

BioMedical Admissions Test

Wednesday

2 November 2005

Morning

30 minutes

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 first write your name, date of birth, BioMedical Admissions Test candidate number and centre number in the spaces provided on the answer sheet. Please write very clearly.

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. Unless otherwise stated, all questions are worth one mark.

Answer on the sheet provided. Many questions ask you to show your choice between options by shading a circle (or circles, if specified in the question). 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.

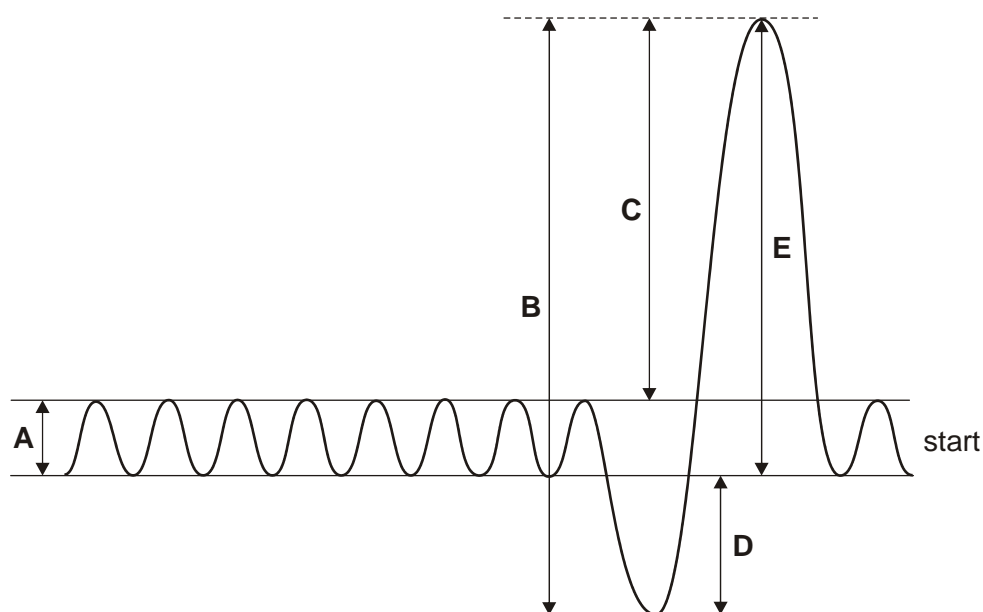
Please wait to be told you may begin before turning this page.

This paper consists of 11 printed pages and 5 blank pages.

The questions in this paper that are marked with an asterisk (* Qs: 1, 3, 5, 10, 12, 16, 26) assume knowledge that is not currently on the BMAT specification.

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- * 1 The movement of air in and out of the lungs can be measured using a spirometer. The graph is a trace from a spirometer.



Which lettered arrow represents the tidal volume?

- 2 You are told that three different gas jars contain carbon dioxide, hydrogen and oxygen respectively.

Which single method of testing for gases will enable you to identify **all three** gases?

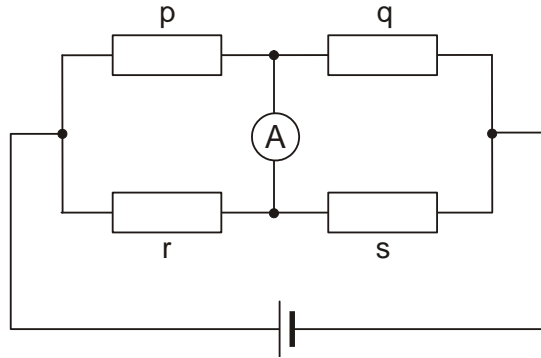
- A bromine water
- B burning splint
- C limewater
- D moist blue litmus paper
- E moist red litmus paper

- * 3 One type of fission of ${}_{92}^{238}\text{U}$ gives ${}_{38}^{95}\text{Sr}$ and ${}_{54}^{139}\text{Xe}$ as the main products.

What else would be given off in the fission reaction?

- A two protons
- B two neutrons
- C four protons
- D four neutrons

- 4 Four 1000Ω resistors are connected as shown in the following circuit.



Two of the resistors are changed to 900Ω .

Changing which pair of resistors would make a current flow in the ammeter?

- A p and q
- B p and r
- C r and q
- D r and s

- * 5 Smoking cigarettes can lead to emphysema. This occurs because:

- A carbon monoxide reduces oxygen carriage by the red blood cells
- B cilia on cells lining the trachea are temporarily paralysed
- C nicotine damages cells in the airways making them grow rapidly
- D smoke particles cause coughing that can rupture alveoli
- E chemicals in tar cause mutations in the nuclei of living cells

- 6 Using the formula:

$$z = xy^2$$

calculate the value of y when:

$$z = 1.2 \times 10^{13}$$

$$x = 3.0 \times 10^{-6}$$

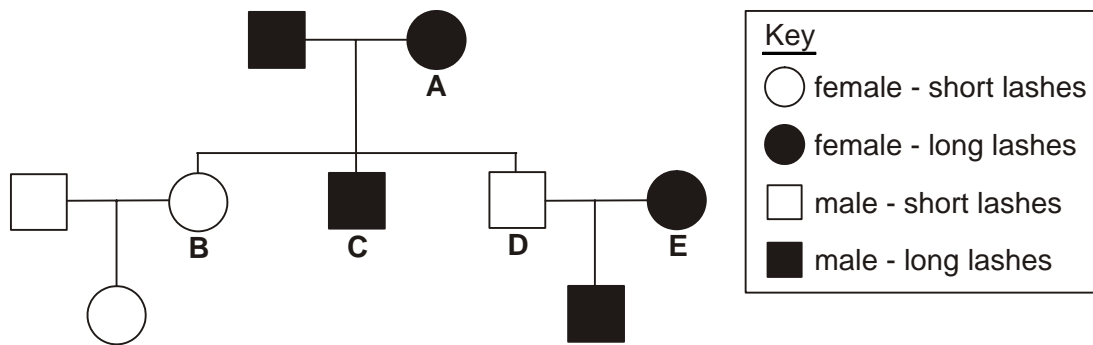
- A 2×10^3
- B 4×10^3
- C 2×10^9
- D 4×10^9

- 7 During metabolism, two molecules of pyruvic acid, $C_3H_4O_3$, are formed from one molecule of glucose, $C_6H_{12}O_6$.

This is an example of which of the following?

- A oxidation and decomposition
- B oxidation and synthesis
- C reduction and decomposition
- D reduction and synthesis

- 8 The length of a person's eyelashes is controlled by a single gene. The diagram shows the inheritance of this feature in a family.



Which individual, **A**, **B**, **C**, **D**, or **E**, **must** be heterozygous for eyelash length?

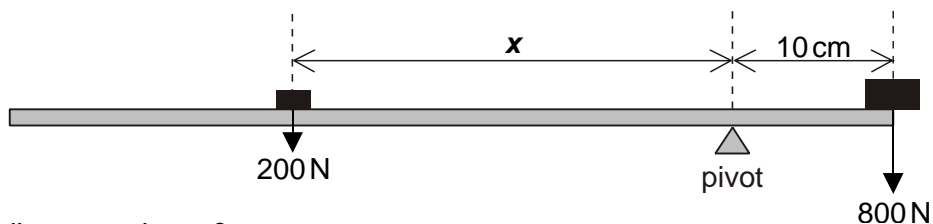
- 9 Two variables are connected by the relation: $A \propto 1/B^2$.

B is increased by 40%.

Describe the change in A in percentage terms.

- A 29% decrease.
- B 44% decrease.
- C 49% decrease.
- D 51% decrease.
- E 80% decrease.
- F 96% decrease.

- * 10 A uniform beam of length 60 cm weighs 10 N. Its centre of gravity (the point where its weight can be assumed to act) is at its centre. A weight of 800 N rests at one end of the beam as shown, and the beam is balanced by another weight of 200 N placed at distance x from the pivot.



What is distance x in cm?

- 11 Which fraction is the percentage by mass of water of crystallisation in sodium carbonate decahydrate?

(Relative atomic masses, A_r : Na=23; C=12; O=16; H=1)

- A $\frac{18 \times 100}{(23 + 12 + 48 + 180)}$
- B $\frac{18 \times 100}{(46 + 12 + 48 + 180)}$
- C $\frac{180 \times 100}{(23 + 12 + 48 + 18)}$
- D $\frac{180 \times 100}{(46 + 12 + 48 + 180)}$

- * 12 Which row of the table shows what occurs in the eye when you watch a bird flying away from you?

	ciliary muscles	suspensory ligaments	lens becomes
A	contract	loosened	more convex
B	relax	tightened	less convex
C	contract	tightened	less convex
D	relax	loosened	more convex
E	contract	loosened	less convex
F	relax	tightened	more convex

- 13 Rearrange the following equation to give x in terms of y .

$$y = \left(\frac{x^2 + 2ax}{b} \right)^{\frac{1}{2}}$$

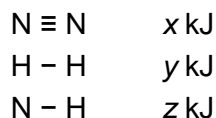
- A $x = (by^2 + a^2)^{\frac{1}{2}} - a$
 B $x = (by^2 - 2a)^{\frac{1}{2}}$
 C $x = (b^2y + a^2)^{\frac{1}{2}} - a$
 D $x = by - a$
 E $x = (by^2 + a^2 - a)^{\frac{1}{2}}$
- 14 A pulse of frequency 100 kHz is emitted from an ultrasound scanner, and is reflected from a fetus 10 cm below the transmitter placed on the mother's abdomen. The speed of sound within the mother's body is 500 m/s.

How long does it take for the pulse to reach the receiver which is adjacent to the transmitter?

- A 0.2 ms
 B 0.4 ms
 C 0.5 ms
 D 1.0 ms
- 15 The reaction between nitrogen and hydrogen to form ammonia is exothermic.



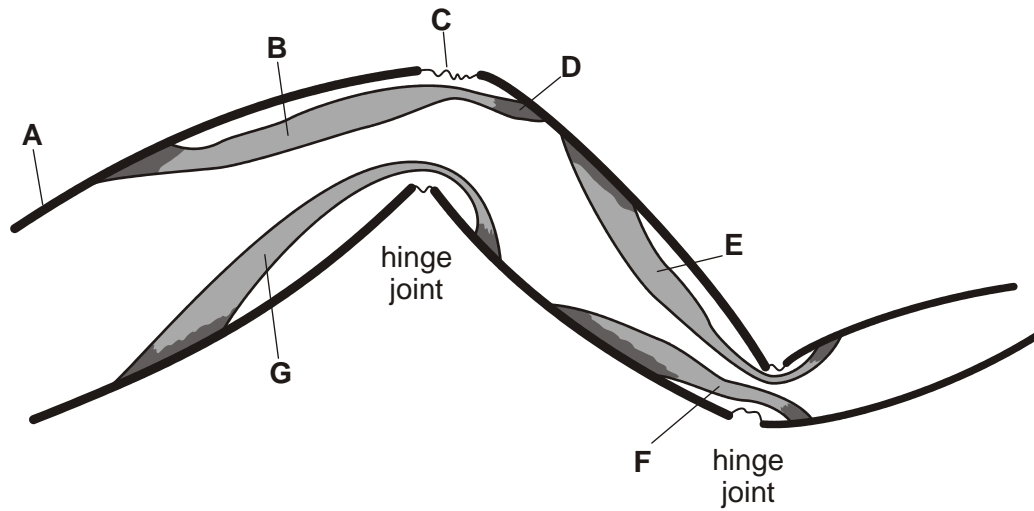
The strengths of the bonds in the three molecules are as shown.



Which statement can be deduced from this information?

- A $z > x + y$
 B $2z > x + y$
 C $2z > x + 3y$
 D $6z > x + 3y$

- * 16 The diagram shows three sections, separated by hinge-like joints, of the leg of a crab with an exoskeleton.



By comparison with the elbow joint of a human, select the letters that match the following:

- i a part that acts in a similar way to a tendon;
- ii a part that has a role that is similar to that of a ligament;
- iii a muscle that is antagonistic to **B**.

- 17 Evaluate:

$$(\sqrt{5} - \sqrt{2})^2 (\sqrt{5} + \sqrt{2})^2$$

- A 9
- B $-19 - 8\sqrt{10}$
- C 49
- D $61 + 20\sqrt{10}$

- 18 A sample of rock contains ^{235}U and ^{207}Pb in the proportion one part ^{235}U to seven parts ^{207}Pb . It is known that ^{235}U decays to ^{207}Pb with a half life of 7.1×10^8 years.

The maximum possible age of the rock is:

- A 1.99×10^9 years
 B 2.13×10^9 years
 C 4.97×10^9 years
 D 5.68×10^9 years
- 19 A sample of an acid, H_2X , weighing 4.5 g was dissolved in water.

This solution was neutralised by 50.0 cm^3 of aqueous sodium hydroxide containing 2 mol/dm^3 .



What is the relative molecular mass, M_r , of the acid?

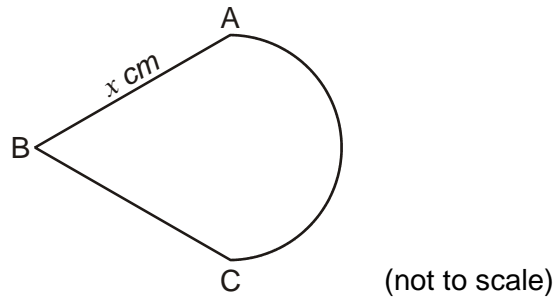
- A 45
 B 90
 C 100
 D 205
- 20 The table shows the concentrations, in arbitrary units, of four substances. These substances are present in each of two animal cells, K and L, whose cell membranes are in contact.

substance	concentration in arbitrary units	
	cell K	cell L
cytosine	9	15
glucose	12	8
magnesium ions	7	4
nitrate ions	6	3

Which movement of a substance between the two cells requires oxygen?

- A cytosine from cell L to cell K
 B glucose from cell K to cell L
 C magnesium ions from cell L to cell K
 D nitrate ions from cell K to cell L

- 21 In the shape shown below, A, B and C are the vertices of an equilateral triangle, side length x cm. The arc AC forms a semicircle.



Which of the following alternatives is a correct expression for the area, in cm^2 , of the shape?

- A $\frac{x^2(2\sqrt{3} + \pi)}{8}$
- B $\frac{x^2(\sqrt{3} + \pi)}{4}$
- C $\frac{x^2(2 + \pi)}{8}$
- D $\frac{x^2(4\sqrt{3} + \pi)}{8}$
- 22 When a 1 kg mass is dropped from the top of a building 20 m high it hits the Earth with a speed of 20 m/s.

What would be its speed if the same experiment was carried out on a planet where the acceleration due to gravity is $\frac{1}{4}$ that on Earth?

- A 1.25 m/s
- B 2.5 m/s
- C 5.0 m/s
- D 10.0 m/s

- 23 A sample of butane, C_4H_{10} is treated with deuterium, D (an isotope of hydrogen) and some of the hydrogen atoms are replaced by deuterium atoms.

Analysis shows that the substituted butane contains 80.0% of carbon by mass.

Which one of the following is its formula? (A_r : H=1; D=2; C=12)

- A C_4H_9D
- B $C_4H_8D_2$
- C $C_4H_7D_3$
- D $C_4H_6D_4$

- 24 During the fetal stage an opening, the foramen ovale, exists in the septum between the two atria. This allows blood to flow from the right atrium to the left atrium.

The opening should close during birth. If this fails to happen, which **one** of the following is the **main** problem to the health of the baby?

- A Blood in the aorta would not be fully oxygenated.
- B The heart beat rate would decrease.
- C The amount of blood pumped at each stroke would fall.
- D The pulmonary vein would only contain deoxygenated blood.
- E The volume of blood pumped to the lungs will increase.

- 25 A heart exerts a maximum (systolic) pressure of 152 mm Hg. This pressure is applied to an aorta of cross sectional area 2.0 cm^2 .

What force must be generated by the heart in order to apply this pressure?
(Take 760 mm Hg to be 1.0 atmosphere which is 100 kPa.)

- A 0.004 N
- B 4 N
- C 40 N
- D 400 N

- * 26 Which of the following thermal decomposition reactions will require the highest temperature?
- A $\text{Ag}_2\text{O} \rightarrow 2\text{Ag} + \frac{1}{2}\text{O}_2$
- B $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \frac{1}{2}\text{O}_2$
- C $\text{HgO} \rightarrow \text{Hg} + \frac{1}{2}\text{O}_2$
- D $\text{Na}_2\text{O} \rightarrow 2\text{Na} + \frac{1}{2}\text{O}_2$
- E $\text{PbO}_2 \rightarrow \text{PbO} + \frac{1}{2}\text{O}_2$

- 27 A circle has a diameter of 20 cm.
The line AC is a diameter of the circle.
B is a point on the circumference of the circle with $AB = 12$ cm.
The point D lies on the arc AC on the opposite side to point B.

What is the sine of $\angle\text{BDC}$?

END OF SECTION 2

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