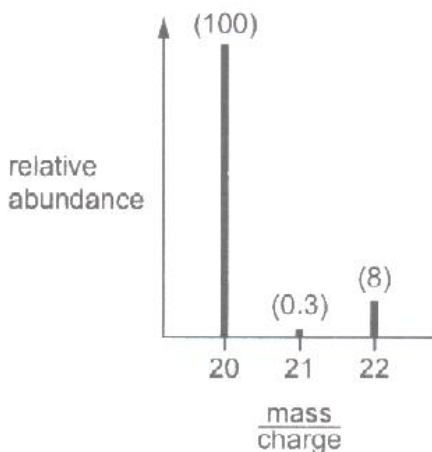


1. Nov/2021/Paper_11/No.1

The mass spectrum of a sample of neon is shown. The relative abundance of each peak is written in brackets above it.



$$R.A.M = \frac{(20 \times 100) + (21 \times 0.3) + (22 \times 8)}{(100 + 0.3 + 8)}$$

$$= \frac{2182.3}{108.3}$$

$$= \underline{\underline{20.15}}$$

What is the relative atomic mass, A_r , of this sample of neon?

- A 20.15 B 20.20 C 21.00 D 21.82

$14 + 4 + 14 + (16 \times 3) = 80g$

$2 + 16 = 18$

2. Nov/2021/Paper_11/No.2

2.0g of ammonium nitrate, NH_4NO_3 , decomposes to give 0.90g of water and a single gas.

What is the identity of the gas?

- A NO B NO_2 C N_2O D N_2

$14 + 4 + 14 + (16 \times 3) = 80g$

$2 + 16 = 18$



Moles of $NH_4NO_3 = \frac{2}{80} = 0.025$

Moles of $H_2O = \frac{0.9}{18} = 0.05$

- Energy is required to remove the electron

$\frac{0.025}{0.025} : \frac{0.05}{0.025}$
1 : 2

3. Nov/2021/Paper_11/No.3

Which of these elements has the highest fifth ionisation energy?

- A C B N C P D Si



- more energy needed

- Removing from a different shell.



Same shell.



Same shell.



Same shell.

4. Nov/2021/Paper 11/No 4

The ion X^{2+} has the same electronic configuration as the atom Kr.

What is the electronic configuration of an atom of X?

- A $[Ar]4s^23d^{10}4p^6$
- B $[Ar]4s^23d^{10}4p^65s^2$**
- C $[Ar]4s^24d^{10}4p^6$
- D $[Ar]4s^24d^{10}4p^65s^2$

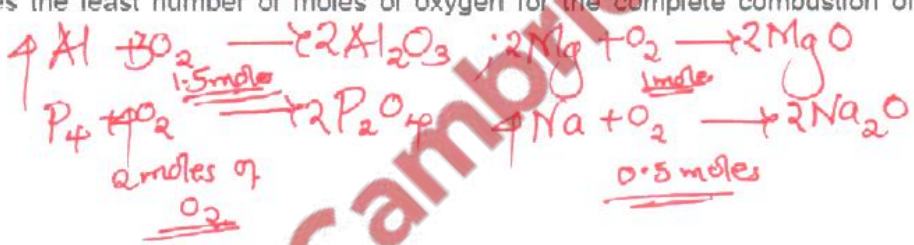
36.
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$
 Ar:

X^{2+} must have lost 2 electrons
 $[Ar]4s^2 3d^{10} 4p^6 5s^2$

5. Nov/2021/Paper_11/No.12

Which element requires the least number of moles of oxygen for the complete combustion of 1 mol of its atoms?

- A aluminium
- B magnesium
- C phosphorus
- D sodium**



6. Nov/2021/Paper_12/No.1

Compound X consists of 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass.

What is the empirical formula of compound X?

- A CH_2O**
- B C_2H_2O
- C C_2H_4O
- D CHO

	C	H	O
Mass	40	6.7	53.3
	12	1	16
moles	3.33	6.7	3.33
mole ratio	$\frac{3.33}{3.33}$	$\frac{6.7}{3.33}$	$\frac{3.33}{3.33}$
	1	2	1
	<u>CH_2O</u>		

7. Nov/2021/Paper_12/No.2

Which statement is correct?

- A 1.0 g of hydrogen gas contains 3.0×10^{23} atoms. ✗
- B 4.0 g of helium gas contains 1.2×10^{24} atoms. ✗
- C 16 g of methane gas contains 3.0×10^{24} atoms. ✓
- D 44 g of carbon dioxide gas contains 6.0×10^{23} atoms. ✗

8. Nov/2021/Paper_12/No.3

Technetium (Tc) is a second row transition element that does not occur naturally on Earth. One of its isotopes has 56 neutrons.

What is the nucleon number of this isotope?

- A 43
- B 56
- C 99
- D 112

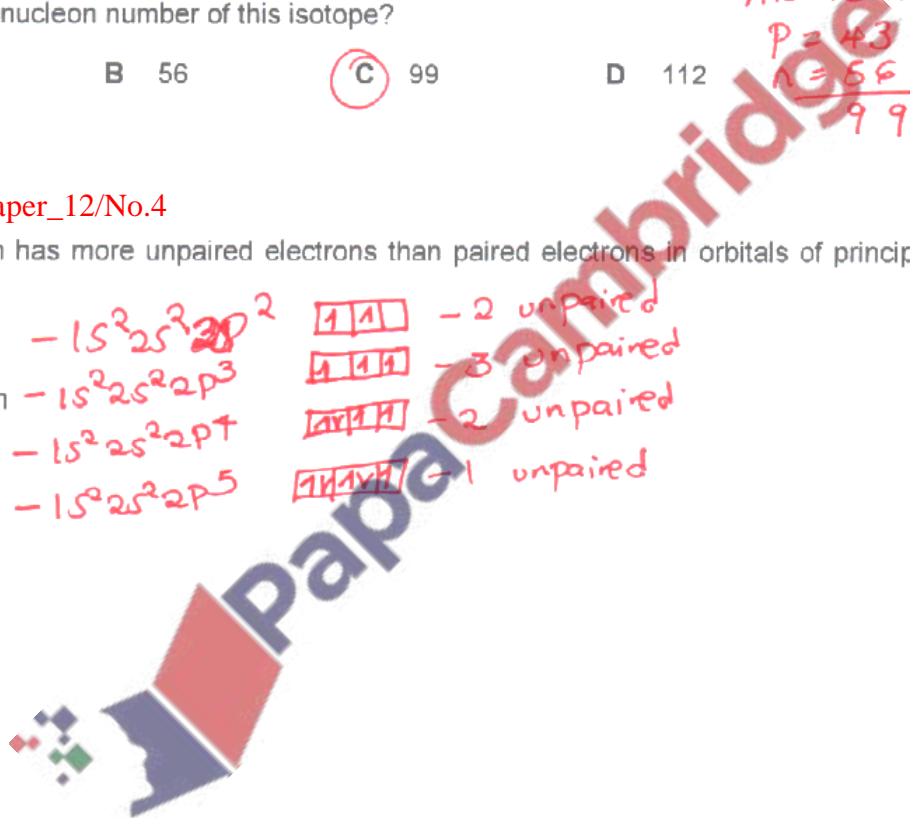
Tc - Mass number \times
Atomic number 43
 $Z = 43$
 $N = 56$

 99

9. Nov/2021/Paper_12/No.4

Which atom has more unpaired electrons than paired electrons in orbitals of principal quantum number 2?

- A carbon - $1s^2 2s^2 2p^2$ [↑] [↑] - 2 unpaired
- B nitrogen - $1s^2 2s^2 2p^3$ [↑] [↑] [↑] - 3 unpaired
- C oxygen - $1s^2 2s^2 2p^4$ [↑↓] [↑] [↑] - 2 unpaired
- D fluorine - $1s^2 2s^2 2p^5$ [↑↓] [↑↓] [↑] - 1 unpaired



10. Nov/2021/Paper_21/No.1(d)

(d) The compound As_2S_3 is a common mineral.

When As_2S_3 is heated strongly in air, it forms a mixture of products, as shown.



(i) A sample containing 0.198 g As_2S_3 is placed in 0.100 dm^3 of pure oxygen, an excess, in a reaction chamber connected to a gas syringe at room temperature.

The reactants are heated until no further change is observed. The products are then allowed to cool to room temperature.

Calculate the volume, in dm^3 , of gas present at the end of the experiment.

The molar volume of gas is $24.0 \text{ dm}^3 \text{ mol}^{-1}$ under these conditions. Assume that the pressure is constant throughout the experiment.

Show your working.

Moles of $\text{As}_2\text{S}_3 = \frac{0.198}{246.1} = 8.05 \times 10^{-4}$

Moles of SO_2 $2 \rightarrow 8.05 \times 10^{-4}$
 $\frac{6}{2} \times 8.05 \times 10^{-4} = 2.41 \times 10^{-3}$

Volume of $\text{SO}_2 = \text{Moles} \times \text{Molar Volume}$
 $2.41 \times 10^{-3} \times 24 = 0.0579 \text{ dm}^3$

volume of gas remaining = 0.0579 dm^3
 [4]

(ii) State the environmental consequences of releasing $\text{SO}_2(\text{g})$ into the atmosphere.

Acid rain. [1]

(iii) $\text{SO}_2(\text{g})$ can be removed from the air by reacting it with $\text{NaOH}(\text{aq})$.

Construct an equation for the reaction of $\text{SO}_2(\text{g})$ with $\text{NaOH}(\text{aq})$. Include state symbols.



11. March/2021/Paper_12/No.1

The table shows the numbers of protons, neutrons and electrons in four different particles, W, X, Y, and Z.

	number of protons	number of neutrons	number of electrons
W	32	40	32
X	32	40	34
Y	32	42	32
Z	34	40	34

- Isotopes have the same number of protons but different number of neutrons.
- Atoms are neutral.
- X is an ion.

Which pair represents the atoms of two isotopes of the same element?

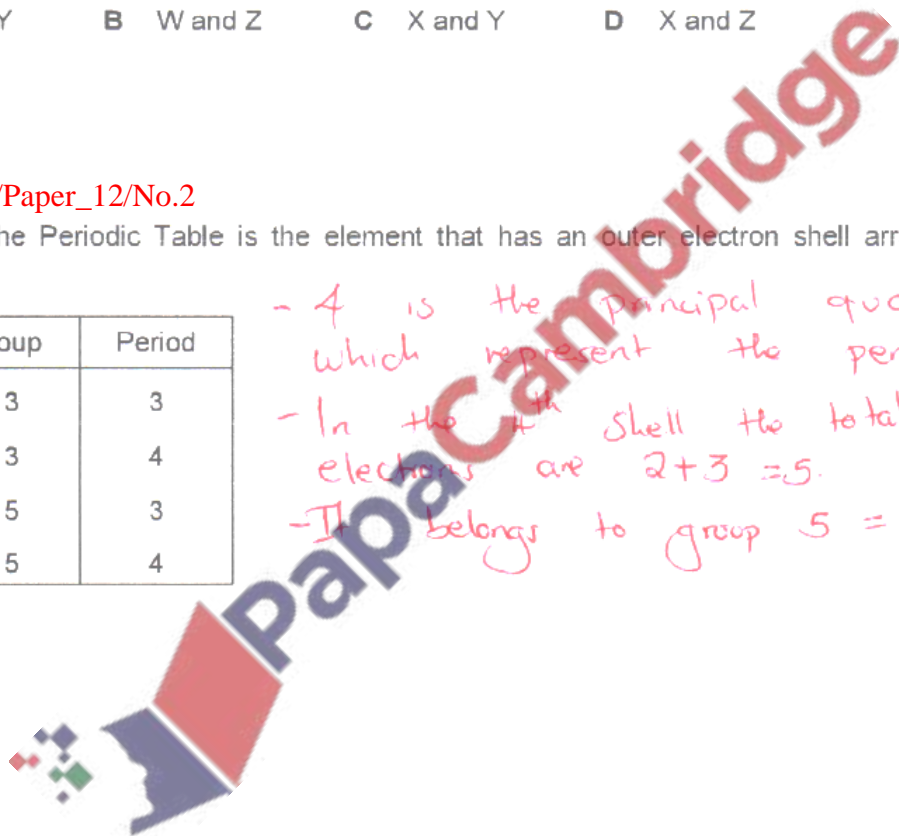
- A W and Y B W and Z C X and Y D X and Z

12. March/2021/Paper_12/No.2

Where in the Periodic Table is the element that has an outer electron shell arrangement of $4s^2 4p^3$?

	Group	Period
A	13	3
B	13	4
C	15	3
<input checked="" type="radio"/> D	15	4

- 4 is the principal quantum number which represent the period.
- In the 4th shell the total number of electrons are $2+3=5$.
- It belongs to group 5 = 15



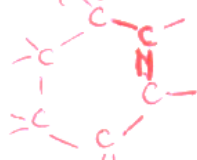
13. March/2021/Paper_12/No.3

Substance Q is a hydrocarbon. When 1.00 g of Q is completely burned, 3.22 g of carbon dioxide is produced.

What could be the identity of Q?

- A cyclohexene Mr 82
- B cyclopentane 70
- C ethene 28
- D pentane $(C_5H_{12}) = 72$

A Cyclohexene.



$$C_6H_{10} = (12 \times 6) + 10 = 82$$



$$\frac{1 \times 0.0732}{6} = 0.0122$$

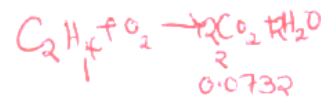
$$\text{Moles of } C_6H_{10} = \frac{1}{82} = 0.0122$$

In A the number of moles are the same. - Work out for the rest and they won't be the same.

eg C. ethene

Moles of ethene

$$\frac{1}{28} = 0.0357$$



$$\frac{1 \times 0.0732}{2}$$

$$= 0.0366$$

This is more than what 1 gram.

Find the moles of CO_2 (Mr 44)

$$\text{Moles} = \frac{\text{Mass}}{Mr} = \frac{3.22}{44}$$

$$= 0.0732$$

Write equations of all.

14. March/2021/Paper_12/No.4

Originally, chemists thought indium oxide had the formula InO . By experiment they showed that 4.8 g of indium combined with 1.0 g of oxygen to produce 5.8 g of indium oxide. The A_r of oxygen was known to be 16.

Which value for the A_r of indium is calculated using these data?

- A 38
- B 77
- C 115
- D 154

$$Mr \text{ of } In = \frac{\text{Mass}}{\text{moles}} = \frac{4.8}{0.0625} = 76.8/77$$



$$\text{Moles of } O_2 = \frac{1}{32}$$

$$\text{Moles of } In = 0.03125$$

$$\frac{2 \times 0.03125}{1} = 0.0625 \text{ mol}$$

A solution contains 0.25 g of sulfur dioxide in 1.00 dm³ of water.

Which volume of sulfur dioxide, measured at 50°C and a pressure of 1×10^5 Pa, must be added to 1.00 dm³ of water to produce this solution?

- A 0.0162 cm³ B 0.105 cm³ C 16.2 cm³ **D 105 cm³**

$M_r = 32 \cdot 1 + (16 \times 2)$
 $= 64$
 $= 273 + 50$

Moles of SO₂ = $\frac{\text{Mass}}{M_r}$
 $= \frac{0.25}{64} = 0.0039$
 $PV = nRT$
 $V = \frac{nRT}{P}$
 $= \frac{0.0039 \times 8.31 \times 323}{1 \times 10^5}$
 $= 0.000105 \times 10^6$
 $= 105 \text{ cm}^3$

Which row is correct?

	statement	reason
A	The first ionisation energy of phosphorus is greater than that of magnesium.	electron is lost from a 3p orbital in both cases X
B	The melting point of phosphorus is greater than that of magnesium.	phosphorus has more valence electrons than magnesium
C	The atomic radius of phosphorus is smaller than that of magnesium.	phosphorus has greater nuclear charge than magnesium ✓
D	The electrical conductivity of phosphorus is smaller than that of magnesium.	bonding changes from ionic in magnesium to covalent in phosphorus

phosphorus is a non metal
 Magnesium has metallic bonding.

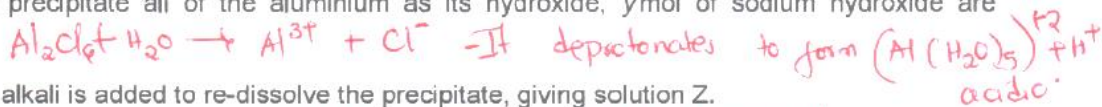
17. March/2021/Paper_12/No.35

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

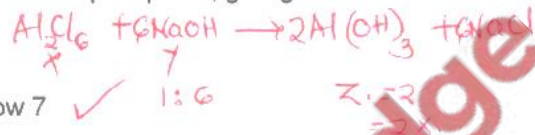
A sample containing x mol of Al_2Cl_6 is dissolved in water to give solution W.

In order to precipitate all of the aluminium as its hydroxide, y mol of sodium hydroxide are required.



More of the alkali is added to re-dissolve the precipitate, giving solution Z.

Which statements are correct?



- D** 1 the initial pH of solution W is below 7 ✓ 1:6
 2 $y = 3x$ ✗
 3 Z contains x mol of aluminium ✗

18. June/2021/Paper_11/No.1

Which contains the largest number of hydrogen atoms?

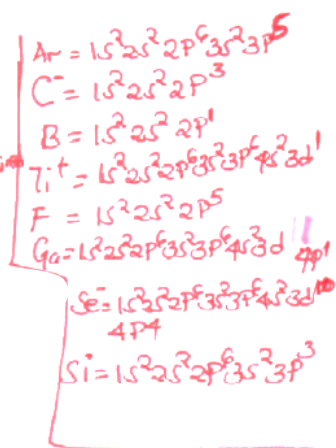
- A 0.10 mol of pentane
 B 0.20 mol of but-2-ene
C 1.00 mol of hydrogen molecules
 D 6.02×10^{23} hydrogen atoms

0.1 and 0.2 are lower than 1 mol and 6.02×10^{23}
 hydrogen molecules has 2 atoms hence more.
 - 1 mol

19. June/2021/Paper_11/No.2

In which pair of species do both species have only one unpaired p electron?

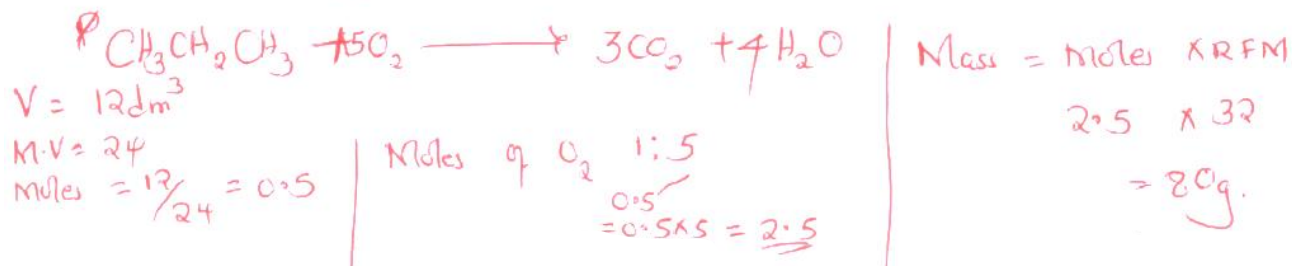
- A** Ar^+ and C^- (3 unpaired)
B B and Ti^+ (one unpaired)
C F and Ga (one unpaired)
D Se^- and Si^+ (8 unpaired)



20. June/2021/Paper_11/No.6

What is the minimum mass of oxygen required to ensure the complete combustion of 12 dm^3 of propane measured under room conditions?

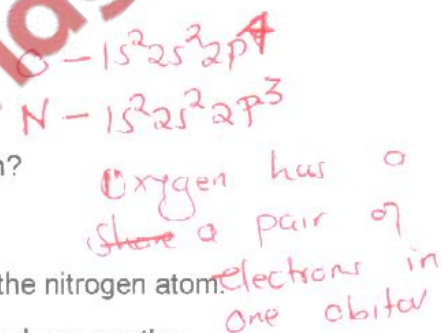
- A 60g **B 80g** C 120g D 160g



21. June/2021/Paper_11/No.7

Why is the first ionisation energy of oxygen less than that of nitrogen?

- A The nitrogen atom has its outer electron in a different subshell.
 B The nuclear charge on the oxygen atom is greater than that on the nitrogen atom.
C The oxygen atom has a pair of electrons in one p orbital that repel one another.
 D There is more shielding in an oxygen atom.



22. June/2021/Paper_12/No.1

Which statement about the Avogadro constant is correct?

- A It is the mass of one mole of any element. Number of particles (elements)
 B It is the mass of 6.02×10^{23} atoms of any element. Number of particles (atoms)
C It is the number of atoms in one mole of neon.
 D It is the number of atoms in 12g of any element. of a carbon 12.

23. June/2021/Paper_12/No.2

Which equation represents the first ionisation energy of iodine?

- Molecule: **A** $\frac{1}{2}I_2(g) + e^- \rightarrow I^-(g)$ - electron affinity
- Molecule: **B** $I(g) + e^- \rightarrow I^-(g)$ - electron affinity
- C** $\frac{1}{2}I_2(g) \rightarrow I^+(g) + e^-$ - Iodine should be an atom not a molecule.
- D** $I(g) \rightarrow I^+(g) + e^-$

24. June/2021/Paper_12/No.31

In which ions are the number of electrons equal to the number of neutrons?

- 1 ${}^{19}_9F^-$ $n = 19 - 9 = 10$ $p = 9$ $e = 10$
- 2 ${}^{31}_{15}P^-$ $n = 31 - 15 = 16$ $p = 15$ $e = 16$
- 3 ${}^{23}_{11}Na^+$ $n = 23 - 11 = 12$ $p = 11$ $e = 10$

25. June/2021/Paper_13/No.1

Compound X is an organic compound that contains 30.6% carbon, 3.8% hydrogen, 20.4% oxygen and 45.2% chlorine by mass.

What is the empirical formula of X?

- A** C_2H_3OCl **B** C_2H_4OCl **C** C_3H_4OCl **D** $C_4H_3O_2Cl_2$

	C	H	O	Cl
Mass %	30.6	3.8	20.4	45.2
Relative atomic mass	12	1	16	35.5
Moles	$\frac{30.6}{12} = 2.55$	$\frac{3.8}{1} = 3.8$	$\frac{20.4}{16} = 1.275$	$\frac{45.2}{35.5} = 1.273$
Simplest ratio	2	3	1	1
Empirical formula	C_2H_3OCl			

A sample of propane, C_3H_8 , with a mass of 9.61 g is completely combusted in an excess of

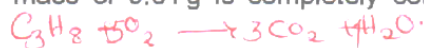
26. June/2021/Paper_13/No.2

A sample of propane, C_3H_8 , with a mass of 9.61 g is completely combusted in an excess of oxygen under room conditions.

RFM $(3 \times 12) + (8 \times 1) = 44$

Which volume of carbon dioxide gas is produced?

- A** 4.89 dm³ **B** 5.24 dm³ **C** 14.7 dm³ **D** 15.7 dm³



$$\text{Moles of } C_3H_8 = \frac{9.61}{44} = 0.2184$$

$$\text{Moles of } O_2 = 5 \times 0.2184 = 1.092$$

$$\text{Moles of } CO_2 = 3 \times 0.2184 = 0.6552$$

$$\text{Volume} = \text{Moles} \times \text{M. Vol} \\ 0.6552 \times 24 \text{ dm}^3 = 15.7248$$

27. June/2021/Paper_13/No.3

Which atom has the same number of electrons as an ammonium ion?

- A Mg ⁻¹² B Na ⁻¹¹ C Ne ⁻¹⁰ D O ⁻⁸

$NH_4^+ = N = 7, 3 \times 1 = 10 \text{ electrons.}$

28. June/2021/Paper_13/No.9

Copper dissolves in dilute nitric acid producing a blue solution of $Cu(NO_3)_2$, water and nitrogen(II) oxide as the only products.

$3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$
 How many moles of acid react with three moles of copper in the balanced equation?

- A 2 B 4 C 6 D 8

Ensure the equation is balanced.
 Start with 3 moles of Cu.

29. June/2021/Paper_13/No.31

Which statements about first ionisation energies are correct?

- 1 They are always endothermic. - heat is used to break the bond.
 B 2 They decrease down Group 2. - Due to increase in the shielding effect
 3 They decrease across Period 3. - If increases due to increase in nuclear charge

Element X is a solid under room conditions. It occurs as a contaminant of fossil fuels.

Its oxide, Y, is formed when fossil fuels are burned.

In the atmosphere, Y can be further oxidised to Z.

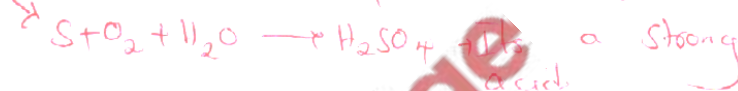
Which statements about X, Y and Z are correct?

1 Atoms of X have paired p electrons.

2 The atmospheric oxidation of Y to Z is a catalysed reaction.

3 With water, Z forms a strong acid.

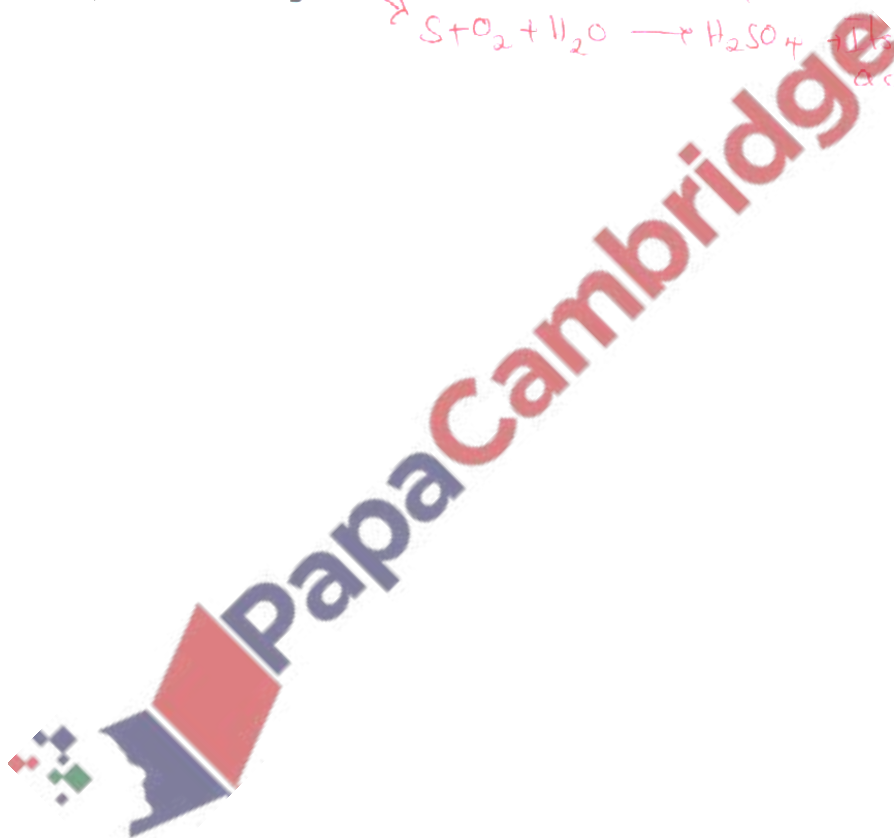
A



either sulfur or nitrogen
X is sulfur

2 P. are paired.

- SO_2 to SO_3 is catalysed by Vanadium (V) oxide



31. June/2021/Paper_21/No.1

Ethanedioic acid, $\text{HO}_2\text{CCO}_2\text{H}$, has a relative molecular mass of 90.0.

(a) (i) Explain what is meant by the term *relative molecular mass*.

..... Mass of a molecule (average) compared to
..... $\frac{1}{12}$ mass of an atom of carbon - 12
..... [2]

(ii) State the empirical formula of ethanedioic acid.

..... COOH [1]

(iii) Calculate how many atoms of carbon are present in 0.18 g of ethanedioic acid, $\text{HO}_2\text{CCO}_2\text{H}$.

Show your working.

$$\begin{aligned} \text{Moles of carbon} &= \frac{0.18}{90} \\ \text{ethanedioic acid} & \\ &= 0.002 \end{aligned}$$

$$\begin{aligned} \text{No. of carbon atoms} &= \text{moles} \times \text{Avogadro's} \\ &= 0.002 \times 6.02 \times 10^{23} \end{aligned}$$

$$\begin{aligned} \text{Moles of carbon} &= 0.002 \times 2 \\ &= 0.004 \end{aligned}$$

$$\text{atoms of carbon present} = 0.004 \times 10^{23} \dots [3]$$

(b) Solid ethanedioic acid reacts with aqueous calcium ions to make a precipitate of calcium ethanedioate, CaC_2O_4 .

CaC_2O_4 breaks down when heated to form calcium oxide, carbon dioxide and carbon monoxide.

(i) Construct an equation to represent the reaction of CaC_2O_4 when heated. Include state symbols.



(ii) Identify the type of reaction which occurs when CaC_2O_4 is heated.

..... Decomposition [1]

(iii) Identify another compound containing calcium ions which will also produce carbon dioxide and calcium oxide when it is heated.

..... CaCO_3 [1]

[Total: 10]

32. June/2021/Paper 23/No.1 (e)

(e) The concentration of NaClO in bleach S is $x \text{ g dm}^{-3}$.

NaClO reacts with $\text{H}_2\text{O}_2(\text{aq})$ as shown.



A 5.00 cm^3 sample of S completely reacts with $\text{H}_2\text{O}_2(\text{aq})$. The volume of $\text{O}_2(\text{g})$ produced is 24.0 cm^3 under room conditions.

Assume that only the NaClO in S reacts with $\text{H}_2\text{O}_2(\text{aq})$.

Calculate x . Show your working.

$$\begin{aligned} \text{Moles of } \text{O}_2 &= \frac{\text{Volume}}{\text{Molar Vol.}} \\ &= \frac{24}{24000} \\ &= \underline{\underline{1 \times 10^{-3}}} \end{aligned}$$

$$\begin{aligned} \text{Moles of NaClO} &: \text{O}_2 \\ 1 &: 1 \\ &= 1 \times 10^{-3} \end{aligned}$$

$$\text{Concentration} = \frac{\text{Moles}}{\text{Volume}}$$

$$\begin{aligned} \text{Vol} &= 5 \text{ cm}^3 \\ 1 \text{ dm}^3 &\rightarrow 1000 \text{ cm}^3 \\ \frac{1 \times 5}{1000} &= 0.005 \text{ dm}^3 \end{aligned}$$

$$\begin{aligned} C &= \frac{1 \times 10^{-3}}{5 \times 10^{-3}} \\ &= 0.2 \text{ mol dm}^{-3} \end{aligned}$$

$$\begin{aligned} \text{NaClO} \\ \text{RFM} &= 23 + 35.5 \\ &+ 16 \end{aligned}$$

$$= 74.5$$

$$1 \text{ mol} \rightarrow 74.5$$

$$\begin{aligned} 0.2 \\ &= 0.2 \times 74.5 \\ &= 14.9 \end{aligned}$$

$$x = \dots 14.9 \dots \text{ g dm}^{-3} \quad [3]$$



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