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Examiners' Report
June 2015

GCSE Physics 5PH3F 01

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Introduction

The questions in this unit were set to test candidates' knowledge, application and understanding from the five topics in the specification.

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. Within the question paper, a variety of question types were included, such as objective questions, 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 candidates' quality of written communication.

Candidates coped well with the majority of questions. For the first of the two longer questions many were able to describe refraction leading to total internal reflection, as the angle of incidence increased. Answers to this question, and to question 6d, about the uses of radioactive materials in medicine, discriminated well between candidates, with some showing good knowledge and understanding whilst others less so. In question 6d quite a number went off track in describing other treatments / imaging techniques involving X-rays and ultrasound.

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.

Question 1 (a) (i)

This was deliberately aimed as a very accessible opening question, with the vast majority of candidates able to identify the three basic atomic constituents.

Question 1 (a) (ii)

Not so many candidates were secure in their knowledge of nucleon number but still a majority succeeded in this, the most commonly stated wrong answers being 6 and 18.

Question 1 (c)

Whilst most got the two responses correct a significant number of candidates misidentified the negatively charged particle.

(c) Choose words from the box to complete the following sentences.

Words may be used once, more than once or not at all.

alpha	beta	gamma	positron

The radiation that is a wave is gamma **(1)**

The particle that is negatively charged is ~~beta~~ positron **(1)**

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Examiner Comments

There were not many incorrect responses to this question; this was the most common.

ResultsPlus
Examiner Tip

Think clearly and carefully. Positrons are the antiparticles of electrons; so if electrons are negatively charged, positrons must be positively charged.

Question 2 (a) (i)

This question was very well done and, as with question 1 a (i) was another good facilitator for helping candidates feel comfortable with this exam, helping them to feel positive about their achievement, with other more demanding questions to follow. The expectation was that the two answers would be 'solid' and 'liquid'; the candidates did not disappoint in this.

Question 2 (b) (i)

This discriminated well, with some candidates getting 1 mark by talking of the movement of molecules and just under a half getting both marks by clearly linking their explanation to collisions with the wall of the container.

(i) Explain how particles of oxygen gas exert a pressure on the inside of the cylinder.

(2)

Particles oxygen exert pressure by the particles move around hitting into the sides of the cylinder leading to extra pressure.

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Examiner Comments

This fulfils the two marking points well, with particles moving (1) and hitting the sides of the container (2).

ResultsPlus
Examiner Tip

Think firstly of 'what are the physics ideas involved here?'.

Then exam technique here needs you to think of two good points.

Question 2 (b) (ii)

As with previous years a good number showed competence with substituting correct numbers, leading to a correct answer. There are still some, however, who take V_2 (the volume after release) as involving a squared number.

(ii) This cylinder can release 340 litres of oxygen at a pressure of 101 000 Pa.

The inside volume of the cylinder is 2.5 litres.

Use the equation

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

to calculate the pressure of the oxygen in the cylinder before the gas is released.

(3)

$P_1 = 101000$
$P_2 =$
$V_1 = 340$
$V_2 = 2.5$

$$P_2 = \frac{101000 \times 340}{2.5} = \frac{34340000}{2.5} = 13736000$$

pressure of oxygen = 13736000

ResultsPlus
Examiner Comments

This candidate has laid out the calculation in a clearly communicated manner, worthy of all three marks. This enables intermediate marks to be easily given in the case of any miscalculation.

ResultsPlus
Examiner Tip

All exams are tests of communication. Make sure you set out your working clearly to get as many marks as possible.

Question 3 (a) (i)

This was generally well answered with the most successful candidates referring to airport security. A significant number were awarded one mark for 'seeing broken bones'.

X-rays

3 (a) A CAT scanner uses X-rays.

It is used in hospitals to 'see' inside the body.

(i) Describe **one** other use of X-rays.

(2)

X-ray are also used to form a picture of a bone in the body. Becouse they are a form of ionising radiation they are also used to treat cancer in the body.

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Examiner Comments

The first sentence would have only scored one mark, but this candidate went on to describe another use (1) with further detail (1).

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Examiner Tip

Mostly it doesn't hurt to try and put down further detail / put things from a different perspective.

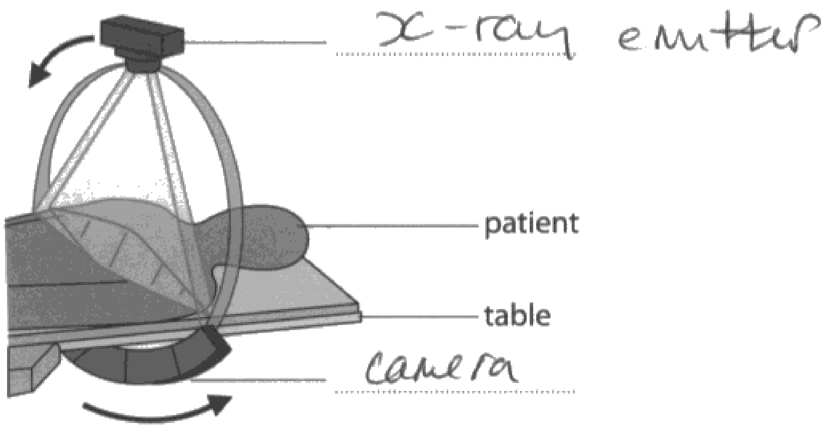
Question 3 (a) (ii)

This question was not well answered. Most candidates did not seem to be aware of the correct vocabulary to describe the equipment – 'emitter' without X-Ray was a common answer for the upper label, which quite a number of candidates seemed to think was firing electrons. There were a high number of blank responses with this question part.

(ii) The diagram shows a CAT scanner in use.

Label the two parts of the scanner.

(2)



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Examiner Comments

This candidate gets the mark for the top label, remembering that 'emitter' by itself would not be enough (emitter of what?).

The second mark was also awarded, where we are looking for anything equating to 'detector' of the X-rays.

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Examiner Tip

Diagrams are important in physics. They should be learnt in context; many candidates confuse different diagrams, mixing them up in their minds.

Question 3 (b)

'Thermionic emission' was awarded two marks, getting succinctly to the heart of the question. Other candidates went into other aspects of the process, including the cathode / anode purpose and earned the marks. However most candidates produced off-beam arguments involving a variety of causes including magnetism and cyclotron-related issues. They were clearly not familiar with the X-ray tube and its' workings.

(b) A beam of electrons is needed to produce X-rays.

Explain how this beam of electrons is produced.

(2)

A cathode which is a filament is heated and this allows electrons to 'boil off' these electrons then ~~are~~ ~~given~~ go towards the anode where they hit metal and their kinetic energy is converted into X-rays. This is done in a vacuum so the electrons don't collide with air and alter their path or lose energy.

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Examiner Comments

Here is an example of a well-reasoned answer with lots of ideas in it, gaining full marks.

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Examiner Tip

It is important to communicate your answer well in exams. This is a good example of that; clear and easy to read. The candidate added 'filament' after, but in a neat way that was easy to follow. Avoid multiple crossings out; legibility also counts. If it can't be read it can't be credited.

Question 3 (c) (ii)

Most candidates achieved the first marking point and could describe the relationship between variables. A few then used data from the graph and gained marking point 2. Very few achieved the third marking point.

Describe the relationship shown on the graph using data from the graph.

(3)

the more Material that is used The less radiation is getting through also every twomm the amoult of radiation ~~go~~getting through is halfed

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Examiner Comments

This candidate starts by noting the general relationship between radiation getting through and thickness of material. Most candidates did this and got one mark. However this candidate goes on to involve the halving idea; this was very infrequently observed. This candidate saw that every 2mm extra thickness resulted in a halving of the radiation getting through. 3 marks.

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Examiner Tip

Always look at the number of marks available in a question. Think that a simple statement will get one mark, but a bit more thinking and application will be needed to get other marks. Describe changes in the gradient (slope) of a graph where you can and if you can see this halving idea you will have succeeded in demonstrating a key scientific skill of being able to identify a pattern in data including perceptive detail.

Question 4 (a) (ii)

A small minority of candidates were aware that there was an accelerating (alternating) voltage that acted on the charged particles (between the 'Dees'). Most candidates wrongly attributed magnetic forces as the causation.

Question 4 (a) (iii)

This question part was more successful than the previous question part, with about a quarter of candidates including a collision in the process. Half of those then went on to explain that the collision was with a target atom (of a stable isotope), producing the unstable product. Where candidates only achieved one mark it was largely due to them thinking it was a Large Hadron Collider type event that occurred, with similar particles colliding with each other being involved.

(iii) Describe how scientists use the charged particles from a cyclotron to produce radioactive isotopes.

(2)

They fire a charged particle at a stable nucleus and it makes it unstable and then its ~~proton~~ proton number changes and it gives off radiation

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Examiner Comments

This shows a good example of a clear answer addressing both the marking points well and succinctly.

ResultsPlus
Examiner Tip

The content should be covered in your revision. Be careful not to just remember one type of collision e.g. what you heard about with the Large Hadron Collider. The specific one needed here doesn't collide identical / similar particles (in order to produce the radioactive isotope).

Question 4 (b) (ii)

Only a quarter of candidates found this question to be amenable to them. Most candidates, on the other hand, gave vague responses about 'charge being used up' or incorrect references to protons and neutrons. The most common points made, achieving marks, were for talking about the charge of the electron and the positron. The central idea of 'conservation' seems not to be well understood.

(ii) Explain how charge is conserved when an electron annihilates a positron.

(3)

Because the electron is negitively ~~cor~~ charged and a positron is ~~negitively~~ positively charged the charges cancel out and neutralise each other.

ResultsPlus

Examiner Comments

This answer is a model of clarity addressing the three marking points extremely well.

ResultsPlus

Examiner Tip

Notice that a single crossing out like this does not cause a problem at all. What does cause problems is not thinking clearly before putting pen to paper and then crossing out lots of what you'd written.

Question 4 (b) (iii)

This was very low-scoring with most candidates repeating the stem of the question in some way or another, without being specific about what had the mass or the energy. Specification statement 4.15 states 'Apply the idea of conservation of mass energy for positron electron annihilation a in a qualitative way'. Most candidates did not appear to be familiar with this. Some effort is now made, via four answers given, to show, how understanding may be developed in this area, avoiding misconceptions where possible.

(iii) Explain how mass and energy are conserved when an electron annihilates a positron.

(2)

mass and energy are conserved as some energy is conserved as momentum and some is lost in the form of heat. The mass is ~~st~~ conserved as the electrons attract other electro replacing ones they lost.

(Total for Question 4 = 10 marks)

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Examiner Comments

This first example shows some mixed up thinking. It appears that half-remembered and half-understood ideas about momentum and energy lost as heat are included in an attempt to gain a mark or two. The idea of 'conservation' was also not understood by many, as in this case. 0 marks.

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Examiner Tip

Answering physics questions always needs you to think 'What idea from physics do I need to use here'? In this case it is Einstein's idea in his famous equation $E = m c^2$. Now physics does need deep thinking, as you know. $E = m c^2$ is all about 'changes in energy' and 'changes in mass'. It is a big concept to think that you can collide a proton with a proton and get two protons out again plus a whole load of other particles (as in the Large Hadron Collider). Where did those extra particles come from? From the 'energy going in'!

Where did the mass of the electron and positron go to? To the energy of the two gamma rays.

(iii) Explain how mass and energy are conserved when an electron annihilates a positron.

(2)

The mass of the positron and electron (being the same) is emitted by the gamma ray / or the gamma ray carries the same mass of 1/2000 + 1/2000). Along with the mass the charge of -1 and +1 is converted to energy of the gamma ray.

(Total for Question 4 = 10 marks)

ResultsPlus
Examiner Comments

This candidate is getting near the mark now. There is recognition of the electron and positron as having mass each and, at the end, the energy of the gamma ray is mentioned. Notice we are not looking for perfect answers. There are some wrong ideas here, but they have included the main scoring points, credited with positive marking involved. Full two marks given.

ResultsPlus
Examiner Tip

Underlining key words in the question may again help here. Think, and talk about, what has **mass** and then what has **energy**. If you can get your head round Einstein's big idea that would be rewarding too.

(iii) Explain how mass and energy are conserved when an electron annihilates a positron.

(2)

Mass is conserved during momentum and emits gamma rays which go in the opposite direction but as momentum is conserved the force of gamma rays ~~...~~ are equal [E = mc²]

ResultsPlus

Examiner Comments

This is a muddled response, with the candidate conflating several ideas. Nevertheless they get a mark for the $E = m c^2$ reference, credited in the mark scheme.

(iii) Explain how mass and energy are conserved when an electron annihilates a positron.

(2)

Mass and energy are the same as the mass of the two particles (9.11x10^-31) is converted to energy via E=mc².

ResultsPlus

Examiner Comments

Here is a good answer where the mark scheme points are met and the candidate shows good (not perfect) understanding of some aspects of what $E = m c^2$ is all about.

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Examiner Tip

Try to express your answer as simply as possible.

Question 5 (b)

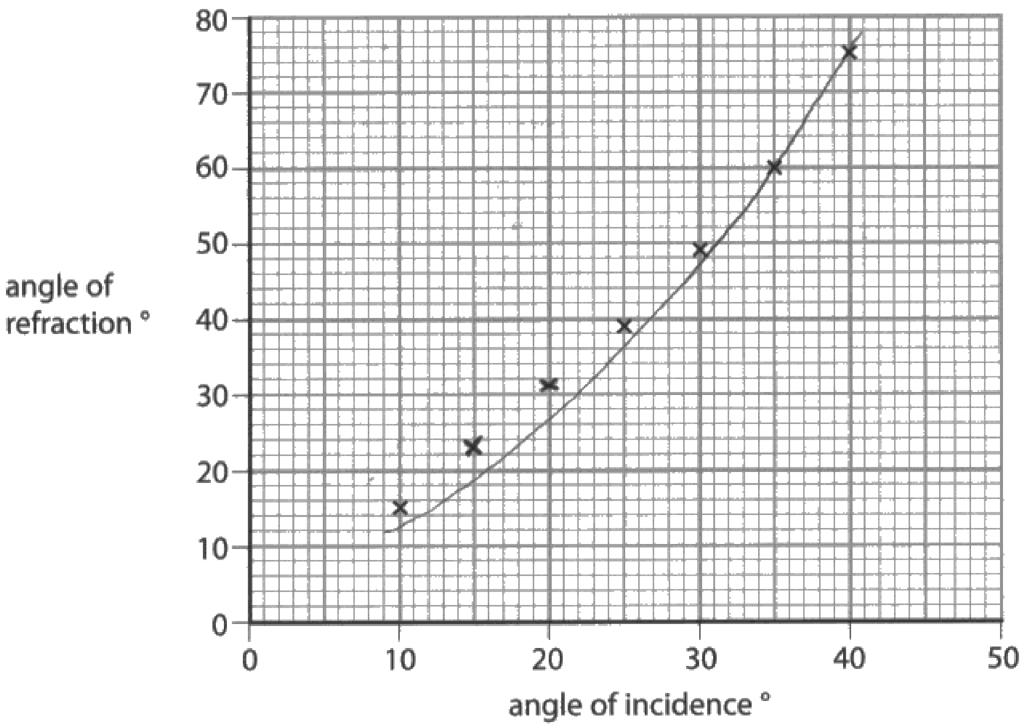
Many candidates made headway with this, with half of all candidates scoring both marks. Two marks were given for simple refraction towards the normal on entering the glass block. One mark often resulted through candidates showing refraction away from the normal upon entering the block. A number had undeviated rays just carrying on regardless, whilst others had erroneous reflections off the normal line.

Question 5 (c) (i)

Candidates are generally adept at graph work. Nearly all candidates could plot the points accurately for two marks.

Question 5 (c) (ii)

Most candidates could make a decent effort at a best fit curve. Exemplars of where candidates went wrong are given below.



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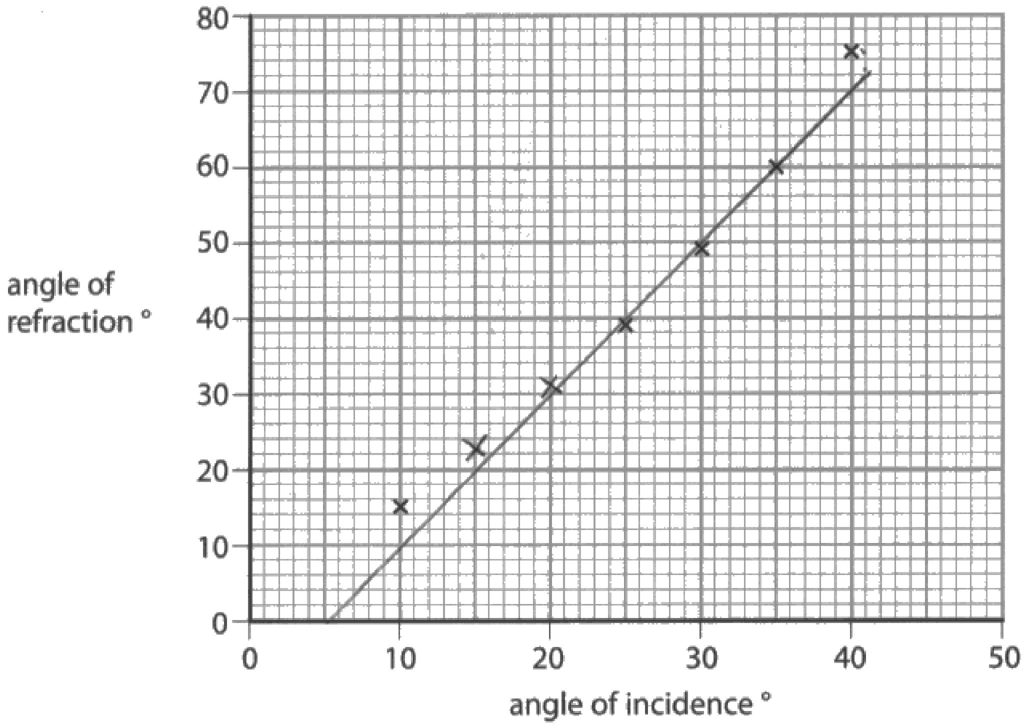
Examiner Comments

This is not a best fit curve; there are too many points above the line drawn.

ResultsPlus
Examiner Tip

Aim to draw your best fit line with a balance of points above and below the line. Often most points lie very close to that best fit line.



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Examiner Comments

This is incorrect; the question asks for 'the curve of best fit'. Even then, by the way, the line drawn isn't well balanced with points above and below the line as you would expect.

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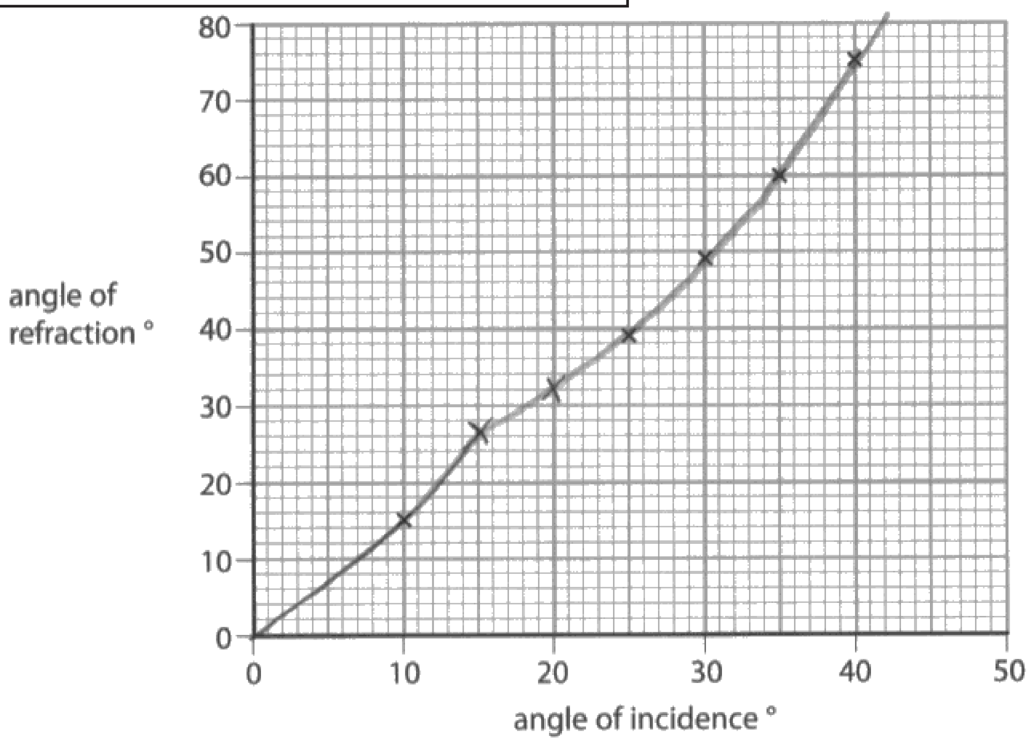
Examiner Tip

There is no substitute for reading the question carefully, including, perhaps, underlining the word curve.



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Examiner Comments

The mark scheme rejects attempts like this which force the line through the origin involving a kink / changing direction like this. The question says 'draw the curve of best fit'.

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Examiner Tip

A best fit line or curve is a balanced **single** one which should not be forced to go through the origin. There are often quite good reasons why data from experiments do give a y-axis intercept.

Question 5 (c) (iii)

Many were able to describe refraction seeing the initial relationship between the angle of refraction and angle of incidence. Not so many were able to go on, with clarity to explain how total internal reflection then occurred. We had a number of 'total internal refractions occurring'.

*(iii) The student continues to increase the angle of incidence until it reaches 80°.

The critical angle for this glass is 42°.

Explain what happens to the ray of light as the angle of incidence is increased from 10° to 80°.

(6)

Before 42°, the ~~angle of incidence~~ critical angle, light goes into the gass and refracts towards the normal, a very small, weak beam of light is reflected. As you increase this angle the strength of the beam of light reflected increases. When you reach 42° the beam of light will go into the glass as normal but instead of being reflected or refracted the beam of light will travel along the boundary of the glass and the air at 90° to the normal. This is because the light entered at the critical angle. Beyond the critical angle total internal reflection will occur, these means all the light that enters the glass is reflected at the boundary

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Examiner Comments

This shows a good balance describing the refraction part with the critical case, followed by the total internal reflection part.

It is a clear 6 marks answer.

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Examiner Tip

The first aim must be to get the physics ideas straight in your mind. This candidate communicates that understanding very well.

The small details about the partially reflected beam also show that this candidate has probably done and remembered well the experiment done in class. Those experiments are key learning opportunities.

Question 6 (b)

The majority of candidates recalled that radiation may cause damage to cells etc., whilst fewer candidates provided the association with ionising ability.

(b) Explain how radiation from radioactive sources can be dangerous to people.

(2)

The radiation could damage your body cells. this could mutate the cells and possibly give you cancer. Radiation is ionising.

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Examiner Comments

This answer meets both marking points spot on.

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Examiner Tip

The additional three words got the second mark!

Think 'What else could I add of relevance to my answer?' Don't sell yourself short.

Question 6 (c)

This question produced good discrimination whilst allowing the vast majority of candidates to display some knowledge. With the expectation that candidates could choose between 'lead-lined clothing', 'distance', 'time exposure', 'shielding from sources' and 'monitoring', candidates produced a variety of responses incorporating many of these, with the first amongst them being the most popular. Shrewd candidates are aware of the marks available and tailor their responses accordingly i.e. here's 3 marks so I need to put down three factors'.

(c) Medical staff who use radioactive materials need more protection than their patients.

Describe some precautions that medical staff can take to ensure their safety from radioactive materials.

(3)

Move further away from soure as intensity decreases as distance decreases. Wearing lead aprons absorbs the radioactive materials. Ensure radioactive soure is in a lead lined box so no radioactive materials can escape. such as gamma rays.

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Examiner Comments

Well set out addressing 3 marking points very well.

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Examiner Tip

Communication in short sharp well-focused sentences is often rewarded.

Question 6 (d)

Answers to this question, about the uses of radioactive materials in medicine, discriminated well between candidates, with some showing good knowledge and understanding whilst others less so. Quite a number went off track in describing other treatments / imaging techniques involving X-rays and ultrasound.

The mark scheme looked for 'a detailed description a procedure used for diagnosis **and** a procedure used for treatment' to access the higher marks.

To access the higher marks a detailed description of a procedure used for diagnosis **and** a procedure used for treatment were needed. These didn't need to be of such a high level in a foundation paper.

*(d) Describe how radioactive materials can be used in the diagnosis and treatment of some illnesses.

(6)

In PET scans an electron and a positron collide inside the body where the ilness is and they emit two gamma rays that travell at differen velocities. these are detected by a computer. When there are three rays they can triangulate the location of the illness.

Gamma rays can be used to treat cancer. Gamma rays can be fired at cancerous cells stopping them from dividing

In CAT ~~scans~~ scans, X-rays are absorbed and give a two dimentional slice of the patients body and they can be ~~of~~ stacked to produce a 3-D image.

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Examiner Comments

This candidate admirably achieves the two aims of including aspects of diagnosis and treatment.

The addition of talking of CAT scans at the end was an irrelevance in connection with the question about the use of radioactive sources. 6 marks.

The assessment of these 6 mark questions is done positively, ignoring irrelevances.

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Examiner Tip

Make sure you read the question carefully. Don't just write 'what you know' if it isn't answering the question. One good exam technique involves underlining key words, in this case it would be the word **radioactive**. Doing so may avoid going off on tangents. (X-rays are not connected with radioactive materials)

Paper Summary

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

- make sure that you have as thorough a knowledge as possible of all the content of the five topics
- get used to the idea of applying knowledge to new situations through practice, with the attempting of other past papers being a key
- always aim at communicating what you are doing on the paper in work that involves deductions and calculations: show your working!
- don't be afraid of writing in short sharp sentences, trying to at least match the number of mark points available in each question
- read the question carefully, answering it directly, avoiding the temptation to just write down 'what you know'
- consider the practice of underlining key words in the questions to try and make sure that you do not deviate from what is being asked.

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