The first two marking points are seen in the response, but they have not taken the final square root to get the correct evaluation.

(b) The kinetic energy, KE, of the person at Q is 950 J.

The mass of the person is 35 kg.

Calculate the velocity of the person at Q.

Use the equation

$$v^2 = \frac{2 \times KE}{m}$$

(3)

$\frac{2 \times 950}{35}$

$2 \times 950 = 1900 = 1900$ ~~1900/3~~

$1900 \div 3 = 633.\dot{3}$

velocity = $633.\dot{3}$ m/s

ResultsPlus
Examiner Comments

The first marking point is scored but the candidate then has confused working, with no more marks possible.

Question 1 (c)(i)

This was very well answered by most candidates.

In this question the answer required spelling out what the lower arrow, represented by X, stood for.

Thermal (energy/store) was expected.

(c) Figure 2 is a diagram that represents energy changes from P to Q.

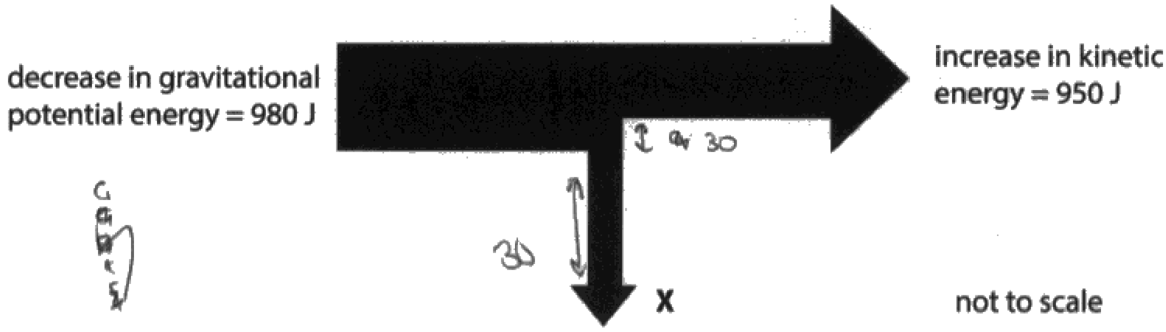


Figure 2

(i) State what is represented by **X**.

(1)

Thermal energy by friction.

ResultsPlus
Examiner Comments

Thermal (energy/store) scores the mark.

The 'of friction' addition was an alternative energy transfer idea also worthy of credit.

Question 1 (c)(ii)

Very many candidates obtained the mark here.

It just required a simple subtraction of the input energy minus output kinetic energy to yield the remainder.

(ii) Calculate the value of **X**.

(1)

980 − 950 = 30

value of **X** = 30 J

ResultsPlus
Examiner Comments

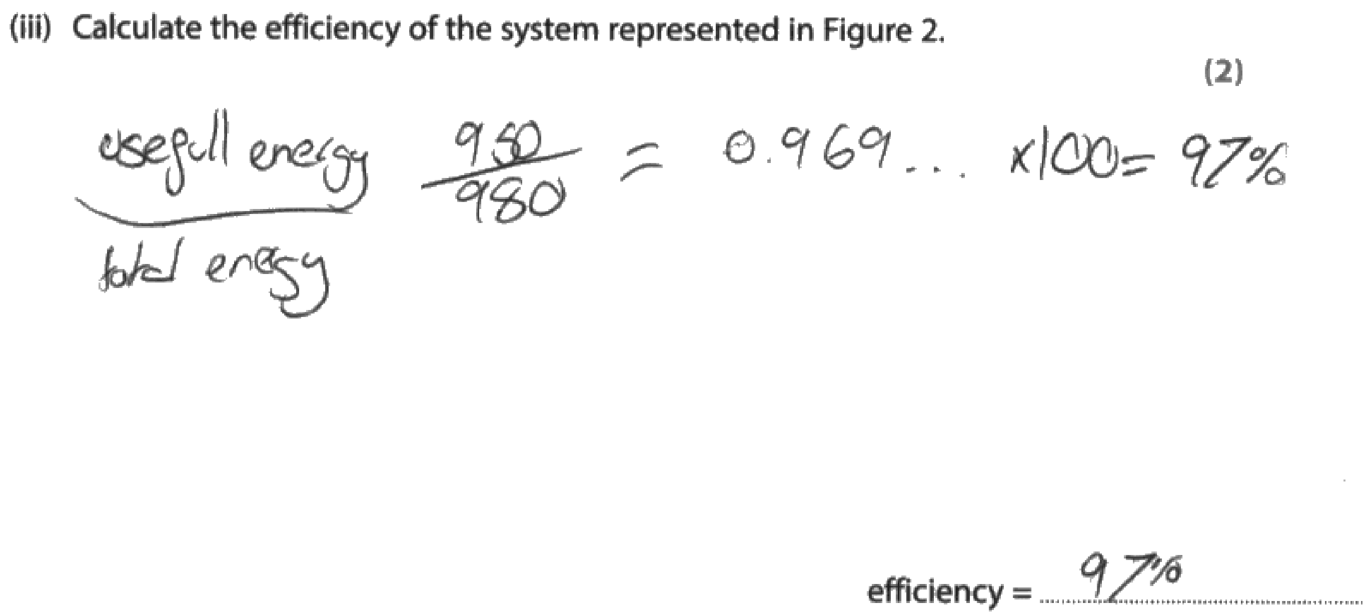
Clear working.

The correct number on the answer line scores the mark anyway.

Question 1 (c)(iii)

This question required a straightforward calculation of efficiency from values in the energy diagram.

Most students obtained full marks on this item.



(iii) Calculate the efficiency of the system represented in Figure 2.

(2)

useful energy / total energy   950 / 980 = 0.969... x100 = 97%

efficiency = 97%

ResultsPlus
Examiner Comments

This shows such a detailed well-communicated answer.

(iii) Calculate the efficiency of the system represented in Figure 2.

(2)

Efficiency = useful energy / total energy

950 / 980 =

efficiency = 95 / 98

(Total for Question 1 = 9 marks)

ResultsPlus
Examiner Comments

One mark out of two is scored for the initial substitution.

ResultsPlus
Examiner Tip

Leaving the answer in fractional form, where the answer required is a decimal, sells yourself short in a physics exam.

Question 2 (a)(i)

This was very high scoring, requiring reading off from the intersection of the two lines on the graph.

Allowance was also made for misinterpretations of the question, whereby candidates were calculating a remaining distance to be run (accepting 32 to 36 then).

2 (a) Two people, L and M, have a 100 m race.

L starts running before M.

Figure 3 shows a distance/time graph of the race.

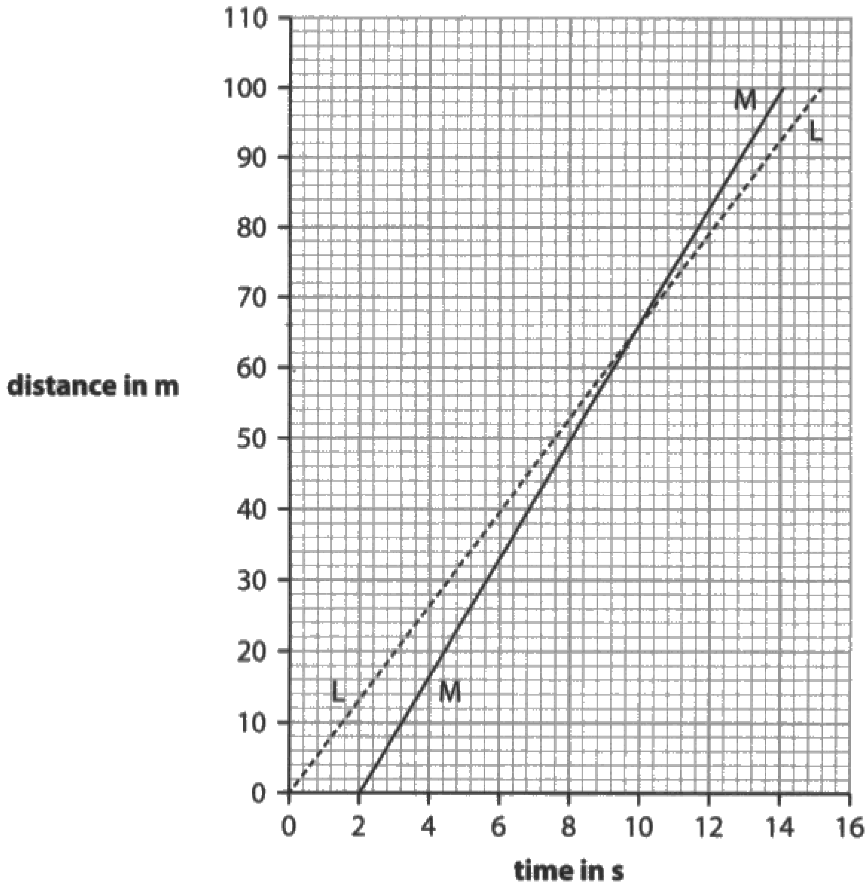


Figure 3

(i) State the **distance** that L has run when M overtakes.

(1)

distance = ...66...... m

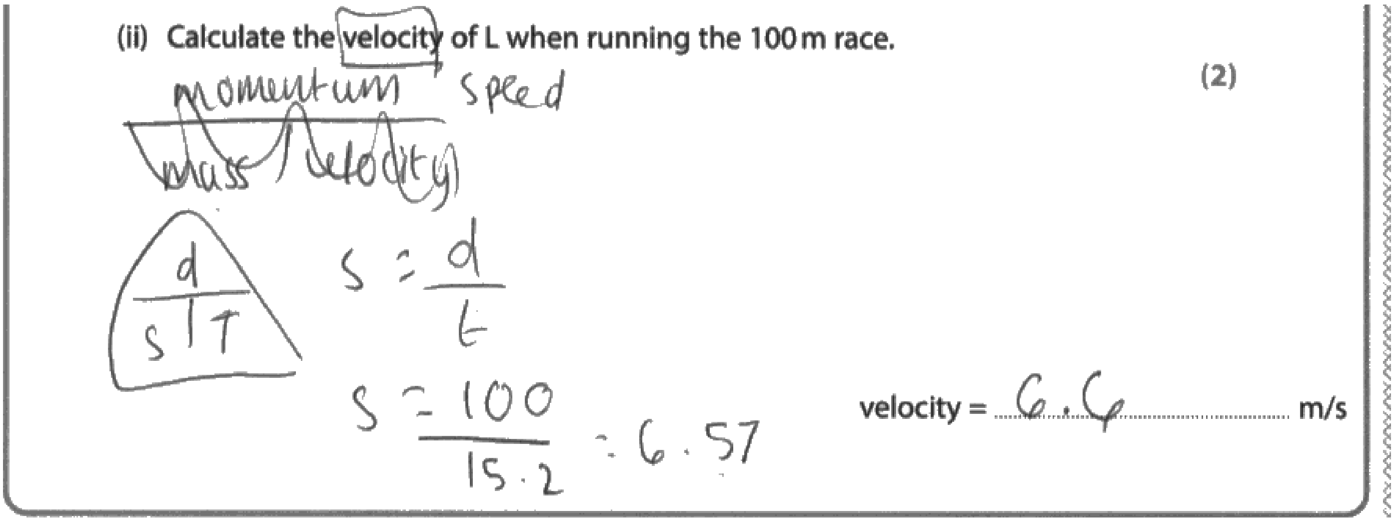
ResultsPlus
Examiner Comments

This was the expected answer.

A range from 64 to 68 was accepted to allow for variations in using the graph.

Question 2 (a)(ii)

Most scored the full two marks, but some failed altogether or were allowed a compensatory mark for choosing any identifiable values of distance and time from the graph.


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

(2)

momentum speed

mass / velocity

$s = \frac{d}{t}$

$s = \frac{100}{15.2} = 6.57$

velocity = 6.6 m/s

ResultsPlus
Examiner Comments

This answer lies within the acceptable range (rounding to a value between 6.5 and 6.7 (m/s)).

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

(2)

$\frac{100}{16} = \frac{25}{4}$

$6\frac{1}{4} = 6.25$

velocity = 6.25 m/s

ResultsPlus
Examiner Comments

This answer goes outside that accepted range, with a misreading of the time involved.

It still scores 1 mark for the 'any identifiable values of distance and time'.

Question 2 (b)(i)

As long as the candidate took the correct values from the question, they scored full marks in this question.

Most did this well.

(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

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}}$$

(2)

$$\frac{10 - 6.2}{2.5} = 1.52$$

time taken = 1.52 s

ResultsPlus
Examiner Comments

A model answer, substituting the correct values with a successful evaluation.

(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

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}}$$

(2)

time taken = (10 − 6.2) / 2.5

= 1.52 hours

= 5472 seconds

time taken = 5472 s

ResultsPlus
Examiner Comments

The substitution is correct, earning a mark.

The candidate then makes a mistake jumping to a conclusion that their answer was in hours, and so spoiling their final answer.

Question 2 (b)(ii)

This was not quite so successfully done as the previous part, but many did get through to a correct evaluation.

There were many ways candidates could go astray with answering this, as the clips demonstrate.

(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/s^2.

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

Use the equation

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

$\frac{100}{2 \times 4.4} = 11.\dot{3}\dot{6}$ m
$= 11.4$

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

$\frac{100}{2 \times 4.4^2} = 2.58264\ldots$
$= 2.6$

distance = ... m

(2)

ResultsPlus
Examiner Comments

This candidate scores the first marking point:

10 – 6.2

2.5

is seen.

However they present two alternative calculations, with no final choice on the answer line.

Had they put 11.4 on the answer line they would have scored 2 marks.

ResultsPlus
Examiner Tip

You can't hedge your bets by leaving alternative answers.

The correct evaluation is needed, clearly shown, to get the second mark point.

(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

$10^2 \quad 0^2 \quad 4.4 \quad ?$

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

initial end distance

(2)

distance = 880 m

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

$2 \times 4.4 \times 10^2 \times 0^2$

8.8×100

$= 880$

ResultsPlus Examiner Comments

This gets the substitution mark.

This is allowed for values written clearly above an equation in a question.

The maths part then goes wrong.

(ii) The motor cycle now decelerates (slows down) from 10 m/s to a stop. – 0 m/s

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

final – initial

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

(2)

$x = (v^2 - u^2) \div (2 \times a)$

$(0^2 - 10^2) \div 2 \times -4.4$

distance = 220 m

ResultsPlus
Examiner Comments

This question scores for either substitution OR rearrangement for the first mark.

A correct rearrangement and substitution is seen, but that can still only score the first mark.

The second mark requires a correct evaluation which is not seen here.

(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

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

(2)

$0 - 10 = 2 \times -4.4$

$x = \dfrac{0 - 10}{2 \times 4.4} = 1.136$

distance = 1.136 m

ResultsPlus
Examiner Comments

The candidate has omitted squaring the 10.

The mark scheme says (additional guidance) accept 1.1(36) for one mark ie acknowledging that one slip.

Question 2 (c)

Various factors were permitted for the first mark.

The second mark was dependent upon the first, needing a corresponding equation linking force with the chosen factor.

(c) A car collides with a barrier on a road.

The time of the collision is very short.

Explain **one** factor, other than the time of the collision, that would affect the force on the car in the collision.

Your explanation should refer to an equation in the Equation Booklet.

(2)

The change in momentum ~~affect~~ affects the force on the ~~car~~ car. The larger the change in momentum, the larger the force on the car. They are directly proportional. This is because the force is equal to the Δmomentum/time.

(Total for Question 2 = 9 marks)

$$F = \frac{(mv - mu)}{t}$$

$$t = (mv - mu) \times F$$

ResultsPlus
Examiner Comments

Momentum is a chosen correct factor.

It is linked with Δ momentum/time for the second mark.

(c) A car collides with a barrier on a road.

The time of the collision is very short.

Explain **one** factor, other than the time of the collision, that would affect the force on the car in the collision.

Your explanation should refer to an equation in the Equation Booklet.

(2)

- The mass of the car.
- force = mass x acceleration
- the car has collided so there is no acceleration
- Mass is smaller = car will be faster
- mass is larger = car will be slower.

ResultsPlus
Examiner Comments

Now acceleration is the chosen factor, linked with F = m x a.

These also feature in the mark scheme.

Question 3 (a)(i)

The answers to this item were very variable.

A good number correctly associated the UVC having the lowest wavelengths with potential danger, getting the first mark.

Others saw that absorption by the atmosphere could afford protection for humans, getting the second mark.

Others were confused about wavelength and danger. Still others thought 100% absorption by the atmosphere to be a dangerous thing for humans.

3 Ultraviolet (UV) waves from the Sun travel towards the Earth.

Ultraviolet waves can be grouped by wavelength.

The three groups of wavelengths are UVA, UVB and UVC.

Figure 4 shows, for each group,

- the wavelength range
- the effect of the Earth's atmosphere on each type of UV wave.

	UVA	UVB	UVC
wavelength range	400 nm to 315 nm	314 nm to 280 nm	279 nm to 100 nm
% energy absorbed by the Earth's atmosphere	5%	95%	100%

Figure 4

(a) (i) Explain why UVC is potentially the most dangerous ultraviolet radiation but does not cause harm to people.

(2)

because ~~%~~ 100% of its energy is absorbed by the earths atmosphere however it has a shorter wavelength than the others UVA + UVB meaning its more ionising but

ResultsPlus
Examiner Comments

This scores both marks.

The comparative short**er** was allowed for mark point 1. See additional guidance in the mark scheme.

'100% absorbed by the Earth's atmosphere' evidence used to gain the second part of the atmosphere.

This also equals their comment 'can't penetrate' seen at the end of the clip.

3 Ultraviolet (UV) waves from the Sun travel towards the Earth.

Ultraviolet waves can be grouped by wavelength.

The three groups of wavelengths are UVA, UVB and UVC.

Figure 4 shows, for each group,

- the wavelength range
- the effect of the Earth's atmosphere on each type of UV wave.

	UVA	UVB	UVC
wavelength range	400 nm to 315 nm	314 nm to 280 nm	279 nm to 100 nm
% energy absorbed by the Earth's atmosphere	5%	95%	100%

Figure 4

(a) (i) Explain why UVC is potentially the most dangerous ultraviolet radiation but does not cause harm to people.

(2)

it is very dangerous because of its low wavelength range but it doesn't harm people because 100% of the energy is absorbed by our atmosphere

ResultsPlus
Examiner Comments

'Because its low wavelength' is insufficient for the first mark; no comparative seen at all.

The second mark is scored.

ResultsPlus Examiner Tip

The question involved comparison:

'why UVC is potentially the **most** dangerous'?

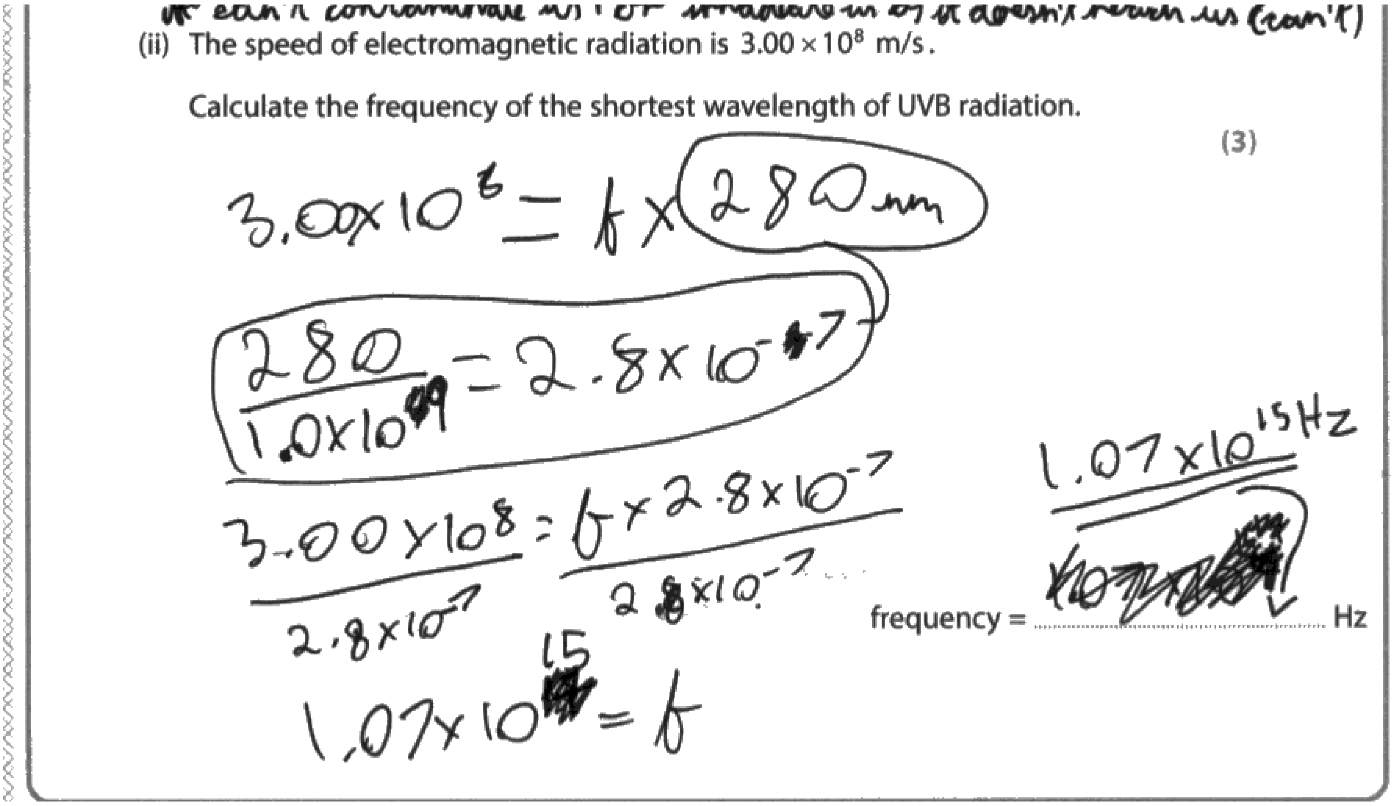
To answer some comparison of the wavelengths of UVC with others is expected.

'low wavelength' isn't a comparison. You could argue they are all low wavelengths (nanometres).

Question 3 (a)(ii)

Most candidates scored 2 marks here, out of a possible 3.

Most candidates did not know nm was 10^{-9} metres so lost the final mark.


(ii) The speed of electromagnetic radiation is 3.00×10^8 m/s.

Calculate the frequency of the shortest wavelength of UVB radiation.

(3)

$3.00 \times 10^8 = f \times 280$ nm

$\frac{280}{1.0 \times 10^9} = 2.8 \times 10^{-7}$

$\frac{3.00 \times 10^8}{2.8 \times 10^{-7}} = \frac{f \times 2.8 \times 10^{-7}}{2.8 \times 10^{-7}}$

$1.07 \times 10^{15} = f$

frequency = 1.07×10^{15} Hz

ResultsPlus Examiner Comments

This candidate chose the correct equation to use, substituted and rearranged and understood what nanometres were.

ResultsPlus Examiner Tip

The whole science specification needs a good recall and understanding of units:

giga(G), mega(M), kilo(k), centi(c), milli(m), micro(μ) and nano(n).

(ii) The speed of electromagnetic radiation is 3.00×10^8 m/s.

Calculate the frequency of the shortest wavelength of UVB radiation.

(3)

wavespeed = frequency X wave length

3.00×10^8 m/s = ? x 314

$\frac{3.00 \times 10^8}{314}$ = 955414.0127

frequency = 955414.0127 Hz

ResultsPlus
Examiner Comments

Substitution and rearrangement with an incorrect wavelength was allowed one mark, with no other mark scored. See additional guidance in the mark scheme.

Question 3 (b)

This question was poorly answered by most candidates.

Candidates often showed little or no recall of electron energy levels and their role in absorption and re-radiation of the uv energy as visible light.

For ease of reference here are the mark scheme points:

1) UV/energy absorbed by electrons (1)

2) electrons change orbit/energy level/shell (1)

3) electrons in an ‘excited’ state (1)

4) electrons emit energy/ move to lower energy level/fall down/de-excite (1)

5) (energy) emitted as (visible) light/at a different frequency/wavelength (1)

6) (process is called) fluorescence/(light emitted is) fluorescent (1).

Please note the mark scheme points must be hit explicitly. Examiners cannot do the work for candidates by inferring or seeing these as implicit. Clearly judgement is required as candidates' language varies.

(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

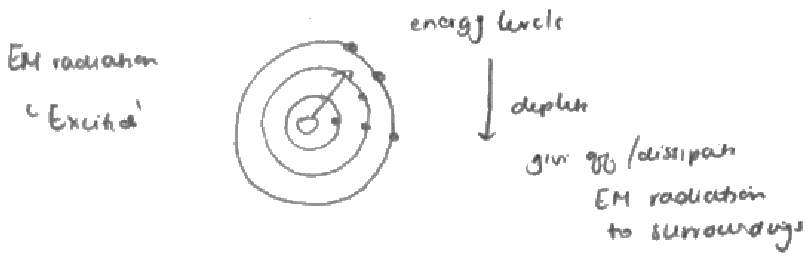
In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.

(4)



Ultraviolet was used for Fluorescent lamps. ~~were~~ However, they ~~was~~ later placed traces that could be identified with Ultraviolet Radiation. When electrons take in Electromagnetic Radiation, they 'jump' to the next shell. They are ~~should~~ said to be 'excited.' However, when the energy levels ~~start~~ are not enough to stay in their electron shell, they 'drop' ~~down~~ down. Electromagnetic energy dissipates to the surroundings. UV radiation detects traces ~~of~~ and can identify forged notes and cash.

ResultsPlus Examiner Comments

Mark points 2, 3, 4 and 6 are most clearly met, with points 2,3 and 4 being discernible in the diagram alone.

ResultsPlus Examiner Tip

Wise use of diagrams can really help your answers.

(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

* In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.

(4)

This is because UV radiation has enough energy for the electron of the atoms in the marks to move up an energy level and when the electron falls back down to the original energy level, it can emit this energy which is carried away by the UV radiation so that we can see the ~~em~~ ~~em~~ emitted UV light. When visible light is shone on the marks, it doesn't have the right amount of energy.

ResultsPlus Examiner Comments

This clearly scores mark points 2 and 4.

(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

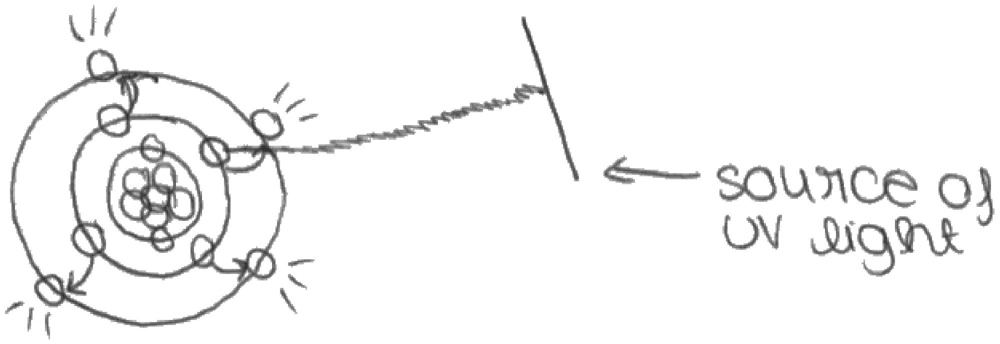
In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.

(4)



› The electrons in the atoms gain enough energy from the UV rays to 'jump up' onto the outer shells of the atom.
› By exerting this energy, the atom gives off this energy as visible light, activated by the UV radiation
› This happens continuously to the electrons whilst under the UV light

ResultsPlus
Examiner Comments

This scores mark points 2 and 6.

(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

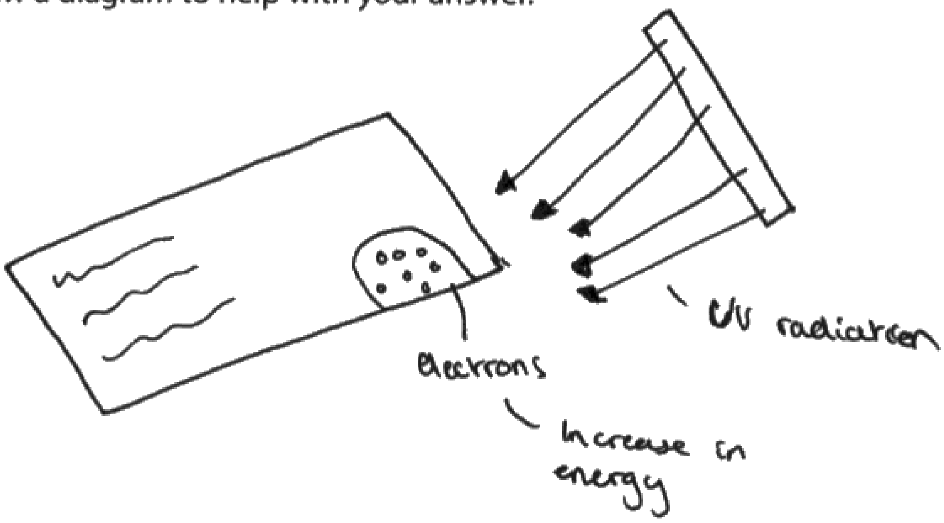
In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.

(4)



The UV radiation gives the electrons more energy due to the shorter wavelength and higher frequency compared to visible light. The increased energy ~~allows the~~ in the electrons allows for the marks to be seen.

ResultsPlus
Examiner Comments

This is an example of where equivalence to a mark point is seen. Mark point 1 describes UV energy being absorbed by electrons. UV radiation giving electrons energy is taken as equivalent to that.

Question 4 (a)(i)

Most candidates read the values of 20s and 45s off the graph, within whose bounds the velocity was constant.

4 (a) A car starts from rest and then travels for 70 s as shown on the graph in Figure 5.

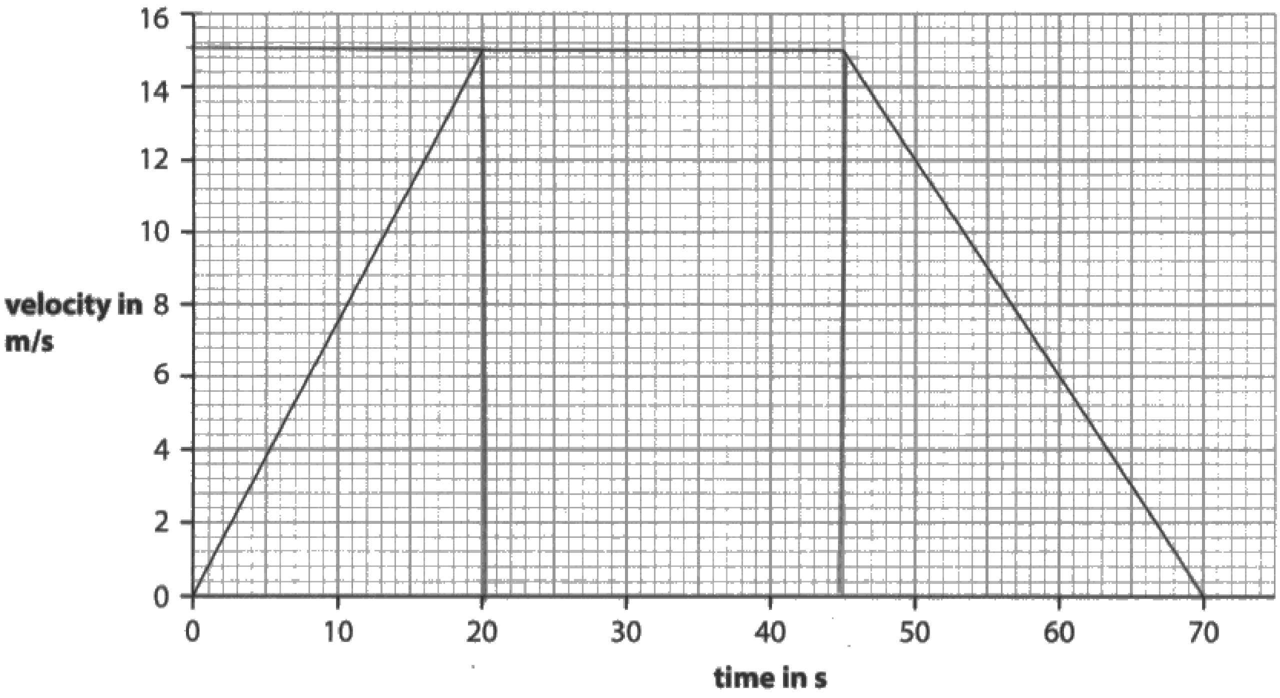


Figure 5

(i) Complete the sentence using data from Figure 5.

(1)

The car is travelling at constant velocity from ......20...... s

to ......45...... s.

ResultsPlus Examiner Comments

Perfect answer.

ResultsPlus Examiner Tip

Note both values needed to be correct to get the single mark available.

Question 4 (a)(ii-iii)

4 (a) A car starts from rest and then travels for 70 s as shown on the graph in Figure 5.

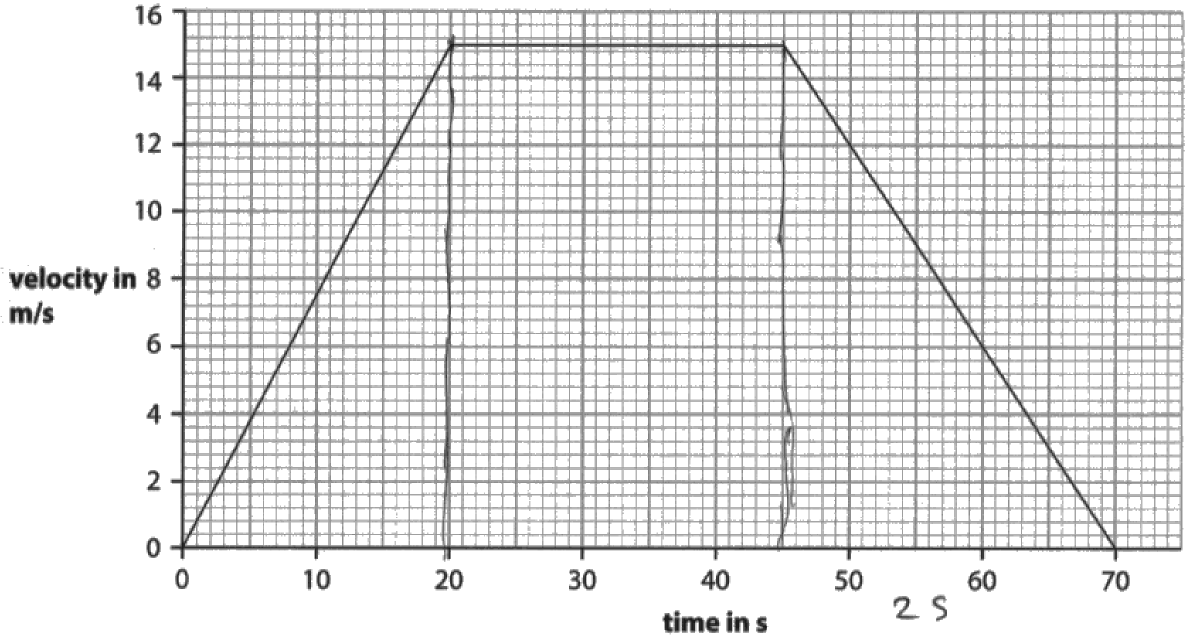


Figure 5

(ii) Use data from the graph in Figure 5 to show that the car travels a total distance of about 710 m in 70 s.

(3)

$\frac{25 \times 15}{2} = 187.5$ +

$\frac{20 \times 15}{2} = 150$ + $= 712.5$ in 70s

close to 710

$25 \times 15 = 375$

(iii) Calculate the average speed of the car for the total distance travelled.

(1)

$\frac{712.5}{70}$

average speed = 10.178 m/s

ResultsPlus
Examiner Comments

(ii) areas calculated correctly yielding a final correct evaluation for the last mark point of (ii)

Substitution and evaluation correct for part (iii)

4 (a) A car starts from rest and then travels for 70 s as shown on the graph in Figure 5.

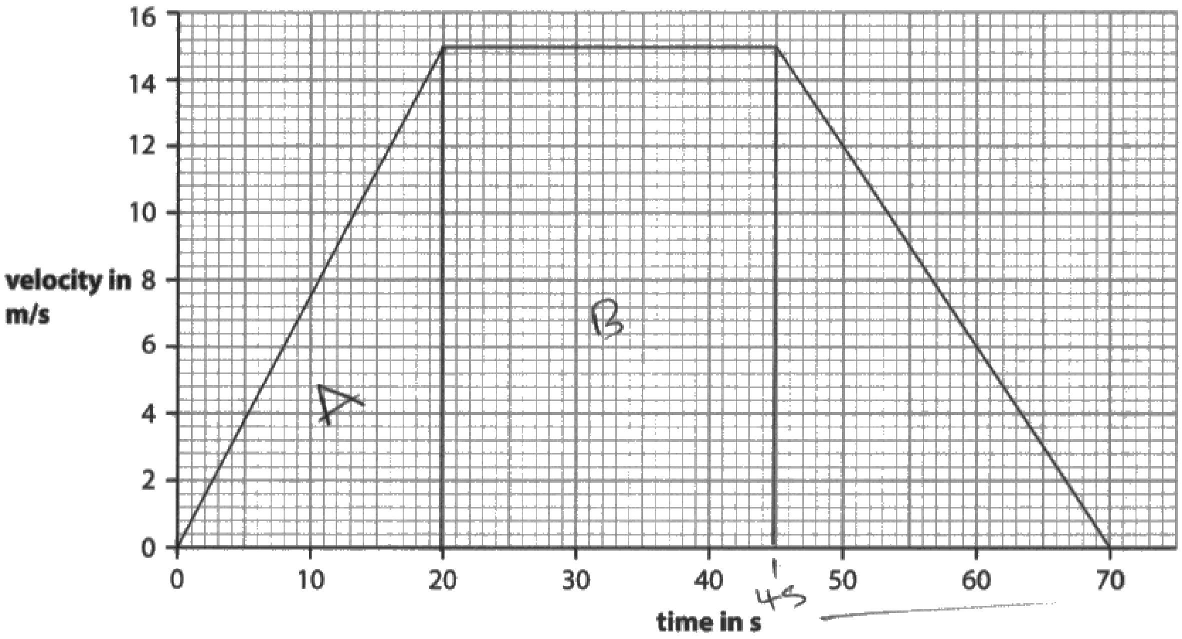


Figure 5

(ii) Use data from the graph in Figure 5 to show that the car travels a total distance of about 710 m in 70 s.

(3)

D = S x t   b x h / 2

A's = 20 x 15

A's D = 300m / 2 = 150m

B's D = 25 x 15   L x W

B's D = 375 m

C's D = 30 x 15

b x h / 2 = 450 / 2 = 225 m

(iii) Calculate the average speed of the car for the total distance travelled.

(1)

~~S = D/T = 215~~

D = 710   S = D/t

T = 70s   = 710/70 = 10.14

average speed = 10.14 m/s

ResultsPlus Examiner Comments

(ii) The candidate calculates areas A and B effectively.

They attempt the last area, but miscalculate, taking the wrong time interval.

Areas attempted get up to 2 marks in this question.

They cannot then score the final evaluation mark.

(iii) average speed correctly calculated.

4 (a) A car starts from rest and then travels for 70 s as shown on the graph in Figure 5.

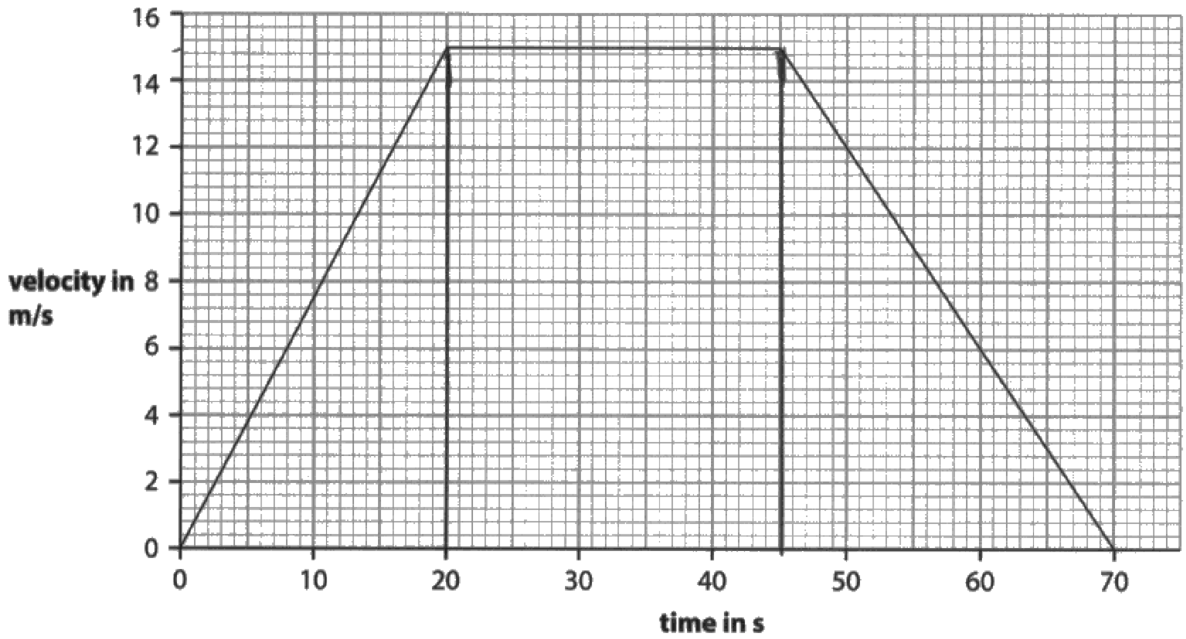
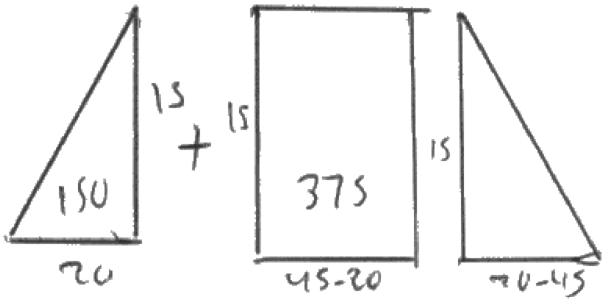


Figure 5

(ii) Use data from the graph in Figure 5 to show that the car travels a total distance of about 710 m in 70 s.

(3)



= distance

$\frac{20 \times 15}{2} = 150$ m

$375 + 150 + 185.5 = 710.5$ m

710.5m ≈ 710m

$15 \times (45 - 20) = 375$ m

$\frac{(70-45) \times 15}{2} = 185.5$

(iii) Calculate the average speed of the car for the total distance travelled.

(1)

$\frac{710}{70} = 10.143$ m/s

↓

to 1dp: 10.1 m/s

average speed = 10.1 m/s

ResultsPlus
Examiner Comments

(ii) The candidate calculates all three areas well.

Unfortunately, their addition is mistaken.

They cannot then score the final evaluation mark.

(iii) average speed correctly calculated.

Question 4 (b)

This requires a rearrangement, following on from identifying F= m x a, to get 'm'.

(b) The **inertial** mass of an object is a measure of how difficult it is to change the velocity of the object.

A force of 450 N acts on a car to give the car an acceleration of 0.35 m/s².

Calculate the **inertial** mass of the car.

(2)

Force = Mass x acceleration

Mass = $\frac{\text{Force}}{\text{Acceleration}}$ = $\frac{450}{0.35}$ = 1285.71

inertial mass of car ......1285.71...... kg

ResultsPlus
Examiner Comments

This candidate explains their process very well, arriving at the correct evaluation.

This question had no significant figures associated with it, so values which rounded to 1300 kg were accepted, like this one.

Question 4 (c)(i)

This question asked for the identification of the appropriate variables corresponding with those in the straight line general equation $y = mx + c$.

(c) Figure 6 shows a different velocity/time graph.

This straight line graph can be represented by the equation

$$y = mx + c$$

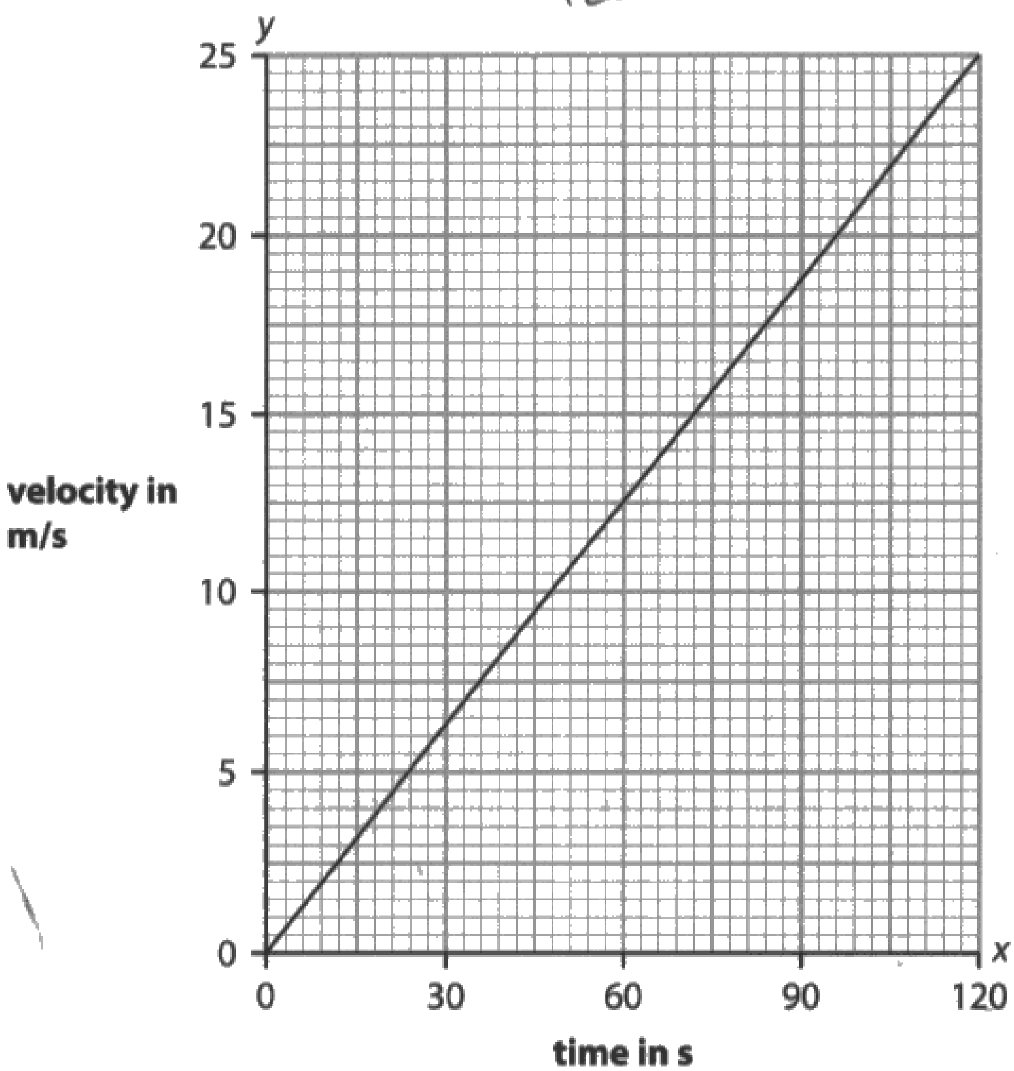


Figure 6

(i) Give the quantities that x and y represent in the equation.

x represents time in s

y represents velocity in m/s

ResultsPlus
Examiner Comments

The variables are

time for x

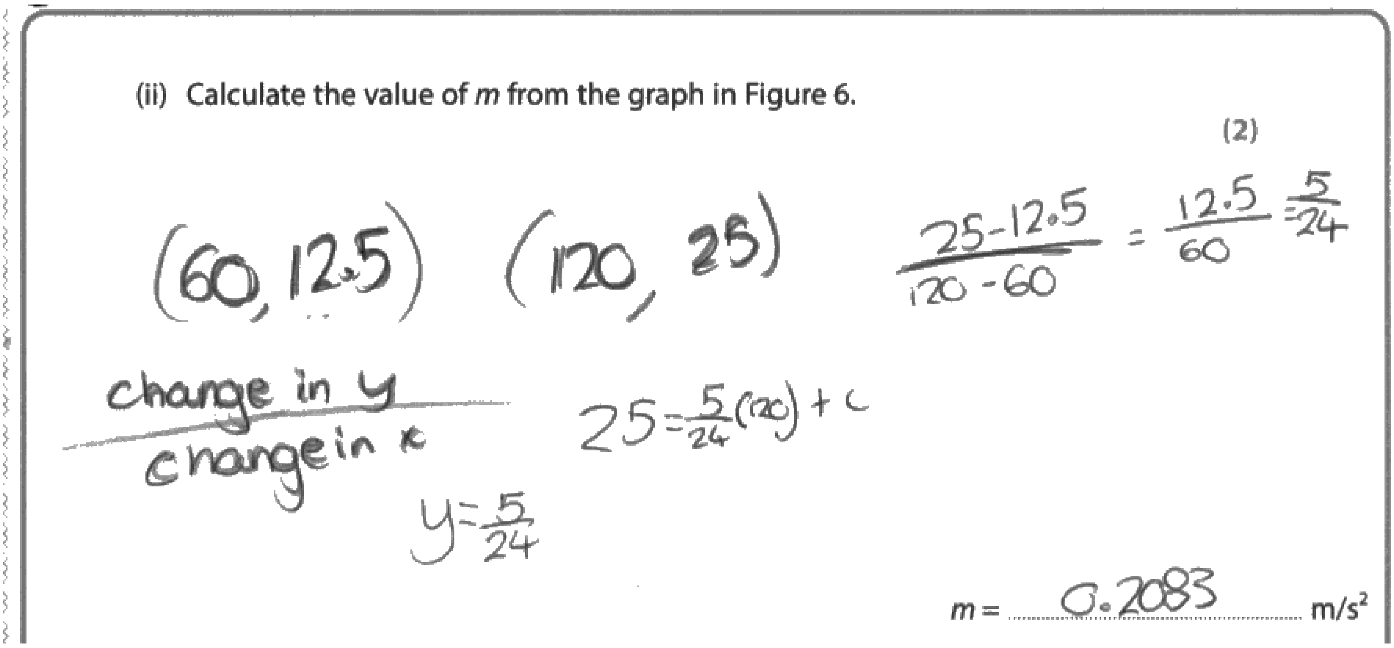
velocity for y

Units are ignored.

Question 4 (c)(ii)

Now an attempt to find the gradient of the graph was needed for the first mark point. This attempt was deemed satisfactory if it would yield a value between 0.18 and 0.24 (m/s^2).

Success for the second mark point was indicated by a value of 'm' lying between 0.20 and 0.22 (m/s^2).


(ii) Calculate the value of *m* from the graph in Figure 6.

(2)

(60, 12.5) (120, 25)

$\frac{25-12.5}{120-60} = \frac{12.5}{60} = \frac{5}{24}$

$\frac{\text{change in y}}{\text{change in x}}$

$25 = \frac{5}{24}(120) + c$

$y = \frac{5}{24}$

m = 0.2083 m/s^2

ResultsPlus
Examiner Comments

Full marks are awarded for an answer lying between 0.20 and 0.22 (m/s^2).

This student spells out the relevant coordinates.

(ii) Calculate the value of *m* from the graph in Figure 6.

(2)

$\frac{\text{Change in y}}{\text{change in x}} = \frac{12.5-0}{60-0} = \frac{12.5}{60} = 0.208\dot{3}$ rounded to 0.21 M/s

m = 0.21 m/s²

ResultsPlus
Examiner Comments

Fully successful using intervals:

Δ v
Δt

(ii) Calculate the value of *m* from the graph in Figure 6.

(2)

y = mx + c.

m = gradient.

m = rise / run.

m = 0.2. m/s²

ResultsPlus
Examiner Comments

Full marks are always awarded for 'the correct answer without working'.

This is inside the range required.

ResultsPlus
Examiner Tip

There is always the danger of not getting an intermediate mark if you don't spell out your calculation.

Question 4 (c)(iii)

The value of 'c' is the y-intercept.

Since the graph goes through the origin 'c' = 0.

(iii) State the value of *c* from the graph in Figure 6.

(1)

value of *c* = 0

ResultsPlus
Examiner Comments

This is all we need.

Question 5 (b)

The meaning of the term 'ionising' was asked for. The mark scheme looks for loss/gain of electrons.

Occasionally candidates cited harm caused as an answer. That was not answering the question.

(b) Alpha, beta and gamma are all **ionising** radiations.

Give the meaning of the term **ionising**.

(1)

They can cause atoms to lose or gain electrons, Penetrating causes harm in skin

ResultsPlus
Examiner Comments

The idea of losing/gaining electrons is there for the mark.

We would not quibble over their slightly misleading use of language in this.

Question 5 (c)

£ marks were available for a question asking for a practical procedure to find the background radiation count.

Many candidates talked of using a GM tube, but not much else.

There were six possibilities given in the marks scheme for scoring those 3 marks.

(c) A teacher determines the background radiation count rate in a laboratory.

Explain how to determine a value for the background radiation count rate.

get a a geiger counter and hold it up. measure how many beeps you hear a ~~second~~ minute. Calculate an average.

ResultsPlus
Examiner Comments

This shows how relatively straightforward it was to obtain 3 marks.

Here for mark points 1,3 and 6.

(c) A teacher determines the background radiation count rate in a laboratory.

Explain how to determine a value for the background radiation count rate.

(3)

- GM counter will beep when radiation is present
- ensure repeat experiment to find an average
- count the number of beeps the GM counter makes
- measure distance of source from counter to find the value for background radiation count rate

ResultsPlus Examiner Comments

This gained 3 marks for

- GM counter mention
- repeat readings
- take an average

Question 5 (d)(i)

This was of variable attainment.

A good number got full marks (2).

Many scoring 1 out of 2 had 3 items labelled including the GM tube, but then positioned the aluminium inappropriately.

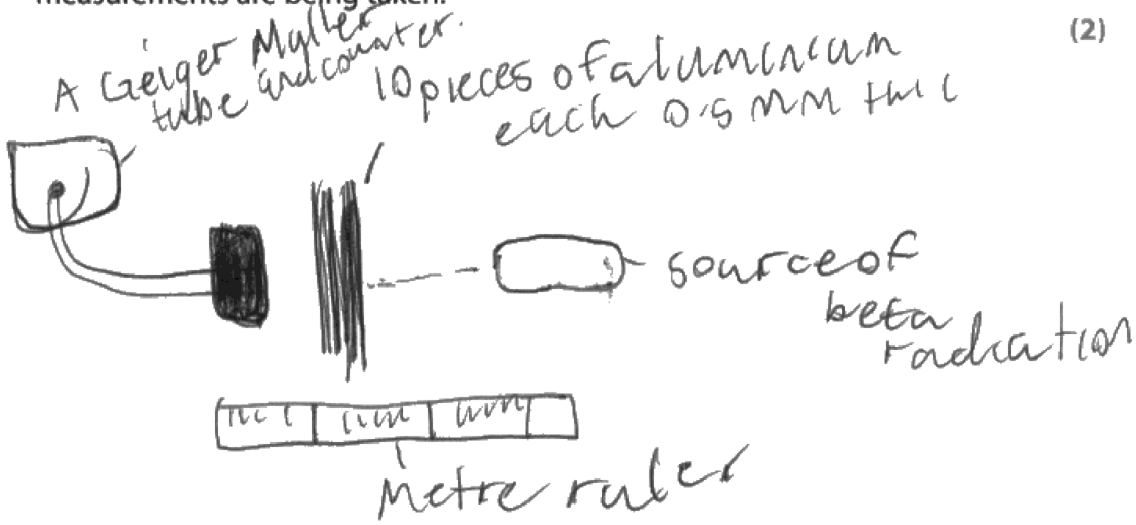
(d) The teacher now investigates the absorption of beta radiation by different thicknesses of aluminium.

The apparatus available is

- a source of beta radiation
- a Geiger–Müller (G-M) tube and counter
- 10 pieces of aluminium, each 0.5 mm thick
- a metre rule.

(i) Sketch a labelled diagram showing the positions of the apparatus when the measurements are being taken.

(2)



ResultsPlus
Examiner Comments

Full marks achieved with the aluminium sheets between the source and the GM tube.

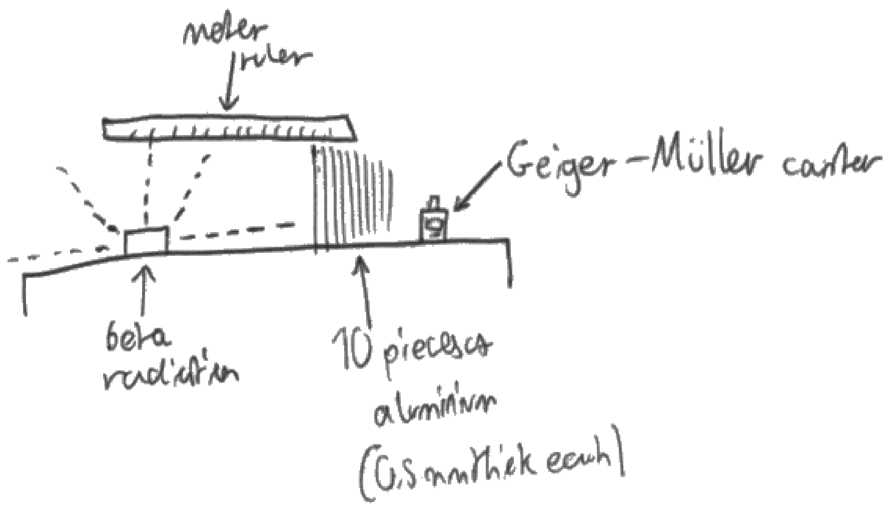
(d) The teacher now investigates the absorption of beta radiation by different thicknesses of aluminium.

The apparatus available is

- a source of beta radiation
- a Geiger–Müller (G-M) tube and counter
- 10 pieces of aluminium, each 0.5 mm thick
- a metre rule.

(i) Sketch a labelled diagram showing the positions of the apparatus when the measurements are being taken.

(2)



ResultsPlus Examiner Comments

Another well drawn sequence with the correct idea.

Question 5 (d)(ii)

A significant number recognised the thickness of aluminium as the independent variable.

(ii) Give the independent variable in this investigation.

(1)

the thickness of aluminium

ResultsPlus
Examiner Comments

Correct response.

Question 5 (d)(iii)

This showed low achievement.

Candidates appeared not to be able to apply their procedural knowledge to this item.

(iii) Name a quantity that must be kept constant during the investigation.

(1)

The distance of the beta radiation source from the geiger-muller counter

ResultsPlus Examiner Comments

This was the expected response, earning the mark.

(iii) Name a quantity that must be kept constant during the investigation.

(1)

the distance between the source and the aluminium

ResultsPlus Examiner Comments

This is also a possible constant.

6 possible ways of getting the mark are listed in the mark scheme.

(iii) Name a quantity that must be kept constant during the investigation.

(1)

~~the source of the beta radiation~~

the amount of beta radiation being ~~admited~~ emited from the source.

ResultsPlus
Examiner Comments

This was an all too frequent response, unfortunately.

It is not a control variable.

An amount of radiation would also be time dependent.

Question 5 (d)(iv)

β – radiation has a proton number of – 1, with the remainder for 'Y' being 39 to balance that on the left and side of the equation.

A compensatory mark reflecting the balancing totals was given where the proton number of β was not put at – 1.

(iv) Strontium-90 is the source of beta minus radiation in this investigation.

Complete the nuclear equation for this emission of beta minus radiation.

$$^{90}_{38}Sr \longrightarrow {}^{0}_{-1}\beta + {}^{90}_{39}Y$$

ResultsPlus Examiner Comments

Fully correct response.

iv) Strontium-90 is the source of beta minus radiation in this investigation.

Complete the nuclear equation for this emission of beta minus radiation.

$$^{90}_{38}Sr \longrightarrow {}^{0}_{-1}\beta + {}^{90}_{37}Y$$

ResultsPlus
Examiner Comments

First marking point scored, but not the second.

Numbers in the boxes should add up to 38.

(iv) Strontium-90 is the source of beta minus radiation in this investigation.

Complete the nuclear equation for this emission of beta minus radiation.

$$^{90}_{38}\text{Sr} \longrightarrow {}^{0}_{\boxed{1}}\beta + {}^{90}_{\boxed{37}}\text{Y}$$

ResultsPlus
Examiner Comments

β proton number was wrong but a second mark awarded for numbers that add up to 38.

Question 6 (a)(ii)

Most candidates scored the mark on this one.

(ii) The ball is moving at constant speed. Give **one** reason why the velocity of the ball is continuously changing.

(1)

This happens because the direction off the ball is continuosly changing.

ResultsPlus
Examiner Comments

This matches mark point one on the mark scheme very well.

(ii) The ball is moving at constant speed. Give **one** reason why the velocity of the ball is continuously changing.

(1)

Despite its speed saying constant it is always moving in a different direction meaning that it is accelerating.

ResultsPlus
Examiner Comments

This candidate elaborates further, showing good understanding, and also matching mark point one.

(ii) The ball is moving at constant speed. Give **one** reason why the velocity of the ball is continuously changing.

(1)

velocity is a vector. When the ball changes direction, velocity changes ↓ it has a direction.

ResultsPlus
Examiner Comments

This matches mark point 3 on the mark scheme.

(ii) The ball is moving at constant speed. Give **one** reason why the velocity of the ball is continuously changing.

(1)

at different points of the circle the velocity will be quicker due to gravity

ResultsPlus
Examiner Comments

An example of a spurious argument concerning gravity, which ignores the question stem which says the ball is travelling in a horizontal circle.

Question 6 (b)

A small minority of candidates achieved all three marks. This was often because of a lack of following up the question asking for answers 'to an appropriate number of significant figures'.

(b) Figure 8 shows a gymnast landing on a mat and coming to rest.

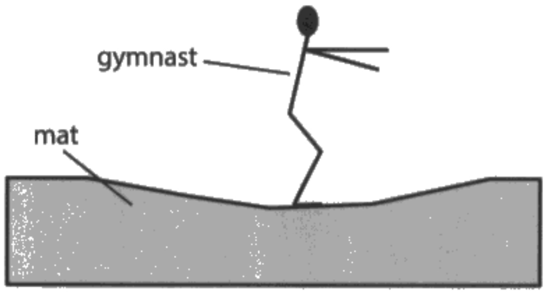


Figure 8

The gymnast has a mass of 53 kg.

The gymnast lands on the mat with a velocity of 4.0 m/s.

The average force exerted by the mat on the gymnast is 3500 N.

Calculate the time taken for the gymnast to come to rest.

Give your answer to an appropriate number of significant figures.

Use the equation

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

momentum = mass × velocity

= ~~37~~ 53 × 4.0

= 212

(3)

$$3500 = \frac{212}{x}$$

$$x = \frac{212}{3500} = 0.0605...$$

time = 0.061 s

ResultsPlus Examiner Comments

This shows an excellent response, well worth the full three marks.

ResultsPlus Examiner Tip

Well-presented work like this is commended, including showing an evaluation which is then rounded to an appropriate number of significant figures.

(b) Figure 8 shows a gymnast landing on a mat and coming to rest.

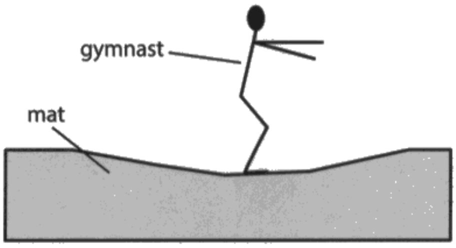


Figure 8

The gymnast has a mass of 53 kg.

The gymnast lands on the mat with a velocity of 4.0 m/s.

The average force exerted by the mat on the gymnast is 3500 N.

Calculate the time taken for the gymnast to come to rest.

Give your answer to an appropriate number of significant figures.

Use the equation

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

$$3500N = \frac{212}{\text{time}}$$

(3)

$$\text{time} = \frac{212}{3500} = 0.0605$$

time = 0.0605 s

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$212 = 53\text{kg} \times 4.0\text{ m/s}$$

ResultsPlus Examiner Comments

This was often seen.

The candidate completes the calculation well but then does not give their answer to an appropriate number of significant figures.

(b) Figure 8 shows a gymnast landing on a mat and coming to rest.

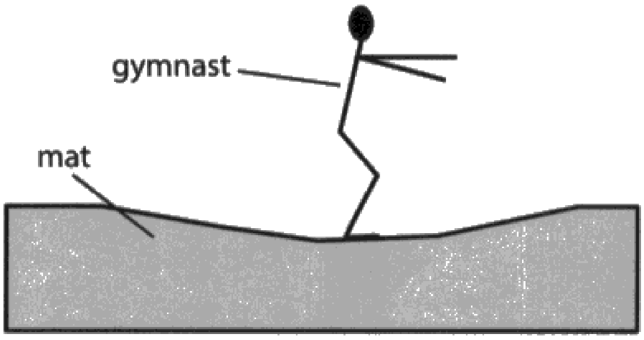


Figure 8

The gymnast has a mass of 53 kg.

The gymnast lands on the mat with a velocity of 4.0 m/s.

The average force exerted by the mat on the gymnast is 3500 N.

Calculate the time taken for the gymnast to come to rest. 1m/s

Give your answer to an appropriate number of significant figures.

Use the equation

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

$f = \frac{(mv - mu)}{t}$

(3)

$t = \frac{(mv - mu)}{f}$ $\quad \frac{(53 \times 1) - (53 \times 4)}{3500} = 0.0454$

time = 0.045 s

ResultsPlus
Examiner Comments

This response gains a mark for a correct rearrangement, but then makes a wrong substitution.

Question 6 (c)

This 6 marker on a momentum conservation (practical) proved to be very difficult for candidates to achieve level 2 or greater.

Misunderstandings abounded in candidates' answers including an idea that kinetic energies could cancel each other out.

Three exemplar answers worth 6 marks each are given in the hope of pointing students forwards to what can be achieved.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

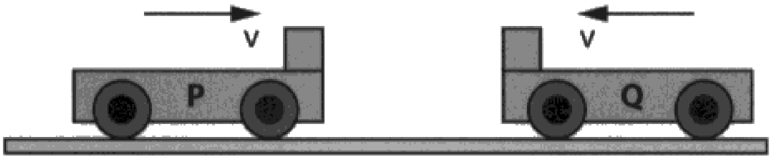


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

Each trolley has the same amount of kinetic energy before the collision as ~~kinetic~~ kinetic energy = mass × ½ × (velocity)² as the masses and velocities are the same (except the velocity of one is negative because it is in the opposite direction). When they collide, no overall force is exerted on either trolley as the forces are balanced and by the end, the momentum equals zero - this is the same as before the ~~collision~~ collision, so we can say that momentum has been conserved. Energy is also not destroyed in any ways, only transferred from one store to another. ~~So the~~ The kinetic energy of each trolley before the collision transfers to the thermal energy store when they collide and stick together, so the energy does not dissipate elsewhere and it is also conserved.

ResultsPlus
Examiner Comments

This answer recognises that the total momentum before and after are both zero, understanding that velocities may be regarded as positive and negative. They also understand energy conservation via conversion from kinetic to thermal. Well worth 6 marks

This standard of answer was rarely seen.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

$p = m \times v$

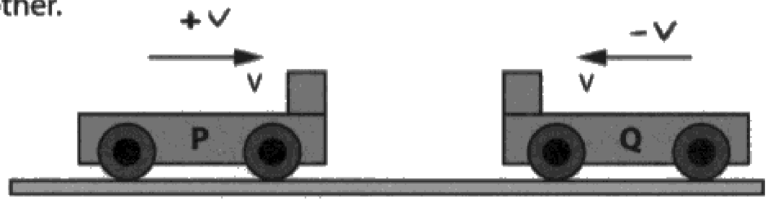


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

0

before = after

cannot be made or destroyed

(6)

Momentum = mass × velocity therefore the momentum of both trolleys is the same due to their equal mass and speed. When they collide, the mass doubles and momentum is conserved. Whilst the initial momentum is equal, due to it being a vector quantity, the momentum of P would be negative of the momentum of Q. This means that the total momentum before was (+v) + (-v) = 0. As momentum is conserved, the momentum after the collision is also 0 therefore the trolleys stop, and don't move. Kinetic energy from the movement of trolleys is dissipated to the surroundings upon collision, ~~through~~ released as thermal energy, and sound waves. Energy is conserved therefore no energy is made or destroyed, just transferred elsewhere. Thermal energy is released due to friction upon the impact of the collision. The resultant force is 0 after the collision.

(Total for Question 6 = 11 marks)

ResultsPlus
Examiner Comments

This answer shows good step by step logic as they sequence through what the question asks for in terms of momentum and energy.

Their momentum argument is particularly compelling, using the idea that both velocity and momentum are vectors in nature go very well. Their energy conservation argument is similarly well articulated.

ResultsPlus
Examiner Tip

Notice how the candidate makes very brief notes underlining key points in the question, unpacking words like 'conserved'.

This shows in their answer which is then very well composed.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

$KE = \frac{1}{2} \times m \times v^2$

·kinetic energy → friction → thermal + sound − dissipated completely

·law of conservation of momentum + energy

·p in opposite + equal mass direction so p=m×v trolleys total = 0 so when no velocity / conserved

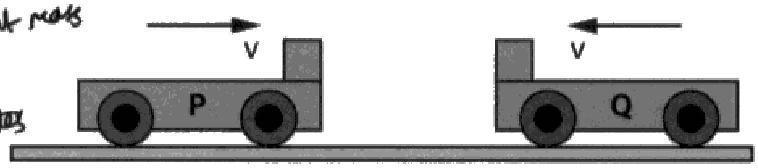


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

Energy is conserved in this collision due to the law of conservation of energy – the total energy input into a system must equal the total energy transferred by the system. Before the collision, the trolleys' ~~have the~~ main energy store is kinetic energy as they are moving. Then, during the collision, all of that energy is transferred to thermal and sound energy stores, due to the friction between the two ~~[illegible]~~ trolleys, until all the kinetic energy has been dissipated, and the trolleys stop moving. The energy has not been created or destroyed, only transferred to the surroundings, so the energy is conserved in the collision. Momentum is also conserved in the collision due to the law of conservation of momentum, where total momentum before the collision must equal the total momentum after a collision. Before the collision, the trolleys have the same momentum but in opposite directions, because they have the same mass and speed but opposite velocities and momentum = mass × velocity. So ~~then the trolleys collide~~ the total momentum is zero because the opposite momentums cancel each other out, so when the trolleys stick together and stop and their momentum is 0 due to no more velocity, the momentum hasn't changed and is ~~conserved~~ conserved.

(Total for Question 6 = 11 marks)

ResultsPlus Examiner Comments

Once again, the key two components of a level 3 answer are focused upon, these being:

- momentum conservation via the realisation of the impact of opposite momenta resulting in a sum of zero before and the same in the stationary situation afterwards
- kinetic energy does not disappear or cancel in some way but is transferred into thermal stores.

ResultsPlus Examiner Tip

Notice the note making in the diagram which proved effective focusing attention on key factors.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

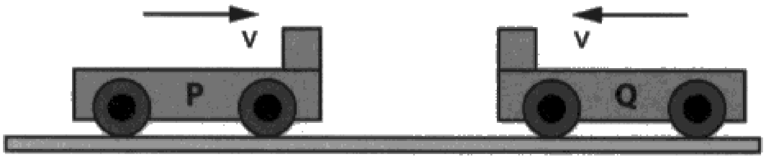


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

Momentum = ~~Mass~~ Mass × velocity.

~~the momentum of~~ in a closed system the momentum before the collision is equal to the momentum after. (*1 force as this energy was transferred out to surroundings)

if both trolleys have the same mass ~~they must have had the~~ and same velocity they would have the same momentum. When they collide and stick total ~~momentum~~ mass will ~~increase~~ ~~double~~ increase causing the velocity to decrease and so the velocity decreases. there should also be no resultant *1 no energy can be created or destroyed (conservation of energy) all kenetic energy was transfered to the surroundings in other forms such as sound energy from the crash sound that would be made. this forces the trolley to come to a stop and so energy is conserved

(Total for Question 6 = 11 marks)

ResultsPlus
Examiner Comments

This is a level 2 answer, not very convincing though, hence an intermediate mark of 3 marks.

Both momentum and energy conservation explanations are quite limited eg momenta of the two trollies are seen as equal, but they have not grasped or included the vector idea. Kinetic energy transfer to sound energy is proposed, but this ignores a more important thermal energy store outcome.

En route also they stray into trying to explain using force ideas. This was the undoing of many candidates trying to answer this question.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

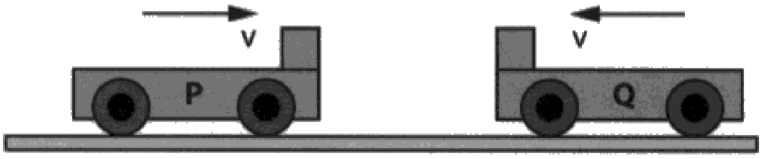


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

- energy is neither created or destroyed but rather transferred.
- Newton's third law states that two forces exerted on eachother are equal and opposite.
- Trolleys P and Q are going in opposite directions as eachother but have the same mass so they abide this law.
- momentum = mass x velocity
- If the trollys are moving at the same speed and are at equal mass the resultant force will be 0 therefore they stop. Kinetic energy has also reached 0.
- energy must be conserved if both trolleys are the same mass and same speed and ending up with the same result.

(Total for Question 6 = 11 marks)

ResultsPlus
Examiner Comments

This is a level 1 answer awarded 2 marks.

There are recognitions that the values of kinetic energy and momentum of each trolley are equal (in size). A basic statement of the law of conservation of energy is given, but it is not really applied.

There aren't even any level 2 limited descriptions of either conservation of energy or of momentum.

The candidate unhelpfully attempts an explanation in terms of Newton's third law.

The equal and opposite notion was often transferred in students' minds to kinetic energies and momenta.

*(c) Figure 9 shows two trolleys, **P** and **Q**, moving at the same speed, v, directly towards each other.

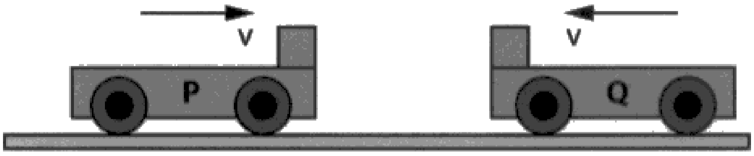


Figure 9

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

In this collision momentum is ~~conserved~~ conserved through the p= m×v equation. Seeing as both trolleys have an equal mass and velocity their momentum will be the same so when they hit each other the same amount of force will go through each trolley. This means that they ~~In the collision energy~~ momentum is conserved as when they collide, they gain the exact same amount of momentum from the other trolley. Energy is conserved in the collision in pretty much the same way. They both have equal energy because they have the same velocity, mass and momentum so during the collision they transfer exactly the same amount of energy to each other as they gain from each other.

ResultsPlus
Examiner Comments

A level 1 answer which only receives some credit for the isolated idea of the two trollies having the same momentum (values).

Then there are some unhelpful phrases such as 'force going through each trolley' and transfers of equal energy to each other.

Paper Summary

Overall, this exam gave ample opportunity for candidates to display their knowledge and understanding at grades 4-9.

Candidates continued to do well with most calculation questions, although many didn't cope well with significant figures and units, such as nanometres in Q 03(b)(ii).

Candidates were hindered in achieving level 3 responses in the 6 mark answer through their lack of application of knowledge and understanding regarding momentum as a vector quantity and kinetic energy as a scalar.

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

- Candidates should make the most of opportunities afforded in school laboratories where they become acquainted with practical work from the specification. This concerns both core practicals and the suggested practicals. It would benefit students to always question 'What is the purpose of this experiment?' making sure they are clear in their minds about it. After the event evaluations are also useful, especially when reflecting about how the experiment could have been improved.
- Candidates seem to need more practice on handling powers of ten in their calculations. They should be able to use their calculators with numbers in standard form when needed. It often helps to put answers in standard form rather than risk writing too many or too few 000s in an answer.
- In constructing explanations students need to take note of the marks allocated to a particular question and respond with a corresponding number of points in their answer. Candidates should take opportunities, where they can, to use diagrammatic illustrations to aid and prompt their explanations.

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

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.