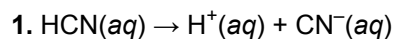


SAT Chemistry Practice Paper 21

SET 1



Hydrocyanic acid dissociates according to the reaction given above. Which of the following expressions is equal to the acid dissociation constant for HCN?

A. $[\text{H}^+][\text{CN}^-]$

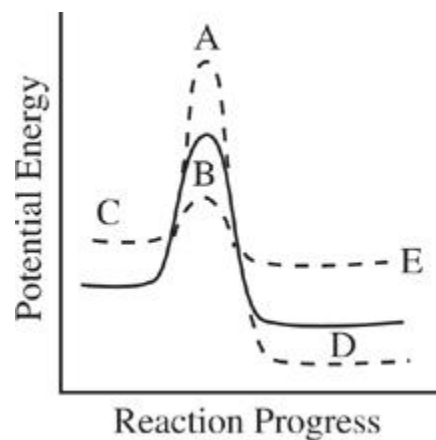
B. $[\text{H}^+][\text{CN}^-][\text{HCN}]$

C. $\frac{[\text{HCN}]}{[\text{H}^+][\text{CN}^-]}$

D. $\frac{[\text{H}^+][\text{CN}^-]}{[\text{HCN}]}$

E. $\frac{1}{[\text{H}^+][\text{CN}^-][\text{HCN}]}$

2. The reaction progress diagram of an uncatalyzed reaction is shown by the solid line. Which dotted line presents the same reaction in the presence of a catalyst?



A.

B.

C.

D.

E.

3. In a hydrogen atom, when an electron jumps from an excited energy state to a more stable energy state,

- A. electromagnetic radiation is emitted by the atom
- B. electromagnetic radiation is absorbed by the atom
- C. the atom becomes a positively charged ion
- D. the atom becomes a negatively charged ion
- E. the atom undergoes nuclear decay

4. A closed 5-liter vessel contains a sample of neon gas. The temperature inside the container is 25°C, and the pressure is 1.5 atmospheres. (The gas constant, R , is equal to 0.08 L·atm/mol·K.)

Which of the following expressions is equal to the molar quantity of gas in the sample?

A. $\frac{(1.5)(5.0)}{(0.08)(25)}$ moles

B. $\frac{(0.08)(25)}{(1.5)(5.0)}$ moles

C. $\frac{(1.5)(25)}{(0.08)(5.0)}$ moles

D. $\frac{(0.08)(298)}{(1.5)(5.0)}$ moles

E. $\frac{(1.5)(5.0)}{(0.08)(298)}$ moles

5. A closed 5-liter vessel contains a sample of neon gas. The temperature inside the container is 25°C, and the pressure is 1.5 atmospheres. (The gas constant, R , is equal to 0.08 L·atm/mol·K.)

If the neon gas in the vessel is replaced with an equal molar quantity of helium gas, which of the following properties of the gas in the container will be changed?

- I. Pressure
 - II. Temperature
 - III. Density
- A. I only
 - B. II only
 - C. III only
 - D. I and II only
 - E. II and III only

6. A closed 5-liter vessel contains a sample of neon gas. The temperature inside the container is 25°C, and the pressure is 1.5 atmospheres. (The gas constant, R , is equal to 0.08 L·atm/mol·K.)

The volume of the vessel was gradually changed while temperature was held constant until the pressure was measured at 1.6 atmospheres. Which of the following expressions is equal to the new volume?

A. $5.0 \times \frac{1.5}{1.6}$ liters

B. $5.0 \times \frac{1.6}{1.5}$ liters

C. $25 \times \frac{1.5}{1.6}$ liters

D. $0.08 \times \frac{1.6}{1.5}$ liters

E. $0.08 \times \frac{1.5}{1.6}$ liters

7. An oxidation-reduction reaction takes place in a chemical cell, and the flow of electrons is used to provide energy for a lightbulb. Which of the following statements is true of the reaction?

A. The reaction is nonspontaneous and has a positive voltage.

B. The reaction is nonspontaneous and has a negative voltage.

C. The reaction is at equilibrium and has a voltage of zero.

D. The reaction is spontaneous and has a positive voltage.

E. The reaction is spontaneous and has a negative voltage.

8. A solution containing which of the following pairs of species could be a buffer?

A. H^+ and Cl^-

B. H_2CO_3 and HCO_3^-

C. Na^+ and NO_3^-

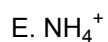
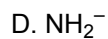
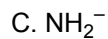
D. Na^+ and OH^-

E. HNO_3 and NO_3^-

9. Which of the following species is the conjugate acid of ammonia (NH_3)?

A. N_2

B. H_2



10. A solution of H_2SO_3 is found to have a hydrogen ion concentration of 1×10^{-3} molar at 25°C . What is the hydroxide ion concentration in the solution?

A. 1×10^{-13} molar

B. 1×10^{-11} molar

C. 1×10^{-7} molar

D. 1×10^{-4} molar

E. 1×10^{-3} molar

11. Which of the following expressions is equal to the number of iron (Fe) atoms present in a pure sample of solid iron with a mass of 10 grams? (The atomic mass of iron is 55.9.)

A. $(10.0)(55.9)(6.02 \times 10^{23})$ atoms

B. $\frac{(6.02 \times 10^{23})}{(10.0)(55.9)}$ atoms

C. $\frac{(10.0)(6.02 \times 10^{23})}{(55.9)}$ atoms

D. $\frac{(55.9)}{(10.0)(6.02 \times 10^{23})}$ atoms

E. $\frac{(10.0)}{(55.9)(6.02 \times 10^{23})}$ atoms

12. A radioactive material is undergoing nuclear decay. After 40 minutes, 25 percent of the sample remains. What is the half-life of the sample?

A. 10 minutes

B. 20 minutes

C. 40 minutes

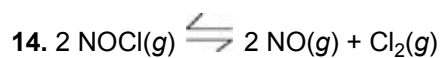
D. 80 minutes

E. 160 minutes

Element	First Ionization Energy (kJ/mol)
Lithium	520
Sodium	496
Rubidium	403
Cesium	376

13. Based on the table above, which of the following is most likely to be the first ionization energy for potassium?

- A. 536 kJ/mol
- B. 504 kJ/mol
- C. 419 kJ/mol
- D. 391 kJ/mol
- E. 358 kJ/mol



Which of the following expressions gives the equilibrium constant for the reaction above?

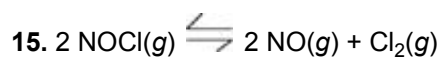
A. $\frac{[\text{NOCl}]}{[\text{NO}][\text{Cl}_2]}$

B. $\frac{[\text{NO}][\text{Cl}_2]}{[\text{NOCl}]}$

C. $\frac{[\text{NOCl}]^2}{[\text{NO}]^2 [\text{Cl}_2]}$

D. $\frac{[\text{NO}]^2 [\text{Cl}_2]}{[\text{NOCl}]^2}$

E. $\frac{[\text{NOCl}]^2}{[\text{NO}]^2 [\text{Cl}_2]^2}$



Which of the following changes to the equilibrium above would serve to decrease the concentration of Cl_2 ?

- I. The addition of $\text{NOCl}(g)$ to the reaction vessel

II. The addition of $\text{NO}(g)$ to the reaction vessel

III. A decrease in the volume of the reaction vessel

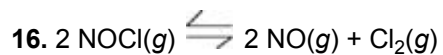
A. I only

B. II only

C. I and II only

D. I and III only

E. II and III only



Which of the following is true of the reaction above as it proceeds in the forward direction?

A. $\text{NO}(g)$ is produced at the same rate that $\text{NOCl}(g)$ is consumed.

B. $\text{NO}(g)$ is produced at half the rate that $\text{NOCl}(g)$ is consumed.

C. $\text{NO}(g)$ is produced at twice the rate that $\text{NOCl}(g)$ is consumed.

D. $\text{Cl}_2(g)$ is produced at the same rate that $\text{NOCl}(g)$ is consumed.

E. $\text{Cl}_2(g)$ is produced at twice the rate that $\text{NOCl}(g)$ is consumed.

17. Which of the following is an organic molecule?

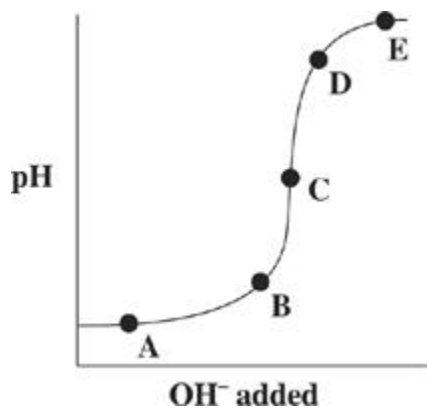
A. SiO_2

B. NH_3

C. H_2O

D. CH_4

E. BeF_2



18. The graph above represents the titration of a strong acid with a strong base. Which of the points shown on the graph indicates the equivalence point in the titration?

- A. A
- B. B
- C. C
- D. D
- E. E

19. Which of the following statements about fluorine is NOT true?

- A. It is the most electronegative element.
- B. It contains 19 protons in its nucleus.
- C. Its compounds can engage in hydrogen bonding.
- D. It takes the oxidation state -1 .
- E. It is found in nature as a diatomic gas.

20. The reactivity and chemical behavior of an atom is governed by many factors. The most important factor is

- A. the number of protons in the atom's nucleus
- B. the number of neutrons in the atom's nucleus
- C. the number of protons and neutrons in the atom's nucleus
- D. the ratio of protons to neutrons in the atom's nucleus
- E. the number of electrons in the atom's valence shell

21. A beaker contains a saturated solution of copper(I) chloride, a slightly soluble salt with a solubility product of 1.2×10^{-6} . The addition of which of the salts listed below to the solution would cause the precipitation of copper(I) chloride?

- A. Sodium chloride
- B. Potassium bromide
- C. Silver(I) nitrate
- D. Lead(II) acetate
- E. Magnesium iodide

22. Bromothymol blue is an acid/base indicator with a pK_a of 6.8. Therefore, at approximately what pH will bromothymol blue undergo a color change during an acid/base titration?

- A. 1
- B. 3
- C. 5
- D. 7
- E. 13

23. Which of the following is necessarily true of a nonionic substance with a high boiling point?

- A. It has a large vapor pressure.
- B. It has strong intermolecular attractive forces.
- C. It has a low freezing point.
- D. It has a low heat of vaporization.
- E. It will be present in gas phase at very low temperatures.

SET 2

1. Which of the following compounds would be expected to have the greatest lattice binding energy?

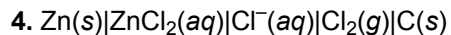
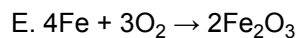
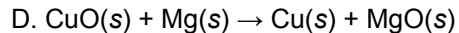
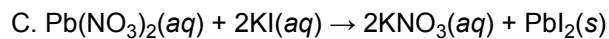
- A. LiNO_3
- B. LiF
- C. KI
- D. NH_4Br
- E. CsNO_3

2. The daughter nucleus formed when ^{18}F undergoes positron emission is

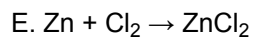
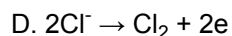
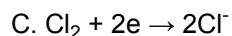
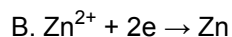
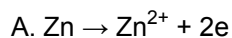
- A. ^{14}N
- B. ^{16}O
- C. ^{18}O
- D. ^{19}F
- E. ^{20}Ne

3. Which of the following reactions produces a yellow precipitate?

- A. $\text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{NaCl}(s) + \text{H}_2\text{O}$
- B. $\text{NaOH}(aq) + \text{BaCl}_2(aq) \rightarrow \text{BaOH}(s) + \text{NaCl}(aq)$



In the electrochemical cell described by the cell diagram above, what reaction occurs at the anode?



5. Given the reaction $\text{A} \rightarrow \text{B} + \text{C}$, where ΔH_{rxn} is negative, what effect would increasing the temperature (at constant pressure) have on the system at equilibrium?

A. No change

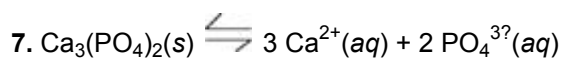
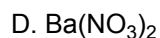
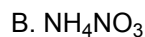
B. Cannot be determined

C. Shift to the right

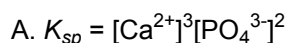
D. Shift to the left for $K < 1$ and to the right for $K > 1$

E. Shift to the left

6. An unknown acid solution was presumed to be either HCl or H_2SO_4 . Which one of the following salt solutions would produce a precipitate when added to H_2SO_4 but not when added to HCl ?



What is the equilibrium expression for the dissolution of $\text{Ca}_3(\text{PO}_4)_2$ where the above is true?



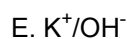
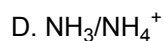
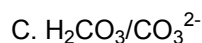
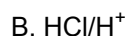
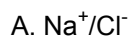
B. $K_{sp} = [\text{Ca}^{2+}]^2[\text{PO}_4^{3-}]^3$

C. $K_{sp} = [\text{Ca}^{2+}][\text{PO}_4^{3-}]/[\text{Ca}_3(\text{PO}_4)_2]$

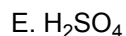
D. $K_{sp} = [\text{Ca}^{2+}]^3[\text{PO}_4^{3-}]^2/[\text{Ca}_3(\text{PO}_4)_2]$

E. $K_{sp} = [\text{Ca}^{2+}]^2[\text{PO}_4^{3-}]^3/[\text{Ca}_3(\text{PO}_4)_2]$

8. Which of the following represents a conjugate acid/base pair?



9. An unknown solution having a pH of 3.5 was titrated with 0.1 M NaOH. Analysis of the resulting titration curve showed a single equivalence point at pH 7. Therefore, which of the following could be the unknown solute in the initial solution?



10. Acid/base titration experiments could be used to determine all of the following directly EXCEPT

A. the acid concentration of an acidic solution

B. the alkalinity of a basic solution

C. the $\text{p}K_a$ of an unknown weak acid

D. whether an unknown acid is monoprotic or polyprotic

E. the molecular weight of an unknown acid or base

11. What is the correct term for the phase change from gas directly to solid?

A. Deposition

B. Sublimation

C. Liquefaction

D. Fusion

E. Vaporization

12. What is the correct name for a straight-chained organic compound with the molecular formula C_3H_8 ?

A. Methane

B. Ethane

C. Methylethane

D. Propane

E. Isopropane

13. If the pH of a solution is changed from 1 to 3 with the addition of an antacid, what percentage of $[H^+]$ was neutralized?

A. 2%

B. 10%

C. 20%

D. 90%

E. 99%

14. Which of the following statements is the most accurate with regard to the significance of Avogadro's number, 6.02×10^{23} ?

A. It is the conversion factor between grams and atomic mass units.

B. It is a universal physical constant just as the speed of light.

C. It is the number of particles that is required to fill a 1-liter container.

D. It is the inverse diameter of an H atom.

E. It is the number of electrons in the universe.

	Appearance	Reactions with dilute HCl	Reaction with dilute HNO_3
Unknown metal #1	Dull gray solid with white oxide coating	Dissolved with bubbles of clear gas	Dissolved with bubbles of clear gas
Unknown metal #2	Solid; lustrous, smooth silver-gray surface	No reaction	Dissolved with bubbles of orange gas

15. Unknown metal #1 could be

A. mercury

- B. copper
- C. zinc
- D. iron
- E. silver

	Appearance	Reactions with dilute HCl	Reaction with dilute HNO ₃
Unknown metal #1	Dull gray solid with white oxide coating	Dissolved with bubbles of clear gas	Dissolved with bubbles of clear gas
Unknown metal #2	Solid; lustrous, smooth silver-gray surface	No reaction	Dissolved with bubbles of orange gas

16. Unknown metal #2 could be

- A. carbon
- B. copper
- C. zinc
- D. sodium
- E. silver

	Appearance	Reactions with dilute HCl	Reaction with dilute HNO ₃
Unknown metal #1	Dull gray solid with white oxide coating	Dissolved with bubbles of clear gas	Dissolved with bubbles of clear gas
Unknown metal #2	Solid; lustrous, smooth silver-gray surface	No reaction	Dissolved with bubbles of orange gas

17. The addition of dilute HCl to unknown metal #1 produced a transparent gas. What is the likely identity of this gas?

- A. Cl₂
- B. H₂
- C. O₂
- D. CO₂
- E. NO₂

	Appearance	Reactions with dilute HCl	Reaction with dilute HNO ₃
Unknown metal #1	Dull gray solid with white oxide coating	Dissolved with bubbles of clear gas	Dissolved with bubbles of clear gas
Unknown metal #2	Solid; lustrous, smooth silver-gray surface	No reaction	Dissolved with bubbles of orange gas

18. The addition of dilute HNO₃ to unknown metal #2 produced an orange gas. What is the likely identity of this gas?

- A. Cl₂
- B. H₂
- C. O₂
- D. CO₂
- E. NO₂

19. Which of the following solutions is the product of the neutralization reaction between 10 ml 0.2 M KOH and 10 ml 0.2 M HI?

- A. 0.1 M KI₃
- B. 0.1 M KI
- C. 0.2 M KI
- D. 0.4 M KI
- E. 0.4 M HOH

20. Which of the following is true regarding an Ne atom with a mass number of 20 and an O²⁻ ion with a mass number of 16?

- A. They contain the same number of protons.
- B. They contain the same number of neutrons.
- C. They contain the same number of protons plus neutrons.
- D. They are isoelectronic.
- E. They are isomers.

21. Which of the following statements is NOT correct regarding chemical catalysts?

- A. They are not consumed during the chemical reaction.

- B. They cannot make nonspontaneous reactions occur.
- C. They do not have to be the same phase as the reactant molecules.
- D. They shift equilibrated reactions to the product's side.
- E. Enzymes are biological catalysts.

22. Most elements are solids at 25°C and 1 atm pressure, the exception being the 11 elements that are gases and 2 that are liquids. What 2 elements are liquids?

- A. Hg and Br
- B. Hg and I
- C. Ag and Kr
- D. Au and Kr
- E. Pt and Co

23. A student conducted an experiment and obtained three values during three repetitive trials: 1.65, 1.68, 1.71. Later, the student discovered that the true value was 2.37. In contrast to the real value, the experimental results should be characterized as

- A. not accurate and not precise
- B. accurate but not precise
- C. not accurate but precise
- D. accurate and precise
- E. accurate, precise, but unreliable