Examiners' Report
June 2014

GCSE Physics 5PH3F 01

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June 2014

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Introduction

This was the second examination of unit P3 of the new specification. Questions were set to test students' knowledge, application and understanding from the five topics in the specification:

- Radiation in treatment and medicine
- X-rays and ECGs
- Production, uses and risks of ionising radiation from radioactive sources
- Motion of particles
- Kinetic theory and gases

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 students' quality of written communication.

The entry for this paper rose by 19% compared with the first year. Students coped well with the majority of questions and did particularly well in the questions asking for calculations using equations. For the two longer questions students were more secure in their knowledge of the X-ray tube than they were concerning cyclotrons.

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 will provide exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come from responses which highlight particular successes and misconceptions, with the aim of aiding future teaching of these topics.

Question 1 (a)

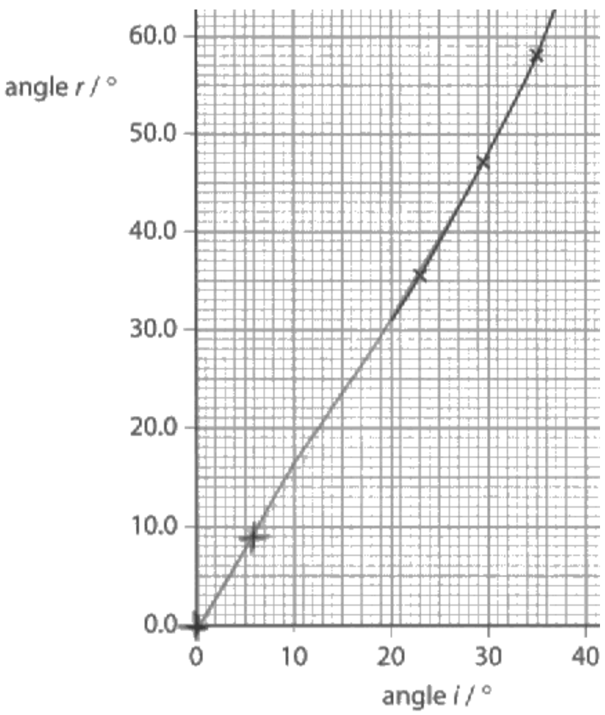
The term 'normal' was known by half of all the students. This is a key construction in understanding refraction and reflection and it is hoped this can be emphasised more, especially via the practical work needed to cover this topic.

Question 1 (b) (iii)

The vast majority of students achieved success in the straightforward reading of 42° from the graph. Given the simplicity of this task, combined with the clarity achieved on the graph paper, this was marked strictly with 43° not being allowed, for instance.

Question 1 (b) (i-ii)

This involved students plotting two points on a graph and then drawing a best fit line through the points. This was successfully completed by the majority of students with most scoring 3/3 in this work. A few students plotted 6,9 as 9,6, which allowed them to still get an error carried forward for the line drawing. Some students clearly used an edge other than a ruler to draw their lines of best fit. This was condoned but the drawing of multiple lines (tram-lining) was not acceptable.

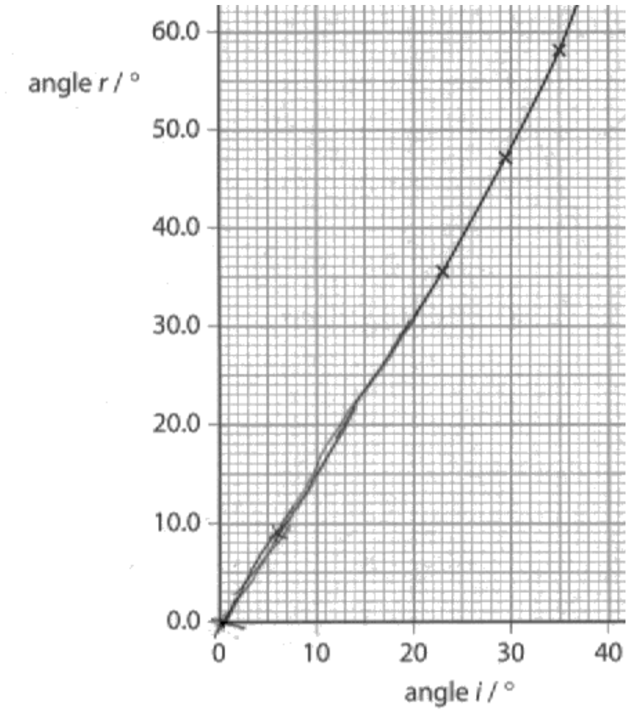


ResultsPlus
Examiner Comments

The points are both plotted correctly scoring two marks (the mark scheme allows 'within one square tolerance'). The line drawn wavers a bit but it is acceptable for 1 (b) (ii).

ResultsPlus
Examiner Tip

Use a ruler where a straight line is warranted. Always critically examine the points plotted deciding whether a straight line or a curve is the most appropriate.



ResultsPlus

Examiner Comments

The points have been plotted correctly but the best fit line drawn has multiple lines and this crosses the boundary in terms of acceptability and so does not get the 1 (b) (ii) mark.

ResultsPlus

Examiner Tip

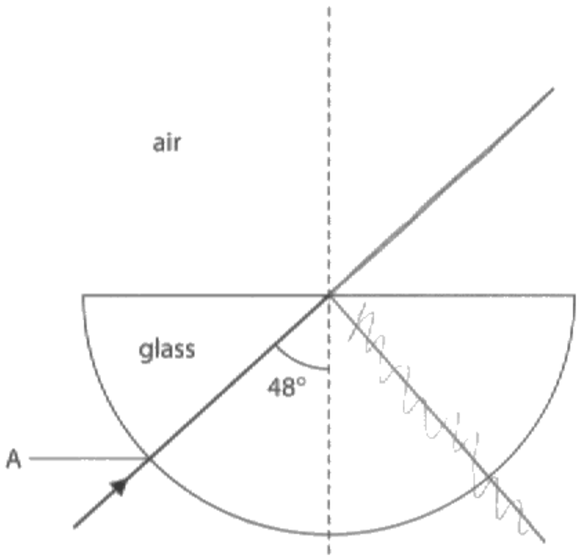
This is called 'tram-lining' by many teachers and it is to be avoided.

Question 1 (c) (i)

This was poorly done by most students, who failed to realise the significance of the 42° they had previously found in the preceding question. This being the critical angle, the angle of incidence they were now presented with (48°), should have led them to draw in a totally internally reflected ray. Of the students that did do this two thirds drew in a reflected ray with care so that the angles of incidence and reflection could be judged as near enough equal by eye, gaining the second mark. Perhaps a greater familiarity with experimental work with a semi-circular glass block could help here.

(c) (i) Complete the diagram to show what happens to the ray of light when angle *i* is 48°.

(2)



ResultsPlus
Examiner Comments

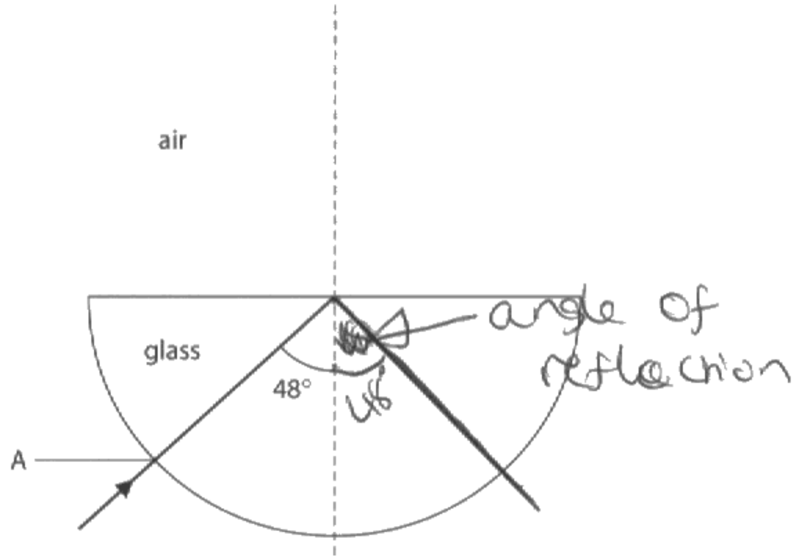
Unfortunately this student clearly had a change of mind and crossed out a correct reflected ray, establishing a continuing on ray as their answer. Regrettably this then scores no points.

ResultsPlus
Examiner Tip

Think carefully about ‘what happens at a boundary’. If it’s going from glass to air and the angle of incidence > critical angle **it will** totally internally reflect. Experiments to show TIR are best done with a ray box and a semi-circular glass block like this.

(c) (i) Complete the diagram to show what happens to the ray of light when angle *i* is 48°.

(2)



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Examiner Comments

This scores 2 marks for the reflection shown, with equal angles. Even if the angles do not look equal the second mark is awarded if the angles are labelled, as with this student.

ResultsPlus

Examiner Tip

Make sure you draw angles with reasonable accuracy.

Continue the line drawn next to the letter A and where it crosses the curved surface again is where the reflected ray comes through.

Why not label angles anyway, to be doubly sure, as this student has done?

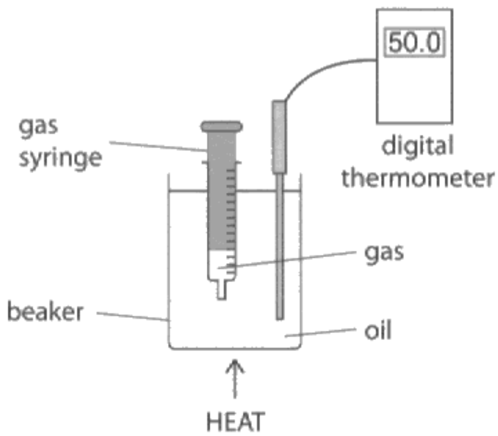
Question 1 (c) (ii)

Only a small minority of students could express themselves correctly with this answer, normally by saying 'because it hits at 90°'. A common answer was 'doesn't refract' and students saying this need to be aware that refraction still takes place even if there is no change of direction of the ray.

Question 2 (b) (i)

Well over half the students had gas particles moving around or colliding. A minority realised it was the collisions with the walls of the syringe causing the pressure on it. Many just left it at 'particles collide with each other'. A student saying 'the (gas) particles hit the syringe' gained both marks.

(b) The apparatus shown in the diagram is used to investigate how the volume of a gas changes with temperature when its pressure is constant.



(i) Explain how the particles in the gas exert a pressure on the syringe.

(2)

Because the gas particles move around freely therefor hitting the syringe and exerting pressure on it.

ResultsPlus
Examiner Comments

Both marks are given as a result of the student saying 'particles . . .**hitting** the **syringe**' as in the 'acceptable answers' in the markscheme.

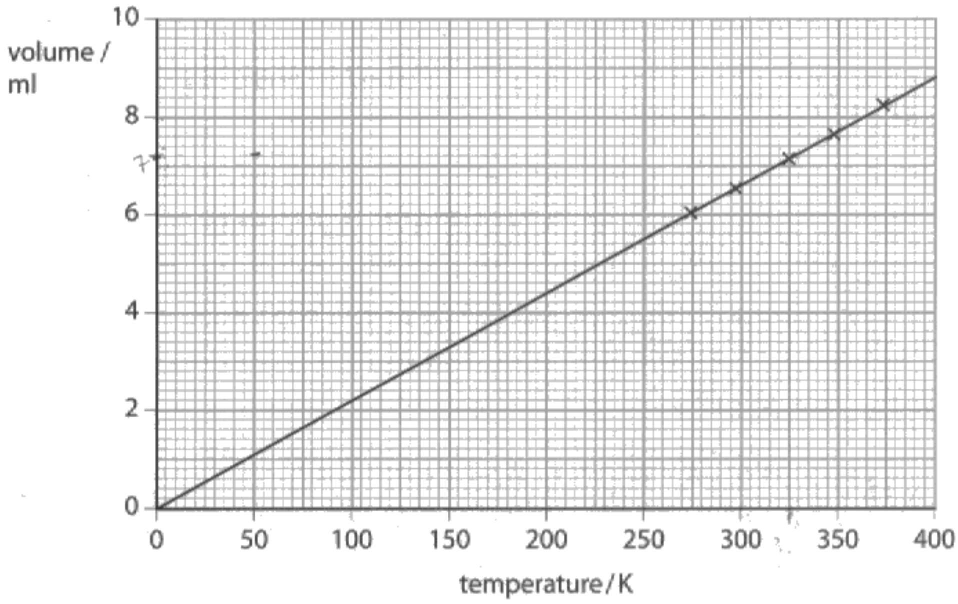
Question 2 (b) (ii)

Over half the students spotted the increase of 25K seen for each step in the table, correctly deducing the missing 323K.

Question 2 (b) (iii)

The vast majority of students stated the trend well (as temperature increases, volume increases) but only a small minority of students alluded to the linear nature by referring either to 'directly proportional' or to the constant increase, in some way. A doubling argument would have been equally accepted but quite a number of students did not go far enough in this by simply quoting pairs of coordinates from the graph.

(iii) The volume of the gas is plotted against the temperature in Kelvin and a line of best fit is drawn.



Describe what this line of best fit shows about how the volume of the gas varies with temperature.

(2)

As the tempoture increases, the Volume increases They are also increasing in proportion and at the same rate.

ResultsPlus
Examiner Comments

This is a good example of a student scoring both marks here, with the trend (1 mark) and the *proportional idea* getting the second mark.

Question 2 (c)

More than half of the students succeeded with this algebraic substitution which was especially pleasing to see at foundation level. Where students went astray, it was often because they misinterpreted the suffixes in some way, either choosing wrong temperatures or thinking the 2 suffix in T_2 meant square it or multiply by 2.

(c) When the temperature of the gas is 298 K, the volume of the gas in the syringe is 6.5 ml.

Calculate the volume of gas when its temperature is increased to 450 K.

Use the equation $V_2 = \frac{V_1 T_2}{T_1}$

(2)

$$\frac{6.5 \times 450}{298}$$

$$= \frac{2925}{298}$$

$$= 9.8$$

volume of gas = 9.8 ml

ResultsPlus
Examiner Comments

This is an example of an excellently communicated answer. Although the final answer by itself (9.8) would get both marks, in case of slips it is always advisable to show the working out to get intermediate marks when a calculation goes wrong.

(c) When the temperature of the gas is 298 K, the volume of the gas in the syringe is 6.5 ml.

Calculate the volume of gas when its temperature is increased to 450 K.

Use the equation $V_2 = \dfrac{V_1 T_2}{T_1}$

(2)

$$= \frac{6.5 \times 298_2}{450}$$

volume of gas = 12827 ml

ResultsPlus
Examiner Comments

This exemplifies a mistake seen quite often where the subscript is taken as a power 2 and the student wrongly squares the temperature. They have not substituted correctly and so can get no marks here.

ResultsPlus
Examiner Tip

This is the kind of calculation that candidates simply need to practise in order to become familiar with those subscripts, which are referring to temperatures and volumes **in a second case**.

Question 3 (a) (i)

Most students deduced at least one of the correct focusing features of the eye with over half getting two. Students were sometimes distracted in the diagram into thinking that the pupil has some focusing function.

Question 3 (a) (ii)

Most students selected lens 'B' as the greater power lens, with it being 'fatter / thicker' correctly allowing the second mark to be given. Students who chose 'A' then invariably chose wrong reasoning, stating that A was more powerful because it was thinner or sometimes coming up with an erroneous argument about the area of the lens.

(ii) Lenses of different powers are shown in diagram 2.

Diagram 2

Explain which lens has the greater power.

(2)

Lens B has the greater power as it is larger in thickness This means it will be able to slow down light particles, refracting light more, as it enters the different medium. Lens A will not do this as much as it is thinner.

ResultsPlus
Examiner Comments

Both marks are obtained. The student has expressed this well, both referring to the thickness and the greater amount of refraction taking place.

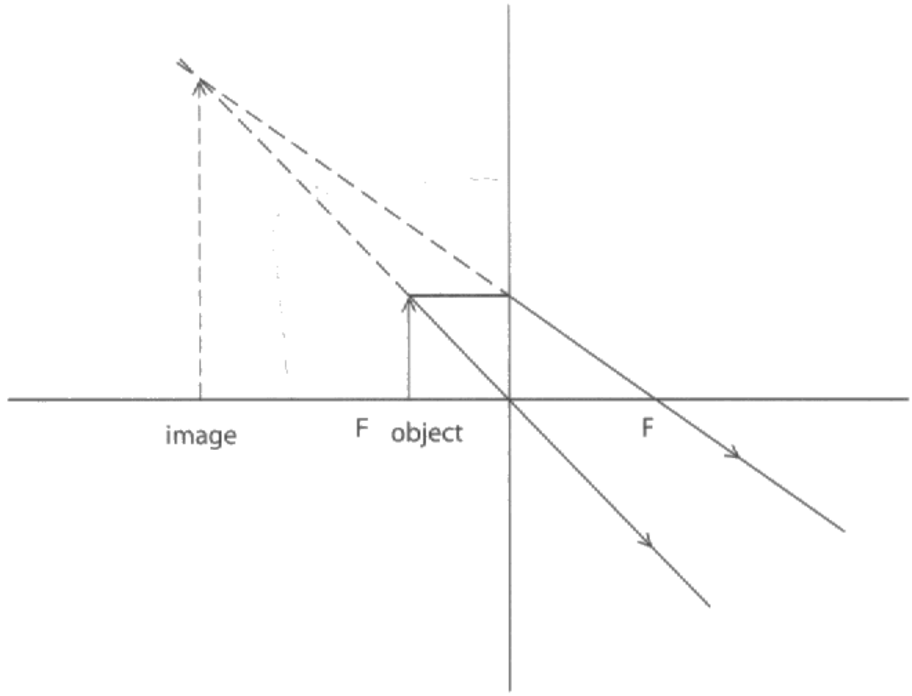
ResultsPlus
Examiner Tip

Having two approaches when you try to explain things can pay dividends. The correct 'bits' are sought after by examiners and credited, provided there is no contradiction along the way.

Question 3 (b) (i)

This question required students to estimate a height using some scaling from the diagram The setting of a wide range of acceptable answers (10 – 15cm) was set with the skill of estimation in mind and enabled many students to achieve the two marks. A few students calculated the height to be 4 X 2 = 8cm. In this case a casual visual inspection of the diagram had not served them well and their estimation was considered out of an acceptable range.

(b) The ray diagram shows the image of an object formed by a converging lens when it is used as a magnifying glass.



(i) The object has a height of 4 cm.
Estimate the height of the image.

4 x 3 = 12

(2)

– About 3 times bigger.

height of image = 12 cm

ResultsPlus
Examiner Comments

The student shows their thoughts/working very clearly, arriving at a correct answer and so gaining 2 marks.

ResultsPlus
Examiner Tip

In exams if you communicate to the examiner what you are doing you will always have a better chance of doing well.

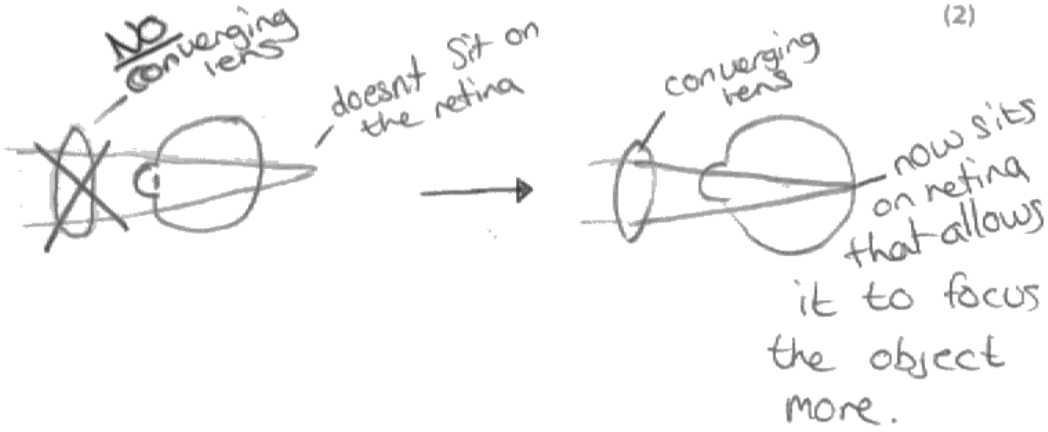
Question 3 (c)

Many showed a good understanding of the physics model of the eye, applying it to long-sight. However a number conflated the ideas they have learnt about long-sightedness and short-sightedness, resulting in a variation of marks achieved.

(c) Explain why a converging lens is used for the treatment of long sight.

You may draw a diagram to help with your answer.

(2)



Converging lenses help us to focus on image we cant properly focus on. Converging lenses now help people to focus on near by objects.

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Examiner Comments

This is an example where both marks could be credited from the worthy diagrams. In the student's writing underneath credit (1 mark) could have been given for the assistance the lenses give for 'viewing nearby objects'.

ResultsPlus
Examiner Tip

This is an example where (flash) cards may aid revision, devoting one to short-sight and one to long-sight, with their corrections. Students mostly go wrong when they confuse the two eg by saying with long-sight the eyeball may be too long; it's the opposite!

Question 4 (a) (ii)

Many students achieved the first mark here, stating what happens to the mass, but fewer gave a correct accompanying explanation.

(ii) Cobalt-60 decays by emitting gamma radiation.

Explain what happens to the mass of a cobalt-60 atom when a gamma ray is emitted.

(2)

The mass does not change because gamma rays are not particles, just energy.

ResultsPlus

Examiner Comments

This is an example of what was envisaged from students and gets 2 marks. Gamma (rays) being 'only energy' is in the 'acceptable answers' in the mark scheme.

Question 4 (b) (ii)

Most students engaged well with the 'protect/absorb' ideas associated with shielding, realising that it was 'others' (including medical staff) who would benefit from this. A few students thought that the shielding enabled more rays to go to the patient.

Question 4 (b) (iii)

Three quarters of students gained one or two marks here through a basic understanding of the benefits perceived in the hospital treatment described. Some stated here that this treatment 'did not affect healthy cells'; this was not addressing the question at hand, though it did have relevance to the subsequent question. The most popular responses were 'no surgery needed' or 'quicker (procedure) to do', which were both fully credited.

(iii) Suggest **two** advantages that this kind of treatment has over other forms of treatment for tumours.

(2)

1 It doesn't kill the healthy cells around the tumour cells

2 Its safer for the patient.

ResultsPlus
Examiner Comments

This scored zero for the reason highlighted in the summary above.

Question 4 (b) (iv)

The idea of beams crossing to deliver a maximum dose to the cancer whilst minimising that to healthy surrounding cells was the main issue here and this was understood/alluded to by about a third of the students.

(iv) Explain why several beams of gamma radiation are used instead of just one.

(2)

Several weak beams of gamma rays are used ~~to~~ because the weak rays do minimal damage to body cells when they pass through but can target cancer cells by crossing the rays at a specific point, making the beams of radiation more concentrated.

ResultsPlus
Examiner Comments

This student has got the right idea with the targeting/concentrating for one mark and the 'not killing healthy cells' for the other. Notice that the student has not specifically used the word 'healthy', but makes the difference between the targeted cancerous cells and other body cells so well that professional judgement dictates that the marks may be awarded in a case such as this.

ResultsPlus
Examiner Tip

Diagrams and animations can greatly assist getting over the important point of overlapping beams delivering the greatest dose to the targeted area.

Question 5 (a) (ii)

Only a minority of students seem to know the idea of centripetal force as a force towards the centre (follows from Q5 (a) (i)).

Question 5 (a) (iii)

In contrast with the previous answer the great majority of students gained 1 or 2 marks here through applying their knowledge to 'what would happen to the ball as the girl gets tired'.

(iii) Suggest what would happen to the ball as the girl gets tired.

(2)

The ball will begin to get slower and it ~~with~~ wouldn't have as big of a resulting force.

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Examiner Comments

The ball getting slower earns the mark. Since the question says *'What would happen to the ball?'*, this is an example of the student not addressing the question when they start talking about the resultant force. The latter part gains no credit.

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Examiner Tip

Make sure you are answering the question and not going off on a tangent.

Question 5 (a) (iv)

Few students demonstrated their knowledge and application when it came to using the principles of momentum and energy conservations. They often lost marks through a lack of clarity in their arguments eg not including the words **'of the ball'** when talking about momentum losses. Similarly, marks were lost when students talked vaguely of 'energy' when they should have been talking clearly of **kinetic** energy in their particular context.

(iv) The girl lets go of the string and the ball hits a wall.

The collision is not elastic.

Explain what happens to both momentum and kinetic energy when the ball hits the wall.

(2)

The momentum of the ball is passed onto the wall and the kinetic energy is left with the ball which bounces off the wall.

ResultsPlus
Examiner Comments

This response gains a mark for 'momentum **of the ball** is passed to the wall' and the comment about the kinetic energy being of no value here, especially since an inelastic collision is being asked about.

ResultsPlus
Examiner Tip

It is important to make it clear what you are writing about when answering questions. Use descriptive phrases like 'the ball's momentum' or equivalent to make it clear. Vagueness leads to a loss of marks.

Question 5 (b)

A good description of a 'cyclotron and how particles move inside it' contained two D-shaped halves with a gap in between them. Particles are accelerated across the gap by a voltage (alternating). The magnetic field causes circular motion and the design is such that the particles spiral outwards.

Unfortunately this question was not very well answered by most students, revealing gaps in their knowledge here.

A good number of students, taking a clue from the word cyclotron, matched the level 1 mark descriptors through 'a limited description of particle movement', as they described the circular motion with a limited diagram and words. A number of candidates confused charge and energy stating that particles 'gain charge as they go round'. They often did not gain higher marks through consequent descriptions of ideas they conflated from other sources, which are not helpful directly in answering this question eg concerning particle collisions or CERN's 'god particle'.

*(b) Describe a cyclotron and how charged particles move inside it.

You may draw a labelled diagram to help with your answer.

(6)

Cyclotrons are a particle accelerator that ~~m~~ accelerates particles in a circular motion. Charged particles start as potential difference is applied and particles begin to move around the cyclotron.
A magnetic field (resultant force) acts on the charged particles in the direction of the centre of the cyclotron to keep the particles moving.
The ~~partic~~ charged particles are constantly accelerating and gain speed after each time the particles pass the start have done a complete circle of the cyclotron, giving the particles energy.
Cyclotrons are used in ~~hospit~~ hospitals to help radiation treatments.

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Examiner Comments

This student has got the basic physics right, with details of the cyclotron's magnetic field keeping the particle moving in a circle, as well as the circular motion of the particle credited in 'particle movement' in the mark scheme. The answer matches the level 3 descriptors in this foundation paper and so represents the minimum standard needed to get 6 marks.

The hospital treatment comment at the end is treated as neutral; it neither helps nor detracts from the answer in this case.

ResultsPlus
Examiner Tip

Ask yourself 'What are the physics ideas involved?' Break your answer down into bitesize chunks/paragraphs as this student has done.

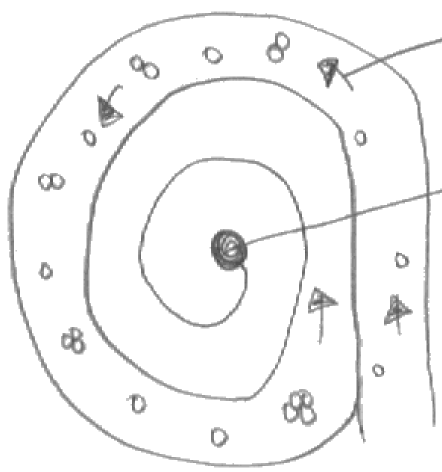
In this instance the student did not draw a diagram in the place provided but has not lost out because the explanation matched 'level 3'.

Examiners do credit the content of diagrams though, remember.

*(b) Describe a cyclotron and how charged particles move inside it.

You may draw a labelled diagram to help with your answer.

(6)



the cyclotron creates a current in order to find the 'God' Atom. To do this the cyclotron needs to create a strong current so that the atoms are moving and charged & collide in to each other. Eventually all of the atoms will collide together to create the 'God' Atom. The current is created by Electricity so that there is enough momentum for the charged particles to collide together. Once all of the atoms have reached the middle of the cyclotron they should have collided in order to create a big/final atom.

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Examiner Comments

This achieves level 1, 'a limited description' of particle movement, and gets 2 marks. The spiral nature of the particle's motion is shown, albeit moving inwards rather than the correct outwards direction. The comments about current and momentum are not within a good context and not communicated well. Nevertheless this still represents a threshold level 1 attainment. Many much more confused versions of this were seen, showing students' 'little bits of knowledge' picked up in class and via the media regarding the LHC experiments.

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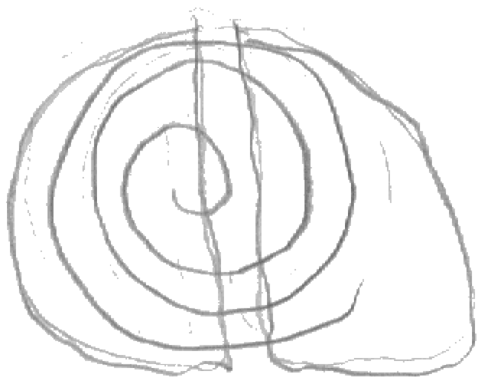
Examiner Tip

This is an example of a topic that needs to be revised well, avoiding confusions and conflated ideas. The making of summary cards/ revision slides and other aids are commended.

*(b) Describe a cyclotron and how charged particles move inside it.

You may draw a labelled diagram to help with your answer.

(6)



A cyclotron is a type of particle accelar-ator. Charged particles move inside the cyclotron in a circular motion with a centripetal force. In a cyclotron two hollow electrodes are used, the charged particles ~~[illegible]~~ travel in a circular motion from one electrode to the other crossing a gap. This movement across the gap creates a potential difference. Scientists use ~~chan~~ particle accelat-ators such as the cyclotron is understand the universe and try to understand the big bang theory and other theorys in more depth. This particle accelarator is also used for medicine.

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Examiner Comments

This is worth 6 marks in a foundation paper. Notice perfection is not a requirement. There is sufficient quality here to match the level 3 mark descriptors, including those for quality of language. This is a good example of a script that goes beyond the 'simple description' of level 2, just satisfying the requirements for 6 marks, judged holistically.

For the 'cyclotron': the diagram shows two D's and a potential difference across the gap is spoken of (albeit with wrong cause and effect).

For 'particle movement': the diagram adds credit, showing spiral motion has circular motion, with a centripetal force considered.

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Examiner Tip

Write in short sentences developing a story-line like this student, aiming for as much detail as possible.

Question 6 (a) (i)

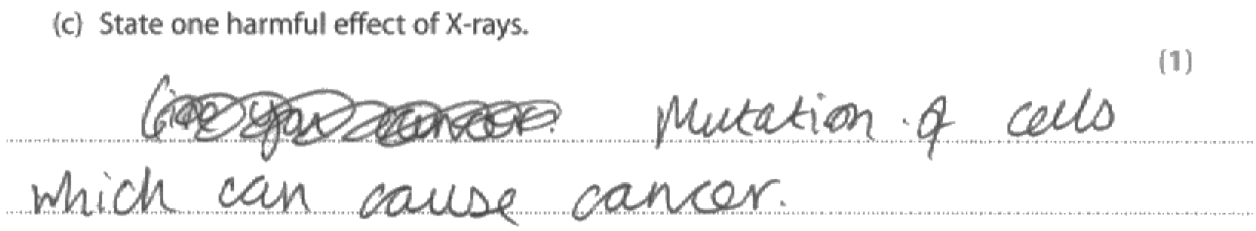
The vast majority of students read the 50 (W/m^2) from the graph through a simple extraction of information from the graphical form.

Question 6 (a) (ii)

This question was partly referred to in the introduction when noting that students did particularly well in the questions asking for calculations using equations. The vast majority of students scored 3/3 with this part question.

Question 6 (c)

Yet again a big majority of students could state a harmful effect of X-rays, which was often 'cancer', with others talking of damage at the cellular level quite well.


(c) State one harmful effect of X-rays.

(1)

Mutation of cells which can cause cancer.

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Examiner Comments

This would gain the mark for either 'mutation of cells' or for 'cancer'.

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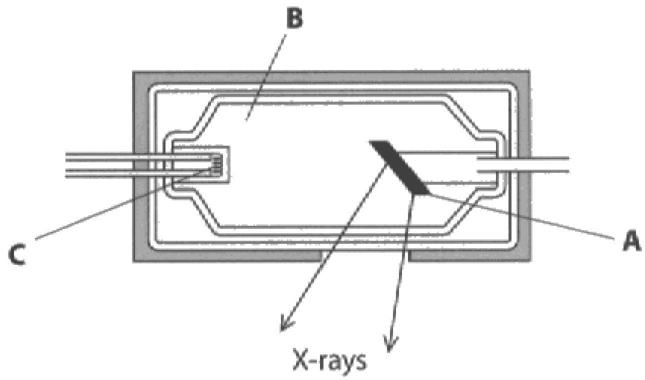
Examiner Tip

Expressing an answer in two different ways can increase your likelihood of addressing a mark-earning point.

Question 6 (d)

A good number of students are engaged with medical physics topics and gave a good account of the process inside an X-ray tube. A significant number used technical terms such as 'thermionic emission' well and with correct spelling. In contrast an equal number were very 'hopeful' in their knowledge, often thinking that the X-rays began at the cathode, C, and then emerged after reflection at A.

*(d) The diagram shows an X-ray tube.



Describe how X-rays are produced in this type of tube.

You may refer to the letters on the diagram in your answer.

(6)

Letter C is the anode it is negative and reppels electrons from here which are attracted to 'A' which is poshve , the parncles then hit the ~~e~~ x-ray and release the x-rays to the ~~pe~~erson/patient. The computer then can see the persons bones and look for any damage. X rays can be used for ultrasound scans to check to see if the babys heart rate ~~r~~ is fine they also can be done to kidneys to test for kidney stones.. However x-rays can be bad because they can cause cells to multipiy and cause cancer.

ResultsPlus
Examiner Comments

There are some correct statements in here: electrons are attracted to A. However there are many mistakes and technical errors. This student is awarded 2 marks for a description limited to isolated facts. The spg aspects are of a higher level, but it is the weak science that has limited them here.

The mistakes are detailed below.

C is the cathode, A is the anode.

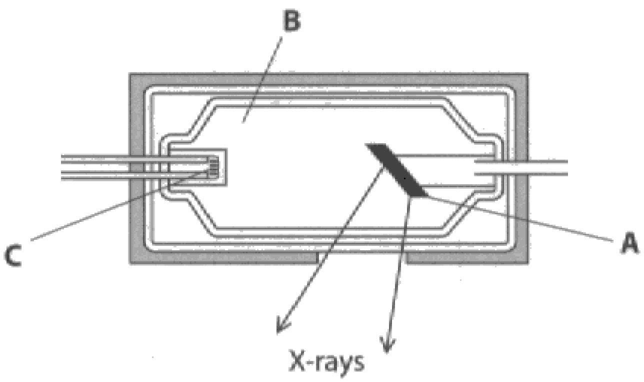
The particles then don't 'hit the X-ray'.

X-rays are not used for ultrasound scans.

ResultsPlus
Examiner Tip

Revise key topics like this using (flash) cards. Tell the story beginning with the emission of electrons at the cathode (thermionic emission) ending with the collisions with the anode target and the X-rays produced.

*(d) The diagram shows an X-ray tube.



Describe how X-rays are produced in this type of tube.

You may refer to the letters on the diagram in your answer.

(6)

- C is a filament lamp (A ~~[illegible]~~ negative Cathode)
- A is a metal Plate (A Positive Anode)
- Electrons flow away from C as C is negative and So are electrons, therefore they flow towards A as it is Positive.
- As the electrons collide with the metal Plate X-rays are formed.
- To increase the ~~$~~ amount of collisions to Produce more X-rays, You may increase the temperature causing more collisions.

ResultsPlus
Examiner Comments

This is an excellent and concise description, with electrons as the key agents, easily enabling the full 6 marks to be given.

ResultsPlus
Examiner Tip

Writing in crisp bullets like this has advantages. Mark schemes often credit such 'bitesize' chunks of knowledge anyway, and this exploits that to great effect. Notice that the student is still using good grammar, spelling and punctuation as well, with very few errors in this case!

Paper Summary

The performance of students in this exam was similar to the previous year. The skills shown with numerical work were commendable. There are some gaps in students' knowledge and, on occasion, exam technique could be improved upon.

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

- make sure that they have as thorough a knowledge as possible of the content of all five topics
- get used to the idea of applying their knowledge to new situations through practising, with the attempting of other past papers being a key
- always aim at communicating what they are doing on the paper in work that involves deductions and calculations: show their working
- not be afraid of writing in short sharp sentences, trying to at least match the number of mark points available in each question
- use diagrams to gain marks, and help them focus on important features, as for example in Q5b
- read the question carefully, answering it directly, avoiding the temptation to just write down what they know.

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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