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Examiners' Report
November 2012

GCSE Applied Physics 5PH2H 01

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November 2012

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Introduction

The unit is divided into six topics and all six topics were tested in the examination.

The topics were:

- controlling and using electric current
- static and current electricity
- motion and forces
- momentum, energy, work and power
- nuclear fission and nuclear fusion
- advantages and disadvantages of using radioactive materials.

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. To achieve this, each question increased in difficulty as the question progressed. 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 longer questions worth three or four marks each. The two six mark questions were used to test quality of written communication.

Successful candidates were:

- well grounded in the fundamental knowledge required
- willing to think, use their knowledge to solve new problems and apply their knowledge to unfamiliar situations
- able to analyse and interpret data in graphical form
- able to tackle calculations methodically and show the stages in their working
- able to construct their explanations in a logical order, using the marks at the side of the questions as a guide.

Less successful candidates:

- had gaps in their knowledge
- found difficulty in applying their knowledge to new situations
- found difficulty in analysing and interpreting data in graphical form
- did not do well in calculations involving changing the subject of an equation
- did not think through their answers before writing.

The quality of written communication was generally appropriate to the level of response. When it was not, the mark within that level was reduced, if possible.

This report will provide exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come mainly from questions which required more complex responses from candidates.

Question 1 (a) (ii)

Nearly all of the candidates correctly calculated the voltmeter reading.

(ii) One of the components being investigated is a 12 ohm resistor.
When it is in the circuit, the ammeter reading is 0.50 A.

Calculate the voltmeter reading. $V = I \times R$ **(2)**

$0.5 \times 12 = 6$

voltmeter reading = 6 V

ResultsPlus
Examiner Comments

Candidates should always start by writing down the equation they are going to use.

ResultsPlus
Examiner Tip

A clearly laid out answer scoring full marks.

(ii) One of the components being investigated is a 12 ohm resistor.
When it is in the circuit, the ammeter reading is 0.50 A.

Calculate the voltmeter reading. **(2)**

voltmeter reading = 6 V

ResultsPlus
Examiner Comments

A correct numerical answer will score full marks

ResultsPlus
Examiner Tip

It is always better to show HOW you arrived at your answer. You may be able to get a mark if your answer is wrong and the examiner can see that you used the correct method.

Question 1 (a) (iii)

Examiners were looking for an increase in both ammeter and voltmeter readings as the resistance of the variable resistor was decreased. Just under half of the candidates scored full marks whilst many thought that the voltmeter reading would either increase or stay the same.

Question 1 (b)

Candidates were asked to identify the current / voltage graphs of three different electrical components. Although many of the candidates were able to do so, many others confused the bulb/lamp and the diode.

Question 2 (a) (ii)

Most of the candidates were able to name a source of background radiation. The most popular responses were radon gas and cosmic rays.

Question 2 (a) (iii)

Examiners were looking for an understanding that background radiation has regional variations. A person who flies a lot would also be subject to more cosmic rays. A mark was given for stating that a person's exposure to background radiation depended on their individual circumstances such as where they live or their lifestyle. A further mark was awarded for an explanation of why that led to more background radiation. Many of the candidates scored full marks but a significant number of the candidates cited where a person lived as a reason for increased background radiation but lost marks failing to explain why and often simply repeated the stem without further explanation.

Most candidates related increased background radiation to where a person lives.

(iii) Explain why some people are exposed to more background radiation than others.

(2)

In different areas of the country there are different amounts of rock that gives off the radioactive gas radon. This gets trapped in houses so some people live in areas ~~of~~ with higher levels of ~~CBP~~ background radiation.

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Examiner Comments

This is a clear answer which scores 2 marks.

(iii) Explain why some people are exposed to more background radiation than others.

(2)

This may be caused by where they live it may be in a more concentrated area.

ResultsPlus
Examiner Comments

This answer does not explain why background radiation might be more in one place rather than another and scores 1 mark only.

Some candidates knew that certain jobs could expose a person to more radiation.

(iii) Explain why some people are exposed to more background radiation than others.

(2)

because some people might work in places where there is more background radiation, and will be exposed to it more.

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Examiner Comments

This answer does not say why a particular job might increase exposure to radiation. It only scored 1 mark.

Question 2 (b) (i)

The vast majority of candidates correctly found the half life from the graph. The most common error was to look for 70Bq (half of the axis maximum rather than the activity at 0 days).

Question 2 (b) (ii)

The acitivity fell to 100Bq point at 2.2 days. Answers between 2 and 2.5 days were accepted. Many candidates, however, seemed to think that days can only be a whole number and gave an answer of the next full day (ie 3 days).

Question 2 (b) (iii)

Dangers to health from beta radiation were well known and, compared with the previous examination series, candidates were more precise in their answers. Most scored the mark.

Question 3 (a) (ii)

Examiners were looking for a description of an alpha particle. Full marks were given for either stating that it was equivalent to a helium nucleus or for giving the correct proton and neutron composition. Alternatively, a mark could be scored by correctly describing at least one property of an alpha particle (such as short range in air) and another mark could be scored by stating that it had a charge of +2.

Some candidates wrote about the properties of alpha particles without actually describing what the particle is.

> (ii) U-235 is radioactive.
> When it decays, it releases an alpha particle.
>
> Describe an alpha particle.
>
> **(2)**
>
> An alpha particle is quite weak as it can't pass through, paper, cardboard, skin. quite thin materials unlike beta and gamma.

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Examiner Comments

One mark for correct statement of a property of an alpha particle.

ResultsPlus
Examiner Tip

Use the number of marks in brackets (2) as a guide to how much detail you need to give.

Examiners were looking for a description of what an alpha particle is.

> (ii) U-235 is radioactive.
> When it decays, it releases an alpha particle.
>
> Describe an alpha particle.
>
> **(2)**
>
> An alpha particle is a helium nuclei, it is strongly positive as it has no electrons. Alpha particles are not very penetrating and they are strongly ionising.

ResultsPlus
Examiner Comments

This answer scored two marks in the first line.

Question 3 (b)

Most candidates knew what happens during nuclear fission and there were a number of ways in which full marks could be scored. A large number of the candidates scored at least 3 out of 4 marks with nearly half gaining full marks. The most common errors were to confuse atoms with their nuclei and to not mention that the nucleus becomes unstable after absorbing an extra neutron. There were only a very small number of candidates who confused fission and fusion.

(b) U-235 can also be made to undergo fission.

Describe what happens during nuclear fission.

(4)

In Nuclear Fission A slow moving neutron ~~g~~ bombards the Uranium atom, splitting it up into three ~~more~~ more atoms and making it unstable. These atoms also ~~release~~ release ~~release~~ more neutrons from the nucleus, which splits up more of the uranium atoms. This is called a chain reaction

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Examiner Comments

This answer can get a mark for mentioning the incoming neutron and a mark for the release of more neutrons. However, the confusion between atom and nucleus prevents any more marks being awarded.

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Examiner Tip

Read your answer to check that you have used the correct terms all the way through.

Many answers gave a complete description.

(b) U-235 can also be made to undergo fission.

Describe what happens during nuclear fission.

(4)

In fission, a slow moving neutron is fired into uranium-235. This causes it's nucleous to become unstable and split forming 2 daughter nuclei. It also releases 2 or 3 neutrons and loads of energy. The neutrons released then go to other uranium atoms causing them to split creating a chain reaction.

ResultsPlus
Examiner Comments

This excellent answer actually gained full marks in the first three lines.

Question 3 (c)

Candidates were asked to explain why a moderator is needed in a nuclear reactor. Many seemed to confuse the moderator with control rods and/or wrote about safety. A small number of the candidates knew that the moderator slowed neutrons but half of those then went on to relate this to safety. Knowledgeable candidates correctly wrote about the need to slow the neutrons down sufficiently so that they became more likely to be absorbed by a fuel nucleus.

The idea of slowing neutrons down was quite well known

(c) Fission is used in nuclear reactors.
Graphite is used as a moderator in nuclear reactors.

Explain why a moderator is needed in a nuclear reactor.

(2)

To control the chain reaction, a moderator is used to slow down the fast moving neutrons so tha ~~reaction of~~ fission reaction doesn't get out of control. Another example of a moderator is water.

(Total for Question 3 = 9 marks)

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Examiner Comments

A mark for writing that the moderator slowed neutrons down, but no marks for keeping the reactor under control.

(c) Fission is used in nuclear reactors.
Graphite is used as a moderator in nuclear reactors.

Explain why a moderator is needed in a nuclear reactor.

(2)

the moderator is used to slow down the speed of the neutrons so that they are at the right speed to be absorbed by the nuclei. This is because when a neutrons is released from fission, they are moving at very high speeds.

ResultsPlus
Examiner Comments

A much better answer which easily scored full marks.

Question 4 (a) (ii)

Although candidates were only required to write a number into two boxes, the reasoning needed to arrive at the correct answers required a good understanding of charging by induction. The most common misconception was that the top of the tower became positively charged by attraction between opposite charges rather than repulsion of electrons by the negative charge of the cloud away from the top of tower. It was pleasing to see that a great many of the candidates scored full marks on this question.

Question 4 (a) (iii)

In this part of the question the charged tower was then struck by lightning. Candiates were asked to described what happened to the charge on the tower as a result of the lightning. Examiners were looking for an explanation which linked a flow of electrons from the cloud to the tower and which resulted in the tower becoming neutral again.

> (iii) Explain what happens to the charge on the metal tower as a result of the lightning flash.
>
> (2)
>
> When the electrons jump from the cloud to the tower, they neutralise the positive charge on the tower, so the tower becomes discharged. The tower now has no charge (Any excess electrons flow down to the earth)

ResultsPlus
Examiner Comments

Full marks for correctly linking a flow of electrons from the cloud to the tower with the tower becoming discharged.

Some candidates wrote about the tower becoming neutral (or discharged) but failed mention anything about a movement of charge to make this happen.

> (iii) Explain what happens to the charge on the metal tower as a result of the lightning flash.
>
> (2)
>
> Because the top of the metal tower first has a positive charge (electrons repel each other), when the lightning hits it, it will become neutral again.

ResultsPlus
Examiner Comments

A mark for becoming neutral again but no mark for explaining why.

(iii) Explain what happens to the charge on the metal tower as a result of the lightning flash.

(2)

The charge on the metal tower becomes neutral (no charge) after the lightning flash.

ResultsPlus
Examiner Comments

A mark for writing that the tower becomes neutral; but the candidate did not go on to explain why this happened.

ResultsPlus
Examiner Tip

If a question asks you to explain something then your answer must say why something happens.

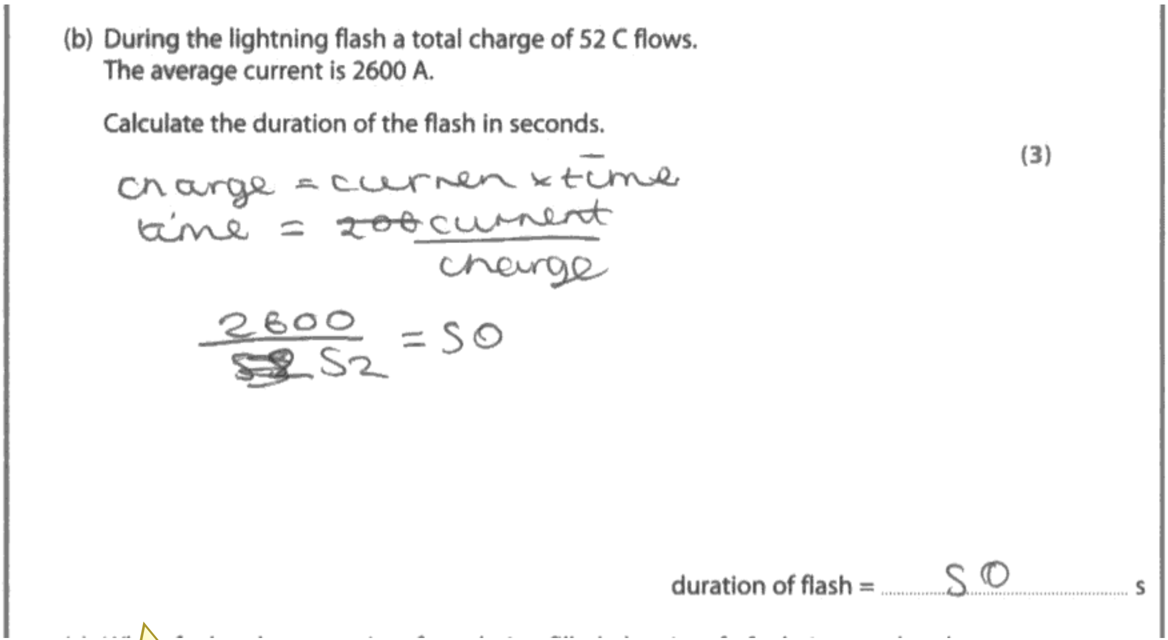
Question 4 (b)

Candidates were required to transpose the equation "Charge = current x time" given in the front of the answer booklet to calculate the duration of a lightning flash given the current and total amout of charge transferred.

Candidates could either substitute the given values into the primary equation and then transpose it find the time or they could transpose the equation first and then subsitue the given values.

As always on this paper, full marks are always given if the candidate writes down the correct anwser without showing any working. However this is a risky strategy and will always score no marks if the answer is wrong.

A mark was given for substituting the correct values into an equation. This mark could be awarded even if the candidate had incorrectly transposed the given equation; provided that the values of the quantities were made clear.



(b) During the lightning flash a total charge of 52 C flows.
The average current is 2600 A.

Calculate the duration of the flash in seconds.

(3)

charge = curren x time

time = ~~200~~ current / charge

2600 / ~~58~~ 52 = 50

duration of flash = 50 s

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Examiner Comments

Although the transposed equation time = current / charge is incorrect, the candidate has used the correct numerical values for current and charge in that equation and so has scored 1 mark.

ResultsPlus
Examiner Tip

It is always good to show your working. You can often get a mark; even if your final answer is wrong.

(b) During the lightning flash a total charge of 52 C flows.
The average current is 2600 A.

Calculate the duration of the flash in seconds. (3)

$Q = I \times t$
$t = Q / I$

$\frac{52}{2600} = 50$

duration of flash = 50 s

ResultsPlus
Examiner Comments

The candidate has written a transposed expression with the correct values for each quantity. Unfortunately the final evaluation of that expression is incorrect and so only 2 out of 3 marks were scored.

ResultsPlus
Examiner Tip

Always check that your answers to calculations make sense. A flash of lightning lasting 50 seconds is clearly going to be wrong!

80% of the candidates did this calculation correctly

(b) During the lightning flash a total charge of 52 C flows.
The average current is 2600 A.

Calculate the duration of the flash in seconds.

(3)

Time = $\frac{\text{charge}}{\text{current}}$

$\frac{52}{2600} = 0.02$

duration of flash = 0.02 s

ResultsPlus
Examiner Comments

A nicely laid out answer which scores full marks.

ResultsPlus
Examiner Tip

Triangles are a good way to help to remember some equations (BUT the examiner will not award any marks for them).

Question 4 (c)

Candidates were clearly very familiar with the scenario and often wrote in great detail about how a spark could occur when refuellng the aircraft before going on to explain how the earth wire works. Examiners, however, were looking for just the explanation of how earthing works.

(c) When fuel tanks on an aircraft are being filled, the aircraft, fuel pipes and tanker are connected by a metal wire to the ground.

Explain why this greatly reduces the chance of a spark.

(2)

Because the wire is touching the ground any Static charge that builds up will go through the metal wire and become "grounded" so that no Sparks will occur.

ResultsPlus
Examiner Comments

This gets a mark for writing that charge goes through the wire and a mark for mentioning grounding.

(c) When fuel tanks on an aircraft are being filled, the aircraft, fuel pipes and tanker are connected by a metal wire to the ground.

Explain why this greatly reduces the chance of a spark.

(2)

This greatly reduce a chance of a spark because they earthed it. Which means all the electrical current built up will spread out across the ground.

ResultsPlus
Examiner Comments

This scored a mark for writing about the aircraft being earthed but did not have enough correct further detail to score a second mark.

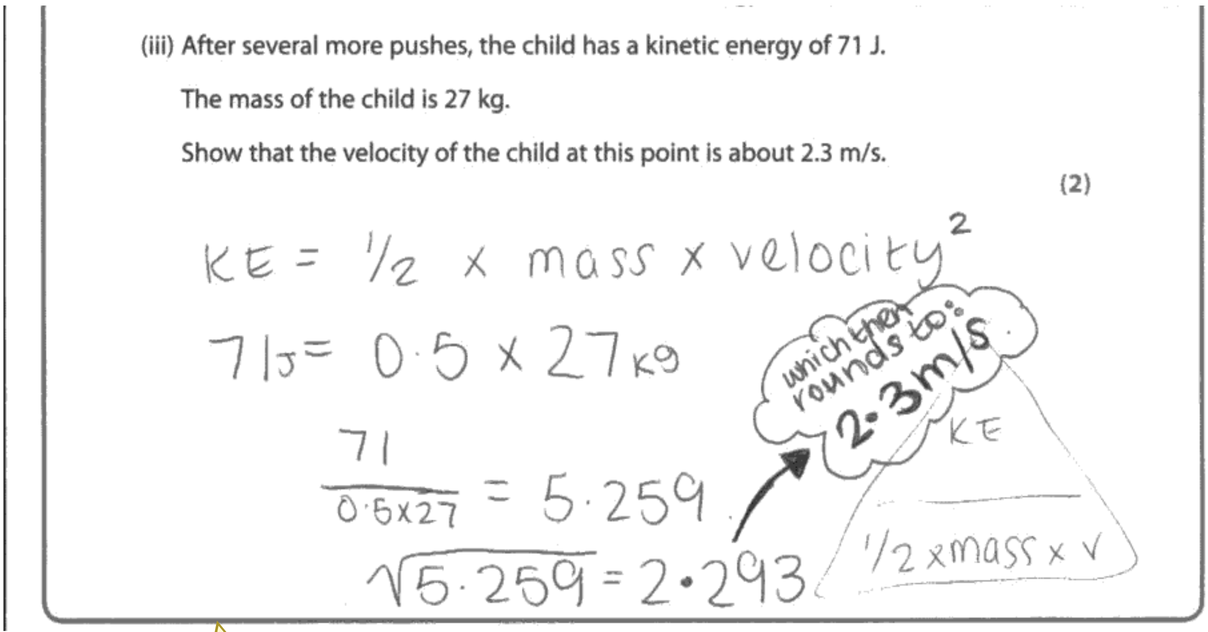
Question 5 (a) (iii)

In this type of "show that" question, candidates can score full marks in two ways.

They can use the values supplied (in this case 71J and 27 kg) and subsitute those into the equation given inside the fornt cover. They can then transpose this expression and perform any other required steps (in this case finding a square root) to arrive at a result which can be compared with the "answer" (in this case 2.3 m/s)

An alternative and mathematically simpler method is to use the "answer" of 2.3 m/s and the given value of mass (27 kg) in the expression for kinetic energy. They can then evaluate this expression and compare the result with the KE given in the question. This requires no transposition and no calculation of a square root.

This candidate has chosen to calculate the velocity from the KE and the mass.


(iii) After several more pushes, the child has a kinetic energy of 71 J.

The mass of the child is 27 kg.

Show that the velocity of the child at this point is about 2.3 m/s.

(2)

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Examiner Comments

Although v^2 is missing in the second line and 71 does not equal 0.5 x 27, the candidate's intentions are clear and the value of 2.293 could only have been obtained by the correct mathematics. Full marks

ResultsPlus
Examiner Tip

Make sure that values on each side of an equals sign really are equal to each other.

Here, the candidate has chosen the easier route.

(iii) After several more pushes, the child has a kinetic energy of 71 J.

The mass of the child is 27 kg.

Show that the velocity of the child at this point is about 2.3 m/s.

(2)

KE = ~~27×~~ $\frac{1}{2} \times 27 \times 2.3^2$

KE = 13.5×5.29

KE = 71.415

~~Very close~~ rounds to ~~7~~ 71

ResultsPlus

Examiner Comments

A simple response which scores full marks.

Question 5 (b)

This was the least well-answered question on the paper. It seemed that many candidates did not read the introduction carefully and gave answers which either implied or stated that the swings were decreasing in amplitude because the brother was still pushing but getting tired. Many other candidates tried to give explanations using the concepts of momentum, forces and acceleration rather than describing changes in kinetic energy. Another common misconception was that the kinetic energy was smallest when the swing was at the bottom.

Examiners were looking for an explanation which described a continuous transfer between kinetic energy and gravitational potential energy. They were also looking for an understanding that this transfer was not perfect and that energy was being dissipated to the surroundings resulting in a gradual loss of kinetic energy.

Rather than scoring individual marking points, examiners arrive at a judgement of the overall level of the response; taking into account how scientific terms are used to give a complete explanation.

This is best shown by the examples below.

A level 1 response would be a limited explanation which correctly stated some facts.

Explain the energy changes during this time.

(6)

the Kinetic energy increases as he moves down from the peak of his swing & then decreases as the child goes back up to the peak of his swing, this continues to happen until the child is no longer swinging.

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Examiner Comments

This is a simple explanation which correctly states how kinetic energy changed over the cycle and where the kinetic energy was greatest. The use of language is suitable for this level. 2 marks

A Level 2 response would be a simple explanation which linked facts together to explain one feature of the graph; either why the kinetic energy decreased and increased over one swing or why the maximum kinetic energy decreased over several swings.

Explain the energy changes during this time.

(6)

At the bottom, the child has the most kinetic energy. As the swing rises, kinetic energy decreases but gravitational potential energy increases. As the swing again accelerates downwards, the kinetic energy increases and GPE decreases. The cycle then repeats itself, with kinetic energy increasing towards the bottom and decreasing as the swing rises, and GPE increasing as the swing rises but decreasing as the swing falls. As the GPE increases less and less each time, the kinetic energy does the same, so the swing starts to go lower before eventually stopping.

ResultsPlus

Examiner Comments

This answer gives a clear description of the transfer between kinetic and gravitational potential energy. Although the candidate has mentioned the decrease in maximum kinetic energy, this has not been explained. Spelling, punctuation and grammar is suitable for this level. 4 marks.

Explain the energy changes during this time.

(6)

The kinetic energy output is reduced with each swing ~~At first~~ The first swing is highest on the graph ~~as~~ It gets lower with each swing as ~~each one~~ energy is wasted in heat from friction and sound energy. This reduces the kinetic energy output. Also, the faster he travels, the more he is affected by air resistance. Due to this, it affects him differently with each swing for it slows him down each time.

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Examiner Comments

This response explains why the maximum kinetic energy decreases over several cycles and is at level 2. It does not mention the transfer between kinetic energy and gravitational potential energy. It scored 4 marks.

Level 3 responses gave a full explanation of both features of the graph.

Explain the energy changes during this time.

(6)

When the child is a the bottom og his swing he has maximum KE. As he swings upwords he gains GPE. This is not without loss and so when he reaches the bottom he has less KE than he started with. This is because og griction and air resistense. Friction acts on the moving parts og the system, turning KE into heat. Also As the child swings gorword he has a large amount og air resistense. This takes KE grom the swing and gives it to the air particals. All the energy lost is conserved but just in other gorms.

(Total for Question 5 = 12 marks)

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Examiner Comments

A well written response which explains both the transfer between kinetic energy and gravitational potential energy and the gradual decrease in maximum kinetic energy. All scientific terms are used correctly. Full marks at level 3.

Candidates need to be especially careful with their English as well as their Physics.

Explain the energy changes during this time.

(6)

the energy changes in this due to air resistance, or Drag, and the friction of the chain at the top. so he gets to the top, loosing kinetic energy and transfering that to ~~[crossed out]~~ Gravational potential, then when he starts to fall, that is changed back to kinetic energy, however air resistance and friction opposes this and with every swing, he looses energy to heat, this means on the next swing he wont go as high or as fast until the air resistance and friction brings the swing to a stop and all the energy ~~is~~ has been lost as heat.

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Examiner Comments

Although the scientific explanation is correct and is at level 3, the answer has many errors of spelling, punctuation and grammar. 5 out of 6 marks only.

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Examiner Tip

Make sure that you use capital letters and punctuation correctly. If you do not then you will lose marks in this type of question.

Question 6 (a) (ii)

Only a few of the candidates knew that , "In a vacuum , all bodies falling towards the Earth's surface have the same acceleration". This was disappointing; especially since this sentence is almost identical to that in the unit specification.

Question 6 (b)

The calculation of the weight of a raindrop was correctly done by nearly all of the candidates.

Many candidates wrote their answer in standard form. Although this is not required in this syllabus, it is good preparation for higher level studies and is encouraging to see.

(b) The mass of one water drop is 0.000 08 kg.

Calculate its weight.

(gravitational field strength is 10 N/kg)

(2)

Weight = mass × gravitational field strength

~~0.00~~

x = 0.00008 × 10

x = 0.0008

weight = 8×10^{-4} N

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Examiner Comments

A well laid out answer

Question 6 (d)

Candidates were asked to explain the pattern of water drops falling from a height. The distance increased between succesive drops at the top of the fall whereas drops at the bottom were equally spaced. Examiners were looking for an answer which identified the pattern at the top with acceleration and the pattern at the bottom with constant velocity. This would have been a level 2 response (max 4 marks) . A level 3 response would include a clear explanation as to why the motion of the drops changed in this way. Such an explanation would need to include the idea of air resistance increasing with velocity until there was no resultant force on the drops. At this point terminal velocity is reached.

It was pleasing to see so many candidates engaging fully with this question and the idea of terminal velocity was well known. A good number of candidates gave excellent explanations. There was, however a lack of accuracy in the use of terms; even within level 3. Candidates would often write about speed decreasing as air resistance increased, even though it was clear from the rest of their answer that they meant acceleration was decreasing. This type of inaccuracy would put an otherwise excellent answer at the lower end of the level (5 marks instead of 6).

*(d) The tank is a long way above the ground.
It drips at a steady rate.

The first drawing shows water drops which have just left the tank.
The second drawing shows water drops which are near to the ground.

drops leaving the tank   drops near to the ground

Explain why the drops which are near to the ground are an equal distance apart but the drops which have just started to fall are not.

(6)

This has happened because of terminal velocity. As the drops leave the tank their weights pulls them down. They accelerate towards the ground. There is little air resistance, so there is a large resultant force downwards. However after some time the weight and air resistance become balanced forces. So the acceleration increased the air resistance. There is now no resultant force on the object. Therefore the water drops would move at a constant ~~sp~~ velocity. So all the water drops would be at the same velocity and distance as the others because they have all reached terminal velocity.

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Examiner Comments

A very good answer which clearly compares initial acceleration with eventual constant velocity. The explanation includes the idea that air resistance increases until there is no resultant force. There is a little clumsiness in the sentence "so the acceleration increased the air resistance" but this is not serious enough to lose marks. The answer scored 6 marks.

*(d) The tank is a long way above the ground.
It drips at a steady rate.

The first drawing shows water drops which have just left the tank.
The second drawing shows water drops which are near to the ground.

drops leaving the tank   drops near to the ground

Explain why the drops which are near to the ground are an equal distance apart but the drops which have just started to fall are not.

(6)

because as the leave the tank they are accerlerating away so the further they go the faster they will get. So their velocity will be increasing. but at some point they will reach terminal velocity and not be able to increase their Speed any more. So this will even out the drops as they get further down.

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Examiner Comments

This response compares an initial acceleration with an eventual terminal velocity. There is no explanation as to why this happens, however. This is a level 2 answer scoring 4 marks.

*(d) The tank is a long way above the ground.
It drips at a steady rate.

The first drawing shows water drops which have just left the tank.
The second drawing shows water drops which are near to the ground.

Explain why the drops which are near to the ground are an equal distance apart but the drops which have just started to fall are not.

(6)

The drops which have just fallen out of the tank have not reached their terminal velocity as they have only just fallen. The ones near the ground have all reached their terminal velocity and so are equally spread out as they are going at the same speed. The drops at the top have only just set off so gravity and their weight have not yet pulled them down while the ones at the bottom have been.

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Examiner Comments

This answer identifies that the drops at the bottom are going at the same speed and correctly calls this terminal velocity. However, there is no menton of the pattern of the drops at the top and no explanation as to why the drops have reached terminal velocity. This is a level 1 response and it scored 2 marks.

Paper Summary

In order to improve their performance candidates should:

- make sure that they have a sound knowledge of the fundamental ideas in all six topics
- make sure that they understand the meaning of terms like force, momentum, acceleration and velocity and that they use these words accurately
- get used to the idea of applying their knowledge to new situations by attempting questions in support materials or previous examination papers
- show their working at each stage of a calculation and check the final answer makes sense
- use the marks at the side of a question as a guide to the form and content of their answer

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