Admissions Testing Service

BioMedical Admissions Test 4500/12

Wednesday 6th November 2013 30 minutes

5243624129

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 16 printed pages and 4 blank pages.

The questions in this paper that are marked with an asterisk (* Qs: 2, 11, 17, 21) assume knowledge that is not currently on the BMAT specification.

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1 Which of the following applies to both the nervous system and the endocrine (hormonal) system?

1. can be involved in homeostasis
2. can involve chemicals
3. can involve the brain

A None of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

*

2 The following chemicals are mixed together. In which of the mixtures will a displacement reaction occur?

1. $Pb(NO_3)(aq) + Al(s)$
2. $2KCl(aq) + 2F^{-}(aq)$
3. $Al_2(SO_4)_3(aq) + 3Fe(s)$
4. $CuSO_4(aq) + Zn(s)$

A 1 only

B 2 and 3 only

C 3 and 4 only

D 1 and 4 only

E 1, 2 and 4 only

F 2, 3 and 4 only

3 Microwave, X-ray and infra-red radiation can all damage living tissues.

Which of the following statements correctly explain why this damage occurs?

1. Microwaves cause damage because they are absorbed by water molecules.
2. X-rays cause damage because of their ionising ability.
3. Infra-red waves cause damage because of their ability to penetrate matter.

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

4 Given that $x = 4.6 \times 10^7$ and $y = 2 \times 10^6$, what is the value of $\frac{x+7y}{x-2y}$?

A $\frac{10}{7}$

B $1\frac{2}{3}$

C 3.1

D 7

E 10

F 31

5 The action of which enzyme(s) could decrease the pH of a mixture of carbohydrate, protein and lipid?

1. Carbohydrase
2. Protease
3. Lipase

A 1 only

B 2 only

C 3 only

D 1 or 2 only

E 1 or 3 only

F 2 or 3 only

G 1, 2 or 3

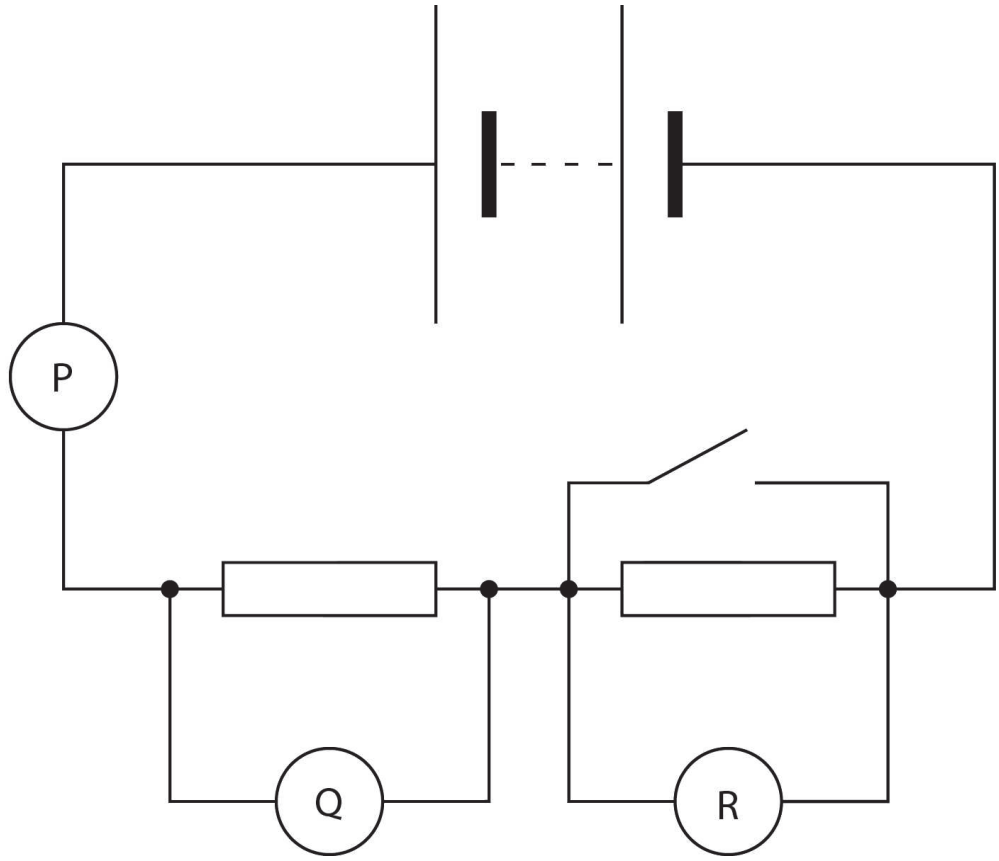
6 The following reaction is at equilibrium:

$2R(g) + 3S(g) \rightleftharpoons 2T(g)$ $\quad \Delta H$ is negative

which conditions (A–E) would produce most of the product T?

	Temperature	**Pressure**	**R**	**S**	**Catalyst**
A	high	low	add	remove	present
B	low	high	add	add	absent
C	low	low	add	add	absent
D	high	high	remove	add	present
E	low	high	remove	remove	absent

7 The diagram shows three appropriate meters, P, Q and R, connected in the conventional way in a circuit. The switch is initially open.



The switch is now closed. What happens to the readings on each meter?

A P decreases, Q decreases, R decreases

B P decreases, Q decreases, R increases

C P decreases, Q increases, R decreases

D P decreases, Q increases, R increases

E P increases, Q decreases, R decreases

F P increases, Q increases, R increases

G P increases, Q decreases, R increases

H P increases, Q increases, R decreases

8 Simplify:

$$4 - \frac{x^2(1-16x^2)}{(4x-1)2x^3}$$

A $2-\frac{1}{2x}$

B $2+\frac{1}{2x}$

C $4-\frac{1}{2x}$

D $4+\frac{1}{2x}$

E $6-\frac{1}{2x}$

F $6+\frac{1}{2x}$

9 In a reflex action in which a person touches a hot plate and pulls their arm away, neurons of different lengths are involved. Which answer identifies the relative lengths of the neurons?

	Length of neuron		
	Longest	**Medium**	**Shortest**
A	sensory	relay	motor
B	motor	sensory	relay
C	relay	motor	sensory
D	motor	relay	sensory
E	relay	sensory	motor
F	sensory	motor	relay

10 1.15 g of sodium completely reacts with water at standard temperature and pressure (STP). What volume of hydrogen at STP is produced by this reaction?

[Assume in this question that 1 mole of any gas at STP has a volume of 22.4 dm^3 (litres).]

[A_r values: H = 1, O = 16, Na = 23]

A 280 cm^3

B 560 cm^3

C 600 cm^3

D 1120 cm^3

E 1200 cm^3

* **11** The diagrams show two glass blocks in air. For the rays of light shown, the critical angle for the glass/air boundary is 42°. A ray of light is shown approaching the boundary in each case, with the angle of incidence labelled. Two possible labelled directions in which each ray might travel after reaching the boundary are also shown.

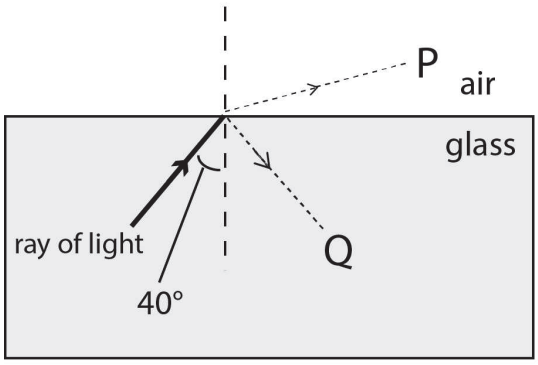


Diagram 1

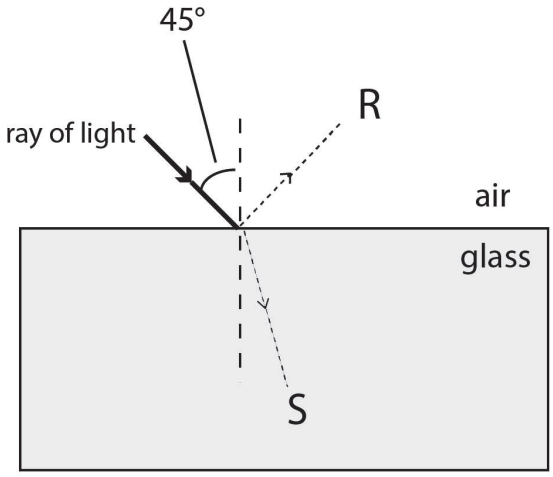


Diagram 2

Which line in the table correctly shows the direction taken by most or all of the light and also states whether total internal reflection (T.I.R.) will occur?

	Diagram 1		Diagram 2	
	Direction	**T.I.R.?**	**Direction**	**T.I.R.?**
A	P	No	R	No
B	P	No	R	Yes
C	P	No	S	No
D	Q	No	S	No
E	Q	Yes	R	Yes
F	Q	Yes	S	Yes

12 The square *ABCD* is positioned so that its vertices are at the points with coordinates:

(1, 1), (-1, 1), (-1, -1) and (1, -1).

The square is rotated clockwise through 90^{o} about the origin and then reflected in the line $y = x$.

Which transformation will return the square to its original orientation?

A A reflection in the x-axis.

B A reflection in the y-axis.

C A reflection in the line $y = -x$.

D A rotation of 90^{o} clockwise about the origin.

E A rotation of 90^{o} anticlockwise about the origin.

13 Which of the following is **not** needed in order to genetically engineer bacterial cells to produce a fluorescent protein from a jellyfish?

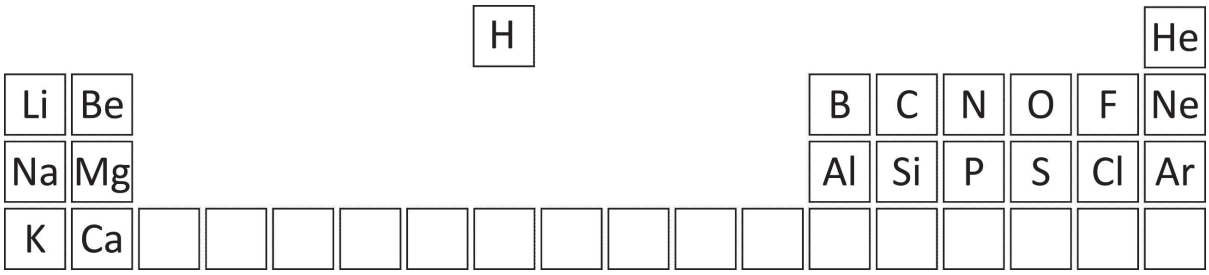
A ligase enzyme

B a plasmid or viral vector

C fluorescent protein from a jellyfish

D enzymes to cut DNA molecules

14 Which one of the following pairs do **not** have the same electronic structure?



A $MgCl_2$ and three atoms of argon

B CO and N_2

C CH_4 and NH_4^+

D NO_3^- and CO_3^{2-}

E NaF and two atoms of Ne

15 Two radioactive sources X and Y have half-lives of 4.8 hours and 8.0 hours respectively. Both decay directly to form only stable isotopes.

The activity of a sample of the source X was measured by a detector as 320 counts per minute, and simultaneously the radioactivity of a sample of the source Y was measured as 480 counts per minute. Immediately after the measurements, the two samples were combined.

What was the count rate when the activity of the combination of X and Y was measured 24 hours later?

[Assume that all readings in this question have been corrected for background radiation.]

A 25 counts per minute

B 50 counts per minute

C 55 counts per minute

D 70 counts per minute

E 100 counts per minute

F 140 counts per minute

16 Three variables x, y and z are known to be related to each other in the following ways:

- x is directly proportional to the square of z
- y is inversely proportional to the cube of z.

Which of the following correctly describes the relationship between x and y?

A The square of x is directly proportional to the cube of y.

B The square of x is inversely proportional to the cube of y.

C The cube of x is directly proportional to the square of y.

D The cube of x is inversely proportional to the square of y.

E x is directly proportional to y^6.

* **17** Since Dolly the sheep, many other mammals have also been cloned by somatic cell nuclear transfer. The genetic material from a body cell is inserted into an egg cell that has had its own nucleus removed. The success rate ranges from 0.1% to 3%, which is why so few cloned animals have been produced.

Which of the following are possible correct reasons why cloning may fail?

1. An egg with a newly transferred nucleus may not begin to divide or develop properly.
2. The sperm cell may not fertilise the egg cell.
3. Implantation of the embryo into the surrogate mother might fail.
4. Implanted stem cells may not differentiate properly.
5. The enucleated egg and the transferred nucleus may not be compatible.

A 1, 3 and 5 only

B 1, 4 and 5 only

C 2, 3 and 4 only

D 2, 4 and 5 only

E 3, 4 and 5 only

F 1, 3 and 4 only

18 An impure sample of sodium hydroxide has a mass of 1.20 g. All the sodium hydroxide completely reacts with a minimum of 50.0 cm^3 of 0.50 mol dm^{-3} hydrochloric acid.

What is the percentage purity of the sodium hydroxide sample?

[A_r values: H = 1; O = 16; Na = 23; Cl = 35.5]

A 37.5%

B 41.6%

C 72.7%

D 75.0%

E 83.3%

F 90.4%

19 Two resistors of R_1 ohms and R_2 ohms are connected in series to a battery which has an e.m.f. of V.

Which formula gives the power dissipated by resistor R_1?

A $\frac{VR_1}{(R_1+R_2)}$

B $\frac{V^2R_1}{(R_1+R_2)}$

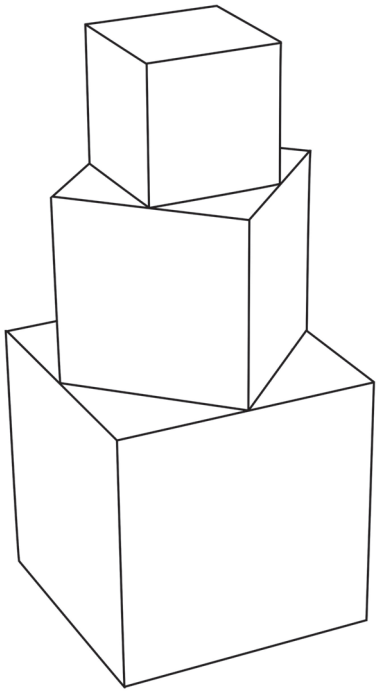
C $\frac{VR_1}{(R_1+R_2)^2}$

D $\frac{V^2R_1}{(R_1+R_2)^2}$

E $\frac{VR_1{}^2}{(R_1+R_2)}$

F $\frac{V^2R_1{}^2}{(R_1+R_2)^2}$

20 A solid shape is made by joining three cubes together with the largest cube on the bottom and the smallest on the top. Where the faces of two cubes join, the corners of the smaller cube are at the midpoints of the sides of the larger cube.



The sides of the smallest cube have a length of 1 cm. What is the total surface area of the shape?

A 30 cm^2

B 32 cm^2

C 33 cm^2

D 36 cm^2

E 39 cm^2

F 42 cm^2

*

21 Which of the following could be found in an adult liver cell?

1. gene for amylase
2. sex chromosomes
3. starch

A None of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

22 By using standard techniques to balance chemical equations and ensuring that the net charge is equal on both sides, find the correct value for ' ***e*** ' in the balanced equation below:

$$\boldsymbol{a}\ C_2H_4O(aq) + Cr_2O_7^{2-}(aq) + \boldsymbol{b}\ H^+(aq) \rightarrow \boldsymbol{c}\ C_2H_4O_2(aq) + \boldsymbol{d}\ Cr^{3+}(aq) + \boldsymbol{e}\ H_2O(l)$$

A 1

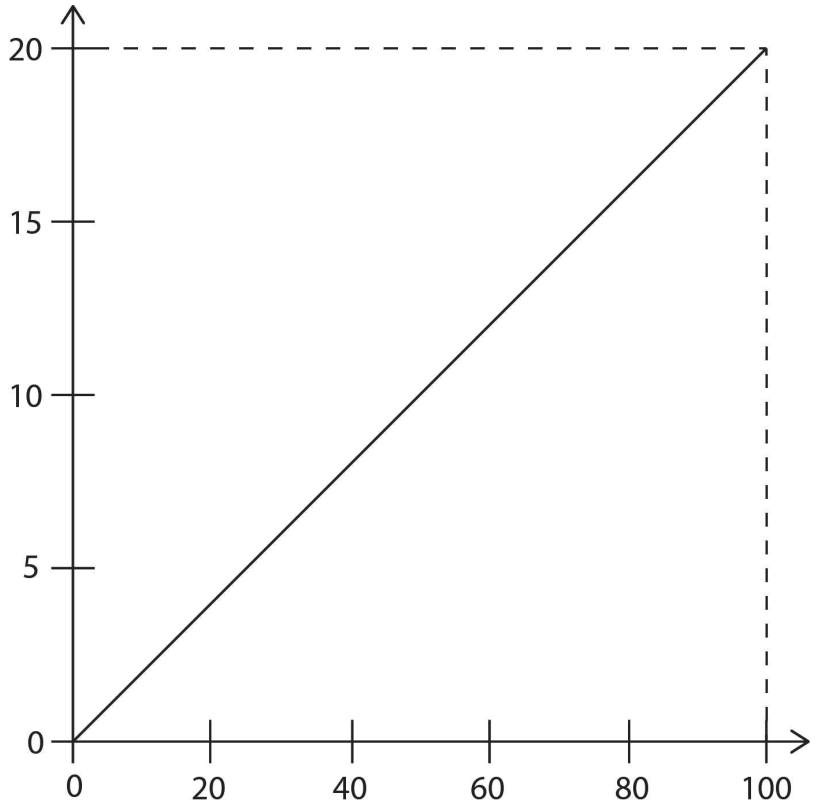
B 2

C 4

D 6

E 8

23 Consider this graph.



Which one of the following could the graph **not** represent if all quantities are in S.I. units?

A The variation of the acceleration (*y*-axis) of a body of mass 5.0 kg with the resultant force acting on the body (*x*-axis).

B The variation of the current (*y*-axis) through a 5.0 Ω resistor with the applied voltage (*x*-axis).

C The variation of the kinetic energy (*y*-axis) of a body of mass 0.4 kg with the square of its speed (*x*-axis).

D The variation of the wavelength (*y*-axis) of waves with a speed of 0.2 m/s with their frequency (*x*-axis).

E The variation of the work done (*y*-axis) by a force of 0.2 N with the distance it moves through (*x*-axis).

24 A bag contains 8 blue and 2 red balls. Three balls are chosen at the same time at random from the bag.

What is the probability that exactly two of the balls are the same colour?

A $\frac{5}{8}$

B $\frac{4}{9}$

C $\frac{8}{15}$

D $\frac{3}{8}$

E $\frac{7}{15}$

F $\frac{6}{7}$

25 Manx cats with two recessive alleles have a tail. Heterozygous Manx cats lack a tail. Individuals with both dominant alleles die before birth.

Which answer shows the percentage of Manx cats without tails in a population for the two crosses given in the table?

	Manx cat with a tail crossed with a Manx cat without a tail	**Manx cat without a tail crossed with a Manx cat without a tail**
A	25	0
B	50	75
C	50	67
D	50	50
E	67	25
F	67	33
G	0	75

26 The addition of NO as a catalyst to a mixture of SO_2 and O_2 speeds up the following reaction:

$SO_2 + ½O_2 \rightarrow SO_3$

The following reactions could be involved in the process.

1. $N_2 + O_2 \rightarrow 2NO$
2. $½N_2 + O_2 \rightarrow NO_2$
3. $NO + ½O_2 \rightarrow NO_2$
4. $NO_2 \rightarrow NO + ½O_2$
5. $SO_2 + NO \rightarrow SO_3 + ½N_2$
6. $SO_2 + NO_2 \rightarrow SO_3 + NO$

Which one of the following shows the most likely course of the overall reaction?

A 3, 1

B 3, 6

C 5, 1

D 3, 2, 4

E 5, 2, 4

27 A resultant force of 20 N has accelerated a body of mass 4.0 kg from rest, until the present moment, at which time its kinetic energy is 1800 J.

If this force continues to act unchanged, how much extra kinetic energy will the body gain during the next 2 seconds?

A 200 J

B 650 J

C 1000 J

D 1300 J

E 1400 J

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