Brainiacs Chemistry Olympiad Preliminary Round Sample Exam Paper

Category II – grades 9 and 10

Q1.
What does **isotope** mean?

A) It's a different simple substance containing the same element.
B) It's the atoms of the same element, which have the same nuclear charge, but the different number of neutrons
C) It's the atoms of the same element, which have the different nuclear charge, but the same number of neutrons
D) It's the atoms of the different elements, but with the same number of neutrons

Q2.
The chloride of element **Q** is hydrolyzed by water to form an acidic solution and its oxide reacts with acid to form a salt. What could be the element **Q**?

A) Magnesium
B) Aluminium
C) Silicon
D) Phosphorus

Q3.
Balance the chemical equation and calculate the sum of the coefficients in the reaction:

$$H_2S + H_2SO_4 \rightarrow S + H_2O$$

Sum of coefficients is equal to:

A) 5
B) 6
C) 12
D) 8

Q4.
A compound exhibits the following properties:
- High melting and boiling points
- Conducts electricity in molten state but not in solid state

Which type of bonding is present in this compound?

A) Covalent
B) Ionic
C) Metallic

D) Hydrogen bonding

Q5.
The first ionization energy decreases down Group 1 because:

A) Nuclear charge decreases
B) Shielding effect increases
C) Atomic radius decreases
D) Electron affinity increases

Q6.
Chloroethane is used as a starting material for the production of 'time-release capsules' in pharmaceutical products. One way of preparing chloroethane is to react chlorine and ethane in the presence of ultraviolet light. Which statement is correct about the first stage of the mechanism of this reaction?

A) The Cl – Cl bond is split homolytically.
B) The Cl – Cl bond is split heterolytically.
C) The C – H bond is split homolytically.
D) The C – H bond is split heterolytically

Q7.
Calculate the standard enthalpy change (ΔH) for the following reaction using bond enthalpies:

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Given: Bond enthalpies (kJ/mol): H-H: 436, Cl-Cl: 243, H-Cl: 431.

A) -185 kJ
B) -245 kJ
C) -431 kJ
D) -256 kJ

Q8.

Which of the following reactions is an example of decomposition?

A) $H_2 + Cl_2 \rightarrow 2HCl$
B) $2H_2O \rightarrow 2H_2 + O_2$
C) $Na + Cl_2 \rightarrow NaCl$
D) $NH_3 + HCl \rightarrow NH_4Cl$

Q9.

What is the empirical formula of a compound with 40% carbon, 6.7% hydrogen, and 53.3% oxygen?

A) CHO
B) CH_2O
C) $C_2H_4O_2$
D) CH_3O

Q10.

What is the product when ethanol is oxidized using an oxidizing agent like potassium dichromate?

A) Methanol
B) Ethanal
C) Ethanoic acid
D) Ethene

Q11.
The pH of a solution changes from 4 to 2. What happens to the hydrogen ion concentration?

A) Increases by 2 times
B) Increases by 10 times
C) Increases by 100 times
D) Remains the same

Q12.
For a second-order reaction, the initial concentration of the reactant is 0.5 M, and its half-life is 10 s. Calculate the rate constant.

A) 0.2 L/mol·s
B) 0.4 L/mol·s
C) 0.1 L/mol·s
D) 0.05 L/mol·s

Q13.
A sample of 0.50 g of an organic compound containing only C, H, and O yields 1.32 g CO_2 and 0.54 g H_2O upon combustion. Determine the empirical formula.

A) CHO
B) CH_2O
C) C_2H_4O
D) C_2H_6O

Q14.

Explain why ionic compounds have high melting and boiling points.

A) Because of strong electrostatic forces
B) Because of weak Van der Waals forces
C) Because of strong covalent bonds
D) Because of presence of delocalized electrons

Q15.

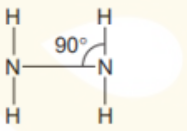
The African weaver ant defends its territory by spraying an intruder with a mixture of compounds. The ease by which these compounds are detected by other ants depends upon the volatility, which decreases as the strength of the intermolecular forces in the compound increases.

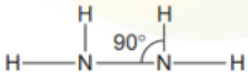
Which compound would be the most volatile?

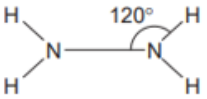
A) $CH_3CH_2CH_2CH_2CH_2CH_3$
B) $CH_3CH_2CH_2CH_2CH_2CHO$
C) $CH_3CH_2CH_2CH_2CH_2NH_2$
D) $CH_3CH_2CH_2CH_2CH_2OH$

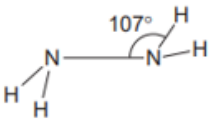
Q16.

Which is the most likely shape of a molecule of hydrazine, N_2H_4?

A 

B 

C 

D 

Q17.

In the contact process for manufacturing sulfuric acid, sulfur dioxide is oxidized to sulfur trioxide using a V_2O_5 catalyst. Write the balanced equation for this step.

A) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

B) $SO_2 + O_2 \rightleftharpoons SO_3$

C) $2SO_2 \rightleftharpoons SO_3 + O_2$

D) $SO_2 + O_2 \rightarrow SO_3$

Q18.

River water in a chalky agricultural area may contain Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^-, Cl^-, and NO_3^- ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide. What will be precipitated following the addition of calcium hydroxide?

A) $CaCl_2$

B) $CaCO_3$

C) $MgCO_3$

D) $Mg(NO_3)_2$

Q19.

Compound **X** undergoes the following reactions.

$$\underset{\textbf{X}}{C_4H_9Br} \xrightarrow{NaOH(aq)\,/\,heat} C_4H_{10}O \xrightarrow{Cr_2O_7^{2-},\,H^+(aq)\,/\,heat} C_4H_8O \text{ only}$$

What is **X**?

A) 1-bromobutane

B) 2-bromobutane

C) 1-bromo-2-methylpropane

D) 2-bromo-2-methylpropane

Q20.

Which factor does NOT affect the rate of a chemical reaction?

A) Temperature

B) Concentration
C) Presence of catalyst
D) Density of reactants