

Questions 1-23 are worth 6 points each. Place your answer on the FRONT side of the Scantron sheet in the space corresponding to the question number.

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- 1: How many milliliters of 0.50 M calcium hydroxide are needed to prepare 2.0×10^3 mL of 0.20 M calcium hydroxide by dilution? (4-6,7,8)
- A: 1.0×10^3 mL B: 8.0×10^2 mL C: 1.3×10^2 mL D: 2.0×10^2 mL E: 2.5 mL
- 2: A 2.8 g sample of nitrogen is reacted with 2.0 g of hydrogen to form ammonia. How many grams (theoretical yield) of ammonia are formed? (4-4)
- A: 4.8 B: 11 C: 3.4 D: 15 E: 1.7
- 3: What is the empirical formula of a compound which contains only cobalt and oxygen if an 8.29 gram sample of the compound contains 5.89 grams of cobalt? (3-10)
- A: CoO B: CoO₂ C: Co₂O D: Co₂O₃ E: Co₅O₂
- 4: Calculate the energy change for the reaction, $P^{2+}(g) + 2 e^- \rightarrow P(g)$,
- Given: $P^+(g) + 1 e^- \rightarrow P(g)$, H = -1,005 kJ
and $2P^+(g) \rightarrow 2 P^{2+}(g) + 2 e^-$, H = 4,520 kJ
- A: 3,265 kJ B: -3,265 kJ C: 3,415 kJ D: -3,415 kJ E: -5,525 kJ

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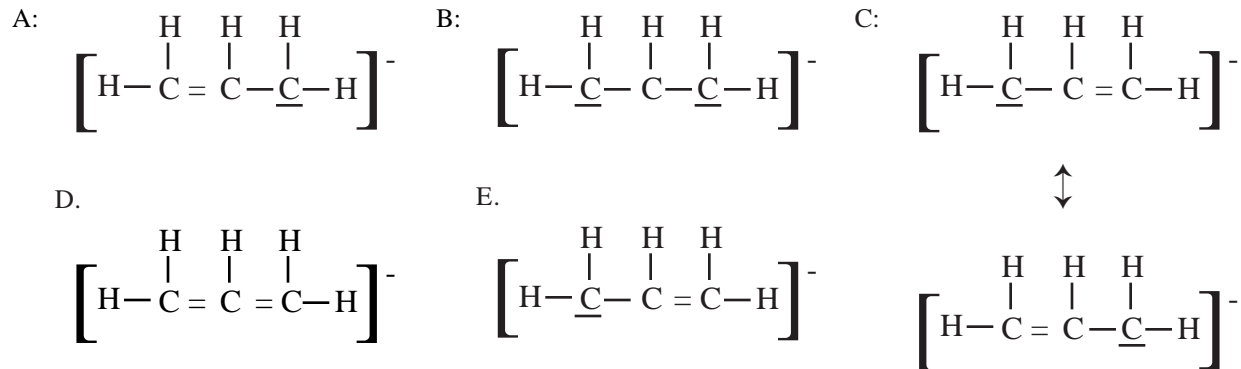
- 5: If 10 moles of A and 13 moles of B are mixed and allowed to react according to the equation,
 $2 A + 3 B \rightarrow 1 C$, how many moles of B remain when 3 moles of C have been formed? (3-7)

A: 0 B: 10 C: 9 D: 3 E: 4

- 6: How many grams of lithium peroxide are required to prepare 329 ml of 0.215 M solution? (4-6,7,8)

A: 3.25 B: 2.75 C: 9.86 D: 15.1 E: 30.0

- 7: What is the best Lewis structure of $C_3H_5^-$? (8A-4,5,7,9,10)



- 8: If ethene (C_2H_4) is burned to produce water and carbon dioxide, what is the theoretical yield of water if 15.0 grams of ethene react? (3-6)

A: 4.82 g B: 9.64 g C: 19.28 g D: 34.8 g E: 30.0 g

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9: When $\text{PbO}_2 + \text{Mn}^{2+} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4 + \text{MnO}_4^-$ (acidic solution) is balanced, the sum of all coefficients is: (9-10)

- A: 17 B: 19 C: 32 D: 29 E: 25

10: What is the molecular weight of a gas if 0.62 g of the substance occupies 275 mL at 127 °C and 380 torr? (5-4)

- A: 61.9 B: 41.9 C: 148 D: 47.0 E: 37.0

11: What is the weight percent of nitrogen in copper(II) nitrate? (3-8)

- A: 33.9% B: 51.2% C: 22.2% D: 18.0% E: 14.9%

12: A sample of gas with a volume of 3.00×10^2 mL is manipulated so that its temperature doubles and its pressure increases to 5 times its original value. What volume does the gas occupy at the end of the manipulation? (5-2,5)

- A: 6.00×10^2 mL B: 3.00×10^3 mL C: 3.00×10^1 mL D: 7.50×10^2 mL E: 1.20×10^2 mL

13: If 3.4 moles of neon and 5.3 moles of chlorine are placed in a 75 liter container at 134°C, what pressure does the mixture exert? (5-6)

- A: 1.3×10^0 atm B: 3.9×10^0 atm C: 1.5×10^0 atm D: 2.4×10^0 atm E: 2.2×10^2 atm

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14: Calculate the heat change when 78.1 grams of water at 108°C is cooled to 38°C. (10-10)

- A: -2.0×10^2 kJ B: -1.1×10^1 kJ C: -2.3×10^1 kJ D: -1.8×10^2 kJ E: -2.1×10^1 kJ

15: Given the following standard bond dissociation enthalpies in kJ/mole,

Bonds with Carbon		Bonds w/H		Bonds w/N		Other Bonds			
C-Br	219	C-I	240	H-Br	324	N-Br	250	Br-Br	193
C-C	350	C=N	615	H-Cl	431	N-Cl	190	Cl-Cl	242
C=C	614	C≡N	891	H-F	567	N-F	280	F-F	155
C≡C	839	C-O	358	H-H	435	N-I	150	I-I	151
C-Cl	330	C=O	799	H-I	299	N-N	160	O-O	146
C-F	485	C=S	477	H-N	390	N=N	946	O=O	495
C-H	413			H-O	463				
				H-S	370				

what is the enthalpy change for the reaction, $1 \text{ CO}_2 + 2 \text{ H}_2\text{S} \rightarrow 1 \text{ CS}_2 + 2 \text{ H}_2\text{O}$? (9-1)

- A: 229 kJ B: 272 kJ C: -272 kJ D: -458 kJ E: 458 kJ

16: A gas initially occupying 125.0 mL at 261 °C is heated to 348 °C and expanded to 150.0 mL. If the final pressure is 647 torr, what was the initial pressure? (5-5)

- A: 582 torr B: 668 torr C: 903 torr D: 464 torr E: 35.1 torr

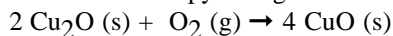
17: The reaction $2 \text{ SO}_3(\text{g}) \rightarrow 2 \text{ SO}_2(\text{g}) + \text{ O}_2(\text{g})$, has an enthalpy change of 198 kJ. How many grams of sulfur dioxide are produced when 564 kJ are absorbed? (6-7)

- A: 183 g B: 365 g C: 730 g D: 456 g E: 273 g

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18: Calculate the enthalpy change for the following reaction. (6-10)



A: -166.7 kJ

B: -11.5 kJ

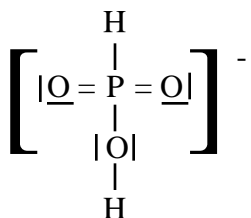
C: -287.4 kJ

D: -954.2 kJ

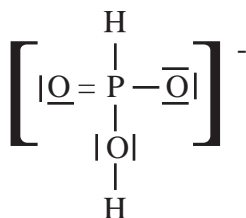
E: 11.5 kJ

19: The best Lewis structure of H_2PO_3^- is: (8A-4,5,7,9,10)

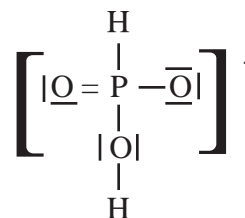
A:



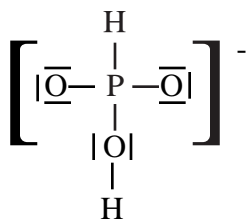
B:



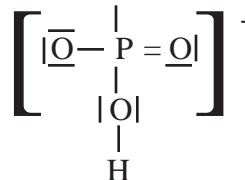
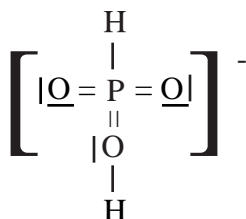
C:



D:



E:



20: What is the density of carbon monoxide gas at 134°C and 754 torr? Express your answer in grams/liter. (5-4)

A: 2.5 g/L

B: 0.83 g/L

C: 6.3 g/L

D: 0.068 g/L

E: 1.2 g/L

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51: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A: Copper is an alkaline earth metal. (2-5)
B: Chlorine, oxygen, and hydrogen are gases under normal conditions. (1-4)
C: Bromine and krypton are in the same group in the periodic table. (2-5)
D: Fluorine, nitrogen, and iodine are diatomic under normal conditions. (1-4)

52: Identify the equations which correctly match reactants and products without regard to whether the equations are balanced using **K-TYPE answer format**. (Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.) (Note: States, if given, are correct.) (3-3)

- A: $\text{C}_2\text{H}_6\text{O} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
B: $\text{Rb} + \text{H}_2\text{O} \rightarrow \text{RbOH} + \text{H}_2$
C: $\text{KOH}(\text{aq}) + \text{FeCl}_3(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + \text{KCl}(\text{aq})$
D: $\text{HNO}_3 + \text{FrOH} \rightarrow \text{Fr} + \text{HSO}_2$

53: Which of the following correctly lists the compounds in order of increasing melting point? (10-4)

- A: $\text{H}_2, \text{H}_2\text{Te}, \text{Na}_2\text{Te}$ B: $\text{H}_2\text{Te}, \text{H}_2, \text{Na}_2\text{Te}$ C: $\text{Na}_2\text{Te}, \text{H}_2\text{Te}, \text{H}_2$
D: $\text{H}_2, \text{Na}_2\text{Te}, \text{H}_2\text{Te}$ E: $\text{Na}_2\text{Te}, \text{H}_2, \text{H}_2\text{Te}$

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54: **K-TYPE** answer format: Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A: The average kinetic energy of the gas molecules in a sample at 25°C is greater than the average kinetic energy of the gas molecules in a sample at 50°C. (5-8)
- B: The average velocity of H₂O(g) is the same as that of O₂ gas at the same temperature. (5-8)
- C: A sample of O₂ gas at 52°C and 3 atm will be less likely to act like an ideal gas than would a sample of O₂ gas at 52°C and 5 atm. (5-9)
- D: When the pressure of a gas is tripled (at constant temperature and amount of substance) the volume is reduced to one-third the original volume. (5-2)

55: What type of force(s) must be broken in order to melt HF? (10-4)

- A: covalent bonds
- B: covalent bonds, induced dipole-induced dipole interaction (London dispersion forces), AND H-bonding
- C: H-bonding AND covalent bonds
- D: H-bonding
- E: induced dipole-induced dipole interaction (London dispersion forces) AND H-bonding

56: **K-TYPE** answer format: Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (8A-8)

- A: The electronegativity of Se is greater than that of O. (8A-8)
- B: The electronegativity of Br is less than that of As. (8A-8)
- C: Electronegativity is the energy absorbed when an atom loses an electron. (8A-8)
- D: The formal charge of C in CO₂ is 0. (8A)

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57: **K-TYPE answer format:** Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A: H₂O is a polar molecule. (8B-7,8)
 B: CO₂ is a polar molecule. (8B-7,8)
 C: All polar substances have polar bonds. (8B-3)
 D: A C-H bond is more polar than a N-H bond. (8B-2)

58: What is the correct electronic configuration of Sb⁴⁺? (7A-10, 7B-1,2)

- A: 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²3d¹⁰ 4p⁶ 4d¹⁰5p¹ B: 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²3d¹⁰ 4p⁶ 5s²4d⁹
 C: 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²3d¹⁰ 4p⁶ 5s¹4d¹⁰ D: 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²3d¹⁰ 4p⁶ 5s²4d¹⁰5p³
 E: 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²3d¹⁰ 4p⁶ 5s¹4d⁹5p¹

59: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A: A N atom in the ground state would be paramagnetic. (7B-3)
 B: K⁺ and Ca²⁺ are isoelectronic. (7B-7)
 C: The two elements with atomic number 16 and 52 would have similar chemical properties. (7B-4)
 D: Atoms with all electrons paired are attracted into magnetic fields. (7B-3)

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60: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (7B-8)

A: The first ionization energy of Ne is less than the first ionization energy of Ar. (7B-8)

B: The first ionization energy of Kr is less than the 2nd ionization energy of Kr. (7B-8)

C: Ionization energy is the energy released when an atom loses an electron. (7B-8)

D: Less energy is required to remove the first electron from a Ge atom than to remove the first electron from a Br atom. (7B-8)

61: If calcium reacts with nitrogen, the formula of the compound formed is likely to be: (2-7)

A: CaN

B: Ca₃N₂

C: Ca₂N

D: CaN₂

E: Ca₂N₃

62: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

A: If the empirical formula of a certain compound is CH and its molecular weight is 52, the molecular formula of the compound would be C₄H₄. (3-9)

B: Covalent bonding occurs as the result of sharing of electrons by two or more atoms. (2-6)

C: If magnesium reacts to form an ionic compound, it would probably form a +2 ion. (2-7)

D: If potassium reacts with sulfur, the compound formed would probably have covalent bonding. (2-6)

63: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (7B-6,7)

A: Al atom has a larger radius than does an Ar atom. (7B-6)

B: Sn atom has a smaller radius than does the Pb atom. (7B-6)

C: N³⁻ ion is larger than the N atom. (7B-7)

D: Rb⁺ has a larger radius than does Rb. (7B-7)

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64: Choose the correct statements concerning the species $^{42}\text{Ca}^+$, using K-TYPE answer format. **I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct. (2-4)**

- A: The species contains 20 protons.
- B: The species contains 42 neutrons.
- C: The species contains 19 electrons.
- D: A species with 22 protons and 21 neutrons would be an isotope of the species.

65: Choose the correct statements from the following using **K-TYPE answer format**. I.E. *Mark a if A,B,C are correct; b if A, C; c if B, D; d if D only; e otherwise. (7B-8)*

- A: Experimental data shows that when electrons fill into degenerate energy levels, two electrons go into a given orbital before any go into others of the degenerate set. **(7A-10)**
- B: The frequency of electromagnetic radiation is inversely proportional to its energy. **(7A-4)**
- C: The wavelength of x-rays is greater than that of visible radiation. **(7A-4)**
- D: Atoms can only absorb certain types of electromagnetic radiation, i.e. have a discrete rather than a continuous spectrum. **(7A-5)**

66: What is the correct electronic configuration of Ba? **(7A-10, 7B-1,2)**

- A: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$
- B: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 5d^{10} 5p^6 6s^2$
- C: $1s^2 2s^2 2p^6 3s^2 3p^6 2d^{10} 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$
- D: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 7s^2$
- E: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 5p^6 6s^1 4d^{10}$

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67: **K-TYPE** answer format: Mark **a** if A,B,C are correct; **b** if A, C; **c** if B, D; **d** if D only; **e** otherwise.

- A: When an electron in an atom moves from the $n = 4$ to the $n = 2$ level, it gains energy. (7A-6)
- B: An electron in the $3p$ orbital would have less energy than one in the $2p$ orbital. (7A-6)
- C: An electron in a $4s$ orbital would be farther from the nucleus than one in a $2p$ orbital. (7A-6)
- D: The angular number l is related to the orbital's energy. (7A-8)

68: **K-TYPE** answer format: Mark **a** if A,B,C are correct; **b** if A, C; **c** if B, D; **d** if D only; **e** otherwise.

- A: The mass of the neutron is 1 amu. (3-3)
- B: ^{14}Si is an isotope of ^{12}Si . (3-3)
- C: The protons in an atom are in the nucleus of the atom. (3-3)
- D: The charge on the proton is zero. (3-3)

69: **K-TYPE** answer format: Mark **a** if A,B,C are correct; **b** if A, C; **c** if B, D; **d** if D only; **e** otherwise.

- A: The $n = 3$ level can contain a maximum of 8 electrons. (7A-8,9,10)
- B: An element with an electronic configuration of $1s^2 2s^2 2p^2$ would be in the same group as silicon. (7B-4,5)
- C: The general electronic configuration of the group containing fluorine is $ns^2 np^4$. (7B-4,5)
- D: An oxygen atom has a filled outer shell if it gains two electrons. (8A-1)

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70: Choose the correct statements from the following using **K-TYPE answer format**. I.E. *Mark a if A,B,C are correct; b if A, C; c if B, D; d if D only; e otherwise.*

- A: It would be possible to add water to a solution with a concentration of 0.30 M and produce a solution with a concentration of 0.002 M. **(4-8)**
- B: Clay and water mix to form a solution. **(4-5)**
- C: According to the kinetic molecular theory of gases, the volume of the gas molecules is negligible compared to the volume of the container which holds the gas. **(5-8)**
- D: 0.2 moles of oxygen gas(atomic weight = 16 amu) exerts four times as much pressure on the walls of its container as does 0.2 moles of hydrogen gas(atomic weight = 2 amu) if both gases are in a 10 liter container at 100°C. **(5-8)**

71: Choose the correct statements from the following concerning FO^- and FO^+ using **K-TYPE answer format**: *Mark a if A,B,C are correct; b if A, C; c if B, D; d if D only; e otherwise.* **(8A-6)**

- A: There is a single bond in FO^+ . **(8A-6)**
- B: The F and O are farther apart in FO^- than in FO^+ . **(8A-6)**
- C: There is a double bond in FO^- . **(8A-6)**
- D: It would take more energy to break the F-O bond in FO^+ than in FO^- . **(8A-6)**

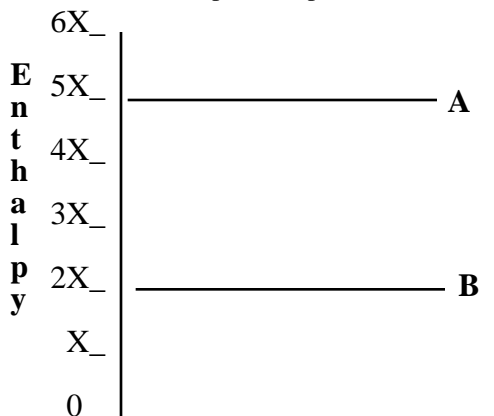
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- 72: On the diagram below: $X = 300$ J, "B" represents reactants, "A" represents products. (6-2,6)

Choose the correct statements regarding the diagram to the right using K-TYPE answer format:

- Mark *a* if A, B, & C are correct.
b if A and C are correct.
c if B and D are correct.
d if D only is correct.
e otherwise.



- A: On the diagram above, the enthalpy of the reactants is approximately 600 J. (6-6)
 B: On the diagram above, the overall enthalpy for the reverse reaction would be 900 J. (6-6)
 C: On the diagram above, the overall reaction is endothermic. (6-6)
 D: If the heat change is measured at a constant volume the value obtained is the enthalpy change. (6-2)

- 73: The specific gravity (density) of gold is 19.32. What would be the volume occupied by 206 grams of gold? (1-9)

- A: 1.07×10^1 mL B: 1.93×10^1 mL C: 9.40×10^{-2} mL D: 3.98×10^3 mL E: 1.52×10^1 mL

- 74: K-TYPE answer format: Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A: Covalent bonding is generally much stronger than ionic bonding. (10-2)
 B: Heat of vaporization increases as intermolecular forces increase. (10-3)
 C: Crystalline solids tend to break with jagged edges and faces. (10-5)
 D: Silicon dioxide, a covalent network solid, would be very hard. (10-6)

Questions 51-82 are worth 3 points each. Twenty-four of these types of questions will appear on the final exam. Place your answer on the BACK side of the Scantron sheet in the space corresponding to the question number.

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75: **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

A: A bond formed by the attraction between positively and negatively charged ions is called a covalent bond.

(8A-2)

B: If sodium and chlorine were to react, the compound which forms would probably be ionic. (8A-2)

C: Ionic substances tend to have low melting points. (8A-2)

D: The formula of the compound which would probably form if the barium reacted with oxygen would be BaO.

(8A-3)

76: **K-TYPE answer format:** **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (2-9)

A: The oxidation number of Cl in ClO_4^- is +5. (2-9)

B: The oxidation number of N in NH_4Cl is -3. (2-9)

C: Fluorine has an oxidation number of -2 in compounds. (2-9)

D: The oxidation number of Cs in Cs(s) is 0. (2-9)

77: **K-TYPE answer format:** Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

A: Water has a higher boiling point than expected on the basis of comparison with similar compounds. (10-2)

B: HI has a lower vapor pressure than expected compared to similar compounds due to hydrogen bonding. (10-2)

C: The vapor pressure is the pressure of the gas phase over a solid or liquid at equilibrium. (10-3)

D: All compounds with hydrogen atoms display hydrogen bonding. (10-2)

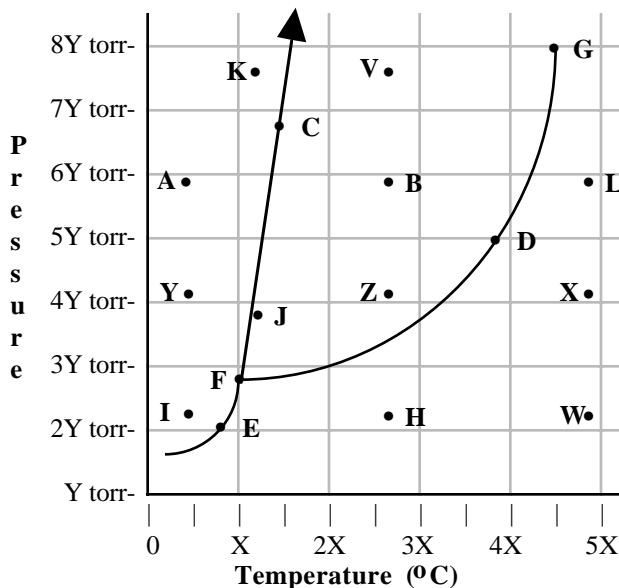
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- 78: Choose the correct statements from the following using **K-TYPE format** where $X = 50$ and $Y = 100$ on the diagram below. (10-9)

K-TYPE answer format:

- Choose *a* if A, B, and C are correct.
- Choose *b* if A and C are correct.
- Choose *c* if B and D are correct.
- Choose *d* if D only is correct.
- Choose *e* if any other pattern is correct.



- A: The normal boiling point of the substance is approximately $155\text{ }^{\circ}\text{C}$.
 B: The boiling point of the substance at 500 torr is approximately $190\text{ }^{\circ}\text{C}$.
 C: The normal melting point of the substance is approximately $50\text{ }^{\circ}\text{C}$.
 D: The substance is a solid at 300 torr and $25\text{ }^{\circ}\text{C}$.

- 79: Choose the correct statements concerning the phase diagram above using

K-TYPE answer format: Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (10-9)

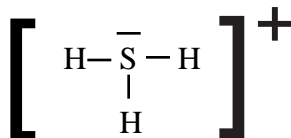
- A: The critical point is at point G.
 B: At point E, gas and solid are in equilibrium.
 C: The substance changes from a solid to a liquid in going from point K to point J.
 D: The substance changes from a solid to a gas in going from point Y to point Z.

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80: The Lewis structure of H_3S^+ is: (9-6)



There is a _____ bond between each H and the S atoms formed by the overlap of a _____ orbital on the H atoms and a _____ orbital on the S.

A: sigma, s, p

B: pi, s, s

C: sigma, sp^3 , sp^3

D: pi, s, sp^3

E: sigma, s, sp^3

81: The H-S-H bond angle in H_3S^+ is approximately (8B-5,6,7,8,9,10)

A: 90°

B: 109.5°

C: 120°

D: 180°

E: 90° or 120°
depending on
atoms considered

82: On the basis of the Lewis shape in question above, the best description of the structure of H_3S^+ is: (8B-5,6,7,8,9,10)

A: The hydrogen atoms are at the corners of an equilateral triangle with the sulfur at the center of the triangle.

B: The hydrogen atoms are at the corners of an equilateral triangle with the sulfur above the plane of the hydrogen atoms at the top of the "trigonal pyramid" the molecule forms.

C: The hydrogen atoms are at the corners of a triangle with the sulfur placed so that the molecule forms a tetrahedron.

D: The hydrogen atoms are at the corners of a triangle with the sulfur placed so that the molecule forms a "T" shape.

E: All four atoms lie in a straight line.