FIFTY FREQUENTLY FORGOTTEN FUN FACTS

This packet contains topics from each of the units we worked on this year with questions. Most of the questions are similar to what you would expect to see on Part B2 and C of the Regents Exam in Chemistry. The multiple choice questions mirror common questions found on Parts A and B1.

I. ATOMIC STRUCTURE & NUCLEAR CHEMISTRY

1) Protons are +1 each with a mass of 1 amu each, the number of protons = atomic number, nuclear charge = + (# protons). [Periodic Table]

a) How many protons are there in a nucleus of Kr-85 ?_____

b) What is the nuclear charge of an atom of Br?_____

c) What is the mass of the protons in a nucleus of O-15?_____

2) Neutrons are neutral with a mass of 1 amu each, # neutrons = mass # - atomic number. Isotopes = atoms of the same element (same atomic #) but different # of neutrons (mass #). [Periodic Table]

a) How many neutrons are there in the nucleus of $^{56}_{26}Fe$?_____

b) Circle the two nuclei that are isotopes of each other: $^{15}_{8}O$ $^{15}_{7}N$ $^{16}_{8}O$ $^{16}_{9}F$

3) Electrons are each -1 with a mass that is VERY, VERY tiny compared to the mass of a proton or neutron.

a) Which particle has a mass that is 1/1836th the mass of a proton?
1) $^{4}_{2}He$ *2)* $^{1}_{1}H$ *3)* $^{0}_{-1}e$ *4)* $^{1}_{0}n$

4) Natural Decay: Parent Nuclide → Decay particle + daughter nuclide [Tables N and O]

a) Write the decay for U-238: _____

b) Write the decay for K-37:_____

c) Write the decay for P-32:_____

5) <u>Artificial Transmutation</u> is when a relatively stable nucleus is impacted by a particle bullet at high speeds and becomes an unstable nucleus of a different element. <u>Nuclear fission</u> occurs when nuclei of U-235 or Pu-239 are impacted by a neutron and split into two smaller nuclei and more neutrons. <u>Nuclear fusion</u> occurs when two small nuclei of hydrogen combine at high temperatures and pressures to form larger nuclei of helium. Both fission and fusion convert mass into a huge amount of energy.

Given the nuclear reactions:
1) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{36}Kr + {}^{141}_{56}Ba + 3\ {}^{1}_{0}n$
2) $^{239}_{94}Pu + {}^{4}_{2}He \rightarrow {}^{242}_{96}Cm + {}^{1}_{0}n$
3) $^{234}_{91}Pa \rightarrow {}^{0}_{-1}e + {}^{234}_{92}U$
4) $^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$

a) Which reaction represents natural decay?_____

b) Which reaction represents artificial transmutation?_____

c) Which reaction represents nuclear fission?_____

d) Which reaction represents nuclear fusion?_____

6) Weight-average mass = $\frac{\text{(\% of isotope 1 X mass of isotope 1)}}{100}$ + $\frac{\text{(\% of isotope 2 X mass of isotope 2)}}{100}$ + …

a) What is the weight-average mass of an isotope if X-50 (mass = 50.0 amu) has an abundance of 20.0% and X-52 (mass = 52.0 amu) has an abundance of 80.0%? Show all work:

answer:_____

7) # Half-lives = (time elapsed / length of half-life) [Tables N and T]

a) A sample of Co-60 is left to sit for 15.78 years. How many half-lives have gone by?

b) What percent of the original sample remains after this number of half-lives?

c) If the original mass of the sample was 20.0 grams, how many grams of Co-60 remain?

II. PHYSICAL BEHAVIOR OF MATTER

8) Heat of Fusion = heat added to MELT or heat removed to FREEZE a substance. $q = m H_f$ [Tables B, T]

a) How many joules are required to melt 10.0 grams of water at the melting point? Show all work:

9) Heat of Vaporization = heat added to BOIL or removed to CONDENSE a substance. $q = m H_v$ [Tables B, T]

a) How many joules are required to boil 20.0 grams of water at the boiling point? Show all work:

10) Calorimetry: $q = mC\Delta t$ = heat that is added or removed to change the temperature of a substance, but NOT its phase. [Tables B, T]

a) How many joules are required to raise the temperature of 15.0 grams of water from 10.0^{o}C to 25.0^{o}C? Show all work:

b) 50.0 grams of water absorb 1000. J of energy. By how much does the temperature increase? Show all work:

11) Gas Laws: Temperature must be in Kelvin, STP is found on Reference Table A. [Tables A, T]

a) 50.0 mL of a gas at STP is heated to 400.0°C and is compressed to 20.0 mL. What is the new pressure of the gas? Show all work:

12) Avogadro's Hypothesis -- When ANY two gases are at the same T and P, they will have the same volume and THEREFORE the same number of molecules.

a) Which of the following samples of gas contain the same number of molecules?

Gas	Pressure	Temperature	Volume
A	100 kPa	300. K	50.0 mL
B	100 kPa	300. K	50.0 mL
C	200 kPa	200. K	100.0 mL
D	200 kPa	200. K	50.0 mL

Answer: _____ and _____

13) Temperature (a measure of the KE) remains constant during a phase change, only PE changes during a phase change (Heat of Fusion or Vaporization).

Given the following data table:

Time (min)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Temp (°C)	70	75	80	80	80	80	89	98	107	116	116	116	116	116	116	136	156	186	206

a) What is the melting point of this substance?_____

b) What is the boiling point of this substance?_____

c) Between minute 0 and 2, what is happening to kinetic energy?_____

d) Between minute 9 and 14, what is happening to kinetic energy?_____

e) Between minute 5 and 9, what is happening to potential energy?_____

f) Between minute 2 and 5, what is happening to potential energy?_____

14) Phase changes and dissolving are physical changes.

a) Which of the following changes is physical?

1) $Li\ (s) + NaCl\ (s) \rightarrow LiCl\ (s) + Na\ (s)$

2) $Li\ (s) \rightarrow Li\ (l)$

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

4) $2\ Li\ (s) + O_2\ (g) \rightarrow Li_2O\ (s)$

III. PERIODIC TABLE AND BONDING

15) Elements Br, I, N, Cl, H, O and F form diatomic molecules through nonpolar covalent bonding when there are no other elements present.

a) Complete the following reaction: 2 Na + 2 HOH →2 NaOH + _____

b) Complete the following reaction: 2 $FeCl_3$ → 2 Fe + 3 _____

16) Noble gases are nonreactive, forming monatomic molecules. [Periodic Table]

a) Name an element that exists as monatomic molecules:_____

17) When metal atoms form ions, they lose all their valence electrons, and their dot diagrams are the metal symbol, in brackets, with no dots and the + charge on the upper right, outside the brackets. [P.T.]

a) What is the electron configuration of a K^{+1} ion? _____

b) A Ca^{+2} ion has the same electron configuration as which noble gas?_____

c) When Fe forms a +2 ion, its radius _____

d) Draw the dot diagram for the Li^{+1} ion:

18) When nonmetal atoms form ions, they gain enough electrons to have a stable octet (8 valence electrons), and their dot diagrams are the nonmetal symbol, in brackets, with 8 dots and the - charge on the upper right, outside the brackets. [Periodic Table]

a) What is the electron configuration of a Cl^{-1} ion? _____

b) A S^{-2} ion has the same electron configuration as which noble gas?_____

c) When O forms a -2 ion, its radius _____

d) Draw the dot diagram for the F^{-1} ion:

19) Hydrogen bonds are strongest between molecules with the greatest electronegativity difference. [Table S]

a) Which molecule has the strongest hydrogen bond attractions? *1) HF 2) HBr 3) HCl 4) H_2O*

20) Ionic character increases as electronegativity difference increases. [Table S]

a) Which compound has the greatest ionic character? *a) NaBr 2) NaI 3) NaCl d) NaF*

21) At STP, the liquids on the Periodic Table are Br and Hg. The gases are N, Cl, H, O, F and the Noble Gases. All other elements are solids. [Periodic Table]

a) Which element on the Periodic Table is a nonmetallic liquid at STP?_____

b) Which element at STP is a liquid that conducts electricity well?_____

c) Name an element that exists in a crystal lattice at STP:_____

d) Name an element that has no definite volume or shape at STP:_____

22) Electronegativity is an atom's attraction to electrons in a chemical bond. [Table S]

a) Which element, when bonded with O, will form the partially negative end of a polar covalent bond?_____

b) Which element has the greatest attraction to electrons when bonded to Na?
1) N *2) O* *3) S* *4) Al*

c) In the molecule CH_3Cl, which element represents the partially negative end of the molecule?
1) C *2) H* *3) Cl* *4) none, it's a nonpolar molecule*

23) Ionization energy is the energy required to remove the most loosely held valence electron from an atom in the gas phase. [Table S]

a) Four elements are heated at the same rate. Which will lose an electron first?
1) Na *2) Br* *3) Fe* *4) Ca*

24) Polyatomic ions form ionic bonds with other ions, but are themselves held together by covalent bonds. [Table E]

a) Which of the following compounds contains both ionic and covalent bonds?
1) NaCl *b) CH_4* *c) $CaCO_3$* *d) CO_2*

IV. COMPOUNDS

25) Ionic compounds are made of a metal and nonmetal, or a metal and a negative polyatomic ion. They have high melting points, and conduct electricity when dissolved in water (electrolytes) or melted. [P. T.]

a) Which of the following substances is the best conductor of electricity when dissolved in water?
1) K_2SO_4 b) CCl_4 c) $C_6H_{12}O_6$ d) NO_2

26) Molecular compounds tend to be soft, have low melting points and high vapor pressures. Hydrogen bonds are the strongest of the intermolecular forces (when the H of one polar molecule attracts the N, O or F of another polar molecule), followed by dipole (where the more electronegative end of one polar molecule attracts the less electronegative end of another polar molecule) and London Dispersion forces are the weakest, where motion of electrons through the molecule causes temporary poles to form. Molecular substances (with the exception of acids) are poor conductors of electricity (nonelectrolytes). [P. T.]

a) Which of the following substances is the poorest conductor of electricity when dissolved in water?
1) $CaCl_2$ *b) HCl* *c) NO_2* *d) NaBr*

b) Which of the following molecules is subject to hydrogen bond attractions in the solid and liquid phase?
a) CH_4 *b) NH_3* *c) CO_2* *d) C_3H_8*

27) Network solids are substances that do not have distinct molecules or ions that can separate with heating. To melt a network solid, covalent bonds have to be broken. This takes tremendous energy, meaning that network solids have extremely high melting points. They are insoluble in water, and are poor conductors of electricity. Examples of network solids are diamond (C), sapphire, ruby, corundum (Al_2O_3) and quartz (SiO_2).

a) Which of the following is a network solid?
1) NaCl *b) H_2O* *c) SiO_2* *d) Hg*

28) ONLY metals with more than one listed charge need a Roman numeral after their name (Stock system) when naming an ionic compound. Nonmetals with more than one oxidation state will also need a Roman numeral in their name if they are the less electronegative atom in a molecular compound. [P. T., Table E]

a) Name the compound $Cu(NO_3)_2$:_____

b) Write the formula for iron (III) sulfite:_____

c) Name the compound NO_2, using the Stock system:_____

d) Write the formula for phosphorous (IV) oxide:_____

29) Formula Mass = sum of all atomic masses in the compound, rounded to the tenths place, with the units g/mole. [Periodic Table]

a) Determine the formula mass of $Cu(NO_3)_2$:_____

30) grams / formula mass = moles moles X formula mass = grams [Periodic Table, Table T]

a) Using the formula mass of $Cu(NO_3)_2$, how many moles are there in 100.0 grams of $Cu(NO_3)_2$ (show all work):

b) Using the formula mass of $Cu(NO_3)_2$, how many grams are there in 2.5 moles of $Cu(NO_3)_2$ (show all work):

31) Molecular Formula = (Molecular Mass / Empirical Mass) X Empirical Formula [Periodic Table]

a) Quantitative analysis determines that a compound has an empirical formula of CH and a molecular mass of 26 grams/mole. Determine the molecular formula of this compound, showing all work:

32) % Of Water In A Hydrate = (mass of water / mass of hydrate) X100 [Periodic Table, Tabe T]

a) What is the % by mass of H_2O in $CaCl_2 \cdot 2\ H_2O$? Show all work:

b) 2.00 grams of hydrate are heated to a constant mass of 1.20 grams. What was the % by mass of water in the hydrate? Show all work:

V. REACTIONS

33) Synthesis, Decomposition, and Single Replacement reactions are all examples of REDOX reactions, because one species is oxidized and another is reduced. Double replacement (including neutralization) reactions are NOT redox reactions.

a) Which of the following reactions is an example of a redox reaction?

1) $NaCl\ (s) \rightarrow Na^{+1}\ (aq) + Cl^{-1}\ \ (aq)$

2) $2\ K\ (s) + CaSO_4\ (aq) \rightarrow K_2SO_4\ (aq) + Ca\ (s)$

3) $Ca(NO_3)_2\ (aq) + K_2CO_3\ (aq) \rightarrow CaCO_3\ (s) + 2\ KNO_3\ (aq)$

4) $H_2O\ (l) \rightarrow H_2O\ (g)$

34) The driving force behind double replacement reactions is the formation of an insoluble precipitate as one of the products. [Table F]

a) Is $PbCl_2$ soluble or insoluble? Explain, based on Table F:

b) In the reaction $Li_2SO_4 + Ba(NO_3)_2 \rightarrow BaSO_4 + 2\ LiNO_3$, write the formula for the precipitate:_____

35) Stoichiometry: moles of given X (coeff. of target / coeff. of given) = moles of target

a) For the reaction $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$, how many moles of H_2O are formed when 20.0 moles of CH_4 are burned? Show all work.

VI. KINETICS & EQUILIBRIUM

36) Energy is absorbed to break chemical bonds and released when new bonds are formed.

a) Which statement best describes the reaction H + H → H_2 + energy:
1) A bond is being broken, which absorbs energy *2) A bond is being formed, which absorbs energy*
3) A bond is being broken, which releases energy *4) A bond is being formed, which releases energy*

37) Activation energy is the energy given to the reactants to get the reaction started.

If the heat of reactants are 45 KJ, the heat of the products are 35 KJ and the heat of the activated complex is 95 KJ,

a) What is the activation energy of this reaction?_____

b) Adding a catalyst will _____ the activation energy by _____ steps from the reaction pathway (mechanism).

c) Adding an inhibitor will _____ the activation energy by _____ steps to the reaction pathway.

d) The heat of reaction (ΔH) of this reaction is_____

e) Sketch and label a PE diagram for this reaction:

38) At equilibrium, the RATES are equal. The amounts don't have to be.

a) For the change H_2O (l) + heat ⇔ H_2O (g) at 100^oC, what must be true about the rate of boiling and the rate of condensing?

39) In Le Chatelier's Principle, if a system is at equilibrium, if something is added, then the equilibrium will shift away from the side it is on. If something is removed, then the equilibrium will shift towards that side. After the shift, whatever is being shifted towards will increase in concentration, and whatever is being shifted away from will decrease in concentration.

For the equilibrium N_2 (g) + 3H_2 (g) ⇔ 2 NH_3 (g) + heat:

a) If N_2 is added, which way will the equilibrium shift?_____

b) If temperature is decreased, which way will the equilibrium shift?_____

c) If pressure is increased, which way will the equilibrium shift?_____

d) If H_2 is removed, what will happen to the concentration of NH_3?_____

e) If NH_3 is added, what will happen to the concentration of N_2?_____

VII. SOLUTIONS

40) Solubility is a measure of how many grams of solute are required to saturate a given amount of solute at a given temperature. [Table G]

a) How many grams of NH_4Cl are required to saturate a 100-gram sample of water at 30^oC?_____

b) What is the solubility of KNO_3 in 50.0 grams of water at 60^oC? _____

41) Molarity = moles / L, if grams are given, convert to moles, if mL are given, convert to L. [Table T]

a) What is the molarity of a solution of NaOH (formula mass = 40.0 g/mole) if it contains 20.0 grams of NaOH dissolved into 400.0 mL of solution? Show all work:

42) moles = Molarity X L. If asked for grams, convert moles to grams at the end. [Table T]

a) How many grams of NaOH (formula mass = 40.0 g/mole) are needed to make 500.0 mL of a 0.200 M solution of NaOH? Show all work:

43) When a solute is dissolved in water, the boiling point of the solution increases and the freezing point of the solution decreases as the concentration increases. The more ions the solute creates upon dissolving the greater the increase in boiling point/decrease in freezing point. Electrolytes (ionic compounds and acids) put ions into solutions, nonelectrolytes (molecular substances) don't.

a) Which solution of NaCl (aq) has the highest boiling point? *1) 1.0 M 2) 2.0 M 3) 3.0 M 4) 4.0 M*

b) Which 1.0 M solution has the lowest freezing point? *1) NaCl 2) CH_4 3) $CaCO_3$ 4) $MgCl_2$*

III. ACIDS AND BASES

44) Use $M_aV_a = M_bV_b$ ONLY for titration problems, where they give information on BOTH the acid and base. If it is not a titration problem, and they ask for the molarity, use Molarity = moles / L. [Table T]

a) 50.0 mL of 3.0 M HCl are required to neutralize 30.0 mL of an NaOH solution. What is the molarity of the NaOH? Show all work:

b) A solution of NaOH contains 2.0 moles dissolved into 4.0 L of solution. What is the molarity of the NaOH solution? Show all work:

45) Bronsted/Lowry Acids are proton donors (give off H^+) and B/L Bases are proton acceptors (pick up H^+).

a) In the reaction $NH_3 + HCl \Leftrightarrow NH_4^+ + Cl^-$, the B/L acid in the forward reaction is:_____

b) In the reaction $HCl + H_2O \Leftrightarrow H_3O^+ + Cl^-$, the B/L base in the reverse reaction is:_____

IX. ELECTROCHEMISTRY

46) ALL species identified in a redox reaction MUST have their charges written. Be sure to indicate whether the charge is positive (+) or negative (-), as well as the numeric value of the charge. [P. T., Table E]

a) For the reaction $2\ Na + 2\ HCl \rightarrow 2\ NaCl + H_2$:

Write the charges of each species above their symbols in the above reaction

Oxidation half-reaction:_____

Reduction half-reaction:_____

Oxidizing Agent:_____ Reducing Agent:_____

Spectator Ion:_____

b) What is the negative ion found in a solution of nitric acid?_____

47) The sum of all the charges of each element in a compound is zero. Oxygen is always -2 (unless it is part of the peroxide ion, O_2^{-2}, in which case O is -1). Any element by itself has a charge of 0. [P. T., Table E]

a) What is the charge of Cl in $CaCl_2$?_____

b) What is the charge of Cl in Cl_2?_____

c) What is the charge of Cl in $Ca(ClO_2)_2$?_____

48) Voltaic cells produce electricity using a spontaneous redox reaction, electrolytic cells use electricity to decompose compounds containing Group 1, 2 or 17 elements. [Table J, P. T.]

a) A voltaic cell has Al and Au as its metal electrodes. Which metal acts as the anode?_____

b) A voltaic cell has Fe and Sn as its metal electrodes. From which metal to which metal will electrons flow?

From _____ to _____.

c) Name a metal that can be formed by electrolytic reduction._____

d) Name a nonmetal that can be formed by electrolytic oxidation._____

X. ORGANIC CHEMISTRY

49) Isomers are organic compounds with the same molecular formula, but with a different structural formula. [Tables P, Q and R]

a) Draw the structural formula of butane:

b) Draw the structural formula of an isomer of butane:

c) Draw the structural formula of 1-propanol:

d) Draw the structural formula of an ether that is an isomer of 1-propanol:

50) Addition reactions involve alkenes or alkynes. Substitution reactions involve alkanes. Use Reference Table Q to determine which type of hydrocarbon you have. [Table Q]

a) Which of the following molecules can undergo a addition reaction?

1) C_3H_8 *2) C_4H_8* *3) C_5H_{12}* *4) CH_4*