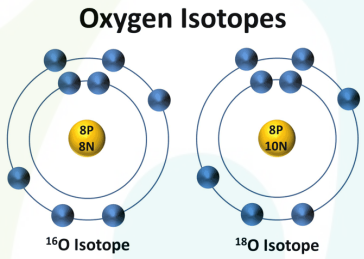
Brainiacs Chemistry Olympiad Preliminary Round Sample Exam Paper 3

Category III – grades 11 and 12

Q1.
Which of the following is a homogeneous mixture?

A) Mixture of soil and water
B) Sugar solution
C) Mixture of sugar, salt and sand
D) Iodized table salt

Q2.
Isotopes of an element have_____.



A) Different chemical and physical properties
B) Similar chemical and physical properties
C) Similar chemical but different physical properties
D) Similar physical but different chemical properties

Q3.
The vertical columns in the periodic table are termed as _____.

A) periods
B) groups
C) series
D) none of these

Q4.
Three amines: **methylamine (**CH_3NH_2**)**, **aniline (**$C_6H_5NH_2$**)**, and **dimethylamine (**$(CH_3)_2NH$**)**, are compared for their basicity in aqueous solution.
Arrange them in decreasing order of basicity.

A) Basicity order: Dimethylamine > Methylamine > Aniline;
B) Basicity order: Methylamine > Dimethylamine > Aniline;
C) Basicity order: Dimethylamine > Methylamine > Aniline;
D) Basicity order: Methylamine > Aniline > Dimethylamine;

Q5.
The most electronegative element in the periodic table is_____.

A) Nitrogen
B) Oxygen
C) Chlorine
D) Fluorine

Q6.
In the complex ion $[Fe(CN)_6]^{4-}$, what is the oxidation state of Fe and the hybridization of the central atom?

A) +3, d^2sp^3
B) +2, d^2sp^3
C) +3, sp^3d^2
D) +2, sp^3d^2

Q7.
The repeating unit in the polymer polystyrene is:

A) $-CH_2-CH(C_6H_5)-$
B) $-CH_2-CHCl-$
C) $-CH_2-C(CH_3)_2-$
D) $-CH_2-CHCN-$

Q8.
$K_2Cr_2O_7 + H_2O_2 + H_2SO_4 = \ldots + \ldots + \ldots + \ldots$
What is the sum of all coefficients in this reaction?

A) 23
B) 22
C) 21
D) 20

Q9.
How many resonance structures can be drawn for SO_3?

A) 1
B) 2
C) 3
D) 4

Q10.

For a reaction at equilibrium, the value of ΔG is:

A) Positive
B) Negative
C) Zero
D) Depends on the temperature

Q11.
Given the following reactions:

$H_2(g) + O_2(g) \rightarrow H_2O_2(g)$, $\Delta H = -188$ kJ/mol

$2H_2O_2(g) \rightarrow 2H_2O(g) + O_2(g)$, $\Delta H = -196$ kJ

What is the enthalpy change for the reaction:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$?

A) -384 kJ
B) -492 kJ
C) -560 kJ
D) -572 kJ

Q12.
Car batteries provide the electrical energy needed to start a vehicle and power its accessories when the engine is off. They typically use lead-acid technology and require regular maintenance to ensure optimal performance and longevity.
Which acid is used in car batteries?

A) Nitric acid
B) Sulfuric acid
C) Hydrochloric acid
D) Phosphoric acid

Q13. What type of isomerism exists between 1-butanol ($CH_3CH_2CH_2CH_2OH$) and diethyl ether ($CH_3CH_2OCH_2CH_3$)

A) Chain isomerism
B) Functional group isomerism
C) Geometric isomerism
D) Optical isomerism

Q14.
A polymer sample contains molecules with the following molecular weights: 6,000 g/mol (50%), 12,000 g/mol (30%), 18,000 g/mol (20%). What is the number-average molecular weight (Mn) of the polymer?

A) 9,500 g/mol
B) 10,000 g/mol
C) 10,200 g/mol
D) 12,500 g/mol

Q15.
A 3.0 L container holds 1 mole of neon gas at 400 K. What is the pressure inside the container? (R = 0.0821 $L \cdot atm \cdot K^{-1} \cdot mol^{-1}$)

A) 10.96 atm
B) 8.21 atm
C) 15.38 atm
D) 20.5 atm

Q16.
50 mL of 0.2 M propanal (CH_3CH_2CHO) is reacted with Tollens' reagent. The aldehyde is oxidized to propanoic acid (CH_3CH_2COOH), and the silver produced is weighed.
$CH_3CH_2CHO + 2[Ag(NH_3)_2]OH \rightarrow CH_3CH_2COONH_4 + 2Ag + 3NH_3 + H_2O$
Determine the mass of silver formed in the reaction.

A) 0.54 g
B) 1.08 g
C) 2.16 g
D) 4.32 g

Q17.
A 0.1 M solution of a weak acid *HA* has a pH of 4. The acid dissociation constant (K_a) of *HA* is approximately:

A) 1×10^{-7}
B) 1×10^{-6}
C) 1×10^{-5}
D) 1×10^{-4}

Q18.
For the reaction:
$A_{(g)} + 2B_{(g)} = C_{(g)} + D_{(g)}$,
the following thermodynamic data is given:
· Standard enthalpy change (ΔH) = +40 kJ/mol
· Standard entropy change (ΔS) = +80 J/mol*K
At what minimum temperature (T) will the reaction become spontaneous under standard conditions?

A) 250 K
B) 300 K
C) 500 K
D) 600 K

Q19.
For the following half-cell reaction: $Ag^{+}_{(aq)} + e^{-} = Ag_{(s)}$, $E^{0} = +0.8$ V,
Calculate the electrode potential (E) when the concentration of Ag^{+} is *0.01M* at *25^{0}C*.
Use the Nernst equation: $E = E^{0} - 0.059/n \log Q$, Where $Q = 1/[Ag^{+1}]$.

A) +0.8 V
B) +0.68 V
C) +0.83 V
D) +0.74 V

Q20.
For the catalytic hydrogenation of 17.8 g of a mixture of formaldehyde and acetaldehyde into the corresponding alcohols, 11.2L of hydrogen at STP were required. Determine the mass percentage of acetaldehyde in the mixture.

A) 50,6%
B) 49,4%
C) 20,5%
D) 18,6%