BIOMEDICAL ADMISSIONS TEST

BMAT 2014

Section 2 explained answers

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

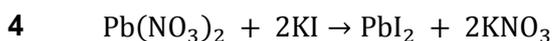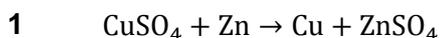**G** 2, 3 and 4 only

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Explanation and answer

Statement 1 is incorrect because deoxygenated blood flows through the right side of the heart.
Statement 2 is incorrect because blood from the vena cava enters a top chamber which is an atrium.

Statement 3 is incorrect because the pulmonary artery is one of the few arteries that carries deoxygenated blood.

Statement 4 is correct because there are valves in the base of the aorta to prevent the backflow of blood into the ventricle, when the ventricle relaxes.

The answer is C

[Turn over

2 Which of the following reactions are redox reactions?

1 $CuSO_4 + Zn \rightarrow Cu + ZnSO_4$

2 $HCl + NaOH \rightarrow NaCl + H_2O$

3 $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

4 $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

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

Explanation and answer

Reaction 1 is a redox reaction because there are changes in oxidation states (ionic charges): the oxidation state of copper changes from +2 to 0 ($Cu^{2+} + 2e^- \rightarrow Cu$ [reduction]), and zinc changes from 0 to +2 ($Zn \rightarrow Zn^{2+} + 2e^-$ [oxidation]).

Reaction 2 is not a redox reaction because there is no electron transfer (no change in ionic charge, nor oxidation state).

Reaction 3 is a redox reaction because there are changes in oxidation states (ionic charges): the oxidation state of magnesium changes from 0 to +2 ($Mg \rightarrow Mg^{2+} + 2e^-$ [oxidation]), and hydrogen changes from +1 to 0 ($2H^+ + 2e^- \rightarrow H_2$ [reduction]).

Reaction 4 is not a redox reaction because there is no transfer of electrons.

The answer is B

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

Explanation and answer

Statement 1 is incorrect; microwaves have a longer wavelength than infrared radiation and many other parts of the electromagnetic spectrum.

Statement 2 is incorrect; energy increases with frequency (and consequently decreases with wavelength), and so in fact the shortest wavelengths transfer the most energy.

Statement 3 is incorrect; the wavelength is inversely proportional to frequency, and the speed is the constant for this relationship ($v = f \times \lambda$).

Statement 4 is correct; ultraviolet waves are higher frequency than visible light, so carry more energy and can damage corneas, causing cataracts.

The answer is D

        [Turn over

4 Simplify:

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

A $\quad \dfrac{x}{4}$

B $\quad \dfrac{x}{x+4}$

C $\quad \dfrac{x}{x-4}$

D $\quad \dfrac{1}{4}$

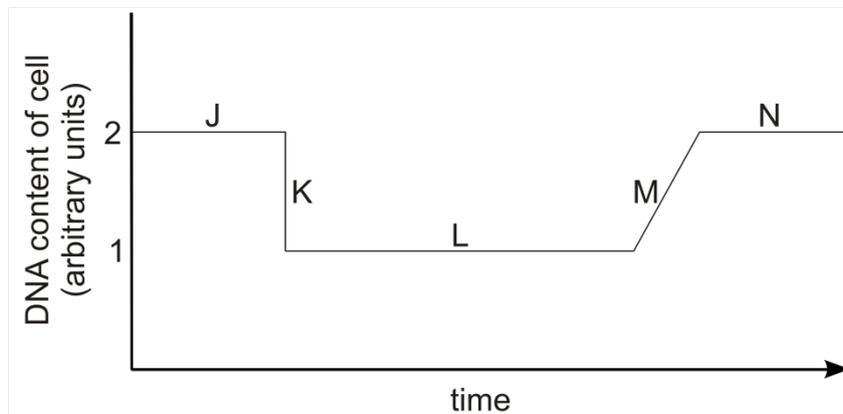**E** $\quad \dfrac{x-4}{x-16}$

Explanation and answer

$$\frac{x^2 - 4x}{x^2 - 16} = \frac{x(x-4)}{(x+4)(x-4)} = \frac{x}{(x+4)}$$

The answer is B

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?

	Cell divides	DNA synthesis	DNA separates
A	J	K	L
B	J	L	M
C	K	L	M
D	K	M	N
E	L	M	N
F	L	M	J
G	M	N	J
H	M	N	K

Explanation and answer

DNA synthesis doubles the DNA content in the cell so the content will increase from 1 to 2 arbitrary units, which is M. The DNA separates within the cell but the total content is still 2, so this is N or J. The cell divides in half thus halving the DNA content per cell back to 1, which is K.

The answer is D

[Turn over

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

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

Explanation and answer

When the temperature of a reaction is increased, the particles gain kinetic energy so they move faster and increase the frequency of collisions. The proportion of successful collisions will also increase because the proportion of particles with energy greater than the activation energy has increased. This is why a small increase in temperature results in a large increase in the rate of a reaction.

The activation energy is the minimum energy required by colliding particles to result in a successful collision and, therefore, a chemical change. Activation energy is a measure of the energy required to break chemical bonds and is not affected by temperature.

To summarise: an increase in temperature will have no effect on the activation energy but it will increase the frequency of collisions as well as the proportion of successful collisions.

The answer is H

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

    A   ampere / second

    B   coulomb × second

    C   joule / coulomb

    D   ohm / volt

    E   volt × ohm

    F   watt / volt

Explanation and answer

From power $P = VI$, current $I = P / V$, so unit (ampere) = watt / volt

The answer is F

                                [Turn over

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 $n = 6pq$

Explanation and answer

$$4^p \times 8^q = (2^2)^p \times (2^3)^q$$
$$= 2^{2p} \times 2^{3q}$$
$$= 2^{2p+3q}$$
$$\therefore n = 2p + 3q$$

The answer is B

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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.
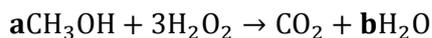

Explanation and answer

To answer this question correctly you need to understand that the process is carried out in order to make more insulin (protein). In order to make more protein, you need to use DNA/genes. Therefore A and B are incorrect since you need to start with DNA/genes. A is also incorrect since the end product required is insulin, not insulin DNA/genes.

E is incorrect since the process involves the removal of a gene from one organism and the insertion of this gene into another organism. This statement describes the process occurring in just one organism.

C and D both correctly describe the removal of a gene from one organism and its insertion into another organism, but C is incorrect since the end product required is the protein insulin, **not** insulin DNA/genes.

The answer is D

[Turn over

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

$$\mathbf{a}CH_3OH + 3H_2O_2 \rightarrow CO_2 + \mathbf{b}H_2O$$

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

A   3

B   4

C   5

D   6

E   7

Explanation and answer

When balancing this chemical equation, you must have the same number of carbon atoms, hydrogen atoms and oxygen atoms on both the reactant side and the product side of the equation. This is only true for the correct answer, C.

'**a**' can be calculated first. With just one carbon on the right hand side of the equation it can be deduced that **a**=1. With this knowledge, the remainder of the equation can be balanced and '**b**' found. For instance, recognising 7 oxygen atoms are present on the left, and therefore 7 oxygen atoms much be present on the right, means that **b** must be 5.
The answer is C

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.

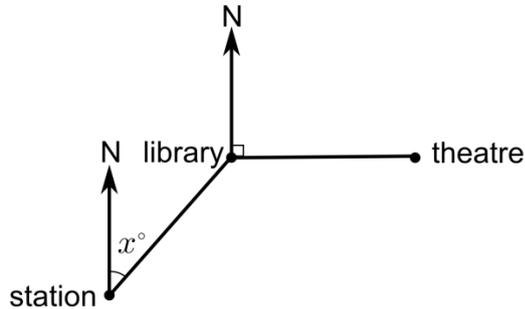
Explanation and answer

Only electrons are transferred when an object becomes charged. Hence options C, D, G and H are all incorrect. The object becomes negatively charged if it gains electrons and positively charged if it loses electrons. For repulsion to occur, two objects must have like charges, so either rod X gained electrons from the cloth and rod Y was negatively charged (which is not one of the options) or rod X lost electrons to the cloth and rod Y was positively charged, option F.

The answer is F

        [Turn over

12 In a town, the bearing of the library from the station is $x°$.

The theatre is due east of the library.

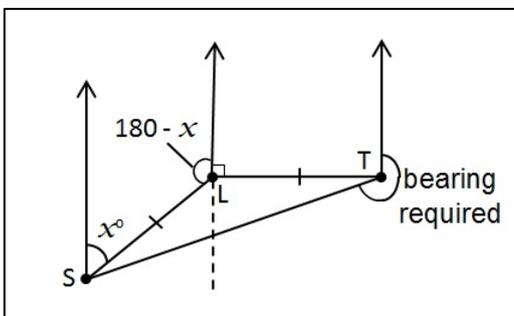The theatre and the station are equidistant from the library.

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

A $\quad 45 + \left(\dfrac{x}{2}\right)$

B $\quad 90 - \left(\dfrac{x}{2}\right)$

C $\quad 90 + \left(\dfrac{x}{2}\right)$

D $\quad 180 + x$

E $\quad 225 - \left(\dfrac{x}{2}\right)$

F $\quad 225 + \left(\dfrac{x}{2}\right)$

G $\quad 270 - \left(\dfrac{x}{2}\right)$

Explanation and answer
There are several approaches to solving this problem. One approach is given below.

Extend north line down at L and recall that alternate angles between parallel lines are equal,
so angle $\text{SLT} = 90 + x$

Because the interior angles of any triangle add up to 180°,
$$\text{LTS} + \text{LST} = 180 - (90 + x)$$
$$\text{LTS} + \text{LST} = 90 - x.$$
Triangle SLT is isosceles so both angles LTS and LST $= \dfrac{90-x}{2}$

Bearing S <u>from</u> T $= 270 - \left(\dfrac{90-x}{2}\right) = 270 - 45 + \dfrac{x}{2} = 225 + \dfrac{x}{2}$

The answer is F

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

Explanation and answer

When the water content of the blood is too low, more ADH is released from the pituitary gland (statement 2). The ADH then travels, via the blood stream, to the kidneys and increases the permeability of the collecting ducts. More water is reabsorbed into the blood (statement 3). The water concentration of the blood is not regulated by an increase or decrease in glucose reabsorption; therefore statements 5 and 6 are not relevant for osmoregulation.

The answer is B

[Turn over

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


Explanation and answer

The name 'but-1-ene' indicates that it is an alkene. Alkenes have the following features:

- general formula is C_nH_{2n}

- they contain C=C double bonds and so are unsaturated

- they undergo addition reactions such as polymerisation (to produce a long chain polymer) and addition of bromine (so they decolourise bromine water – the test for unsaturation / presence of C=C double bonds).

But-1-ene can form a polymer, it fits the general formula C_nH_{2n} and decolourises bromine water; and because it contains carbon-carbon double bonds it is not saturated.

The answer is C

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.

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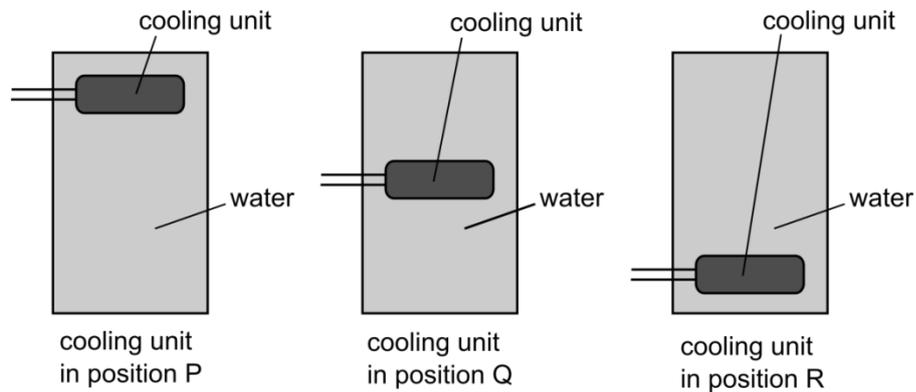
In order to cool all the water as quickly as possible to 5 °C, in which position should the cooling unit be fitted, and should the outside of the container be dull black or shiny?

	Position of cooling unit	*Outside of container*
A	P	black
B	P	shiny
C	Q	black
D	Q	shiny
E	R	black
F	R	shiny

Explanation and answer

Cooled water will become more dense and fall, causing a convection current in the container. The cooling unit should be positioned at the top to ensure that all the water is cooled, including the warmer, less dense water at the top.

The water starts at room temperature, and will soon become cooler than its surroundings. This means that a dark surface would absorb more infra-red from the surroundings than it would emit. A shiny surface reduces this effect and will help to keep the water cooler than the surroundings.

The answer is B

[Turn over

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.

Explanation and answer

Class 1 contains twice as many students as Class 2, so if there are n students in Class 2, then there are $2n$ students in Class 1.

The total of all of the scores in Class 1 must be $61 \times 2n = 122n$.

The total of all of the scores in Class 2 must be $63n$.

If there are m students in Class 3, then the total of all the scores in Class 3 must be $70m$.

The total score of all of the students must be $65 \times (2n + n + m)$,
so $195n + 65m = 122n + 63n + 70m$.

This simplifies to $10n = 5m$, so $m = 2n$.

The number of students in Class 3 is $2n$, which is the same as the number of students in Class 1.

The answer is D

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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

Explanation and answer

Whilst emulsification increases overall surface area as it breaks a large lipid droplet into many smaller droplets, at the individual droplet level, it decreases the droplet's surface area. Hence statement 1 is correct.

Bile is alkaline and neutralises the acid material released from the stomach into the small intestine. This will increase the pH rather than reduce it. Therefore statement 2 is incorrect.

Lipase is not present in human bile. Therefore statement 3 is incorrect.

The answer is B

[Turn over

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 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 dm^3 at room temperature and pressure)

A CH_2O

B $C_2H_4O_2$

C C_3H_8O

D $C_3H_6O_3$

E C_6HO_8

Explanation and answer
The key steps in this solution are finding the molecular mass, from the mass, volume and mole information, and then dividing this mass over the 3 elements to figure out how many atoms of each are present in the molecule.

Using the molar gas volume given (1 mole = 24 dm^3), we can deduce that 2.4 dm^3 of the compound must contain 0.1 moles.

So 0.1 moles of the compound weighs 6 g.

So 1 mole of the compound would weigh 60 g. Hence the relative molecular mass must be 60.

The ratio of C : H : O by mass is 6 : 1 : 8; dividing the mass into this ratio gives us the mass of each element in the molecule.
C: $\frac{6}{15} \times 60$ H: $\frac{1}{15} \times 60$ O: $\frac{8}{15} \times 60$
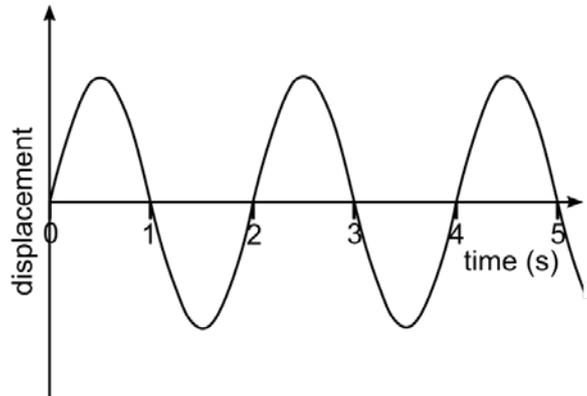
The relative masses are: C: 24   H: 4   O: 32

Using the A$_r$ values, we can see this relates to 2 carbons, 4 hydrogens, and 2 oxygens.

The molecular formula is $C_2H_4O_2$

The answer is B

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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
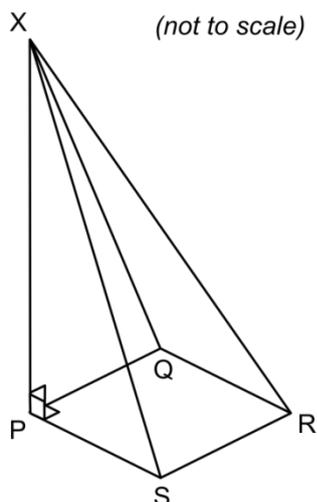
D   1.33 cm/s

E   1.5 cm/s

F   3.0 cm/s

Explanation and answer

Period = 2.0 s so frequency = (1/2.0) = 0.50 Hz

$v \; = \; f \times \lambda \; = \; 0.50 \times 1.5 \; = 0.75 \, cm/s$
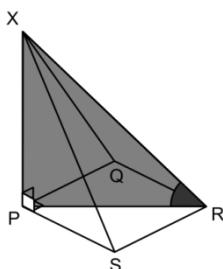
The answer is C

[Turn over

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.

(not to scale)

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

A $\quad \dfrac{1}{3}$

B $\quad \dfrac{\sqrt{2}}{4}$

C $\quad \dfrac{\sqrt{2}}{2\sqrt{3}}$

D $\quad \dfrac{4}{3\sqrt{2}}$

E $\quad \dfrac{2}{\sqrt{3}}$

F $\quad \dfrac{1}{\sqrt{17}}$
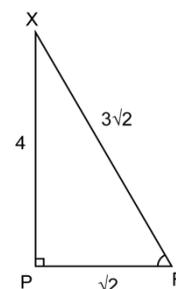
G $\quad \dfrac{1}{17}$

Explanation and answer

The angle required is XRP
Using Pythagoras theorem PR = $\sqrt{2}$, since PR is a diagonal of square PQRS.

Then triangle XPR is a right angled triangle as X is vertically above P, and by Pythagoras $XR = \sqrt{18} = 3\sqrt{2}$

then $\cos(XRP) = \dfrac{PR}{XR} = \dfrac{\sqrt{2}}{3\sqrt{2}} = \dfrac{1}{3}$

The answer is A

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

Explanation and answer

Statement 1 is not true. In the opening paragraph you are told that oxygen supply is essential for neurons in the brain to function for more than 5 – 10 seconds. Anaerobic respiration cannot, therefore, be used for prolonged periods of time.

Statement 2 is true because a by-product of aerobic respiration is heat so as respiration occurs, the body will have to work to counteract the corresponding increase in temperature.

Statement 3 is true. Too much insulin will lower body glucose levels and this could prevent sufficient respiration from occurring, resulting in a lack of energy and therefore brain function.

Statement 4 is true because carbon dioxide is produced during aerobic respiration.

The answer is G

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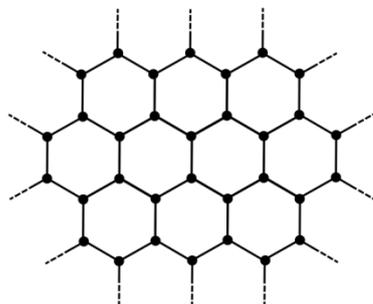
Considering its structure, which of the properties below could be predicted about graphene?

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

Explanation and answer

The graphene description indicates that it has a giant covalent structure. Typically, substances with a giant covalent structure have high melting and boiling points; they do not dissolve in water and they do not conduct electricity. However, the structure of graphene is very similar to that of graphite in that each C atom is covalently bonded to only 3 other C atoms which means that each C atom has a 'free' electron. This 'free' electron can migrate within the structure, so enabling graphene to conduct electricity.

Graphene should have a high melting point and good electrical conductivity but not dissolve in water.

The answer is D

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?

|	Number of neutrons released	Mass number of barium isotope produced	Mass number of krypton isotope produced
A	2	141	92
B	2	142	94
C	3	140	92
D	3	140	94
E	3	141	92
F	3	142	94

Explanation and answer

The total mass number of the particles before fission is 235 + 1 = 236 (uranium + neutron). Because the total mass number is conserved, the total mass number of the particles after fission must also be 236.

E) is the only statement in which the products have a total mass of 236 units.
A) has products with a total mass of 235 units.
B) has products with a total mass of 238 units.
C) has products with a total mass of 235 units.
D) has products with a total mass of 237 units.
F) has products with a total mass of 239 units.

The answer is E

[Turn over

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

$$T$$
$$\frac{4}{5}$$
$$C$$
$$\frac{1}{100}$$
$$T'$$

$$T$$
$$\frac{1}{10}$$
$$C'$$
$$T'$$
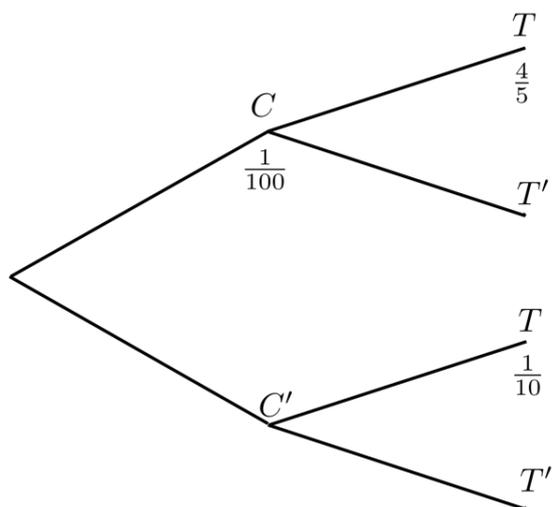
Three of the branches' proportions are shown in the tree diagram:

- $\frac{1}{100}$ 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	$\frac{107}{1000}$

Explanation and answer

The following is a partially completed tree diagram, showing all the information we need.
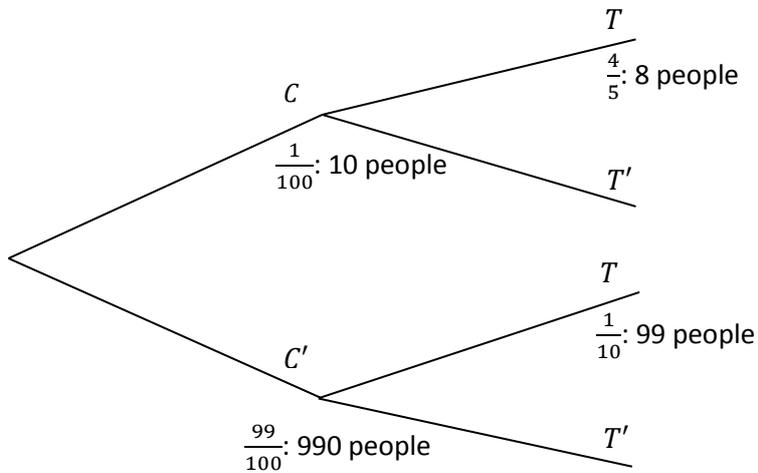
Therefore $8 + 99 = 107$ people test positive, of whom 8 have the condition, so the probability that someone has the condition, given that they test positive, is $\frac{8}{107}$.

Comment: This is only about 7.5%, so the test is quite poor on this population: over 90% of the positive test results are false positives. Tests for rare conditions which are applied indiscriminately will often suffer from this problem, and can lead to costly treatments (physically, financially and emotionally) for many perfectly healthy people.

The answer is E

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.

Explanation and answer

In order to have the condition, the woman must have two copies of the recessive allele – information from the question. In order to inherit two copies, she must have inherited a recessive copy from each of her parents. As neither of them have the disorder, they must be heterozygous, so A is true. Her parents must have inherited a recessive allele each from their parents (the woman's grandparents) so they could all be carriers (D), one of each set of grandparents could be a carrier (C) or they may have the condition (B). Any of these options is possible.

In order for the woman to develop a condition that requires two copies of the recessive allele, however, the DNA mutation in one gamete is not sufficient. DNA in the gametes from both parents would have had to mutate if neither of them possessed the recessive allele to start with. Therefore E cannot be true.

The answer is E

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

1	$^{18}_{8}O$
2	$^{34}_{16}S$
3	$^{35}_{17}Cl$
4	$^{37}_{17}Cl^-$
5	$^{40}_{20}Ca^{2+}$

A   1 only

B   2 only

C   2 and 3 only

D   3 and 4 only

**E**   4 and 5 only

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Explanation and answer

In an atom, the number of electrons equals the atomic number (the number of protons). None of the atoms (options 1, 2 and 3) have atomic number 18.

Negative ions have additional electrons. For example, a 2– ion has two extra electrons compared to the atom it is formed from. Positive ions have fewer electrons. For example, a 2+ ion has two fewer electrons than the atom it was formed from. Option 4 has 17 protons and as a 1– ion has 17 + 1 electrons, i.e. 18 electrons. Option 5 has 20 protons and so as a 2+ ion has 20 – 2 electrons, i.e. 18 electrons.

The answer is E

               [Turn over

27 The graph shows the variation with time of the height through which a crane lifts a mass of 20 kg.
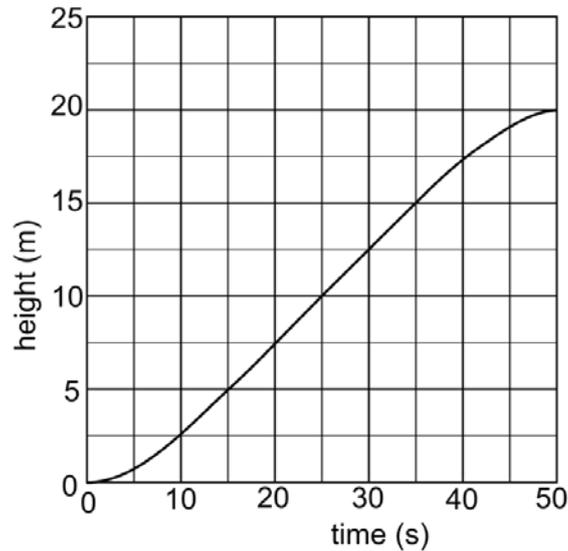
Assume the gravitational field strength g is 10 N/kg, and that the effects of air resistance and friction are negligible.

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

Explanation and answer

Power output in this question is about the change in potential energy (mgh) per unit time.

The mass and gravitational field strength are constant, so the change in potential energy with time is directly related to the change in height with time.

In the graph above we can see that the change in height with time (the gradient) is constant from 15 s to 35 s (which includes the time at which it is at the height of 10 m).So we can use this as the time interval from which to calculate the power and energy change.

The change in height is 10 m (15 – 5 m) in this interval of 20 s. This relates to a change in potential energy of 2000 J (mgh = 20×10×10) in the interval. The power output is given by change in potential energy, divided by the time interval: $\frac{2000}{20} = 100W$.

The answer is D

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