Brainiacs Chemistry Olympiad Preliminary Round Sample Exam Paper

Category III – grades 11 and 12

Q1.
What is the most abundant element in the universe?

A) Oxygen
B) Hydrogen
C) Carbon
D) Helium

Q2.
What is the SI unit for measuring energy?

A) Joule
B) Calorie
C) Watt
D) Erg

Q3.
In a reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, increasing the pressure will:

A) Shift the equilibrium to the right.
B) Shift the equilibrium to the left.
C) Have no effect.
D) Increase the concentration of all species.

Q4.
Quicklime is an essential chemical compound with a wide range of applications across various industries, including construction, environmental, agricultural, steelmaking, paper and pulp, and food and pharmaceuticals. Its unique chemical properties and versatility make it a vital component in many processes.
Which substance is commonly known as quicklime?

A) $CaCO_3$
B) CaO
C) $Ca(OH)_2$
D) $CaSO_4$

Q5.
The pH (potential of hydrogen) is a measure of the acidity or basicity of a solution. It's a logarithmic scale that ranges from 0 to 14, with 7 being neutral (neither acidic nor basic).
The pH of a 0.01 M HCl solution is approximately:

A) 2
B) 3
C) 4
D) 10

Q6.

Out of the following compounds: H_2O, Cl_2, H_2SO_3, and F_2, which of these compounds does NOT have a polar covalent bond?

A) only Cl_2
B) H_2O and H_2SO_3
C) only F_2
D) F_2 and Cl_2

Q7.
How many grams of NaOH are required to prepare 250 mL of 0.1 M solution?

A) 4.0
B) 1.0
C) 10.0
D) 0.25

Q8.
Ammonium nitrate is soluble in water and is often used as a nitrogen fertilizer in agriculture, as it provides the nutrient elements required for plant growth.
What is the sum of the oxidation numbers of the nitrogen (N) atoms in the NH_4NO_3 compound?

A) +5
B) +4
C) +3

D) +2

Q9.
Propane is a crucial fuel source with various applications, including domestic and industrial uses, and as a fuel for internal-combustion engines.
What volume of oxygen gas is needed for the complete combustion of 1 mole of propane?

A) 3 moles
B) 5 moles
C) 10 moles
D) 4 moles

Q10.
Hybridization is a fundamental concept in chemistry that plays a crucial role in understanding molecular structure, bonding, and reactivity. By understanding hybridization, chemists can better comprehend the behavior of molecules and design new compounds with specific properties, ultimately leading to advances in various fields, including materials science, pharmaceuticals, and biotechnology.
Which of the following compounds has an sp^3 hybridized central atom?

A) CO_2
B) CH_4
C) C_2H_2
D) C_2H_4

Q11.
Which substance will not react with hydrochloric acid?

A) $CaCO_3$
B) Zn
C) NaOH
D) Cu

Q12.
Identify the reducing agent in the following reaction:
$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

A) MnO_4^-
B) $C_2O_4^{2-}$
C) H^+
D) H_2O

Q13.
Which type of isomerism is exhibited by $C_2H_4Br_2$?

A) Structural
B) Geometrical
C) Optical
D) Conformational

Q14.
What is the main product when $CH_3CH=CH_2$ reacts with HBr?

A) $CH_3CHBrCH_3$
B) $CH_3CH_2CH_2Br$
C) $CH_3CH_2CHBr_2$
D) $CH_3CHBr_2CH_3$

Q15.
Which allotropic modification of phosphorus has the highest reactivity?

A) White (P_4)
B) Red
C) Purple
D) Black

Q16.
The standard reduction potentials of the following half-reactions are:
$Zn^{2+} + 2e^- \rightarrow Zn$ ($E° = -0.76$ V)
$Cu^{2+} + 2e^- \rightarrow Cu$ ($E° = +0.34$ V)
What is the standard cell potential (E°cell) for the reaction?
$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

A) 1.10 V
B) 0.42 V
C) -1.10 V
D) -0.42 V

Q17.
Stereoisomers are molecules with the same molecular formula but different spatial arrangements of atoms, resulting in distinct physical properties. Enantiomers are non-superimposable mirror images, while diastereomers and atropisomers have different spatial arrangements without mirror-image.
How many stereoisomers exist for 2-bromo-3-chlorobutane?

A) 2
B) 4
C) 6
D) 8

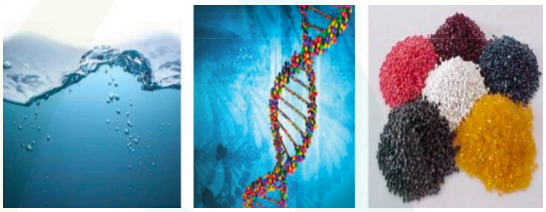
Q18.
For the reaction $2A + B \rightarrow C$, the rate law is given as:
Rate = $k[A]^2[B]$
If the concentration of A is doubled and B is halved, by what factor will the reaction rate change?

A) 0.5
B) 2
C) 4
D) 8

Q19.
Which of the following will act as a bidentate ligand?

A) Cl^-
B) H_2O
C) $C_2O_4^{2-}$
D) NH_3

Q20.
Hydrogen bond is an electrostatic force of attraction by a hydrogen (H) atom, which is covalently bound to a more electronegative atom or group of atoms, on neighboring molecules. Hydrogen bonds are present everywhere in almost all areas of life, e.g. in water molecules, human DNA, proteins, nylon.



I. HF
1I. H_2S
III. NH_3
IV. CH_4
Which substances have hydrogen bonds between their molecules in liquid state?

A) I-II
B) II-III
C) I-III
D) III-IV