BioMedical Admissions Test

Specimen Section 2 answers

1 This question requires you to draw on your knowledge of the regions of the digestive system where the three types of nutrient are broken down. T

1 The table indicates that nutrient 1 undergoes a small amount of digestion in the mouth; very little, if any, digestion in the stomach; and the remainder of the digestion in the small intestine. That some digestion takes place in the mouth, should indicate to you that this nutrient is starch, which is acted on by amylase (a carbohydrase) produced by the salivary glands. This is supported by the observation that digestion of this nutrient does not take place in the stomach, but is completed in the small intestine, the site of further carbohydrase activity.

2 Digestion of this nutrient begins in the stomach. This alone should tell you that this nutrient is protein, since the stomach is the site of protease activity, which also occurs in the small intestine.

By this stage, you should be fairly sure that the correct answer is **B**.

3 Digestion of nutrient 3 takes place only in the small intestine, which should confirm that this is fat, which is acted on by lipase in the small intestine, but is not digested in either the mouth or the stomach.

This confirms that the correct answer is **B**.

2 If we start with the equation: $\frac{x+5}{2} - \frac{2x-1}{3} = 4$

multiply both sides by 6: $3(x+5) - 2(2x-1) = 24$

remove brackets: $3x + 15 - 4x + 2 = 24$

so: $17 - x = 24$

subtract 17 from both sides: $-x = 7$

the answer is: $x = \mathbf{-7}$

3 The relationship between resistance, voltage and current is:

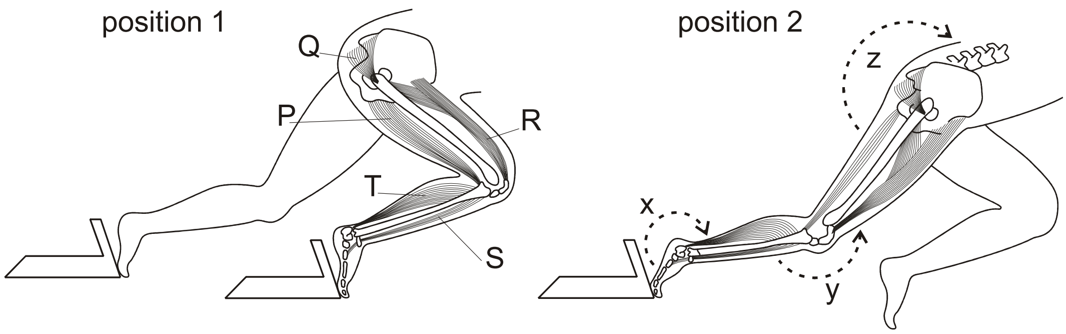
$$I = \frac{V}{R}$$

Where I is the current in amperes, V is the voltage in volts and R is the resistance in ohms.

So the current in this case is: $\frac{30\text{V}}{1500\Omega} = \mathbf{0.02A}$

4 The main differences between arterial and venous blood are the levels of dissolved oxygen and carbon dioxide present. Venous blood typically has a higher level of dissolved carbon dioxide, which forms carbonic acid in aqueous solution. Venous blood is, therefore, likely to be slightly more acidic than arterial blood (i.e. have a slightly lower pH). Your knowledge of acidity and alkalinity should alert you to the fact that a pH of 4.35 is quite strongly acidic (similar to that of vinegar), making **A** an unlikely answer. The correct answer is **B**.

5 The first stage in finding the answer to this question is to carefully inspect the diagram to work out how the relative positions of the parts of the leg change between positions 1 and 2. These changes are indicated by arrows x, y and z on the diagram below:



- x The foot is extended backwards to press against the block – muscle T contracts while muscle S relaxes.
- y The knee straightens – muscle R contracts, while muscle P relaxes.
- z The upper part of the leg is pulled back so that it is more in line with the torso – muscle Q contracts.

Muscles Q, R and T contract, and muscles P and S relax.
The correct answer is **C**.

6 The second law of motion states that the relationship between mass (m), acceleration (a) and force (F) can be expressed by the equation:

$$F = ma$$

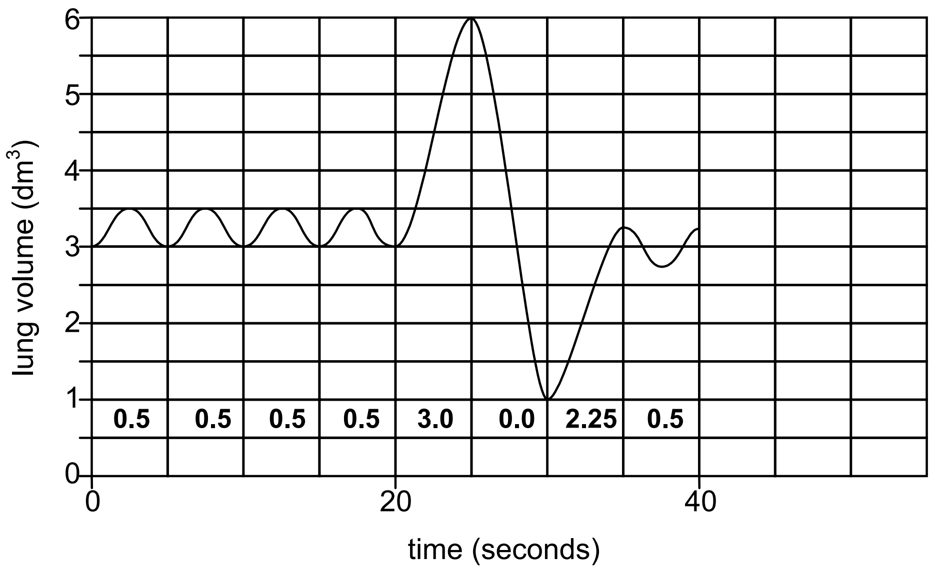
Where: mass is in kg; acceleration is in m/s^2; and force is in N.

So the average force, in newtons, exerted on the vest is:

$$F = 0.01 \times \frac{200}{1 \times 10^{-4}} = 0.01 \times 200 \times 10^{4} = \mathbf{20\,000}$$

7 During the manufacturing process, four atoms of hydrogen are removed from the glucose molecule ($C_6H_{12}O_6$) to produce the vitamin C molecule ($C_6H_8O_6$). This conversion involves a process of oxidation. The answer is **A**.

8 The volume of air breathed in during each 5 second period is shown on the graph:



So the total volume breathed in is **7.75 dm^3**.

9 This question becomes much easier if you recognise that $3.426 = 2 \times 1.623$

so: $$\frac{3.246 \times 10^6 + 3.246 \times 10^4}{1.623 \times 10^{11}}$$

simplifies to: $$= \frac{2 \times 10^6 + 2 \times 10^4}{10^{11}}$$

$$= 2 \times 10^{-5} + 2 \times 10^{-7}$$

$$= 0.00002 + 0.0000002$$

$$= \mathbf{0.0000202}$$

10 The series of events will begin when the image of the food falls on the retina, initiating one of many impulses that are transmitted to the brain via a sensory neurone. Here the brain interprets the pattern of impulses as representing an image of food. This results in an impulse being transmitted to the salivary gland via a motor neurone. (The need for the visual image to be interpreted should alert you to the fact that, although the reaction is involuntary, it is not a simple reflex. The impulse will travel via the brain, not the spinal cord.) This gives the sequence:

retina $\rightarrow$ sensory neurone$\rightarrow$ brain $\rightarrow$ motor neurone $\rightarrow$ salivary gland

The correct answer is **D**.

11 **i** The voltage across each branch of the parallel section of the circuit will be 12V. The voltage across each of the two bulbs arranged in series will be half of the total voltage across that branch. So the voltmeter V_1 will read 6 volts. Statement **i** is **true**.

ii Since the voltage across each branch of the parallel circuit is 12V, the voltmeter V_2 will read 12 volts. Statement **ii** is **true**.

iii Resistance in the branch with two bulbs in series will be greater than that of the branch with only one bulb, so the reading on A_2 will be lower than the reading on A_3. Statement **iii** is **false**.

iv Current is not 'used up' a it flows around the circuit, so the readings on ammeters A_1 and A_4 will be the same. Statement **iv** is **false**.

v The sum of the currents in the two branches of the parallel circuit is equal to the current entering or leaving the parallel section. The sum of the readings on A_2 and A_3 will equal the reading on A_4. Statement **v** is **true**.

12 The quadrant is a quarter of a circle, so the area of the whole quadrant will be:

$$\frac{\pi r^2}{4}$$

The unshaded part of the quadrant is a right-angled triangle, the area of which is:

$$\frac{r^2}{2}$$

The shaded area is equal to the area of the quadrant minus the area of the triangle:

$$\frac{\pi r^2}{4} - \frac{r^2}{2} = \frac{\pi r^2}{4} - \frac{2r^2}{4} = \frac{(\pi - 2)r^2}{4}$$

As a fraction of the quadrant; this is:

$$\frac{\frac{(\pi - 2)r^2}{4}}{\frac{\pi r^2}{4}} = \frac{(\pi - 2)r^2}{\pi r^2} = \frac{\pi - 2}{\pi}$$

The answer is **C**.

13 The son of male **X** has the disease, but neither parent has the disease. This indicates that the disease is caused by a recessive allele, and that both parents must be heterozygous, each having the genotype Rr. So male **X** has the genotype Rr.

Male **Y** has the disease. We have established that the disease is caused by the recessive allele, so male **Y** must be homozygous, having two copies of the recessive allele. So male **Y** has the genotype rr.

Female **Z** is the offspring of a mother who has the disease. The mother must have two copies of the recessive allele, one of which will have been inherited by female **Z**. However, female **Z** does not have the disease, so she must be heterozygous. Female **Z** has the genotype Rr.

The answer is **D**.

14 Using the relative atomic masses given, the relative molecular masses of the products can be calculated as CO_2 = 44; H_2O = 18. So one mole of each is produced by the reaction. Since all of the carbon and hydrogen in the products comes from the original hydrocarbon, this must have contained C and H in the ratio 1:2. Of the five hydrocarbons listed, only C_2H_4 has this ratio of carbon and hydrogen.
The answer is **B**.

15 The largest pressure will be exerted by the block if it stands on its smallest face.

Area of smallest face: $0.05\text{m} \times 0.15\text{m} = 0.0075\text{m}^2$

The pressure exerted by the block can be expressed by the equation:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Where pressure is in Pa, force in N and area in m^2.

The pressure, in pascals, exerted by the block when it stands on this face will be:

$$\frac{150}{0.075} = \mathbf{20000}$$

16 As the parachutist leaves the aircraft, he accelerates towards the ground. His velocity will increase, and the air resistance will also increase until it equals the force of gravity acting on him. At this point the parachutist reaches terminal velocity; his rate of decent, and the air resistance acting on him, will remain constant until he opens his parachute. Up to this point, all four graphs correctly depict this sequence of events.

The opening of the parachute has the effect of dramatically increasing the surface area of the falling 'object', and the air resistance increases sharply. This is reflected in the shapes of graphs **A** and **C**. During this phase of the descent, the air resistance exceeds the force of gravity acting on the parachutist, and his velocity decreases.

As the velocity of the parachutist falls, so the air resistance acting on him falls. After a while, the velocity of the parachutist will fall to a level where the resulting air resistance once again equals the force of gravity acting on him. The parachutist has reached a new (lower) terminal velocity.

The important thing to appreciate (possibly the main source of difficulty in this question) is that the mass of the parachutist has not changed during the fall. Consequently, although the new terminal velocity is much lower than that which was established before the parachute opened, the air resistance is once again equal to the force of gravity acting on the parachutist. Thus, the air resistance will return to the same level that it reached earlier in the fall (but now a larger surface area is pushing proportionately more slowly against the air).

The correct answer is **A**.

17 If we square both sides of the equation:

$$\frac{2}{x} + 1 = (y-3)^2$$

So:

$$\frac{2}{x} = (y-3)^2 - 1$$

$$x = \frac{2}{(y-3)^2 - 1}$$

$$x = \frac{2}{y^2 - 6y + 8}$$

$$x = \frac{2}{(y-4)(y-2)}$$

The answer is **A**.

18 In the human circulatory system, blood does not flow directly from kidneys to the liver, but passes via the heart. Blood passing through the heart enters through the right side, passes from the right ventricle to the lungs, and then returns to the left side of the heart before being pumped to the rest of the body. This passage through the heart involves the sequence of blood vessels indicated on the diagram by 11-12-1. This knowledge alone should lead you to conclude that **D** is the correct answer. (The full sequence indicated by **D** is: renal vein (7); inferior vena cava (8 & 11); pulmonary artery (12); pulmonary vein (1); dorsal aorta (2); hepatic artery (3).)

19 To balance the number of Pb atoms on both sided of the equation, **a** must be equal to **b**. To balance the number of N atoms, **c** must be equal to 2**a**. The equation can now be re-written as:

$$\mathbf{a}\ Pb(NO_3)_2 \rightarrow \mathbf{a}\ PbO + 2\mathbf{a}\ NO_2 + O_2$$

The total number of O atoms on each side of the equation can now be calculated:

$$6\mathbf{a} = 5\mathbf{a} + 2$$

So: **a** = **2**
b = **a** = **2**
c = 2**a** = **4**

20 The relationship between force, distance time and power can be expressed by the equation:

$$\text{power} = \frac{\text{force} \times \text{distance}}{\text{time}}$$

Where power is in watts (W), force is in newtons (N), distance is in metres (m), and time is in seconds (s).

Taking the acceleration of free fall as 10 m/s, the upward force that must be exerted to lift the 20 kg mass is 200 N.

So the average power generated is: $\frac{200\text{N} \times 0.5\text{m}}{2\text{s}} = 50\text{W}$

The answer is **C**.

21 Catalysts increase the rate of reaction by providing an alternative reaction path with a lower activation energy. However, the point of equilibrium, the nature of the products, and the overall energy change are unaffected.

The correct answer is **D**.

22 If we consider the options in turn:

A this would cause the bubble to move from **Y** to **X** as the oxygen in the boiling tube is absorbed;

B this would cause the bubble to move from **Y** to **X** as the carbon dioxide in the boiling tube is absorbed by the potassium hydroxide;

C this would cause the bubble to move from **Y** to **X** as the increased pressure outside pushes the fluid along the capillary tube;

D this would cause the bubble to move from **X** to **Y** as the increased temperature causes the gases in the boiling tube to expand;

E this would cause the bubble to move from **Y** to **X** as the carbon dioxide in the boiling tube is absorbed by the potassium hydroxide;

The answer is **D**.

23 As you move up the alkane series (i.e. as the size and mass of the molecule increases) the boiling point and viscosity increase, and the flammability and volatility decrease. **B** is the correct answer.

24 The relationship between the voltages and numbers of turns on the coils of a transformer can be expressed by the equation:

$$\frac{\text{secondary voltage}}{\text{primary voltage}} = \frac{\text{secondary turns}}{\text{primary turns}}$$

The output voltage (secondary voltage) will be reduced if there are fewer turns on the secondary coil, so the answer is **B**. **A** would result in an *increase* in the output voltage. **C** & **D** might reduce the output current slightly but, within the bounds of practicality, could not reduce the voltage by half. (If the primary wire were sufficiently thin, there would be insufficient current to produce the magnetic flux in the core. If the secondary wire were sufficiently thin, there would be insufficient current to charge the mobile phone.)

25 For any pair of parallel lines AB and CD, the lines AD and BC intersect such that the ratio of the lengths of lines AE:DE is the same as the ratio of the lines BE:CE.

So:
$$\frac{2}{5} = \frac{x}{6+x}$$

$$2x + 12 = 5x$$

$$12 = 3x$$

So length BE = x = **4cm**

26 During menstruation, the lining of the uterus breaks down and is discarded. This process is accompanied by the loss of blood. In the following days, increasing levels of oestrogen promote the repair and thickening of the lining of the uterus, in advance of the release of the egg at around day 14. Levels of oestrogen reach their peak and start to decline shortly before ovulation.

Knowing this, you should be able to deduce that oestrogen levels will be highest during period **B**.

27 If $24\,dm^3$ of air contains 6×10^{23} molecules, then the number of molecules in $0.5\,dm^3$ of air is:

$$\frac{0.5}{24} \times 6 \times 10^{23}$$

80% of these are nitrogen molecules, so the number of nitrogen molecules is:

$$0.8 \times \frac{0.5}{24} \times 6 \times 10^{23}$$

each of which contains two nitrogen atoms. So the number of nitrogen atoms is:

$$2 \times 0.8 \times \frac{0.5}{24} \times 6 \times 10^{23}$$

By simple multiplication and cancelling, this gives 0.2×10^{23}, which is equal to: 2×10^{22}. The answer is **C**.