Admissions Testing Service

BioMedical Admissions Test 4500/12

Wednesday 4th November 2015 30 minutes

6641553395

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. Questions ask you to show your choice between options by shading a circle. 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 question in this paper marked with an asterisk (* Q11) assumes knowledge that is not currently on the BMAT specification.

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1 Which one of the following is **not** part of a reflex to the stimulus of placing your hand on a hot object?

A Sensory neuron transmits electrical impulse to the central nervous system.

B Muscle cells contract.

C Motor neuron transmits electrical impulse to muscle cells.

D Relay neurons pass electrical impulse from sensory to motor neurons.

E Brain transmits electrical impulse to relay neuron.

2 Which of the following organic compounds will decolourise bromine water by reacting with it at room temperature?

1 C_2H_4

2 Polypropene

3 $CH_2C(CH_3)_2$

4 CH_3CH_2I

A 1 only

B 2 only

C 1 and 3 only

D 2 and 4 only

E 3 and 4 only

F 1, 2 and 3 only

3 The colour of the surface of an object has an effect on the rate of infrared radiation that it absorbs and emits. As a result of this, some clothes which are otherwise identical will keep a person warmer when outside in winter because of their differences in colour.

Which line in the table shows the correct comparison between black and white surfaces?

	Better absorber of infrared	*Better emitter of infrared*	*Better colour of clothes to keep a person warm in winter*
A	black	black	black
B	black	black	white
C	black	white	black
D	black	white	white
E	white	black	black
F	white	black	white
G	white	white	black
H	white	white	white

4 A bag contains only 8 beads.

The beads are identical in all respects except colour.
3 of the beads are black and the other 5 beads are white.
A bead is taken at random from the bag and not replaced.
A second bead is then taken at random from the bag.

What is the probability that both beads are black?

A $\frac{3}{32}$

B $\frac{3}{28}$

C $\frac{9}{64}$

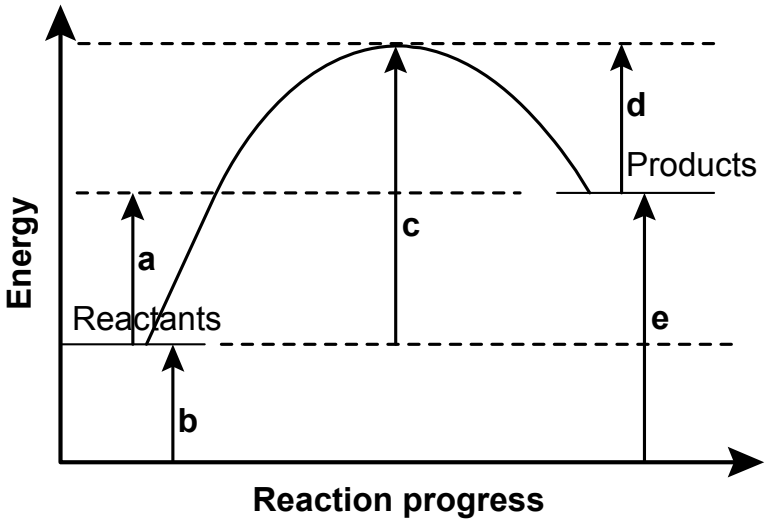
D $\frac{3}{14}$

E $\frac{37}{56}$

5 Which row identifies what is occurring during anaerobic respiration in animal cells?

	Carbon dioxide formed	*Oxygen used*	*Water formed*
A	no	no	no
B	no	no	yes
C	no	yes	no
D	no	yes	yes
E	yes	no	no
F	yes	no	yes
G	yes	yes	no
H	yes	yes	yes

6 The diagram shows the suggested changes in energy labelled as **a, b, c, d** and **e**, during a chemical change from reactants to products.



Which value is the correct energy change for the **REVERSE** reaction?

A – a

B d

C – c

D c – d

E e – b

7 A 100% efficient step-down transformer decreases the voltage of an alternating current (a.c.) electricity supply.

What effect does this step-down transformer have on the mean power transferred and the alternating current delivered?

	Power	*Current*
A	decreases	decreases
B	decreases	does not change
C	does not change	decreases
D	does not change	increases
E	increases	does not change
F	increases	increases

8 *PQR* is an isosceles triangle in which $PQ = PR = 6\,\text{cm}$ and $QR = 8\,\text{cm}$.

What is the value of the tangent of angle PQR?

A $\frac{2}{\sqrt{13}}$

B $\frac{2}{\sqrt{5}}$

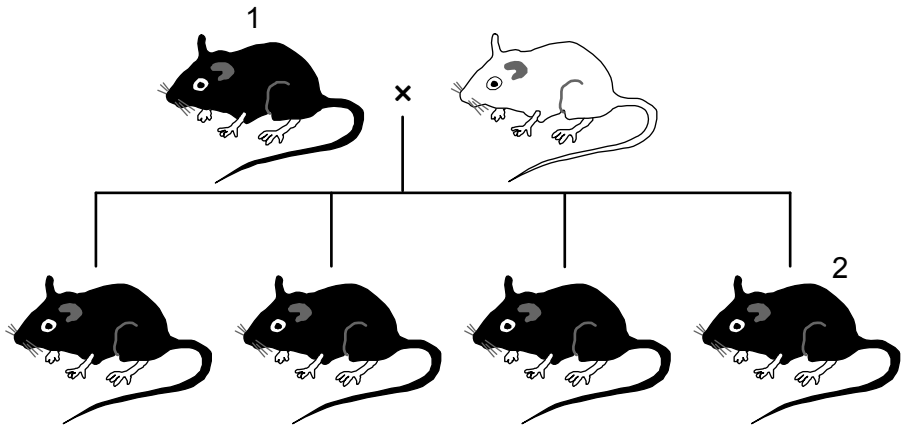
C $\frac{2}{3}$

D $\frac{3}{2}$

E $\frac{\sqrt{5}}{2}$

F $\frac{\sqrt{13}}{2}$

9 The diagram shows the results of a breeding experiment using a homozygous black mouse and a white mouse.



Mouse 1 was then allowed to mate with mouse 2. Using C for the dominant allele for coat colour and c for the recessive allele, which answer below correctly identifies the details of their offspring?

	Details of offspring when mouse 1 and mouse 2 are mated		
	Percentage heterozygous (%)	*Phenotype(s)*	*Genotype(s)*
A	100	black only	all Cc
B	100	black and white	all heterozygous
C	75	black only	Cc and CC
D	50	black only	homozygous and heterozygous
E	50	black and white	CC, Cc and cc
F	50	black and white	homozygous and heterozygous
G	0	black only	all homozygous

10 Which of the following statements about the alkali metal rubidium is correct?

A Rubidium and chlorine are formed when an aqueous solution of rubidium chloride is electrolysed.

B Rubidium has higher melting and boiling points than sodium.

C Rubidium reacts more slowly with water than sodium, forming hydrogen gas.

D Rubidium is stored under oil.

E Rubidium sulfate has the formula $RbSO_4$

*

11 Below are three statements about radioactivity or nuclear energy.

1 Neutrons emitted in nuclear fission can cause further fission.

2 The half-life of a radioactive substance is half the time taken for all its nuclei to decay.

3 The process that produces heat and light in the Sun is called nuclear fission.

Which of these statements is/are correct?

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

H None of them

12 Given that $a = \frac{3}{5+X}$, $b = \frac{3+X}{5}$ and $c = \frac{3+X}{5+X}$, where X is a whole number greater than zero, which one of the following is true?

A $a < b < c$ for all values of X

B $a < c < b$ for all values of X

C $b < a < c$ for all values of X

D $b < c < a$ for all values of X

E $c < a < b$ for all values of X

F $c < b < a$ for all values of X

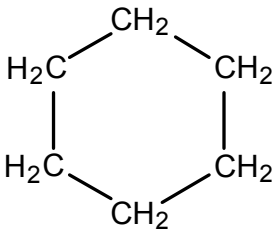
G The order of the fractions depends on the value of X

13 A human consumes the same amount and type of food and drink on two consecutive days. He also does the same activities on both days. However, one of the days is hot and the other is cold.

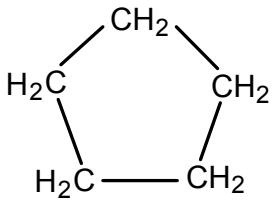
Which row in the table correctly shows the mass of two substances found in the urine of this human on the hot day compared with the cold day?

	Mass of substance found in urine on a hot day compared with a cold day	
	water	*urea*
A	less	less
B	less	same
C	less	more
D	same	same
E	same	more
F	more	less
G	more	same
H	more	more

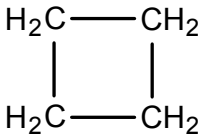
14 Cycloalkanes are alkane compounds that are in a ring shape.
Some examples of cycloalkanes are given below.



Cyclohexane



Cyclopentane



Cyclobutane

Which statement about these compounds is correct?

A They have the general formula C_nH_{2n+2}

B They react rapidly with bromine water

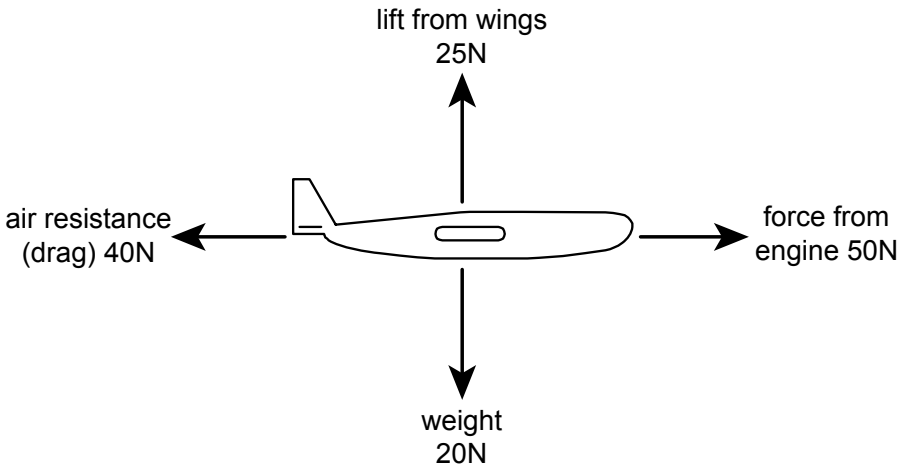
C They are saturated compounds

D They burn in excess oxygen to form CO_2 and H_2

E They are not members of a homologous series

F They are giant covalent compounds

15 The diagram shows the only four forces acting on a model aircraft of mass 2.0 kg whilst flying.



Which line in the table states the horizontal and vertical accelerations of the aircraft at this instant?

	Horizontal acceleration	*Vertical acceleration*
A	5.0 m / s^2 to the right	2.5 m / s^2 upwards
B	5.0 m / s^2 to the right	10 m / s^2 downwards
C	5.0 m / s^2 to the right	zero
D	25 m / s^2 to the right	10 m / s^2 downwards
E	25 m / s^2 to the right	2.5 m / s^2 upwards
F	25 m / s^2 to the right	zero
G	zero	2.5 m / s^2 upwards
H	zero	10 m / s^2 downwards

16 A city football club collected money for charity at all of its matches for a year. At the end of the year the total collected was divided among three charities, A, B and C, in the ratio $1 : \frac{2}{3} : \frac{4}{5}$. Charity C received £3 000.

What was the total amount collected for charity during the year?

A £3 750

B £7 000

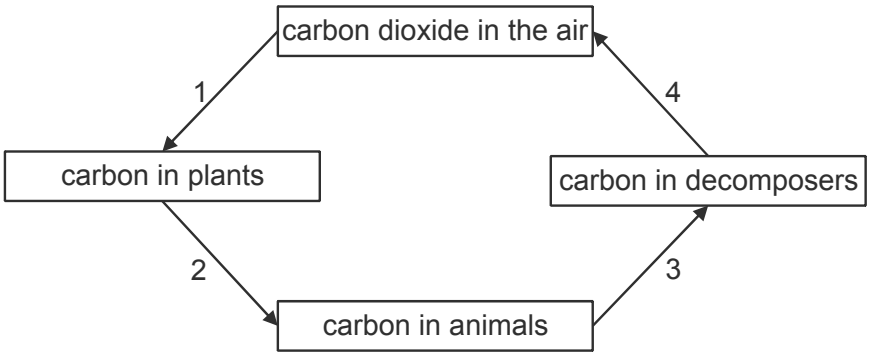
C £8 250

D £9 000

E £9 250

F £12 375

17 The diagram shows part of the carbon cycle.



Which row shows the numbered processes that use digestive or respiratory enzymes?

	Process or processes that involve digestive enzymes	*Process or processes that involve respiratory enzymes*
A	1 only	2 and 3 only
B	2 only	1 and 4 only
C	3 only	2 and 4 only
D	4 only	2 and 3 only
E	2 and 3 only	1 only
F	3 and 4 only	2 only
G	1 and 4 only	3 only
H	2 and 3 only	4 only

18 The reaction between the gases S and T occurs according to the following equation.

$$S(g) + 2T(g) \rightarrow W(g) + 2X(g) \qquad \Delta H = -12 \text{ kJ mol}^{-1}$$

Which statement about this reaction is correct?

A A solid catalyst would slow down the rate of the reaction.

B If the chemical 'T' was a powder the reaction would be faster.

C A high activation energy would give a slower rate than a lower activation energy.

D Increasing the temperature would decrease the rate.

E The rate of reaction can be monitored by measuring the change in gas volume.

19 Part of a radioactivity decay series is represented below. It involves the change of a nucleus M into a nucleus N by the emission of a beta-particle, followed by a further change into a nucleus Q by the emission of an alpha particle. Four quantities V, W, X and Y are shown.

$$^{V}_{W}M \xrightarrow{\beta^-} {}_{X}N \xrightarrow{\alpha} {}^{Y}Q$$

What are the expressions for X and Y?

	X	*Y*
A	W – 2	V – 4
B	W – 2	V – 2
C	W – 2	V
D	W	V – 3
E	W	V – 2
F	W + 1	V – 3
G	W + 1	V – 4
H	W + 1	V

20 A class of n pupils takes a spelling test. Their mean score for the test is m. Another pupil takes the test and scores n. When this pupil's result is included with the other results it is found that the mean has decreased by 2.

Which equation below gives the correct expression for n in terms of m?

A $n = \dfrac{m}{m-1}$

B $n = \dfrac{m}{m-3}$

C $n = \dfrac{2}{m-3}$

D $n = \dfrac{m-2}{3}$

E $n = \dfrac{m+2}{m-1}$

F $n = \dfrac{m}{3}$

G $n = \dfrac{m+2}{3}$

21 Mitochondria are the site of aerobic respiration in animal cells. A theory of the evolution of animal cells states that these mitochondria may once have been aerobic bacteria that were taken into the cytoplasm of a cell in an early ancestor of the animals, allowing the cells to gain the ability to respire using oxygen.

Assuming this theory is correct, which of the following statements are true of these aerobic bacteria and human white blood cells?

1 The structure of their DNA is a double helix.

2 They would both possess a cell wall.

3 They would both possess a nucleus.

4 They would both possess a cell membrane.

A 1 and 4 only

B 2 and 3 only

C 2 and 4 only

D 3 and 4 only

E 1, 2 and 3 only

F 1, 3 and 4 only

22 Which of the following have the same electron arrangement?

$^{35}_{17}\mathrm{Cl}^{-}$ $^{36}_{17}\mathrm{Cl}^{+}$ $^{40}_{18}\mathrm{Ar}$ $^{39}_{19}\mathrm{K}^{+}$ $^{40}_{20}\mathrm{Ca}^{+}$ $^{41}_{19}\mathrm{K}^{-}$

A $^{39}_{19}\mathrm{K}^{+}$, $^{41}_{19}\mathrm{K}^{-}$ and $^{40}_{18}\mathrm{Ar}$ only

B $^{35}_{17}\mathrm{Cl}^{-}$, $^{36}_{17}\mathrm{Cl}^{+}$ and $^{40}_{20}\mathrm{Ca}^{+}$ only

C $^{35}_{17}\mathrm{Cl}^{-}$, $^{40}_{18}\mathrm{Ar}$ and $^{39}_{19}\mathrm{K}^{+}$ only

D $^{36}_{17}\mathrm{Cl}^{+}$, $^{40}_{18}\mathrm{Ar}$ and $^{41}_{19}\mathrm{K}^{-}$ only

E $^{40}_{20}\mathrm{Ca}^{+}$, $^{40}_{18}\mathrm{Ar}$ and $^{41}_{19}\mathrm{K}^{-}$ only

23 A car is being driven at 20 m / s when the driver sees a child run into the road. The driver's usual reaction time is 0.70 s, but this is doubled because the driver is tired. Once the driver applies the brakes, the car is brought uniformly to rest in a further 3.3 s. What is the total distance travelled by the car between when the driver first sees the child to when the car stops?

A 33 m

B 40 m

C 47 m

D 61 m

E 66 m

F 80 m

G 94 m

24 Simplify:

$$\frac{2x+3}{2x-3}+\frac{2x-3}{2x+3}-2$$

A 0

B $\dfrac{2(2x-1)}{(2x-3)(2x+3)}$

C $\dfrac{18}{(2x-3)(2x+3)}$

D $\dfrac{36}{(2x-3)(2x+3)}$

E $\dfrac{8(x^2-2)}{(2x-3)(2x+3)}$

F $\dfrac{12}{2x-3}$

25 The sex of a species of fruit fly is determined by the number of X chromosomes relative to the number of non-sex chromosomes (A) in a cell. This is called the X : A ratio.

A fruit fly will be male if X : A = 0.5 : 1 and female if X : A = 1 : 1.

The Y chromosome contains genes necessary for making sperm.

Which row of the table correctly shows the sex of the five fruit flies with different numbers of these chromosomes?

	XAA	*XYAA*	*XXAA*	*XXYAA*	*XXYYAA*
A	female	female	female	male	male
B	female	female	male	male	male
C	female	male	female	male	female
D	female	male	female	male	male
E	male	female	male	female	female
F	male	female	male	female	male
G	male	male	female	female	female
H	male	male	female	female	male

26 The equation for the complete combustion of methane is:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

If 1.60 g of methane were completely burned in 8.00 g of oxygen (an excess) to produce 4.40 g of carbon dioxide, what mass of oxygen is left unreacted?

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

A 0.20 g

B 1.60 g

C 2.00 g

D 3.40 g

E 4.80 g

F 5.20 g

27 Consider the following three statements:

1 A mass of 4.0 kg requires a resultant force of 5.0 N to act on it in order to accelerate it at 1.25 m / s^2.

2 A wave of frequency 4.0 Hz travelling at a speed of 5.0 m / s has a wavelength of 1.25 m.

3 A voltage of 4.0 V applied across a 5.0 Ω resistor causes a current of 1.25 A to flow.

Which statement(s) is / are true?

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

H None of them

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