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# Examiners' Report March 2009

GCSE

## 360Science

## GCSE Science (2101)
## GCSE Additional Science (2103)
### GCSE Biology (2105)
### GCSE Chemistry (2107)
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# GCSE Science 5005
# GCSE Biology 5025

## Multiple Choice Paper B1a

### Foundation tier

Overall, the performance of foundation tier candidates was generally disappointing with many questions being answered incorrectly despite similar mistakes being made and highlighted in previous examination series.

Interestingly, a greater percentage of students scored correctly on the food web than on the food chain – 77% as opposed to 56% – implying that selecting and extracting the correct information from the paragraph proved more difficult for the lower ability candidates. A disappointing 63% of students failed to identify **X** as fleas in the pyramid of number, an answer that students should have easily derived at using the information either from the previous question or the food chain from question (1). Conversely, question (4) which demanded straight recall posed much fewer problems with 89% of candidates correctly labelling the fox as a predator.

Students performed fairly well on identifying the cell components for question (5) although the less able failed to define 'clones' and to a greater extent 'alleles' correctly with 51% and 44% of candidates respectively gaining the correct answer. Lack of confidence in the topic of genetics was also evident later in this section of the paper and although students performed well on question (13), many being able to follow the examples already given in the Punnet square to arrive at the correct genotype, only 30% of students realised that they were identifying the genotype of the offspring (question (14)). Over half of the responses suggested that the shaded area in the Punnet square referred to the parent genotype. A majority of students also had difficulty in concluding the phenotype of the offspring as being brown eyes with 76% of candidates responding incorrectly for this particular question. 24% of students gained credit for their correct response to question 16 although whereas 33% of students incorrectly thought that the phenotype of the offspring was one brown eye and one blue eye. It was quite apparent that all levels of foundation tier candidates are still having problems in the application of their knowledge of genetics with the statistics implying that guesswork was most likely implemented by the majority for many of the questions based on this topic. In general students' interpretation of information related to genetics and their understanding of the terminology, even for D/C grade candidates, is clearly a weak area and candidates would benefit from further opportunities to develop their application of scientific terminology in genetics to a wider variety of contexts.

As in previous examination series candidates again showed a general lack of confidence in classifying organisms. As a result of many students likely associating wings to a bird nearly one third of candidates incorrectly identified the bat as a bird. Only 43%, the more able students sitting this section of the paper, realised from the information given in the introduction that the features of this 'new species' were characteristic of a mammal.
A good number of students recognised that genetic engineering is a process that can be used by humans to produce animals with desired characteristics although the second most popular answer, albeit incorrect, was that humans carried out 'natural selection' in order to obtain more desirable organisms. Only 37% of candidates were able to conclude that the named horses do not belong to the same species but despite statistics from previous

examinations series supporting the students apparent lack of understanding of this topic area, it have been the case in this particular instance that some students may overlooked the negative in the question. Working on this assumption the next most viable answer for a student that had misread the question would have been 'genus' – 28% of candidates chose this option.

**Foundation/ Higher tier (Questions 17-24)**

Both foundation and higher tier students performed well overall on the overlap questions although the foundation and higher tier students tended to score lower on the genetics questions than on the other questions in this section. However, there were several questions that were able to discriminate well between higher and foundation level students including question (21) where 71% of higher tier students answered correctly compared to 35% of foundation candidates. The statistics for questions (18) and (19) were very pleasing indicating that a large number of both higher and foundation tier candidates are getting to grips with the 'How Science Works' aspect of the specification.

**Higher tier**

The responses that students made to the higher tier were very varied depending on the nature of the topic being questioned. It is clear that their understanding of Darwin's ideas in particular, although not necessarily evolution in general, is still causing problems for many. Interestingly, only 55% of candidates responded correctly to the simple adaptation question (question (26)) with 31% of students incorrectly thinking that the beak shape of the finches evolved due to the availability of mates. Students showed more confidence in their interpretation of the graph where 61% arrived at the correct response. Of those that were included in the statistics for the second most popular response (distracter B), it is likely that some did not read the graph correctly as it very clearly shows that there was a drop of 7% in the amount of land used to grow GM corn as opposed to 8% which was stated in the distracter. Only the higher ability students were able to show their understanding of genetic engineering and the reasons why crops might be modified. There is still a very high percentage of students that are confused by the processes involved in genetically modifying organisms. 44% of candidates seemed unaware that plasmids are an integral part of the genetic modification procedure in many cases and responded by incorrectly selecting 'hormones and enzymes'.

Questions (33) to (36) were generally answered well with students performing better on the more generic questions that did not require a high level of understanding of more complex science. For example, 73% of students scored correctly when questioned on their understanding of the ethics of the Personal Genome Project and 84% of candidates were able to correctly state the final procedure of the cloning process shown by the diagram.
The final questions on the paper were also answered well by many candidates showing that their skill in interpreting information in tabular form is improving. Question (40) proved to be a real discriminator with 25% of the most able candidates opting for the correct response. An almost equal number of candidates (23%) chose distracter C but the majority of responses for this particular question remained with distracter B (44%) where most students concluded from the data given that obesity was a result of both genetic and environmental factors. It has been noted previously that students tend not to go for options that state 'none' and the statistics for this particular case also indicate the same where the correct option D stated that 'no conclusion can be made'. Furthermore, the

nature of this question may have led students to using their broader understanding and knowledge of obesity to derive at their answer. Although this is far from a bad thing, it should be noted that when a question states that answers must be derived from the data given then any other information that the student may have acquired should be put temporarily to one side.

# GCSE Science 5006
# GCSE Biology 5026

## Multiple Choice Paper B1b

Overall the candidates accessed the paper very well and scored marks on all sections of the paper. Candidates appear to be becoming better at accessing objective tests across many of the subject areas.

### Foundation tier

In the foundation part of the paper the ability to interpret information from graphs, bar charts, pie charts and data tables is steadily improving with 89% of candidates able to answer this style of interpretive question. Knowledge of the role of red blood cells is good but the role of the plasma is less well understood with only 28% of candidates able to recognise that hormones are carried by the plasma. Candidates' understanding of drugs and their affect on the body is sound with 60 – 80% of candidates able to answer questions on this area. The understanding of reflex actions is still limited with only 30% of candidates able to understand the role of reflex actions in the eye in accommodation and the iris reflex. On the crossover questions many candidates were successful when asked recall questions on Tuberculosis and the role of pathogens but were less successful on the role of the body in removing infection and in particular the role of the white blood cells in the defence against disease.

### Higher tier

The higher tier candidates accessed the crossover questions well, in particular, the questions on caffeine and the stimulant affect of this were understood with 73% of candidates able to answer these questions successfully. The understanding of disease transmission is still a problem with only 30% of candidates able to recognise vector borne disease transmission as that by a vector such as a mosquito. Candidates' understanding of the menstrual cycle is improving with over 50% of candidates able to answer questions on menstruation and the time it occurs in the menstrual cycle. Graph interpretation is once again well accessed with 89% of candidates able to interpret correct information from a given graph however treatment regimes for Tuberculosis are less well understood especially the use of multiple antibiotics and directly observed treatment. Candidates are able to name areas of the brain reasonably well with 50% of candidates able to identify the cerebellum, however the functions of the areas of the brain is less well understood even at the higher end of the paper with only 32% of candidates able to identify the area of the brain which controls the automatic responses such as breathing as the medulla.

# GCSE Science 5007
# GCSE Chemistry 5035

## Multiple Choice Paper C1a

### Foundation tier

All areas of the specification were accessible. The first five questions were generally well answered though there was some evidence to suggest that a more careful reading of the questions would be beneficial. 34% of candidates gave Po as the symbol for potassium in question (1) and only 37% correctly identified the formula of carbon dioxide in question (5) – $CO^2$ was a popular incorrect response.
Candidates understand and can explain some of the chemical changes specified in this unit. However, the apparatus that could not be used to collect a sample of carbon dioxide in question (8) caused problems. Only 28% of candidates chose the correct option and downward delivery and collection through water were popular choices. Question (15) revealed a lack of understanding as only 16% of candidates recognised that the removal of the elements of water from sugar was a dehydration reaction. The colour of precipitates formed when sodium hydroxide solution is added to metal salt solutions is still poor- only 29% successfully identified copper in question (16).
Questions (17) to (20) showed that the knowledge and understanding of issues concerned with atomic structure and noble gases is good. 56% of candidates correctly described the particles in an atom of helium and 65% successfully identified the state and possible uses of hydrogen and helium in question (19).
Questions (21) to (24) involving the preparation of salts were poorly answered. Only 16% of candidates realised that excess magnesium oxide is needed to react all of the sulphuric acid in question (21) with 42% believing heat to be the answer. The preparation of insoluble salts showed a lack of knowledge and understanding, e.g. only 16% gave the correct practical procedure in question 24 suggesting a lack of practical experience in this area.

### Higher tier

The first four questions showed a good knowledge and understanding. However, the preparation of insoluble salts in questions (23) and (24) revealed a lack of knowledge and understanding.
Questions (25) to (28) on the halogens showed that candidates have a sound grasp of basic ideas such as hazard symbols and recognition of the appearance of the halogens. Surprisingly 37% of candidates believe that chlorine turns moist blue litmus blue.
In question (30) many candidates did not know that sodium nitrate is not a base and that it would not react with ethanoic acid. 70% of candidates chose the incorrect equation in question (32) showing confusion between sodium hydrogencarbonate and sodium carbonate.
Questions (33) to (36) involving the Periodic table were good discriminators. 73% of candidates failed to recognise sodium selenate in question (36) with the most popular answer being sodium selenium oxide. This assessment statement is clearly described in the specification.
Information regarding extraction of metals from their ores and redox behaviour caused a significant number of candidates problems. Only 31% of candidates correctly identified the oxidation and reduction processes in question (38).

Candidates generally performed well with questions (39) and (40) involving the extraction of metals with regard to their relative reactivity.

# GCSE Science 5008
# GCSE Chemistry 5036

## Multiple Choice Paper C1b

### Foundation tier

In question (2) 35% of candidates thought that charcoal obtained from wood is a fossil fuel and in question (4) 58% of candidates thought that hydrocarbons are a mixture of carbon and hydrogen. In question (6) only 39% chose the correct answer with 37% believing that fermentation and distillation are involved in wine production. In question (7) only 39% chose the correct answer with 34% believing that a temperature of 70$^{o}$C is used for fermentation and a further 20% that the temperature is 100$^{o}$C. In question (9) 23% of candidates thought that glass cannot be put into landfill sites and a further 17% that glass decomposes to produce methane.
Some questions in the next section were also poorly answered. In question (12) 20% of candidates thought that the complete combustion of LPG would produce carbon and carbon dioxide and a further 18% that carbon dioxide only would be produced. In question (13) all four answers were popular choices. In question (15) only 33% chose the correct answer with 42% thinking that the disadvantage is that burning hydrogen causes pollution.
Answers to questions (17) to (24) were generally as expected for foundation tier candidates but in question (19) 28% thought that nitrogen is obtained from liquid air by a chemical reaction and in question (20) 38% thought that nitrogen is used in food packaging because it has a high boiling point. In question (24) only24% chose the correct answer with 47% believing that the sun protection product does not reflect or absorb UV radiation

### Higher tier

As would be expected higher tier candidates performed better than foundation candidates on questions (17) to (24) but 18% thought that nitrogen has a high boiling point and 36% that the sun protection product does not reflect or absorb UV radiation.
In question (25) only 35% of candidates knew the correct answer with 47% believing that the formation of soot shows the production of carbon monoxide. Questions (26) and (27) were very poorly answered with an almost equal choice of all four answers. Only 37% knew the correct answer to question (29) with the other three answers all being fairly popular choices. In question (34) only 46% chose the correct answer with a total of 39% choosing A or B indicating that they thought that burning ethanol does not produce carbon dioxide. Chemical equations continue to be a problem for many candidates. In question (35) only 28% chose the correct answer with 30% choosing B involving monatomic oxygen and 28% choosing A showing the product as hydrogen peroxide. Question (36) proved difficult with only 31% choosing the correct answer. All three distracters were popular choices. Question (37) was another equation with 29% choosing the correct answer.
The last three questions on crude oil were poorly answered. Many candidates thought that crude oil enters the bottom of the fractionating column as a liquid and that each fraction contains only one compound. Only 40% knew the answers to questions (39) and (40) with all three distracters being equally popular.

# GCSE Science 5009
# GCSE Physics 5045

## Multiple Choice Paper P1a

### Foundation tier

Overall the performance of candidates in the first sixteen questions showed that they had been well prepared. In 10 out of the first 16 questions over 50% of candidates opted for the correct response.
In particular candidates were very well prepared for questions on solar cells and the interpretation of data on batteries.
Candidates also showed a good understanding of the electric motor.
However only about one third of candidates could identify a graph of d.c. current or knew the equivalence of the watt and joule per second.
Candidates showed a good understanding of electric current and lines of best fit but only about 40% could calculate battery capacity and recognise a control variable in an electricity investigation.
Most of the common questions differentiated well between foundation and higher tier candidates and most discriminated well between less able and more able candidates.
Candidates showed that they had been well prepared to explain the idea of efficiency and were comfortable with calculations of electrical power and the cost of using electrical appliances. Candidates displayed a very good understanding of a scientific prediction.
The only area for concern was the high percentage of foundation and higher tier candidates who included an obviously anomalous result when calculating the mean of a number of readings.

### Higher tier

Candidates once again showed that they had been well prepared for the examination with over 50% of candidates identifying the correct response in 9 out of the 16 questions and 60% or more in 6 of these questions.
Candidates displayed a very good understanding of the dynamo and using current and voltage graphs to calculate the output power of a dynamo.
Candidates showed that they had been well prepared to answer questions on the use of meters in electrical circuits with almost two thirds correctly identifying the positioning of an ammeter and a voltmeter and a similar number of candidates recognised an evaluation of the investigation.
Over 50% of candidates could calculate resistance from an I/V graph and also give a correct interpretation of the graph.
However over 50% of candidates thought that an RCCB detected the difference in currents between the live and earth wires and only about 40% recognised the equivalence of the watt and joule per second in a straightforward calculation of electrical power.

*Teachers are reminded that past papers are available on the Edexcel website and can be accessed by candidates. This gives opportunities to encourage self-study by candidates or as class homework exercises with problem questions discussed in a subsequent lesson.*

# GCSE Science 5010
# GCSE Physics 5046

## Multiple Choice Paper P1b

Overall there was some problem with the word 'because'. Foundation candidates correctly related it to 'the reason that ….' when they were in the same sentence. In other items, however, candidates seemed to choose the first statement which was correct but often this was **not** the **reason**. Pointing this out to candidates might improve their performance on similar items in the future.

### Foundation tier

Some of the percentage responses to the items were very poor. This started from the first item for which as many as 48% of candidates thought the force of gravity on the Moon was zero, even though there was a photograph of two astronauts standing on it. Another straightforward bit of knowledge "A comet orbits … the Sun." attracted only 38%. Similarly, while 48% identified the digital signal from the four given, as few as 18% knew that such signals had the advantage of being less affected by noise than analogue signals. Almost half thought that digital signals travel faster than analogue ones.
These results contrast sharply with quite high percentages for the health and safety aspects of space travel and medical uses of waves with percentages ranging between 83 and 60. A question which required some thought, item 15, was correctly answered by 45% of candidates.

### Overlap questions

Higher level candidates on average performed markedly better on all the overlap items, as would be expected. At foundation level 49% (37% higher) thought weight is measured in kg while 54% (44% higher) thought that weight becomes zero at the top of the atmosphere. A useful piece of research might be into how these scores fit with those who correctly responded to items 19 and 20 (51% foundation and 77% higher).
The greatest difference (47% F - 80% H) between tiers concerned the scientific interpretation of data about the use of gel in ultrasound scans.

### Higher tier only

At this tier also, candidates answered some items, which were directly taken from specification statements, quite poorly. For example, 57% thought that X-rays travelled through space faster than visible light rays. Similarly, only 39% recognised the equality of action and reaction forces. The search for intelligent life caused major problems. As many as 85% of candidates thought that scientists study **sound** waves from space and 32% thought that astronauts have landed on other planets.
At a fundamental level of understanding, the calculations produced good results averaging 76% while as many as 78% understood the basic idea of a black hole. Furthermore, 70% were able to interpret the results from an experiment to demonstrate a model of earthquakes by linking the sudden jerk to the difficulty of predicting when an earthquake will happen.

# GCSE Additional Science 5015
# GCSE Biology 5027

## Multiple Choice Paper B2

Overall the candidates accessed the paper very well and scored marks on all sections of the paper. Candidates appear to be becoming better at accessing objective tests across many of the subject areas.

### Foundation tier

At foundation level the candidates were easily able to identify adaptations and predator-prey relationships in addition to the affect of global warming on populations with 90% of candidates gaining the correct answers. Recall questions on DNA and base pairing were also well accessed with 78% of candidates able to recognise that the shape of a DNA molecule is a double helix. The use of stem cells in research is still a tricky issue for foundation candidates with only 55% of them able to demonstrate the knowledge that stem cells can differentiate into any type of cell. The crossover questions on food webs were accessed well with 80% of candidates able to correctly interpret quite complicated food webs. It was disappointing to note that respiration and photosynthesis are still subjects which cause candidates difficulty with only 68% of candidates having the knowledge that respiration continues all the time in plants but photosynthesis only occurring in the light.

### Higher tier

Higher tier candidates accessed the crossover questions well both on interpretation of food webs and displaying good knowledge of photosynthesis and respiration. The role of mineral ions in plant growth and the method of active transport was less well understood with only 59% of candidates able to correctly identify the role of nitrates in plants as helping to form proteins. The difficult topics of mitosis and meiosis once again proved to be a problem with only 51% of candidates able to identify that meiosis results in haploid nuclei and mitosis in diploid nuclei. Knowledge of the impact of global warming continues to improve with over 80% of candidates able to correctly identify living indicators the greenhouse effect. Protein synthesis is another topic area where candidates show mixed knowledge. Only 42% of candidates were able to recognise that proteins are formed from amino acids or that the site for protein formation is the ribosome.

# GCSE Additional Science 5017
# GCSE Chemistry 5037

## Multiple Choice Paper C2

### Foundation tier

Several questions in the first section 'At the barbecue' were poorly answered. Only 30% of candidates chose the correct answer for question (2) with 28% thinking that small pieces burn at a lower temperature and 25% that they contain more concentrated charcoal. Only 37% knew that molecules of polyunsaturated fat contain more than one double bond with 36% choosing one double bond. 42% knew that enzymes are biological catalysts but 55% thought that they are bacteria. 46% knew that ethene is a monomer but 19% thought that it is a large molecule and 23% that it is a plasticizer. Whilst 56% knew that ethene is obtained from crude oil, 36% believed that it is obtained from methane.

Candidates also found some questions in the second section difficult. Only 32% knew that covalent bonds contain electrons with 31% choosing ions and 23% atoms. 58% could calculate the relative formula mass of hydrogen peroxide but 28% chose 17. Only 32% knew that the mass of a catalyst is unchanged at the end of a reaction.
In question (14) only 37% chose the correct answer with 30% believing that a chlorine atom loses an electron to form an ion. Only 37% knew the formula of a chlorine molecule with 33% choosing Cl and 22% $Cl^2$.

Answers to questions (17) to (24) were mainly as expected for foundation tier candidates with (17) and (24) being the two most difficult.

### Higher tier

As would be expected higher tier candidates generally performed better than foundation candidates on questions (17) to (24) but only 50% of candidates knew the answer to question (17). Only 40% chose the correct answer to question (24) with 40% believing that carbon nanotubes contain ions.

Surprisingly only 60% could identify the correct answer for question (25) with 30% believing that ethane is not saturated. In question (26) 39% believed that ethane would turn bromine water colourless despite the structure clearly being displayed with no double bonds. In question (27) only 54% could identify the correct answer with 22% thinking that D was correct. The strength of bonds and forces in simple covalent compounds continues to be poorly understood, in question (28) only 36% chose the correct answer with 30% choosing D and 24% C. Only 34% chose the correct answer to question (31) with the three distracters being equally popular. Not surprisingly the ionic equation in question (32) proved difficult for many candidates with only 26% choosing the correct answer. 34% chose A which is a strong distracter, but 27% chose C involving the loss of electrons. In question (33) only 36% chose the correct answer, a further 28% chose $FeCl_3$, possibly by guessing, 20% chose $Fe_2Cl$ and 15% $Fe_2Cl_7$ probably by forgetting to subtract the mass of iron from the mass of the compound.

As usual balanced equations proved difficult with only 25% choosing the correct answer in question (35), 36% chose B believing the formula of ammonium sulphate to be $NH_5SO_4$. In

question (36) 48% of candidates believed that at equilibrium the amounts of reactants and products are equal. Only 18% chose the correct answer to question (37) with responses showing a poor understanding of both atom economy and the effect of temperature on equilibrium yield. The two questions on rates of reaction were poorly answered with only 24% getting question (38) correct and 33% getting question (39) correct. In both questions all distracters were popular.

# GCSE Additional Science 5019
# GCSE Physics 5047

## Multiple Choice Paper P2

### General Comments

Difficulties were experienced with some of the How Science Works experimental ideas. 53% of foundation students correctly identified that 'choosing the same car each time' made it a *controlled* variable but as many as 33% thought it was the *dependent* variable. Working the other way round to identify which of four suggestions was the independent variable was even worse with only 27% at foundation level (55% H) selecting the key.

Finding the average value to use for half life from five given results caused problems for many. This involved ignoring an obviously anomalous result before doing the arithmetic. As many as 43% of higher students found the average INCLUDING the anomalous result, with only 42% ignoring it.

### Foundation tier

The performance of candidates in the first sixteen questions showed quite good preparation for this module test. In 11 out of the first 16 questions over 50% of candidates opted for the correct response. Candidates appeared reasonably secure in their understanding of uses of radioactivity and the disposal of waste products from nuclear reactors. When asked explicitly, they were able to identify that charge transfer was the movement of electrons (71%). When, however, they were asked how a parachute had become charged positively, 53% of foundation students thought this was because it GAINED electrons, 20% because it gained protons and only 21% because it lost electrons (higher 46%).

One particular problem was experienced with only 29% realising the basic idea that a car continues at constant speed when the resultant force on it is zero.

With regard to conservation of energy, as few as 31% spotted the anomalous result in terms of the highest mark reached being higher than the height of release for a rolling glass ball. Furthermore, the vast majority of candidates failed to realise that the reason the ball does not hit a person when it swings back is because some of the ball's energy will have been transferred into thermal (heat) energy. They selected the true but not causal link that some had been transferred into GPE.

### Overlap questions

Higher level students on average performed markedly better on all the overlap items, as would be expected. The greatest differences between tiers, 58%F - 88%H, concerned the calculation of electrical energy needed to raise a rollercoaster car at the start of a ride and 61%F - 90%H, which required understanding that an attractive force was needed for dust to stick to a parachute and that the charges had to be opposite.

### Higher tier only

48% of candidates recognised that the velocity of a car on a funfair ride changed and 61% that the acceleration had a constant size. But only 32% did both. The calculation of mass for a car with given momentum and with a velocity to be found from the graph was a problem for 68% of students. Developing an argument by being able to spot an advantage **and** a disadvantage was poorly done. As many as 75% of students, however, were able to calculate the half-life of a radioactive isotope from the graph.

# GCSE Additional Science 5016F
# GCSE Biology 5028F

## Structured Paper B2

This paper consisted of seven questions with (6) and (7) in common with the 1H paper. All questions were accessible to the candidates.
The candidates in this series seemed to either produce a good answer or gave responses that were completely wrong. Candidates entered for 5028F on average scored slightly higher than candidates entered for 5016F on most questions. It was pleasing to see candidates using techniques like underlining key words in the body of the question.
"How Science Works" is also examined throughout the paper. Teachers may find it helpful to revisit the criteria for this aspect as some candidates do seem to find it difficult.

### Question 1

Cells
This question was designed to test basic knowledge of cell structures. Around 60% of candidates scored 2 marks on part (a)(i). The main error seen was labelling the cytoplasm as chloroplast or membrane. The majority of candidates correctly answered parts (a)(ii) and (b).
Overall, this question was accessible to candidates.

### Question 2

Growth in cells
This question was designed to allow candidates to demonstrate their knowledge of how cells change to allow growth. Greater accessibility was allowed by using the 'join the box' style.
The great majority of candidates (89%) got all three marks here with a significant number (10%) scoring just 1 mark. Candidates clearly found this question accessible and completed the exercise neatly. Only very few examples were seen where candidates drew more than one line from a 'cell activity' box.

### Question 3

Respiration in muscle cells
Although part of this question allowed pupils to select words from the box, the answers from many suggest that the processes involved were not known by a significant number of the candidates.

In part (a) 71% of candidates correctly identified oxygen as the gas required by cells to respire aerobically. As expected the commonest error seen was carbon dioxide. Some candidates chose words from the box for part (b), with just a very few of these also using the words from the box to answer part (c).

In part (b) just under 50% scored 1 mark, usually for diffusion. Almost 30% scored both marks and there was some evidence that candidates had worked the answers out as they had annotated the diagram.

The success rate in part (c) with roughly 33% obtaining either 0, 1 or 2 marks. Some very good detailed answers describing how lactic acid was produced and builds up to cause cramp were seen. It was disappointing, however, that having given the word 'aerobically' in the stem, so many candidates did not give the correct response of anaerobic in part (c)(i).

**Question 4**

Lichens

It was pleasing to see pupils ticking off the lichens as they counted them, although even then, there were a significant number of errors with 7.7% getting no marks.

In part (b) the majority of candidates scored the first easy mark correctly stating that the numbers of lichens increase as you move away from the power station. Many though went on to state the same for the types of lichens which, of course, only increased for the first 50/75 km and then stayed roughly the same. A significant number of candidates did score here for stating specific points, for example, stating that the clear oval lichens are not found at 100 km from the power station.

The most frequently seen correct response for part (c) was that the 'material' the wall was made from should be the same although this was phrased in a variety of ways. Some long and vague answers were also seen in part (c), possibly indicating that these candidates were struggling to express their ideas lucidly. Many candidates stated that Jason should sample $1m^2$ each time suggesting that they had misread the question.

**Question 5**

Rabbits in Australia

This question allowed candidates to apply their understanding of how populations and individuals interacted. 46.6% of candidates scored one of the two marks available, mainly through offering a correct reason for why the density of rabbits in Britain was less than that in Australia. In part (b) candidates often just stated 'the amount of food' missing the point that to cause a population 'crash', a change in circumstances needs to occur. The high number of rabbits eating all the food, so many starve, was the most frequent seen correct answer with more predators and a disease occurring being other commonly seen correct responses.

Part (c) was well answered with around 50% gaining both marks available. This required the answer to be developed with a significant number of candidates just stating that rabbits eat the same food as sheep without going to state the consequence of this on the sheep. This was a question where the candidates taking 5028F were significantly better than those taking 5016F

**Question 6**

Photosynthesis and respiration

This is the first of the crossover questions.

This question was designed to test candidate's understanding of the way that photosynthesis and respiration interact in plants.

This was well answered by many foundation candidates, with 69% gaining 2 and 40% gaining 3 of the 5 marks available. Many foundation candidates still indicated that respiration only occurred in plants in the dark. Candidates often showed their understanding of reduced

oxygen being given out in the winter by drawing the line lower than the one printed on the diagram, but did not reflect the reduced day length.

**Question 7**

Pandas

This was the second cross over question.

This question was designed to allow candidates to demonstrate their knowledge with regard to populations and conservation.

Foundation candidates tended to score well on parts (a) and (b) with 44% gaining both available marks. Only 3% of foundation candidates scored both marks on parts (c) and (d). Very few candidates correctly defined conservation in part (c), often losing marks through vague responses. Part (d) was mainly gained through stating that if we did not protect natural populations, the species would become extinct. Again vague answers, for example, 'so that animals do not die' lost foundation candidates marks.

# GCSE Additional Science 5016H
# GCSE Biology 5028H

## Structured Paper B2

This paper consisted of seven questions with (1) and (2) in common with the 1F paper. Most questions were accessible to the candidates with only question (6) performing below the expected response level.
The candidates in this series seemed to either produce a good answer or gave responses that were completely wrong.

### Question 1

Photosynthesis and respiration
This crossover question was designed to test the candidate's understanding of the way that photosynthesis and respiration interact in plants.
This was well answered by many candidates, with 60% gaining 3 and 90% gaining 4 of the 5 marks available. Many candidates still thought that respiration only occurred in plants in the dark. Candidates often showed their understanding of reduced oxygen being given out in the winter by drawing the line lower than the one printed on the diagram, but did not reflect the reduced day length.

### Question 2

Pandas
This was the second cross over question.
This crossover question was designed to allow candidates to demonstrate their knowledge with regard to populations and conservation.
Candidates tended to score well on parts (a) and (b) with 66% gaining both available marks. 89% of candidates scored both marks on parts (c) and (d). Good responses for part (c) referred to the protection or management of the environment, ecosystem or natural resources. In part (d) many candidates gained credit through stating that if we did not protect natural populations, the species would become extinct. Some good answers referring to biodiversity were seen.

### Question 3

Growth in plants
This question was designed to test the candidate's ability to apply their knowledge of growth in plants and factors that influence that growth.
In part (a) 66% of candidates gave the correct answer of mitosis. In part (b) only 22% were able to give the answer differentiation.
In part (c) and (d) most candidates scored at least 1 mark with by giving a factor that could affect the growth rate in plants. Many were able to explain that plants cells get bigger or longer during elongation, but very few knew that the cells absorb water during this process.

### Question 4

Protein synthesis

This question tested the candidate's ability to explain how DNAS controls the making of a specific protein, and about how make protein can be made that are useful to humans
In part (a) only 50% of candidates score any marks. Some, 18%, gained a mark by knowing that a triplet codes for an amino acid, or that mRNA was involved. A few knew the details of the DNA unzipping and the function of mRNA. Only 17% gained full marks, but here there were excellent descriptions of transcription and translation covering all 8 marking points. In that, the question discriminated very well.

In part (b)(i) 45% of candidates gave a correct example of a useful protein, frequently insulin. There were many strange responses, many of which were not even proteins. Part (b)(ii) also discriminated very well, with some excellent answers referring to how proteins can be made in a fermenter and the conditions required for this to happen. The majority of answers referred to the fermenter, about 30% got the mark for optimum conditions, very few obtained a mark for large increase in numbers and only one candidate mentioned 'protein purified'.

**Question 5**

Mitosis and meiosis
This question tested the candidate's knowledge of mitosis and meiosis. Sadly 20% candidates completely reversed the two columns in the table, and gained no credit.
The majority of candidates were clear that mitosis was for growth and meiosis was involved in reproduction. There was more confusion regarding the number of chromosomes in each cell, with many thinking that there were the same in each or that one had 2 chromosomes and the other 4. Where the terms "diploid" and "haploid" were used, they were generally used correctly. Several candidates talked about the Hayflick limit, which was not relevant to this question. 34% of candidates gained full marks.

**Question 6**

Changes in the environment
This question tested the ability of candidates to interpret some data and apply scientific principles regarding the effect of changes to the environment. It also gave them the opportunity to discuss ideas in more depth with extended writing.
In part (a) the candidates had numerous ways of taking readings from the graph and often did not strictly describe the trend. Most got the idea of the trend fluctuating. The overall trend of the rise in temperature above the average temperature for the period was less commonly mentioned. Common errors included not reading the vertical axis and assuming that it referred to temperature, so talked about "rising above freezing;" misreading of the scales and so not placing the rise from 1965 to 2000 but perhaps placing it from 1960. This was quite a difficult graph to interpret, but this is the last question on the paper and is targeted at the highest grades. 80% of candidates gained 2 marks.
In part (b) candidates appeared to be well informed of the consequences of higher Arctic temperatures but many failed to score all 3 marks as they appeared to feel that flooding was different to ice caps melting by enough of a margin to warrant another mark.
Candidates seemed to have a good knowledge of this topic most gaining 2 marks for ice melting/flooding and impact on wildlife with particular reference to polar bears but some candidates find penguins in the arctic. The effect on ocean currents and the Gulf Stream seemed to be less well known. 97% gained 2 marks on this part of the question.

# GCSE Additional Science 5018F
# GCSE Chemistry 5038F

## Structured Paper C2

This foundation tier paper contained 5 questions. Question (5) was common with the higher tier papers.

### Question 1

Most candidates knew where at least one sub-atomic particle was located in the atom, although terminology was sometimes poor. The 'centre of the atom' was allowed as an alternative to the nucleus but 'inner shell' was sometimes used and was not allowed. A more frequent error was the use of 'outer shell' as the location for electrons – a confusion presumably picked up when bonding is taught. Even on this question it was surprising that only 20% of candidates got all three marks.

### Question 2

The most commonly scored mark in the table was the name of the polymer (although nearly 20% of candidates scored no marks at all). In the other parts, the double bond in ethene was commonly wrong. In the repeating unit, the 'extension bonds' were commonly missed out. Problems with the disposal of polymers were often well done, with about one third of candidates scoring 2, one third 1 and one third 0 marks. The most common problem was poor expression; this has often been seen in previous examination sessions, for example 'bad gases' emitted on combustion, where harmful or toxic was required. 'Pollution' is a general term and is never going to score a mark without explanation. Part (ii) was better answered, with the non-biodegradable nature of some plastics being well known. The terms used (rot, corrode, erode…) varied, and not all were precise enough to score a mark.

### Question 3

More than one half of the candidates scored 0 on parts (a) and (b) together. The straightforward learning of definitions is poor. Alloys were referred to as mixtures of elements, or as a type of metal found on cars. There were many references to rusting in part (b). Rusting refers to the corrosion of iron/steel, and is not permitted as an alternative to corrosion for non-ferrous metals (as well as being irrelevant in this case). Also, cost is not accepted as a property in questions of this type. In (3)(c)(i) only 25% of candidates could name electrolysis (and unusual spellings were allowed). Perhaps surprisingly, a greater percentage of candidates scored marks on the second part. It was evident from the scripts that many candidates had a reasonable understanding, but were unable to write clearly enough what they meant. The idea of attraction was well known, but a large minority referred to magnetic attraction. Some referred to the electrodes being attracted to each other. There was also confusion between the copper electrode and copper ions.

### Question 4

Parts (a) and (b) of this question were done well, with 2/3 of candidates getting full marks. The link of temperature rise to exothermic was well done by most, but less able candidates just quoted data without explaining their answer. Other less able candidates compared the ribbon and powder. Part (b) was very well done. In parts (c) and (d) 2/3 of candidates scored 0. In (c) more able candidates referred to surface area and some even went on to refer to more (frequent) collisions. Less able candidates referred to the powder mixing or dissolving more easily. Some also wrote about a **smaller** surface area for the powder, perhaps thinking of an individual particle. In part (d) a common error (again) was to use different quantities of reactant. Some more able candidates mentioned rolling up the ribbon to reduce surface area.

**Question 5**

This question revealed a lack of commitment of the candidates to learning the details of the specification. In part (a) over 1/3 of the candidates scored no marks. Given that part (i) had a clear hint in the diagram (heat and aluminium oxide were allowed as answers), and parts (ii) and (iii) were straightforward work from alkenes, this was remarkable. In part (i) pressure and water were often mentioned. In part (ii) one error was to name a specific alkene, rather than alkenes as a type of hydrocarbon. Only 20% of candidates answered part (b) correctly. There was clearly little knowledge of what polyunsaturated means. Some did not even know the double bond symbol (referring to equals signs etc). There were blanks, many gave molecule A as the answer, and those that gave molecule B could not always explain why. In part (c) 92% scored 0. In part (i) many had no idea at all about intermolecular forces. In part (ii) there were many answers in terms of cooking – milk, flour, eggs, oil, etc. In part (d) 38% scored one and 4% two marks. Thus, fewer than half could define an enzyme. Many got tangled up in biology. In part (ii) many simply repeated the stem of the question. There were many attempts but saying that 'the body would clog up' or even 'rot'.

**Suggestions for revision:**

- Draw repeating units of different polyalkenes
- Produce a list of terms and their definitions (e.g. nucleus, alloy, biodegradable, polyunsaturated, enzyme)
- Understand the difference between the terms rusting and corrosion
- Explain the terms electrolysis, electrode, electrolyte
- Apply the collision theory to examples to explain how to speed up or slow down reactions
- Learn carefully all aspects of the specification, particularly organic chemistry.

# GCSE Additional Science 5018H
# GCSE Chemistry 5038H

## Structured Paper C2

The paper consisted of four questions. Question (1) was common with the foundation tier; questions (1) and (2) were targeted at C/D and the remaining two questions were targeted at A*/B. Overall, the results for the 5038H entry were better than that for the 5018H entry.

### Question 1

Part (a)(i) was generally well answered with the majority of responses indicating a requirement for heat with a few indicating the use of a catalyst. Part (ii) was not as well answered as expected. A good number gave **alkanes** as the answer, showing a lack of differentiation between the two terms. A significant number also gave a specific name of an alkene, which might indicate a lack of understanding of the question. Although the majority of responses to part (iii) were correct, indicating the presence of a C=C double bond, there was a significant number of incorrect answers. Some of these seemed to mix up their terminology, stating that unsaturated molecules lacked a double bond. For part (a), 90% of the candidates achieved at least one mark, with over 26% scoring all three marks.

Part (b) was a well answered question identifying molecule B having more than one double bond; just over 51% of the candidates achieved the mark. A common misconception concerning saturated/unsaturated molecules related to their symmetry, in that the molecule chosen (A or B) had a particular symmetric arrangement or even/uneven number of double bonds.

Part (c) (i) was poorly answered with only a few giving a correct response relating to weaker inter-molecular forces. Most answers related to the strength of bonds between atoms and especially the C=C bonds. Answers were further justified through the ease/difficulty of breaking these bonds between atoms. In some cases use of correct terminology contributed to incorrect answers, with many candidates mixing atoms for molecules. Similarly in (ii) the majority of candidates gave poor answers overall with most referring to other foodstuffs such as milk, butter, lard etc. or to saturated fats. Only a few scored here with the correct answer of hydrogen. Overall for part (c), only a disappointing 35% of the candidates achieved at least one mark.

It was surprising that (d) (i) was poorly answered with not many being aware of what enzymes are. Many stated enzymes simply as proteins or as substances used in the process of digestion. Many candidates in (d) (ii) simply regurgitated the question in various ways and not enough said what these effects would lead to. Just over 51% scored at least one mark on part (d).

### Question 2

In part (a) the majority of answers correctly identified the three particles in an atom, although a significant number of these omitted to state their position within the atom. Additionally, around one quarter of these responses gave incorrect numbers for each

particle. This resulted in about 50% of all responses being allocated two marks for this question. A significant number of candidates also misunderstood the question, as their answers related to fluorine being a halogen; it's position within the periodic table and the properties of halogens.

Overall (b) (i) was a well answered question. Incorrect responses were mainly caused by misuse of terminology; for example, stating molecule or element rather than atom or particle. Other incorrect answers related to ionic bonds or the formation of compounds.

The marking for part (a) and (b)(i) was grouped together and it was found that about 60% achieved at least one mark but only 20% scored all four marks.

About 75% of the candidates score the mark for the correct formula of calcium fluoride in (b) part (ii). Part (iii) was poorly answered with only around 13% of answers gaining the mark. Most incorrect answers were due to either incorrect formula for the product, incorrectly balanced equations or using '2F' for the reactant.

**Question 3**

Most candidates found part (a) challenging. The question was not well answered and only 13% of the candidates could answer this item correctly. Not that many mentioned strong bonds; fewer mentioned forming carbon-carbon bonds. Most candidates were content to state that carbon has four bonds as their answer without further elaboration. Alternatively they were content to state that carbon can bond with hydrogen or many other elements. Many tried something around the possibility of multiple bonds. A number thought that it was about polymerisation and discussed double bonds opening up.

Part (b) had a mixed response, with many candidates not understanding what was required in this situation, but over 60% gave a correct response. Most recognised that some form of further testing was required, but many gave examples for testing for specific properties for standard materials without differentiating the need to identify a new compound.

In part (c) there were some very poor answers for part (i) with a tendency to state that 'lithium is a metal therefore it is malleable'. Few recognised the idea of layers (or similar) of atoms sliding over each other explaining why lithium is malleable. Although part (ii) was not well answered it performed better than (i). Most correct answers identified the presence of free electrons that move; a few stated a sea of electrons or the presence of delocalised electrons. The majority of incorrect answers related to spare electrons, ions or charged molecules. Overall for part (c), 35% of the candidates achieved at least one mark.

In (d)(i), 54% of the candidates gave a correct answer identifying shared electrons for one mark. Only a few gained the second mark by stating that 2 electrons were involved in a covalent bond. Many answers gave details of carbon needing to gain four electrons to complete its outer shell, but lost marks by failing to state the need for atoms to share electrons. Just under half the candidates scored in part (ii) but few achieved all three marks. Many knew that graphite existed in sheets or layers. However, many clearly took the diagrams that they had seen at face value and thought that there were just two layers of carbon atoms. Many expressed the second point badly, claiming that there were three bonds in graphite rather than each carbon atom forming three bonds. Similarly, many said

that there was one free electron in graphite which conducted the electricity. Many candidates seemed to think that the gaps between the layers were simply a space through which the electric current could move. Many also thought that the closeness of the atoms meant that electricity could move easily from one to another. Quite a few thought that the movement of the plates sliding over each other accounted for the conductivity. Some stated that graphite was a metal and therefore can conduct electricity.

**Question 4**

It was surprising to see that only 40% of the candidates could score a mark for the correct formula required for the balanced equation in part (a) (i) and only about 30% scored the second mark for the balancing of the correct formulae. Many incorrect answers gave reactants such as $O_2 + H_2$, $H_2O_2 + O_2$, $H_2O_2 + H_2O$. There was a similar range of answers for the products of the reaction. Many candidates lost marks by not giving oxygen in its diatomic form as a product. There was some evidence of candidates writing the correct formulae and then altering them to make the equation balance.

In (a) (ii), the marking was looking at three areas: a temperature measurement mark, a volume/time reading mark and a further experiment mark. Many answers showed the total inability of the great majority of candidates to make even a half good attempt to describe a relatively simple experiment. Answers contained phrases such as 'fair test' and 'independent variable' in ways which had no real meaning at all. A large proportion of candidates chose to continuously heat the solution, they took some hydrogen peroxide and kept on heating it and measured how much was given off in a minute and took the temperature, then continued heating and took the temperature again etc. Many candidates had little idea that you had to measure time and temperature. A number said measure the time to decompose but did not say how you would know when this would occur. Some said to collect the hydrogen. Some said to bubble the gas which was in the syringe through the solution. The temperature variation also proved difficult for many, with the use of hot rooms, cold rooms etc or moving the Bunsen burners to various distances from the apparatus or heating it for various times such as 30 seconds, 60 seconds etc without reference to temperature. Some measured the temperature of the Bunsen flame or the gas. Some suggested testing the oxygen with a glowing splint. Some candidates merely stated the results without doing the experiment. Most who scored picked up the odd mark for talking about repeating something at a range of temperatures or for reading the gas syringe after a given time. The main weakness was the failure to explicitly refer to **measurement** of either temperature or volume. The statistics showed that fewer than half the candidates achieved at least one mark and only 8% scored all three marks.

In part (b), the action of a catalyst on the rate of a chemical reaction was generally well known and 80% of the candidates were able to score marks. Most candidates chose Z as a catalyst but many also stated that X was a catalyst because it also made the reaction take less time. It was relatively few candidates that recognised and made comment on the lowering of reaction time for X was **not** significant in the context of the experiment. Many candidates did make comment on X 'not being a good catalyst' but did not go on to question whether or not it was a catalyst. Less able candidates did not seem able to interpret the data correctly and stated that Y was the catalyst and Z (and X) were not catalysts.

**Revision tips**

- Practice writing and balancing chemical equations.
- Learn the formulae of the common substances such as water.
- Learn and understand the explanations to the properties of different structural types.
- Use the past examination papers of this specification to become familiar with the style of question and how marks relate to the points in an answer.

# GCSE Additional Science 5020F
# GCSE Physics 5048F

## Structured Paper P2

### Question 1

(a) It was encouraging to see that the vast majority of candidates were able to identify correctly a use for X-rays and a use for gamma rays.

(b) About half of the candidates were able to identify how X-rays and gamma rays are produced but a disturbing number of the others thought that microwave ovens produce gamma rays.

### Question 2

(a) In this part of the question candidates were asked to identify from a list the quantities which must be measured to calculate acceleration. Over two thirds of them did so correctly.

(b) Only one third of the candidates gained full marks here. Most did not seem to realise that braking is negative acceleration.

### Question 3

(a) Candidates were asked to label a diagram of a carbon-14 atom. Just over half of them gained full marks and nearly all of them were able to gain at least one mark.

(b) and (c) In a question about charge, penetration and ionizing properties of alpha, beta and gamma radiation most were able to score at least one mark out of the three available.

### Question 4

(a) A good percentage of candidates answered successfully, mentioning the lack of carbon dioxide or not causing global warming but some used the words 'pollution' or 'damage to the environment' without qualification and gained no credit. Incorrect responses frequently used the word 'reusable' for nuclear power. A very noticeable number put $CO^2$ rather than $CO_2$.

(b) A great many answers started 'it' which in the context of the question means 'nuclear power' but clearly it was not meant to mean this, such as 'it could cause cancer', 'it can harm people', 'it is hard to dispose of safely'.

### Question 5

In (a) finding the distance by a simple subtraction and then converting it to metres was executed correctly by only a very small percentage of candidates. Many used the value of the force in some way and obtained a huge number which should have indicated to them that their answer was not correct. Even those who completed (a) correctly rarely used it in (b) and so gained no marks here unless they put the correct units.

It is disappointing in (c) that so few recognised that the work done was equal to the maximum energy. Many just wrote down the value of the force and should have realised that this was incorrect if the units were newtons and not joules.
Nearly half of the candidates used the equation for calculating electrical energy correctly but few were able to explain what happens to the energy that is not used to crush the can.

**Question 6**

Over two thirds of the candidates calculated the average velocity correctly but a very small number went on to realise that the 'average' was due to the fact that the ball slowed down or changed direction on the alley.

# GCSE Additional Science 5020H
# GCSE Physics 5048H

## Structured Paper P2

### General Comments

As mentioned in the report for November series, there was evidence that candidates' familiarity with standard definitions and vocabulary is a weak area. Candidates could have gained relatively straightforward marks relating directly to statements in the learning outcomes and glossary in the specification. Centres are advised to address this is a problem area; a possible route is by analysing previous papers with their candidates as a preparation for future exams.

In general the standard of calculation still causes concern; candidates could, on the whole, select the correct equation and substitute in a dimensionally correct value. However they fared badly with even the simplest linked calculation as in questions (1)(a) and (1)(b). Transposition is still a problem area for many candidates; a substantial minority (40%) were unable to do this. In this series there was also a problem with units. There were a number of candidates who appeared not to have a calculator. This can be a disadvantage on a paper of this length because of the additional time taken to do, for example, long division.

As in previous series, the legibility of the responses seen was a problem in a number of cases. There was no evidence that candidates had insufficient time for the paper. It was apparent that candidates struggled to structure free response questions. The quality of the written work was such as to cause concern; this was not just lack of punctuation or failure to follow basic rules of grammar but the fact that many candidates wrote contradictory responses and with little regard to causality. Candidates would be well advised to re-read their answer for flow of logic and sense.

There was considerable evidence that centres entered candidates who were ill prepared for the content in bold in the specification.

1. Work and Energy

The question started with a calculation of the distance moved by a force. Candidates showed that they could interpret the diagram but a surprisingly large number were unable to convert the distance into metres as requested.

In part (b) many candidates did not continue with the value that they had calculated in (a) but instead used 13.5 cm and thus lost marks. Presumably the calculation was more difficult when using 0.135 m. Units were often omitted, despite the direct instruction to include them; there were a surprisingly large variety of incorrect responses for the unit including ohms.

Part (c) was poorly done by most candidates; the equivalence of work done and energy transferred not known. Common responses included '250 000' (the value of the force), '3 750 000' (250 000 ×15) and '3 725 000' (3 750 000-250 000). Over 40% of the candidates gained a total of two (or less) in parts 1(a), 1(b) and 1(c).

Conversely, the last parts of this question were well done with over 90% of candidates gaining two, or all, of the three marks.
The most common mistakes in part (e) were:

- inclusion of inappropriate energy types (kinetic or potential for example) in an otherwise correct list;
- suggesting that the energy was in some manner 're-used' or 'stored' so that the next crushed can took less energy;
- giving incomplete answers such as 'the energy is wasted'.

There were some pleasing responses such as 'dissipated as heat'.

In part (d), the calculation, almost all candidates were able to gain both marks; however, it must be pointed out that bald incorrect answers score zero marks, but that candidates can gain marks for showing correct substitution even when they subsequently evaluate incorrectly. It is fortunate that units were not tested in this part.

2. Average velocity and acceleration

Ninety percent of the candidates gained both marks in part (a), with a further 3% gaining one mark. A lack of calculator was apparent here, resulting in various ingenious and non standard methods for evaluating 18 /2.4. Some candidates rounded down to '7' (or rounded up to '8') without showing their working-out and so lost both marks.

The majority of candidates misinterpreted part (b). Rather than give a response in terms of speed change or direction change, candidates answered in terms of either variable force at launch, or differing time taken for successive bowls. Many candidates appear to believe that a bowling ball continues to accelerate down a bowling alley lane after being released, although the exact nature of the force is a mystery.

In part (c) the calculation (of acceleration) was not as well done as the calculation in (a) with over 40% of candidates failing to gain any marks. As can be expected, the most common errors were either to incorrectly transpose 'f = m.a' or to use an incorrect equation; 'a = (v-u)/t', 'a = ½ m $v^2$', and 'a= m.v' were quite common. There was evidence that candidates who first substituted into 'f = m.a' before doing the transposition were more likely to get the calculation correct.

3. Properties of alpha, beta particles and radioactive isotopes and static electricity

In part (a), it was disturbing to note that less than 40% of the candidates could correctly state the charge (size and sign) of an alpha particle even when given the same facts for a beta particle.

Slightly more candidates (43%) were able to deduce the sign of the charge on the insulated beta source in part (bi). In this case a common incorrect response was '**from negative** to positive', showing that the candidates thought that the source (rather than the beta particle) was originally negative.

In part (b)(ii) over 60% of the candidates were able to correctly identify the action of an (electrostatic) force at a distance. There were some excellent and well reasoned responses seen with nearly ¼ of all candidates gaining both marks. There were also some surprising reasons given; 'the beta particles weaken the strip', 'the beta particles add to

the weight of the strip making it bend', and 'the intense ionisation heated the strip until it melted'. Candidates should be warned to be very careful not to mention magnetism in the context of an answer about electrostatics, as even quite innocent references have to be assumed erroneous if there is any possible ambiguity.

Part (b)(iii) proved to be more challenging with over 50% of the candidates gaining zero marks. Very few could explain why the gap size does not affect the battery life. A significant number indicated that they thought there was a separate battery to the device shown. Some mentioned the vacuum as being a contributing factor. Responses for the time taken to touch the source often showed faulty reasoning; 'alpha is positive so it will repel the strip or take longer', 'alpha does not penetrate the strip so it will never touch', and 'copper is positive so it repels'. Many candidates used poor technical language; 'alpha is more/less powerful',' 'it' is stronger' and 'alpha is more 'reactive''. Less than 15% of the candidates gained two or all of the three marks.

In part (b)(iv), approximately 25% gained one mark, 30% gained two marks, 25% gained three marks and 15% gained all four marks. There were many good answers seen but sadly poor exam technique lost some candidates marks.

- Many candidates used imprecise terminology; 'radiation' or 'radioactivity' instead of energy, also 'weaker/stronger energy' and so lost marks.
- Some did not read the question with care, i.e. the use of 'least' in the question indicates that some form of comparative is needed in the answer.
- A number of candidates gave the causal consequence i.e. instead of writing that the half life of strontium-89 is too short, they responded with 'strontium will not last long enough' (for what?).
- There were a number of incomplete answers especially in the last section; 'explain your reasoning' means just that, it does *not* mean just write down your conclusion. A full answer should be along the lines of: 'nickel-63 has a long half life and so is unlikely to run out during his life span', or 'he is quite young and so he will need a pacemaker for a long time and so he will need the one with the longest half life'.

4. Nuclear Fission and Fusion

In part (a)(i) many candidates showed a lack of both knowledge and how to structure a free response question. More than 55% failed to gain any of the three marks. The question required a comparison of fusion and fission and a statement of the conditions required for fusion. Some candidates went straight to the obvious 'one mark' for the condition**s** but only stated one condition. The more usual condition given was high temperature; the particle density/pressure condition was infrequently mentioned. The comparison between fission and fusion was often very poorly done. Some candidates gave a good description of fission (or fusion) but failed to give both. The responses for fission were slightly better done than those for fusion.

Characteristically, responses:

- lacked essential detail; for fusion there was no mention of which nuclei were involved;
- had muddled language; 'daughter cells' in fission, 'neutrons join the uranium';
- showed confusion with other topics; 'hydrogen molecules bonded'---a confusion of fusion with chemical bonding was common as was a confusion of fission and radioactive decay;
- had basic facts incorrect; 'electrons hit the uranium-235' or 'fusion occurred because the high temperature melted the atoms and 'fused' them'.

There were references to, and sometimes detailed accounts of, a chain reaction, which was not relevant here.

There were some excellent responses both in content and in structure; however these often were for specific centres. Many centres failed to have any of their candidates gaining more than one of the available marks. This seems to indicate that this content (shown in bold in the specification) had either not been taught or had not been given sufficient attention.

As could be expected, the lack of knowledge about fusion was also evident in part (a)(ii). Few candidates seemed aware of current research into fusion. Less than 20% of the candidates gained the mark available. Very few candidates mentioned the difficulty in **maintaining** the required conditions for long enough; most concentrated on **reaching /creating** the required temperature, with no mention of pressure. Many answers stated temperature and /or pressure but did not mention **high**. A number of responses included phrases such as 'we have not got the same conditions as the sun / stars'. Safety / danger or economics aspects of the (high) temperatures / pressures were also frequently mentioned.

In part (b), over 60% were able to gain at least one mark. Candidates tended to write either at length (and ramble) or write far too briefly; 'no proof that it works' needs to be expanded. There were many very vague references to cold fusion being 'something new' or 'solving our energy problems' in part (b)(i), and it was fairly common to find candidates interpreting 'cold' as meaning 'less energy input' and answering the question in terms of energy put in v energy got out. There was confusion of the term 'reaction' with 'reactivity' and 'valid' with 'reliable/reproducible'. In part (b)(ii) many candidates assumed that the discovery had been made and scientists did not acknowledge it for a variety of reasons such as safety or "narrow-mindedness".

**Suggestions for improvement**

1. Analyse this and previous papers with your students as a preparation for future exams. Demonstrating that there are always marks for:

- recall of standard definitions, units, and vocabulary
- calculations
- interaction with data
- applications

can enable students to target their revision more effectively.

2. Ensure that the vocabulary of physics is well known. There is a glossary of terms in the specification that can be helpful. Many starter or plenary activities can be devised along these lines. There will always be some of these 'recall' type questions on each paper.

3. Practice the type of linked and carefully structured calculations as in question (1)(a)/(1)(b). There is often one of these in each series.

4. Students need to be taught about the 'flow' of a question. For example, in question (3), part (a) asked for the charge on an alpha, and the charge on beta was given. Part (a) was there to start the candidates thinking about charges. This lead into parts (b)(i)/(b)(ii)/(b)(iii) where the charge on the beta was used for what was effectively static

electricity questions. The remaining part (b)(iv) returned to a more familiar application question about properties of isotopes linked back to beta decay.

5. Students need to know which sections are in bold in the specification. There are not many of them but the last part of the paper usually covers at least some of them. It was evident that many students have either omitted these in their revision, or do not consider that they will be asked in any depth.

6. As always, get students to check that they have answered every section. There was some evidence that some students had not seen question (3)(a). Some students are helped by using a highlight pen to focus in on the detail of the question. The specific meanings of the instruction words could be included in vocabulary revision.

7. Refuse to mark illegible work or calculations done without showing the workings. You can be tough with your class marking and/or mock exam and it should ensure that your students get the mark that they deserve. In a GCSE exam incorrect bald calculations get no marks whereas calculations with working shown usually can gain at least some of the marks. If a candidate's writing is illegible or if s/he writes crucial words so poorly that we can't make them out (e.g. fission and fusion) s/he will not gain the mark.

8. Ensure that your students practice writing logically sequenced answers of the type needed for (3)(b)(iv) or (4)(a).

# Grade Boundaries
## Multiple Choice Papers – Science and Additional Science

### Raw Mark Grade Boundaries

| 5005/5025 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 20 | 18 | 15 | 13 | 10 | 8 | | |
| F | 24 | | | | 16 | 13 | 11 | 9 | 7 |

| 5006/5026 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 19 | 17 | 15 | 13 | 10 | 8 | | |
| F | 24 | | | | 18 | 15 | 13 | 11 | 9 |

| 5007/5035 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 17 | 14 | 11 | 9 | 6 | 4 | | |
| F | 24 | | | | 13 | 11 | 9 | 7 | 5 |

| 5008/5036 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 17 | 15 | 12 | 10 | 6 | 4 | | |
| F | 24 | | | | 17 | 14 | 11 | 9 | 7 |

| 5009/5045 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 18 | 16 | 14 | 12 | 8 | 6 | | |
| F | 24 | | | | 16 | 13 | 11 | 9 | 7 |

| 5010/5046 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 17 | 15 | 13 | 11 | 8 | 6 | | |
| F | 24 | | | | 15 | 12 | 10 | 8 | 6 |

| 5015/5027 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 21 | 19 | 17 | 15 | 12 | 10 | | |
| F | 24 | | | | 19 | 16 | 13 | 11 | 9 |

| 5017/5037 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 17 | 14 | 12 | 10 | 6 | 4 | | |
| F | 24 | | | | 15 | 12 | 9 | 7 | 5 |

| 5019/5047 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 24 | 20 | 17 | 14 | 12 | 9 | 7 | | |
| F | 24 | | | | 16 | 13 | 10 | 8 | 6 |

### Uniform Mark Grade Boundaries for these units

| | Max UMS | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 40 | 36 | 32 | 28 | 24 | 20 | 18 | | |
| F | 27 | | | | 24 | 20 | 16 | 12 | 8 |

Note: On higher tier papers, the "allowed" grade E is calculated as half a grade width

# Grade Boundaries

## Structured Papers

## Additional Science

### Raw Mark Grade Boundaries

| 5016/5028 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 30 | 20 | 17 | 14 | 11 | 9 | 8 | | |
| F | 30 | | | | 21 | 18 | 15 | 12 | 9 |

| 5018/5038 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 30 | 16 | 13 | 10 | 7 | 5 | 4 | | |
| F | 30 | | | | 16 | 13 | 10 | 7 | 4 |

| 5020/5048 | Max mark | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 30 | 20 | 17 | 14 | 11 | 8 | 6 | | |
| F | 30 | | | | 21 | 17 | 14 | 11 | 8 |

### Uniform Mark Grade Boundaries for these units

| | Max UMS | A* | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| H | 40 | 36 | 32 | 28 | 24 | 20 | 18 | | |
| F | 27 | | | | 24 | 20 | 16 | 12 | 8 |

Note: On higher tier papers, the "allowed" grade E is calculated as half a grade width

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