BIOLOGY

Paper 5090/11
Multiple Choice

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

General

Candidates must be reminded to read the stem of each question carefully.

Comments on individual items.

These questions, mainly requiring recall, presented few problems: **Questions 7**, **16**, **21**, **23**, **28**, **29**, **33**, **35**, **39** and **40**

Question 1

Chlorophyll has a high magnesium content. **A** is a nucleus, **B** is a chloroplast, **C** is cytoplasm and **D** is a cell wall.

Question 2

Both situations show material moving against a concentration gradient and must therefore be active.

Question 3

Water will move down the potential gradient, so cell 1 is higher than cell 2, which is higher than cell 3.

Question 4

The shape of the substrate (lipid) allows it to fit into the active site (lipase) on the enzyme.

Question 5

The stem refers to full sunlight. Normal atmospheric CO_2 concentration is close to 0.04% and at this point on the graph the rate of photosynthesis is directly proportional to the CO_2 concentration at both temperatures.

Question 6

All organisms respire, so in the dark even the pond weed will absorb oxygen.

Question 9

The urea content increases, so the organ must be the liver, where urea is synthesised after deamination

Question 10

Amylase is found in saliva, but largely denatured in the stomach. Pancreatic amylase completes starch digestion in the ilium.

Question 11

The bark contains the phloem, so nutrients from photosynthesis cannot reach the roots, which will be unable to respire without sugars. Roots will continue to supply minerals and water to the leaves, via the xylem, and to absorb oxygen from the soil air.

Question 12

The water level has dropped slightly. As the mass has decreased by 5 g in six hours, clearly the water must have left the plant completely.

Question 13

Capillaries leak fluid into the surrounding tissues due to the pressure of the blood.

Question 14

There is no pulse in a vein, but the pressure must fall as blood flows from the capillaries to the heart.

Question 15

The stem refers to ventricle pressure, which rises as the ventricle contracts in period **B** and relaxes during periods **C** and **D**. The ventricle fills as the atrium contracts during period **A**.

Question 17

Options **B**, **C** and **D** involve respiration, which uses and transfers energy. Photosynthesis takes in light energy.

Question 18

Ribs rise as we inhale and fall as exhaling begins, with a consequent rise in pressure in the lungs.

Question 19

The stem refers to stages 2 and 3. Clearly the arm straightens, which is due to the contraction of the triceps.

Question 20

The liver deaminates amino acids, forming urea, which leaves in the hepatic vein. Most urea leaves the blood in the kidneys, so the lowest concentration is in the renal vein.

Question 22

Bright light will result in the pupil size decreasing, due to the circular muscles of the iris contracting.

Question 24

Insulin promotes the conversion of blood glucose to glycogen, so the blood glucose level will fall more rapidly.

Question 25

Nicotine is the addictive drug, but the carcinogen in cigarette smoke is the tar.

Question 26

Bacteria are added to the liquid milk, before it is coagulated, since the surface area of the coagulated proteins is less available to bacterial action.

Question 27

Air bubbles in through Y. The antibiotic, in solution, can only be drawn off through Z.

Question 30

CO_2 only enters the cycle through photosynthesis, option **A**.

Question 31

The mosquito is a vector of the malarial pathogen, but it is not a pathogen itself. However, they are ectoparasites, since they obtain nourishment from and hence damage their human hosts, but do not kill their hosts when they feed.

Question 32

The nitrates will promote the growth of algae, which will die and rot, thus using more oxygen and leading to the death of the fish.

Question 33

The gametes, P and Q, must be haploid cells as are cells S, T, U and V. Cell R is diploid.

Question 34

Options **A**, **B** and **C** are all plausible, but bean seeds are known to contain starch polymerised after photosynthesis and must, therefore, also contain an amylase.

Question 36

Option **A** is a correct statement, but does not refer to preventing HIV infection.

Question 38

As with the A, B and O blood groups, the six possible genotypes are EE, EF, EG, FF, FG and GG. Four phenotypes are E–, F–, EF and GG.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General

Candidates must be reminded to read the introductory sentences in the questions. A good example is in **Question 1**, which refers to processes that are controlled by the cell surface membranes; all the options refer to materials passing through the membranes, but are not necessarily controlled by them.

Comments on individual items.

Questions 2 and **35** proved easy, while **Questions 16**, **21**, **22** and **23** were straightforward and only needed recall of information.

Question 1

Processes 1, 2 and 4 occur through the cell surface membranes, but only 1 is controlled there. Process 3 is passive.

Question 3

Water will move down the potential gradient, so cell 1 is higher than cell 2, which is higher than cell 3.

Question 4

The shape of the substrate (lipid) allows it to fit into the active site (lipase) on the enzyme.

Question 5

The stem refers to full sunlight. Normal atmospheric CO_2 concentration is close to 0.04% and at this point on the graph the rate of photosynthesis is directly proportional to the CO_2 concentration at both temperatures.

Question 6

Structure P is a chloroplast which contains chlorophyll, which in turn contains magnesium. During the daytime the oxygen concentration will be high. Option **C** was popular; perhaps candidates wrongly thought that structure P was a mitochondrion, with consequently low oxygen concentrations due to respiration. Mitochondria are generally more frequent (100s) and far smaller (1.0 mm) than chloroplasts.

Question 7

The raw materials for synthesis of cellulose are CO_2 and H_2O. Magnesium ions are essential for chlorophyll synthesis, and nitrate ions are used in the synthesis of amino acids and hence proteins.

Question 8

Lettuce leaves contain vitamin C and fibre but lack significant quantities of vitamin D.

Question 9

Only very small quantities of nutrients, other than water, leave the small intestine and enter the large intestine.

Question 10

The energy content per gram of fat is far higher than that of carbohydrates or proteins, so a food containing 83% fat must have the highest energy content per gram. Food **B** could be butter. Food **D** was a popular choice.

Question 11

The bark contains the phloem, so nutrients from photosynthesis cannot reach the roots, which will be unable to respire without sugars. Roots will continue to supply minerals and water to the leaves, via the xylem, and to absorb oxygen from the soil air.

Question 12

The water level has dropped slightly. As the mass has decreased by 5 g in six hours, clearly the water must have left the plant completely.

Question 13

Capillaries leak fluid into the surrounding tissues due to the pressure of the blood.

Question 14

Only two labelled features show differences. The walls of the left atrium (R) and left ventricle are different thicknesses (option **B**), but cannot affect the pressure of blood leaving the right side of the heart.

Question 15

It is a common error to assume that urea molecules deliberately go to the kidney (option **C**). Since urea is synthesised in the liver, the greatest concentration in the blood must be in the hepatic vein. The lowest concentration is in the renal vein.

Question 16

The concentration of CO_2 in exhaled air (4%) was generally well known.

Question 17

Elastic alveolar walls are not essential, but do aid the functioning of the lungs. Thin alveolar walls will allow gas passage more easily. If the concentrations of oxygen on both sides of the alveolar walls are the same, then no significant gas exchange would occur.

Question 18

Respiration in muscle produces no alcohol. Lactic acid is the only product of anaerobic respiration.

Question 19

CO_2 and urea are both waste products of metabolism. Undigested food, fibre, bacteria, etc. are egested, not excreted.

Question 20

Negative feedback systems lead to a constant state, so if a variable increases, the reaction will be to decrease it. The correct option, **A**, has a decrease leading to a decrease in respiration rate, which would not raise the body temperature.

Question 21

Sensory neurones must supply impulses to the central nervous system, while relay neurons form the network of cells within the system.

Question 24

The stem refers to light intensity and hence the iris mechanism, option **B**, not the focussing muscles, option **D**.

Question 25

There was a lot of information to consider, but options **A**, **B** and **D** could be dismissed, since they are clearly not true.

Question 26

The external intercostals and diaphragm muscles are used when breathing in, so the internals will be involved in forced exhalation.

Question 27

Air bubbles in through Y. The antibiotic, in solution, can only be drawn off through Z.

Question 28

Although grass is the producer shown in the web, it gains energy, as do all food webs, from the Sun.

Question 29

The nitrates will promote the growth of algae, which will die and rot, thus using more oxygen and leading to the death of the fish.

Question 30

All cellular tissues contain protoplasm, consisting mainly of proteins, which in turn are made of amino acids, so although option **A** is plausible, the key must be **C**.

Question 31

The stem asks how the disease is transmitted, so the mosquito must first suck blood from an infected person and then spit it into a second person, who then catches the disease.

Question 32

Food chains start with a green, photosynthetic producer.

Question 33

The gametes, P and Q, must be haploid cells, as are cells S, T, U and V. Cell R is diploid.

Question 34

Options **A**, **B** and **C** are all plausible, but bean seeds are known to contain starch polymerised after photosynthesis and must therefore also contain an amylase.

Question 36

Candidates who chose option **D** may have confused cutting the urethra (vessel in the penis), with cutting the vasa deferensia (vasectomy).

Question 37

After mitosis, a daughter cell will have the same number (8) and types (4 pairs) of chromosomes.

Question 38

The I^O allele is recessive. I^A and I^B are dominant. Only the I^AI^B genotype is co-dominant.

Question 39

There are two distinct groups of peas in the sample – perhaps a group of Mendel's tall and short peas – and within each group there is continuous variation.

Question 40

Mutations are not common. The wife cannot be heterozygous since she is group O (I^OI^O). A heterozygous father and his homozygous wife would have a predicted ratio of 1 : 1, so the small sample, **B**, was the correct option.

BIOLOGY

Paper 5090/21
Theory

Key messages

It is expected that candidates will have acquired a good basic level of biological knowledge enabling them to answer the questions. Some of the questions require analysis of data, others to recall and recount facts, however, if the underlying biological principles are not understood, the answer becomes confused.

General comments

The majority of candidates were able to make a good start to the paper, but found some of the later questions more challenging. It is important that the answers should be neatly written, concise and accurate in their detail, e.g. readings from a graph or a stated temperature must always be accompanied by the appropriate units. There were some candidates who did not study carefully the wording in the stem of the question and hence did not actually answer the question asked. It can be helpful to candidates if they are given accurate definitions of the major physiological processes to use for reference.

Generally the rubric was followed except in ***Section C*** where some candidates attempted both **Questions 8** and **9**, and did not cross out the unwanted answer. There was no evidence to suggest that the time allowed was insufficient.

Comments on specific questions

Section A

Question 1

(a) (i) The kidney was almost universally recognised and there were many correct identifications and spellings of ureter and urethra, however, there was some confusion with the alimentary canal; the urethra being identified as the rectum or anus by some candidates.

(ii) The bladder and its correct function were also well recognised although there were some who referred only to storing waste, or faeces.

(b) (i) Two arrows were required. It was hoped that the two already on the diagram showing the oxygen intake would suggest the response for the carbon dioxide leaving the blood. One arrow should leave from the plasma and pass to the moisture layer, the other pass from the moisture layer to the alveolar air. A common error was for an arrow to leave from a red blood cell.

(ii) In this part credit was lost as much by omission as by error, e.g. the waste was not always described as being removed from the body or the waste was not designated as a product of metabolism or respiration.

(c) Most of the candidates knew that it is the liver that deals with used hormones, although some believed it to be the kidney. The majority did describe the break down of the hormones and that the products are sent to the kidney for excretion.

Question 2

(a) (i) This section was well done. Most candidates knew that pH referred to the acidity/alkalinity of a medium although they did not always indicate that it gave a measure of it.

(ii) At least half of the candidates, (even otherwise good candidates), scored no credit because they failed to give units, others read the scale incorrectly as 44 not 48 – 52 arbitrary units.

(iii) Most candidates were awarded credited for naming the stomach, although there were some who chose mouth or duodenum. The majority of candidates scored at least partial credit in the second part but did not always make reference to the presence of hydrochloric acid in the stomach.

(b) This proved to be the most challenging part of this question. Many candidates did not read the question carefully and selected a part of the alimentary canal as their named body part. The most popular correct answer was the liver, which changes glucose to glycogen, but not all candidates knew which were the smaller molecules so glycogen being changed to glucose was a common error. There was a confusion of spellings, with glucagon or glucogen being given for glycogen The other examples given were protein synthesis (in muscle) and less frequently fat (in skin.)

Question 3

(a) A significant number of candidates did not know the composition of inhaled and exhaled air. Minor differences apart, the figure for inhaled carbon dioxide caused the most problems, which were often due to an incorrect placing of the decimal point.

(b) (i) Descriptions of aerobic respiration using oxygen, to release energy, from glucose, for muscle contraction rarely gained full credit, mainly because the majority of candidates stated that the energy was <u>produced</u> as opposed to released, which was unacceptable.

(ii) Anaerobic respiration involving the production of lactic acid was quite well known, but the fact that this released less energy was less familiar. The muscle can become fatigued or cramp can be experienced, but it is a temporary situation rather than a permanent weakness. There were some references to 'muscle pull' which may indicate a confusion. It is safer to use standard terms.

(c) The question required the candidates to use their knowledge of the circulatory and respiratory systems to suggest modifications which would be beneficial to people living at high altitudes. This proved to be very challenging for some. The good candidates confidently suggested faster heartbeat / faster blood flow / deeper breathing or modified lung structure, (although some thought that the heart rate and blood flow should slow), and answered the question as required. There were others who were unable to relate their knowledge to the situation and made irrelevant suggestions, e.g. the use of oxygen masks, the planting of trees to produce more oxygen or lifestyle changes.

Question 4

(a) The correct equation for photosynthesis was given by approximately half of the candidates. Candidates can choose to use either a word equation or a chemical equation but a chemical equation must balance. In most answers, the conditions in the boxes were correct gaining initial credit, but further credit was frequently lost because the chemical equation did not balance, or due to confusion with respiration. The equation must have been learned by many without real understanding, since the correct words were used but were not correctly positioned.

(b) (i) Most candidates scored partial credit. Some suggested the process involved, rather than the place, others just the air, and while any reasonable plant part was acceptable, it was difficult to understand why, given the diagram, roots / root hairs were suggested. Some of the weaker candidates described the <u>appearance</u> of the bubbles.

(ii) Candidates most often gained credit for photosynthesis and for those who had read the question carefully and noted that the stem was green, were credited for chloroplasts / chlorophyll. Descriptions of the passage of the oxygen out of the tissues were imprecise, except for its exit via the stomata / lenticels.

(c) The answers given were reasonable and most candidates scored at least partial credit, usually for a food reference despite the focus of the question being on photosynthesis. To score full credit, candidates needed to tie up the source of the oxygen, its beneficial effect in removing carbon dioxide, and its subsequent use. Many candidates strayed from the confines of the question and described food chains, some of which included whales or other unsuitable animals.

Question 5

(a) Candidates coped well with the requirement to complete a table and provided matching pairs or a feature and its negative. However, the characteristics of a fungal hypha were not familiar to all. The presence or absence of chloroplasts gained credit for almost all candidates; many thought that the hypha did not possess cytoplasm, a nucleus, or a wall, while others made accurate references to both cellulose and chitin. There were some candidates who made reproductive or nutritional comparisons.

(b) There were comparatively few correct, balanced equations. More candidates attempted to use formulae than words, and the formula of lactic acid was not secure, but the main problem was that many did not know the answer to this question. Common errors included adding water to either side of the equation and omitting the carbon dioxide, but including energy. Candidates may find it easier to remember a word equation, although a chemical equation offers greater understanding, and good candidates gave both equations.

(c) The majority of candidates made valid suggestions as to what was a suitable temperature (a range of 25 to 40 °C. was accepted) although some were well out of range, e.g. 700 °C. Credit was lost due to the omission of units.

(d) (i) This question was not answered well. The most common answer given was fermentation or anaerobic respiration, perhaps because the apparatus was recognised but the information from the data table was not considered.

(ii) There were very few references to a lack of oxygen since most candidates were working on the basis that fermentation was already underway. It was generally thought that it took time for alcohol production to start because the sugar concentration was too high.

(iii) Many candidates were awarded credit here, either for knowing that the yeast would be killed by the high alcohol level or for stating that all the sugar would be used up.

Section B

Question 6

(a) Candidates who were familiar with the structure of the stem and its tissues scored credit for easy penetration of the phloem (since the walls are softer) and ease of access due to its position on the outside of the vascular bundle. In general, candidates know more about the xylem than the phloem. There was lack of precision when describing the contents of the phloem; the carbohydrate, if named, was usually glucose, any reference to the presence of amino acids was rare as was the fact that the contents were in solution.

(b) Many candidates did not carry forward information from the first part of the question and described events with reference to the xylem, concentrating on lack of water and wilting. Almost all answers gained credit for reference to the stunted growth or death of the plant eventually; some realised that the plant would be physically damaged by the activities of the aphids and that this could lead to infection, but few candidates were able to provide the detail needed to score the remaining credit. It was lack of nutrition due to the aphids removing the contents of the phloem that caused the problems. In particular amino acids and their role in protein synthesis was almost ignored, while only a few candidates described glucose being acquired from the carbohydrate to use in respiration and release energy to carry out other vital functions. Overall, although there were some good answers, this section yielded low credit,.

Question 7

(a) This question produced some very varied responses although the requirements were clear. There were some concise answers with all points given and full credit scored. Others, however, confused the two processes and so could not be credited. The answers were set out in an orderly and comparative way. Common errors included: mitosis occurs in plants and meiosis in animals; meiosis occurs in gametes, rather than during gamete formation; meiosis was confused with fertilisation; the chromosome number was not always correct, e.g. gametes were said to be diploid, and it was not always clear that the haploid / diploid reference was to the chromosome number.

(b) Candidates showed that they had studied the genetics of blood groups but their accounts were frequently not detailed or accurate enough to gain more than partial credit. It was essential to note that the offspring produced should **only** be children with blood groups **different** from their parents. This required a distinction to be made between a blood group and its possible genotypes, e.g. a choice of Group A and Group B for the parents worked out well provided the genotypes were homozygous, when all the offspring would be Group AB. However, if the parental genotypes were AO and BO then some Group A and some Group B offspring would occur, which was not correct. The only other acceptable parent pairing was Group O and Group AB. There was no instruction to use a genetic diagram on this occasion but those who did benefitted if the diagram was fully labelled with gametes correctly shown.

Section C

Question 8

(a) Almost all candidates scored credit for knowing that 'double circulation' referred to the passage of blood through the heart twice in one complete circulation, but many did not give a full description of the pulmonary and systemic circuits or make reference to the state of oxygenation of the blood. There was no mention made of the difference in pressure between the pulmonary and systemic circulations.

(b) There were some excellent answers but in general the response was disappointing. Candidates knew plasma to be the liquid part of blood responsible for its circulation but, in general, did not supply the actual details of its composition, whereas, those who stated that plasma contained water with glucose and salts dissolved in it gained more than half of the available credit. Many candidates also lost the focus of the question and digressed into accounts of the functions of the cells. The answers describing the transport role of the plasma carried most of the substances named but the transfer of heat was rarely mentioned.

Question 9

This was a low scoring question but it was the preferred option in ***Section C***.

(a) (i) There was a general understanding of the basic requirement of fertilisation, i.e. that there should be a fusion of male and female gametes or nuclei; candidates could gain credit for this in either **(a)(i)** or **(a)(ii)**. The question asked for a description of the process, so some background details were needed. The candidates coped well with human fertilisation, the names of the gametes were known and the site of fertilisation was usually correct although occasionally it was described as happening in the uterus. The terms ovum and ovary were sometimes confused (in both parts of this question there was some confusion between an ovum, an ovary, or an ovule).

(ii) To adequately describe fertilisation in a flowering plant requires knowledge of the flower parts involved. Candidates knew that the pollen is male and that the ovary constitutes the female part, and pollination was usually described. Very few diagrams or sketches were drawn to show that the female nucleus is in the ovule which is in the ovary, and descriptions often became confused. The most common error was to confuse the male gamete and the pollen grain. After pollination candidates recorded the growth of a pollen tube down the style, but many stated that the pollen grain, not just the male nucleus, passed down it to reach the ovule to effect fertilisation. A few candidates made reference to a double fertilisation.

(b) The majority of candidates thought that there would not be any, rather than only very limited, variation due to the fact that there would be few new alleles. The good candidates understood the effect that this would have in the long term on the vigour and evolution of the species but did not find it easy to express their ideas. In some instances asexual reproduction was described rather than self-fertilisation in sexual reproduction.

BIOLOGY

Paper 5090/22
Theory

Key messages

It is expected that candidates will have acquired a good basic level of biological knowledge enabling them to answer the questions. Some of the questions require analysis of data, others to recall and recount facts, however, if the underlying biological principles are not understood, the answer becomes confused.

General comments

There were occasions on this paper where candidates found difficulty in relating the questions to relatively basic syllabus material. Although questions may sometimes appear in an unfamiliar form, particularly in ***Section A***, the answers will always be based on factual material that will have been covered whilst working through the syllabus. Only questions that invite candidates to 'suggest' an answer will require a degree of reasoned speculation which, even then, should be well within the scope of any well-prepared candidate. Some answers were of a high standard, although it appears that an understanding of the basic principles of evolution have not been accurately grasped, even by some candidates who otherwise showed an impressive degree of competence.

Comments on specific questions

Section A

Question 1

(a) The identity of **A** was more often given than that of **B**, however, neither was well known with candidates sometimes giving the names of completely unrelated structures. Confusion between the terms 'larynx' and 'pharynx' was common throughout both this part-question and in part **(c)**.

(b) Peristalsis was well known, although 'digestion' was quite often suggested.

(c) Many candidates were able to give a correct explanation and understood the principle of there being two possible pathways, one of which will be blocked by structure **C**. Some candidates answered with an explanation of the peristalsis process they had named in part **(b)** which did not gain credit. It was common to read that the epiglottis is a muscular structure that contracts to push the bolus down the oesophagus.

(d) Digestion was well known and many candidates went on to name the correct enzyme and explain the process occurring in the bolus. Some candidates incorrectly made reference to other parts of the digestive system and the digestive processes occurring there.

Question 2

(a) Many candidates were unable to identify both causes of variation. Reference to environmental conditions or a suitable named example was more common than reference to genes. Several candidates stated the two forms of variation – continuous and discontinuous.

(b) Evolution was given by a significant number of candidates, however, many incorrectly made reference to 'mutation'. Again, references were made to continuous and discontinuous variation.

(c) Many candidates gained credit in this question for identifying that a change in environment had occurred, that better adapted organisms survived and that these reproduce. Candidates' answers were often not chronologically structured and the sequence of events occurring during the processes was often unclear. It was rare to read that variation is the result of mutation, and equally rare to see that it is the sum total of adaptations over many generations that would lead to the development of a new species.

(d) Genetic differences between species **D** and **E** were commonly identified. However, a significant number of candidates simply repeated the question by stating that the species 'would no longer be able to breed' which did not gain credit.

Question 3

(a) Many candidates were able to correctly identify two ions and their importance. Commonly seen errors included 'nitrogen' instead of 'nitrate' and 'chloroplast' instead of 'chlorophyll'. A significant number of candidates gave responses other than the two ions listed on the syllabus.

(b) Few candidates gained full credit in this part. It was not always realised that the dead leaves constituted dead organic matter which is then decayed by saprotrophic organisms. The role of bacteria and fungi in the decay of a named molecule existing in the leaf was not often identified. Many responses incorrectly related to the uptake of ions by active transport. Nitrogen-fixing bacteria were occasionally incorrectly identified as being responsible for the process of decay.

(c) The presence of chlorophyll / chloroplasts and the process of photosynthesis or light absorption were commonly known, although a significant number of candidates described an adaptation without providing an explanation. Absorption of water by spongy absorbent tissue was often identified, however, the necessity for this in the particular situation presented to them was often overlooked, as was the fact that the water, once absorbed, can be contained for future use within the spongy tissue.

Question 4

(a) (i) This question proved demanding with very few candidates realising that it is a pulse beat of increased pressure in an artery in the leg that causes the foot to kick. There were fewer problems with realising that each kick represented one heartbeat.

(ii) Many candidates were able to state that the heart rate increases or that adrenaline is released when watching an exciting programme.

(b) The information given in the question was intended to lead candidates towards their knowledge of how blood is returned to the heart in veins, and that this process would be less efficient if the student was not using their leg muscles. Unfortunately, reference to knowledge of blood moving through the circulatory system led to many accounts of the double circulation system. Those who thought carefully were able to identify that an increased weight in the leg due to blood entering the leg would cause the chair to fall.

Question 5

(a) This was well answered by most candidates, the majority of whom included correct units in their response. Common incorrect responses were 20 minutes, 40 minutes and 50 minutes.

(b) Identifying the person as being either a smoker or passive smoker was achieved by most candidates.

(c) This was well answered by most candidates. Incorrect links between components and the harm they cause were made by some candidates, the most notable being associated with tar which was variously thought to line the trachea thus preventing diffusion and to cause heart disease. The effect of carbon monoxide was particularly well known and described by a large number of candidates.

(d) This part proved more challenging. Many candidates identified that the blood pressure increased, with fewer noting a subsequent decrease or quoting data from the graph. An incorrect belief in part **(ii)** that components of the cigarette smoke itself (tar in particular) deposit on the interior of the blood vessels leading to a decrease in diameter, was demonstrated by a proportion of candidates. In part **(iii)**, many were able to identify specific damage to the heart or blood vessels or a 'stroke' as a possible harmful effect. Reference to capillaries was rarely seen.

Section B

Question 6

It was evident that the appearance of xylem tissue as seen in cross section through a microscope was unfamiliar to a large number of candidates and thus the identity of the tissue in Fig. 6.1 was often incorrectly stated. Common incorrect responses included reference to both xylem and phloem or to spongy mesophyll cells. Candidates who referred to xylem in their response often went on to gain credit for reference to lignification and to the transport of water and / or mineral ions.

The identity of the tissue in Fig. 6.2 was much better known and the majority of candidates gained credit for reference to photosynthesis, for identifying the structures labelled **J** and **K** and for describing the partial permeability of the cell membrane and its value to the cell.

Question 7

(a) A correct definition of excretion was given by the majority of candidates, many of whom gained full credit in this part. A number of candidates demonstrated the misconception that excretion is the removal of solid waste from the body via the anus and did not therefore gain credit for reference to 'removal from the body'.

(b) Candidates often scored well on this part of the question and some well-organised responses were seen. There was a tendency for some responses to take the form of a description of dialysis rather than an answer to the question, and, as a result, some important points were overlooked. Reference to maintenance of a concentration in the dialysis fluid the same as that found in the blood was common, rather than that of a 'difference' in concentration being established of specific components to enable diffusion to occur. There was appreciation from the majority of candidates that blood flows through a tube constructed from a partially-permeable membrane and that substances enter and leave the blood during this flow. The details provided of what enters and leaves the blood, plus those of the processes involved in enabling this exchange, is what discriminated between higher and lower-scoring candidates in this part.

Section C

Question 8

(a) The concept of the 'lock and key' hypothesis was generally well known by candidates, however, some found it difficult to express their knowledge clearly in their responses. Incorrect reference to the 'active site' being a component of the substrate rather than of the enzyme was not uncommon and reference to enzyme and substrate being the 'same' rather than of 'complementary' shapes was frequent. Candidates were, however, familiar with the concept of enzyme specificity, the formation of an enzyme-substrate complex and the breakdown of substrates to form products and hence often gained substantial credit in this part.

(b) This was soundly answered with the majority of candidates scoring well. It was, however, sometimes unclear exactly which stage during the 'increase in temperature' they were describing. All marking points were commonly seen, with the exception of that which required candidates to appreciate that the fall in activity with increased temperature beyond the optimum was more rapid than its preceding rise.

Question 9

This question was very rarely the chosen, and those who chose it were often the less able candidates who found difficulty in clearly expressing their ideas.

(a) Most commonly seen in this part were references to ‘mass’, ‘organisms’, ‘producers’, ‘consumers’ and ‘food chain’. But although the terms were used, it was far from clear whether some candidates appreciated their full relevance to the question. The construction of a pyramid and the significance of the blocks it contains were often not mentioned.

(b) A few candidates were able to make a valid contextual reference to ‘number’ and were able to draw a pyramid of the correct shape. Very few of the candidates answering this part were able to express clearly the relationship between both types of pyramid and the information which they display.

BIOLOGY

Paper 5090/31

Practical Test

Key Messages

Candidates do well if they draw on their experience and knowledge of practical work and can apply practical skills and techniques.

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. The questions tested candidates' abilities to follow instructions, make and record accurate observations using writing and drawing skills, take measurements and perform simple calculations. Candidates appeared to have more than sufficient time to complete the paper.

Comments on Specific Questions

Question 1

(a) Responses overall were excellent, with many tables clear and well-constructed, comprising ruled lines to include a column / row for each of **A** and **B**, and a row / column for each of the appearance and volume of the mixture (with units), and two volumes recorded. In weaker answers the table was neither completed nor neatly constructed, and the rows / columns for appearance and volumes (with units) of both mixtures were overlooked.

(b) When asked to compare the volume and appearance of both juices from **A** and **B**, the best answers gave the actual volumes recorded and, apart from confirming that the volumes were larger in **A** (with enzyme) compared with **B** (without enzyme), the appearance of the juice was also described as clearer / lighter / light yellow or with little residue in **A**. Weaker answers omitted to mention these differences or incorrectly described them.

(c) (i) When asked to explain why a number of procedures were carried out during the preparation of **A** and **B**, the best answers showed that washing the plastic spoon prevented the enzyme from **A** contaminating **B**, and that stirring the mixture in **A** resulted in an even distribution of the enzyme. The addition of an equal volume of water in **B** acted as a control and also kept the volumes of both solutions the same.

(d)(i)(ii) From the graph, the majority of candidates correctly indicated pH 5 as the optimum value. The best answers then went on to report that less juice / enzyme activity increases / decreases to / from an optimum pH 5 and that below or above this optimum, the enzyme is denatured and the shape of the active site of the enzyme is changed. Weaker responses focused on the acidic nature of the enzyme increasing the volume of juice, or the results were considered in terms of temperature rather than pH.

Question 2

(a) (i) The majority of candidates presented drawings of a suitable size (at least 6 cm), good proportions, and drawn with clear and continuous lines. Those candidates who gave excellent answers also included the presence of three loculi and the inclusion of vascular bundles or a well drawn outer layer.

(ii) Calculating the magnification of a drawing in relation to the size of **K1** is a standard biological procedure. In the best answers two correct measurements (with units) were made of the diameter of **K1** and the line drawn across the drawing, and these were expressed and calculated accurately. In weaker answers no units were given and the magnification was incorrectly calculated and expressed.

(b) (i) The majority of candidates produced very good drawings of both slices opening up or increasing in size in water compared with closing or decreasing in size in the salt solution. In weaker responses, the slices had either been mixed up or irrelevant statements were made on texture, colour or no change was recorded.

(ii) In the best answers, candidates clearly explained that water movement had occurred across a partially permeable membrane resulting in an increase or decrease in cell size / turgor. Weaker answers frequently referred to the process of osmosis taking place (already given in the question) or that movement of particles occurred from a lower to a higher concentration.

Question 3

(a) (i) The best answers stated the presence of five digits, joints, an opposable thumb, nails, hairless palm / hairs on the upper surface and lines on the palm.

(ii) In the best answers the main differences included more hair, longer fingers, a shorter thumb and darker finger nails in the orang-utan compared with the human hand. In weaker responses there was no comparison made or that the candidates simply stated that the surfaces of the skin were either rough or smooth.

(b) Most candidates produced excellent responses by identifying the process involved as sweating, resulting in the evaporation of sweat, thus cooling the body. Other candidates described more blood flowing near the skin surface / vasodilation / dilation of blood vessels / arterioles resulting in heat loss from the blood. Some weaker responses focused on the thickness of skin and the process of insulation.

BIOLOGY

Paper 5090/32

Practical Test

Key Messages

Candidates do well if they draw on their experience and knowledge of practical work and can apply practical skills and techniques.

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. The questions tested candidates' abilities to follow instructions, make and record accurate observations using writing and drawing skills, take measurements and perform simple calculations. Candidates appeared to have more than sufficient time to complete the paper.

Comments on Specific Questions

Question 1

(a) The best answers showed that both columns representing test-tubes **A** and **B** in Table 1.1 were completed at least up to when an appropriate colour change had occurred with a good sequence of colours ranging from blue-black to blue, brown, yellow-brown and yellow after ten minutes. Fewer results were recorded in **B** compared with **A**. In weaker responses the opposite effect was shown with more rapid changes occurring in **A** and with a mix of colours occasionally beginning and ending with blue-black.

(b) (i)(ii) Using the data on colour changes recorded in Table 1.1, the best responses gave the correct times for starch to be completely broken down, and stated that starch in test-tube **B** was broken down first, with relative speeds indicated. In weaker answers more rapid changes were observed in **A** and the sodium chloride solution in **B** was often described as acting as a catalyst or even influencing the pH of the starch solution.

(c) The best answers showed that a white tile made colour changes clearer / easier to see and that shaking the mixture resulted in thorough mixing and produced a more even distribution of the contents. These better responses also correctly stated that the addition of water to test-tube **A** acted as a control / comparison instead of using sodium chloride as in **B**, and that the same volume of water / sodium chloride had been used. There was, however, some confusion with those candidates who simply stated that the water diluted, dissolved or neutralised the contents.

(d) (i) Responses overall were very good with the axes correctly orientated and labelled and pH given on the *x*-axis and the time taken (with units) on the *y*-axis. The scales were linear and filled to at least half the printed grid, with correct plots either neatly joined by ruled lines or curves clearly drawn through the plots. Weaker answers included non-linear scales on the *x*-axis, the reversal of axes, missing units and unclear plots and lines.

(d)(ii)(iii) The optimum pH for enzyme activity was generally correctly given as pH 5 and the best answers stated that the enzyme activity increases to an optimum pH and subsequently decreases as the pH rises. This showed that high / low pH denatures / inactivates the enzyme and also changes the shape of its active site. Weaker answers repeated the time given in Table 1.2 and either focused on the enzyme being more active at the lower end of the pH scale, or confused temperature with pH and stated that the enzyme was killed.

Question 2

(a) (i) The majority of candidates produced very good labelled drawings at least 8 cm in size, with clear lines, good proportions and with the radicle and plumule well drawn. The less well-prepared candidates confused the labelling of radicle and plumule and assumed that the cotyledon was the embryo.

(ii) Calculating the magnification of a drawing in relation to the size of a specimen is a standard biological procedure. In most cases measurements were given and expressed accurately, but in weaker answers neither units were given nor the magnification correctly expressed and calculated.

(b) (i) The best answers provided very good comparative descriptions of colour, shape and texture, with frequent reference to the seeds being present / absent or that seeds differed in number.

(ii) The majority of candidates produced excellent responses by measuring the weight / volume of an equal quantity of seeds, followed by grinding / cutting / crushing the contents. This was correctly followed by applying a constant volume of the biuret reagent to show the presence of protein when the blue colour changed to purple / violet, relative to the amount of protein present. In weaker answers, fruit rather than seed contents were crushed, without any weight or volume measurements being made, and also incorrect reagents were used, e.g. Benedict's and iodine solution. The occasional incorrect reference to the burning of seeds to detect fats was also made.

Question 3

(a) There were some correct responses such as there being one bone in the upper part and two bones in the lower part, or statements that the long bones were placed side by side. Other similarities included the presence of five digits / pentadactyl and / or the occurrence of many bones in the hand / wrist and foot / ankle. Many candidates appeared to misinterpret the word 'excluding' in the question and focused on how joints functioned rather than including the relevant similarities.

(b) The best answers showed that movement at **X** (the elbow/knee region) was up and down or two-dimensional movement in one plane or that this was a hinge joint. In the case of **Y** (the shoulder / pelvic region) movement occurred in three planes or this was rotational / circular or simply a ball and socket joint. Many weaker responses either omitted to answer this section or were confused between **X** and **Y**.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key Messages

This paper tests the ability to use practical skills such as observation, drawing, data handling, interpretation of results and experimental design. It is important that candidates have experience of practical work, are familiar with biological tests such as food tests, and demonstrate awareness of safety procedures.

All the information provided with each question should be read thoroughly, including introductory material, such as the details of how an investigation has been carried out. That information may well be necessary for answering the questions that follow.

The credit allocation gives a good indication of the amount of content expected in the answer.

It is important to note that in questions that ask for a comparison, reference to both specimens should be made in order for the answer to be creditworthy.

General comments

It appears that candidates had sufficient time to complete the paper.

Almost all scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written. Candidates should ensure that any alterations to answers are legible, i.e. not written on top of their original answer.

There were some excellent drawings that were clear and drawn to a good size.

Comments on specific questions

Question 1

(a) Few candidates scored all the available credit. Most recognised that there was a higher volume of juice in the 1st container, but few quoted the correct volumes for both containers. Many candidates attempted to describe the difference in appearance in a number of ways, although a clear comparison was required to gain credit.

(b) (i) The majority of candidates correctly selected the *x*-axis for plotting the given values (pH) and the *y*-axis for the variable values (volume of juice). Most candidates labelled the axes correctly, and included units.

The majority used linear scales that made use of the whole grid. Due to the nature of the data to be plotted, most candidates did not start with the origin at 0,0. However, candidates should be aware that this may result in a non-linear scale, if a scale break is not indicated.

Most candidates plotted the points correctly.

Some candidates did not realise that a line of best fit could be a curve, and joined the plotted points with a ruler.

(ii) Most candidates correctly stated that the optimum pH was 5.

(iii) Both a description and explanation were required in order to score maximum credit.

Most candidates were able to state that as pH increases up to pH5 / the optimum, more juice is produced. However, fewer candidates were able to explain the shape of the graph with reference to the enzyme denaturing or the active site changing shape.

A small number of candidates misread the question and answered in terms of the effects of temperature rather than pH, on the production of juice.

(c) It was expected that four factors should be named. Temperature and time were two of the most common correct answers given. Volumes of enzyme and apple, as well as concentration of enzyme, were also common acceptable responses.

A significant number of candidates thought that pH should also be controlled. However, since pH was the independent variable in this investigation, credit was not given without specific reference to buffer solutions.

Temperature and pressure were commonly seen, but non-creditworthy, answers.

A few candidates did not attempt to answer this question.

Question 2

(a) There were many excellent biological drawings, of a good size, with good proportions and drawn with clear continuous lines.

A few poorer drawings were drawn with sketchy lines or included shading that is not needed in biological drawings.

A small number of candidates did not follow the instructions and drew the whole of Fig. 2.1, rather than just the portion in box **Y** that was indicated.

(b) (i) Some candidates described the cells in Fig. 2.3 as shrunken or flaccid and those in Fig. 2.2 as hexagonal, none of which gained credit. Better answers referred to the nuclei being more visible in Fig. 2.2, and also to the idea that the contents filled the cells, whereas in Fig. 2.3 they did not. A clear comparison between Figs. 2.2 and 2.3 was required.

A small number of candidates tried to explain why these differences had occurred, which was not required in this question.

(b) (ii) The majority of candidates that identified that osmosis had taken place, which earned them the majority of the available credit. The most common omission was reference to the selectively permeable membrane. Some answers referred to relative concentrations, but did not specify clearly whether it was the solute concentration or water potential, and thus could not be given credit.

A significant number of candidates wrote nothing worthy of credit in this part.

Question 3

(a) (i) Most candidates scored well here. Answers that did not gain credit tended to be too vague, e.g. number of fingers, shape.

(ii) Candidates need to be aware that when asked to describe differences between / compare, two specimens, that reference to both must be made in order to gain credit. This part was not answered as well as **(a)(i)**.

(b) Reference to a process and a description of how that process works was required for maximum credit. The best answers referred to sweat production and the consequent evaporation of sweat / water having a cooling effect on the body. A few candidates correctly named vasodilation as an alternative process, although some thought, incorrectly, that this caused blood vessels to move closer the surface of the skin, thus negating the credit. Few recognised that heat was lost from the blood.

Question 4

In order to gain maximum credit, at least one relevant safety measure had to be included in the response.

(a) This question was generally answered well. Most candidates identified Benedict's solution as the correct reagent and also suggested a suitable range of colours to indicate the presence of reducing sugar. Some candidates omitted to specify that the solution should be heated, but those who did often also referred to the use of a water bath, thus scoring extra credit for a relevant safety procedure. A few candidates did not indicate that the Benedict's solution / mixture is blue at the beginning, and thus did not gain full credit.

(b) This part of the question was not quite so well answered. Some candidates mistakenly thought that the reagent used to test for protein was Benedict's or iodine solution. However, the majority correctly named Biuret or gave the alternative combination of reagents – sodium or potassium hydroxide and copper sulfate, although some incorrectly then went on to heat the mixture. There was also some confusion regarding the expected colour change, with some giving the results for the reducing sugar test rather than the correct colour of mauve / purple. Fewer candidates noted the starting colour (blue) in this test compared with part **(a)**. There were almost no references to safety in this part, although credit could have been given if not already awarded in part **(a)**.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key Messages

This paper tests experience of practical work and the ability to use practical skills such as observation, drawing, data handling, interpretation of results and experimental design. Many candidates demonstrated by their answers that they do have experience of practical work, but the answers given by some candidates showed a lack of such experience.

It is important that all the information provided within each question is read, including introductory material, such as the details of how an investigation has been carried out. That information may well be necessary for answering the questions that follow.

It might help candidates to use the information describing such an investigation to imagine themselves actually carrying out the processes.

The questions themselves, even if quite short, should be read carefully so that, for example, when a labelled drawing is asked for, the drawing is labelled.

The credit allocation for each question section gives some indication of the amount of content expected in the answer.

General Comments

Almost all scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written.

It appears that candidates had sufficient time to complete the paper.

Comments on Specific Questions

Question 1

(a) (i) Many candidates applied their knowledge and experience of testing for the presence of starch to the information given in Table 1.1 and were able to work out that starch had been completely broken down when the added iodine solution remained yellow, i.e. after 10 minutes and 5 minutes respectively in the test-tubes **A** and **C**. A few candidates recorded the units of measurement as seconds rather than the minutes clearly stated in the Table. Some candidates omitted units while others recorded times that showed either that they did not know the starch test or that they did not know how to use the information in the Table.

(ii) Many candidates correctly described the breakdown of starch by amylase taking a shorter time when sodium chloride was present. Better candidates also observed that the breakdown took half the time or was twice as fast. Some candidates tried to explain how the effect described came about, which was not asked for in the question.

The following questions, **(b)(i) – (b)(v)**, tested candidates' awareness of the principles involved in the design of a good investigation.

(b) (i) An awareness that the use of a white tile would make any colour change more clearly visible than, for example, in a test-tube was stated by many candidates.

(ii) Many candidates correctly realised that stirring was needed to mix the components in the test-tube together, to distribute them uniformly.

(iii) Test-tube **C** was not mentioned in this question which should have led candidates to look for any difference between that test-tube and test-tubes **A** and **B**. Only the better candidates did that and realised that test-tube **C** was the only one that contained 1 cm^3 sodium chloride solution. As this was not needed in test-tubes **A** and **B**, the 1 cm^3 water had been added to make the volume of mixture in each test-tube the same.

(iv) Better candidates realised that 5 cm^3 of 1% starch solution was added to all the tubes so that the volume or amount of starch for the enzyme to act on was the same in each tube.

(v) Many candidates knew that boiling an enzyme would make it inactive, but that does not explain why boiled enzyme was added to test-tube **B**. Good answers referred to its use as a comparison with the active enzyme in test-tube **A**, or a control.

(c) (i) The majority of candidates answered this well, constructing a graph as asked with many scoring all the available credit. A few constructed a bar chart which reduced the amount of credit available to them.

A good number of candidates orientated their graph on the grid correctly, with pH on the horizontal *x*-axis and time taken to break down the starch on the vertical *y*-axis. There were, however, a number who reversed these axes. It may be helpful to remember that the variable that is decided upon by the investigator, in this case the pH values to be used, i.e. the independent variable, goes on the *x*-axis. The variable that is being investigated and is unknown at the beginning of the investigation, in this case the time taken, is the dependent variable and should go on the *y*-axis.

Axes should be fully labelled with the variable and, where possible, units, e.g. time taken / mins. Most candidates did this well.

Most candidates used linear scales, inserting a scale break where needed, and of a size that used most of the grid provided.

The majority of candidates correctly plotted all six points and joined them appropriately with a line or a curve. The lines constructed by some candidates who had reversed the axes did not form meaningful curves and could not be credited.

(ii) Many candidates correctly stated that the optimum pH was 5.

A few read the value from their own graphs resulting in values slightly more or less than 5 which received due credit.

Other candidates assumed that the highest point on the graph, at pH 8, was the optimum, whereas what that actually indicated was that enzyme activity was the slowest at that pH, not the fastest.

(iii) There were some very good answers describing how enzyme activity increased with increasing pH up to the optimum, after which it decreased with increasing pH. They then went on to explain that low enzyme activity can be attributed to denaturing which changes the shape of the enzyme's active site.

Some candidates wrote generally about the effect of pH on enzyme activity but not in relation to the activity of the particular enzyme in this investigation. A number of these candidates stated that the optimum pH for all enzymes is pH 7, although they had correctly given pH 5 as the optimum for this enzyme.

Some weaker candidates answered in terms of temperature rather than pH.

Question 2

(a) (i) There were many excellent biological drawings, of a good size and drawn with clear continuous lines.

A few poorer drawings were drawn with sketchy lines or included shading which is not needed in biological drawings.

Most candidates observed that the cotyledon did not lie centrally within the testa and represented the wider area on the right hand side of their drawing well.

The plumule and radical were generally well drawn.

Many candidates failed to score any credit for labelling their drawing, most often because they did not write any labels. If a labelled drawing is asked for, some of the credit in the allocation for the section will be for labels.

Only a few candidates correctly labelled the radical and plumule.

(ii) Many candidates scored credit for correctly recording the measurements of Fig. 2.1 and their drawing.

Some, who measured well, recorded their measurements in cm, although mm was written on the answer lines.

Some candidates chose to draw a line at one side of their drawing and to measure that. It should be noted that this is acceptable as long as the line drawn is of the same length as the object being measured. A few candidates drew lines unrelated to the length of the object and could not be credited with correctly recording those measurements.

Many candidates knew how to calculate the magnification of their drawing from these measurements, noticing that the Fig. 2.1 was already magnified ×4, and expressed the magnification well.

(b) (i) This was answered well by many candidates. They observed the two specimens and recorded comparative differences between them.

Some candidates wrote statements that did not apply to both bean fruits, e.g. simply stating that 'the climbing bean fruit is long' does not point out how it differs from the groundnut. But if it had been stated that 'the climbing bean is longer' credited was awarded.

(ii) There were some excellent answers here. These recognised the need to use similar masses of seed, and similar volumes of reagent in order to do a comparative test. Many candidates related to the question, realising that the seeds would need to be ground up or crushed before testing. Most used biuret reagent or specified sodium or potassium hydroxide solution and copper sulfate solution as the means for testing for the presence of protein. The initial colour of this reagent should be stated. Many candidates knew that a purple / mauve / violet colour indicates the presence of protein and that the darker the colour, the more protein is present.

Weaker candidates used the wrong reagent, e.g. Benedict's solution, iodine solution or ethanol. Some assumed that because the seeds in the groundnut were bigger they would contain more protein and simply stated that without explaining how that could be proved. These answers could not be credited. Others wrote generally about the need for protein in our diet which was irrelevant to this question.

Question 3

(a) There were some excellent answers describing the similar pattern of arrangement of bones in both limbs, e.g. one upper bone, two lower bones side by side, many bones in wrist/ankle, five digits.

Some, although the question stated that joints should not be included in this answer, compared the joints rather than the bones and could not be credited.

(b) There were some very good answers expressed in a number of different ways, e.g. how the joint acted (like a hinge or like a ball and socket), the direction in which movement at the joint is possible (up and down or rotation), or the degree of movement possible (180° and 360°).

Among those candidates who described **X** as ball and socket and **Y** as hinge may have been those who did not take sufficient care in relating their answers to the **X** and **Y** on Fig. 3.1.