Test: 2021 Chemistry NCE

Question 1 of 75

Which is the part of an experiment that serves as the point of comparison for the results?

- **A)** Hypothesis
- **B)** Independent variable
- **C)** Constant
- **D)** Control

Question 2 of 75

Which is the term used for the measurement of the average kinetic energy of the particles of a substance?

- **A)** Density
- **B)** Temperature
- **C)** Length
- **D)** Mass

Question 3 of 75

Which value has only 4 significant digits?

- **A)** 6.930
- **B)** 0.045
- **C)** 8450
- **D)** 0.392

Question 4 of 75

What is the distance that light travels through a vacuum in 1/299 792 458 of a second?

- **A)** Centimeter
- **B)** Kilometer
- **C)** Meter
- **D)** Nanometer

Question 5 of 75

Which scientist described a positively charged core (“nucleus”) in the middle of a lot of empty space?

- **A)** Chadwick
- **B)** Thomson
- **C)** Rutherford
- **D)** Bohr

Question 6 of 75

Which scientist described an atom made of a solid positively charged substance with electrons dispersed throughout it?

- **A)** Chadwick
- **B)** Thomson
- **C)** Rutherford
- **D)** Bohr

Question 7 of 75

Which scientist described the existence of the neutron?

- **A)** Chadwick
- **B)** Thomson
- **C)** Rutherford
- **D)** Bohr

Question 8 of 75

Radioactive decay of ^{81}Rb involves _____ , resulting in the formation of ^{81}Kr and the emission of an X-ray photon.

- **A)** Beta decay
- **B)** Electron capture
- **C)** Gamma emission
- **D)** Positron emission

Question 9 of 75

Under certain conditions, some nuclei can emit _____ radiation.

- **A)** Alpha
- **B)** Beta
- **C)** Gamma
- **D)** Alpha, beta, & gamma

Question 10 of 75

Why are boron or cadmium rods used in a nuclear fission reactor?

- **A)** To absorb the alpha emission
- **B)** To absorb the neutrons produced
- **C)** To protect people from radiation
- **D)** To provide chemical combustion

Question 11 of 75

How does the nucleus of an atom change after a gamma irradiation?

- **A)** The atomic mass reduces by four and the atomic number reduces by two.
- **B)** The atomic mass remains the same, but the atomic number increases by one.
- **C)** The atomic mass remains the same, but energy is lost as the nucleus decays.
- **D)** The atomic mass changes by one, but the atomic number remains the same.

Question 12 of 75

Which scientist classified elements into four categories: gases, metals, nonmetals, and earths?

- **A)** Mendeleev
- **B)** Lavoisier
- **C)** Newlands
- **D)** Mosely

Question 13 of 75

Which scientist characterized the “law of octaves”?

- **A)** Mendeleev
- **B)** Lavoisier
- **C)** Newlands
- **D)** Mosely

Question 14 of 75

Which are the spectator ions in the reaction shown?

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

- **A)** Cl^-, Na^+, NO_3^-
- **B)** Ag^+, Na^+, NO_3^-
- **C)** Ag^+, Cl^-
- **D)** Na^+, NO_3^-

Question 15 of 75

Which type of reaction can be recognized by the general pattern A + BC → AC + B?

- **A)** Combustion
- **B)** Synthesis
- **C)** Single replacement
- **D)** Decomposition

Question 16 of 75

The _____ law of thermodynamics states that energy is neither created nor destroyed.

- **A)** first
- **B)** third
- **C)** second
- **D)** fourth

Question 17 of 75

One calorie equals _____ joules.

- **A)** 0.4184
- **B)** 4.184
- **C)** 41.84
- **D)** 418.4

Question 18 of 75

What is the equation for calculating heat?

- **A)** $c = m \times q \times \Delta T$
- **B)** $m = c \times q \times \Delta T$
- **C)** $q = c \times m \times \Delta T$
- **D)** $\Delta T = c \times m \times q$

Question 19 of 75

Which of the following statements about a catalyst is true?

- **A)** A catalyst can initiate a reaction.
- **B)** A catalyst can accelerate a reaction.
- **C)** A catalyst can be consumed during a reaction.
- **D)** A catalyst can be changed during a reaction.

Question 20 of 75

A/An _____ is a substance that slows down the rate of a reaction.

- **A)** Catalyst
- **B)** Inhibitor
- **C)** Reactant
- **D)** Product

Question 21 of 75

The sequence of steps that occurs in a reaction process is called the

- **A)** Order of the reaction
- **B)** Rate law
- **C)** Overall reaction
- **D)** Reaction mechanism

Question 22 of 75

When acids react with metals, they produce _____ gas.

- **A)** Hydrogen
- **B)** Nitrogen
- **C)** Sulfur
- **D)** Oxygen

Question 23 of 75

A _____ is produced when a base accepts a hydrogen ion from an acid.

- **A)** Conjugate acid
- **B)** Conjugate base
- **C)** Acid
- **D)** Base

Question 24 of 75

The _____ of a weak acid is strong.

- **A)** Conjugate acid
- **B)** Conjugate base
- **C)** Acid
- **D)** Base

Question 25 of 75

Redox equations are _____ when the total increase in oxidation numbers equals the total decrease in oxidation numbers.

- **A)** Balanced
- **B)** Combined
- **C)** Different
- **D)** Equal

Question 26 of 75

A/An _____ agent is a substance that has the potential to cause another substance to be reduced.

- **A)** Reducing
- **B)** Oxidizing
- **C)** Chemical
- **D)** Biological

Question 27 of 75

The electrode where oxidation takes place is called the:

- **A)** Anode
- **B)** Cathode
- **C)** Cell
- **D)** Dry cell

Question 28 of 75

A voltaic cell converts _____ energy to _____ energy.

- **A)** Chemical, electrical
- **B)** Electrical, chemical
- **C)** Kinetic, potential
- **D)** Potential, kinetic

Question 29 of 75

Which term is described as the lowest whole-number ratio of elements in a compound?

- **A)** Hydrate
- **B)** Molecular formula
- **C)** Empirical formula
- **D)** Percent composition

Question 30 of 75

The name of a hydrate is calcium chloride dihydrate. What is its formula?

- **A)** $CaCl_2 \cdot H_4O_2$
- **B)** $CaCl_2 \cdot 2H_2O$
- **C)** $2CaCl_2 \cdot H_2O$
- **D)** $CaCl_2 \cdot H_2O$

Question 31 of 75

Which of the following visible colors of light has the highest frequency?

- **A)** Green
- **B)** Red
- **C)** Blue
- **D)** Yellow

Question 32 of 75

The heat that is felt from a hot object is called _____ radiation.

- **A)** Ultraviolet
- **B)** Gamma
- **C)** Infrared
- **D)** X-ray

Question 33 of 75

Define energy.

- **A)** the flow of energy caused by a chemical reaction
- **B)** the flow of energy caused by a temperature difference
- **C)** the result of a force acting through a distance
- **D)** the capacity to do work

Question 34 of 75

Which of the following signs on q and w represent a system that is doing work on the surroundings, as well as losing heat to the surroundings?

- **A)** q = –, w = –
- **B)** q = +, w = +
- **C)** q = –, w = +
- **D)** q = +, w = –

Question 35 of 75

Choose the reaction that illustrates ΔH°_f for $Ba(NO_3)_2$.

- **A)** $Ba(s) + N_2(g) + 3\ O_2(g) \rightarrow Ba(NO_3)_2(s)$
- **B)** $Ba_2^{+}(aq) + 2\ NO_3^{-}(aq) \rightarrow Ba(NO_3)_2(aq)$
- **C)** $Ba(s) + 2\ N(g) + 6\ O(g) \rightarrow Ba(NO_3)_2(s)$
- **D)** $Ba(NO_3)_2(aq) \rightarrow Ba_2^{+}(aq) + 2\ NO_3^{-}(aq)$

Question 36 of 75

A molecule with a trigonal bipyramidal molecular geometry has a bond angle of

- **A)** < 120° for equatorial bonds and < 90° for axial bonds.
- **B)** 180°.
- **C)** < 90°.
- **D)** 120° for equatorial bonds and 90° for axial bonds.

Question 37 of 75

Give the molecular geometry and number of electron groups for SF_4.

- **A)** square pyramidal, 6 electron groups
- **B)** T-shaped, 5 electron groups
- **C)** octahedral, 6 electron groups
- **D)** seesaw, 5 electron groups

Question 38 of 75

Place the following in order of increasing X-Se-X bond angle, where X represents the outer atoms in each molecule: SeO_2, $SeCl_6$, SeF_2

- **A)** $SeCl_6 < SeF_2 < SeO_2$
- **B)** $SeF_2 < SeO_2 < SeCl_6$
- **C)** $SeF_2 < SeCl_6 < SeO_2$
- **D)** $SeO_2 < SeF_2 < SeCl_6$

Question 39 of 75

What is the conjugate acid of HCO_3^- ?

- **A)** H_2O
- **B)** CO_3^{2-}
- **C)** OH^-
- **D)** H_2CO_3

Question 40 of 75

Which of the following is NOT a conjugate acid-base pair?

- **A)** NH_4^+ / NH_3
- **B)** H_3O^+ / OH^-
- **C)** H_2SO_3 / HSO_3^-
- **D)** $C_2H_3O_2^- / HC_2H_3O_2$

Question 41 of 75

Which one of the following will form an acidic solution in water?

- **A)** NH_4Cl
- **B)** LiF
- **C)** NaI
- **D)** $LiNO_3$

Question 42 of 75

Identify the scientist(s) that were awarded the Nobel Prize in physics for the discovery of radioactivity in 1903.

- **A)** Johannes Geiger, Marie Curie
- **B)** Albert Einstein
- **C)** Antoine-Henri Becquerel, Marie Curie, Pierre Curie
- **D)** Ernest Rutherford, Johannes Geiger

Question 43 of 75

Identify the elements discovered by Marie Curie.

- **A)** polonium and radium
- **B)** radium and cesium
- **C)** argon and xenon
- **D)** radon and xenon

Question 44 of 75

Determine the identity of the daughter nuclide from the positron emission of A=11 / Z=6 C.

- **A)** A=5 / Z=11 B
- **B)** A=7 / Z=11 N
- **C)** A=6 / Z=12 C
- **D)** A=5 / Z=10 B

Question 45 of 75

Which of the following statements is TRUE?

- **A)** If N/Z ratio lies somewhere below 1, the nuclide is stable.
- **B)** If N/Z ratio is too low, there are too many neutrons and the nuclide will undergo beta decay.
- **C)** The valley of stability is the geographic location where many of the known nuclides were first discovered.
- **D)** None of the above is true.

Question 46 of 75

In a hydrogen-oxygen fuel cell,

- **A)** both oxygen and hydrogen atoms are oxidized.
- **B)** both oxygen and hydrogen atoms are reduced.
- **C)** oxygen atoms are reduced and hydrogen atoms are oxidized.
- **D)** oxygen atoms are oxidized and hydrogen atoms are reduced.

Question 47 of 75

What element is being reduced in the following redox reaction?
$MnO_4^-(aq) + H_2C_2O_4(aq) \rightarrow Mn_2^+(aq) + CO_2(g)$

- **A)** C
- **B)** O
- **C)** Mn
- **D)** H

Question 48 of 75

What element is being oxidized in the following redox reaction?
$MnO_4^-(aq) + H_2C_2O_4(aq) \rightarrow Mn_2^+(aq) + CO_2(g)$

- **A)** C
- **B)** O
- **C)** Mn
- **D)** H

Question 49 of 75

Give the characteristic of a first-order reaction having only one reactant.

- **A)** The rate of the reaction is proportional to the square of the concentration of the reactant.
- **B)** The rate of the reaction is proportional to the square root of the concentration of the reactant.
- **C)** The rate of the reaction is proportional to the natural logarithm of the concentration of the reactant.
- **D)** The rate of the reaction is directly proportional to the concentration of the reactant.

Question 50 of 75

Give the characteristic of a zero-order reaction having only one reactant.

- **A)** The rate of the reaction is not proportional to the concentration of the reactant.
- **B)** The rate of the reaction is proportional to the square of the concentration of the reactant.
- **C)** The rate of the reaction is proportional to the square root of the concentration of the reactant.
- **D)** The rate of the reaction is proportional to the natural logarithm of the concentration of the reactant.

Question 51 of 75

Give the characteristic of a second-order reaction having only one reactant.

- **A)** The rate of the reaction is not proportional to the concentration of the reactant.
- **B)** The rate of the reaction is proportional to the square of the concentration of the reactant.
- **C)** The rate of the reaction is proportional to the square root of the concentration of the reactant.
- **D)** The rate of the reaction is proportional to the natural logarithm of the concentration of the reactant.

Question 52 of 75

What data should be plotted to show that experimental concentration data fits a first-order reaction?

- **A)** 1/[reactant] vs. time
- **B)** [reactant] vs. time
- **C)** ln[reactant] vs. time
- **D)** ln(k) vs. 1/T

Question 53 of 75

What data should be plotted to show that experimental concentration data fits a second-order reaction?

- **A)** ln[reactant] vs. time
- **B)** [reactant] vs. time
- **C)** ln(k) vs. 1/T
- **D)** 1/[reactant] vs. time

Question 54 of 75

What data should be plotted to show that experimental concentration data fits a zeroth-order reaction?

- **A)** 1/[reactant] vs. time
- **B)** ln(k) vs. 1/T
- **C)** [reactant] vs. time
- **D)** ln(k) vs. Ea

Question 55 of 75

Give the complete electronic configuration for Br^{-}.

- **A)** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^6$
- **B)** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$
- **C)** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$
- **D)** $1s^2\ 2s^2\ p^6\ 3s^2\ p^6\ 4s^2\ 3d^{10}\ 4p^6$

Question 56 of 75

Define bond energy.

- **A)** energy required to form 1 mole of the bond in the gas phase
- **B)** energy required to break 1 mole of the bond in the liquid phase
- **C)** energy required to break 1 mole of the bond in the gas phase
- **D)** energy required to break 1 mole of the bond in the solid phase

Question 57 of 75

Place the following in order of decreasing XO bond length, where "X" represents the central atom in each of the following compounds or ions: SiO_3^{2-}, CO_2, CO_3^{2-}

- **A)** $CO_2 > CO_3^{2-} > SiO_3^{2-}$
- **B)** $CO_3^{2-} > CO_2 > SiO_3^{2-}$
- **C)** $SiO_3^{2-} > CO_3^{2-} > CO_2$
- **D)** $CO_3^{2-} > SiO_3^{2-} > CO_2$

Question 58 of 75

Which of the following statements is TRUE?

- **A)** There is a "heat tax" for every energy transaction.
- **B)** A spontaneous reaction is always a fast reaction.
- **C)** The entropy of a system always decreases for a spontaneous process.
- **D)** Perpetual motion machines are a possibility in the near future.

Question 59 of 75

The _____ Law of Thermodynamics states A system's entropy approaches a constant value as its temperature approaches absolute zero

- **A)** Zero
- **B)** First
- **C)** Second
- **D)** Third

Question 60 of 75

The _____ Law of Thermodynamics states that for any spontaneous reaction, the entropy of the universe increases.

- **A)** Zero
- **B)** First
- **C)** Second
- **D)** Third

Question 61 of 75

Identify the alkane with the highest boiling point.

- **A)** pentane
- **B)** butane
- **C)** ethane
- **D)** methane

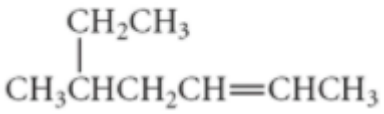
Question 62 of 75

An equimolar mixture of two optical isomers is called

- **A)** an achiral molecule.
- **B)** a diastereomer.
- **C)** an enantiomer.
- **D)** a racemic mixture.

Question 63 of 75

Name the following compound.



- **A)** 4-isobutyl-2-butene
- **B)** 3-methyl-5-hexane
- **C)** 5-methyl-2-heptene
- **D)** 4-isopropyl-2-butene

Question 64 of 75

Which reaction becomes more spontaneous as temperature increases?

- **A)** $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
- **B)** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
- **C)** $3CO_2(g) + 4H_2O(g) \rightarrow C_3H_8(g) + 5O_2(g)$
- **D)** $SO_2(g) + H_2O_2(l) \rightarrow H_2SO_4(l)$

Question 65 of 75

Which apparatus can be used to monitor the rate of this reaction?

$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + H^+(aq) + I^-(aq)$

I. A pH meter
II. A gas syringe
III. A colorimeter

- **A)** I and II only
- **B)** I and III only
- **C)** II and III only
- **D)** I, II and III

Question 66 of 75

Which of the following is correct in an electrolytic cell?

	Electrode	Process at this electrode	Electrons lost or gained at this electrode
A.	Anode (positive)	Oxidation	Gained
B.	Anode (positive)	Reduction	Lost
C.	Cathode (negative)	Oxidation	Lost
D.	Cathode (negative)	Reduction	Gained

- **A)** A
- **B)** B
- **C)** C
- **D)** D

Question 67 of 75

Which of these molecular formulae are also empirical formulae?

I. C_2H_6O
II. $C_2H_4O_2$
III. C_5H_{12}

- **A)** I and II only
- **B)** I and III only
- **C)** II and III only
- **D)** I, II, and III

Question 68 of 75

Which atom does not obey the octet rule?

- **A)** C in CO_2
- **B)** F in BF_3
- **C)** O in H_2O
- **D)** S in SF_6

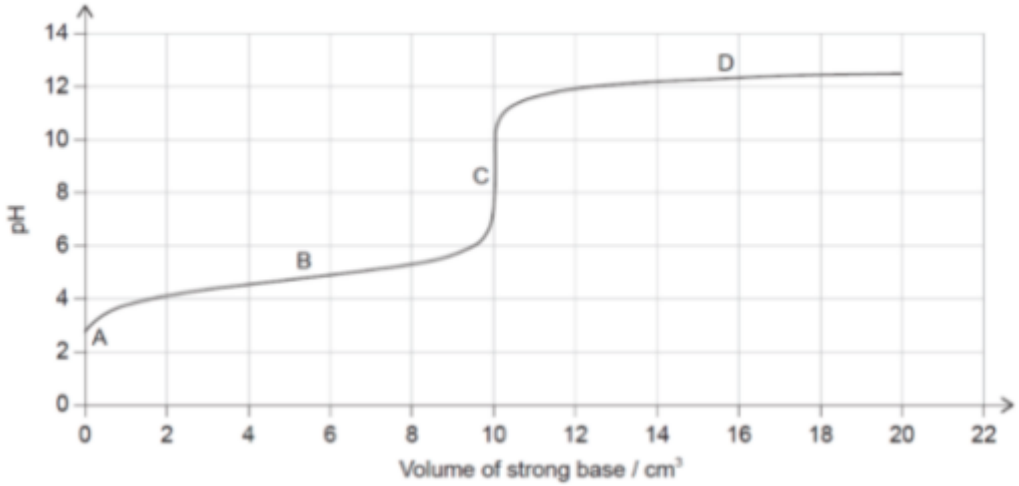
Question 69 of 75

Which is a Lewis acid but not a Brønsted−Lowry acid?

- **A)** $AlCl_3$
- **B)** CH_3CO_2H
- **C)** HF
- **D)** CCl_4

Question 70 of 75

Where is the buffer region for the titration of a weak acid with a strong base?



- **A)** A
- **B)** B
- **C)** C
- **D)** D

Question 71 of 75

Which reaction has the greatest increase in entropy of the system?

- **A)** $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$
- **B)** $(NH_4)2Cr_2O_7(s) \rightarrow Cr_2O_3(s) + N_2(g) + 4H_2O(g)$
- **C)** $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
- **D)** $I_2(g) \rightarrow I_2(s)$

Question 72 of 75

Which has the strongest conjugate base?

- **A)** HCOOH (Ka = 1.8×10^{-4})
- **B)** HNO_2 (Ka = 7.2×10^{-4})
- **C)** HCN (Ka = 6.2×10^{-10})
- **D)** HIO_3 (Ka = 1.7×10^{-1})

Question 73 of 75

Which is not a requirement of the standard hydrogen electrode (SHE)?

- **A)** V = 1 L
- **B)** $p(H_2)$ = 100 kPa
- **C)** use of platinum as the electrode material
- **D)** $[H_3O^+]$ = 1 mol L^{-1}

Question 74 of 75

Which solvent is aprotic?

- **A)** H_2O
- **B)** $C_6H_5CH_3$
- **C)** CH_3OH
- **D)** CH_3NH_2

Question 75 of 75

How is colour produced in transition metal complexes?

- **A)** Light is absorbed when electrons are promoted between split d-orbitals.
- **B)** Light is emitted when electrons fall between split d-orbitals.
- **C)** Light is absorbed when electrons escape from the complex.
- **D)** Light is emitted when the complex returns to ground state.