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Examiners' Report
January 2010

GCE Physics 6PH04

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General Comments

This was the first of the new style A2 examinations for Physics. The vast majority of candidates had made some attempt to answer every part of every question. Most answer spaces were sensibly used suggesting the number of answer lines were appropriate for most students. Candidates did not appear to be disadvantaged or deterred by questions set within a context and these questions were just as well answered as any others.

Question 4 and 5

Proved the most difficult multiple choice questions with just under half the candidates getting these correct. The rest of the multiple choice questions had a 65-80% correct response rate.

Question 8

About 30% of candidates scored full marks. Common errors included not specifying that very few alpha particles are reflected through large angles and using words such as concentrated, massive, dense within a vague statement. Some candidates wasted time discussing the apparatus details.

***8 Rutherford designed an experiment to see what happened when alpha particles were directed at a piece of gold foil. Summarise the observations and state the conclusions Rutherford reached about the structure of gold atoms.**

(5)

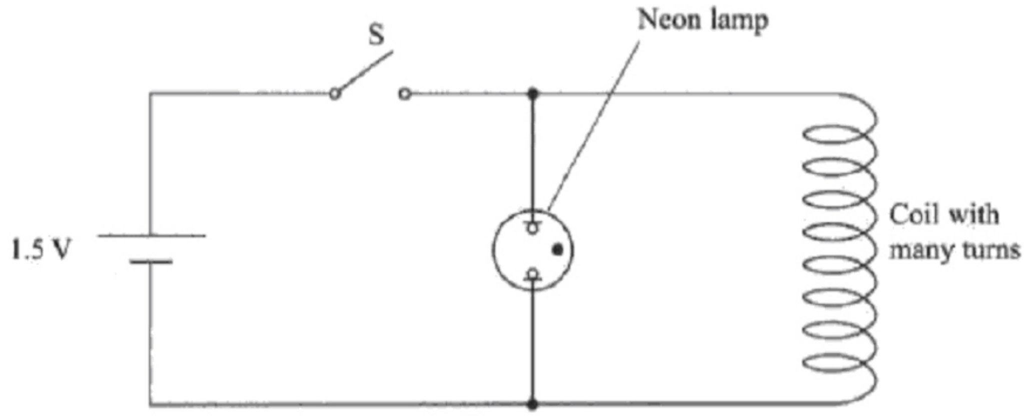
The model at the time suggest that the alpha particles would travel straight through almost unaffected by the foil.
What happed is that ~~[illegible]~~ some we deflected, few were deflected at almost 90° and even fewr were sent straight back, but most went straight through.
This means that there must be a highly dense object where the majority of the mass of the particle is.
Because of the deflections, it must have been charged positivly (as alpha is positive).

In this answer the word "nucleus" wasn't used and "atom" has become particle. This answer would still score 4 marks because it has described the observations correctly and stated that this dense object (presumably the nucleus rather than the atom) is positively charged. Candidates generally seemed better at the observations and less sure about the conclusions.

Question 9

Many candidates correctly quoted Faraday's law but didn't apply it specifically to this context. Candidates referred to coils producing magnetic fields rather than current. They also often used incorrect terminology such as produced an e.m.f. rather than induced an e.m.f..

The answer below covers the idea of a change of flux but doesn't convey the idea of a quick change of flux or that this instantaneous change induces a high e.m.f. larger than 200 V. This would score 1 mark.



Use Faraday's law to explain why the lamp flashes once when the switch S is **opened**.

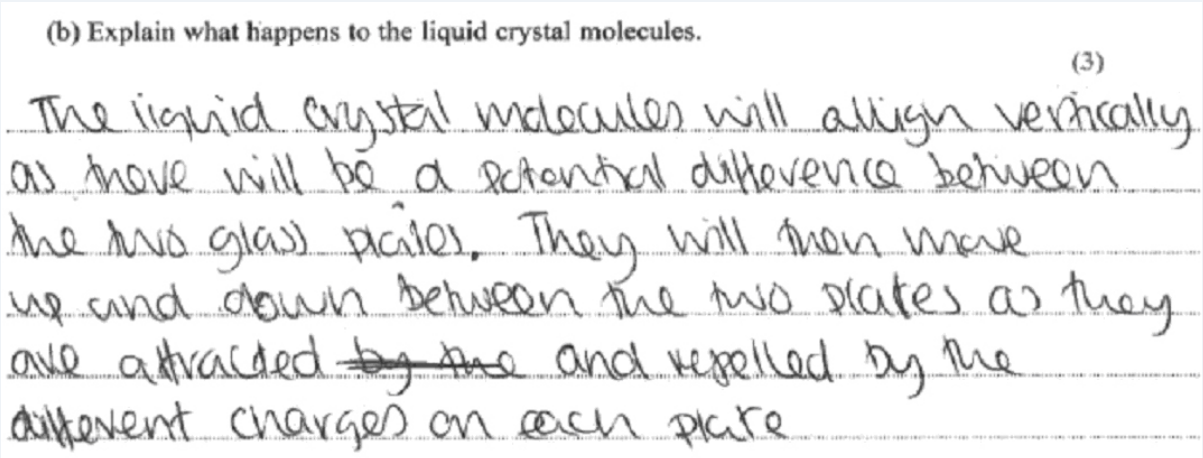
(4)

$(emf) = \frac{d(N\Phi)}{dt}$ as the Switch opens the motion of that switch creates an induced emf due to the lines of flux being cut. this creates a small current which then travels to the neon lamp causing one quick flash.

Question 10

Part (a) was correctly done by the vast majority of candidates – the occasional answer either omitted the units or quoted an incorrect unit (often Tesla).

Part (b) Most candidates correctly suggested that the molecules would rotate or align vertically but didn't spell out the detail eg that the top plate would be the positive plate, that the two forces would act in opposite directions.



(b) Explain what happens to the liquid crystal molecules.

(3)

The liquid crystal molecules will allign vertically as there will be a potential difference between the two glass plates. They will then move up and down between the two plates as they are attracted ~~by the~~ and repelled by the different charges on each plate

A useful tip is look at the number of marks allocated. Three marks in this case meant that there would be three distinct relevant and worthwhile points to be made. This candidate scores 1 mark for the "aligning vertically".

Question 11 (a)

Candidates should use a ruler to draw straight lines. They also need to show equispacing. Most candidates gave the correct direction for the field.

Here is an example of all three faults.

(b) Candidates frequently used the formula for field strength. If they did use the formula for force not all of them appreciated the magnitude of charge on a proton is the same as on an electron.

(b) Calculate the electrostatic force on the electron in a hydrogen atom.

Average distance between proton and electron = 5.4×10^{-11} m

(3)

colombs law = $F = \frac{kQ_1Q_2}{r_2}$ where $k = \frac{1}{4\pi\varepsilon}$

$k = \frac{1}{4 \times \pi \times (8.85 \times 10^{-12})} = 8.99 \times 10^{9}$

$F = \frac{(8.99 \times 10^{9}) \times (1.67 \times 10^{-27}) \times (1.6 \times 10^{-19})}{r^2}$

$F = \frac{2.4 \times 10^{-36}}{(5.4 \times 10^{-11})^2}$

Force = 8.23×10^{-16} N

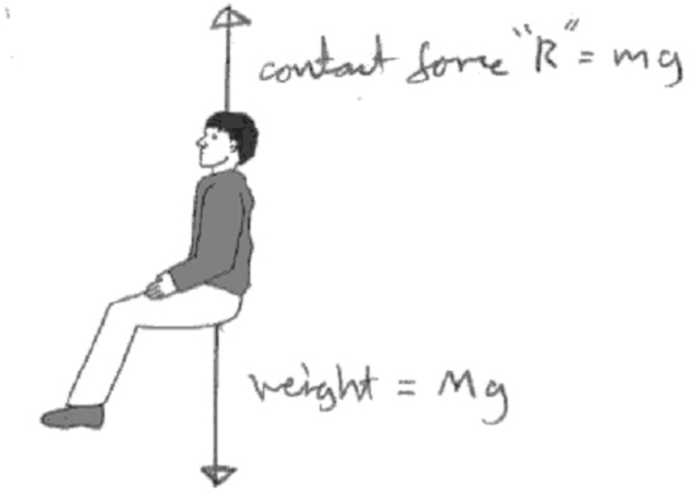
This example shows a candidate has muddled the charge on a proton with its mass.

It is worth noting that the charge on the proton is not explicitly given with the data.

Question 12

Many candidates struggled with circular motion and two forces to consider (R and mg). Many candidates drew a diagram (often not a free body diagram) with two correctly labelled forces but failed to use it to answer part (c). Centres should note that equations of motion are for use on rectilinear motion and therefore energy conservation should be used to answer part (d).

Point X is just before the train leaves the horizontal track and moves into the first bend. Complete the free-body diagram below to show the two forces acting on a rider in the train at this point.



Whilst the two forces are correctly labelled a free-body diagram should show both forces starting at a point.

Many candidates, including this one, had earlier drawn a diagram showing the reaction force and weight but then only included the reaction force as the centripetal force and ignored the weight.

(c) The mass of the rider is m and g is the acceleration of free fall. Just after point X, the reaction force of the train on the rider is $4mg$ and can be assumed to be vertical. This is referred to as a g-force of 4g.
Show that the radius of curvature of the track at this point is about 100 m.

(3)

$F = \frac{mv^2}{r}$ $F = 4g$ $4mg = \frac{mv^2}{r}$

$v = \omega r$ $4g = \frac{\omega^2 r^2}{r}$ $\omega = \frac{2\pi}{T}$ $4g = \frac{v^2}{r}$

$4g = \omega^2 r$

$4g = \frac{2\pi^2}{3.5^2} \times r$ $4g = \frac{(\omega r)^2}{r}$

$4 \times 9.8 = 3.2272 \times r$ $r \approx 100$ m

$= 121.467$

Question 13 (a)

Candidates generally understood that the capacitor would be charged but did not consider the movement of electrons.

(a) Describe what happens to the capacitor when the switch S is closed.

(2)

When ~~t~~ swith S is closed, the positive electrons build up on the positive plate whilst negative electrons build up on the negative plate. The charges between the two plates attract and the capacitor becomes charged.

This candidate hasn't understood that positive charge is an absence of electrons.

(b) The formula Q = I △t was not understood by candidates. They often looked to see what numbers could "make" the value in the required cell. They need to appreciate that spreadsheets calculate values in a particular order so quoting an operation between cells later in the spreadsheet will not work.

(i) Explain how the value in cell C4 is calculated.

(2)

$Q = I \times t \therefore \Delta Q = \Delta I \times t$

$\therefore \Delta Q = ((1.11 - 0.74) \times 10^{-3}) \times 0.2$

$C4 = (B3 - B4) \times A4$

Note that this candidate has muddled the use of △ (or change of).

	A	B	C	D	E
1	t / s	I / mA	ΔQ / μC	Q / μC	p.d. across capacitor/V
2	0	1.67	167	167	1.67
3	0.1	1.11	111	278	2.78
4	0.2	0.74	74	352	3.52
5	0.3	0.49	49	401	4.01
6	0.4	0.33	33	434	4.34
7	0.5	0.22	22	456	4.56
8	0.6	0.15	15	471	4.71
9	0.7	0.10	10	480	4.80
10	0.8	0.07	7	487	4.87

(i) Explain how the value in cell C4 is calculated. $C = Q/V$

(2)

D4 – D3

This candidate has spotted that cell D4 – D3 gives the correct numerical answer. However spreadsheets do not work backwards. Cell C4 has to be calculated from preceding cells.

(c) Candidates generally recognised the use of V = Q/C and answered this well although some did not explicitly explain that the “micros” for Q and C would cancel out.

(d) This part was generally well answered with candidates regularly able to use time constant = RC and able to estimate it sensibly from the graph usually using “37%” within their answer (although a variety of other techniques were credited).

(e) Many candidates appeared to think that a log-log graph would verify an exponential form.

(ii) The student thinks that the graph is an exponential curve. How would you use another graph to confirm this?

(3)

$I = I_0 e^{-t/RC}$ $\therefore \ln I = \ln I_0 e^{-t/RC}$

$\therefore \dfrac{\ln I}{\ln I_0} = -t/RC$

Plot $\ln I$ against $\ln I_0$ and the gradient should be a straight line.

Question 14

The first two parts were generally well done by candidates as was part (d) provided they recognised that momentum conservation was the argument.

Many candidates did not read (c) carefully enough and gave general answers rather than specifically referring to electric and magnetic fields. The general idea of what the electric fields do to particles is stated but omitted the fact that an electric field exerts a force on a charged particle whereas a magnetic field exerts a force on a moving charged particle. The candidate also incorrectly implies that the magnetic field gives the particle more energy.

(c) Pions can be produced by accelerating protons using a cyclotron. Briefly explain the role of electric and magnetic fields within a cyclotron.

(5)

Within a cyclotron the electric fields are used to accelerate the particles to high velocities. The magnetic fields are used to make the particles continue accelerating outwards to gain more and more energy by moving faster. The magnetic field does this by utilising the fact that the motion of a particle has to be perpendicular to the field according to flemings law. To avoid being in the same place as the field the particle continuously changes direction

The answer below nicely illustrates that the missing point is that the fragments shoot out in all directions because the initial momentum is negligible so would obtain 2 out of 3 marks.

(d) When pions are used to treat brain tumours they are slowed by the tissue in the brain and cause little damage. When a pion is moving very slowly it may be absorbed by the nucleus of an atom. The atom nucleus then becomes unstable and breaks up into several fragments.

Explain why these fragments shoot out in all directions.

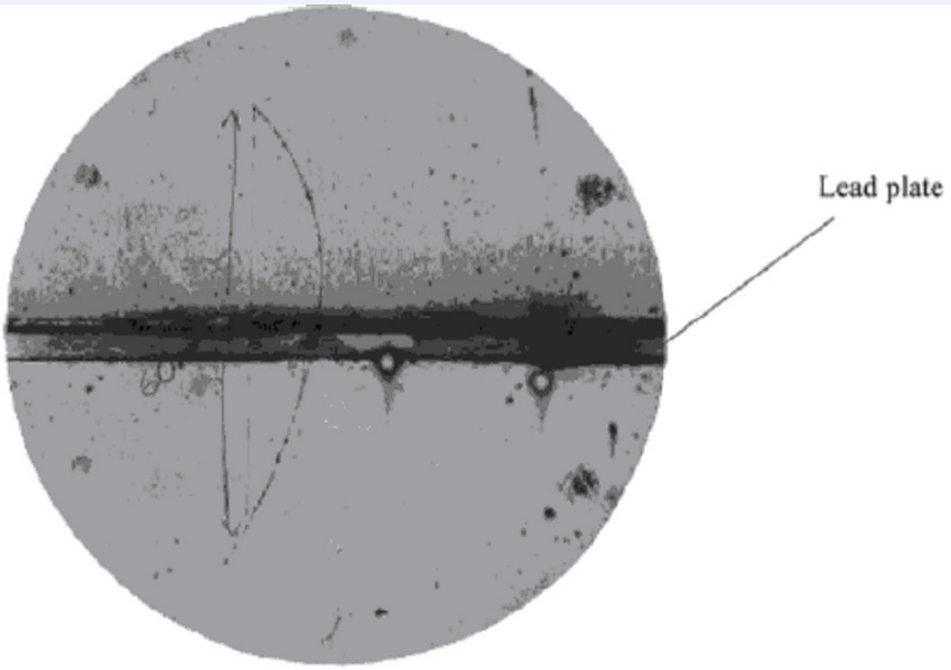
(3)

The fragments shoot out in all direction because momentum has to be conserved. Therefor the vector sum of all the fragments = the momentum of the pion.

Question 15 (a)

Few students considered a sensible method to estimating the radius for instance by drawing two perpendicular lines and seeing where they crossed to find the centre. Many thought the photograph was full size (the lead thickness was actually between 4 and 5mm). However they followed this with a correct calculation of momentum (a few candidates omitted the units).

This answer shows that the candidate believes the photograph shows a full semicircle. The candidate has completely ignored the information about the thickness of lead and assumed the photograph is full scale.



The particle was deflected by a magnetic field of magnetic flux density 1.5 T. The field is perpendicular to the plane of the photograph.

(a) (i) Estimate the actual radius of the track above the lead plate.

The lead plate is 6 mm thick.

(3)

$r = \frac{P}{BQ}$ Total R = 60mm

Above Pipe = 30mm

~~$r = \frac{P}{1.5 \times 1.6 \times 10^{-19}}$~~ $30mm \times 10^{-3}$

= 0.03m

-19

(b) Many candidates gave a good account of the reason why the direction of movement was up but some tried to use Fleming's left hand rule even though the direction of the B field wasn't given.

The majority of candidates could use FLHR in part (d).

(b) Explain whether this particle was moving up or down through the lead plate. (3)

Positively charged particles move anticlockwise in a magnetic field, as the particle was positively charged, it must have been moving up through the lead plate to move anticlockwise.

(c) On the list below circle the correct direction of the magnetic field. (1)

Into the page from left to right down the page out of the page (up the page)

This answer reveals that this candidate could not visualise Flemings left hand rule as the only two viable answers were either in or out of the page.

Some candidates appeared to run out of time in the final two parts of this question which differentiated the able candidates well and about 20% of candidates gave very good answers.

The lack of observation shown by the answer below was very unusual!

(d) This particle was identified as a positron.

(i) Calculate the speed of the positron while it is moving above the lead plate. (2)

$p = mv \quad v = \frac{p}{m} = \frac{1.1\times10^{-20}}{9.11\times10^{-31}} = 1.2\times10^{10}$

Speed = 1.2×10^{10} ms^{-1} (2sf)

(ii) Comment on your answer. (2)

This is very fast.

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Grade	Max. Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	55	49	43	37	32

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