1 Which statement describes the structure of an atom?

1. The nucleus contains positively charged electrons. (no, electrons are negative, not in nucleus)
2. The nucleus contains negatively charged protons. (no, protons are positive, but are in nucleus)
3. The nucleus has a positive charge and is surrounded by negatively charged electrons. (YES)
4. The nucleus has a negative charge and is surrounded by positively charged electrons. (reversed)

2 Which term is defined as the region in an atom where an electron is most likely to be located?

1. nucleus 2. orbital (YES) 3. quanta 4. spectra

3 What is the number of electrons in an atom of scandium? Scandium's atomic number is 21. Choice 1. 21

4 Which particle has the least mass? 1. proton mass = 1AMU 2. electron (in HS, electrons have no mass)
3. a helium atom mass = 4 AMU 4. a hydrogen atom mass = 1 AMU

5 Which electron transition in an excited atom results in a release of energy?

1. first shell to the third shell (X ↑ = excited) 3. third shell to the fourth shell (X ↑ = excited)
2. second shell to the fourth shell (X ↑ = excited)
4. fourth shell to the second shell (YES ↓ = energy released—and spectra released too)

6 On the Periodic Table, the number of protons in an atom of an element is indicated by its

1. atomic mass 2. atomic number 3. selected oxidation states 4. number of valence electrons

7 Which type of formula shows an element symbol for each atom and a line for each bond between atoms?

1. ionic 2. structural 3. empirical 4. molecular (AKA chemical)

8 What is conserved during all chemical reactions?

1. charge (and mass, and energy) 2. density 3. vapor pressure 4. melting point

9 In which type of reaction can *two compounds exchange ions to form two different compounds*?

1. synthesis 2. decomposition 3. single replacement 4. double replacement

10 At STP, two 5.0-gram solid samples of different ionic compounds have the same density.
These solid samples could be differentiated by their (density = mass/volume and both are at same Temp)

1. mass (X) 2. volume (X) 3. temperature (X) 4. solubility in water

11 What is the number of electrons shared between the atoms in an I_2 molecule? 1. 7 2. 2 3. 8 4. 4
They make a single, nonpolar covalent bond, both have 7 electrons, both need one electron for octet.

12 Which substance has nonpolar covalent bonds?

1. Cl_2 2. SO_3 (different EN values) 3. SiO_2 (different EN values) 4. CCl_4 (different EN values)

13 Compared to a potassium atom, a potassium ion has

1. a smaller radius (lost 1 electron plus orbital) 2. a larger radius 3. fewer protons 4. more protons

14 Which form of energy is associated with the random motion of particles in a gas?

1. chemical 2. electrical 3. nuclear 4. thermal

15 The average kinetic energy of water molecules decreases when The TEMPERATURE DROPS

1. $H_2O_{(L)}$ at 373 K changes to $H_2O_{(L)}$ at 300. K
2. $H_2O_{(L)}$ at 373 K changes to $H_2O_{(G)}$ at 373 K
3. $H_2O_{(S)}$ at 200. K changes to $H_2O_{(S)}$ at 237 K
4. $H_2O_{(S)}$ at 273 K changes to $H_2O_{(L)}$ at 273 K

16 The joule is a unit of 1. concentration 2. energy 3. pressure 4. volume

17 Compared to a sample of helium at STP, the same sample of helium at a higher temperature and a lower pressure

1. condenses to a liquid
2. is more soluble in water
3. forms diatomic molecules
4. behaves more like an ideal gas (this is the KMT)

18 A sample of a gas is in a sealed, rigid container that maintains a constant volume. Which changes occur between the gas particles when the sample is heated?

1. The frequency of collisions increases, and the force of collisions decreases.
2. The frequency of collisions increases, and the force of collisions increases.
3. The frequency of collisions decreases, and the force of collisions decreases.
4. The frequency of collisions decreases, and the force of collisions increases.

19 At STP, which gaseous sample has the same number of molecules as 3.0 liters of $N_{2(G)}$?

This is the Avogadro's Hypothesis question

1. 6.0 L of $F_{2(G)}$ 2. 4.5 L of $N_{2(G)}$ 3. 3.0 L of $H_{2(G)}$ 4. 1.5 L of $Cl_{2(G)}$

20 Distillation of crude oil from various parts of the world yields different percentages of hydrocarbons. Which statement explains these different percentages?

1. Each component in a mixture has a different solubility in water.
2. Hydrocarbons are organic compounds.
3. The carbons in hydrocarbons may be bonded in chains or rings.
4. The proportions of components in a mixture can vary. (vocab)

21 In which 1.0-gram sample are the particles arranged in a crystal structure? SOLIDS are CRYSTALS

1. $CaCl_{2(S)}$ 2. $C_2H_{6(G)}$ 3. $CH_3OH_{(L)}$ 4. $CaI_{2(AQ)}$

22 When a reversible reaction is at equilibrium, the concentration of products and the concentration of reactants must be

1. decreasing 2. increasing 3. constant 4. equal

23 In chemical reactions, the difference between the potential energy of the products and the potential energy of the reactants is equal to the

1. activation energy 2. ionization energy 3. heat of reaction (or ΔH) 4. heat of vaporization

24 What occurs when a catalyst is added to a chemical reaction?

1. an alternate reaction pathway with a lower activation energy
2. an alternate reaction pathway with a higher activation energy
3. the same reaction pathway with a lower activation energy
4. the same reaction pathway with a higher activation energy

25 What is the name of the compound with the formula $CH_3CH_2CH_2NH_2$?

It has 3 carbons (prop) and has to be 2 or 4, but no double bonded oxygen, so it's 2

1. 1-propanol 2. 1-propanamine 3. propanal 4. propanamide

26 Which compound is an isomer of $C_2H_5OC_2H_5$? (same atom count, different shape— 4 C, 10 H, one O)

1. CH_3COOH 2. $C_2H_5COOCH_3$ 3. $C_3H_7COCH_3$ 4. C_4H_9OH

27 Ethanoic acid and 1-butanol can react to produce water and a compound classified as an

1. aldehyde 2. amide 3. ester (vocab) 4. ether

28 During an oxidation-reduction reaction, the number of electrons gained is (perfect transfer of electrons)

1. equal to the number of electrons lost
2. equal to the number of protons gained
3. less than the number of electrons lost
4. less than the number of protons gained

29 Which process requires energy for a nonspontaneous redox reaction to occur?

1. deposition (X physical change)
2. electrolysis (needs electricity to force redox)
3. alpha decay (X nuclear change)
4. chromatography (X physical separation of a mixture)

30 Which pair of compounds represents one Arrhenius acid and one Arrhenius base? (tables K and L)

1. CH_3OH & NaOH 2. CH_3OH & HCl 3. HNO_3 & NaOH 4. HNO_3 & HCl

31 Which electron configuration represents the electrons of an atom of neon in an excited state? (Ne 2-8)

1. 2-7-3 (X too many) 2. 2-8 (Ne ground state) 3. 2-7-1 4. 2-8-1 (X too many)

32 Some information about the two naturally occurring isotopes of gallium is given in the table below.

Isotope	Natural Abundance (%)	Atomic Mass (u)
Ga-69	60.11	68.926
Ga-71	39.89	70.925

Which numerical setup can be used to calculate the atomic mass of gallium?

1. (0.6011)(68.926 u) + (0.3989)(70.925 u)
2. (60.11)(68.926 u) + (39.89)(70.925 u)
3. (0.6011)(70.925 u) + (0.3989)(68.926 u)
4. (60.11)(70.925 u) + (39.89)(68.926 u)

33 A student measures the mass and volume of a sample of copper at room temperature and 101.3 kPa. The mass is 48.9 grams and the volume is 5.00 cubic centimeters. The student calculates the density of the sample. What is the percent error of the student's calculated density? (do math, do % error math)

1. 7.4% 2. 8.4% 3. 9.2% 4. 10.2%

34 What is the chemical formula for sodium sulfate? (Na^{+1} and SO_4^{-2}, criss-cross)

1. Na_2SO_4 2. Na_2SO_3 3. $NaSO_4$ 4. $NaSO_3$

35 Given the balanced equation representing a reaction:

$2Na_{(S)} + Cl_{2(G)} \rightarrow 2NaCl_{(S)}$ energy (this is conservation of mass, an addition problem 46 + 71 =)

If 46 grams of Na and 71 grams of Cl_2 react completely, what is the total mass of NaCl produced?

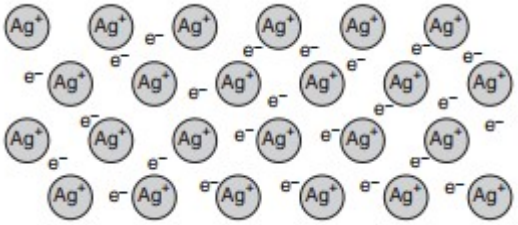
1. 58.5 g 2. 117 g 3. 163 g 4. 234 g

36 Given the balanced equation representing a reaction:

$2NO + O_2 \rightarrow 2NO_2$ energy

The mole ratio of NO to NO_2 is 1. 1 to 1 2. 2 to 1 3. 3 to 2 4. 5 to 2

37 The particle diagram represents a solid sample of silver



Which type of bonding is present when valence electrons move within the sample?

1. metallic bonding 2. hydrogen bonding
3. covalent bonding 4. ionic bonding

38 Given the formula representing a molecule: Which statement explains why the molecule is nonpolar?

1. Electrons are shared between the carbon atoms and the hydrogen atoms.
2. Electrons are transferred from the carbon atoms to the hydrogen atoms.
3. The distribution of charge in the molecule is symmetrical. (polar bonds but with radial symmetry)
4. The distribution of charge in the molecule is asymmetrical.

39 A solid sample of a compound and a liquid sample of the same compound are each tested for electrical conductivity. Which test conclusion indicates that the compound is ionic? (solid ionic has NO loose ions, melted ionic always has loose ionic; nothing about aqueous here in the question)

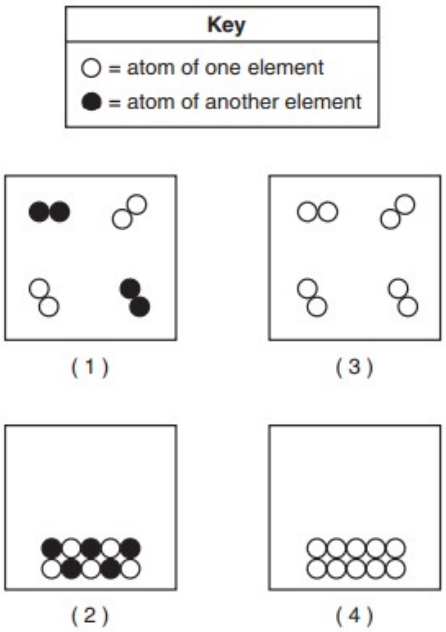
1. Both the solid and the liquid are good conductors.
2. Both the solid and the liquid are poor conductors.
3. The solid is a good conductor, and the liquid is a poor conductor.
4. The solid is a poor conductor, and the liquid is a good conductor.

40 Which statement explains why 10.0 mL of a 0.50 M $H_2SO_{4(AQ)}$(solution exactly neutralizes 5.0 mL of a 2.0 M $NaOH_{(AQ)}$ solution?

1. The moles of $H^+_{(AQ)}$ equal the moles of $OH^-_{(AQ)}$. (the H^{+1} must = the OH^{-1} to neutralize)
2. The moles of $H_2SO_{4(AQ)}$ equal the moles of $NaOH_{(AQ)}$.
3. The moles of $H_2SO_{4(AQ)}$ are greater than the moles of $NaOH_{(AQ)}$.
4. The moles of $H^+_{(AQ)}$ are greater than the moles of $OH^-_{(AQ)}$.

41 Which particle diagram represents one substance in the gas phase?

(1) is 2 substances in the gas phase (H_2 and O_2 maybe)
(2) is a solid
(3) one diatomic element (maybe N_2 or F_2)
(4) another solid



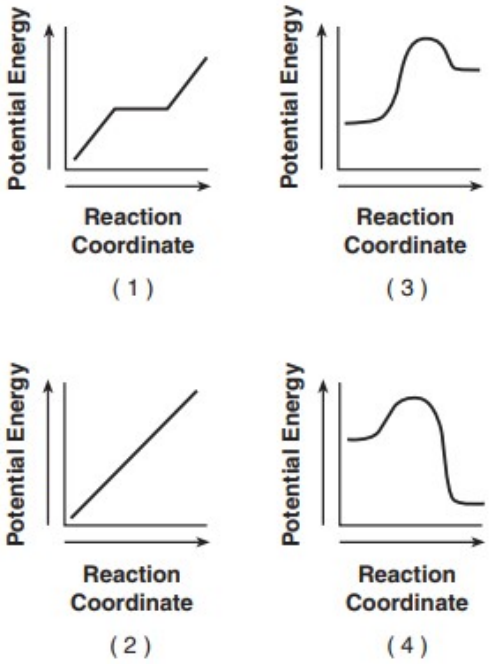
42 Given the equation representing a chemical reaction at equilibrium in a sealed, rigid container:

$$H_{2(G)} + I_{2(G)} + \text{energy} \rightarrow 2HI_{(G)}$$

When the concentration of $H_{2(G)}$ is increased by adding more hydrogen gas to the container at constant temperature, the equilibrium shifts
1. to the right, and the concentration of $HI_{(G)}$ decreases
2. to the right, and the concentration of $HI_{(G)}$ increases (they should have said forward!)
3. to the left, and the concentration of $HI_{(G)}$ decreases
4. to the left, and the concentration of $HI_{(G)}$ increases

43 Which diagram represents the potential energy changes during an exothermic reaction?

(1) X part of a heating curve
(2) X endothermic PE diagram
(3) X fake graph
(4) YES, exo thermic reaction PE diagram



44 Which compound is classified as an ether? (needs an "oxygen bridge in the middle"

1. CH_3CHO 2. CH_3OCH_3 3. CH_3COCH_3 4. CH_3COOCH_3

45 Given the equation representing a reversible reaction:

$HCO_3^{-1}{}_{(AQ)} + H_2O_{(L)} \leftrightarrow H_2CO_{3(AQ)} + OH^{-1}{}_{(AQ)}$

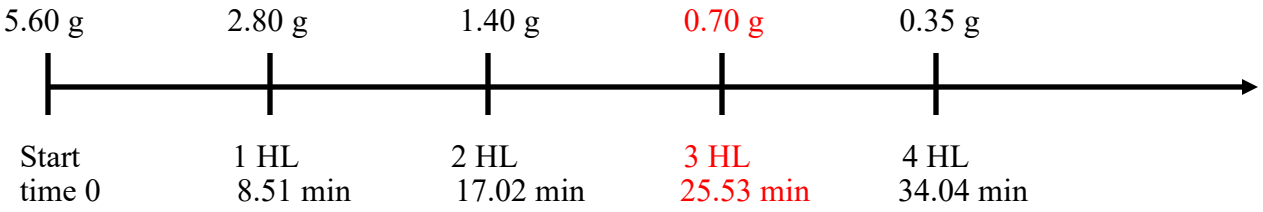
Which formula represents the H^+ acceptor in the forward reaction?

1. HCO_3^{-1} 2. $H_2O_{(L)}$ 3. H_2CO_3 4. $OH^{-1}{}_{(AQ)}$

46 What is the mass of an original 5.60-gram sample of iron-53 that remains unchanged after 25.53 minutes?

MAKE THE T-CHART!!! LOOK at table O for iron-53 half life = 8.51 minutes

1. 0.35 g 2. 0.70 g 3. 1.40 g 4. 2.80 g



47 Given the equation representing a nuclear reaction:

$${}^{1}_{1}\mathrm{H} + X \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$$

The particle represented by X is

Do the "math"

The top math is

1 + X = 6 + 4 X = 9

The bottom math is

1 + X = 3 + 2 X = 4

1 $^{9}_{4}\mathrm{Li}$ 3 $^{10}_{5}\mathrm{Be}$

2 $^{9}_{4}\mathrm{Be}$ 4 $^{10}_{6}\mathrm{C}$

48 Fission and fusion reactions both release energy. However, only fusion reactions

1. require elements with large atomic numbers
2. create radioactive products
3. use radioactive reactants
4. combine light nuclei

49 The chart shows the crystal shapes and melting points of two forms of solid phosphorus.

Two Forms of Phosphorus

Form of Phosphorus	Crystal Shape	Melting Point (°C)
white	cubic 	44
black	orthorhombic 	610

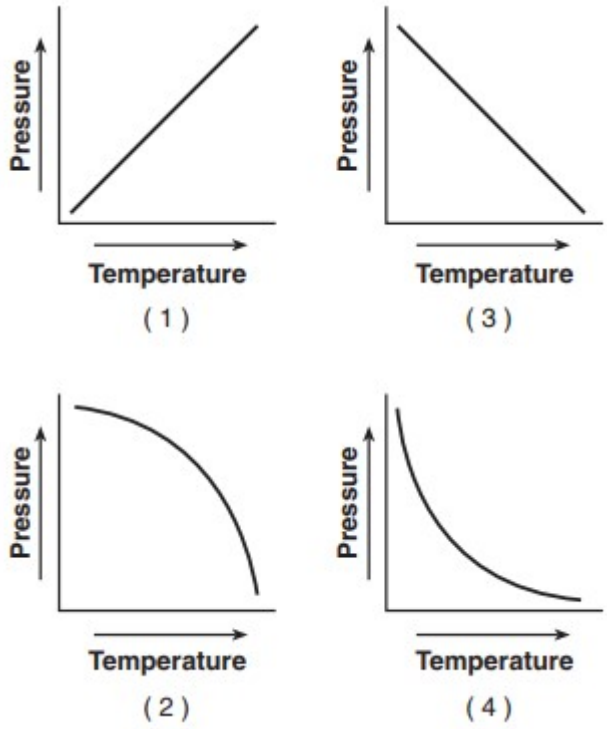
Which phrase describes the two forms of phosphorus?

(1) same crystal structure and same properties
(2) same crystal structure and different properties
(3) different crystal structures and different properties
(4) different crystal structures and same properties

50 Which graph shows the relationship between pressure and Kelvin temperature for an ideal gas at constant volume?

(1) shows directly proportional
(2) shows directly proportional X
(3) fake graph for gases X
(4) shows inversely proportional

Combined gas law has pressure divided by temperature which is directly proportional, like fractions



The elements in Group 17 are called halogens. The word "halogen" is derived from Greek and means "salt former."

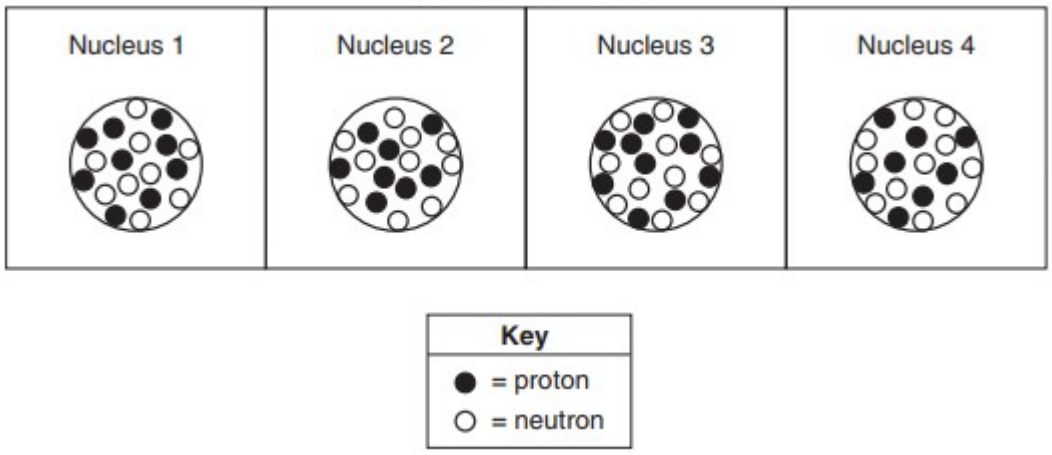
51 State the trend in electronegativity for the halogens as these elements are considered in order of increasing atomic number.
Going down the group, Electronegativity decreases (F 4.0, Cl 3.2, Br 3.0, and I 2.7 Look up on table S)

52 Identify the type of chemical bond that forms when potassium reacts with bromine to form a salt.
All metals combine with nonmetals in IONIC bonds, by transferring electrons

53 Based on Table F, identify one ion that reacts with iodide ions in an aqueous solution to form an insoluble compound.
LOOK at table F, find iodine, which is a HALIDE, on the left side. Iodide anions can form insoluble compounds in water (not aqueous) with Ag^{+1}, Pb^{+2}, or Hg_2^{+2}

The diagrams below represent four different atomic nuclei.

Four Atomic Nuclei



54 Identify the element that has atomic nuclei represented by nucleus 1. 9 protons, 8 neutrons = FLUORINE

55 Determine the mass number of the nuclide represented by nucleus 2. 9 protons + 9 neutrons = 18 AMU

56 Explain why nucleus 2 and nucleus 4 represent the nuclei of two different isotopes of the same element.
Both have 9 neutrons, but different numbers of neutrons, yielding different masses of same type of atom

57 Identify the nucleus above that is found in an atom that has a stable valence electron configuration.
Stable valence electron configuration = NOBLE GAS, Nucleus 3 = NEON

The equation below represents a chemical reaction at 1 atm and 298 K. (that is screaming the title of Table I)

$$2H_{2(G)} + O_{2(G)} \rightarrow 2H_2O_{(G)}$$

58 State the change in energy that occurs in order to break the bonds in the hydrogen molecules.
Energy is added (or absorbed) to break the bonds. This is ENDOTHERMIC.

59 In the space in your answer booklet, draw a Lewis electron-dot diagram for a water molecule.
Two styles at right, or something very similar.

60 Compare the strength of attraction for electrons by a hydrogen atom to the strength of attraction for electrons by an oxygen atom within a water molecule.
Each of these is good…
The oxygen atom has a stronger attraction for electrons than a hydrogen atom.
The electronegativity of oxygen is 3.4 and hydrogen is 2.2.
The H atom has a weaker attraction for electrons

Base your answers to questions 61 through 63 on the information below and on your knowledge of chemistry
A test tube contains a sample of solid stearic acid, an organic acid.
Both the sample and the test tube have a temperature of 22.0°C.
The stearic acid melts after the test tube is placed in a beaker with 320. grams of water at 98.0°C.
The temperature of the liquid stearic acid and water in the beaker reaches 74.0°C

61 Identify the element in stearic acid that makes it an organic compound. CARBON

62 State the direction of heat transfer between the test tube and the water when the test tube was placed in the water.
Heat is transferred from the H_2O to the test tube. Or… The test tube absorbs thermal energy from the water. Or… Stearic acid gained heat from the water.

63 Show a numerical setup for calculating the amount of thermal energy change for the water in the beaker.
$q = mC\Delta T = (320.\ g)(4.18\ J/g{\bullet}K)(24.0K)$ - this is enough, you could solve it, but it doesn't help.

A nuclear reaction is represented by the equation below.

$$^{3}_{1}H \rightarrow {}^{3}_{2}He + {}^{0}_{-1}e$$

64 Identify the decay mode of hydrogen-3. Beta decay (use words, or you can use symbols from table O)

65 Explain why the equation represents a transmutation. Hydrogen becomes a different kind of atom, helium

A technician recorded data for two properties of Period 3 elements. The data are shown in the table below.

Two Properties of Period 3 Elements

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Ionic Radius (pm)	95	66	51	41	212	184	181	—
Reaction with Cold Water	reacts vigorously	reacts very slowly	no observable reaction	no observable reaction	no observable reaction	no observable reaction	reacts slowly	no observable reaction

66 Identify the element in this table that is classified as a metalloid. Silcon

67 State the phase of chlorine at 281 K and 101.3 kPa. GAS check BP on table S to be sure

68 State evidence from the technician's data which indicates that sodium is more active than aluminum.
Sodium reacts vigorously with cold water, but aluminum has no observable reaction.
Or...Only the Na has an observable reaction.

Ammonia, $NH_{3(G)}$, can be used as a substitute for fossil fuels in some internal combustion engines.
The reaction between ammonia and oxygen in an engine is represented by the unbalanced equation below.

$$NH_{3(G)} + O_{2(G)} \rightarrow N_{2(G)} + H_2O_{(G)} + \text{energy}$$

69 Balance the equation in your answer booklet for the reaction of ammonia and oxygen, using the smallest whole-number coefficients.

$$4\,NH_{3(G)} + 3\,O_{2(G)} \rightarrow 2\,N_{2(G)} + 6\,H_2O_{(G)} + \text{energy}$$

70 Show a numerical setup for calculating the mass, in grams, of a 4.2-mole sample of O_2.
Use 32 g/mol as the gram-formula mass of O_2.

$$\frac{4.2 \text{ moles}}{1} = \frac{32 \text{ grams}}{1 \text{ mole}}$$

71 Determine the new pressure of a 6.40-L sample of oxygen gas at 300. K and 100. kPa after the gas is compressed to 2.40 L at 900. K. Use whole combined gas law, answer is 800. kPa

Fruit growers in Florida protect oranges when the temperature is near freezing by spraying water on them. It is the freezing of the water that protects the oranges from frost damage. When $H_2O_{(L)}$ at 0°C changes to $H_2O_{(S)}$ at 0°C, heat energy is released. This energy helps to prevent the temperature inside the orange from dropping below freezing, which could damage the fruit.

After harvesting, oranges can be exposed to ethene gas, C_2H_4, to improve their color.

72 Write the empirical formula for ethene. CH_2

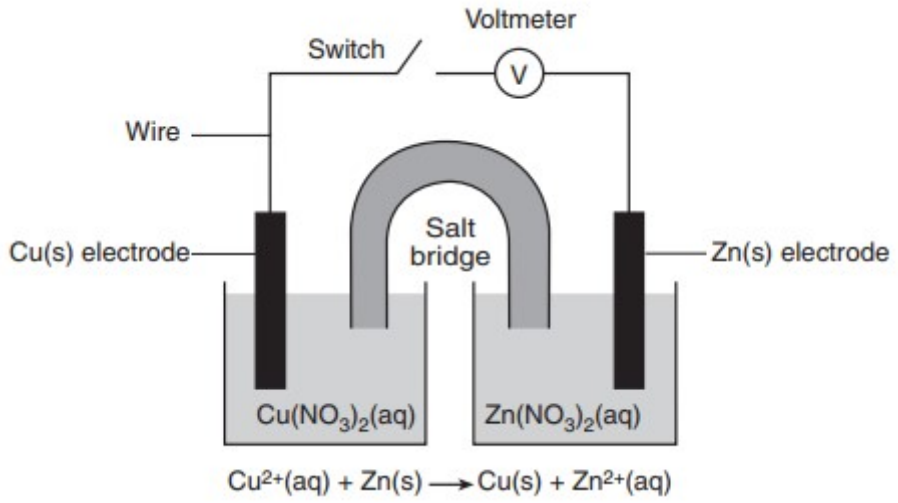
73 Explain, in terms of bonding, why the hydrocarbon ethene is classified as unsaturated.
There is a double bond C=C, or, more H atoms could bond to 2 carbon atoms like with ethane.

74 Determine the gram-formula mass of ethene. This means MOLAR MASS, it's 28 g/mole

75 Explain, in terms of particle arrangement, why the entropy of the water decreases when the water freezes.
Solids have lower entropy than liquids—the solid particles are more orderly and less random,
or liquids have higher entropy than solids—because the liquid particles are more random than with solids.

76 Determine the quantity of heat released when 2.00 grams of $H_2O_{(L)}$ freezes at 0°C.
$q = mHF = (2.00\text{ g})(334\text{ J/g}) = 668$ Joules

A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and ionic equation below represent this cell and the reaction that occurs.



77 State the form of energy that is converted to electrical energy in the operating cell.
CHEMICAL ENERGY, or possibly you would get away with potential energy.

78 State, in terms of the $Cu_{(S)}$ electrode and the $Zn_{(S)}$ electrode, the direction of electron flow in the external circuit when the cell operates. Electrons flow from the zinc to the copper electrode (through the wires, not through the salt bridge!)

79 Write a balanced equation for the half-reaction that occurs in the Cu half-cell when the cell operates.
$Cu^{+2} + 2e^- \rightarrow Cu^\circ$

80 State what happens to the mass of the Cu electrode and the mass of the Zn electrode in the operating cell.
The copper electrode grows larger, the zinc electrode gets smaller. Make sure you mention BOTH!

A solution is made by dissolving 70.0 grams of $KNO_{3(S)}$ in 100. grams of water at 50.°C and standard pressure.

81 Show a numerical setup for calculating the percent by mass of KNO_3 in the solution.
Use the percent comp by mass formula from the back of the reference table, insert numbers in the correct places, you do NOT have to solve this.

$$\%\text{ comp by mass} = \frac{\text{Mass of the part}}{\text{Mass of the whole}} \times 100\% = \frac{70\text{g } KNO_3}{170\text{ g solution}} \times 100\% =$$

82 Determine the number of additional grams of KNO_3 that must dissolve to make this solution saturated.
Table G shows that at 50.°C you can fit about 84 g KNO3 into 100 mL water.

There is ONLY 70 grams in this solution, so 84-70 = 14 grams (about). Acceptable answers are 12 to 16 g

Vinegar is a commercial form of acetic acid, $HC_2H_3O_{2(AQ)}$. One sample of vinegar has a pH value of 2.4.

83 Explain, in terms of particles, why $HC_2H_3O_{2(AQ)}$ can conduct an electric current.
In water, this is an ionic compound and aqueous, which means it will have loose, mobile ions in solution, and they conduct electricity (they make an electrolyte)

84 State the color of bromthymol blue indicator in a sample of the commercial vinegar.
Check Table M, this is a weak acid, pH has to be less than 7, likely about pH 6, this indicator will be YELLOW for ALL ACID pH values.

85 State the pH value of a sample that has ten times fewer hydronium ions than an equal volume of a vinegar sample with a pH value of 2.4
The pH scale is an exponent scale (or log scale). Each whole number change in pH is a 10X change in the concentration of H^{+1} ions. Acids are below 7, the lower pH is the more acidic.

To have 10X LESS acid ions, you'd have to move a WHOLE pH NUMBER HIGHER, or pH 3.4