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Examiners' Report
June 2016

GCSE Physics 5PH3H 01

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Introduction

The Physics component of the Science2011 suite aims to test the contents of the specification, by giving opportunities to all students to show their knowledge and understanding, as well as stretching the most able with more demanding applications of fundamental knowledge. Questions were set to test students' knowledge, application and understanding from the five topics in the specification:

1.Radiation in treatment and medicine

2.X-rays and ECGs

3.Production, uses and risks of ionising radiation from radioactive sources

4.Motion of particles

5.Kinetic theory and gases

Within the question paper, a variety of question types were included, such as objective questions, short answer questions worth one or two marks each and two longer questions worth three marks each. The two six mark questions were used additionally to test students' quality of written communication.

Question 1 (b) (i)

The first question in a paper is designed to be as accessible to all. This part needed the simple recall of momentum = mass x velocity. With mass and speed given and the answer as well in a 'show that' question this was not problemmatic for the vast majority of students.

(i) Show that the momentum of glider M_1 before the collision is about 0.10 kg m/s. **(2)**

momentum = mass x velocity

= 0.21 x 0.47

= 0.0987

= 0.10 (2 s.f.) (1 d.p)

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Examiner Comments

This answer is well communicated by the student, getting the marks for the number substitution and for the evaluation.

ResultsPlus
Examiner Tip

If you explain what you are doing it helps you and the examiner marking your work.

(i) Show that the momentum of glider M_1 before the collision is about 0.10 kg m/s. **(2)**

0.21 x 0.21 = 0.0441

$\frac{0.0441}{0.47}$ = 0.0938

= 0.10 kg m/s

ResultsPlus
Examiner Comments

No marks could be awarded as the candidate has not shown the correct method, despite appearing to have arrived at the "correct" response.

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Examiner Tip

Work from your physics knowledge, always asking yourself 'What is the physics principle here?'

Use the formula sheet as a stimulus, where possible. However there are some simple formulae, like the one needed here, which you should learn.

It's no use just conjuring the numbers in a vain attempt 'to get the right answer'.

Question 1 (b) (ii)

This question developed the ideas in b (i) asking students to apply momentum conservation to the data at hand.

(ii) The total momentum before the collision is equal to the total momentum after the collision.

Calculate the velocity of the two gliders combined after the collision.

(3)

0.0987 ~~÷~~ mv

$\frac{0.0987}{0.42} = 0.235$

velocity after the collision = 0.235 m/s

ResultsPlus
Examiner Comments

This gets full marks. The student has taken his answer from b (i), the initial momentum, and divided it by the total mass of the two stuck-together gliders. This gives a correct answer of 0.235 m/s.

ResultsPlus
Examiner Tip

This was a good answer, however the student's communication would have been aided by a few words explaining what he/she was doing, referring to the idea momentum before = momentum after.

(ii) The total momentum before the collision is equal to the total momentum after the collision.

Calculate the velocity of the two gliders combined after the collision.

(3)

Momentum = 0.10 kgm/s

Mass = 0.21 + 0.21 = 0.42 kg

Velocity = Momentum / Mass

0.10 kgm/s / 0.42 kg = 0.24 m/s

velocity after the collision = 0.24 m/s

ResultsPlus
Examiner Comments

This student's work is very clear and easy to follow. Full marks have been obtained.

ResultsPlus
Examiner Tip

The best practice always involves some explanation of what you are doing, don't just present disordered equations; communicate what you are doing. This clarifies your thinking and gives you the best chance of getting a good outcome.

(ii) The total momentum before the collision is equal to the total momentum after the collision.

Calculate the velocity of the two gliders combined after the collision.

0.47 ÷ 2 = 0.235 m/s

The velocity halves as a result of the mass doubling

0.21 + 0.21 = 0.42kg (3)

Momentum = mass x velocity

0.42 x 0.235 = 0.0987 kg m/s

velocity after the collision = 0.235 m/s

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Examiner Comments

This student shows a comprehensive understanding, realising that if the mass doubles the velovcity must halve to conserve momentum. Such insights are worthy of 'grade A' thinking.

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Examiner Tip

There may be more than one way of looking at the scenario involved, so that a shortcut to the answer may be found for the ablest students.

Question 1 (b) (iii)

Most students knew this was an inelastic collision. In explaining it the word 'kinetic' had to be associated with energy in order to get the second mark.

(iii) The total kinetic energy before collision = 0.023 J.

The total kinetic energy after collision = 0.012 J.

Discuss whether the collision is elastic or inelastic.

(2)

This collision is inelastic, this is because the energy has not been conserved as there is a difference of 0.011 J from before and after the collision. The energy could have been lost as heat.

(Total for Question 1 = 8 marks)

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Examiner Comments

Inelastic is correct. There is no mention of Kinetic or 'KE', so no credit for mark point 2 may be given.

One mark was awarded.

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Examiner Tip

This has to be precise:-

Inelastic collisions are ones where **kinetic** energy is not conserved.

(iii) The total kinetic energy before collision = 0.023 J.

The total kinetic energy after collision = 0.012 J.

Discuss whether the collision is elastic or inelastic.

(2)

The collision is inelastic. This due to the fact that when it collides it doesn't keep the same kinetic energy it loses kenetic energy, 0.011 J worth.

ResultsPlus
Examiner Comments

'Inelastic' is correct and 'kinetic energy has been lost' - awarded 2 marks.

Question 2 (b) (i)

A lot of students did well on this, with most of them focussing on collisions between alpha particles and air molecules.

(b) (i) Explain why alpha (α) particles only travel a few centimetres in air.

(2)

They are weakly penetrating and alpha particles are absorbed by a few cm of air or a thin sheet of paper

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Examiner Comments

This response does not answer the question and so scores 0 marks. Comments on 'penetration' just repeat the stem of the question, not explaining 'why'? Comparisons / ideas about alppha particles not being able to penetratie through paper may be well-remembered but again they don't answer this question.

ResultsPlus
Examiner Tip

The question requires you to think about the processes by which alpha paricles are stopped in air, with key ideas being those of ionization and energy loss.

(b) (i) Explain why alpha (α) particles only travel a few centimetres in air.

(2)

Alpha travels only a few centiometeress in the air because it is very ionising and it ionises the air very quickly and losing all it's energy very quickly.

ResultsPlus
Examiner Comments

There is a reference to losing energy and this is linked to the alpha particle being very ionising - this is worthy of 2 marks. The reference to range is in the stem of the question and so that is ignored.

Question 2 (b) (ii)

This question requires a comparison. Some students lost the mark here by making no comparison.

(ii) State why beta particles can travel further in air than alpha particles.

(1)

This is because it is less ionising but more penetrating so it can only be stopped by materials like lead but not by paper or a few centimetres.

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Examiner Comments

The less ionising comment gets the mark.

(ii) State why beta particles can travel further in air than alpha particles.

(1)

Beta particles are smaller so are less likely to collide with air particles so go further and they are lighter as they only have a mass of 1/2000 while alpha has a mass of 6.

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Examiner Comments

Comparisons are made here and so get the mark. Smaller and lighter. (Either comparison would get the mark.)

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Examiner Tip

It may help to underline parts of the question, for instance, here:-

State why beta particles can travel further than alpha particles.

Question 2 (b) (iii)

Quite a number of students went astray on this question by using $E = mc^2$.

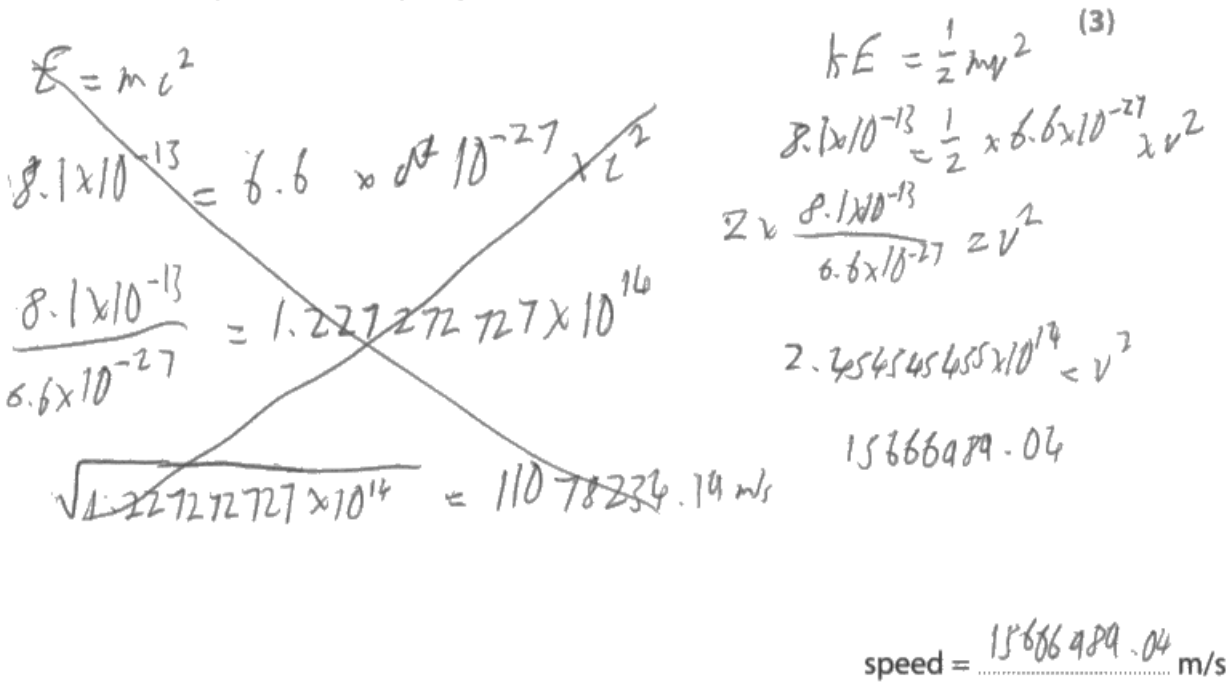
The question needs the 'KE' formula on the formula sheet.

(iii) The kinetic energy of an alpha particle is 8.1×10^{-13} J.

The mass of the alpha particle is 6.6×10^{-27} kg.

Calculate the speed of the alpha particle.

(3)



speed = 15866489.04 m/s

ResultsPlus
Examiner Comments

The student realises he / she has used the wrong formula to begin with and the produces the correct one with accurate substitution and transposition.

ResultsPlus
Examiner Tip

Physics papers do need the application of mathematics and on a few occasions this will include such transposition, including taking a square-root at the end.

(iii) The kinetic energy of an alpha particle is 8.1×10^{-13} J.

The mass of the alpha particle is 6.6×10^{-27} kg.

Calculate the speed of the alpha particle.

(3)

$KE = \frac{1}{2}mv^2$

$\frac{8.1 \times 10^{-13}}{\frac{1}{2} \times 6.6 \times 10^{-27}} = 2.45 \times 10^{14}$

$2KE = mv^2$

$\sqrt{2.45 \times 10^{14}} = 1.56$

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

$\sqrt{2.45 \times 10^{14}} = 1.6 \times 10^7$

speed = 1.6×10^7 m/s

ResultsPlus
Examiner Comments

3 marks awarded for correct application of physics.

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Examiner Tip

Setting out your answer to communicate well can help get intervening marks even if you slip up with the arithmetic.

Question 2 (b) (iv)

This question required the simple recall that gamma waves are electromagnetic ones and so travel at the speed of light (3 x 10^8 m/s).

(iv) State the speed of gamma rays emitted by an unstable nucleus.

(1)

3.0×10^8

ResultsPlus
Examiner Comments

3 x 10^8 is allowed without any units, since this is the commonly remembered number. The lack of units is condoned in this case.

ResultsPlus
Examiner Tip

Don't take it for granted that units are not necessary. They are needed in most physics questions, and should be put.

(iv) State the speed of gamma rays emitted by an unstable nucleus.

(1)

The speed of light - 300,000 km/s

ResultsPlus
Examiner Comments

300,000 km/s is equivalent 3 x 10^8 m/s - so 1 mark is awarded.

ResultsPlus
Examiner Tip

Units matter though as the next example shows.

(iv) State the speed of gamma rays emitted by an unstable nucleus.

(1)

300,000 mph

ResultsPlus
Examiner Comments

If the number supplied is associated with the wrong units like this it scores 0.

Question 3 (a) (iii)

Quite a number of students launched into an answer of 'as the pressure increases so does the volume'. They had failed to read the axes carefully.

(iii) Describe the relationship shown by the graph.

(2)

There is a directly proportional relationship between pressure /kPa and 1/V/1/cm³.

~~directly proportional relationship between~~

ResultsPlus
Examiner Comments

This is a full statement of the relationship, getting two marks.

(Alternatively 'volume is inversely proportional to pressure')

ResultsPlus
Examiner Tip

Study axes labels of graphs very carefully.

(iii) Describe the relationship shown by the graph.

(2)

As the ~~to~~ Pressure decreases, the Volume of air increases in the apparatus. As we can see the lowest pressure has given the highest Volume of air.

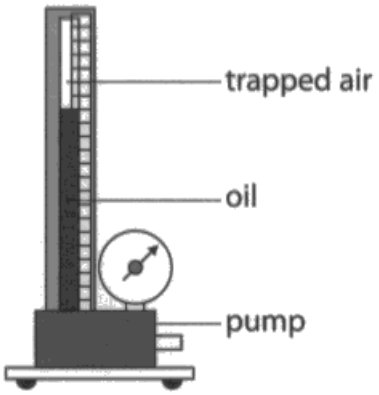
ResultsPlus
Examiner Comments

This is an acceptable alternative way of getting the first mark.

Question 3 (a) (i)–(ii)

This question was quite high-scoring by most students, as long the points were plotted carefully along with a decent line of best fit.

3 A student uses this apparatus to investigate how the volume of air changes with pressure.



He obtains these results and starts to plot a graph.

Pressure / kPa	Volume, V / cm^3	1/ V / 1/ cm^3
190	14.9	0.067
168	16.6	0.060
156	18.1	0.055
139	20.7	0.048
119	23.7	0.042
95	30.1	0.033

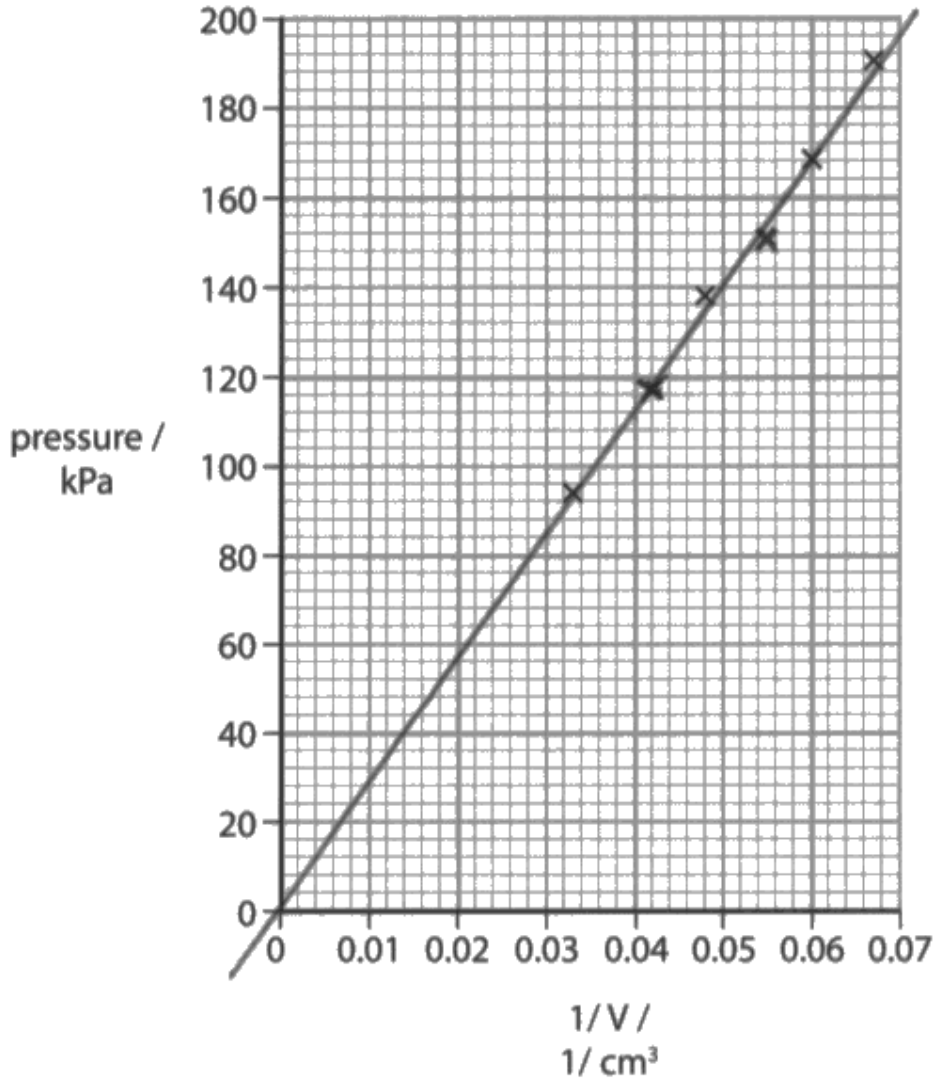
(a) (i) The two sets of results not plotted on the graph are shaded in the table.

Complete the graph by plotting these results.

(2)

(ii) Draw a line of best fit.

(1)



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Examiner Comments

The point at 0.042, 119 is plotted well enough.

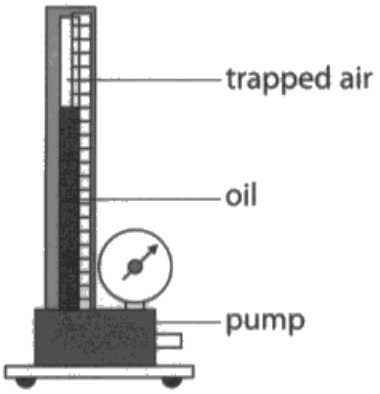
The point at 0.055, 156 is plotted too inaccurately and so the plotting only gets 1/2 marks.

The best fit line is appropriate 1/1 scored for that.

ResultsPlus
Examiner Tip

Be careful in reading off scales. Here each vertical square represents 4 kPa.

3 A student uses this apparatus to investigate how the volume of air changes with pressure.



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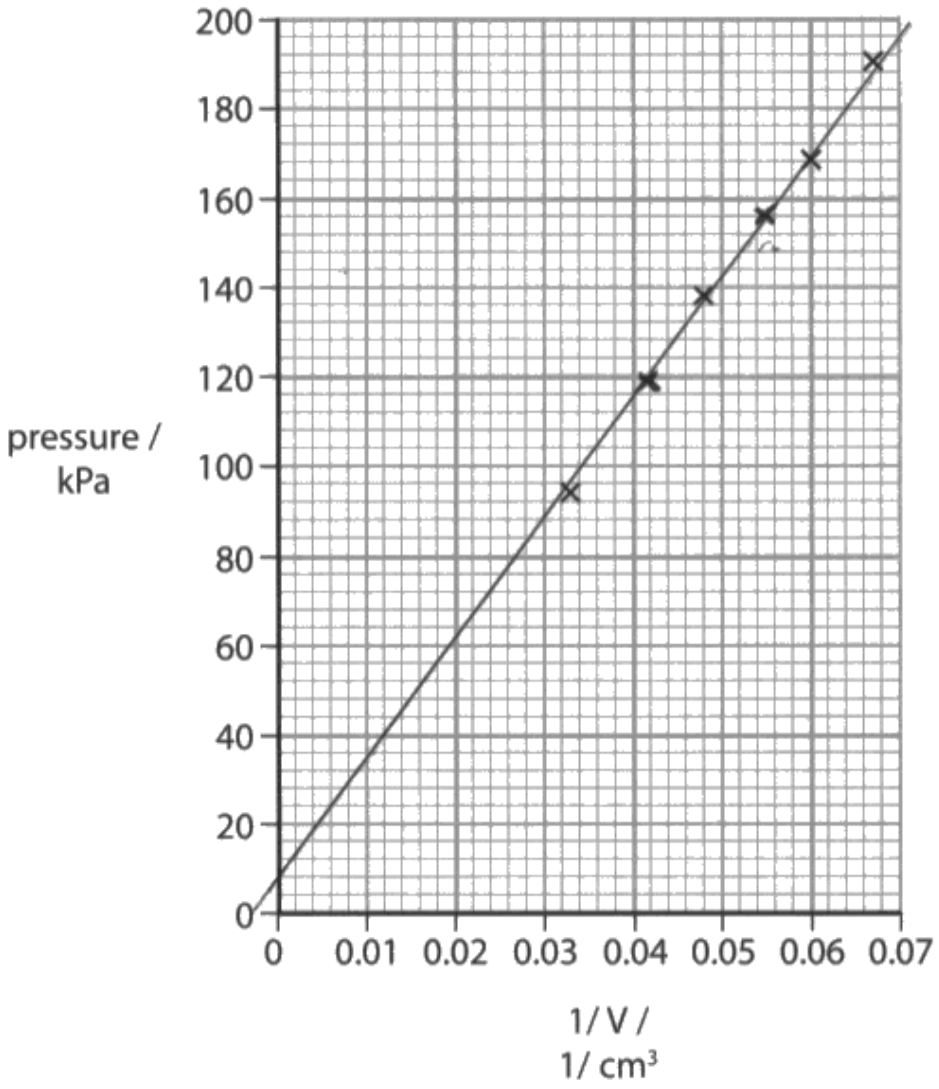

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Examiner Comments

3 (a) (i) - both points are plotted to the required tolerance - 2 marks awarded

3 (a) (ii) a good best fit line has been drawn - 1 mark awarded

Question 3 (b) (i)

Most people got this right by adding 273 to the Celsius temperature arriving at 283 (K).

Question 3 (b) (ii)

A lot of students used Boyle's law here i.e. $p_1V_1 = p_2V_2$. This ignores the temperature change and gets no marks.

The temperatures need to be in kelvin in the gas law equation else a maximum of one mark was given.

(ii) Use the data in the diagram to calculate the volume of the air bubble when its pressure is 78 kPa.

(3)

$V_1 \times P_1 = V_2 \times P_2$

$V_2 = \frac{V_1 \times P_1}{P_2}$

$100 \times 98 = V_1 \times 78$

$V_1 = 125.64$

$\frac{100 \times 98}{78} = V_1$

volume = 125.64 m^3

ResultsPlus
Examiner Comments

This shows the error of not taking into account the temperature change thus getting 0 marks.

(ii) Use the data in the diagram to calculate the volume of the air bubble when its pressure is 78 kPa.

(3)

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

$$\frac{100 \times 98}{10} = \frac{78 \times V_2}{4}$$

$$980 = \frac{78 \times V_2}{4}$$

$(\times 4)$ $\quad 3920 = 78 \times V_2$

$\div 78$ $\quad 50.2 = V_2$

volume = 50 m^3

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Examiner Comments

This is well set out but, unfortunately, the student has not used temperatures in kelvin, which the gas law requires so only one mark is awarded.

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Examiner Tip

If the student had used 283 K and 277 K they would have scored 3/3 with a correct evaluation.

Question 4 (a)

This question concerned 'why light refracts towards the normal' on entering glass / water. If students mentioned a change in speed they got one mark; if they mentioned 'slows down' that gave them two marks. Credit could also be given for correct refractive index or optical density changes. Many students talked simply of 'density change' which of itself did not get a mark. However the same students often accompanied their remarks with 'slowing down' comments and so scored the two marks anyway.

The first clip shown shows a minimalist answer, which, nevertheless, gets full marks.

4 Defects of vision can be corrected by changing the paths of light rays.

(a) Explain why light refracts towards the normal when it passes from air into glass or water.

(2)

because the density of the mediums are different therefore it refracts and slows down

ResultsPlus
Examiner Comments

'Slows down' achieves the first two mark points on the scheme and so gets two marks.

ResultsPlus
Examiner Tip

By not limiting themselves to just 'density change' - which is not enough, the student obtained full marks.

Media with higher densities don't necessarily have higher optical densities / refractive indices. The cause is not simply due to a change in density.

4 Defects of vision can be corrected by changing the paths of light rays.

(a) Explain why light refracts towards the normal when it passes from air into glass or water.

(2)

This is because it travels from an optically rarer medium to an optically denser medium resulting in it slowing down, causing it to ~~to~~ refract towards the normal.

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Examiner Comments

This student is correct in talking about **optical** density and they mention slows down as well. 2 marks.

ResultsPlus
Examiner Tip

The precise and correct terminology, in physics, does matter.

'Density' and 'optical density' are not the same thing.

4 Defects of vision can be corrected by changing the paths of light rays.

(a) Explain why light refracts towards the normal when it passes from air into glass or water.

(2)

The speed of the light changes as water or glass is more denser. This means that the direction also changes so the light bends towards the normal.

ResultsPlus
Examiner Comments

Zero marks because the student has not qualified 'density' with the word optical, nor have they mentioned a change in speed.

Question 4 (c) (iii)

The key is that it's the **cornea** that needs adapting. Any mention of lens or other part of the eye would negate the marks.

(iii) Describe how this defect of vision can be corrected using laser surgery.

(2)

Laser surgery will change the shape of the cornea as the cornea of short sighted people is curved to sharply leading to the rays ~~meeting~~ focusing in front of the retina as the rays converge more due to the sharpness of the cornea.

ResultsPlus
Examiner Comments

'Change the shape of the cornea' gets both marks.

ResultsPlus
Examiner Tip

This student clearly understands the physics involved; their additional correct comment confirms this.

(iii) Describe how this defect of vision can be corrected using laser surgery.

(2)

Laser surgery can be used to change the shape of the lens and cornea so that they focus the light onto the retina.

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Examiner Comments

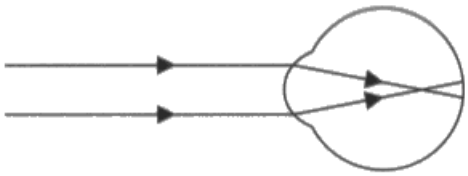
Giving an additional answer with cornea denies mark point 1 on the mark scheme, which says 'reject other parts of the eye e.g. lens'. Mark point 2 is dependent on the first marking point so no marks here either.

Hence 0 marks awarded

Question 4 (c) (i)–(ii)

This question was well answered by many students.

(c) This diagram shows light from a distant object being brought to a focus in front of the retina of an eye with a defect of vision.



(i) State the name of this defect of vision.

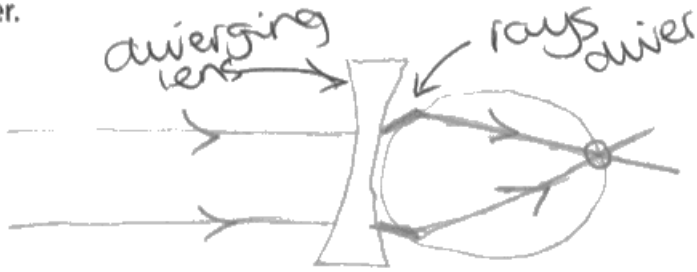
(1)

Short sighted

(ii) Explain how this defect of vision can be corrected with a lens.

You may add to the diagram above or draw another diagram to help with your answer.

(2)

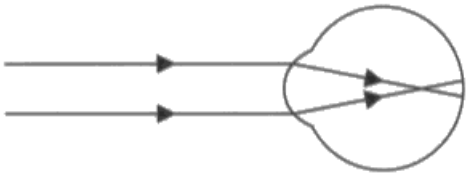


by adding a diverging lense it will spread the rays out so when it hits the cornea it will still be converged at the same power but it'll be at the back of the rehina.

ResultsPlus
Examiner Comments

This is a well composed answer with a helpful diagram as well. Full marks are awarded.

(c) This diagram shows light from a distant object being brought to a focus in front of the retina of an eye with a defect of vision.



(i) State the name of this defect of vision.

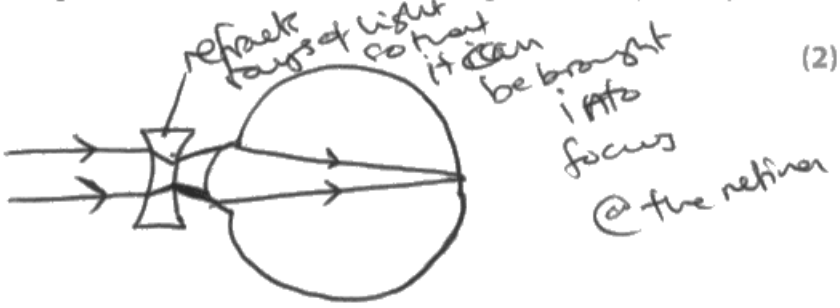
(1)

Short sighted

(ii) Explain how this defect of vision can be corrected with a lens.

You may add to the diagram above or draw another diagram to help with your answer.

(2)



The use of a ~~diverging~~ diverging lens allows the ~~rays~~ light to be into focus at the retina, and increase the focal length. It changes the path of the rays so it can be brought into focus at the retina

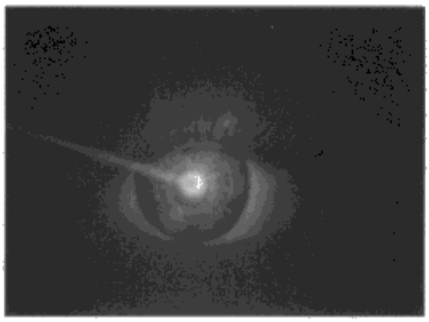
ResultsPlus
Examiner Comments

Full marks again for a well composed answer.

Question 4 (c) (iv)

Nearly all students used the correct formula, dividing power by area. Unfortunately then most didn't convert the milliwatts into watts to obtain a correct evaluation.

iv) The image shows a laser beam incident on an eye.



The power of the laser is 40 mW.

The beam covers an area of $1.8 \times 10^{-6}\ m^2$.

Calculate the intensity of the laser beam.

(2)

intensity = power / area

= ~~8 x 10~~

$= \frac{40\ mW}{1.8 \times 10^{-6}\ m^2}$

22222222.22

intensity of laser beam = ... W/m^2

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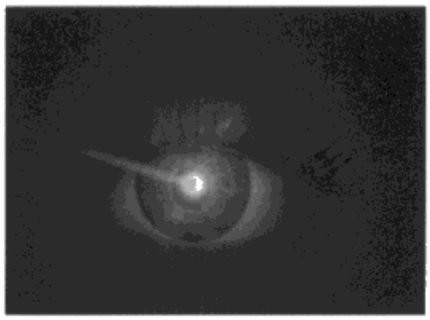
Examiner Comments

There is a resultant power of ten error here and so only one mark is achieved.

This was a common mistake.

(iv) The image shows a laser beam incident on an eye.



The power of the laser is 40 mW.

The beam covers an area of 1.8×10^{-6} m^2.

Calculate the intensity of the laser beam.

(2)

Intensity = power (W) / area. (m^2)

40mW = 40 × 1/1000 × 40 = 0.04

W/m^2 = 0.04 / 1.8×10^{-6} = 22222.

intensity of laser beam = 22222 W/m^2

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Examiner Comments

A correct substitution and evaluation earns 2 marks.

Question 5 (b) (i)

Less than half of the students got this correct.

The idea of mass-energy equivalence is still not well understood by many students.

This seems to be a recurrent problem for students, having occurred in previous years.

(b) (i) Both the positron and electron have mass.

The gamma rays do not have any mass.

State what happens to the mass in a positron-electron interaction.

(1)

They annihilate each other so the mass is converted into energy.

ResultsPlus
Examiner Comments

A simple but corect response earns the mark.

(b) (i) Both the positron and electron have mass.

The gamma rays do not have any mass.

State what happens to the mass in a positron-electron interaction.

(1)

It is cancelled out, or destroyed

ResultsPlus
Examiner Comments

Quite a number of inappropriate statements like this were seen.

ResultsPlus
Examiner Tip

$E = mc^2$ is to do with energy being able to be converted into mass and vice versa.

Question 5 (b) (ii)

The vast majority of students got this correct. There is no power of ten trap - both values given with no adjustment of power of ten needed.

(ii) Calculate the energy of an electron of mass 9.1×10^{-31} kg.

The speed of light, $c = 3.0 \times 10^{8}$ m/s.

(2)

$E = MC^2$

$= (9.1 \times 10^{-31}) \times (3.0 \times 10^{8})^2 = 8.19 \times 10^{-14}$

energy = 8.19×10^{-14} J

ResultsPlus
Examiner Comments

This answer is totally correct in substituting and evaluating - two marks.

ResultsPlus
Examiner Tip

Just be careful about applying the square on your calculator.

Question 5 (b) (iii)

The idea that the isotopes have a short half life is wanted here. The time aspect must come into it.

(iii) Suggest a reason why PET scanners need to be located near a cyclotron.

(1)

So the isotopes / radioactive material used doesn't decay before being used

ResultsPlus
Examiner Comments

The time aspect was made clear here. One mark awarded.

(iii) Suggest a reason why PET scanners need to be located near a cyclotron.

(1)

The isotopes have a short half life so would be useless if kept too far away, as they would've decayed by the time of use.

ResultsPlus
Examiner Comments

Well written answer with a half-life reference.

Question 5 (c)

High achieving students showed a comprehensive understanding of the processes involved in PET scans as they linked the three stages required in a complete answer, these being 1) the use of a beta-plus producing isotope labelled pharmaceutically 2) the annihilations producing pairs of gamma rays at the sites of accumulation and 3) the detection of the gammas via triangulation, assisted by computer reconstructions.

This answer shows the comprehensive understanding of the processes involved in PET scans as linking the three stages required with great proficiency.

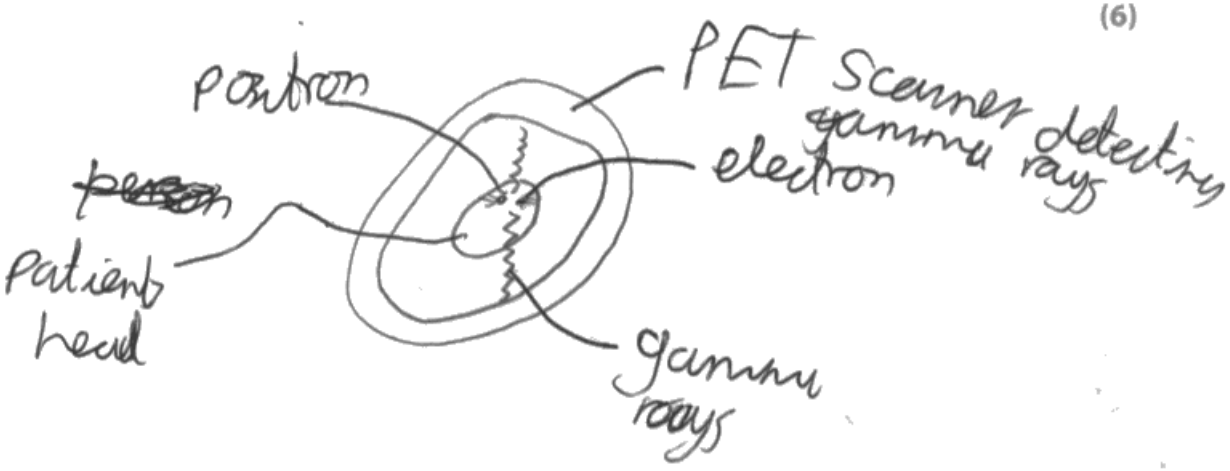
*(c) A patient with a brain tumour is given a fluorine-18 injection.

The patient is then given a PET scan.

Explain the steps in the PET scan process used to locate the brain tumour.

You may draw a diagram if it helps your answer.

(6)



The tracer is injected into the patient with glucose and the radioactive isotope. The glucose travels to the tumour as tumour need a lot of energy, which takes the isotope there. Flourine-18 has a short half life so one inside the body, will release a positron. This positron will hit an electron inside the body and annihilate, causing two gamma rays to be released in opposite directions. The PET scanner will detect these gamma rays, so will pinpoint the tumour

ResultsPlus
Examiner Comments

Three steps are required in a good quality answer. They are all there; the last one is less detailed but it still suffices for 6 marks.

ResultsPlus
Examiner Tip

Diagrams help. This diagram, produced by the student, has enabled them to focus on the important points of the process.

*(c) A patient with a brain tumour is given a fluorine-18 injection.

The patient is then given a PET scan.

Explain the steps in the PET scan process used to locate the brain tumour.

You may draw a diagram if it helps your answer.

(6)

The fluorine-18 isotope is in a form with glucose which is carried by the bloodstream. Glucose is taken to cells needing to respire and as tumors rapidly grow, glucose is taken to cancer cells. Beta$^+$ decay occurs and a positron is emitted from the isotope. Electrons are emitted into the body and the positron and electron annihilate. Two gamma rays are released from the annihilation at 180° from each other and these are detected. This allows for the location of the tumour.

ResultsPlus
Examiner Comments

This response has good content regarding steps 1 and 2 of the process but, unfortunately, has an insufficient description of the detection stage. Hence they score 4 marks.

ResultsPlus
Examiner Tip

It may seem as if they've gone some way regarding detection but remember a 'locating the tumour' by iteslf only repeats the stem of the question. Beware of thinking you've done the job just by repeating what the question says.

*(c) A patient with a brain tumour is given a fluorine-18 injection.

The patient is then given a PET scan.

Explain the steps in the PET scan process used to locate the brain tumour.

You may draw a diagram if it helps your answer.

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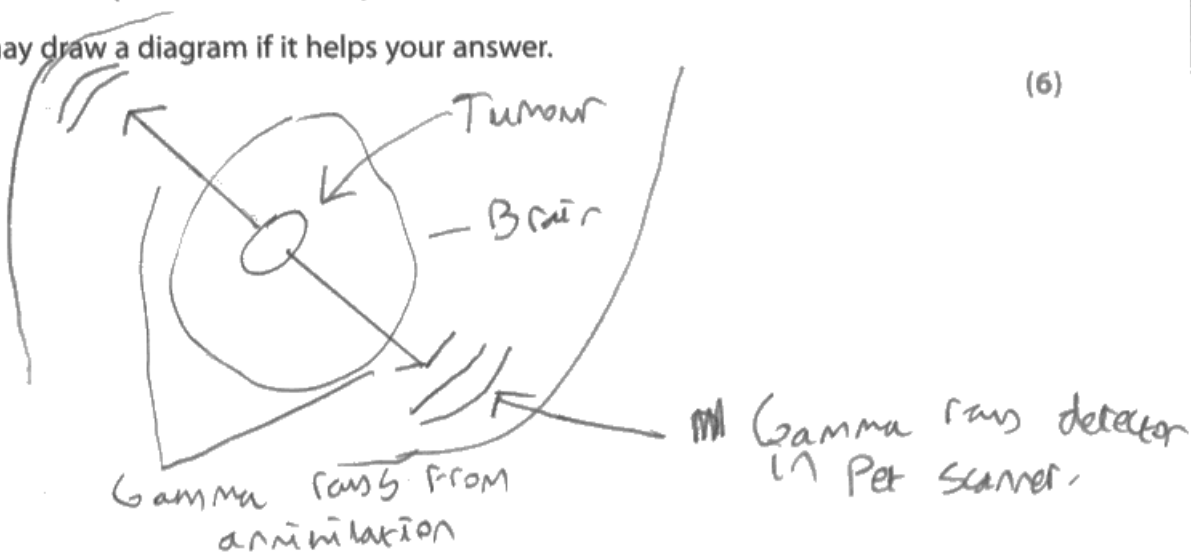

PET

In a ~~Pet~~ Scan a positron emmiting radioisotope such as flourine-18 is inoected into the patient combined with glucose molecules. The radioisotope will then collect in large quantities at the tumour due to the fact that tumours ~~grow~~ grow, and thus respire (using glucose) very quickly. The radioisotope then releases Positron radiation, which has a charge of +/-. The opposing charges of an electron in the body and a positron will result in a collision between them. This will result in annihilation occuring with all the ~~of~~ mass of the electron and positron being converted into 2 gamma rays moving in opposite directions. Detectors in the Pet scanner will then find the source of the gamma rays; annihilation in the tumour and display it on the screen. If 3 gamma ray pairs are detected the tumour can be located via triangulation

ResultsPlus
Examiner Comments

A very full answer is seen here, displaying detailed knowledge of all three steps of the process. 6 marks

ResultsPlus
Examiner Tip

The detail shown is impressive e.g. concerning the triangulation comment at the end. Thorough learning, combined with effective revision, always pays off. Here is the evidence of that.

Question 6 (a) (i)

The majority of students knew that 'thermionic emission' takes place at the cathode of the X-ray tube.

Non-serious spelling errors were condoned.

Question 6 (a) (ii)

Students needed to link electrons with collisions with air particles for 1 mark. Mentioning them losing energy typically got the second mark.

(ii) Explain why there must be a vacuum inside the X-ray tube.

(2)

if there was air inside the X ray tube then the electrons in the beam would collide with air particles and lose energy. If there is a vacuum then there is no air particles in the tube so ten energy is lost from collision.

ResultsPlus
Examiner Comments

The 'otherwise' argument of then they (the electrons, specified) would collide with air particles (1 mark) is combined with the consequence of losing energy (1 mark).

ResultsPlus
Examiner Tip

The student even goes on to explain what if there was a vacuum. . .

This is a well-expressed answer deserving the full two marks.

(ii) Explain why there must be a vacuum inside the X-ray tube.

(2)

To avoid the electrons losing energy from colliding with air particles before reaching the anode.

ResultsPlus
Examiner Comments

Mentions electrons losing energy (1 mark on mark scheme) from colliding with air particles (1 mark on mark scheme) and 'reaching anode' argument would also be creditable.

ResultsPlus
Examiner Tip

This is a direct concise answer.

Question 6 (a) (iii)

This was very high-scoring, with the powers of 10 given all that was required was multiplying the two quantities together.

(iii) 3.0×10^{17} electrons reach the target every second.

The charge on an electron is 1.6×10^{-19}C.

Calculate the current in the circuit.

(2)

Current = number of particles per second × charge on each particle

$0.048 = 3.0 \times 10^{17} \times 1.6 \times 10^{-19}$

current = 0.048 A

ResultsPlus
Examiner Comments

Perfect answer for two marks.

ResultsPlus
Examiner Tip

It always helps to follow the pattern

1) write down the equation in words or symbols
2) transpose items if needed
3) substitute values
4) evaluate

Question 6 (b)

In Question 6 (b) most high achieving students demonstrated a facility with the relationship between physics and society as they considered the benefits and risks associated with the use of CAT scanners and fluoroscopes. Quite a number of superb answers were seen showing such understanding and application. In doing so students demonstrated a comprehensive understanding of the differences between those two types of imaging used in practice. Unfortunately quite a number of students showed confusion between the different types of diagnostic procedure. Fluoroscopes were often confused with endoscopes for example.

*(b) CAT scanners and fluoroscopes both use X-rays.

CAT scanners and fluoroscopes can be used by doctors to investigate medical conditions.

Discuss when it is more appropriate to use CAT scanners and when it is more appropriate to use fluoroscopes to investigate medical conditions.

(6)

~~Fluoroscopes are used to deet detect where there is a low iron level in the blood. or~~

CAT scans are appropriate to use when a medical problem is needed to be detected. In order for a CAT Scan to be carried out a tracer solution has to be injected into the patient. This tracer solution would collect where there are abnormal activities happening. This would show up as a really brightly coloured spot, which is seen on a special camera. Where there is a ~~bright~~ brightly coloured spot, there is high levels of radioactivity. This helps us to locate problems in the body. CAT scans are appropriate when the exact and precise locations are need to be seen in order to treat the disease. Fluoroscopes use x-rays to detect problems. It helps to see where there is a low oxygen level in blood. Fluoroscopes determine how much heamoglobin is in red blood cells. ~~and~~

ResultsPlus
Examiner Comments

The candidate is describing elements of PET scanning. Fluoroscopes do not measure oxygen levels.No creditable points.

ResultsPlus
Examiner Tip

It is important to learn the different types of scan / diagnostic procedures. Making summary notes of these e.g. as flash cards, may help.

blood clots

*(b) CAT scanners and fluoroscopes both use X-rays.

CAT scanners and fluoroscopes can be used by doctors to investigate medical conditions.

Discuss when it is more appropriate to use CAT scanners and when it is more appropriate to use fluoroscopes to investigate medical conditions.

(6)

CAT scanners produce 2D slices of a particular part of the body which can then be put together to create 3D images of the body. They are created by x-rays surrounding a tube, with the x-rays being absorbed in areas which are more dense (eg. tumours). This allows ~~these~~ tumours to be detected, especially in the brain, as each cross section can be examined to find the site of the tumour. However, as this only produces an image, it is not the most accurate way of detecting tumours and can result in a high dosage of radioactivity. Fluoroscopes are used for detecting blood clots of gastronomical issue ~~in~~ in the digestive system. The x-rays are converted into ~~light~~ beams when shot at a fluorescent sheet, which then travel into the body, again being absorbed into organs with a higher density. The ~~the~~ intensity of the beams can be adjusted by the distance the x-ray machine is from fluoresent screen and from the patient. This limits the amount of radiation absorbed, reducing the health risks such as mutation of DNA ~~to~~ resulting in an increased risk of developing cancers

ResultsPlus
Examiner Comments

The student shows a detailed knowledge of CAT scans and fluoroscopes and discusses them relevantly in answer to the question. Clear 6 marks.

ResultsPlus
Examiner Tip

Often students' knowledge was found to be detailed and accurate regarding CAT scanning, but less so concerning fluoroscopes. The remedy to this is paying close attention to all the content of the specification.

*(b) CAT scanners and fluoroscopes both use X-rays.

CAT scanners and fluoroscopes can be used by doctors to investigate medical conditions.

Discuss when it is more appropriate to use CAT scanners and when it is more appropriate to use fluoroscopes to investigate medical conditions.

(6)

Computerised Axial Tomographys (CAT) are used to produce 2-D slices of the body. These slices can then be stacked in order on top of each other to produce a three dimensional image. CAT scanners use high intensity X-rays to take 'pictures' of inside the body. They are useful for discovering bleeds in the brain and so it is most appropriate to use them when someone has had a stroke or a fall to discover if they have had a bleed. CAT scans are also good to find underlying problems when doctors do not know the cause of the illness. The scan produces high quality pictures due to the high X-ray intensity. Flouroscopes also use X-rays. They take a two dimensional moving image of inside a patient by placing them between an X-ray source and a flourescent screen. The X-rays pass through soft tissue but are absorbed by dense structures like bones. They then are absorbed by the flourescent screen which then flouresces light which is brighter depending on the amount of X-rays absorbed. As it produces moving images that are in real time it can be used to diagnose problems in the gastrointestinal tract and also see the way certain muscle structures are working and whether there are problems. Flourescopes are often used for specific things whereas CAT scanners can do full body scans. Flourescopes are normally used when you know where the problem is and because it is moving it can show the speed at which the problem is deteriorating.

(Total for Question 6 = 12 marks)

ResultsPlus
Examiner Comments

This shows well applied detailed knowledge and understanding. The discussion is first-rate.

ResultsPlus
Examiner Tip

Clearly this student has learnt the ideas involved in these two techniques in a thorough and extremely competent manner. If you take the opportunity via your lessons, outside reading and research, such knowledge and understanding can be yours too.

Paper Summary

Students coped well with the majority of questions. For the first of the two longer questions many were able to describe the main three steps (stages) in producing a PET scan. Most students performed very well on this, although some didn't get as many marks as they could have through missing out one or two of the stages involved. Answers to this question, and to 6 (b), about the use of CAT scanners and fluoroscopes, discriminated well between students, with some showing good knowledge and understanding whilst others less so. In the latter long question a number went off track in describing other treatments / imaging techniques e.g. involving fibre-optics.

Successful candidates were:

- well-acquainted with the content of the specification
- skilled in graphical work
- 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 knowledge
- misinterpreted graphical forms
- 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 provides exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification is from responses which highlight particular successes and misconceptions, with the aim of aiding future teaching of these topics.

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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