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Applied Science SC02

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Unit 2: Energy Transfer Systems

Report on the Examination

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General Comments

The performance of students in this exam compared well with that in June 2011.

Weaker students sometimes had difficulty with the equations, either putting the numbers into their calculators correctly but dividing the numbers the wrong way round or misreading the final answer by adding too many or too few zeros.

Several scripts scanned very faintly, perhaps caused by the use of blue ink. The rubric on the paper specifies that black ink or black ball-point pen is to be used and schools and colleges should ensure that students are aware of this before the examination. Some students tend to write in incredibly small handwriting which often becomes unreadable. It would be useful to remind students that illegible writing will result in no marks being awarded for their answer. Those students whose handwriting skills are known to be less than perfect could possibly be advised to write in block capitals to ensure that their work is able to be read and marked.

Question 1

(a) There were many correct references to 'systole / diastole', accompanied by good explanations. However, many answers confused breathing with heart function. There was also some confusion between heart rate and the actions of the heart. Students often talked about valves 'opening and closing' rather than whether they were opening or closing. When referring to valves, the name of the valve was often omitted. A significant number of weaker students thought they were looking at a trace concerned with breathing.

(b) Mostly correct answers.

(c)(i) Mostly correct.

(c)(ii) Mostly only one mark was awarded for recognising that the shorter the time taken to return to a resting heart rate, the fitter the person. Many failed to see that the test measures only the heart rate and spoke in vague terms about recovery rate / blood pressure / breathing rate, none of which were correct or adequate responses. The need to measure the recovery time was seldom acknowledged and many failed to establish that 'faster recovery' was equivalent to 'fitter' or the converse.

(d) Mostly correct but about 10% of students chose the wrong person and thus gained no marks. Many good answers here, using all the data supplied and relating to normal ranges. No marks were awarded for incorrectly using 'average' instead of the correct term, 'normal'. Marks were also lost due to vague statements rather than referring to the data and normal ranges for heart rate etc.

(e) Most answers gained one mark for mentioning that a faulty valve would not prevent the backflow of blood. Very rarely did they continue to say that the backflow would have been into the left ventricle, thus losing a potential mark. Many said that no blood was pumped to the rest of the body, rather than less blood, with some saying that blood flow to the body was 'affected', which is too vague, rather than 'reduced'. Also, many appeared not to know where the aortic valve is situated in the heart, and a large number thought that the valve pumps blood. Some said that valves contracted rather than opened or closed, while others said that blood would flow back into the left atrium rather than the left ventricle, again indicating that they were not sure about the structure of the heart and its function.

Many talked about the aortic valve being blocked, suggesting that they did not fully understand the function of the valve. In about 10% of answers blood clots were incorrectly linked to faulty valves. Use of the expression 'less efficient' is meaningless unless the candidate is calculating energy or power. Finally, 'cause problems' is too vague to score a mark.

(f) Mostly answered correctly, although 'stethoscope' was often spelt incorrectly.

(g) Generally well answered. Most answers were confined to religious objections. Many vague statements about 'patient's preferences' scored no marks unless tied to a specific point. Many referred, correctly, to animal rights issues. Just mentioning 'risks' did not score as highly as details of the possible risks (e.g. rejection). Many students did not appear to realise that the question referred to the choice of valve and answered in terms of whether the operation should be performed at all. There were many brief and non-reasoned answers such as 'the patient may not want an artificial valve'.

Question 2

(a)(i) The 'trachea' was mostly identified correctly, but the spelling was erratic. No mark for 'windpipe' instead of 'trachea', or 'pleural cavity' / 'alveoli' instead of 'lung'. The 'trachea' was often confused with the 'oesophagus' and the 'larynx'. The order of 'trachea' and 'lung' was sometimes reversed, leading to no marks. Also, whereas 'lung tissue' received a mark, 'lung muscle' did not.

(a)(ii) Many fully correct answers but also many that gained no marks. Many wasted time and space describing the process of breathing 'in'. Comments about gaseous exchange also scored no marks. 'Lungs being inflated because the pressure was higher inside the lungs' was seen in a number of scripts.

(b)(i) Most spotted the basic trend but nearly all made just one statement, despite the two marks available. Many students gained mark point one but a significant minority wrote their answer the wrong way round and lost the mark. Relatively few gained the second mark by observing the sudden increase in breathing rate at around 6.0% CO_2 concentration. The change in trend rate was usually overlooked or not mentioned. A few tried for extra credit by making the same point twice, e.g. once as 'more CO_2 results in an increased breathing rate' and once as 'less CO_2 results in a slower breathing rate' but this duplicated point was not rewarded. Any suggestion that an increased breathing rate actually caused a rise in concentration CO_2 received no credit. Other incorrect answers included 'an increase in CO_2 means that there is less O_2', 'an increase in breathing occurs as a response to the drop in ratio of O_2 within the blood' and incorrect involvement of the heart such as 'the more CO_2 in inspired air, the more beats per minute the heart has to make to breathe'.

(b)(ii) This question revealed a general lack of understanding. There was much confusion between breathing and heart rates with responses such as 'increased frequency of impulses from medulla to heart causes an increase in breathing rate'. Very few realised that **more** impulses will be passing to the medulla or intercostal muscles. A common response was that more CO_2 in blood causes an increase in breathing, without explaining the mechanism involved.

Question 3

(a) Generally well answered. Incorrect responses included 'thermoregulation', 'sweating', 'hyperthermia' and, in exceptional cases, 'osmosis' or 'death'.

(b)(i) Generally well answered, with the odd exception of 'sun stroke'. Many students did not grasp what a fever is, assuming that is it a cause of overheating, rather than a result. Many failed to realise that the geologist is already hyperthermic at two hours and therefore will not become hyperthermic after two hours as he is already in that state.

(b)(ii) Mostly correct answers, although many that talked about taking readings from other parts of the body received no credit.

(b)(iii) Many made only one point despite the two marks available. Many (correctly) referred to the (extra) decimal place. 'Because it is more accurate' is not a good answer to 'which is more accurate and explain why'. 'Gives an exact reading' begged the question about accuracy and gave no evidence in support. Stating that 'the liquid in glass thermometer was less likely to be faulty as it does not need a battery' suggests a general lack of understanding of the question, and indeed the topic.

(c) Generally well answered but too many incorrect references to 'respiration' and 'breathing' rather than 'breathing out'.

(d) Generally well answered although many weaker students penalised themselves with one-word answers such as 'exercise' or 'temperature'. Many talked about height or size being a factor and missed the surface area/volume ratio mark.

Question 4

(a) Many answers simply described the route taken, with no attempt at an explanation. Mostly only one mark gained for referring to convection. There was the usual confusion between hot water, hot air, heat, heat particles and the vague use of 'it'. In particular, 'air' was used instead of 'water', and 'steam' instead of 'hot water', a large minority believing that water is turned into steam in a domestic heating system. There were a significant number of detailed answers that showed total misunderstanding of the convection process.

(b)(i) The majority of answers focused on only one heat transfer method, despite three marks being available. A regular theme was: 'dark attracts' / 'dark colours absorb heat' / 'copper is a good insulator'. There was much confusion about what a conductor (or insulator) actually does. Several thought that dark colours attract heat. Most answers gained one mark for stating that copper / metal is a (good) conductor.

(b)(ii) Mostly one mark for providing a correct substitution. Most students were not able to manipulate the equation and many were also unable to substitute values correctly. Too many students failed to convert 0.48kW to 480W. A significant minority just multiplied everything they could see. Several thought that 1.2 sq m was equivalent to 1.44 (variable units).

(c) This question was not well answered. The majority of answers referred to increased global warming or words to that effect. There were many vague comments in relation to danger from touching hot pipes, greenhouse gases and fossil fuels. Hot water pipes are unlikely to be damaged by hot water and not 'worn away' either. 'Energy efficiency' is a vague concept unless it is explained which, unfortunately, it never was. Most marks were awarded for 'heat lost'.

(d) Most students identified at least one improvement but failed to provide a sound scientific explanation for the benefits. Several answers had more than two ideas, but only the first two were marked. Some answers suggested a 'more efficient material' with no link to the physics they had been taught. 'Heat is trapped in small pockets' instead of 'pockets of air' scored no marks. Some thought that air is a poor insulator. Many students wanted to alter the interior of the pipes without any consideration of the difficulties involved.

(e) Answers were generally vague and lacked detail. Many students thought that precautions were directed at the engineer (wearing eye protection, gloves etc.) and gave detailed safety precautions, rather than the precautions needed to obtain accurate and valid data. 'Take readings', 'keep everything the same' or 'control all the variables' is not enough detail at this level. Also, many students said to repeat all readings three or four times, which is not necessary when taking a lot of sequential readings as any anomalies will show up as odd points on the graph.

Many said to repeat readings without saying that they should be taken over several days / nights. Also, students often ignored the need to take readings 'overnight' and did so every 5 or 10 minutes. Many students gave details of their expected findings and underlying theory which scored no marks. They should know that 'measuring' two things is not the same as 'making sure they are the same'. Questions about 'water tanks' should not be answered by comments about 'pipes', 'beakers' or 'tubs'. A list of things to keep constant scored well, while just 'take readings' of the same data did not. It should be noted that time spent copying out parts of the question is time wasted. Very few students attempted to provide five separate points in their answer, despite the five marks available.

(f) Many students got the right number and then had a wild guess at the units. Also, many students gained one mark but there was a great problem with converting pence into pounds, either dividing by 1000 rather than by 100.

Question 5

(a) This was very poorly understood by most students, despite similar questions appearing on previous papers. Those who focused on the time (or distance) to stop the bullet were able to develop an effective explanation. Use of the word 'impact' caused much confusion; it is not a scientific concept, nor is it helpful. 'Impulse' would have been a useful idea but it was not seen in the answers. 'Slow down the force (or acceleration or momentum)' is not clear and scored no marks. Students who used scientific terms, correctly, scored more marks. 'Rate of change of momentum' is a key concept here but few students mentioned it. 'Momentum before = momentum after' is not good physics unless the 'total' momentum of everything in the collision is considered.

(b) Usually well attempted. Nearly all remembered the equation, while most used grams instead of kilograms. Working was shown and helped many students get some marks for making some headway with the calculation. A sizeable minority quoted ‘v squared’ but did not square the value of 'v' when calculating and many failed to convert 60g into 0.06 kg.

(c)(i) There was much confusion between KE and GPE. Where the equation was stated it was generally correct. Working was generally shown, but the mathematics was often faulty. Rearranging an equation seemed to cause great difficulty for many students. A regular mistake was to get a fraction upside down, when rearranging an equation. The majority still used 'grams' instead of 'kilograms' as the unit of mass, but where working was shown this only incurred a small penalty.

(c)(ii) This question caused difficulty to many. Friction force on the bullet, and resulting loss of energy, were the keys to a correct answer. Many students confused energy, momentum and forces as one concept instead of three separate concepts. Momentum theory is helpful for collisions but not for energy transfer questions such as this one. A number of students thought that ‘g’ increased as the bullet rose higher and that the wind reduced the height reached.

Question 6

(a) Very few referred to 'total input energy' and 'useful output energy'. Many quoted an equation (eff = Eo/Ei) but did not define what the letters meant. Those who stated the equation in words and then explained it got full marks; however, few actually did this. Many referred to fuel used instead of energy. Many thought that efficiency was ratio of total output to (total) input, omitting the word 'useful'.

(b) Generally well answered, although many lost marks by omitting detail. Many students failed to realise that the turbine could be a danger or a distraction. Also, many students fell back on standard answers about wind power such as ‘not always windy’ or ‘an eyesore’ etc. 'Pollution' is too vague to gain a mark. Also, some confused a motor home with a yacht and talked about the cost of running a wind turbine on a yacht. One answer suggested using the mains to generate electricity while another suggested ‘lightning’.

(c) Most put 'solar panels / cells' but a few suggested ways of reducing electricity demand (no credit) and one mentioned ‘sun dials’. Answers such as ‘use coal’, ‘hydroelectricity’ or ‘cycle to generate electricity’ did not score any marks.

(d) Most mentioned CO_2 being given off but missed the second mark by not mentioning that it is a greenhouse gas. Many responses were couched in terms of acid rain, ozone depletion and other irrelevant ideas. Again, 'pollution' or 'harmful emissions' alone is not enough to get a mark at AS level. Repeating part of the question (‘global warming’) never receives marks. There was still significant confusion between global warming and ozone layer, the majority getting this wrong. Also many confused CO_2 and CO; ‘carbon emissions’ is too vague to be creditworthy.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA website.