



BioMedical Admissions Test

4500/12

Wednesday 31 October 2018

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.

This paper is Section 2 of 3. Your supervisor will collect this question paper and answer sheet before giving out Section 3.

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 marks for correct answers, so you should attempt **all** 27 questions. Each question is worth one mark.

Answer on the sheet provided. Questions ask you to show your choice between options by shading one circle. If you make a mistake, erase thoroughly and try again.

You **must** complete the answer sheet within the time limit.

You can use the question paper for rough working or notes, but **no extra paper** is allowed.

Calculators are NOT permitted.

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

This paper consists of 19 printed pages and 5 blank pages.

The question in this paper marked with an asterisk (* Q5) assumes knowledge that is not currently on the BMAT specification.



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- 1** People with cystic fibrosis may be unable to digest their food fully because of thick sticky mucus. This prevents the secretion of pancreatic juices. Doctors sometimes prescribe enzyme supplement medication to improve digestion.

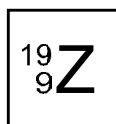
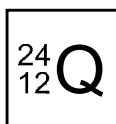
Which of the following enzymes should be included in the medication?

- 1** amylase
 - 2** lipase
 - 3** protease
-
- 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



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- 2 Elements Q and Z are shown in the Periodic Table as:



What is the empirical formula and bonding type of the compound formed between these elements?

	<i>empirical formula</i>	<i>bonding type</i>
A	QZ	ionic
B	QZ	covalent
C	QZ ₂	ionic
D	QZ ₂	covalent
E	Q ₂ Z	ionic
F	Q ₂ Z	covalent

- 3 Here are four statements about light:

- 1 In a vacuum, green light travels faster than blue light.
- 2 In a vacuum, the wavelength of red light is greater than the wavelength of green light.
- 3 In water, red light travels faster than it travels in a vacuum.
- 4 In water, the frequency of blue light is greater than the frequency of red light.

Which pair of statements is correct?

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

4 Which one of the following is a simplification of $\frac{48m^5p}{40m^2p^3}$?

A $\frac{6}{5}m^{\frac{5}{2}}p^{\frac{1}{3}}$

B $\frac{6}{5}m^3p^{-2}$

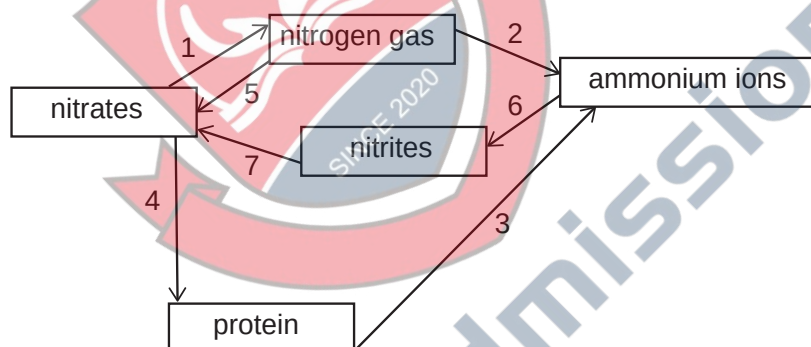
C $\frac{6}{5}m^3p^{-3}$

D $8m^{\frac{5}{2}}p^{\frac{1}{3}}$

E $8m^3p^{-2}$

F $8m^3p^{-3}$

* 5 The diagram shows part of the nitrogen cycle.



Which of the numbered arrows represent(s) denitrification?

A 1 only

B 2 only

C 3 only

D 5 only

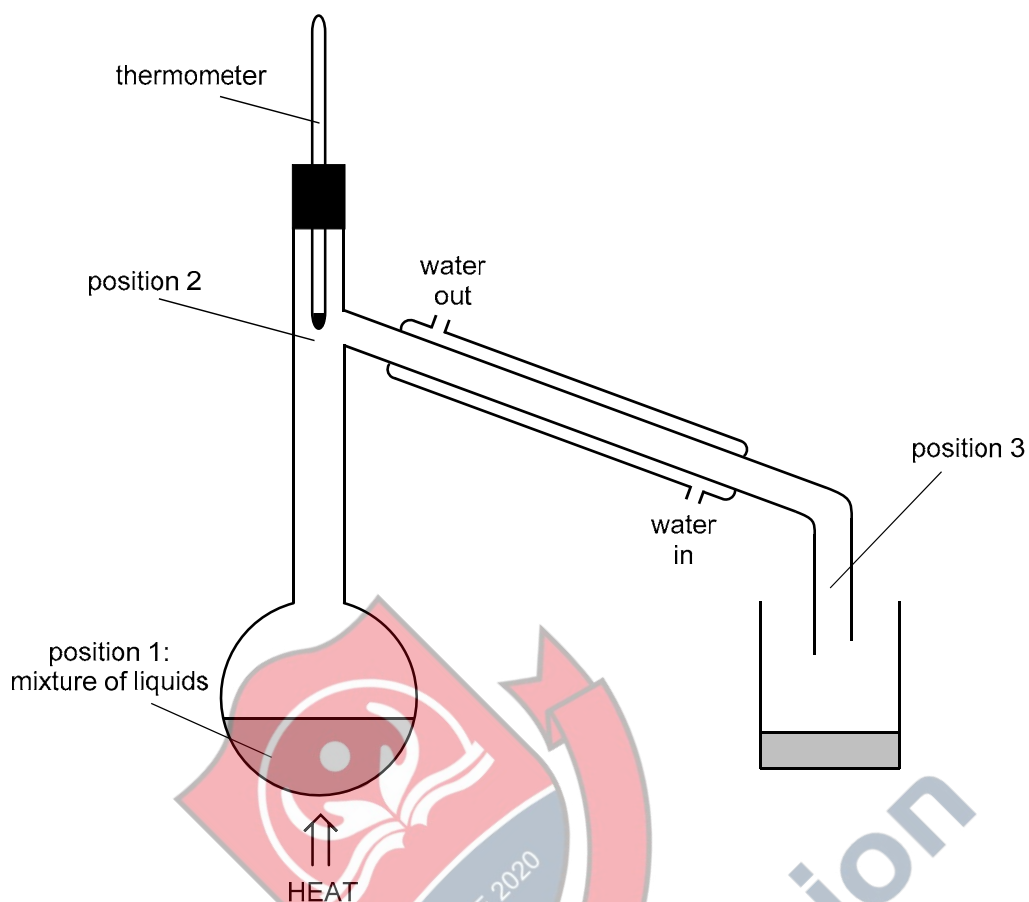
E 1 and 4 only

F 2 and 5 only

G 3 and 6 only

H 6 and 7 only

- 6 The diagram below shows the apparatus that can be used in fractional distillation.



Which of the following statements is/are correct about the process shown in the diagram?

- 1 Covalent bonds between atoms are broken at position 1 and have reformed at position 3.
 - 2 The particles are closer together at position 3 than at position 2.
 - 3 The physical process at position 1 involves an exothermic change.
- 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

- 7 A wave travelling through a material has a frequency of 50 Hz and a wavelength of 0.40 m.
How long does it take the wave to travel 100 m through this material?

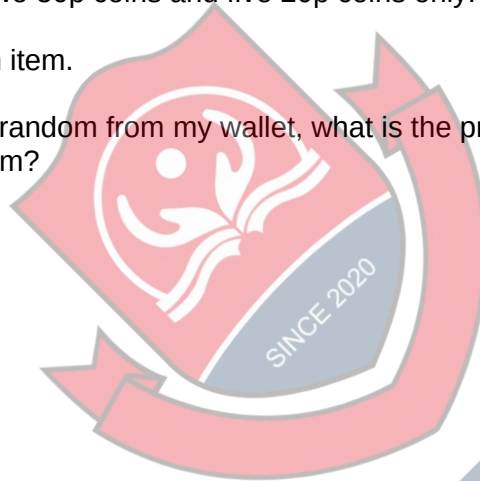
A 0.20 s
B 0.80 s
C 1.25 s
D 2.00 s
E 5.00 s
F 20.0 s

- 8 My wallet contains two 50p coins and five 20p coins only.

I need 70p to buy an item.

If I pick two coins at random from my wallet, what is the probability that I have picked the exact money to buy the item?

A $\frac{1}{2}$
B $\frac{5}{21}$
C $\frac{10}{21}$
D $\frac{20}{49}$
E $\frac{25}{441}$
F $\frac{50}{441}$



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- 9 A sample of healthy human cells contains 4 cells. After they were allowed to divide 5 times using the same type of cell division, there were 128 cells in the sample.

Assuming that no mutations occur, which two of the following statements are correct?

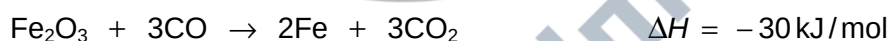
- 1 All the cells would have the same number of chromosomes.
- 2 The cells were gametes.
- 3 The cells would be clones of the original cells.
- 4 This type of cell division is called meiosis.

- 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

- 10 Iron is extracted from iron ore (which contains Fe_2O_3) using carbon monoxide.

This overall reaction is slow and so must be heated.

The chemical equation for this reaction under certain conditions is shown below:



Which one of the following statements about this process is correct?

- A The iron ions in Fe_2O_3 lose electrons to become Fe.
B The oxide ions in Fe_2O_3 each have a charge of -6 .
C The Fe_2O_3 acts as an oxidising agent in this reaction.
D The reaction is an endothermic process.
E The reaction is an example of electrolysis.

- 11 Quantities associated with a moving vehicle include its velocity, speed, momentum and kinetic energy.

Which of these quantities will **always** change if the vehicle changes direction?

- A speed and kinetic energy only
- B speed and momentum only
- C speed, kinetic energy and momentum only
- D velocity and kinetic energy only
- E velocity and momentum only
- F velocity, kinetic energy and momentum only

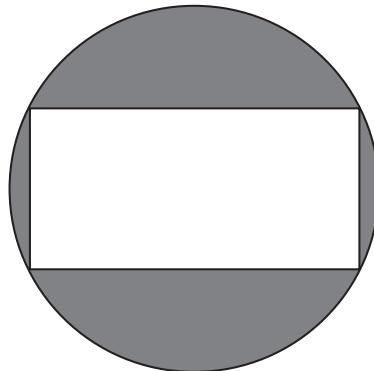


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- 12** All four corners of a rectangle are on the circumference of a circle.

The rectangle has a perimeter of 24 cm.

The ratio of length : width for the rectangle is 3 : 1



[diagram not to scale]

What is the area of the shaded region in cm^2 ?

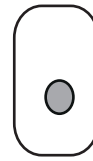
- A** $\frac{9}{4}\pi - 27$
- B** $9\pi - 27$
- C** $16\pi - 32$
- D** $20\pi - 32$
- E** $\frac{81\pi}{4} - 27$
- F** $\frac{45\pi}{2} - 27$
- G** $64\pi - 32$
- H** $80\pi - 32$



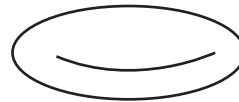
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13 The diagram shows three different types of animal cell.

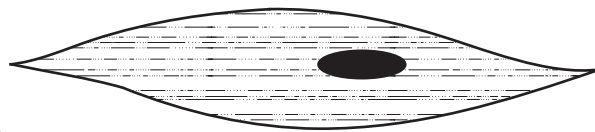
1 epithelial cell



2 mature red blood cell



3 muscle cell



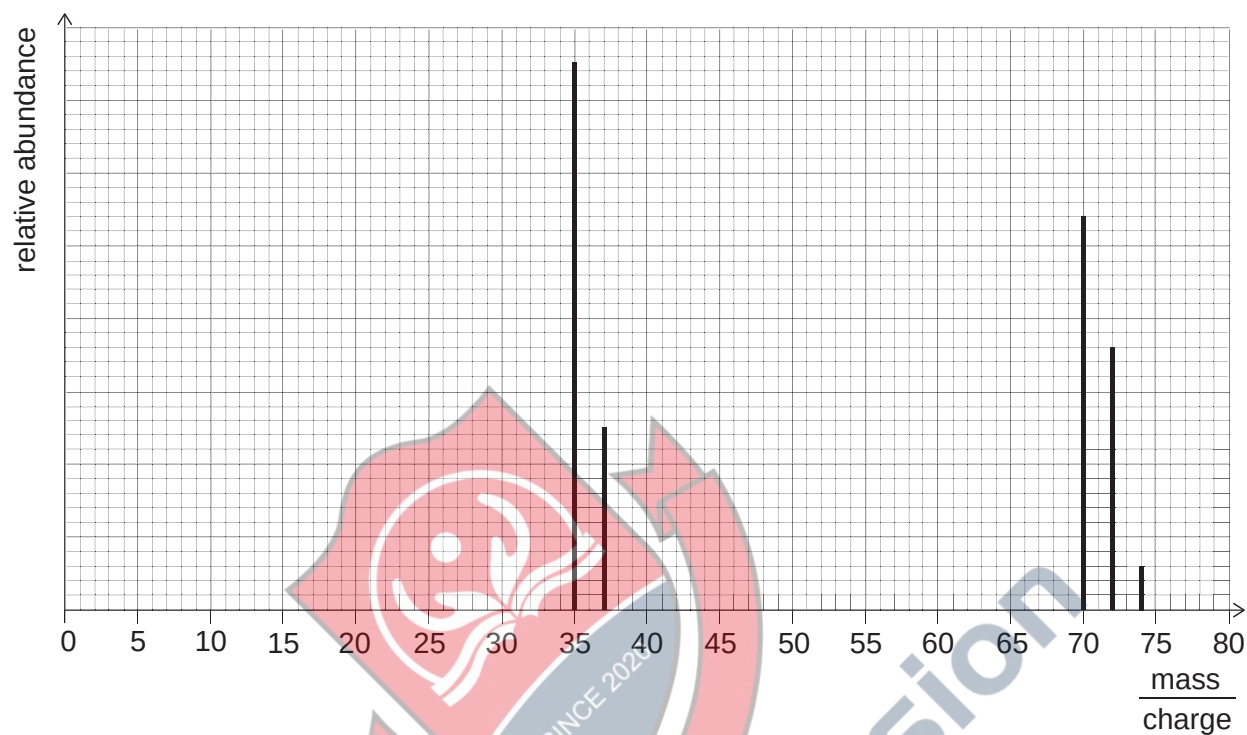
Which of these cells is/are found as part of a tissue?

- 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

- 14 The masses of atoms and molecules can be determined using a mass spectrometer. The masses can be shown as a series of peaks.

Element X exists as a diatomic molecule. The mass spectrum will show the mass of ions from individual atoms of X **and** from X_2 molecules.

The mass spectrum for element X is shown below:



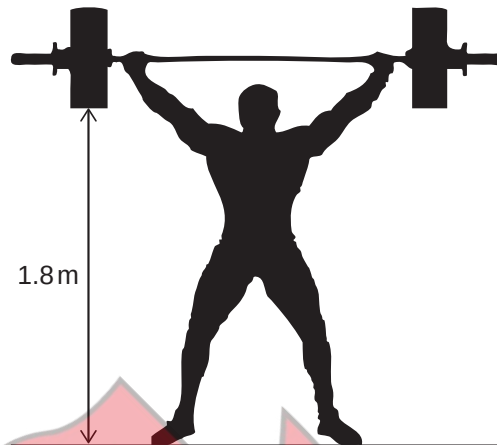
How many different isotopes of X can be determined from this spectrum?

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

- 15** A champion weightlifter raises a 200 kg set of weights from the floor to above his head in one movement.

The bar is lifted through a vertical distance of 1.8 m.

When the lift is completed the weightlifter holds the weights stationary for 2.0 seconds and then drops them to the floor.

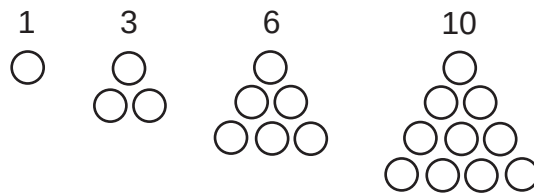


At what speed do the weights hit the floor?

(gravitational field strength = 10 N/kg)

- A** 0.90 m/s
- B** 1.1 m/s
- C** 3.0 m/s
- D** 3.6 m/s
- E** 6.0 m/s
- F** 9.0 m/s
- G** 18 m/s
- H** 36 m/s

16 The first four triangular numbers are:



The difference between the first and second triangular numbers is 2.

The difference between the second and third triangular numbers is 3.

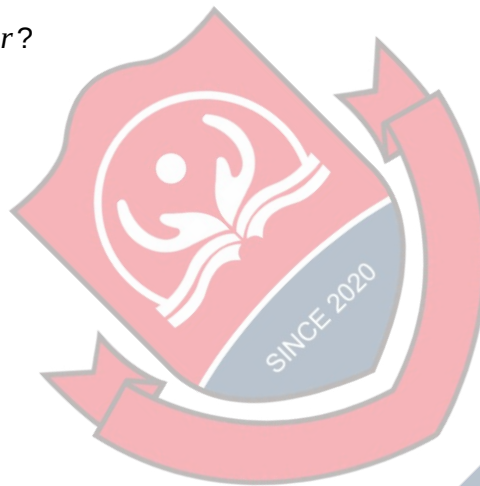
The difference between the third and fourth triangular numbers is 4.

All the triangular numbers follow this pattern.

The difference between the r^{th} triangular number and the $(r + 3)^{\text{th}}$ triangular number is 126.

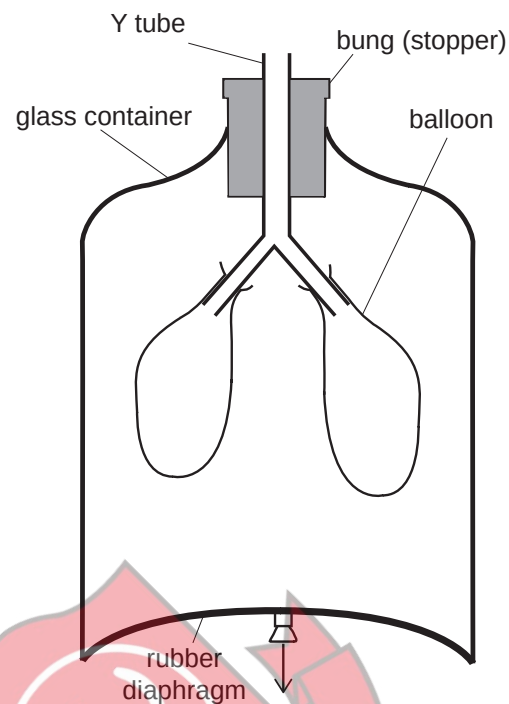
What is the value of r ?

- A** 39
- B** 40
- C** 41
- D** 42
- E** 43



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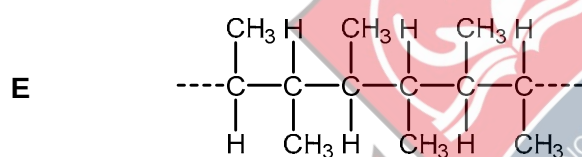
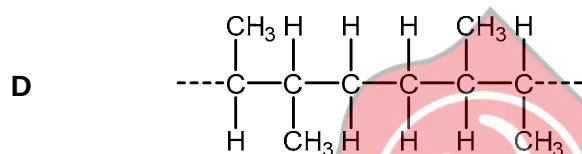
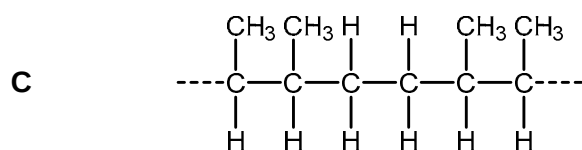
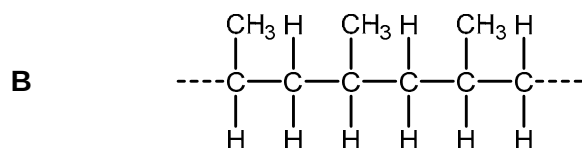
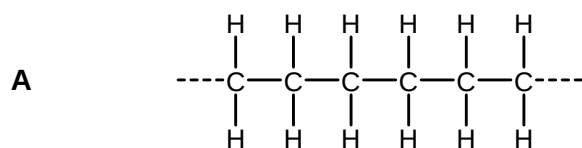
- 17 The diagram shows a simple piece of apparatus that can be used to demonstrate some of the events involved in human ventilation.



Which events occurring during ventilation will be demonstrated by pulling the rubber diaphragm downwards, as shown by the arrow?

- 1 diaphragm relaxes
 - 2 diaphragm contracts
 - 3 volume of thorax increases
 - 4 volume of thorax decreases
 - 5 pressure in thorax increases
 - 6 pressure in thorax decreases
- A 1, 3, 5
- B 1, 3, 6
- C 1, 4, 5
- D 1, 4, 6
- E 2, 3, 5
- F 2, 3, 6
- G 2, 4, 5
- H 2, 4, 6

- 18 Which of the following shows the correct structure of part of the polymer formed by the polymerisation of $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$?



- 19 A circuit consists of a 10Ω resistor and a variable resistor connected in series with a 6.0V battery. The variable resistor has a minimum resistance of 2.0Ω and a maximum resistance of 20Ω .

What is the **difference** between the largest and smallest currents possible in this circuit?

- A 0.20 A
 B 0.30 A
 C 0.40 A
 D 0.50 A
 E 0.60 A
 F 0.70 A

- 20** The mean mass of a sweet in a bag of 20 sweets must be greater than 10 grams but not greater than 10.5 grams.

A bag is being filled with sweets. The mean mass of the first 16 sweets is exactly 9.5 grams.

Four more sweets, each of mass x grams, are added to the bag to bring the mean mass of the 20 sweets into the correct range.

What is the complete range of possible values of x ?

- A** $12 < x \leq 14.5$
- B** $12 < x < 14.5$
- C** $12 \leq x < 14.5$
- D** $10.125 < x \leq 10.725$
- E** $10.125 < x < 10.725$
- F** $10.125 \leq x < 10.725$

- 21** An animal cell is surrounded by a very dilute glucose solution which has a lower concentration of glucose than the glucose solution in the cytoplasm of the cell. There is net movement of glucose molecules and water molecules into the cell.

A second, identical cell is treated for a short time with a chemical which inhibits respiration. The cell is then surrounded by the same glucose solution.

Which row in the table shows the effect of this chemical on the movement of glucose molecules into the cell and the movement of water molecules across the cell surface membrane immediately after it is surrounded by the solution?

	<i>net movement of glucose molecules</i>	<i>net movement of water molecules</i>
A	do not move into the cell	move into the cell
B	move into the cell	move into the cell
C	do not move into the cell	no net movement into or out of the cell
D	move into the cell	no net movement into or out of the cell
E	do not move into the cell	move out of the cell
F	move into the cell	move out of the cell

- 22** A compound of oxygen and fluorine has a relative molecular mass which is twice that of its empirical formula mass. 105 g of the compound contains 57 g of fluorine.

What is the molecular formula of the compound?

(A_r values: O = 16; F = 19)

- A** OF
- B** OF₂
- C** O₂F₂
- D** O₃F₃
- E** O₆F₆

- 23** The radioactive isotope plutonium-244 becomes radon-220 after a succession of decays. The atomic number of plutonium is 94 and the atomic number of radon is 86.

How many alpha particles and how many beta particles are emitted altogether during the decay of one nucleus of plutonium-244 to radon-220?

	<i>alpha particles</i>	<i>beta particles</i>
A	6	2
B	6	4
C	8	8
D	12	4
E	12	16

24 Which one of the following is a simplification of $\frac{x}{x-1} - \frac{x^2+3}{x^2+2x-3}$?

A $\frac{1}{x+1}$

B $\frac{3}{x+3}$

C $\frac{3(x-1)}{(x+1)(x-3)}$

D $\frac{3(x+1)}{(x-1)(x+3)}$

E $\frac{x^2-3}{(x-1)(x^2+2x-3)}$

25 In a type of fruit fly the brown body colour allele is dominant to the black body colour allele. A male fruit fly heterozygous for body colour and a female fruit fly heterozygous for body colour were allowed to mate, producing offspring.

What is the ratio, in its simplest form, of the maximum number of genotypes in the offspring to the maximum number of phenotypes in the offspring?

A 4:3

B 3:4

C 3:2

D 3:1

E 2:3

F 1:2:1

- 26 Xenon gas reacts with fluorine gas to form gaseous xenon hexafluoride at high temperature and pressure. The overall energy change is -330 kJ/mol .

Under these conditions, the $\text{F}-\text{F}$ bond energy of the fluorine gas is 158 kJ/mol .

What is the $\text{Xe}-\text{F}$ bond energy?

- A 81.3 kJ/mol
 - B -81.3 kJ/mol
 - C 134 kJ/mol
 - D -134 kJ/mol
 - E 213 kJ/mol
 - F -213 kJ/mol
 - G 804 kJ/mol
 - H -804 kJ/mol
- 27 The radioactive isotope carbon-14 is found in living material in small quantities. There are approximately 1000 carbon-14 atoms for every 10^{15} carbon-12 atoms. Whilst the material is still living this ratio remains constant, because even though the carbon-14 is decaying, it is being constantly replenished. When the material dies the carbon-14 decays and is not replaced. The half-life of carbon-14 is about 6000 years.

In a bone the ratio of carbon-14 to carbon-12 atoms is found to be $100:10^{15}$.

Which of the following is the closest estimate of the age of the bone?

- A 60 years
- B 600 years
- C 1000 years
- D 10 000 years
- E 20 000 years
- F 30 000 years
- G 50 000 years
- H 60 000 years

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