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Examiners' Report
June 2016

GCSE Applied Science Physics 5PH2H 01

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Introduction

This unit is divided into six topics and all six topics are tested in the examination.

The topics are:

- 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 is 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 1 or 2 marks each and longer questions worth 3 or 4 marks each. The two 6- 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 using scientific terms when developing arguments
- did not show their working in calculations
- did not think through their answers before writing.

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 (b)(i)

Most candidates gained a mark for identifying the separation of charge. Two marks were often obtained for recognising that electrons moved from her to the carpet. Candidates normally lost the third mark for failing to identify that friction was responsible for the separation of the charge. Marks were also lost for stating that protons moved from the carpet to her or electrons moved from the carpet to her. A significant number wrote, incorrectly, about both positive and negative charge moving.

Quite frequently candidates mentioned induction. On this occasion examiners ignored this incorrect reference provided that the rest of the answer was correct.

(b) A student has a nylon carpet in her bedroom.

She becomes positively charged as she walks across the carpet.

(i) Explain how the student becomes positively charged.

(3)

The student becomes possitively charged because she transfers electrons to the carpet meaning she now has more protons making her unstable

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Examiner Comments

This response, typical of many, correctly describes transfer of electrons from student to carpet for 2 marks.

It falls short of explaining why this charge transfer occurs; i.e. friction between two surfaces.

As the student rubs along the carpet the electrons transfer from her to the carpet. This takes away her negative charge leaving only the protons and neutrons which make her positively charged.

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Examiner Comments

This response gives an acceptable description of charge separation (it is not true that **only** protons and neutrons remain; simply that there are fewer electrons than before which causes an imbalance).

The idea of friction is implied by the "student rubs along the carpet". This was just acceptable for the examiner to award the full three marks.

~~think~~ frickshen creates a positive charge as she Drags her feet & makes lots of fricksten.

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Examiner Comments

This shows a limited understanding of electrostatics. Although friction is correctly identified , the answer does not mention charges being transferred or separated.

1 mark out of 3

Candidates sometimes wrote correctly about charge transfer caused by friction but neglected to state the direction in which the electrons moved.

The friction between her shoes/feet an her floor causes an exchange of electrons which causes a positive charge on her feet

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Examiner Comments

Almost correct. It mentions an exchange of electrons due to friction but does not make clear in which direction this exchange occurs.

2 marks out of 3

Question 1 (b)(ii)

Many candidates were clearly familiar with this scenario and understood that charge could now flow because the student had become "earthed". There was some confusion about the direction of flow (and indeed about the nature of the charge that moved). Fewer candidates mentioned that charge could flow because the metal handle was a conductor; although the full two marks could still be obtained without this statement.

It was pleasing to note that there were fewer answers using inaccurate phrases such as "the static electricity flows.." than in previous years.

(ii) When the student touches a metal door handle she feels an electric shock.
Explain why she feels an electric shock.

(2)

The metal door handle is a conductor, therefore she becomes discharged when she touches the door handle as the charge passes through ~~it~~ the door handle as she gains electron to discharge her.

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Examiner Comments

There is a mark for stating that the metal handle is a conductor.

The statement that the student becomes discharged is an acceptable answer for a second mark.

However, the statement that the student gained electrons is a more secure second mark.

2 marks in total for this answer

As neither the door or the student are earthed, when touching the door a spark or shock can occur. This is due to the forces of attraction between her positively charged hand and the negatively charged handle.

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Examiner Comments

Although the answer mentions charge, it does not refer to movement of charge.

0 marks

Metal is a good conductor of electricity and had a lot of energy built up from the friction.

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Examiner Comments

One mark (only) here for recognising that the metal handle is a conductor.

The charge flows through her and into the door handle, causing a shock as she earths

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Examiner Comments

There is a correct statement about charge flowing which is acceptable for one mark.

However, the answer implies that the charge flows from the student whereas in reality it is electrons (carrying a negative charge) which flow into the student.

Question 1 (c)

Candidates were able to identify and use the correct equation to calculate the charge flowing. The most common error was to either neglect the conversion from mA into A or to multiply the result by 1000 rather than divide.

(c) An electric torch is switched on for 90 s.

The current in the torch is 70 mA.

Calculate the amount of charge flowing from the torch battery during this time.

(2)

charge = current X time

charge = 70mA x 90

charge = 0.07A x 90

charge = 6.3

charge = 6.3 C

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Examiner Comments

A clearly written answer which scored full marks. The candidate took care to include the units mA in the first line and then converted into amps before evaluating.

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Examiner Tip

Look carefully at the values in the question. Make sure that you include any conversions, such as mA into A , before doing the final calculation.

Question 2 (b)

Most candidates were secure in their understanding of the notation used to describe nuclei and could use this to provide the correct number of protons and neutrons in the isotope given.

Question 2 (c)

Although there a very large number of fully correct answers, many candidates demonstrated a limited understanding of the moderator. They knew that the moderator slowed neutrons down but then went on to say that this would keep the reaction "under control". Examiners were able to award one mark for the idea of slowing neutrons in such cases.

A large number of candidates appeared to confuse the action of the moderator in a nuclear reactor with that of the control rods and wrote about absorbing neutrons in order to limit the rate of the nuclear reactions.

(c) Describe the purpose of the moderator in a nuclear fission reactor.

(2)

The moderator slows down the neutrons so they are more likely to be absorbed by uranium-235 nuclei.

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Examiner Comments

A good and concise answer which scored 2 marks.

This is where neutrons are slowed down to help control the chain reaction. So it doesn't cause an explosion.

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Examiner Comments

One mark for the idea of neutrons being slowed down, but the reason for slowing the neutrons down is incorrect.

1 mark out of 2

A moderator slows the very fast moving neutrons so that they are more easily absorbed.

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Examiner Comments

One mark for neutrons being slowed down, but the candidate did not specify where they would be absorbed; only that they would be more easily absorbed.

This scored 1 mark out of 2.

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Examiner Tip

Check your answer to make sure that the examiner is in no doubt about what you mean.

Question 2 (d)

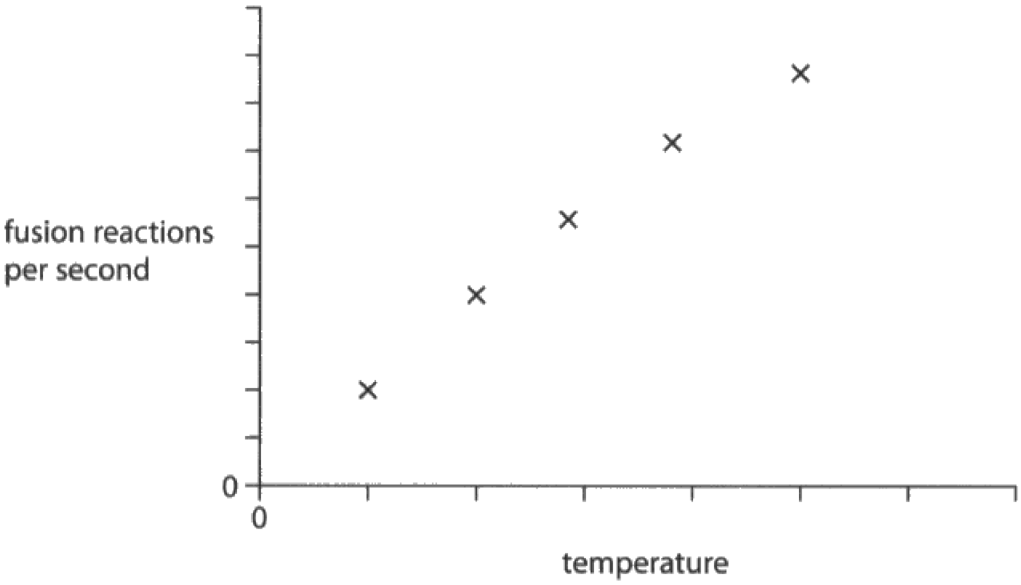
Most candidates who scored two marks stated that the nuclei have high kinetic energy and this enabled them to overcome repulsion. Several candidates scored one mark for identifying that the nuclei needed to overcome repulsion but lost the second mark for failing to either link temperature with the kinetic energy of the nuclei or to explain how this would increase the chance of a collision resulting in fusion.

Many candidates, who failed to score any marks for this question, described how the higher temperature increased the energy of the reaction or even that temperature acted like a catalyst.

(d) Scientists have studied fusion reactors.

They have found that the number of fusion reactions per second varies with temperature.

This variation is shown on a graph.



Explain why the number of fusion reactions per second varies with temperature in this way.

(2)

Fusion reactions require high temperatures and pressures for the atoms to overcome their repulsion and fuse to make energy.

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Examiner Comments

This answer makes correct reference to the need to overcome electrostatic repulsion but does not go far enough in explaining why high temperatures make this more likely. Although there is a reference to energy in this answer, it is about the energy arising from fusion and not the kinetic energy of the moving atoms.

It scored 1 mark out of 2.

As the temperature increases the particles have more energy to overcome the repulsion between the positively charged nuclei so there are more frequent collisions.

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Examiner Comments

An acceptable answer which links increased energy of the moving ions with the ability to overcome repulsion.

Although the candidate has used the term "energy" rather than the more accurate term "kinetic energy", the meaning was sufficiently clear for the examiner to award the mark.

Examiners would also condone the term "particles" in this case.

2 marks

Many candidates described **what** the graph showed rather than explaining **why** the graph had this shape.

0 marks

As the temperature increases the rate of reaction increases which means fusion reactions increase.

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Examiner Comments

This response does not give any explanation. It simply states the relationship between temperature and reactions per second.

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Examiner Tip

Make sure you read the question carefully. Look for key words such as "explain why" before deciding how to answer.

The two hydrogen atoms need travel at high speeds to fuse, therefore at higher temperatures, the hydrogen will be travelling quicker so successful fusion will be more frequent.

ResultsPlus
Examiner Comments

A acceptable link between the temperature and speed of the atoms. This is then linked to more frequent successful collisions.

2 marks

Question 2 (e)

Although some candidates simply stated that fusion could not take place at room temperature, many knew about "cold fusion" and could demonstrate an appreciation of the scientific method. Examiners saw and gave marks for a wide range of ways in which this could be stated. Here are a few examples.

(e) In 1989, some scientists claimed to have achieved fusion at room temperature. take place.

Suggest why their claim is no longer believed.

(1)

~~the~~ Other Scientists could not replicate the experiment and achieve the same result.

ResultsPlus
Examiner Comments

An acceptable response.

because it wasn't validated by the scientific community

ResultsPlus
Examiner Comments

An acceptable response.

The results which the scientists published could not be reproduced by other scientists, so the claim is no longer believed.

ResultsPlus
Examiner Comments

An acceptable response.

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Because they could not do it again and other scientists could not do it either.

ResultsPlus
Examiner Comments

An acceptable response.

Question 3 (a)(b)

This question assessed understanding of energy transfers. Examiners were expecting to see use of the equation work done = force x distance. However calculations which used potential energy = mgh were more frequent. Of course, both approaches evaluate to the same answer of 1,710,00 J and are equally acceptable.

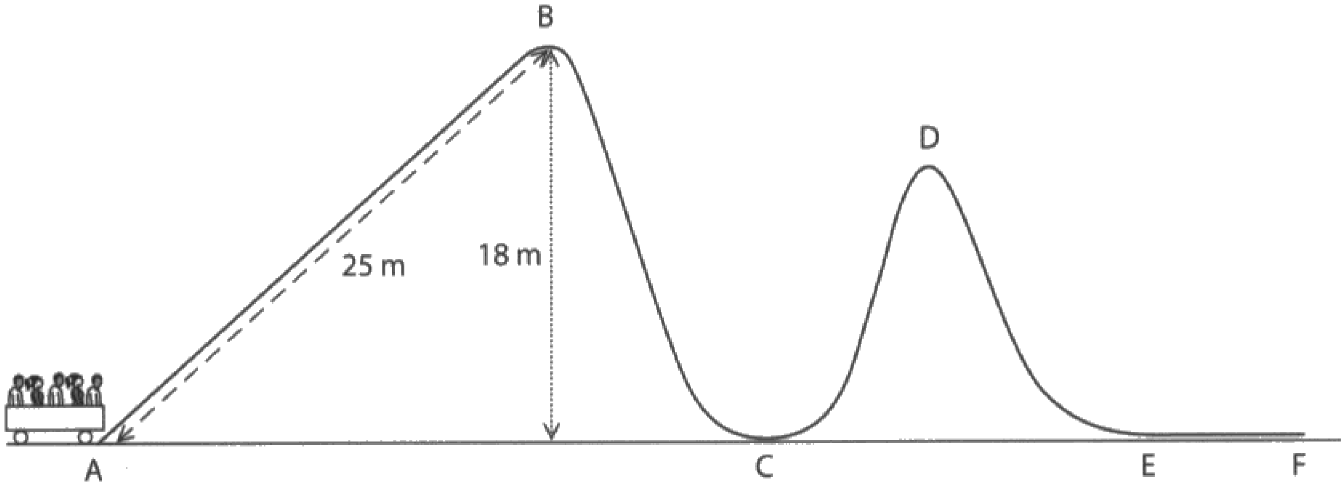
The most common error was to use the distance along the slope (25m) rather than the distance above the ground (18m). This produced an answer of 2,375,000 J. Examiners allowed 1 mark for this.

For part (b), candidates needed to recognise that work done against gravity would become kinetic energy as the car went down the slope and that the maximum kinetic energy would be the value calculated for part (a).

Examiners allowed incorrect values for (a) to be carried through to part (b) for 1 mark.

Work, energy and momentum

3 The diagram shows a car and passengers at the start of a roller coaster ride at an amusement park.



(a) An electric motor pulls the car from A to B at a steady speed.

The total mass of the car and passengers is 9500 kg.

Calculate the amount of work done on the car and passengers.
[Gravitational field strength, g = 10 N/kg]

(2)

10 × 25 = 250

work done = 250 J

(b) The car is released at B and continues down the track.

State the maximum possible kinetic energy of the car and passengers at C.

(1)

maximum KE = 250 J

ResultsPlus
Examiner Comments

The calculation in part (a) was incorrect and scored no marks.

However the candidate demonstrated understanding that the maximum kinetic energy gained would be the same as the work done in part (a) and scored the mark.

(a) An electric motor pulls the car from A to B at a steady speed.

The total mass of the car and passengers is 9500 kg.

Calculate the amount of work done on the car and passengers.
[Gravitational field strength, g = 10 N/kg]

(2)

force = mass × acceleration
= 9500 ×

force × dist

9500 × 10 × 18

work done = 171 0000 J

(b) The car is released at B and continues down the track.

State the maximum possible kinetic energy of the car and passengers at C.

(1)

maximum KE = 4750 J

½ × mass × velocity

½ × 9500 × 0

ResultsPlus
Examiner Comments

This response shows a good answer for the first part and gave the correct value for 2 marks.

The candidate did not recognise that the work done would be transferred to kinetic energy and attempted an incorrect calculation instead. This did not score a mark.

ResultsPlus
Examiner Tip

If the question asks you to "state" a value then you do not need to do a calculation.

(a) An electric motor pulls the car from A to B at a steady speed.

The total mass of the car and passengers is 9500 kg.

Calculate the amount of work done on the car and passengers.
[Gravitational field strength, g = 10 N/kg]

(2)

9500 x 25 = 237500

work done = 237500 J

(b) The car is released at B and continues down the track.

State the maximum possible kinetic energy of the car and passengers at C.

(1)

maximum KE = 237500 J

ResultsPlus
Examiner Comments

The wrong distance was used. Furthermore, the candidate did not include g in the calculation . No marks for part (a).

However the candidate demonstrated understanding that the maximum kinetic energy gained would be the same as the work done in part (a) and scored the mark in part (b).

Question 3 (c)

Examiners were looking for a description of kinetic energy being transferred to gravitational potential energy (although simply "potential energy" would have been accepted).

Answers which correctly identified the two energy stores, but had the direction of the transfer the wrong way round would still score 1 mark out of 2.

Examiners did not award marks for transfers to other energy stores such as electrical, heat, sound etc. These are not the **main** energy transfers in this system.

(c) Describe the main energy transfer that takes place between C and D.

(2)

Kinetic energy turns to heat energy and sound energy

ResultsPlus

Examiner Comments

Although in many systems, some energy is transferred to heat (and possibly sound), this is not the **main** energy transfer in this case.

No marks

(c) Describe the main energy transfer that takes place between C and D.

(2)

The kinetic energy is transfered to gravitational potential energy.

ResultsPlus

Examiner Comments

A correct description of the energy transfer. This scored 2 marks.

Question 3 (d)

This required identification and re-arrangement of the equation given at the front of the exam paper followed by an evaluation. The value shown on a calculator has several decimal places. It was very pleasing to see that the majority of candidates correctly rounded this value to an appropriate number of significant figures. The correct use of significant figures continues to improve each year.

(d) When the car and passengers reach E, they have a total momentum of 150 000 kg m/s.

The total mass of the car and passengers is 9500 kg.

Calculate the velocity of the car and passengers at E.

(3)

$P = m \times v$

$150{,}000 = 9500\text{kg} \times$ ____

$\frac{150{,}000}{9500} =$

velocity = 1.6 m/s

ResultsPlus

Examiner Comments

The examiner could see that the candidate had arrived at a correct expression (150,000 / 9500) but then made a mistake in the final evaluation. This could still score 2 marks.

(d) When the car and passengers reach E, they have a total momentum of 150 000 kg m/s.

The total mass of the car and passengers is 9500 kg.

Calculate the velocity of the car and passengers at E.

(3)

momentum = mass × velocity.

$$velocity = \frac{momentum}{mass}$$

$$= \frac{150,000}{9500}$$

= 15·7894

= 16

velocity = 16 m/s

ResultsPlus

Examiner Comments

One example of many good answers worth all three marks.

Question 3 (e)

Most candidates showed some understanding of motion by correctly relating the increased distance with an increase in the time taken to come to a stop. Weaker candidates often expressed this in terms of being "less sudden" which was acceptable for the first mark. However, expressions such as "more gradual" or "more smoothly" were too vague to be credited.

More able candidates then displayed detailed knowledge and understanding by using the fact the force was proportional to the rate of change of momentum or that the slower deceleration would require a smaller force on the car and its passengers.

Less able candidates lost the second mark for trying to provide explanations including "whiplash" or that it would allow the passengers time to prepare themselves. Several candidates stated that the momentum would be less instead of referring to the rate of change of momentum. Some candidates attempted to discuss overall stopping distance together with thinking distance and breaking distance.

(e) Brakes are applied as the car passes E.

This brings the car to a stop at F.

Explain why it is more comfortable for the passengers if there is a large distance between E and F.

(2)

It is more comfortable for the passengers is there is a large distance between E and F because the car can gradually slow down and it is comfortable, whereas is the distance is short then the car has to stop quicker meaning it is less comfortable as it has to stop in a shorter distance.

(Total for Question 3 = 10 marks)

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Examiner Comments

This response scores a mark for describing the car "gradually slowing down". This is an acceptable way of saying that the time taken to stop is longer. However it does not go on to make the point about force being less but simply repeats the stem about being "more comfortable for the passengers".

1 mark out of 2

(e) Brakes are applied as the car passes E.

This brings the car to a stop at F.

Explain why it is more comfortable for the passengers if there is a large distance between E and F.

(2)

Because force is reduced if change in momentum takes place over a longer time period. The longer the distance between E and F, the less force will be felt by the passengers. Force = change in momentum ÷ time.

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Examiner Comments

An excellent answer which shows a detailed understanding of the topic.

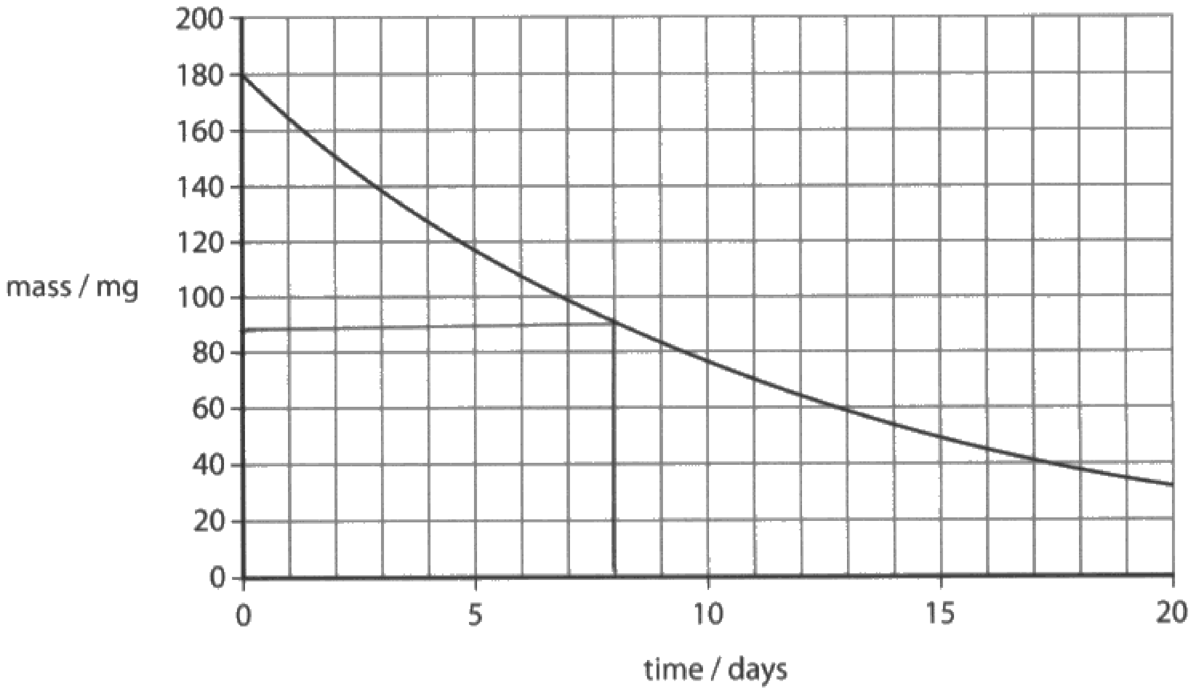
Question 4 (a)(i)

Each year, the number of candidates who correctly determine half-life from a radioactive decay curve continues to improve. Most candidates found the time taken to fall to 90mg, but others found the difference between the time when it was 100mg and 50mg. This was a perfectly acceptable method even though it did require subtracting two readings from the graph with the risk of making an error.

Some weaker candidates read the horizontal axis incorrectly. Provided that there was clear evidence of using the graph correctly then this could still score 1 mark out of 2.

Radioactivity and its uses

4 (a) Iodine-131 is used in hospitals.
The graph shows the decay of a sample of iodine-131.



(i) Use the graph to find the half-life of iodine-131.

(2)

half-life = ...7.......... days

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Examiner Comments

Although the final answer was incorrect, the candidate showed a "method" which attempted to find the time taken to fall from 180mg to 90mg. This was sufficient evidence for the examiner to award 1 mark out 2.

Question 4 (a)(ii)

Only a limited number of candidates were able to provide an answer within the acceptable range. Such candidates recognised that 7 days was just under 1 half-life and therefore there would be a little under twice as much material present then.

(ii) Estimate the mass of iodine-131 in the sample 7 days before the start of the graph.

(1)

180 × 2 = 360 = 8 days before.

mass = 350 mg

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Examiner Comments

This is a perfectly acceptable response. It recognises that there would be a little under 360 mg. Examiners would accept any value in the range 300 mg to 360 mg.

(ii) Estimate the mass of iodine-131 in the sample 7 days before the start of the graph.

(1)

8 days earlier = 360g

$\frac{360}{8} \times 7 = 315g$

mass = 315 mg

ResultsPlus
Examiner Comments

Not only has the candidate recognised that there would be approximately twice as much material present, there is also a very creditable attempt to refine the estimate. This was not required for the mark, but it does show a good understanding of half-life.

Question 4 (a)(iii)

There was generally a good understanding of the dangers associated with ionising radiation and most candidates were able to describe the possible effects on living tissue.

Fewer candidates applied this to the particular situation of those whose work involves repeated exposure to ionising radiation and are therefore exposed to greater risk than the population as a whole.

(iii) Iodine-131 emits beta particles and gamma rays.

A patient is only given a small dose of iodine-131 during treatment.

Hospital staff who administer this treatment to a lot of patients are potentially exposed to greater risk.

Explain the dangers to hospital staff.

(2)

The gamma rays can damage the skin cells which may lead to cancer. The cells mutate.

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Examiner Comments

There was often good understanding of the risks from ionising radiation in general but often this was not related directly to workers in the hospital.

1 mark out of 2

(iii) Iodine-131 emits beta particles and gamma rays.

A patient is only given a small dose of iodine-131 during treatment.

Hospital staff who administer this treatment to a lot of patients are potentially exposed to greater risk.

Explain the dangers to hospital staff.

(2)

Because they are reguarly exposed to radiation, they get a abnormaly high dose compared to average which could lead to illness

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Examiner Comments

Several candidates appreciated that increase exposure carries a higher risk but failed to specify what that risk was.

1 mark out of 2

(iii) Iodine-131 emits beta particles and gamma rays.

A patient is only given a small dose of iodine-131 during treatment.

Hospital staff who administer this treatment to a lot of patients are potentially exposed to greater risk.

Explain the dangers to hospital staff.

(2)

If they administer the treatment a lot, they are getting a lot of exposure to radioactive substances and so have a higher chance of having cells in their body harmfully mutate.

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Examiner Comments

An answer typical of many seen. There is a secure understanding that the risks of ionising radiation increase with the amount of exposure to it.

2 marks

Question 4 (a)(iv)

The type of radioactive material was not specified in this part of the question and therefore examiners would accept any sensible precaution. Many candidates were confident in their knowledge of this topic and related it to situations they may have encountered such as using tongs, storage in lead-lined boxes and directing the source away from the body and other people. Others considered industrial situations where lead screens and remotely controlled handling methods could be used.

The mark was most often lost where the answer was not specific enough; for example "wear protective clothing". This could relate to a wide range of protective equipment not directly related to radioactive material.

(iv) State one safety precaution related to the use of radioactive material.

(1)

Stay behind a thick sheet of lead.

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Examiner Comments

An acceptable precaution which scored 1 mark.

(iv) State one safety precaution related to the use of radioactive material.

(1)

Using tongs instead of using your hands.

ResultsPlus
Examiner Comments

A typical acceptable answer which scored 1 mark.

(iv) State one safety precaution related to the use of radioactive material.

(1)

Keep the radioactive source in a lead box when not in use.

ResultsPlus
Examiner Comments

Another acceptable answer for 1 mark.

(iv) State one safety precaution related to the use of radioactive material.

(1)

Wear goggles.

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Examiner Comments

Goggles were not accepted unless it was qualified by reference to the possibility of radioactive liquids splashing into the eyes, as in this example.

Question 4 (b)(ii)

For the first mark, examiners were looking for answers which demonstrated an understanding of how the amount of radiation passing through a material would vary with the thickness of the material; in this case paper. For the next two marks, examiners were looking for a logical description of how this can be applied as part of a process.

Most candidates gained the first mark.

Several candidates stated the materials that would stop the three different radiations but were unable to apply this knowledge to the question. Some candidates stated that the detector measured the time taken by the radiation to travel through the paper: longer time = thicker paper. The third mark for this question was mainly lost for not explaining what change needed to be made to the rollers. Many candidates stated the rollers could be changed to make the paper thicker or thinner without being specific.

The relative penetrating properties of different types of radiation were often well known. Although the system uses beta radiation, this fact was tested in the previous part of the question. Candidates who attempted to use alpha radiation in a plausible context were not penalised.

(ii) Explain how this system controls the thickness of the paper.

(3)

alpha cant penetrate through paper and beta can penetrate through paper. therefore by using these sources, if alpha penetrates through, the paper is too thin whereas if beta cant penetrate through, the paper is too thick.

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Examiner Comments

The answer shows limited understanding of how the system might work. It does not address how the thickness can be controlled; only that an incorrect thickness can be recognised. 1 mark scored.

(ii) Explain how this system controls the thickness of the paper.

(3)

If the beta particle cannot make it through the paper, the paper is too thick and the rollers move closer together. If the beta particle gets through the paper too easily or too quickly, the paper is too thin and the rollers move apart

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Examiner Comments

In this response, it is clear that there will be a difference in the amount of radiation penetrating the paper and how the rollers should be adjusted. It does not, however, mention the part that the detector plays in the process by measuring the amount of radiation received and sending a signal to control the rollers.

This scored 2 out the 3 marks.

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Examiner Tip

Check your answer to see if you might have left something out.

Some candidates wrote more than was necessary.

(ii) Explain how this system controls the thickness of the paper.

(3)

Beta can pass through paper, unlike alpha. The more Beta dectected shows the paper is ~~thicker~~ thinner. However, the less beta passing through and being ~~dete~~ detected means the paper is thicker. The system allows the paper to be the right thickness, bey seeing ~~tha~~ how much beta passes through.

(Total for Question 4 = 10 marks)

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Examiner Comments

The answer makes valid points about the amount of radiation detected increases as the paper gets thinner. There is no need to re-state the argument for cases when the paper gets thicker. The candidate found it necessary to write outside of the space given for the answer and did not go on to explain how the thickness could be controlled.

It scored 2 marks out of 3.

ResultsPlus
Examiner Tip

Try to plan your answer and think through what you are going to write before putting pen to paper.

Candidates with a secure understanding of this application of radiation were easily able to provide a fully correct answer in the space provided.

(ii) Explain how this system controls the thickness of the paper.

(3)

When the paper is less thick more beta can get through, when the paper is too thick & not much beta is detected, the detector causes the rollers to come together more & produce thinner paper. Beta is ionising so it ionises the air.

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Examiner Comments

A correct observation on how the amount of radiation penetrating is affected by the thickness of the paper is then linked to a concise and clear description of how this is detected and used to control the rollers.

Full marks were awarded.

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Examiner Tip

If you think for a while before answering you should be able to easily write a fully correct answer in the space provided.

Question 5 (a)

Candidates were generally secure in their understanding of how a voltmeter should be connected. However, it was surprising that a large number of candidates failed to make any attempt at this question.

Question 5 (c)

The most common approach was to calculate the resistance as 10.8 ohms using the values of voltage and current given. Other, equally acceptable, approaches were to take the resistance as 11 ohms and then either calculate the voltage(4.07 V) using the given value of current or find the current (0.37 A) using the given value of voltage.

It is pleasing to see that so many candidates are confident with this type of question and are able to perform the correct calculation and then draw the correct conclusion.

(c) When the variable resistor is at the half-way position, the ammeter reads 0.37 A and the voltmeter reads 4.0 V.

Show that the resistance of the filament in the lamp is about 11 Ω.

(2)

$V = I \times R$

~~4.0÷0.40~~

$R = V \div I$

$R = \frac{4.0}{0.37}$

$R = 10.8\ \Omega$

rounds to 11Ω

ResultsPlus
Examiner Comments

This was typical of very many good answers seen.

2 marks

(c) When the variable resistor is at the half-way position, the ammeter reads 0.37 A and the voltmeter reads 4.0 V.

Show that the resistance of the filament in the lamp is about 11 Ω.

(2)

potential difference = current x resistance

4 = 0.37 x resistance

$\frac{4}{0.37}$ = 10.81

check

0.37 x 10.81 = 3.9

ResultsPlus
Examiner Comments

The candidate has not only carried out the correct calculation, but has then gone on to check by performing the calculation again in reverse to confirm.

ResultsPlus
Examiner Tip

If you have time, doing a check on your calculation is an excellent idea. Try taking your answer and one of the other values given and see if you can calculate the second value given in the question.

Question 5 (e)

A level 1 response would use the information in the graph to identify a relevant change in the filament . Most commonly this would be that the resistance increases with current. Sometimes this was expressed in terms of the changing gradient of the graph.

A level 2 response would link the changes shown by the graph to some other change in the filament; typically an increase in resistance linked to an increase temperature as the current increased. Sometimes a correct link was made between the increase in resistance and the increase in energy transfer per second without specific reference to temperature. This was equally acceptable.

A level 3 response would explain those links in terms of what is happening on a microscopic scale within the filament. This was often described in terms of collisions between electrons and ions in the lattice, but answers which described a change in how the ions in the lattice vibrated were equally acceptable.

There were a large number of candidates who demonstrated a secure understanding of this topic with a level 3 response.

Of the weaker responses, many only commented on the shape of graph. Such descriptions were often vague and used expressions like "the current slows down as the voltage increases".

Explain how changes in the filament of the lamp account for this graph.

(6)

The current increases at a constant rate from 0A to 0.3A ~~After~~ and at every 0.1A the ~~to~~ volts increase by ~~0~~1V. After 0.3A the Amps change and start to ~~contine~~ contine going up ~~by~~ but at a ~~sto~~ slower rate. ~~Then and at~~ This happens between ~~0~~3V and ~~10V~~ ~~Then~~ 8V. Then it ~~sto~~ the Amps start to level out until they reach full resistance at 12V.

ResultsPlus
Examiner Comments

This response shows a limited understanding of changes in the behaviour of the filament. There is an attempt to use values from the graph to describe how the gradient of the graph changes.

The examiner could find just sufficient credit-worthy statements to score this at level 1.

The answer has some errors in the use of scientific terms such as "the Amps change … at a slower rate" but overall the quality of written communication is just acceptable at this level.

2 marks

Explain how changes in the filament of the lamp account for this graph.

(6)

As the potential difference ~~in the~~ across the lamp increases, the current begins to rise but then gradually levels off. This is because, as the potential difference increases, the filament lamp begins to get hotter. As the filament lamp gets hotter, the resistance of it increases. This means that it will reduce the current or prevent it from increasing any more. Therefore the higher the voltage, the higher the resistance which prevents the current from increasing

(Total for Question 5 = 11 marks)

ResultsPlus

Examiner Comments

The candidate has made a good attempt to describe the graph and then made the correct observation that the resistance increases with increasing current. This is then correctly linked to the rise in temperature of the filament.

Two correctly linked changes in the filament indicates a secure level 2 response.

If the candidate had gone on to explain why these changes occur then this would have reached level 3.

The quality of written communication was suitable at this level so 4 marks were awarded.

Explain how changes in the filament of the lamp account for this graph.

(6)

When the voltage goes up in a filament lamp, the resistance also goes up. As the voltage / potential difference increases, so does the current in the lamp so therefore the resistance also increases.

ResultsPlus

Examiner Comments

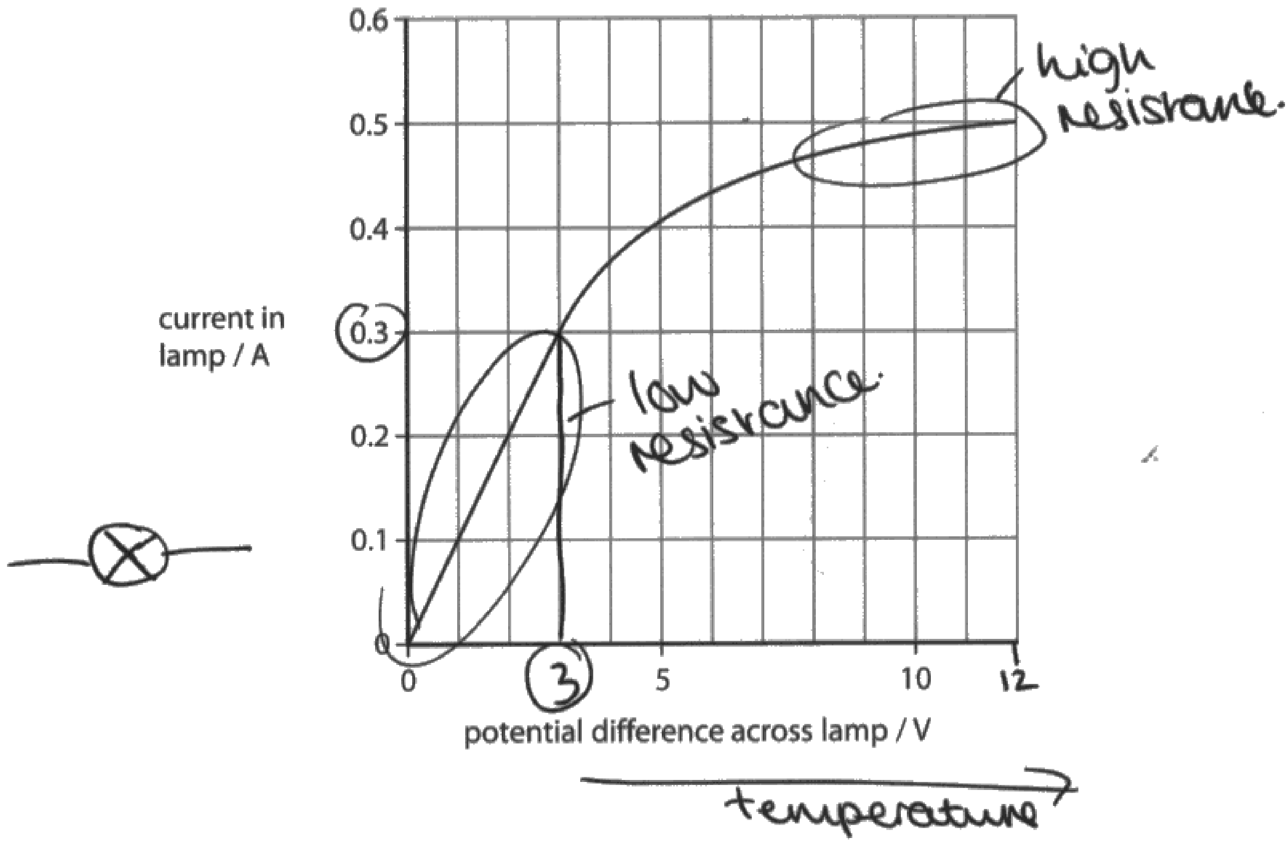
The candidate has identified the fact that the resistance of the filament has increased as the voltage increases.

The next sentence is a little ambiguous. It might mean that any increase in current implies an increase in resistance or it may simply be re-stating the previous observation. Since this sentence is not incorrect and does not contradict the correct statement, the examiner gave the benefit of doubt and scored it at level 2.

There were very many excellent responses to this question.

*(e) The student takes a range of measurements for the filament lamp.

He plots this graph from his measurements.



-use some maths.

pd= current×resistance.

3= 0·3

Explain how changes in the filament of the lamp account for this graph.

(6)

In the filament lamp, as the voltage applied increases, so does the current. However, electrons collide with the ions in the lattice and release thermal energy, so the filament lamp gets hotter as voltage increases, which increases resistance and causes the current to plateau. At 3volts, the filament lamp has a resistance of 10 ohms (3v ÷ 0·3A). However, as the voltage increases, so does resistance. So, at 12 volts, the filament lamp has a resistance of 24 ohms! High resistance means the current cannot flow as easily, but the graph begins with a low resistance.

(Total for Question 5 = 11 marks)

ResultsPlus
Examiner Comments

The candidate has described what is shown by the graph and how this is linked to changes in the filament. This is supported by an acceptable explanation of what is happening inside the filament.

Furthermore, the candidate has clearly planned the answer by making a few notes on the graph. This has helped to ensure that the answer is both concise and accurate.

A good level 3 answer.

ResultsPlus
Examiner Tip

If you can spend a little time in planning your answer you are more likely to be able to write what you need to say in a logical way and fewer words.

Question 6 (a)(iii)

A large number simply restated the question with answers such as "if he did not keep pedalling he would slow down".

Of those who attempted to address the question with a reason, a large number of candidates demonstrated a poor understanding of forces and motion in this situation. In particular, a common view was that a "resultant force" is necessary to maintain a constant speed.

Nevertheless there were many examples of a clear understanding that frictional forces would decelerate the cyclist if a driving force were not applied to balance them.

(iii) The cyclists have to keep pedalling to maintain their constant velocity.

Give one reason why they have to keep pedalling to maintain their constant velocity.

(1)

If they stop pedalling ~~frictio~~ there will be no resultant force so they will stop moving

ResultsPlus
Examiner Comments

Very many candidates thought that a resultant force was necessary to maintain velocity.

0 marks

If they stopped pedalling they would decelerate, this changes the velocity.

ResultsPlus
Examiner Comments

This was typical of quite a large number of answers. It does little more than repeat the information given in the question.

0 marks

because otherwise friction would slow them down

ResultsPlus
Examiner Comments

Examiners could give a mark if the candidate clearly identified that frictional forces act against the motion of the cyclist.

1 mark.

Because to remain at a constant velocity the forces must be balanced and so they have to continue pedalling to balance the force of friction slowing them down

ResultsPlus
Examiner Comments

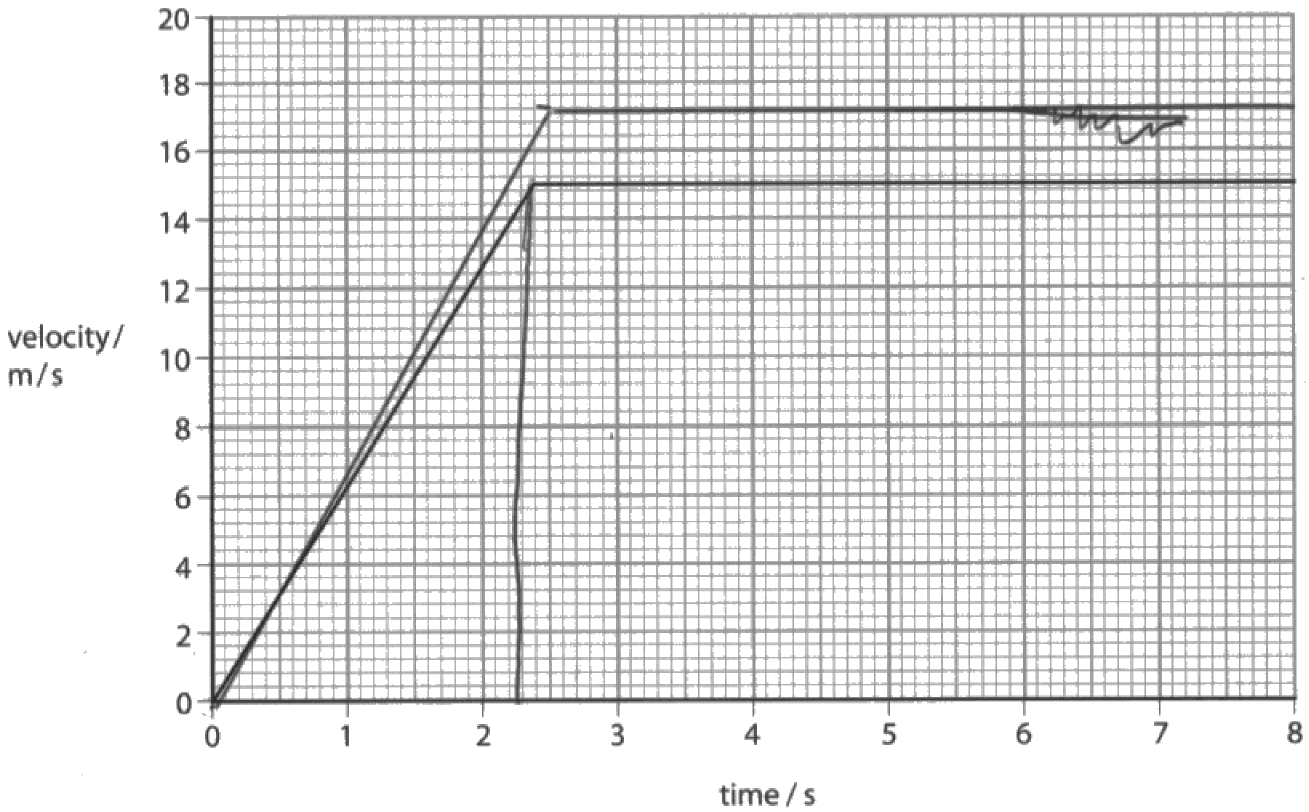
A very clear answer which demonstrated very secure understanding of the topic. The examiner had no hesitation in awarding the mark.

Question 6 (a)(i–ii)

Generally there was a secure understanding of the use of velocity-time graphs with most candidates correctly calculating the acceleration form the gradient. Candidates seem to have taken the advice to show their working. This allowed examiners to award partial credit to those who could demonstrate the correct method, but perhaps made an error in reading the horizontal axis value.

Forces and motion

6 (a) The graph represents the motion of a cyclist at the start of an Olympic race.



(i) Calculate the initial acceleration.

(2)

15 ÷ 2.2 = 6.818

acceleration = 6.81 m/s²

(ii) Another cyclist has a smaller initial acceleration but then reaches a constant velocity of 17 m/s.
Draw her motion on the graph above.

(1)

ResultsPlus
Examiner Comments

In part (i), the candidate has clearly attempted to read the time taken to reach 15 m/s . However the line from the graph to the axis was very poorly drawn. This resulted in an inaccurate reading and an answer which was outside of the allowed range.

1 mark out of 2.

The line for part (ii) was incorrect and did not score.

ResultsPlus
Examiner Tip

Make sure you bring a ruler to the exam and use it!

Question 6 (a)(iv)

Most candidates were able to identify and apply the correct equation. The most common error was to neglect to convert 4 minutes into 240 seconds.

(iv) One cyclist produces an average power output of 600 W during the race.
She completes the race in exactly 4 minutes.

Calculate the work done by the cyclist during the race.

(3)

W = Force x Distance

P = WD / T

Power x time

600 x 240

4 minutes → 240 seconds.

seconds

work done = 144000 J

ResultsPlus
Examiner Comments

This is typical of a very large number of responses. The candidate has shown working, made the correct conversion of time and evaluated correctly to arrive at the right answer. It scored all 3 marks.

(iv) One cyclist produces an average power output of 600 W during the race. She completes the race in exactly 4 minutes.

Calculate the work done by the cyclist during the race. $P = E/t$

(3)

$E = P \times t$

$E = 4 \times 600$

$4 \times 600 = 2400$

work done = 2400 J

ResultsPlus

Examiner Comments

Although the candidate used the correct equation, the time was left as minutes rather than being converted into seconds. This was awarded 2 out of the 3 marks.

Question 6 (b)

Candidates should already be familiar with objects falling through air and reaching a terminal velocity when the downward force from gravity is balanced by an upward force from the air resistance. The scenario of competitive cycling presented here can be described using similar principles. In this case the time to complete the race depends on the average velocity.

A level 1 response would identify a relevant change in one item of equipment. Most candidates described improvements in clothing design which made the rider more streamlined. However, there were also many correct references to cycles becoming lighter, tyres becoming narrower and rider position presenting a lower profile.

A level 2 response would explain why this change was an advantage. This could include reference, for example, to smaller forces of air resistance opposing motion, or a smaller mass to accelerate.

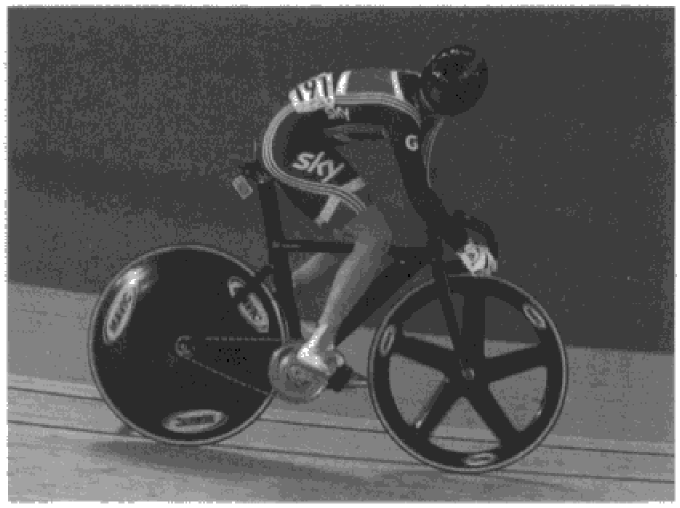
A level 3 response would have to explain how the time was thereby reduced. This usually included an explanation of how the average speed, before frictional forces balance the driving force from the cyclist, has increased; with the implication that the overall time over the same distance is reduced. An alternative explanation would be that, for cyclists having equal power, the time would be reduced if the total work done (against frictional forces over the same distance) was less.

Many candidates gave a level 2 response but then struggled to develop their argument using scientific principles into a level 3 response.

In particular, those who correctly identified that the modern cycle could be accelerated more rapidly concluded that a "faster acceleration means he can go faster". Those who identified air resistance as a limiting factor very often wrote that "the resultant force is larger meaning he will go faster".

*(b) The photographs show cyclists and the winning times for the same event in two different Olympic Games.

1920: 5 min 14 s



2012: 3 min 51 s

The designs of the cyclists' clothing and their bicycles have changed.

These changes have helped the modern cyclist to improve the winning time from 5 min 14 s to 3 min 51 s.

Describe **one** of these changes and use scientific principles to explain how this change has helped cyclists improve the winning time.

They have decressed the average mass they have. The design changes allow everything to be lighter meaning they aren't weighed down as much. In 1920 the wheels were thicker as well as the frame. They also wore a blazer. In 2012 they wore a lightweight suit and the bike was thin and light using lighter materials.

ResultsPlus

Examiner Comments

This is a level 1 response.

The answer clearly identifies that the mass of the cycle (and clothes) have been reduced but does not go one to explain why this is an advantage.

The spelling, whilst not perfect, is acceptable at this level.

2 marks

Several candidates wrote of two or more changes, even though the question only asked for one. In these cases, examiners carefully read all of the arguments presented and scored the change which had the best explanation. However, candidates who did this tended to disadvantage themselves by not focussing sufficiently on developing their explanation.

The handlebars are lower down so the cyclist has to lean further forward. This gives them a more aerodynamic shape as there is less air resistance because the air is able to easily slide over the top of them rather than hitting their torso full on. Also, the wheels are much thinner. This also reduces air resistance because there is less space for the air to hit so they aren't slowed down as much and the cyclist can go much faster

ResultsPlus
Examiner Comments

This is a level 2 response.

The answer identifies the differences in rider position and explains why this reduces the amount of air resistance.

It does not go on to explain how the cyclist "can go much faster".

Quality of written communication is acceptable at this level.

4 marks

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Examiner Tip

Use your time wisely. If you are asked to explain **one** thing then focus on giving a good explanation instead of trying to think of several examples.

Many candidates used the words "terminal velocity" in their answer. This is an indication that they have taken the more familiar scenario of falling objects and applied understanding of this to this less familiar situation of horizontal rather than vertical movement through air.

(6)

The clothes of the cyclist from 2012 are
much tighter than those in 1920. The clothes
~~wa~~ worn in 1920 would account for a lot
of air resistance as they are fairly loose and
would be a big surface for the air to hit.
Having tighter clothes means that this factor
for air resistance is taken away. This means
the cyclist from 2012 needs to be going much
faster than the cyclist from 1920 to get the same
amount of force from air resistance. Therefore
the cyclist from 2012 also has a higher
terminal velocity.

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Examiner Comments

The answer gives a clear description of a change: "clothes .. much tighter" and then goes on to explain that that this effects the "force from air resistance".

The answer also makes the point that the force air resistance depends on velocity and that modern clothes enable a greater velocity to be reached for the same air resistance.

This is a level 3 response.

The quality of communication was appropriate to this level and so it scored the full 6 marks.

Some level 2 responses identified that modern equipment is lighter.

Even though it may be correctly linked to the possibility of greater acceleration, this does not explain why overall times are less.

The cyclists bikes' have become lighter. By this logic the formula F=ma helps explain how this helps the cyclists to improve the wining time. F=ma can be re-arranged to a=F/m. This then means that if the cyclist ~~and~~ in 1980 and in 2012 both had the same force but the cyclist in 2012 had less mass, (eg how heavy the bike is) this means that their acceleration values would be different. The 2012 ~~speed~~ cyclist would have a higher acceleration, therefore this means that he/she would be able to travel faster in a race. Therefore improving how fast they finish.

ResultsPlus
Examiner Comments

A larger acceleration may enable the cyclist to reach a given speed more quickly at the start but does not then make the cyclist able to travel faster during the race.

Many Level 2 responses tried to use forces out of the correct context.

Describe **one** of these changes and use scientific principles to explain how this change has helped cyclists improve the winning time.

(6)

The outfit worn by the 2012 cyclist is tight to the skin compared to the 1920s cyclist. This would reduce air resistance as surface area is reduced. This means the air can easily flow over and around the modern cyclist as they are smaller and more stream lined. Therefore, the modern cyclist would travel faster as their peddling force forwards would be significantly larger than the air resistance pushing them backwards.

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Examiner Comments

The response correctly describes why modern clothing has reduced the forces of air resistance on the cyclist.

However, it then goes on to imply that speed is directly related to the resultant force. In reality the resultant force is only significant while the cyclist is accelerating; perhaps at the very start of the race. For most of the race the cyclist is travelling at a constant speed and so the forces are balanced. The pedalling force is **equal** to, not greater than, the air resistance.

ResultsPlus
Examiner Tip

Remember that an unbalanced (or resultant) force makes an object change velocity. It is not need to keep a constant velocity.

Paper Summary

Based on their performance in this paper, 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 resultant 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, including interpretation of graphs, and know how to tackle calculations involving changing the subject of an equation
- use the marks at the side of a question as a guide to the form and content of their answer
- give a reason as well as a statement when answering an 'explain' question
- check that they have attempted every part of every question.

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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