Examiners' Report
June 2014

GCSE Physics 5PH3H 01

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Introduction

This examination aims to allow students to demonstrate that they can accurately recall concepts and phenomena in physics and can communicate their understanding using both qualitative and quantitative models. The specification uses physical principles and links these to medical applications

The assessment is through multiple choice questions, short answers, extended writing, calculations and analysis. Students need to be able to transform equations, apply mathematic skills, be able to express their ideas clearly and concisely and interpret scientific data which is presented in a variety of ways.

The work produced for the examination showed that many students are confident in their use of mathematical models and were able to explain complex phenomena with clarity and insight. Many students were able to demonstrate their understanding of quarks and the use made of electron –positron annihilation in PET scanners. However, when collisions were to be analysed in terms of momentum and kinetic energy, it became clear that the meaning of conserved was not always understood. 'Conservation of momentum' and 'conservation of kinetic energy' were often quoted correctly for each of the collisions but the meaning of these in the context of an actual collision could not be explained. Making the answer relevant to the question is also a skill that needs attention. The photograph of the security check in an airport was largely ignored when students were asked how security staff were protected from X-rays. Most students considered the protection given to operators of X-ray machines in hospitals.

Students need to be aware of the link between the units of a quantity and the equation used to determine that quantity as this helps understanding and can be very useful when the equation is not given. Students should also expect to provide a quantitative answer to a question which contains numerical values.

It is important that students are able to interpret diagrams showing refraction and have the opportunity to use lenses and appreciate the variations in curvature. The use of correct units when substituting in equations, the ability to convert units, the use of standard form and correct use of calculators are all skills which are necessary.

Most students made use of the formulae sheet at the front of the examination paper and were able to quote equations correctly. Although full marks are given to correct answers to calculations, with or without working, it was pleasing to see that most candidates quoted the equation and transposed or substituted into the equation. This allowed them to gain some marks even if the final answer was incorrect.

Question 1 (a) (iii)

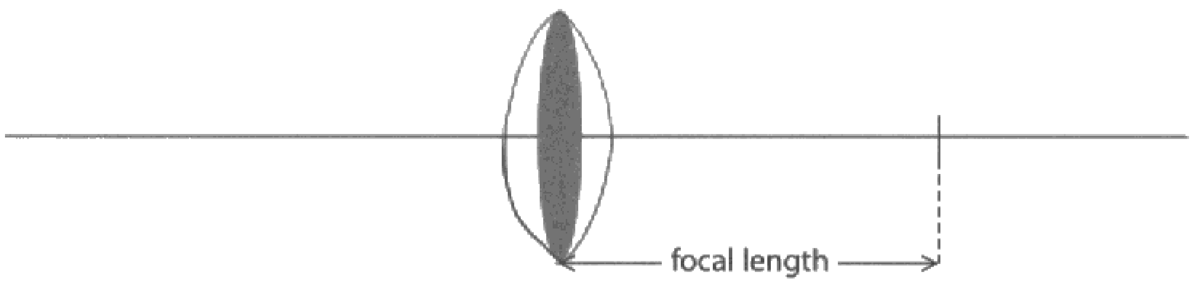
Candidates need to be familiar with the shape of lenses by using them. Candidates that had seen lenses of different powers should not have encountered any difficulty in drawing a lens that was more powerful over the diagram of the lens shown in the question.

This question followed on from a multiple choice question asking candidates to determine the power of a lens when the focal length was given in centimetres. Very few candidates got the multiple choice question right because the focal length was not changed to metres before working out the power in dioptres.

This and the number of candidates that left Q1aiii blank would suggest that practical work with lenses is quite limited.

(iii) The diagram shows a converging lens with its focal length marked. Over this diagram draw a converging lens of greater power and mark in its focal length.

(2)



ResultsPlus
Examiner Comments

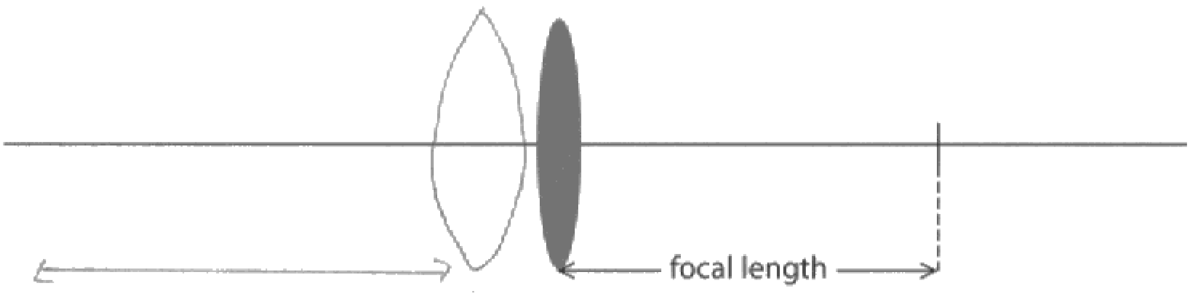
Make sure each requirement of the question is completed. This diagram shows a lens with increased power but either the new focal length is not marked in or the candidate believes that any change in the power of the lens does not change its focal length.

ResultsPlus
Examiner Tip

Bring a pencil to the examination and be prepared to draw diagrams or add to them.

(iii) The diagram shows a converging lens with its focal length marked. Over this diagram draw a converging lens of greater power and mark in its focal length.

(2)



ResultsPlus
Examiner Comments

This answer shows a lens with a greater power and was awarded the mark for that, although the instruction in the question to draw it over the original lens was not heeded.

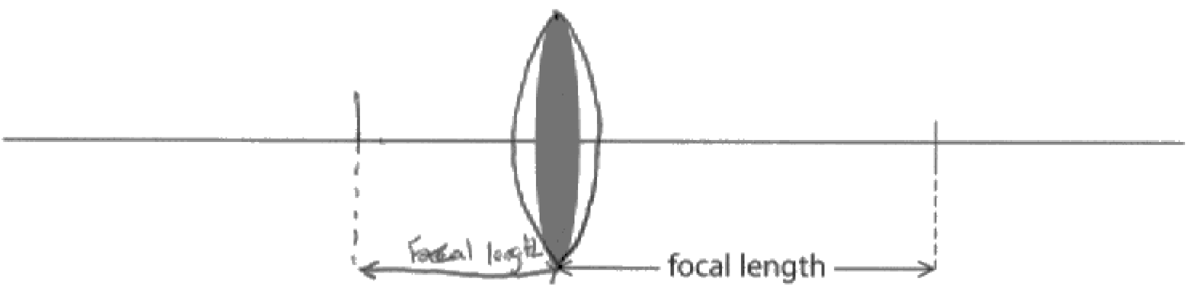
The second mark for showing a shorter focal length was not awarded as 'by eye' the two focal lengths appear to be about the same.

ResultsPlus
Examiner Tip

Follow the instructions in the question.

(iii) The diagram shows a converging lens with its focal length marked. Over this diagram draw a converging lens of greater power and mark in its focal length.

(2)



ResultsPlus
Examiner Comments

The candidate gave the correct answer to both parts of the question.

Question 1 (b)

Most candidates were familiar with the use of the lens equation and could substitute correctly. The transposition to find 1/v was usually correct. However, the inversion to find the image distance was often missed or the negative value was forgotten in the answer line. Strangely, although few candidates changed centimetres to metres to calculate power, quite a number changed centimetres to metres in this calculation where it was not necessary and then rarely got the correct answer.

(b) An object is placed 8.5 cm in front of a converging lens of focal length 12.0 cm.

Calculate the image distance.

(4)

$$\frac{1}{12} = \frac{1}{8.5} + \frac{1}{v}$$

$$12 - 8.5 = 3.5$$

image distance = 3.5 cm

ResultsPlus

Examiner Comments

This candidate gets one mark for a correct substitution.

ResultsPlus

Examiner Tip

Always write down the equation from the formula sheet and put in the correct values. Even if it is not possible to go any further with the calculation at least a mark is salvaged.

(b) An object is placed 8.5 cm in front of a converging lens of focal length 12.0 cm.

Calculate the image distance.

(4)

$$1/f = 1/u + 1/v$$

object   distatce.

$$1/f - 1/u = 1/v$$

$$1/12 - 1/8.5 = -7/204 = -0.034$$

image distance = -0.034 cm

ResultsPlus

Examiner Comments

This example scores three marks for substitution, transposition. and evaluation. A mark is lost for not completing the inversion.

ResultsPlus

Examiner Tip

-7/204 would still have gained 3 marks but if it had been inverted to -204/7 for the image distance, the final mark would not have been awarded.

Fractions should be converted to decimals for the final answer line.

(b) An object is placed 8.5 cm in front of a converging lens of focal length 12.0 cm.

Calculate the image distance.

(4)

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{V}$$

$$\frac{1}{12} = \frac{1}{8.5} + \frac{1}{V}$$

$$\frac{1}{12} - \frac{1}{8.5} = \frac{1}{V}$$

$$\frac{1}{V} = -\frac{7}{204}$$

$$V = -\frac{7}{204}^{-1}$$

image distance = -29 cm

ResultsPlus

Examiner Comments

This example shows every stage of the calculation and gives the correct answer. It also shows that the use of the reciprocal button on the calculator is understood.

ResultsPlus

Examiner Tip

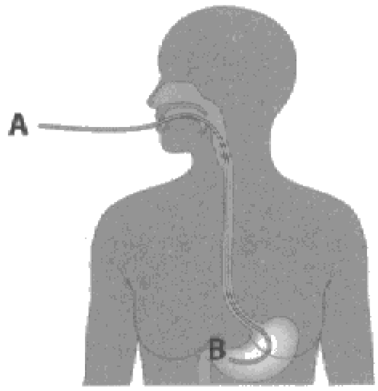
Complete calculations one stage at a time and write each stage down. This gives a much better chance of getting the right answer.

Question 2 (b) (i)

This calculation was successfully completed by the majority of candidates. The equation was selected from the formulae page and substitution and transposition were correctly completed.

This question required an understanding of standard form and/or the ability to use it correctly in a calculator.

(b) The diagram shows how an endoscope is used to see inside a person's stomach.
Light is shone into the optical fibres in the endoscope at A and it comes out at B.



(i) The cross-sectional area of an optical fibre is 6.3×10^{-6} m².
The intensity of the light entering the optical fibre is 3.2×10^{7} W/m².

Calculate the power of the light entering the optical fibre.

(3)

intensity = power of incident radi / area

i x a

$3.2 \times 10^{7} \times 6.3 \times 10^{-6}$

= 5480.056166

power = 5480 W

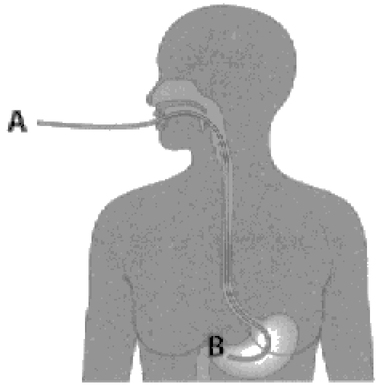
ResultsPlus
Examiner Comments

This question gets two marks for the correct substitution and transposition can be clearly seen but the multiplication of the two numbers is incorrect and the relevance of 10^{-6} has obviously not been appreciated.

ResultsPlus
Examiner Tip

Either learn to use powers of 10 on your calculator or limit the use of the calculator to the numerical values and work out the powers of 10 in your head.

(b) The diagram shows how an endoscope is used to see inside a person's stomach. Light is shone into the optical fibres in the endoscope at A and it comes out at B.



(i) The cross-sectional area of an optical fibre is 6.3×10^{-6} m². The intensity of the light entering the optical fibre is 3.2×10^{7} W/m².

Calculate the power of the light entering the optical fibre.

(3)

$$I = \frac{P}{A}$$

$$\text{Intensity} = \frac{\text{Power of incident } \sout{\text{ray}} \text{ radiation}}{\text{area}}$$

$$3.2 \times 10^{7} \text{ w/m}^2 = \frac{P}{6.3 \times 10^{-6} \text{ m}^2} \qquad P = 1.96875 \times 10^{-13} \text{ w}$$

$$\frac{6.3 \times 10^{-6} \text{ m}^2}{3.2 \times 10^{7} \text{ W/m}^2} = P$$

power = 1.96875×10^{-13} W

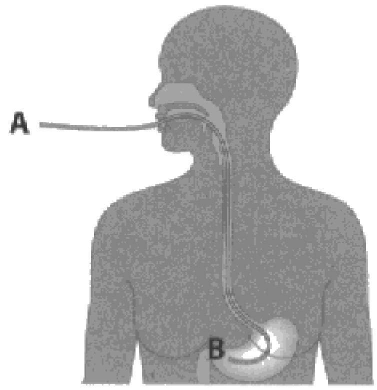
ResultsPlus
Examiner Comments

One mark is given for the correct substitution in the equation that has been written down. The transposition is incorrect, which gives the wrong answer. This candidate shows that s/he understands standard form but unfortunately no mark is awarded for this.

ResultsPlus
Examiner Tip

Always show your working and in most cases you will get at least one mark.

(b) The diagram shows how an endoscope is used to see inside a person's stomach. Light is shone into the optical fibres in the endoscope at A and it comes out at B.



(i) The cross-sectional area of an optical fibre is 6.3×10^{-6} m².
The intensity of the light entering the optical fibre is 3.2×10^{7} W/m².

Calculate the power of the light entering the optical fibre.

(3)

intensity = Power / area

$3.2 \times 10^{7} = \frac{\text{Power}}{6.3 \times 10^{-6}}$

$3.2 \times 10^{7} \times 6.3 \times 10^{-6} = \text{Power}$

power = 201.6 W

ResultsPlus
Examiner Comments

Calculation shown with correct answer gains 3 marks.

ResultsPlus
Examiner Tip

Always show your working.

Question 2 (b) (ii)

As the question referred to an endoscope, many candidates linked this correctly to total internal reflection or internal reflection. However, a significant number of candidates called this phenomena 'total internal refraction' and did not get a mark. Candidates used internal reflection to explain why no light or energy was lost. As power was used in the stem of the question this was not acceptable as part of the answer.

(ii) Explain why the power of the light at B is the same as the power of the light at A.

(2)

The power of light is the same because no light gets lost when you are shining the endoscope into a person's stomach.

ResultsPlus
Examiner Comments

This response is given one mark for 'no light gets lost'. However, the reason for this is not given and no further marks are awarded

ResultsPlus
Examiner Tip

When there are two marks for the answer, remember to make two points.

(ii) Explain why the power of the light at B is the same as the power of the light at A.

(2)

In the optical fibre all of the light rays that enter are totally internally reflected (TIR) so none of the light energy refracts and leaves the glass so the power remains the same

ResultsPlus
Examiner Comments

This response gets two marks for 'all of the light'.......'totally internally reflected'. The inference being that if all the light is totally internally reflected, then no light is lost. However, the candidate goes on to explain this.

ResultsPlus
Examiner Tip

Answer questions as accurately and concisely as possible.

Question 2 (c)

The majority of candidates were able to find sin c but finding the angle c having calculated the sin proved more problematic.

Many candidates were able to find angle c just using their calculators and did not require the graph. However just producing a value for angle c with no working being shown meant that a wrong angle got no marks.

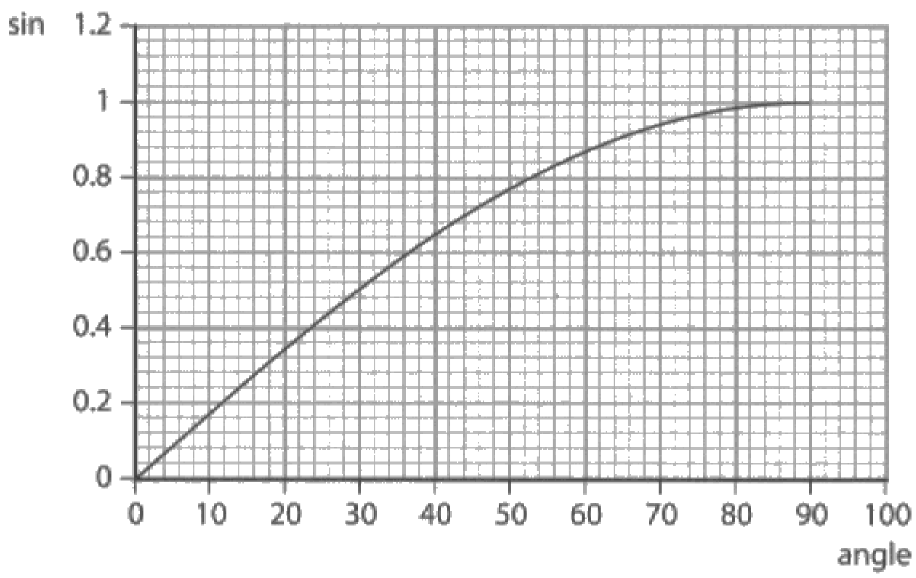
(c) The optical fibre cable in an endoscope has a refractive index of 1.70.

The critical angle for a material can be calculated using the equation

$$\sin c = \frac{1}{n}$$

where c is the critical angle
and n is the refractive index

The graph shows the relationship between an angle and the sine of the angle.



Use the equation and the graph to calculate the critical angle for the optical fibre.

(2)

Sin c = 1/n

Sin c = 1/1.70

critical angle = 0.58 °

ResultsPlus
Examiner Comments

This response gained one mark for the correct evaluation of sin c which could be seen because the working had been included.

ResultsPlus
Examiner Tip

Always include your working

Question 3 (a) (i)

Many candidates realised that X-rays were harmful to humans in some way but did not go on to make a second point worthy of another mark. The second point should have been that X-rays are not necessary in airports because dangerous items can be detected by metal detectors which are not harmful to human health or that people have an X-ray in hospital because it is necessary and the benefits outweigh the risks.

An X-ray machine is used to scan luggage for dangerous items.
A metal detector is used to check people for dangerous items.

(a) (i) Suggest why people are not scanned with X-rays in an airport but have X-rays in a hospital.

(2)

Because X-rays are ionising and if used to scan someone could damage their cells and/or cause cancer.

ResultsPlus
Examiner Comments

This response is worth one mark because it describes how X-rays are harmful.

ResultsPlus
Examiner Tip

Look to see how many marks are awarded and if there are two marks then two separate points are needed to gain both marks.

An X-ray machine is used to scan luggage for dangerous items.
A metal detector is used to check people for dangerous items.

(a) (i) Suggest why people are not scanned with X-rays in an airport but have X-rays in a hospital.

(2)

As the risks outweigh a reason to, x-rays can cause cancer and aren't as neccisary in a hospital where an x-ray could save a life.

ResultsPlus
Examiner Comments

This answer covers all three marking points but it still only gets two marks.

ResultsPlus
Examiner Tip

Answer each question as fully as possible but keep to the lines provided if at all possible.

Question 3 (a) (ii)

This question was answered poorly because candidates did not read the question properly and did not use the information in the photograph.

The question stated that security people work near X-ray machines. The majority of answers assumed the question was about protection provided for radiographers in hospital X-ray departments.

The use of lead or metal shielding was the most common correct answer for one mark. The only reason that was accepted for the X-rays not getting through the lead shielding was that they were absorbed. This was not often used in the responses.

Candidates did not apply their knowledge to the situation given in the question and suggested the security workers were behind thick lead shields or wore lead lined aprons.

(ii) The security people work near the X-ray machine.

Explain how they are protected from the X-rays.

(2)

The X-ray machine is clearly lined with lead, which will absorb the X-ray, and not allow the people to be exposed to them.

ResultsPlus
Examiner Comments

This response gets 2 marks as it deals with the situation shown in the photograph and states that X-rays are absorbed.

ResultsPlus
Examiner Tip

Use the information provided in the stem of the question to inform your answer.

treatment

(ii) The security people work near the X-ray machine.

Explain how they are protected from the X-rays.

(2)

They can wear lead aprons, or there can be ~~lead~~ - ~~shielding~~ lead-shielding on the scanner so that X-rays do not penetrate through. They can also wear a dosimeter and when high enough, lower their dosage.

ResultsPlus
Examiner Comments

This answer gets one mark for the lead shielding on the scanner but the rest of the answer can be ignored as it bears no relationship to security checks in airports.

ResultsPlus
Examiner Tip

Read the whole of an introduction to a question and note the photographs or diagrams used as these are given to put the questions in context.

Question 3 (b) (i)

As the question includes that electrons come from a cathode in the process of thermionic emission, stating that thermionic emission was the emission of electrons from a cathode did not get any marks.

The points to be included were: that a cathode (filament) was heated, to give electrons enough energy, to escape (boil off).

Candidates could name any two of these for the maximum of two marks.

(b) X-rays are produced when fast moving electrons collide with a metal anode in a vacuum tube.

(i) The electrons come from the cathode by the process of thermionic emission.

Explain what is meant by thermionic emission.

(2)

The Cathode is a thin metal wire that, when heated up produces electrons, this is thermionic emission

ResultsPlus
Examiner Comments

This response gets one mark for mentioning heating the cathode, but the heat does not produce electrons - it gives the electrons that are there sufficient energy to escape.

ResultsPlus
Examiner Tip

Choose words carefully when describing physical phenomenon in order to make the description accurate.

(b) X-rays are produced when fast moving electrons collide with a metal anode in a vacuum tube.

(i) The electrons come from the cathode by the process of thermionic emission.

Explain what is meant by thermionic emission.

(2)

Thermonic emission is the heating of the cathode to a certain temperature in which the electrons "boil off" or emitt from the cathode.

ResultsPlus
Examiner Comments

This response is awarded two marks. The first for heating the cathode and the second for electrons being 'boiled off'.

Question 3 (b) (iii)

This calculation was successfully completed by the majority of candidates, with just a few confusing v with V and trying to take a square root or being unable to deal with the powers of 10.

(iii) In order to produce X-rays which can penetrate the luggage, each electron must have at least an energy of 1.4×10^{-14} J.
The charge on an electron is 1.6×10^{-19} C.

Calculate the accelerating potential difference which will produce electrons of this energy.

(3)

Kinetic energy = electronic charge × accelerating potential difference

acceleating potential difference = electronic charge ÷ kinetic energy

$1.6 \times 10^{-19} \div 1.4 \times 10^{-14} = 1.14 \times 10^{-33}$

accelerating potential difference = 1.14×10^{-33} V

ResultsPlus
Examiner Comments

The equation here is incorrectly transposed but the substitutions are then correct so one mark is awarded.

ResultsPlus
Examiner Tip

Always show your working to maximise your marks.

(iii) In order to produce X-rays which can penetrate the luggage, each electron must have at least an energy of 1.4×10^{-14} J.
The charge on an electron is 1.6×10^{-19} C.

Calculate the accelerating potential difference which will produce electrons of this energy.

(3)

KE = electronic charge × V?

$1.4 \times 10^{-14} = 1.6 \times 10^{-19} \times V$

$$\frac{1.4 \times 10^{-14}}{1.6 \times 10^{-19}} = V$$

V = 87500

accelerating potential difference = 87500 V

ResultsPlus
Examiner Comments

Correct answer for 3 marks with the working shown.

(iii) In order to produce X-rays which can penetrate the luggage, each electron must have at least an energy of 1.4×10^{-14} J.
The charge on an electron is 1.6×10^{-19} C.

Calculate the accelerating potential difference which will produce electrons of this energy.

(3)

K / ec | Apd

$1.4 \times 10^{-14} \div 1.6 \times 10^{-19} =$

accelerating potential difference = 8.75 V

ResultsPlus
Examiner Comments

The answer is incorrect and there is no allowance for powers of ten in the answer. However this response still gets two marks for correct substitution and transposition. Without the working this response would not get any marks.

ResultsPlus
Examiner Tip

Always include working.

Question 4 (a) (ii)

This question has numerical values and should therefore have a numerical answer ie the kinetic energy is halved or divided by 2. The majority of candidates stated the kinetic energy was reduced but not by how much.

(ii) The temperature of a gas changes from 300 K to 150 K.

State how the average kinetic energy of the gas particles changes.

(1)

The kenetic energy decreases by a half.

ResultsPlus
Examiner Comments

When just one mark is awarded for the response to a question, the answer must be accurate and quantitative if the question includes numerical values.

ResultsPlus
Examiner Tip

When values are given, give a numerical answer.

Question 4 (b)

Most candidates gained two marks on this question, one for considering particles colliding and the other for knowing that the particles collided with the walls of the balloon.

Candidates that did not mention particles could get a maximum of one mark if it was explained that there was a force on the walls of the balloon or a change in momentum. 'Push' was not accepted neither was the reuse of 'pressure' as this was given in the stem of the question.

(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.

Explain how the helium gas exerts a pressure on the balloon.

(3)

The gas particles inside the balloon move rapidly in the contained space and hit the inside of the balloon which exerts a build up of pressure on the balloon.

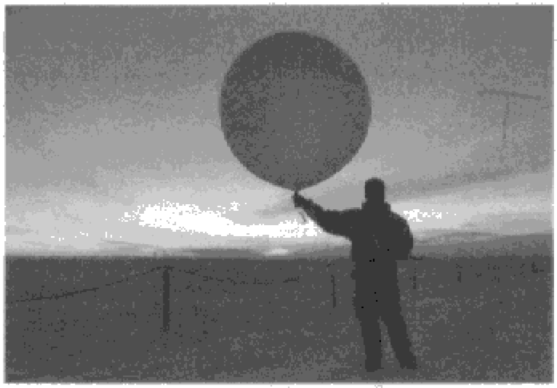
ResultsPlus
Examiner Comments

This response gets the first two marks.

ResultsPlus
Examiner Tip

Three marks require three points to be made but take care not to restate the information in the question.

(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.



Explain how the helium gas exerts a pressure on the balloon.

(3)

~~The helium gas heats up at~~ As it rises, the pressure in the atmosphere increases and the helium gas expands, stretching the baloon which will eventually pop.

ResultsPlus
Examiner Comments

This response is not worthy of any marks as the action of particles on the balloon wall is not considered.

ResultsPlus
Examiner Tip

Pressure exerted by gases must be explained using kinetic theory. Remember to consider particles.

(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.

Explain how the helium gas exerts a pressure on the balloon.

(3)

The ~~p~~ gas particles move around randomly and often collide with the balloon wall and exert a force onto it. If the ~~pressure is~~ temperature is higher than the particles move faster and exert more presure on the ballon.

ResultsPlus
Examiner Comments

This response is concise and accurate and gets three marks.

ResultsPlus
Examiner Tip

Three marks are awarded for making three points: particles colliding...... with the balloon walls.... exerting a force.

Question 4 (c) (i)

This question only required a 273 to convert degrees Celsius to Kelvin. Some candidates spend time trying to use the gas equation here instead of noting that the answer was only worth one mark.

(c) On the surface of the Earth the weather balloon has a volume of 9.1 m^3, when the temperature is 0 °C and the pressure inside the balloon is 101 kPa.

At 30 000 m above the Earth, the temperature is –46 °C and the pressure inside the balloon is 1.12 kPa.

(i) Show that –46 °C is 227 K.

(1)

$-46 + 273 = 227$

ResultsPlus
Examiner Comments

As there was only one mark available, candidates should not have expected to provide more than a straightforward response.

ResultsPlus
Examiner Tip

Note the number of marks that the answer can be awarded, do not spend a long time on an answer which is only worth one mark.

Question 4 (c) (ii)

The previous question was intended to encourage candidates to convert °C to Kelvin for use in the general gas equation. However, there were a large number of candidates who still attempted to use °C and were then confused by the zero which appeared once the values had been substituted.

Whist the conversion to Kevin was often missed, some candidates tried unnecessarily to convert kPa to Pa and as a result ended with a power of ten error in the answer line.

(ii) Calculate the volume of the weather balloon when it is at a height of 30 000 m.

(3)

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{101 \times 9.1}{273} = \frac{1.12 \times V_2}{227}$$

$$\frac{101}{30} = \frac{1.12 \times V_2}{227}$$

$$\frac{22927}{30} = 1.12 \times V_2$$

$$V_2 = 682.3511905 \text{ m}^3$$

$$682 \text{ m}^3$$

volume = 682 m^3

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Examiner Comments

Three marks are given for a completely correct solution taken to the correct number of significant figure with all working shown.

ResultsPlus

Examiner Tip

Show your working and work through this type of mathematical example one stage at a time.

(ii) Calculate the volume of the weather balloon when it is at a height of 30 000 m.

(3)

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$P_1 = 101$ $V_1 = 9.1$ $T_1 = 0$

$P_2 = 1.12$ $V_2 = ?$ $T_2 = -46$

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$$

$$V_2 = \frac{101 \times 9.1 \times -46}{0 \times 1.12}$$

$$= \frac{-42278.6}{0}$$

$=$

volume = ... m^3

ResultsPlus

Examiner Comments

There is no conversion to Kelvin, but this response did gain one mark for correct transposition.

ResultsPlus

Examiner Tip

Show your working to maximise marks on calculations.

Question 4 (c) (iii)

Many candidates worked out that the balloon must expand and eventually burst even without being able to calculate the volume increases from $9m^3$ to $682m^3$.

Question 5 (a) (i)

The majority of candidates gained at least one mark either from considering the short time that the radioactive Fluorine was in the body as the advantage, or that the isotope has to be produced close in either time or distance to where it is being used as the disadvantage.

(i) Fluorine-18 has a half-life of 1.8 hours.
State one advantage and one disadvantage of using a substance with such a short half-life.

1. Advantage

They don't stay in the body for long so are less likely to do damage

(1)

2. Disadvantage

Have to be created nearby as they can't be transported for long

(1)

ResultsPlus
Examiner Comments

This answer gained two marks. As Fluorine-18 is given in the question, they refer to substances with short half-lives.

Question 5 (a) (ii)

The question asked the candidates to 'explain' how the site of the tumour was located once positron-electron annihilation had taken place.

Unfortunately many candidates wasted both time and space for the answer by writing about what was happening prior to the annihilation.

Most candidates were able to gain at least two marks by knowing that two gamma rays were released and a third mark for knowing that the gamma rays were released in opposite directions.

If a fourth mark was awarded, it was usually for the idea of triangulation or the sensors being placed around the patient. Very few candidates considered conservation of momentum or simultaneous detection.

(ii) When a positron meets an electron they annihilate each other.
Explain how this enables the site of the tumour to be located.
(4)

When the two annihilate, ~~gama~~ gamma rays are released in oposite directions, a ~~scanner~~ sensor surrounding the patient can pinpoint the source of the gamma rays and this is where the tumor is.

ResultsPlus
Examiner Comments

This is a concise answer but only gets three marks. The mention of two gamma rays would have given the fourth mark.

ResultsPlus
Examiner Tip

Make four points if there are four marks to be obtained.

(ii) When a positron meets an electron they annihilate each other.
Explain how this enables the site of the tumour to be located.

(4)

The radioactive site at the tumour releases a positron. This meets an electron and they annihilate each other. This releases two gamma rays that travel in opposite directions with the same amount of energy. These are detected by the gamma ray detector ~~and~~ at the same time and the system draws ~~an~~ a ~~than~~ line ~~where they~~ connecting the points. This happens many times and the system has created an asterisk of gamma ray lines and the point where they all cross is where the tumour is.

ResultsPlus
Examiner Comments

This answer gets four marks but gives five of the possible marking points:

1. gamma rays
2. two (gamma rays)
3. opposite directions
4. simultaneous detection
5. idea of triangulation.

ResultsPlus
Examiner Tip

Note the number of marks that are awarded and make that number of correct points to get the marks.

Question 5 (b)

Many candidates were able to accurately describe beta minus and beta plus emission in terms of quarks and gain full marks on this question. Some errors in a description that was basically correct gained four marks, and two marks were awarded if beta plus and beta minus emission were described without considering quarks or if only the quarks that make up protons and neutrons were given.

No marks were awarded for the erroneous idea that beta plus (positrons) or beta minus (electrons) were made up of quarks.

*(b) Positrons (β^+ particles) are emitted from the nuclei of some atoms. Electrons (β^- particles) are emitted from the nuclei of other atoms.

The table gives some information about quarks.

quark	charge (compared to the charge on a proton)
u	+2/3
d	−1/3

Describe, in terms of quarks, how β^+ particles are emitted from the nuclei of some atoms and β^- particles are emitted from the nuclei of others.

(6)

In β^+ particles, there are two up quarks and one down quark. In β^- particles, there are two down quarks and one up quark. For both of the particles, the mass is '1'.

β^+: $\frac{1}{3} + \frac{1}{3} - \frac{1}{3} + \frac{2}{3} = 1$

$\frac{1}{3} - \frac{1}{3} - \frac{1}{3} - \frac{1}{3} = -2/3$

ResultsPlus
Examiner Comments

No marks were awarded as beta plus and beta minus particles are not made up of quarks.

*(b) Positrons (β^+ particles) are emitted from the nuclei of some atoms.
Electrons (β^- particles) are emitted from the nuclei of other atoms.

The table gives some information about quarks.

quark	charge (compared to the charge on a proton)
u	+2/3
d	−1/3

Describe, in terms of quarks, how β^+ particles are emitted from the nuclei of some atoms and β^- particles are emitted from the nuclei of others.

(6)

A proton is made from 2 up quarks and 1 down quark giving it a charge of 1. In β^- decay, an up quark changes to become a down quark and it releases an electron to conserve charge. A neutron is made of 2 down quarks and 1 up quark giving it a charge of 0. In β^+ decay, a down quark changes to become an up quark and it releases a positron, an antimatter electron with an opposite charge to conserve charge.

ResultsPlus
Examiner Comments

This response gets four marks. The idea of quarks changing flavour is correct but the particle emitted for each change is incorrect.

ResultsPlus
Examiner Tip

Understanding a process is always preferable to just trying to learn it.

→ proton → neutron -1

*(b) Positrons (β^+ particles) are emitted from the nuclei of some atoms.
Electrons (β^- particles) are emitted from the nuclei of other atoms.

↳ neutron → proton +1

The table gives some information about quarks.

$p = u + u + d$

$N = d + d + u$

quark	charge (compared to the charge on a proton)
u	+2/3
d	−1/3

Describe, in terms of quarks, how β^+ particles are emitted from the nuclei of some atoms and β^- particles are emitted from the nuclei of others.

(6)

when B^+ particles are emitted from a nuclei ~~an~~ a proton is being turned into a neutron as theres too many protons in that atom. In terms of quarks this means that an up quark of 2/3 is turned into a down quark of -1/3 in order for the neutron to be formed.

when B^- particles are emitted from a nuclei a neutron is being turned into a proton as theres too many neutrons in that atom. In terms of quarks this means that a down quark of -1/3 is being turned into an up quark of 2/3 in order for the proton to form.

ResultsPlus

Examiner Comments

This completely correct answer scores 6 marks.

*(b) Positrons (β^+ particles) are emitted from the nuclei of some atoms.
Electrons (β^- particles) are emitted from the nuclei of other atoms.

The table gives some information about quarks.

quark	charge (compared to the charge on a proton)
u	+2/3
d	−1/3

Describe, in terms of quarks, how β^+ particles are emitted from the nuclei of some atoms and β^- particles are emitted from the nuclei of others.

(6)

When a nucleus is unstable, radiation is emmitted
A nucleus can be un stable if there are two
many neutrons, too little neutrons, it has too
much ~~ene~~ energy or it is too heavy. A neutron and has no charge
consists of 2 down quarks and 1up. When a nucleus
has too many neutrons, a neutron must turn into
a proton. The charge must remain the same so β-
particles are emmitted. If a nucleus is proton heavy
a proton must turn into a neutron. Protons consists
of 2up quarks and one down, they have a charge of
+1. So when this happens, β + ~~decay~~ Electrons are
emmitted from the nucleus to keep the charge the
same.

(Total for Question 5 = 12 marks)

ResultsPlus
Examiner Comments

This response gets 2 marks. The quarks that make up the proton and neutron are correct as is the emission of beta plus and beta minus particles, but as there is no mention of quarks changing from up to down or down to up then this answer is limited to level 1.

ResultsPlus
Examiner Tip

Make sure you read the question carefully and answer what the question asks.

Question 6 (a) (i)

The shape of the path of a changed particle in a cyclotron could be described as spiral or circular.

Question 6 (a) (ii)

Many candidates missed the point of this question and described cyclotrons and how they accelerated particles. However, many candidates were able to gain one mark for realising that particles collide but were very vague about which particles were involved.

Protons were required as the particles which are absorbed by nuclei or stable atoms or elements to produce unstable nuclei.

Absorbed should be used rather than collide with or hit although these were considered acceptable answers.

As 'radioactive isotopes' was given in the stem of the question 'radioactive nuclei' was not accepted as an alternative to 'unstable nuclei' for the last marking point.

(ii) Explain how radioactive isotopes can be produced using cyclotrons.

(3)

A Charged particle is accelerated towards a nucleus at a very high speed. The nucleus then absorbs the charged particle, causing it to become unstable. The new, unstable nucleus then releases ~~radiat~~ radiation, and is a radioactive isotope.

ResultsPlus
Examiner Comments

This response gets three of the four possible marking points and is awarded the full three marks for the question.

ResultsPlus
Examiner Tip

Learn the correct terms, vague answers are rarely awarded marks.

(ii) Explain how radioactive isotopes can be produced using cyclotrons.

(3)

Cyclotrons causes charged particles to move in a spiral path, ~~and~~ due to the magnetic field which produces the centripetal force required. A voltage between the two D-shape magnetic field accelerates the particles. On leaving the magnetic field the charged particles move in a straight line towards a specific target.

ResultsPlus
Examiner Comments

No marks were awarded. The response does not answer the question that was asked.

(ii) Explain how radioactive isotopes can be produced using cyclotrons.

(3)

protons are moved by a centripetal force in a cyclotrons and these fast moving protons are fired towards stable elements. The nuclei of the elements absorb the protons and become an unstable or radioactive iscotope.

ResultsPlus
Examiner Comments

3 marks were awarded for the response. However, this answer includes all four marking points:

1. protons
2. absorbed
3. by nuclei
4. that become unstable.

Question 6 (b) (ii)

Although the equation for momentum is not given on the formula page, this question was not to test recall but to test an understanding of the link between units and equations.

Common errors were taking kilograms to be the unit of weight instead of mass and assigning m/s to speed rather than velocity but yet often stating that momentum was a vector quantity.

(ii) State why momentum has the unit kg.m/s.

(1)

because momentum is caused by the weight on an object as it travels

ResultsPlus

Examiner Comments

No marks were awarded as it does not give the equation for momentum or link the units to their quantities.

ResultsPlus

Examiner Tip

Take note of the units that are ascribed to quantities.

(ii) State why momentum has the unit kg.m/s.

(1)

Because momennum is calcucated as mass multiplied by velocity = kg x m/s = kg.m/s

ResultsPlus

Examiner Comments

This correct answer also shows the link between the units and the equation.

ResultsPlus

Examiner Tip

Use units to see the relationship between quantities in equations.

Question 6 (b) (iii)

Most candidates were able to gain level 1 (2 marks) for this question. This required a correct description of what happened to the kinetic energy or the momentum in one of the collisions.

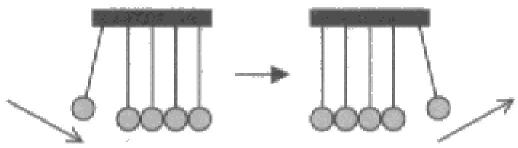
To gain level 2 (4 marks) both collisions needed to be described correctly in terms of kinetic energy and momentum. The level 2 answers generally described the first collision as inelastic with conservation of momentum but not kinetic energy, and the second collision as elastic with conservation of both momentum and kinetic energy. However, the information from the diagrams was not used to explain why this was the case. It also became apparent from some answers that candidates do not always understand the meaning of 'conserved'.

Level 3 (6 marks) required reference to the diagrams to justify conclusions. Therefore collision two could have kinetic energy conserved because the last ball reaches the same height as the first one, or almost conserved as some kinetic energy is converted to sound because you can hear the balls knock together, or not conserved because the balls eventually come to rest after many collisions.

*(iii) Different types of collision are shown in the diagrams.

Analyse both collisions in terms of momentum and kinetic energy.

collision 1



collision 2

(6)

Collision 1 is an inelastic collision, where momentum has been conserved, however kinetic energy has not been conserved. The cars are moving towards each other at opposite directions and assuming they both have equal and opposite momentums, giving a total momentum before the collision of 0, momentum would have been conserved, as as both cars are now stationary so would both have zero momentum. Kinetic energy is not conserved, as before the collision both cars would have had a positive kinetic energy, however a lot of this energy after the crash would have been lost as thermal or sound energy. Collision 2 is an elastic

(Total for Question 6 = 12 marks)

collision. Before the collision the ball would be moving at a certain velocity, and after the collision, the end ball would also be moving with the same velocity as well as both balls having the same mass, so momentum would be conserved. It could be argued that this collision is inelastic however, as some of the kinetic energy is lost during the collision into sound energy, however much more kinetic energy is conserved in collision ~~on~~ two than collision one.

TOTAL FOR PAPER = 60 MARKS

ResultsPlus
Examiner Comments

This answer is given 6 marks.

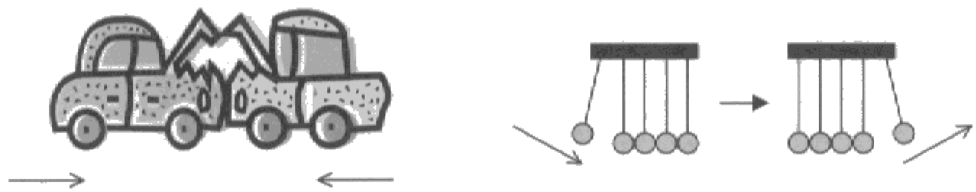
The candidate correctly describes both collisions in terms of kinetic energy and momentum. The answer also explains why momentum is conserved and goes on to consider that the Newton's cradle might not be elastic because some of the kinetic energy could be lost.

ResultsPlus
Examiner Tip

Use the information in the question to explain statements that you make.

*(iii) Different types of collision are shown in the diagrams.

Analyse both collisions in terms of momentum and kinetic energy.



collision 1 collision 2

(6)

Collision 1, the momentum would stay the same ~~after~~ during the crash as momentum always stays the same but the kinetic energy would have ~~on~~ stopped or slowed down making it an inelastic collission. Collission 2 however, the momentum has not changed and niether has the kinetic energy, this means its an elastic collision. Momentum doesn't change in both elastic & inelastic collisions.

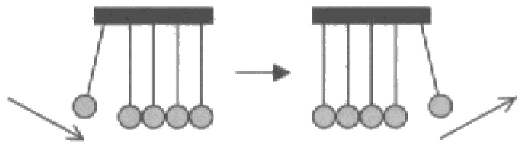
ResultsPlus
Examiner Comments

This was awarded 4 marks (level 2) as it correctly describes kinetic energy and momentum for both collisions but does not use the diagrams to explain this.

*(iii) Different types of collision are shown in the diagrams.

Analyse both collisions in terms of momentum and kinetic energy.

collision 1



collision 2

(6)

Collision 1, is when inelastic collisions take place momentum is not conserved. The two cars are accelerating and they collide but they have different velocities, when they collide, kinetic energy is transferred to the surroundings as heat energy or sound energy, it is wasted. The total kinetic energy after collision is zero as momentum has not been conserved. Collision 2, is where a ball accelerates at a constant velocity and as it hits the next ball, it stops and the second ball starts to move with the same velocity as the previous ball, therefore energy has been conserved, this is an example of elastic collision. Each ball has the same kinetic energy however in collision 1, the cars had different kinetic energy and the energy is converted to waste energy.

(Total for Question 6 = 12 marks)

ResultsPlus
Examiner Comments

This response is level 1 (2 marks). There is a basic error in physics in the first line stating that 'momentum is not conserved' in a collision. The second collision has no mention of momentum. Kinetic energy changes are described correctly in both collisions for level 1 (2 marks) to be awarded.

ResultsPlus
Examiner Tip

Make sure you include all that the question asks for.

Paper Summary

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

- always show transpositions for calculations
- be able to calculate using standard form
- understand when and why units need to be changed or can be left unchanged
- use the information provided by diagrams and images to help answer questions
- learn the meanings of scientific terms such as thermionic emission
- read extended writing questions carefully and complete all parts
- remember questions citing numerical values require quantitative answers
- when questions have four marks make four relevant points.

Grade Boundaries

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

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

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