Roll No. :
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1. How many number of atoms are present in 52 u of He? 1

Ans : 1 atom of He = 4 u of He
i.e. 4 u of He = 1 atom of He
Therefore, 52 u of He = $\frac{1}{4} \times 52$ = 13 atoms of He

2. How many significant figures are present in (i) 0.0025 (ii) 600.0? 1

Ans : (i) Two, (ii) Four

3. The following data are obtained when dinitrogen and dioxygen react together to form different compounds: 1

	Mass of dinitrogen	Mass of dioxygen
(i)	14 g	16 g
(ii)	14 g	32 g
(iii)	28 g	32 g
(iv)	28 g	80 g

Which law of chemical combination is obeyed by the above experimental data? Give its statement.

Ans : Law of multiple proportion: It states 'whenever two elements combine to form two or more compounds, the ratio between different weights of one of the elements which combines with fixed weight of another is always simple.

4. Calculate the number of He atoms in (i) 52 u, (ii) 52 g, (iii) 52 moles of He. Atomic wt. of He is 4 u. 1

Ans : (i) 4 u is mass of 1 atom

$\Rightarrow 52 \text{ u is mass of } \frac{1}{4} \times 52 = 13 \text{ atoms}$

(ii) 4 g of He contains 6.022×10^{23} He atoms

$\Rightarrow 52 \text{ g of He contains } \frac{6.022 \times 10^{23} \times 52}{4}$

$= 7.8286 \times 10^{24} \text{ atoms}$

(iii) 1 mole of He contains 6.022×10^{23} atoms 52 moles of He contains $52 \times 6.022 \times 10^{23} = 3.131 \times 10^{25}$ atoms

5. How many cm are there in 1 pm? 1

Ans : 1 pm = 10^{-12} m = 10^{-10} cm

6. Which one of the following will have the largest number of atoms? 1
(i) 1 g Au(s)
(ii) 1 g Na(s)
(iii) 1 g Li(s)
(iv) 1 g of Cl2(g)

Ans : 1 g of Li will have the largest number of atoms because it has lowest atomic mass.

7. How many atoms of calcium are there in 2 g of Ca? (At. mass of Ca = 40 u) 1

Ans : 1 mole of Ca = 40 g = 6.022×10^{23} atoms

$$\Rightarrow 2 \text{ g of Ca} = \frac{6.022 \times 10^{23}}{40} \times 2 = 3.011 \times 10^{22}$$

8. Calculate the number of atoms present in 1.4 g of N_2 molecule. 1

Ans : 28 g of N_2 molecules contain $2 \times 6.023 \times 10^{23}$ atoms

Hence, 1.4 g of N_2 molecules contain $\frac{2 \times 6.023 \times 10^{23}}{28} \times 1.4 = 6.023 \times 10^{22}$ atoms

9. What is mass silicon in 100 g of sodium silicate, Na_2SiO_3? [Na = 23, Si = 28, O = 16u] 1

(a) 16.7%
(b) 23.0%
(c) 28.0%
(d) 82.0 %

Ans : (d) 82.0 %.

Molar mass of silicon = 46 + 28 + 48 = 122 g mol^{-1}

$$\%Si = \frac{28}{122} \times 100 = 22.95 \simeq 23\%$$

10. In the following question two or more options may be correct. 1

One mole of oxygen gas at STP is equal to _____.
(a) 6.022×10^{23} molecules of oxygen
(b) 6.022×10^{23} atoms of oxygen
(c) 16 g of oxygen
(d) 32 g of oxygen

Ans : (a) and (d).

1 mole = 6.022×10^{23} molecules of oxygen
1 mole = 32 g

11. A sample of drinking water was found to be severely contaminated with chloroform ($CHCl_3$), supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass). 2
(i) Express this in per cent by mass.
(ii) Determine the molality of chloroform in the water sample.
[Given molar mass of $CHCl_3$ = 119.5 g mol^{-1}]

Ans : (i) 15 ppm means 15 g of $CHCl_3$ is present in 10^6 g of solution. Since 10^6 g of solution contains 15 g of $CHCl_3$.

Therefore, 100 g of solution contains $\frac{15}{10^6} \times 100 = 15 \times 10^{-4}\ \% = 1.5 \times 10^{-3}\ \%$.

Molecular weight of $CHCl_3$

$= 12 + 1 + 35.5 \times 3 = 12 + 1 + 106.5$

$= 119.5\ g\ mol^{-1}$

$$m = \frac{W_B}{M_B} \times \frac{1000}{W_A} = \frac{15}{119.5} \times \frac{1000}{10^6}$$

$= 0.1255 \times 10^{-3}$ mol/kg

$= 1.255 \times 10^{-4}$ mol/kg

[$\because$ Mass of solvent = Mass of solution – Mass of solute = $10^6 - 15 \simeq 10^6$]

$m = 1.255 \times 10^{-4}$ mol/kg

12. What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20 g are dissolved in enough water to make a final volume up to 2 L? 2

Ans :
$$M = \frac{W_B}{M_B} \times \frac{1}{\text{Volume of solution in litres}}$$
$$= \frac{20}{342} \times \frac{1}{2} = \frac{5}{171} = 0.0292\ \text{mol}\ L^{-1} = 0.0292\ M$$

13. An organometallic compound on analysis was found to contain, C = 64.4%, H = 5.5% and Fe = 29.9%. Determine its empirical formula (At. mass of Fe = 56 u). 2

Ans :

Element	%	Atomic Weight	Relative No. of Atoms	Divide by Least	Simplest Ratio
C	64.4	12	$\frac{64.4}{12} = 5.36$	$\frac{5.36}{0.53} = 10.1$	10
H	5.50	1	$\frac{5.50}{1} = 5.50$	$\frac{5.50}{0.53} = 10.4$	10
Fe	29.9	56	$\frac{29.9}{56} = 0.53$	$\frac{0.53}{0.53} = 1$	1

Therefore, empirical formula = $C_{10}H_{10}Fe$

14. Calculate the mass of sodium acetate (CH_3COONa) required to make 500 ml of 0.375 molar aqueous solution. Molar mass of sodium acetate is 82.0245 g mol^{-1}. 2

Ans :
$$M = \frac{W_B}{M_B} \times \frac{1000}{\text{Volume of solution in ml}}$$
$$\Rightarrow 0.375 = \frac{W_B}{82.0245} \times \frac{1000}{500}$$
$$W_B = \frac{0.375 \times 82.0245}{2}$$
$$W_B = 15.38\ g$$

15. The density of 3 M solution of NaCl is 1.25 g ml^{-1}. Calculate the molality of the solution. 2

Ans : Mass of solution = 1000×1.25 g $ml^{-1} = 1250$ g

Mass of solute = $3M_B = 3 \times 58.5 = 175.5$ g

Mass of solvent = $1250.0 - 175.5 = 1074.5$ g

$$m = \frac{\text{Number of moles}}{\text{Mass of solvent in g}} \times 1000 = \frac{3}{1074.5} \times 1000$$

$$= \frac{3000}{1074.5} = 2.79 \text{ mol/kg}$$

16. The mass of an electron is 9.1×10^{-31} kg. If its K.E. (kinetic energy) is 3×10^{-25} J, then calculate its velocity. 2

Ans : $$\text{K.E.} = \frac{1}{2}mV^2$$

$$\Rightarrow V = \left(\frac{2\text{K.E.}}{m}\right)^{1/2} = \left(\frac{2 \times 3 \times 10^{-25} \text{kg m}^2\text{s}^{-2}}{9.1 \times 10^{-31} \text{kg}}\right)^{1/2}$$

$$= 8.12 \times 10^2 \text{ m s}^{-1}$$

17. Explain giving reason, which of the following sets of quantum numbers are not possible: 2

(*i*) $n = 1,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

(*ii*) $n = 0,\ l = 2,\ m_l = -2,\ m_s = -\frac{1}{2}$

Ans : (i) It is not possible because $n \neq$ l.
(ii) It is also not possible because *l* cannot be greater than *n*.

18. Red light has wavelength 750 nm, whereas violet light has wavelength 400 nm. Calculate their frequency and energy ($c = 3 \times 108$ m s^{-1}, $h = 6.63 \times 10^{-34}$ J s). 2

Ans : $$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m s}^{-1}}{750 \times 10^{-9} \text{ m}} = 4 \times 10^{14} \text{ Hz};$$

$$E = h\nu = 6.63 \times 10^{-34} \times 4 \times 10^{14}$$

$$= 2.652 \times 10^{-19} \text{ J}$$

$$\nu = \frac{3 \times 10^8 \text{ m s}^{-1}}{400 \times 10^{-9} \text{ m}} = 7.5 \times 10^{14} \text{ Hz};$$

$$E = 6.63 \times 10^{-34} \times 7.5 \times 10^{14} = 4.972 \times 10^{-19} \text{ J}$$

19. What is meant by (i) Stark effect and (ii) Zeeman effect? 2

Ans : (i) The splitting of spectral lines in electric field is called Stark effect.
(ii) The splitting of spectral lines in magnetic field is called Zeeman effect.

20. When would the wavelength associated with an electron be equal to the wavelength associated with a proton? Mass of electron = 9.1095×10^{-28} g; 2
Mass of proton = 1.6725×10^{-24} g.
Or
Calculate the velocity condition for the wavelength associated with a moving electron to be equal to the wavelength associated with a moving proton.

Ans : $\lambda_e = \frac{h}{m_e V_e}$, $\lambda_p = \frac{h}{m_p V_p} \Rightarrow \lambda_e = \lambda_p \Rightarrow m_e V_e = m_p V_p$

$\Rightarrow \frac{V_e}{V_p} = \frac{m_p}{m_e} = \frac{1.6725 \times 10^{-24}}{9.1095 \times 10^{-28}} = 1836$

$\Rightarrow V_e = 1836\ V_p$

21. The first (IE_1) and second (IE_2) ionisation energies (kJ/mol) of a new element designated by Roman numerals are shown below: 2

	IE_1	IE_2
I	2372	5251
II	520	7300
III	900	1760
IV	1680	3380

Which of these elements is likely to be (i) a reactive metal, (ii) a reactive non-metal, (iii) a noble gas, and (iv) a metal that forms a binary halide of the formula, AX_2?

Ans : (i) II, (ii) IV, (iii) I, (iv) III

22. Among the elements of the third period Na to Ar, pick out the element: 2
(i) with highest first ionisation enthalpy
(ii) with largest atomic radius
(iii) which is most reactive non-metal
(iv) which is most reactive metal.

Ans : (i) Ar has highest first ionisation enthalpy.
(ii) Na has largest atomic radius (covalent radius).
(iii) Cl is most reactive non-metal in third period.
(iv) Na is most reactive metal in third period.

23. Predict the formulae of the stable binary compounds that would be formed by the following pairs of elements: 2
(i) Silicon and oxygen
(ii) Aluminium and bromine
(iii) Calcium and iodine
(iv) Element with atomic number 114 and fluorine
(v) Element with atomic number 120 and oxygen.

Ans : (i) SiO_2
(ii) $AlBr_3$
(iii) CaI_2
(iv) $UuqF_4$
(v) XO where 'X' is element with atomic number 120.

24. Consider the following species: 2
N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+} and Al^{3+}
(i) What is common in them?
(ii) Arrange them in the order of increasing ionic radii.

Ans : (i) They have same number of electrons.
(ii) $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$ is increasing order of ionic radii as number of protons i.e., nuclear charge decreases.

25. Among the second period elements, the actual ionization enthalpies are in the order 2
Li < B < Be < C < O < N < F < Ne.
Explain, why

(i) Be has higher $\Delta_i H$ than B?
(ii) O has lower $\Delta_i H$ than N and F?

Ans : (i) Be (4) $1s^2 2s^2$ and B (5) $1s^2 2s^2 2p^1$ Be has stable electronic configuration, i.e. completely filled *s*-orbital from which removal of electron is difficult as compared to Boron.

(*ii*) N (7) $1s^2 2s^2 2p^3$,
O (8) $1s^2 2s^2 2p^4$ and
F (9) $1s^2 2s^2 2p^5$

Oxygen has lower ionisation energy than 'N' because 'N' has stable electronic configuration due to half filled *p*-orbitals.
O (8) has lower I.E than F (9) because effective nuclear charge is less than that of fluorine.

26. The first ionization enthalpy values (in kJ mol^{-1}) of group 13 elements are: 2

B	Al	Ga	In	Tl
801	577	579	558	589

How would you explain this deviation from the general trend?

Ans : It is due to poor shielding effect in case of Ga, the effective nuclear charge is more, therefore, I.E. is slightly higher than that of 'Al'.
In case of Tl, effective nuclear charge is increased due to poor shielding effect of felectrons, therefore, its I.E. is higher than that of In.

27. Which series of lines of the hydrogen spectrum lies in the visible region? 1

Ans : Balmer series of lines lies in the visible region of the hydrogen spectrum.

28. How many electrons in an atom have the following quantum numbers? $n = 3$, $l = 0$. 1

Ans : The value of $n = 3$ and $l = 0$ implies 3*s* orbital. 3*s* orbital can have maximum of 2 electrons. Hence 2 electrons can have this set of quantum numbers.

29. How many sub-shells are present in M shell? 1

Ans : For M shell, $n = 3$ and $l = 0, 1, 2$
s, *p*, *d*
i.e., there will be three sub-shells (*s*, *p* and *d*) for M shell.

30. Write electronic configuration of Cu^+ (atomic no. of Cu = 29). 1

Ans : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^{10}$

31. An atomic orbital has $n = 3$, what are the possible values of l? 1

Ans : $n = 3$; $l = 0, 1, 2$

32. What is the shape of 1
(i) *s*-orbital and (ii) *p*-orbital?

Ans : (i) Spherical (ii) Dumb-bell

33. What is the value of Bohr's radius for the first orbit of hydrogen atom? 1

Ans : $r_1 = 0.529\ Å = 0.529 \times 10^{-10}\ m = 5.29 \times 10^{-11}\ m$

34. In which of the following set of quantum numbers an electron will have the highest energy? 1
(i) 3, 2, 1, ½
(ii) 4, 2, –1, –½
(iii) 4, 1, 0, –½
(iv) 5, 0, 0, ½.

Ans : (ii) 4, 2, –1, –1/2, i.e. 4*d*-electron will be highest energy because (*n* + l), i.e. 4 + 2 = 6 is highest.

35. Out of X-rays, infra-red, visible rays and microwaves, which has largest frequency? 1

Ans : X-rays have largest frequency.

36. How many unpaired electrons are there in Ni^{2+} ion? Atomic number of Ni is (28). 1

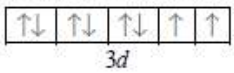
Ans : Ni (28) has electronic configuration

$$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$$

Ni^{2+} ion has electronic configuration

$$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^0\,3d^8$$

The number of unpaired electrons is 2.



37. Which one of the atomic orbital has higher energy? 1
(i) *n* = 3, l = 2, *m* = + 1
(ii) *n* = 4, l = 0, *m* = 0.

Ans : (i) 3*d* has higher energy than (ii) 4*s* orbital.

38. State physical significance of ψ^2. 1

Ans : ψ^2 represents probability of finding the electron.

39. The electronic configuration of N (7) is $1s^2\,2s^2\,2p_x^1\,2p_y^1\,2p_z^1$ and not $1s^2\,2s^2\,2p_x^2\,2p_y^1$. Why? 1

Ans : N(7) has electronic configuration $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$ and not $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1$ because latter violates Hund's rule which states degenerate (having equal energy) orbitals are first singly filled and then pairing starts so as to avoid repulsion.

40. Write the IUPAC name and symbol for the element with atomic number 119. 1

Ans : Ununennium, Uue

41. Arrange the elements F, Cl, O and N in the correct order of their chemical reactivity in terms of oxidising property. 1

Ans : F, Cl, O and N can be arranged in order of their chemical reactivity in terms of oxidising property as F > O > Cl > N.

42. Give general electronic configurations of *s*-block elements. 1

Ans : $ns^{1 \text{ to } 2}$

43. What are representative elements? 1

Ans : *s*-Block and *p*-block elements together are called representative elements or main group elements.

44. What is meant by Lanthanoids and Actinoids? 1

Ans : The fourteen elements after La (57) are called Lanthanoids and the fourteen elements after Ac (89) are called actinoids.

45. Which of the following requires highest energy? 1
(a) $M(g) \rightarrow M^{+}(g)$
(b) $M(g) \rightarrow M^{2+}(g)$
(c) $M(g) \rightarrow M^{3+}(g)$
(d) $M(g) \rightarrow M^{4+}(g)$

Ans : (d) $M(g) \rightarrow M^{4+}(g)$ requires highest energy to loose four electrons.

46. Among Li, Na, K, Rb, Cs, the element with lowest ionisation energy is …… . 1

Ans : Cs has lowest ionisation energy.

47. Which is the smallest among Na^{+}, Mg^{2+}, Al^{3+} and why? 1

Ans : $A1^{3+}$ is smallest because it has the highest number of protons (13) among Na^{+}, Mg^{2+} and $A1^{3+}$ ions, due to which effective nuclear charge is maximum.

48. Arrange the following species in increasing order of their size: Mg^{2+}, Al^{3+}, Na^{+}, O^{2-}, F^{-}. 1

Ans : $O^{2-} > F^{-} > Na^{+} > Mg^{2+} > Al^{3+}$

49. Considering the elements B, Al, Mg, and K, the correct order of their metallic character is: 1
(a) B > Al > Mg > K
(b) Al > Mg > B > K
(c) Mg > Al > K > B
(d) K > Mg > Al > B

Ans : (d)

50. Considering the elements B, C, N, F, and Si, the correct order of their non-metallic character is: 1
(a) B > C > Si > N > F
(b) Si > C > B > N > F

(c) F > N > C > B > Si
(d) F > N > C > Si > B

Ans : (c)

51. Considering the elements F, Cl, O and N, the correct order of their chemical reactivity in terms of oxidizing property is: 1
(a) F > Cl > O > N
(b) F > O > Cl > N
(c) Cl > F > O > N
(d) O > F > N > Cl

Ans : (b)

(i) Which is largest in size— Cu^{+}, Cu^{2+} or Cu, and why? 3
(ii) Which element in periodic table has highest I.E. (ionisation energy)?
(iii) Which element is more metallic—Mg or Al and why?

Ans : (i) Cu is largest due to less effective nuclear charge. It has 29 electrons, 29 protons, Cu^{+} has 28 electrons and 29 protons, Cu^{2+} has 27 electrons and 29 protons.
(ii) He has highest ionisation energy.
(iii) Mg is more metallic due to lower ionisation energy.