

## BioMedical Admissions Test

4500/12

Wednesday 5<sup>th</sup> November 2014

30 minutes

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### SECTION 2                      Scientific Knowledge and Applications

#### Instructions to Candidates

**Please read this page carefully, but do not open the question paper until you are told that you may do so.**

A separate answer sheet is provided for this section. Please check you have one. You also require a soft pencil and an eraser.

Please complete the answer sheet with your:

- BMAT candidate number
- centre number
- date of birth
- name

Speed as well as accuracy is important in this section. ***Work quickly, or you may not finish the paper.*** There are no penalties for incorrect responses, only points for correct answers, so you should attempt all 27 questions. All questions are worth one mark.

Answer on the sheet provided. Most questions ask you to show your choice between options by shading a circle. If questions ask you to write in words or numbers, be sure to write clearly in the spaces provided. If you make a mistake, erase thoroughly and try again.

Any rough work should be done on this question paper.

Calculators are NOT permitted.

**Please wait to be told you may begin before turning this page.**

*This paper consists of 20 printed pages and 4 blank pages.*

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- 1 The following statements relate to the flow of blood through the heart.
- 1 Oxygenated blood flows through the right side of the heart.
  - 2 The vena cava empties deoxygenated blood into the ventricle.
  - 3 The heart pumps oxygenated blood through the pulmonary artery.
  - 4 There is a valve that prevents backflow of blood from the aorta into the left ventricle.

Which of these statements is / are correct?

- A 1 only
  - B 2 only
  - C 4 only
  - D 1 and 3 only
  - E 1 and 4 only
  - F 1, 2 and 3 only
  - G 2, 3 and 4 only
- 2 Which of the following reactions are redox reactions?

- 1  $\text{CuSO}_4 + \text{Zn} \rightarrow \text{Cu} + \text{ZnSO}_4$
- 2  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- 3  $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
- 4  $\text{Pb}(\text{NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3$

- A 1 and 2 only
- B 1 and 3 only
- C 1 and 4 only
- D 2 and 3 only
- E 2 and 4 only
- F 3 and 4 only

3 Below are four statements about electromagnetic radiation.

- 1 Microwaves have a shorter wavelength than all other electromagnetic waves.
- 2 For identical amplitudes, waves with the largest wavelength transfer the most energy.
- 3 The speed of electromagnetic waves is inversely proportional to their frequency.
- 4 Ultraviolet radiation can cause cataracts.

Which of these statements is / are correct?

- A** 1 only
- B** 2 only
- C** 3 only
- D** 4 only
- E** 1 and 3 only
- F** 1 and 4 only
- G** 2 and 3 only
- H** 2 and 4 only

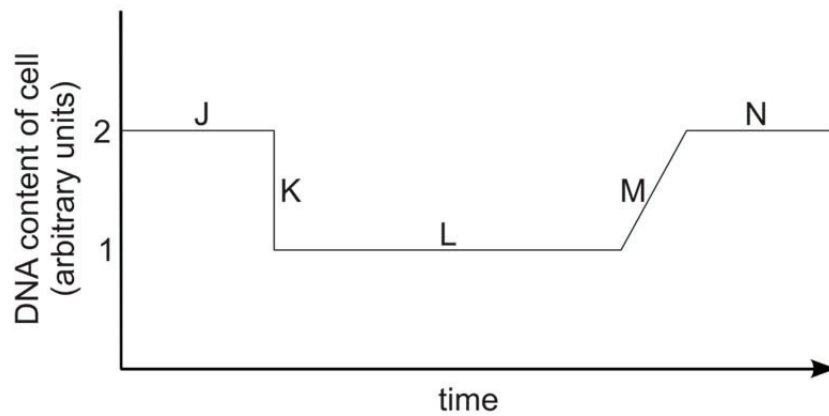
4 Simplify:

$$\frac{x^2 - 4x}{x^2 - 16}$$

- A**  $\frac{x}{4}$
- B**  $\frac{x}{x + 4}$
- C**  $\frac{x}{x - 4}$
- D**  $\frac{1}{4}$
- E**  $\frac{x - 4}{x - 16}$

- 5 Before a cell can divide by mitosis, DNA synthesis has to take place. Following DNA synthesis, the DNA is separated into each half of the cell and then the cell divides.

The graph below shows the DNA content per cell over a period of time.



Which of the letters on the graph represent the sequence of the three events described above?

	<i>Cell divides</i>	<i>DNA synthesis</i>	<i>DNA separates</i>
<b>A</b>	J	K	L
<b>B</b>	J	L	M
<b>C</b>	K	L	M
<b>D</b>	K	M	N
<b>E</b>	L	M	N
<b>F</b>	L	M	J
<b>G</b>	M	N	J
<b>H</b>	M	N	K

- 6 Which row in the table correctly explains why an increase in temperature increases the rate of a reaction?

	<i>Effect on activation energy of reaction</i>	<i>Effect on collision frequency between particles</i>	<i>Effect on proportion of collisions which are successful</i>
<b>A</b>	decreases	no effect	increases
<b>B</b>	increases	no effect	no effect
<b>C</b>	no effect	increases	no effect
<b>D</b>	increases	increases	no effect
<b>E</b>	decreases	no effect	no effect
<b>F</b>	no effect	no effect	increases
<b>G</b>	decreases	increases	increases
<b>H</b>	no effect	increases	increases

- 7 Which one of the following is a unit of current?

- A** ampere / second
- B** coulomb  $\times$  second
- C** joule / coulomb
- D** ohm / volt
- E** volt  $\times$  ohm
- F** watt / volt

- 8 Given that  $4^p \times 8^q = 2^n$ , express  $n$  in terms of  $p$  and  $q$ .

- A**  $n = p + q$
- B**  $n = 2p + 3q$
- C**  $n = 2p + 4q$
- D**  $n = p + q + 5$
- E**  $n = 6pq$

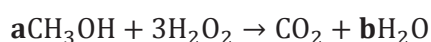
- 9 Insulin is a protein involved in the regulation of human blood glucose levels.

Genetic engineering can be used to allow the large-scale production of human insulin.

Which statement describes the process of genetic engineering in this case?

- A** Taking insulin from a human and inserting it into the DNA of a bacterium. As the bacterium reproduces, it makes large quantities of insulin DNA that can be used to treat human diabetes.
- B** Taking insulin from a human and inserting it into the DNA of a bacterium. As the bacterium reproduces, it makes large quantities of insulin that can be used to treat human diabetes.
- C** Taking the insulin gene from a human chromosome and inserting it into the DNA of a bacterium. As the bacterium reproduces, it makes large quantities of insulin DNA that can be used to treat human diabetes.
- D** Taking the insulin gene from a human chromosome and inserting it into the DNA of a bacterium. As the bacterium reproduces, it makes large quantities of insulin that can be used to treat human diabetes.
- E** Taking the insulin gene from a human chromosome and replacing it in another human chromosome in the same human, so that it will work better to produce large quantities of insulin.

- 10 Methanol can be oxidised by hydrogen peroxide to produce carbon dioxide and water.



What is the value of **b** when this equation is balanced?

- A** 3
- B** 4
- C** 5
- D** 6
- E** 7

- 11 Two rods, X and Y, are made from different electrically insulating materials. A student rubs rod X, which is initially uncharged, with a cloth, then holds it near to rod Y. The two rods repel each other.

Which statement explains why repulsion occurs in this experiment?

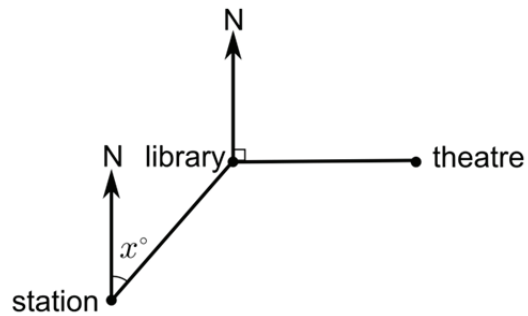
- A Rod X gains electrons from the cloth and rod Y is positively charged.
- B Rod X gains electrons from the cloth and rod Y is uncharged.
- C Rod X gains protons from the cloth and rod Y is negatively charged.
- D Rod X gains protons from the cloth and rod Y is positively charged.
- E Rod X loses electrons to the cloth and rod Y is negatively charged.
- F Rod X loses electrons to the cloth and rod Y is positively charged.
- G Rod X loses protons to the cloth and rod Y is negatively charged.
- H Rod X loses protons to the cloth and rod Y is uncharged.



12 In a town, the bearing of the library from the station is  $x^\circ$ .

The theatre is due east of the library.

The theatre and the station are equidistant from the library.



What is the bearing (in degrees) of the station from the theatre?

- A**  $45 + \left(\frac{x}{2}\right)$
- B**  $90 - \left(\frac{x}{2}\right)$
- C**  $90 + \left(\frac{x}{2}\right)$
- D**  $180 + x$
- E**  $225 - \left(\frac{x}{2}\right)$
- F**  $225 + \left(\frac{x}{2}\right)$
- G**  $270 - \left(\frac{x}{2}\right)$

**13** In humans, the water content in the blood is regulated via the hormonal system.

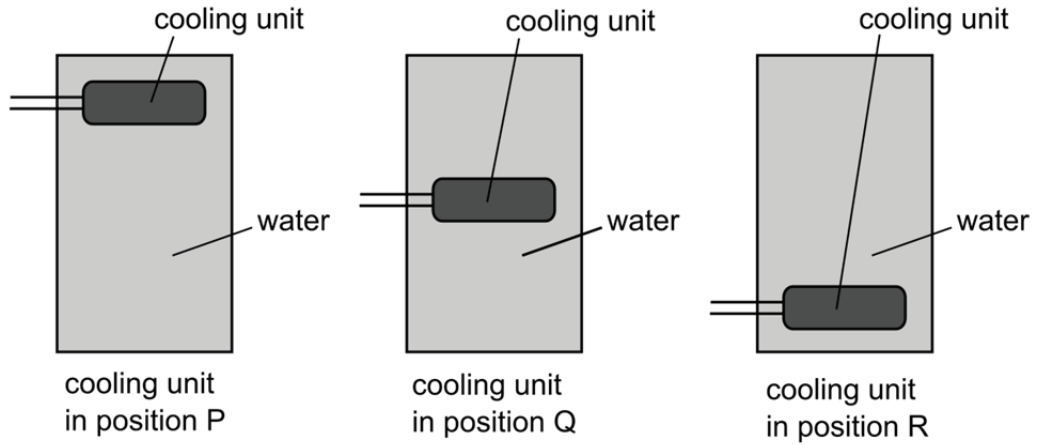
Which of the following occur when the water content of the blood is too low?

- 1** pituitary gland releases less ADH
  - 2** pituitary gland releases more ADH
  - 3** increase in water reabsorption by the kidneys
  - 4** decrease in water reabsorption by the kidneys
  - 5** increased reabsorption of glucose in the kidneys
  - 6** decreased reabsorption of glucose in the kidneys
- 
- A** 1 and 3 only
  - B** 2 and 3 only
  - C** 1 and 4 only
  - D** 2 and 4 only
  - E** 1, 3 and 5 only
  - F** 2, 4 and 6 only
  - G** 1, 4 and 5 only
  - H** 2, 3 and 6 only

14 Which of the following statements about but-1-ene are true?

- 1 it can form a polymer
  - 2 it contains C–C single bonds only
  - 3 it conforms to the general formula  $C_nH_{2n}$
  - 4 it decolourises bromine water
  - 5 it is saturated
- 
- A 1, 2 and 3 only
  - B 1, 2 and 5 only
  - C 1, 3 and 4 only
  - D 1, 3 and 5 only
  - E 2, 3 and 5 only
  - F 2, 3 and 4 only
  - G 2, 4 and 5 only
  - H 3, 4 and 5 only

- 15 A container is filled with water at 20 °C and placed in a room that is also at 20 °C. The container can be fitted with an internal electric cooling unit, in one of the three labelled positions P, Q or R. The outside of the container can either be painted dull black, or be covered in shiny aluminium foil.



In order to cool all the water as quickly as possible to 5 °C, in which position should the cooling unit be fitted, and should the outside of the container be dull black or shiny?

	<i>Position of cooling unit</i>	<i>Outside of container</i>
<b>A</b>	P	black
<b>B</b>	P	shiny
<b>C</b>	Q	black
<b>D</b>	Q	shiny
<b>E</b>	R	black
<b>F</b>	R	shiny

- 16** Three classes in a school all took the same test. Class 1 achieved a mean score of 61, Class 2 achieved a mean score of 63, and class 3 achieved a mean score of 70. The mean score of the students for all three classes combined was 65. Class 1 contains twice as many students as Class 2.

Which one of the following statements about the number of students in class 3 is true?

- A** Class 3 contains fewer students than Class 2.
  - B** Class 3 contains the same number of students as Class 2.
  - C** Class 3 contains more students than Class 2, but fewer than Class 1.
  - D** Class 3 contains the same number of students as Class 1.
  - E** Class 3 contains more students than Class 1.
- 17** Which of the following statements about lipid digestion in the small intestine is/are correct?
- 1** Emulsification by bile makes smaller lipid droplets, each with a smaller surface area.
  - 2** Bile contains an alkali to reduce the pH of the material from the stomach.
  - 3** Lipase secreted in bile breaks bonds in lipids to produce glycerol and fatty acids.
- A** none of the statements
  - B** 1 only
  - C** 2 only
  - D** 3 only
  - E** 1 and 2 only
  - F** 2 and 3 only
  - G** 1 and 3 only
  - H** 1, 2 and 3

- 18 An organic compound is found to contain 6 parts of carbon, 1 part of hydrogen and 8 parts of oxygen by mass.

6 g of a gaseous sample of the compound would have a volume of  $2.4 \text{ dm}^3$  at room temperature and pressure.

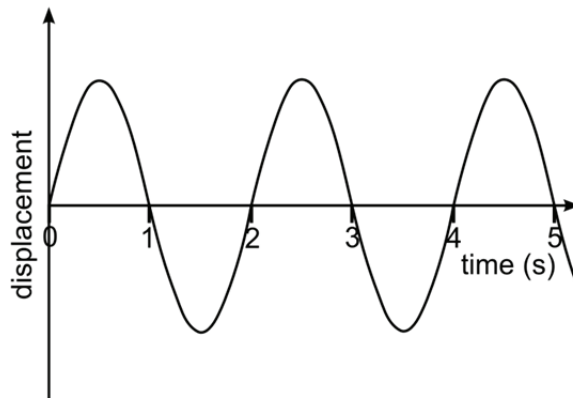
Which formula (A–E) is the molecular formula for this compound?

( $A_r$ : H = 1; C = 12; O = 16)

(1 mole of any gas occupies  $24 \text{ dm}^3$  at room temperature and pressure)

- A  $\text{CH}_2\text{O}$   
B  $\text{C}_2\text{H}_4\text{O}_2$   
C  $\text{C}_3\text{H}_8\text{O}$   
D  $\text{C}_3\text{H}_6\text{O}_3$   
E  $\text{C}_6\text{HO}_8$

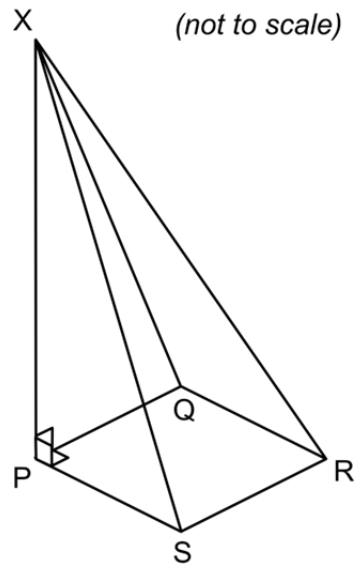
- 19 The displacement/time graph shown represents a wave of wavelength 1.5 cm.



What is the speed of the wave?

- A 0.33 cm/s  
B 0.67 cm/s  
C 0.75 cm/s  
D 1.33 cm/s  
E 1.5 cm/s  
F 3.0 cm/s

- 20 The diagram shows part of a glass structure. PQRS is a horizontal square with sides of 1 metre, and point X is 4 metres vertically above P.



What is the cosine of the angle that XR makes with the horizontal?

- A**  $\frac{1}{3}$
- B**  $\frac{\sqrt{2}}{4}$
- C**  $\frac{\sqrt{2}}{2\sqrt{3}}$
- D**  $\frac{4}{3\sqrt{2}}$
- E**  $\frac{2}{\sqrt{3}}$
- F**  $\frac{1}{\sqrt{17}}$
- G**  $\frac{1}{17}$

- 21** In order to function, the cells of the brain need large amounts of energy. Any reduction in the function of these cells can have serious consequences for the body. For example, a loss of oxygen supply to the brain can cause unconsciousness within 5–10 seconds.

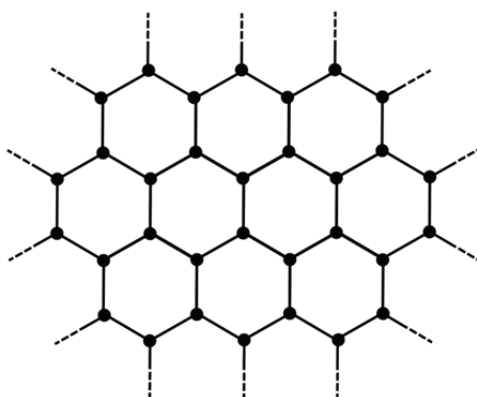
Which of the following statements are true?

- 1** Neurons in the brain are capable of relying on anaerobic respiration for long periods of time.
  - 2** The homeostatic systems of the body will constantly have to work to resist temperature increases in the brain.
  - 3** An overdose of insulin in the body could produce a serious loss of brain function, such as inducing a coma.
  - 4** During normal functioning of neurons in the brain, high levels of carbon dioxide could be produced.
- A** 1 and 2 only
- B** 1 and 3 only
- C** 2 and 3 only
- D** 2 and 4 only
- E** 1, 3 and 4 only
- F** 1, 2 and 4 only
- G** 2, 3 and 4 only



- 22 Graphene is a new material composed of carbon atoms arranged in tightly bound hexagons just one atom thick.

The diagram shows a simplified structure of graphene.



Considering its structure, which of the properties below could be predicted about graphene?

- 1 high melting point
  - 2 good electrical conductivity
  - 3 soluble in water
- 
- A 1 only
  - B 2 only
  - C 3 only
  - D 1 and 2 only
  - E 1 and 3 only
  - F 2 and 3 only
  - G 1, 2 and 3

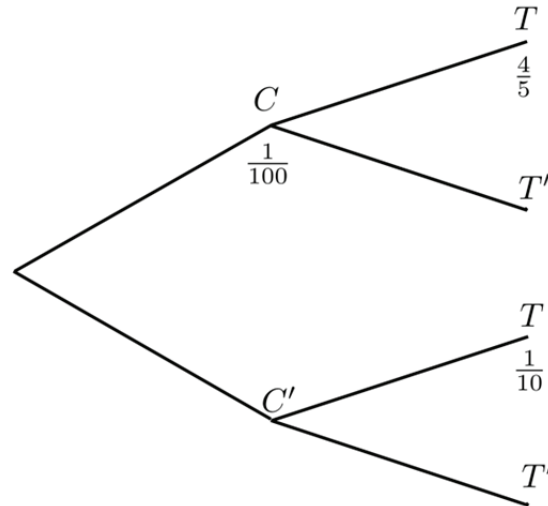
- 23 When a particular nucleus of uranium-235 undergoes the process of nuclear fission, it absorbs a neutron and then splits into a nucleus of barium and a nucleus of krypton, as well as releasing further neutrons.

Which one of the rows of the table below gives the correct number of neutrons released and the isotopes of barium and krypton produced by this nuclear reaction?

	<i>Number of neutrons released</i>	<i>Mass number of barium isotope produced</i>	<i>Mass number of krypton isotope produced</i>
<b>A</b>	2	141	92
<b>B</b>	2	142	94
<b>C</b>	3	140	92
<b>D</b>	3	140	94
<b>E</b>	3	141	92
<b>F</b>	3	142	94

24 A test is developed to detect a certain medical condition. The test is not perfect, and sometimes gives incorrect results. The behaviour of the test on 1000 randomly selected members of the population is shown in this tree diagram, where the following notation is used:

- $C$  = has the condition
- $C'$  = does not have the condition
- $T$  = tests positive for the condition
- $T'$  = tests negative for the condition



Three of the branches' proportions are shown in the tree diagram:

- $\frac{1}{100}$  of the 1000 people have the condition
- $\frac{4}{5}$  of those with the condition test positive for the condition
- $\frac{1}{10}$  of those without the condition test positive for the condition

A person is selected at random from these 1000 people, and tests positive for the condition.

What is the probability that this person has the condition?

- A**  $\frac{4}{5}$
- B**  $\frac{9}{10}$
- C**  $\frac{9}{20}$
- D**  $\frac{8}{99}$
- E**  $\frac{8}{107}$
- F**  $\frac{4}{500}$
- G**  $\frac{107}{1000}$

25 A woman has a recessive genetic condition but neither of her parents has the condition.

Which one of the following could **not** be true?

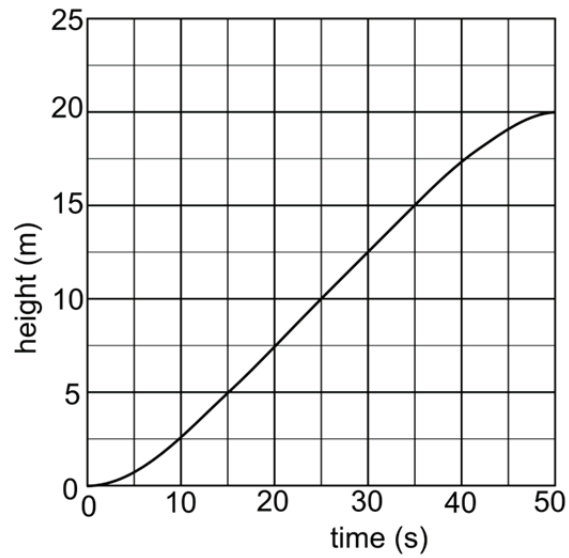
- A Both her parents are heterozygous for this gene.
- B One maternal grandparent and one paternal grandparent have the condition.
- C One maternal grandparent and one paternal grandparent are heterozygous for this gene.
- D All her grandparents were carriers of the recessive allele.
- E Both parents are homozygous and a mutation occurred in the DNA of a gamete from one of her parents.

26 Which of the following atoms / ions contain(s) exactly 18 electrons?

- 1  $^{18}_8\text{O}$
- 2  $^{34}_{16}\text{S}$
- 3  $^{35}_{17}\text{Cl}$
- 4  $^{37}_{17}\text{Cl}^-$
- 5  $^{40}_{20}\text{Ca}^{2+}$

- A 1 only
- B 2 only
- C 2 and 3 only
- D 3 and 4 only
- E 4 and 5 only

- 27 The graph shows the variation with time of the height through which a crane lifts a mass of 20 kg.



Assume the gravitational field strength  $g$  is  $10 \text{ N/kg}$ , and that the effects of air resistance and friction are negligible.

What is the power output of the crane when the mass is at a height of 10 m?

- A 0.1 W
- B 10 W
- C 40 W
- D 100 W
- E 400 W
- F 4000 W

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