

BIOLOGY

Paper 5090/11
Multiple Choice

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	B	21	D
2	C	22	D
3	A	23	A
4	A	24	B
5	B	25	B
6	B	26	C
7	B	27	A
8	D	28	A
9	A	29	C
10	C	30	C
11	D	31	D
12	C	32	D
13	D	33	A
14	A	34	B
15	A	35	C
16	C	36	D
17	C	37	D
18	B	38	C
19	C	39	C
20	B	40	C

General

This paper proved to be slightly more challenging for some candidates and as ever candidates must be reminded to read carefully both the stem and the options. Some candidates seemed to be guessing on what would be expected to be easy topics such as **Question 4** and **Question 5**. Knowledge was missing too, such as in **Questions 12, 13, 22, 23** and **40**.

Comments on individual item

Questions 1, 8, 19, 21 and **30**

These items were straightforward and produced few problems for candidates.

Question 2

During osmosis, water always flows down the potential gradient through the partially permeable membrane.

Question 3

Osmosis is a passive process.

Question 4

Starch is digested by amylase, but acid slows or stops enzyme action.

Question 5

The magnesium ion is the centre of the chlorophyll molecule.

Question 6

The graph shows that for low concentrations of CO₂, (point X) as the concentration increases, so does the rate of photosynthesis, but at point Y some other factor must be limiting.

Question 7

The focus of the question is chewing, which has no effect on solubility (option **A**), but does increase surface area, allowing effective enzyme action. Saliva does contain mucus and lubrication is an important function in aiding peristalsis.

Question 9

The water in the experimental jar is replaced by sodium hydroxide in option **A**, so CO₂ is being absorbed and no starch would be detected in the leaves of the plant. The hydrogen carbonate indicator in option **C** will turn purple, but starch will still be synthesised in the leaves. Option **B** – in the dark – will show the need for light, while option **D** will synthesise starch similarly to the original experiment and option **C**.

Question 10

Protein will give a positive reaction (purple colour) with the biuret test.

Question 11

Tissue Q is xylem, which carries water as part of the transpiration stream, so the speed of its contents is related to the humidity. The speed of phloem contents (tissue P) is not dependent upon humidity.

Question 12

This question should have been easy since it follows **Question 11**. Xylem (label 3) is clearly visible although phloem (label 2) is less obvious.

Question 13

Mainly knowledge was missing here. Artery walls are muscular and elastic, with a narrow lumen.

Question 14

High oxygen levels show this vessel to be the aorta or pulmonary vein, but the high pressure picks out the aorta.

Question 15

Labelling the semi-lunar valves helped this question, but many candidates did not identify label 1 as the pulmonary artery.

Question 16

While the contraction of diaphragm muscles is well known it should also be known that the diaphragm is domed, when relaxed, but is pulled down into a more flattened shape when breathing in.

Question 17

Diffusion is not an active process (**C**). The conduction of impulses depends upon the active sodium pump in nerve cells, although the movement of sodium and other ions is passive during the actual passage of an impulse.

Question 18

The soaked pea seeds will be respiring, producing CO₂ and raising the pressure in tube 2, thus lowering the level of the coloured water. The CO₂ will be absorbed in tube 1, so the level will rise.

Question 20

Waste products of metabolism are excreted. CO₂ is a waste product of respiration and urea is a waste product of deamination, so regardless of how it is lost, it is being excreted. Defecation is the loss of undigested food material.

Question 24

Adrenaline causes the well-known "fight or flight" reactions, including raised blood glucose and heart rate and dilated pupils.

Question 25

Although all four statements may be true, only **B** can be deduced from the information given.

Question 26

Fungal cells are eukaryotic and contain nuclei.

Question 27

Penicillium is an aerobic organism, so the air must provide oxygen, but it also serves to circulate the culture, which would otherwise require stirring.

Question 28

All four molecules contain carbon, but the dry weight of plants is largely cellulose which is made up of many glucose molecules and must be the major source of the CO₂ produced during decay.

Question 29

The stem refers to the nitrogen cycle, so the organic substances at X must be nitrogenous.

Question 31

Anti-malarial drugs are available which stop the development of merozoites and can kill sporozoites, so statements 1, 2 and 3 are all correct.

Question 32

Added nitrates cause increased green plant growth, but they die and rot, leading to an increase in bacteria. Since the bacteria are aerobic, statement 2 must be followed by statement 3.

Question 33

The male gamete, not the whole pollen grain, moves down the pollen tube. Most of the grain remains on the stigma.

Question 34

Self-pollination involves pollen from a flower being transferred to the same flower's stigmas or to another flower on the same plant. It is effective and economical, but produces little variation in offspring.

Question 35

The penis deposits sperm in the vagina. Fusion of the egg and sperm is usually in the fallopian tube.

Question 37

The man's genotype may be $I^A I^O$ or $I^A I^A$ so half his gametes will contain I^O , which could lead to his having a child with the genotype $I^B I^O$ and hence blood group B.

Question 38

A haploid cell has only one of the alleles, which rules out both options **A** and **B**. **D** cannot be correct since a recessive phenotype must be homozygous for the recessive allele.

Question 39

Crossing RR with rr gives an F_1 of all Rr and then an F_2 of 3 red to 1 white flowered plant. The small numbers in this example have a ratio of only 2 to 1.

BIOLOGY

Paper 5090/12
Multiple Choice

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15	A	35	D
16	B	36	C
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20	B	40	C

General

This paper proved to be slightly more accessible for some candidates, with many candidates performing very well, although the differentiation of candidates was good. Only one question (**Question 27**) produced a real surprise, with only one fifth of candidates realising that most of the dry weight of plants is made of cellulose. The bifurcating key style in **Question 25** may have been unfamiliar, although it is normally used in many identification books.

Comments on individual items

Questions 2, 3, 4, 5, 8, 10, 11, 13, 14, 19, 21, 23, 24, 31, 33, 35, 36, 38, 39

These items were straightforward and produced few problems.

Question 6

The graph shows that for low concentrations of CO₂, (point X) as the concentration increases, so does the rate of photosynthesis, but at point Y some other factor must be limiting.

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Question 9

Reading all the words in the stem is important – the focus of the question is chewing, which has no effect on solubility (option **A**), but does increase surface area, allowing effective enzyme action. Saliva does contain mucus and lubrication is an important function in aiding peristalsis.

Question 12

Tissue Q is xylem, which carries water as part of the transpiration stream, so the speed of its contents is related to the humidity. The speed of phloem contents (tissue P) is not dependent upon humidity.

Question 15

The heart valves are well known – and labelled – but the unlabelled pulmonary artery (labelled 1) was less well known.

Question 16

The soaked pea seeds will be respiring, producing CO₂ and raising the pressure in tube 2, thus lowering the level of the coloured water. The CO₂ will be absorbed in tube 1, so the level will rise.

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Adrenaline cause the well-known “fight or flight” reactions, including raised blood glucose and heart rate and dilated pupils.

Question 25

Fungal cells are eukaryotic and contain nuclei.

Question 26

Drawing conclusions must use the information in the graph. Although all four statements may be true, only **B** can be deduced from the information given.

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All four molecules contain carbon, but the dry weight of plants is largely cellulose, which is made up of glucose molecules and must be the major source of the CO_2 produced during decay.

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The man's genotype may be $I^A I^O$ or $I^A I^A$ so half his gametes will contain I^O , which could lead to his having a child with the genotype $I^B I^O$ and hence blood group B.

Question 40

A haploid cell has only one allele, which rules out both options **A** and **B**. **D** cannot be correct since a recessive phenotype must be homozygous for the recessive allele.

BIOLOGY

Paper 5090/21

Theory

Key Messages

Successful candidates had a good basic biological knowledge and read and answered the question carefully.

General Comments

Most candidates presented their work clearly and in a form that was easily followed. Most attempted all of the questions required, and a few attempted both **Questions 8** and **9**, contrary to the rubric instructions. The quality of the answers varied from excellent to those showing little biological understanding. In **Section A** questions, information is often provided to augment the candidate's own biological knowledge. It is important for candidates to read this information carefully and to apply it in their answers. Similarly, when a question asks for information from "this diagram" then only features which can be seen on the diagram will be awarded credit.

Comments on Specific Questions

Section A

Question 1

- (a) Most candidates answered correctly.
- (b) Although there were many correct answers, some candidates gave the answer as 1.9.
- (c) Candidates found this question difficult. Some candidates recognised that the consumers needed to ingest large quantities of the preceding member of the food chain, thus multiplying the amount of mercury present but there needed to be more references to the inability of the organisms to dispose of the mercury once it had been absorbed into the body cells, leading to subsequent accumulation. Many erroneously stated that the level of mercury decreased along the food chain and qualified this with an explanation of energy flow. The candidates who answered the question without any mention of mercury received no credit.
- (d) It was expected that candidates could make the link between fishermen eating the contaminated fish they caught and that the high levels of mercury could have an effect on their nervous system. It was pleasing that many candidates were able to do this.

Question 2

- (a) Many candidates realised that the air bubble would move towards the shoot, but few explained that this was caused by transpiration or use of water in photosynthesis.
- (b)
 - (i) Most candidates said the air bubble would stop, but few realised the process would slow, before stopping.
 - (ii) There were some good answers, but many candidates' answers referred solely to photosynthesis which has only a small effect. The answers that referred to the black bag reducing air flow, thus increasing humidity and so causing a reduction in transpiration, were the ones which scored well.

Question 3

- (a) Most candidates answered correctly.
- (b) Again, most were correct, although several incorrectly opted for meiosis.
- (c) The candidates who gave specific genetic differences, e.g. blood group or shape of ears, received credit. The answers such as “they look alike”, “they are the same” did not. For the explanation, candidates should have mentioned that the twins were the result of a single fertilisation and so had the same genetic make-up.
- (d) Not all candidates realised that differences between the same identical twins were required. Again, two features that were clearly affected by the environment were needed.

Question 4

- (a)
 - (i) This was correctly answered by most candidates.
 - (ii) Insect pollination was usually recognised. The question asked how the process was brought about in “this flower”, so the reasons had to be related to the flower structure shown in the diagram. This means that answers including “colour and smell” did not receive credit.
- (b) This was a recall question but candidates had great difficulty and only a few correct answers were seen.
- (c) The development of the fruit after fertilisation was not well known. Candidates who read the question carefully realised that when asked for “parts of the flower”, more than one was required. A few candidates, who attempted to name the part, rather than use the letters, did not gain much credit.

Question 5

The interpretation of the graph was found difficult by many of the candidates, who, as a consequence, received little credit. Those who could interpret it gave some excellent answers.

- (a) Most candidates realised that regions **K** and **L** had to be found after the duodenum and some identified them correctly.
- (b) The lack of digestion of starch in the stomach and the reasons for it were explained well.
- (c) Some candidates did not realise that the information on the graph showed that there were no undigested starch molecules left in the gut after **K**.

Section B

Question 6

- (a) This question specifically asked candidates to refer to blood vessels and to describe how the liver obtained its requirements and exported its products. There were some very good answers from candidates who attempted to answer the question. Most candidates interpreted the question in terms of needing to write ‘all they knew about the liver’ and as a consequence received little, if any credit. Candidates should have mentioned the hepatic artery carrying oxygen, glucose and hormones to the liver, the hepatic portal vein joining the gut to the liver, and as a consequence carrying glucose and amino acids to it and also the hepatic vein removing carbon dioxide, urea and other metabolic products from the liver. Some candidates were unsure of the correct nomenclature; the ‘hepatic portal artery’ was often included. The different roles of arteries and veins need to be more clearly understood.
- (b) The specific reference to excretory organs caused problems for the candidates. They need to recognise that the characteristics of capillaries present around the alveoli or in the villi apply equally to those in the excretory organs.

Question 7

- (a) This question received the most credit in **Section B** and was very well answered. The candidates described photosynthesis well and most linked this with respiration. Some candidates still stated that respiration occurs only in the dark. References were made to herbivores eating the plants, plant decay and also to fossil fuels to enable the trapped carbon in the leaf to be returned, as carbon dioxide, into the cycle.
- (b) This question was not so well answered. Candidates need to realise that the answer should relate to any limiting factors present, although most did realise that there was an upper limit for the rate of photosynthesis. A high percentage of candidates stated that the plant stores up light to use when it is dark, which is a serious misconception.

Section C

Candidates were fairly equally divided in their choice of these questions.

Question 8

- (a) Candidates who gave the functions, rather than the structure, of the cell membrane were able to score well. Although osmosis was often mentioned, there were only one or two references to active transport.
- (b) The osmotic advantages of surrounding the cell membrane with cellulose were well described by many candidates. Also there were many references to support in herbaceous plants.

Question 9

- (a) Many candidates gained full credit in this section as the information was well known. Candidates should be reminded that nerves 'carry impulses' rather than 'send messages'.
- (b) Candidates did not perform well in this part. References to the sound being the stimulus for the reflex action were not common. Candidates mentioned adrenaline but did not say that it is transported in the blood to the heart muscle so that the beat rate increases.

BIOLOGY

Paper 5090/22

Theory

Key messages

Candidates were required to combine carefully learnt detail with equally carefully reasoned responses. Sometimes it was evident that a little more time spent thinking about the exact requirement of a question before beginning the answer might have been more worthwhile. Questions that ask for an 'explanation' will always require a little more than simple factual statements.

General comments

The overall performance of candidates at this session appears to have been very good. The entire paper was accessible to most candidates with some performing exceptionally well. Very few candidates did not follow the rubric and answered both **8** and **9**. A higher proportion of candidates appear to have attempted **8** rather than **9**, but whichever of these options was chosen, it was often most competently answered, with full credit often being awarded. Definitions had been carefully learnt, and osmosis and excretion were topics with which candidates were clearly comfortable.

Section A

Question 1

- (a) This was generally well answered, although virus and bacterium were sometimes interchanged for **B** and **C** respectively. Some candidates, perhaps unfamiliar with the appearance of a virus, suggested that **B** might be a zygote.
- (b) The order of size was often well known, but candidates need to be sure they have understood the question before answering it as listing the organisms in reverse order was sometimes seen.
- (c) Labelling of the components was often incorrect. The genetic material of the virus was often labelled as **N**. The protein coat was commonly correctly labelled. Others then confused the issue by labelling a second structure incorrectly.
- (d) Bacterium was widely known as the type of microorganism involved. Candidates who appreciated that a gene is transferred from one location to another did not always go on to specify that the destination of transfer was into the genetic material of the bacterium. It was uncommon, yet not unseen, for candidates to refer to transfer of the gene product (insulin) rather than the gene itself.

Question 2

- (a) Candidates who appreciated the need to link named constituents of the food source to their biological functions often gained maximum credit. Those who listed constituents with no link to appropriate functions gained no credit. Incorrect links between constituents and their functions were sometimes seen, most notably with reference to iron which was usually linked to bone structure.
- (b) As in (a), candidates who appreciated the need to link named constituents to their biological functions often gained maximum credit. References to protein and calcium were most common. As in (a), candidates listing constituents with no link to their appropriate functions gained no credit. An incorrect reference to vitamin C was common.

- (c) Many candidates made the link between banana being a good source of carbohydrate and the energy released from this being important at the start of a race. A significant number of candidates went on to identify glucose as an example of a carbohydrate and to identify carbohydrate as a 'quick' source of energy. Several candidates, although fewer than in previous sessions, did not gain credit due to incorrect reference being made to the production rather than release of energy during respiration. Candidates who correctly identified avocado as providing a higher amount of energy often did not go on to gain further credit.

Question 3

- (a) The majority of candidates correctly identified an organism, chemical energy and 2 % in parts (i), (ii) and (iii) respectively.
- (b) Again, the majority of candidates correctly identified the process as 'respiration'. The most commonly seen incorrect response was 'photosynthesis'.
- (c) This question was a good discriminator in favour of the most able candidates. In (i) correct responses demonstrated that candidates were commonly able to identify bacteria as being responsible for decomposition of dead matter, resulting in the release of energy. Incorrect responses made reference to bacteria of the nitrogen cycle other than those causing decay and their role in the production of inorganic nutrients in the soil. In (ii) correct responses most commonly made reference to energy use during germination or to the release of energy in the form of heat. Reference to increasing the rate of enzyme action was uncommon. Reference to 'growth' was often made with no explanation that the growth would be at a faster rate. Incorrect responses were often characterised by reference to inorganic nutrients in the soil being used for germination.

Question 4

- (a) A significant proportion of candidates did not gain credit due to the inaccuracy of the label line drawn in their response. Label lines ending just short of, or extending beyond the membrane drawn in Fig. 4.1 did not gain credit.
- (b) Many candidates gained maximum credit for responses which indicated a good understanding of osmosis theory and terminology. Candidates' responses were often clearly ordered and fully explained the events that would occur in both cells. Incorrect reference was sometimes made to turgidity with reference to the treated cell prior to it bursting. The role of turgor in the untreated cell was well known and the most able candidates fully explained the role of the cell wall in opposing this pressure and hence preventing bursting.
- (c)
- (i) Mitosis was well known, although meiosis and hybrid spellings of both words were occasionally seen and did not gain credit.
 - (ii) Reference was most commonly made to an increased yield of genetically identical offspring. A number of candidates went on to include details of desirable characteristics that had been selected for and to refer to the economic benefit of the chosen commercial application. Responses relating to fungi or bacteria production in a fermenter were sometimes seen and did not gain credit. Reference was occasionally made to the process of genetic engineering and did not gain credit.

Question 5

- (a) Many candidates were able to correctly identify the times required. Very few candidates omitted units which were required for both figures.
- (b) Many candidates gained maximum credit for responses which included an appreciation of increased demand for energy by muscles necessitating an increased blood flow and oxygen supply to the respiring muscles. Reference was less often seen to an increased requirement to remove carbon dioxide. Candidates sometimes did not make sufficiently clear that there was an increased demand for blood, oxygen, glucose and energy and removal of carbon dioxide during exercise which is above that required whilst at rest.

- (c) The principle of student **F** being more used to physical exercise and of **E** exercising vigorously were the most commonly awarded marking points. Reference was also made to more efficient transport of oxygen in student **F** due to more red blood cells. Candidate **E** being possibly obese or a smoker. Candidates sometimes overlooked the 4 marks available for this part, and supplied only one or two suggestions.

Section B

Question 6

- (a)
- (i) The principle of transpiration was widely known and many candidates gained maximum credit for responses containing all available marking points. A minority of candidates made reference to intake of water at the roots rather than loss of water from the leaves.
 - (ii) 'Nitrates' was the most commonly seen correct answer. That they are dissolved or that they combine with carbohydrates was less commonly seen. Candidates often did not appreciate the role of transpiration in supplying the plant with mineral salts and many who did, did not specify nitrates as being those relevant to this part-question.
- (b) It was the first part of the answer that often did not receive enough attention from candidates. Those who thought to describe the entry of the dye into the roots regularly said that it entered by osmosis. The permeable nature of the cell wall allowing entry of the dye was not mentioned. Xylem as a transport vessel for water was well known, although a number of candidates did not go on to describe that the dye would also be present in this tissue resulting in it being stained. Movement of water containing dye upwards in the xylem was commonly seen. Reference to 'root cells' was often made with reference to water alone so did not gain credit.

Question 7

- (a) The dual function of the kidneys in 'excretion' and 'osmoregulation' was well known. Formation of urine was also commonly seen and, when coupled with removal of urea, often allowed candidates to gain maximum credit in this question. Reference to removal 'from the body' was more frequent than the credit-worthy removal 'from the blood'.
- (b) Many candidates began their responses with a simple reference to the possibility of a kidney transplant. Reference was then often made to the process of dialysis, followed by a description of the process in varying levels of detail. The most able candidates provided a full and very detailed account of the process including the role of dialysis fluid, diffusion, the removal of urea and excess water and of controlling the contents of dialysis fluid. Very few candidates provided incorrect responses to this question, (though, sometimes, the dialysis fluid was thought to be inside a partially permeable tube in a bath of blood) – with differentiation between candidates being largely dependent upon the number of credit-worthy points included in their response. Centres are reminded that diagrams drawn by candidates as part of their response must be fully annotated in order to be considered for credit.

Section C

Question 8

- (a) Many candidates did well to learn the definition of a drug and thus scored full credit. Those who had not done so spoke vaguely about what they considered to be a description rather than a definition of a drug of abuse.
- (b) There were some extremely accurate responses to this question. Several candidates did not make reference to a named drug and therefore gained limited credit. Some unwisely chose 'smoking' as their named drug, and were then not sufficiently precise over the effect of nicotine rather than of the other constituents of cigarette smoke. Some had learnt a list of possible effects that might apply to almost any drug of abuse. The more able candidates set out their response in a logical, well ordered manner.

Question 9

- (a) A common error was for candidates to use incorrect terminology such as 'gene' or 'allele' referring to the X and Y chromosomes. It was also common for candidates to incorrectly state that gametes contain pairs of chromosomes (e.g. sperm cells contain both X and Y). Rarely was it mentioned that X-containing and Y-containing sperms are produced in equal numbers.
- (b) A good proportion of candidates gave full, accurate and relevant accounts. Many candidates gained full credit for a complete genetic diagram clearly displaying a sound knowledge of the principle of codominant inheritance. As expected, the most commonly known example of a codominant characteristic was blood group AB, however it was not uncommon for candidates to use other examples that were able to gain full credit if expressed correctly. Candidates who selected parents with a pair of identical codominant alleles (e.g. $I^A I^A$) and those who relied on a simple monohybrid cross were limited in the number of acceptable marking points available to them.

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Paper 5090/23

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Key messages

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- (a) Many candidates were able to correctly identify the times required. Very few candidates omitted units which were required for both figures.
- (b) Many candidates gained maximum credit for responses which included an appreciation of increased demand for energy by muscles necessitating an increased blood flow and oxygen supply to the respiring muscles. Reference was less often seen to an increased requirement to remove carbon dioxide. Candidates sometimes did not make sufficiently clear that there was an increased demand for blood, oxygen, glucose and energy and removal of carbon dioxide during exercise which is above that required whilst at rest.

- (c) The principle of student **F** being more used to physical exercise and of **E** exercising vigorously were the most commonly awarded marking points. Reference was also made to more efficient transport of oxygen in student **F** due to more red blood cells. Candidate **E** being possibly obese or a smoker. Candidates sometimes overlooked the 4 marks available for this part, and supplied only one or two suggestions.

Section B

Question 6

- (a)
- (i) The principle of transpiration was widely known and many candidates gained maximum credit for responses containing all available marking points. A minority of candidates made reference to intake of water at the roots rather than loss of water from the leaves.
 - (ii) 'Nitrates' was the most commonly seen correct answer. That they are dissolved or that they combine with carbohydrates was less commonly seen. Candidates often did not appreciate the role of transpiration in supplying the plant with mineral salts and many who did, did not specify nitrates as being those relevant to this part-question.
- (b) It was the first part of the answer that often did not receive enough attention from candidates. Those who thought to describe the entry of the dye into the roots regularly said that it entered by osmosis. The permeable nature of the cell wall allowing entry of the dye was not mentioned. Xylem as a transport vessel for water was well known, although a number of candidates did not go on to describe that the dye would also be present in this tissue resulting in it being stained. Movement of water containing dye upwards in the xylem was commonly seen. Reference to 'root cells' was often made with reference to water alone so did not gain credit.

Question 7

- (a) The dual function of the kidneys in 'excretion' and 'osmoregulation' was well known. Formation of urine was also commonly seen and, when coupled with removal of urea, often allowed candidates to gain maximum credit in this question. Reference to removal 'from the body' was more frequent than the credit-worthy removal 'from the blood'.
- (b) Many candidates began their responses with a simple reference to the possibility of a kidney transplant. Reference was then often made to the process of dialysis, followed by a description of the process in varying levels of detail. The most able candidates provided a full and very detailed account of the process including the role of dialysis fluid, diffusion, the removal of urea and excess water and of controlling the contents of dialysis fluid. Very few candidates provided incorrect responses to this question, (though, sometimes, the dialysis fluid was thought to be inside a partially permeable tube in a bath of blood) – with differentiation between candidates being largely dependent upon the number of credit-worthy points included in their response. Centres are reminded that diagrams drawn by candidates as part of their response must be fully annotated in order to be considered for credit.

Section C

Question 8

- (a) Many candidates did well to learn the definition of a drug and thus scored full credit. Those who had not done so spoke vaguely about what they considered to be a description rather than a definition of a drug of abuse.
- (b) There were some extremely accurate responses to this question. Several candidates did not make reference to a named drug and therefore gained limited credit. Some unwisely chose 'smoking' as their named drug, and were then not sufficiently precise over the effect of nicotine rather than of the other constituents of cigarette smoke. Some had learnt a list of possible effects that might apply to almost any drug of abuse. The more able candidates set out their response in a logical, well ordered manner.

Question 9

- (a) A common error was for candidates to use incorrect terminology such as 'gene' or 'allele' when referring to the X and Y chromosomes. It was also common for candidates to incorrectly state that gametes contain pairs of chromosomes (e.g. sperm cells contain both X and Y). Rarely was it mentioned that X-containing and Y-containing sperms are produced in equal numbers.
- (b) A good proportion of candidates gave full, accurate and relevant accounts. Many candidates gained full credit for a complete genetic diagram clearly displaying a sound knowledge of the principle of codominant inheritance. As expected, the most commonly known example of a codominant characteristic was blood group AB, however it was not uncommon for candidates to use other examples that were able to gain full credit if expressed correctly. Candidates who selected parents with a pair of identical codominant alleles (e.g. $I^A I^A$) and those who relied on a simple monohybrid cross were limited in the number of acceptable marking points available to them.

BIOLOGY

Paper 5090/31
Practical Test

Key messages

The questions tested candidates' abilities to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The use of techniques and apparatus in experiments and the ability to evaluate and apply data resulting from an investigation were also tested.

General comments

The objectives of this paper were to test not only biological knowledge but also knowledge and experience of practical work, together with the use and application of practical skills and techniques. Candidates appeared to have more than sufficient time to complete the paper.

Comments on specific questions

Question 1

(a)

- (i) The Benedict's test for reducing sugars was well done especially with correct responses to the heating of Benedict's solution to produce a change in colour from blue to yellow/orange/red and hence a positive test for reducing sugar. The best answers also included the use of equal volumes of each of **S1** and Benedict's solution prior to heating.
- (ii) A positive result linking this colour change with reducing sugar was mainly correct, despite the occasional incorrect reference to starch.
- (iii) Testing the potato tissue as described in (i) showed that little or no reducing sugar is present although in some cases incorrect responses showed a positive colour change for reducing sugar.

(b)

- (i)(ii) Most responses were satisfactory with all columns of the table being completed in cm to the first decimal place, with positive/negative signs being appropriately included for each change in length. Some errors included incomplete columns in the table plus the absence of decimal places and also positive/negative signs when measurements were made.
- (iii) Responses overall were excellent with candidates recording a decrease in the length of potato chips in **A** relating this to exosmosis or that water had been absorbed from the potato. There is no change in length in **B** as movement of water into and out of the potato is equal. In **C** the increase in length is due to water entering the potato by endosmosis. Weaker answers confused the processes of exosmosis and endosmosis and focused instead on plasmolysis, flaccidity, turgidity and that the solutions contained high /low concentrations of water and a low/high concentration of solute.

Question 2

(a)

- (i)(ii) The best answers included the completion of 3 readings of the initial and final volumes plus correct calculations of the volume used to make the blue colour disappear. Readings with one decimal place were also included in at least one/two columns. Weaker responses

showed incomplete readings either without a decimal place and /or incorrectly calculated the difference between the initial and final volumes.

- (iii) Responses overall were excellent as the majority of candidates understood that taking multiple readings would provide a mean value resulting in more reliability, accuracy and minimised errors
 - (iv) The calculation of mean values was overall satisfactory except for some candidates who did not include the appropriate units of cm^3 .
- (b) Responses to (i), (ii) and (iii) were of a similar standard to those in (a) above.
- (iv) Many excellent answers demonstrated a clear understanding that **S2** had the higher vitamin C content.
- (c)
- (i) As expected, the most able candidates produced first class plots placing the fruit names and bars equally on the x-axis with vitamin C /mg/100 g on the y-axis, with both axes correctly orientated and labelled. Plots were drawn with clear lines and shading and with bars not touching. Weaker responses showed a reversal and /or lack of labelling of the axes with incomplete or no plots.
 - (ii) Many very good responses showed correct calculations here.
- (d) When asked to investigate how the length of time oranges are stored influences their vitamin C content, the best answers referred to dark/cool conditions under which oranges should be stored, with sampling undertaken at regular intervals and that juice should be extracted. Excellent responses also showed that measurements of the volume of juice were required for testing with the blue dye DCPIP. In addition, sampling should be replicated and the results calculated for plotting or tabulating. Weaker answers incorrectly suggested that oranges should be exposed to adverse weather conditions over time to show that air/temperature depleted the levels of vitamin C.
- (e) Many able candidates appreciated that vitamin C in the diet prevented scurvy and it cannot be produced by the human body,. Less specific and incorrect responses suggested that this vitamin is needed for growth and development or to produce strong bones, ensure healthy gums or replace worn out tissues.

Question 3

- (a)
- (i) There was a considerable difference in the size of specimens provided and Examiners were careful to ensure that candidates were not penalised for this. Candidates were expected to make a large drawing of the back leg of **S3**. The very best responses showed the leg to be larger than the insect with a clear outline and preferably no shading plus detail of the attachment to the body. The correct number of parts/segments along the length of the leg and a distinct claw at tip of the leg were also correctly drawn. The majority of responses on the other hand tended to overlook the detail of the attachment end to the body and omitted to include the correct number of parts/segments along the leg. In many Centres no attempt at all was made to answer (a)(i) and this in turn reflected no response in (a)(ii). Candidates must therefore consider all of the subject matter, support their answers with careful observation and analysis as in the case of (a)(ii). Candidates also need to answer the question set.
 - (ii) Apart from occasionally confusing the orientation of the legs, measurements of the lengths of both front /back legs were overall satisfactory. Candidates on the other hand were largely confused about how to calculate the ratio of the front to the back leg and the majority either repeated the figures given in the measurements as a ratio or entirely omitted this part of the question.

BIOLOGY

Paper 5090/32
Practical Test

Key messages

The questions tested candidates' abilities to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The use of techniques and apparatus in experiments and the ability to evaluate and apply data resulting from an investigation were also tested.

General comments

The objectives of this paper were to test not only biological knowledge but also knowledge and experience of practical work, together with the use and application of practical skills and techniques. Candidates appeared to have more than sufficient time to complete the paper.

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(a)

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- (ii) A positive result linking this colour change with reducing sugar was mainly correct, despite the occasional incorrect reference to starch.
- (iii) Testing the potato tissue as described in (i) showed that little or no reducing sugar is present although in some cases incorrect responses showed a positive colour change for reducing sugar.

(b)

- (i)(ii) Most responses were satisfactory with all columns of the table being completed in cm to the first decimal place, with positive/negative signs being appropriately included for each change in length. Some errors included incomplete columns in the table plus the absence of decimal places and also positive/negative signs when measurements were made.
- (iii) Responses overall were excellent with candidates recording a decrease in the length of potato chips in **A** relating this to exosmosis or that water had been absorbed from the potato. There is no change in length in **B** as movement of water into and out of the potato is equal. In **C** the increase in length is due to water entering the potato by endosmosis. Weaker answers confused the processes of exosmosis and endosmosis and focused instead on plasmolysis, flaccidity, turgidity and that the solutions contained high /low concentrations of water and a low/high concentration of solute.

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showed incomplete readings either without a decimal place and /or incorrectly calculated the difference between the initial and final volumes.

- (iii) Responses overall were excellent as the majority of candidates understood that taking multiple readings would provide a mean value resulting in more reliability, accuracy and minimised errors
 - (iv) The calculation of mean values was overall satisfactory except for some candidates who did not include the appropriate units of cm^3 .
- (b) Responses to (i), (ii) and (iii) were of a similar standard to those in (a) above.
- (iv) Many excellent answers demonstrated a clear understanding that **S2** had the higher vitamin C content.
- (c)
- (i) As expected, the most able candidates produced first class plots placing the fruit names and bars equally on the x-axis with vitamin C /mg/100 g on the y-axis, with both axes correctly orientated and labelled. Plots were drawn with clear lines and shading and with bars not touching. Weaker responses showed a reversal and /or lack of labelling of the axes with incomplete or no plots.
 - (ii) Many very good responses showed correct calculations here.
- (d) When asked to investigate how the length of time oranges are stored influences their vitamin C content, the best answers referred to dark/cool conditions under which oranges should be stored, with sampling undertaken at regular intervals and that juice should be extracted. Excellent responses also showed that measurements of the volume of juice were required for testing with the blue dye DCPIP. In addition, sampling should be replicated and the results calculated for plotting or tabulating. Weaker answers incorrectly suggested that oranges should be exposed to adverse weather conditions over time to show that air/temperature depleted the levels of vitamin C.
- (e) Many able candidates appreciated that vitamin C in the diet prevented scurvy and it cannot be produced by the human body,. Less specific and incorrect responses suggested that this vitamin is needed for growth and development or to produce strong bones, ensure healthy gums or replace worn out tissues.

Question 3

- (a)
- (i) There was a considerable difference in the size of specimens provided and Examiners were careful to ensure that candidates were not penalised for this. Candidates were expected to make a large drawing of the back leg of **S3**. The very best responses showed the leg to be larger than the insect with a clear outline and preferably no shading plus detail of the attachment to the body. The correct number of parts/segments along the length of the leg and a distinct claw at tip of the leg were also correctly drawn. The majority of responses on the other hand tended to overlook the detail of the attachment end to the body and omitted to include the correct number of parts/segments along the leg. In many Centres no attempt at all was made to answer (a)(i) and this in turn reflected no response in (a)(ii). Candidates must therefore consider all of the subject matter, support their answers with careful observation and analysis as in the case of (a)(ii). Candidates also need to answer the question set.
 - (ii) Apart from occasionally confusing the orientation of the legs, measurements of the lengths of both front /back legs were overall satisfactory. Candidates on the other hand were largely confused about how to calculate the ratio of the front to the back leg and the majority either repeated the figures given in the measurements as a ratio or entirely omitted this part of the question.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key messages

This paper is designed to test candidates' experience of practical work. This includes:

- following instructions;
- interpreting and using data;
- using given information about an investigation as a basis for designing a new investigation;
- biological drawing, that, unlike sketching, involves using a sharp pencil to make clean lines to show the specimen and its observable features;
- measuring precisely with due regard to units.

General comments

The information provided in the questions is given to guide candidates' thinking. When an investigation that may be new to the candidate is described, it is intended to help the candidates to imagine that they themselves were carrying it out. That will then help them to apply relevant information to other situations.

Comments on specific questions

Question 1

(a)

- (i) The vast majority of candidates measured and recorded the lengths of the strips precisely. It should be noted that they were given the information that the strips initially measured 5.0 cm and therefore, if there was no change in length, the final measurement should also have been recorded as 5.0 cm.
- (ii) Most candidates were able to calculate the changes in length, but only some recorded whether the change was a loss or a gain.
- (iii) Many candidates correctly described the changes in length. Explaining those changes in terms of osmosis and correct direction of water movement was done well by the more able candidates.

(b)

Candidates were asked to apply the techniques already described to a new situation. A different plant tissue was to be used and some candidates named suitable material other than potato. Many candidates did not notice that this new investigation was to relate to changes in mass, and repeated the references to length in (a). Those who thought through the investigation in (a) applied similar techniques - a similar range of sucrose solutions, leaving the tissue for a similar time and drying it after removing it from the solutions before measuring its final mass.

More able candidates appreciated that, with a different tissue, the concentration of sucrose solution that produced no change in mass might not be the same as for the potato in (a) and used these solutions as a preliminary to narrowing the range of concentrations for a final answer.

Some candidates chose to place the tissue in a 13 g per 100 cm³ sucrose solution without realising that a different tissue might respond differently from the potato.

Some candidates, having seen the word 'sucrose' in the question, chose to describe testing plant tissue for sucrose using Benedict's solution which is not what the question required.

Question 2

- (a) Most candidates knew that tests were repeated in order to arrive at a more reliable or accurate answer or to reduce experimental error.
- (b) (i) The vast majority of candidates constructed bar charts as instructed; a few attempted line graphs. Following instructions is an important practical technique.
- Both axes on the bar chart should be fully labelled. In this case, the *y*-axis with vitamin C/mg per 100 g and the *x*-axis either with the names of the fruits or with symbols explained in a key.
- Some candidates correctly used a scale from 0 to 3100 on the *y*-axis, making full use of the whole grid.
- Other candidates incorrectly used two different scales – one from 0 – 200 and another for the higher values on the same *y*-axis.
- There were those candidates who incorrectly wrote down the values given in the table equidistantly along the scale.
- The plotting of the values was often done precisely.
- The vast majority of candidates who drew the chart did use rulers and constructed bars of equal width.
- (ii) There were candidates who were unable to answer this question although all the information needed was provided. Of those who did attempt an answer, many calculated the difference between the two i.e. 3100 – 50 mg instead of how many times greater one was than the other i.e. 3100/50.
- (c) As an investigation involving the use of DCPIP to determine vitamin C content of fruit had already been described, it was expected that the DCPIP test would be applied to oranges stored for different periods of time. This was not appreciated by candidates who wrote generally about storing oranges, tasting them for sweetness, or testing them for sugar. Better candidates recognised the need to keep experimental conditions constant except for the one under investigation, the length of storage time.
- (d) Many candidates made good references to the prevention of scurvy etc. or vitamin C's effect on the immune system. No candidate stated that vitamin C cannot be manufactured by the body and therefore has to be taken in as a part of our diet.

Too often candidates made general statements about the need for vitamins for healthy bodies, or gave answers related to other vitamins e.g. rickets being a deficiency symptom.

Question 3

- (a) (i) Biological drawing is not the same as artistic drawing. A biological drawing should show that the specimen has been carefully observed for details, which are then recorded in a clear, good-sized drawing with clean lines drawn with a sharp pencil in the proportions and positions observed.
- Most candidates followed instructions and drew one back leg; some, however, drew the whole specimen and could not be awarded full credit.
- Biological drawing is done freehand but some candidates used rulers to construct the longer lines.
- The shape and proportion of the leg were often well drawn.

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The detail of the end 'claw' and of the spines were often omitted or poorly depicted with sketchy lines.

- (ii) This question proved to be difficult for many candidates. Credit was given to those who recorded reasonable measurements with the front leg shorter than the back leg and units given. Often the ratio was omitted, reversed (with the larger leg first) or incorrectly expressed.
- (b) No specialist insect terminology was required here, only the description of similar features visible in the Figure given. The vast majority of candidates did this well. Some, however, listed features that were not visible e.g. all lay eggs, or that did not apply to all three e.g. all have wings.
- (c)
- (i)(ii) Most candidates correctly described differences.
- (iii) The drawing of the fly should have been measured and that length divided by its actual length of 1.5 cm indicated on the Figure to give the magnification. The magnification should be expressed as x or times and with no units.

Some candidates did not attempt this question. Whether this is because they did not know how to calculate the magnification or because they failed to notice the Turn Over instruction at the bottom of page 7 is not known.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key messages

This paper is designed to test candidates' experience of practical work. This includes:

- following instructions;
- interpreting and using data;
- designing investigations;
- biological drawing, that, unlike sketching, involves using a sharp pencil to make clean lines to show the specimen and its observable features;
- measuring precisely with due regard to units.

General comments

Candidates should consider carefully what each question is asking of them.

They should also note that the number of marks allocated for each section will give them an indication of the amount of information their answers should include.

Comments on specific questions

Question 1

The introduction to the question includes the word 'inherited'. This should direct the candidates' thinking initially towards genetics.

- (a) The vast majority of candidates counted the seedlings and recorded them correctly. Those who mis-counted may have benefitted by crossing through each seedling with a pencil as it was counted.
- (b) The question asks for suggestions about the inheritance of green pigment. The numbers counted in (a) indicated a ratio of green to white seedlings of 3:1. This was an example of discontinuous monohybrid inheritance with the green allele being dominant to the white. The parent plants must have both been heterozygous. The most able candidates stated all this.

Many candidates noticed the 3:1 ratio and noted that green was dominant to white. In some cases, it was apparent that although the terms 'dominant' and 'recessive' were known, what they meant was not necessarily understood. Some answers incorrectly stated or implied that dominance made the green plants more able to compete, confusing the word with 'dominate'. Some made no reference to inheritance and answered in terms of green seedlings containing chlorophyll which does not answer the question in terms of inheritance.

- (c) That the results of an investigation could be made more reliable by repeating the investigation, increasing the size of the sample being investigated, keeping external conditions constant or ensuring the seeds were evenly distributed in the dishes were suggested by many candidates.

- (d) Some candidates found this question confusing, not having appreciated that white seedlings with no chlorophyll would not be able to flourish even if given the best of conditions. Some candidates just listed what the 'right conditions' should be, having not read the question carefully.

With 3 marks available more than stating 'green seedlings' was required; information about photosynthesis and carbohydrate production was required. Credit was given to candidates who observed that the seedlings in dish **A** would flourish more because there would be less competition for available resources. A small number of candidates suggested that the green seedlings would flourish because they would dominate. They show a misunderstanding of the term 'dominance' in genetics.

Question 2

- (a) Many candidates labelled the three structures on the diagram correctly. Some thought the capillaries were arterioles or even some sort of sensory receptor. Candidates should name structures carefully e.g. 'hair root' or 'root of hair' is acceptable but 'root hair' is not as that is a different biological structure.
- (b) The answers of many candidates indicated that temperature control is not understood clearly. Many incorrectly stated that capillaries vasoconstrict/dilate which they do not. Others stated incorrectly that capillaries move nearer to or further away from the skin's surface. However, many correct statements about increased or decreased blood flow near the surface of the skin and consequent heat loss or retention were seen.

Question 3

- (a) Some candidates did this well but many did not gain any credit because they did not contrast the same feature.
- (b)
- (i) Many candidates found the calculation of the magnification difficult. The line given measured 28 mm. This represented 0.05 mm. The magnification therefore was $28/0.05$. Magnification should be expressed as x or times and with no units.
 - (ii) Some candidates wrote accounts of pollen tube growth and subsequent fertilization which was not asked for. More able candidates mentioned the following:
 - that the stamens and carpels were on separate flowers so cross-pollination must take place or that the pollen grains must be carried from a male to a female flower;
 - that the most likely agent was an insect e.g. bee as the pollen grain had projections that would help it to attach itself to an insect;
 - that the anthers / stigma were enclosed within the flowers.

There were candidates who suggested incorrectly that wind or water were the agents with no evidence to support these statements.

- (c) The candidates were asked to make a large, labelled drawing of a specimen. It should be noted that biological drawing is not the same as artistic drawing. A biological drawing should show that the specimen has been carefully observed for details, which are then recorded in a clear, good-sized drawing with clean lines drawn with a sharp pencil in the proportions and positions observed. Biological drawing is done freehand; compasses should not be used even when a specimen appears to be more or less circular in section.

Very few candidates delineated the outer, darker, layer on their drawing. Many drew the central area with good detail of the seeds and in appropriate proportion to the whole section. A few candidates drew only a part of the section, not the whole section as asked.

A few candidates incorrectly drew plant sections not related to the specimen e.g. a tomato presumably because they misread the question as asking them to draw a section through 'a' fruit instead of through 'the' fruit.

Most candidates labelled seeds and the fruit wall / pericarp correctly. A few candidates labelled the seeds and the fruit wall / pericarp labels altogether.

- (d) Most candidates answered this question well. They knew that the investigation should involve heating the prepared fruits with Benedict's solution and comparing any changes of colour observed. References to using similar volumes/masses of fruit (not amounts) were sometimes omitted. Some candidates omitted the heating of Benedict's solution.

Some candidates incorrectly thought that the iodine test or biuret test should be used to show the presence of sugar. A small number of candidates described experiments to compare the energy content of the fruits by burning them and measuring the temperature rise in some water although the question stated quite clearly that their sugar content was to be compared.

- (e) (i) The vast majority of candidates constructed bar charts as instructed; a few attempted line graphs. Following instructions is an important practical technique.

Both axes on the bar chart should be fully labelled. In this case, the y-axis with sugar content g/ 100 g of fruit and the x-axis either with the names of the fruits or with symbols explained in a key.

Most candidates correctly used a scale from 0 to 20 on the y-axis, making full use of the whole grid. Others used a full scale but only a small part of the grid. There were candidates who incorrectly wrote down the values given in the table equidistantly along the scale.

The plotting of the values was often done precisely. The vast majority of candidates who drew the chart did use rulers and constructed bars of equal width.

- (ii) Many candidates divided 20 g (the sugar content of banana) by 6.3 g (the sugar content of melon) to obtain the correct answer. The error most commonly seen was $20 - 6.3$ to give an incorrect answer of 13.7.

BIOLOGY

Paper 5090/63
Alternative to Practical

Key messages

This paper is designed to test candidates' experience of practical work. This includes:

- following instructions;
- interpreting and using data;
- designing investigations;
- biological drawing, that, unlike sketching, involves using a sharp pencil to make clean lines to show the specimen and its observable features;
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General comments

Candidates should consider carefully what each question is asking of them.

They should also note that the number of marks allocated for each section will give them an indication of the amount of information their answers should include.

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The introduction to the question includes the word 'inherited'. This should direct the candidates' thinking initially towards genetics.

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- (d) Some candidates found this question confusing, not having appreciated that white seedlings with no chlorophyll would not be able to flourish even if given the best of conditions. Some candidates just listed what the 'right conditions' should be, having not read the question carefully.

With 3 marks available more than stating 'green seedlings' was required; information about photosynthesis and carbohydrate production was required. Credit was given to candidates who observed that the seedlings in dish **A** would flourish more because there would be less competition for available resources. A small number of candidates suggested that the green seedlings would flourish because they would dominate. They show a misunderstanding of the term 'dominance' in genetics.

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There were candidates who suggested incorrectly that wind or water were the agents with no evidence to support these statements.

- (c) The candidates were asked to make a large, labelled drawing of a specimen. It should be noted that biological drawing is not the same as artistic drawing. A biological drawing should show that the specimen has been carefully observed for details, which are then recorded in a clear, good-sized drawing with clean lines drawn with a sharp pencil in the proportions and positions observed. Biological drawing is done freehand; compasses should not be used even when a specimen appears to be more or less circular in section.

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- (d) Most candidates answered this question well. They knew that the investigation should involve heating the prepared fruits with Benedict's solution and comparing any changes of colour observed. References to using similar volumes/masses of fruit (not amounts) were sometimes omitted. Some candidates omitted the heating of Benedict's solution.

Some candidates incorrectly thought that the iodine test or biuret test should be used to show the presence of sugar. A small number of candidates described experiments to compare the energy content of the fruits by burning them and measuring the temperature rise in some water although the question stated quite clearly that their sugar content was to be compared.

- (e) (i) The vast majority of candidates constructed bar charts as instructed; a few attempted line graphs. Following instructions is an important practical technique.

Both axes on the bar chart should be fully labelled. In this case, the y-axis with sugar content g/ 100 g of fruit and the x-axis either with the names of the fruits or with symbols explained in a key.

Most candidates correctly used a scale from 0 to 20 on the y-axis, making full use of the whole grid. Others used a full scale but only a small part of the grid. There were candidates who incorrectly wrote down the values given in the table equidistantly along the scale.

The plotting of the values was often done precisely. The vast majority of candidates who drew the chart did use rulers and constructed bars of equal width.

- (ii) Many candidates divided 20 g (the sugar content of banana) by 6.3 g (the sugar content of melon) to obtain the correct answer. The error most commonly seen was $20 - 6.3$ to give an incorrect answer of 13.7.