

Chem 3A Answer Keys to Midterm Versions with Explanations

Versions A and B are here

NOTE: A.I. was used for two things here:

1. To match the shuffle of questions for Versions A and B.
2. To actually study/analyze and choose the correct response, which it appears to have done. The use of A.I. here is an extra level of confidence.

Note in the Correct Answer and Explanation, this is a copy and paste from a text-based and so the correct formatting of text may not be exact or perfect, such as molecular formula subscripts. Let me know if this is confusing for you.

IF YOU SEE ANY ERRORS in matching A and B questions or in what is the correct choice of the question, please notify me.

VERSION A

Question	Correct Answer	Explanation
1	b) H-B>D-D>LDF	The order of strength is: Hydrogen Bonding (H-B, strongest) > Dipole-Dipole (D-D, intermediate) > London Dispersion Forces (LDF, weakest).
2	a) g	Mass is a measure of the amount of matter and is correctly expressed in grams (g).
3	a) ΔH_{vap}	Boiling is the phase change from liquid to gas (vaporization), and the associated enthalpy change is the enthalpy of vaporization (ΔH_{vap}).
4	c) solid	A solid has both a definite volume and a definite shape.
5	c) 75.0 J	Use the heat formula $q=m \times c \times \Delta T$. $q=(10.0 \text{ g}) \times (0.250 \text{ J/(g}^\circ\text{C)}) \times (50^\circ\text{C}-20^\circ\text{C})$ $q=(10.0 \text{ g}) \times (0.250 \text{ J/(g}^\circ\text{C)}) \times (30^\circ\text{C})=75.0 \text{ J}$
6	d) all the above	A Type II ion is a positively charged metal cation (a transition metal) that can form more than one charge state, and its name in a compound requires a Roman numeral (Stock system).
7	REMOVED FROM EXAM (see note at end)	
8	c) 246.5 g/mol	The molar mass of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ is calculated by summing the molar masses: $\text{Mg}+\text{S}+(4 \times \text{O})+7 \times [(2 \times \text{H})+\text{O}]$. $24.31+32.07+(4 \times 16.00)+7 \times (18.02) \approx 246.5 \text{ g/mol}$.

9	c) 51.16%	The mass percentage of water is Molar mass of HydrateMass of 7H ₂ O×100%. Mass of 7H ₂ O=7×18.02 g/mol≈126.14 g/mol. Mass Percentage=246.5 g/mol126.14 g/mol×100%≈51.17% (which matches option c) 51.16%).
10	d) 18	The total number of valence electrons for the NO ₂ ⁻ ion is: Nitrogen (Group 15) has 5 e ⁻ . Oxygen (Group 16) has 6 e ⁻ . Charge (-1) adds 1 e ⁻ . 5+(2×6)+1=**18** valence electrons.
11	e) 8	A stable electron configuration, or octet, means the atom is surrounded by 8 valence electrons.
12	c) The central atom nitrogen has no nonbonding (lone) pairs of electrons	The Lewis structure for NO ₂ ⁻ shown in the text (though incorrectly drawn as [:O=N=O:] ⁻) or the correct resonance structure [O ^{••} =N ^{••} -O ^{••}] ⁻ both show the central Nitrogen atom with one nonbonding (lone) pair of electrons. Therefore, the statement that it has no lone pairs is FALSE.
13	c) trigonal pyramidal	NH ₃ has a central N atom with three bonding pairs (to H atoms) and one nonbonding (lone) pair of electrons. This AX ₃ E configuration results in a trigonal pyramidal molecular geometry.
14	c) (nonpolar) covalent	A very little difference in electronegativity between atoms results in an even sharing of electrons, forming a nonpolar covalent bond.
15	d) molecular	H ₂ O (ice), CO ₂ (dry ice), and I ₂ are all formed from distinct, neutral molecules held together by intermolecular forces (H-bonding, LDF). This makes them molecular solids.
16	c) 274 K	To convert from Celsius to Kelvin, use the formula K=°C+273.15. K=1°C+273≈274 K
17	a) ionic	The largest difference in electronegativity (like between the metal Cs and the nonmetal F) results in a transfer of electrons and the formation of an ionic bond.
18	b) 2 mol	Avogadro's Number (6.022×10 ²³) is defined as the number of particles in one mole. If you have two (2) times Avogadro's Number of particles, you have 2 moles.
19	b) elemental analysis	Elemental analysis is the laboratory procedure used to determine the mass percent of each element in a compound, which is the key information needed to calculate the empirical formula.

20	d) dipole-dipole interaction	A dipole-dipole interaction is an electrostatic force between molecules that have a permanent partial positive charge (δ^+) on one end and a partial negative charge (δ^-) on the other, meaning they have a permanent dipole moment.
21	c) iron(III) oxide	Oxygen always has a charge of -2 . The total negative charge is $3 \times (-2) = -6$. To balance this, the two iron (Fe) atoms must have a total charge of $+6$, so each Fe must be Fe^{3+} . This is named iron(III) oxide.
22	e) N_2Cl_4	The prefix "dinitrogen" means 2 nitrogen atoms (N_2). The prefix "tetrachloride" means 4 chlorine atoms (Cl_4). The correct formula should be N_2Cl_4 .
23	c) 40.08 g	The molar mass of calcium (Ca) is 40.08 g/mol. Since 6.022×10^{23} atoms is the definition of 1 mole, then 1 mol of Ca has a mass equal to its molar mass.
24	d) both (b) and (c)	Group 2 elements are the alkaline earth metals. Both Calcium (Ca) and Magnesium (Mg) are in Group 2. Sodium (Na) is in Group 1.
25	b) The difference in electronegativity between O and H atoms enables hydrogen bonding	Hydrogen bonding is a special, strong dipole-dipole force enabled by the large electronegativity difference between H and highly electronegative atoms like O, N, or F.
26	a) true	One mole of any element or compound contains the exact same number of particles: Avogadro's Number (6.022×10^{23}). Therefore, 1 mol of Na atoms and 1 mol of K atoms contain the equal numbers of atoms.
27	a) true	Kinetic energy is the energy of motion and is mathematically related to mass and velocity ($\text{KE} = \frac{1}{2}mv^2$).
28	a) true	Valence Shell Electron Pair Repulsion (VSEPR) theory is based on the idea that both bonding and nonbonding (lone) pairs of electrons repel each other and arrange themselves in space to minimize this repulsion, which determines the molecular geometry.
29	b) false	The burning of gasoline releases heat and is therefore an exothermic process, not an endothermic one.
30	b) false	2.0 moles of H_2 molecules is $2.0 \times (6.022 \times 10^{23})$ molecules. 6.022×10^{23} molecules is only 1.0 mole.
31	a) true	The accepted average atomic mass (molar mass) of Beryllium (Be) on the periodic table is approximately 9.012 g/mol.

32	b) false	Equal moles of any two substances contain an equal number of molecules (Avogadro's Law). 0.50 mol of CO ₂ has the exact same number of molecules as 0.50 mol of SO ₂ .
33	b) false	A formula unit is the basic, neutral grouping of ions in an ionic compound (a concept), not a unit of mass. Mass is measured in grams (g).
34	a) true	London Dispersion Forces (LDF) are the weakest intermolecular forces and arise from the temporary, instantaneous, and uneven distribution of electrons, which creates a momentary (or induced) dipole.
35	b) false	Cesium (Cs) is Group 1 (+1 charge) and Chloride (Cl) is Group 17 (-1 charge). They combine in a 1:1 ratio to form the ionic compound CsCl. The formula Cs ₂ Cl is incorrect.

VERSION B

Question	Correct Answer	Explanation
1	a) g	Mass is a measure of the amount of matter and is correctly expressed in grams (g).
2	a) ΔH_{vap}	Boiling is the phase change from liquid to gas (vaporization), and the associated enthalpy change is the enthalpy of vaporization (ΔH_{vap}).
3	c) solid	A solid has both a definite volume and a definite shape.
4	d) 18	The total number of valence electrons for the NO ₂ ⁻ ion is: Nitrogen (Group 15) has 5 e ⁻ . Oxygen (Group 16) has 6 e ⁻ . Charge (-1) adds 1 e ⁻ . $5 + (2 \times 6) + 1 = 18$ valence electrons.
5	e) 8	A stable electron configuration, or octet, means the atom is surrounded by 8 valence electrons.
6	c) The central atom nitrogen has no nonbonding (lone) pairs of electrons	The Lewis structure for NO ₂ ⁻ shown in the text (though incorrectly drawn as [:O-N=O:] ⁻) or the correct resonance structure [O ⁻ =N ⁺ -O:] ⁻ both show the central Nitrogen atom with one nonbonding (lone) pair of electrons. Therefore, the statement that it has no lone pairs is FALSE.
7	c) 75.0 J	Use the heat formula $q = m \times c \times \Delta T$. $q = (10.0 \text{ g}) \times (0.250 \text{ J/(g}\cdot\text{C)}) \times (50\text{C} - 20\text{C})$ $q = (10.0 \text{ g}) \times (0.250 \text{ J/(g}\cdot\text{C)}) \times (30\text{C}) = 75.0 \text{ J}$
8	d) all the above	A Type II ion is a positively charged metal cation (a transition metal) that can form more than one charge state, and its name in a compound requires a Roman numeral (Stock system).

9	c) (nonpolar) covalent	A very little difference in electronegativity between atoms results in an even sharing of electrons, forming a nonpolar covalent bond.
10	REMOVED FROM EXAM (see note at end)	
11	c) 246.5 g/mol	The molar mass of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ is calculated by summing the molar masses: $\text{Mg} + \text{S} + (4 \times \text{O}) + 7 \times [(2 \times \text{H}) + \text{O}]$. $24.31 + 32.07 + (4 \times 16.00) + 7 \times (18.02) \approx 246.5 \text{ g/mol}$.
12	c) 51.16%	The mass percentage of water is Molar mass of Hydrate / Mass of $7\text{H}_2\text{O} \times 100\%$. Mass of $7\text{H}_2\text{O} = 7 \times 18.02 \text{ g/mol} \approx 126.14 \text{ g/mol}$. Mass Percentage = $246.5 \text{ g/mol} / 126.14 \text{ g/mol} \times 100\% \approx 51.17\%$ (which matches option c) 51.16%).
13	d) molecular	H_2O (ice), CO_2 (dry ice), and I_2 are all formed from distinct, neutral molecules held together by intermolecular forces (H-bonding, LDF). This makes them molecular solids.
14	c) trigonal pyramidal	NH_3 has a central N atom with three bonding pairs (to H atoms) and one nonbonding (lone) pair of electrons. This AX3E configuration results in a trigonal pyramidal molecular geometry.
15	c) 274 K	To convert from Celsius to Kelvin, use the formula $K = ^\circ\text{C} + 273.15$. $K = 1^\circ\text{C} + 273 \approx 274 \text{ K}$
16	a) ionic	The largest difference in electronegativity (like between the metal Cs and the nonmetal F) results in a transfer of electrons and the formation of an ionic bond.
17	b) 2 mol	Avogadro's Number (6.022×10^{23}) is defined as the number of particles in one mole. If you have two (2) times Avogadro's Number of particles, you have 2 moles.
18	b) $\text{H-B} > \text{D-D} > \text{LDF}$	The order of strength is: Hydrogen Bonding (H-B, strongest) > Dipole-Dipole (D-D, intermediate) > London Dispersion Forces (LDF, weakest).
19	b) elemental analysis	Elemental analysis is the laboratory procedure used to determine the mass percent of each element in a compound, which is the key information needed to calculate the empirical formula.
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35	b) false	Cesium (Cs) is Group 1 (+1 charge) and Chloride (Cl) is Group 17 (-1 charge). They combine in a 1:1 ratio to form the ionic compound CsCl. The formula Cs ₂ Cl is incorrect.

Question 7 in Version A and Question 10 in Version B was originally phrased to discuss the nitrate ion but was changed to the carbonate ion because you were more familiar with that in lecture, although the same principles for Lewis structure building would be the same. But not all the changes were made & the proofreading was terrible. It was removed.

FLAWED QUESTION

In drawing a Lewis structure for the carbonate (NO_3^-) ion, you have placed the octet around the three oxygen (O) atoms, but you see the central carbon (N) atom has only six electrons (3 bonding pairs) to the oxygen atoms. You have no electrons remaining to add in your inventory. What step do you need to do?

- a) Nothing: your Lewis structure is ready and complete
- b) Add a hydrogen atom to the molecule
- c) A lone pair from one of the oxygen (O) atoms will have to be used to create a double bond with the central nitrogen (N)
- d) Use Avogadro's Number at an earlier step
- e) The noble gas argon (Ar) must provide a single electron to complete this structure

INTENDED QUESTION

In drawing a Lewis structure for the carbonate (CO_3^{2-}) ion, you have placed the octet around the three oxygen (O) atoms, but you see the central carbon (C) atom has only six electrons (3 bonding pairs) to the oxygen atoms. You have no electrons remaining to add in your inventory. What step do you need to do?

- a) Nothing: your Lewis structure is ready and complete
- b) Add a hydrogen atom to the molecule
- c) A lone pair from one of the oxygen (O) atoms will have to be used to create a double bond with the central **carbon (C)**
- d) Use Avogadro's Number at an earlier step
- e) The noble gas argon (Ar) must provide a single electron to complete this structure

The correct answer was supposed to be C. This is the classic “Step 6” point. Choice (a) can't be true since you are told that the central carbon (C) atom doesn't have an octet. Adding hydrogen (H) atom is not really part of the steps: this is a distractor response. Choice (d) is also a distractor: use of Avogadro's Number is not mentioned in building a Lewis structure. Same for choice (e): all these are distractors if you recall the steps.