AP Chemistry Practice Ladder

Use this key to check answers and read the explanations.

1. In an idealized photoelectron spectrum, two peaks have equal heights. Peak X is at a lower binding energy than peak Y. What do the peaks indicate?

A. The subshells have equal numbers of electrons. It takes less energy to remove an electron from X.
B. The subshells have equal numbers of electrons. It takes more energy to remove an electron from X.
C. The subshell for X has fewer electrons. It takes equal energy to remove an electron from either.
D. The subshell for X has more electrons. It takes equal energy to remove an electron from either.

Correct answer: A. The subshells have equal numbers of electrons. It takes less energy to remove an electron from X.

Equal ideal peak heights indicate equal electron counts. The lower binding energy at X indicates that its electrons are easier to remove.

2. A linear molecule model has a central atom with two identical polar bonds pointing in opposite directions. What is the net molecular dipole?

A. Equal to the magnitude of one bond dipole
B. Twice the magnitude of one bond dipole
C. Zero, because the two bond dipoles cancel
D. Half the magnitude of one bond dipole

Correct answer: C. Zero, because the two bond dipoles cancel

The bond dipoles have equal magnitudes and opposite directions, so their vector sum is zero.

3. Two comparable model liquids are at the same temperature. The molecules in liquid A attract one another more strongly than those in liquid B. Which liquid has the lower equilibrium vapor pressure?

A. Liquid B
B. Liquid A
C. Their equilibrium vapor pressures are equal.
D. Both equilibrium vapor pressures are zero.

Correct answer: B. Liquid A

Stronger intermolecular attractions make it harder for molecules to escape the liquid. The model therefore gives liquid A the lower equilibrium vapor pressure.

4. In a fictional particle model, a single metal ion changes from a charge of 2+ to 4+. Which change accounts for that increase?

A. Reduction by gaining four electrons
B. Reduction by gaining two electrons
C. Oxidation by losing four electrons
D. Oxidation by losing two electrons

Correct answer: D. Oxidation by losing two electrons
Losing two negatively charged electrons raises the ion's charge by two units. Electron loss is oxidation.

5. A closed model system interconverts C and D. At equilibrium, the concentration of D is three times that of C. How do the forward and reverse reaction rates compare?

A. The forward rate is three times the reverse rate.
B. They are equal.
C. The reverse rate is three times the forward rate.
D. Both rates must be zero.

Correct answer: B. They are equal.
Forward and reverse reactions continue at equal rates at dynamic equilibrium. The two concentrations can settle at different constant values.

6. A model ideal-gas mixture contains 1.50 mol of A, 3.00 mol of B, and 0.50 mol of C at a total pressure of 120.0 kPa. What is the partial pressure of A?

A. 36.0 kPa
B. 60.0 kPa
C. 72.0 kPa
D. 18.0 kPa

Correct answer: A. 36.0 kPa
The total is 5.00 mol, so A has mole fraction 1.50/5.00 = 0.300. Its partial pressure is 0.300 × 120.0 kPa = 36.0 kPa.

7. A simulated graph of absorbance versus concentration is linear through the origin. Its absorbance is 0.16 at 0.020 mmol/L. What concentration gives an absorbance of 0.56?

A. 0.112 mmol/L
B. 0.0057 mmol/L
C. 0.040 mmol/L
D. 0.070 mmol/L

Correct answer: D. 0.070 mmol/L
The ratio of the absorbances is 0.56/0.16 = 3.5. The line goes through the origin, so the second concentration is 3.5 × 0.020 = 0.070 mmol/L.

8. A fictional rate table lists triples in the order [A], [B], initial rate, with consistent units: (2, 1, 3), (4, 1, 12), and (2, 3, 3). Which rate law fits?

A. Rate = k[A]
B. Rate = k[A][B]
C. Rate = k[A]²
D. Rate = k[B]²

Correct answer: C. Rate = k[A]²
Doubling [A] at fixed [B] quadruples the rate. Tripling [B] at fixed [A] leaves the rate unchanged. The orders are two in A and zero in B.

9. In a fictional buffer model, the weak acid has pKa 6.40 and the conjugate-base concentration is 0.10 times the acid concentration. Assuming Henderson–Hasselbalch applies, what is the pH?

A. 5.40
B. 6.30
C. 6.50
D. 7.40

Correct answer: A. 5.40
Use pH = pKa + $\log_{10}$([base]/[acid]). The ratio is 0.10, whose base-ten logarithm is −1.00, giving pH 5.40.

10. In a calorimetry model, 40.0 g of surroundings with specific heat 4.00 J/(g·K) warm by 3.00 K. The surroundings exchange heat only with the reaction. What is the heat change for the reaction?

A. +120 J
B. +480 J
C. −160 J
D. −480 J

Correct answer: D. −480 J
The surroundings gain 40.0 × 4.00 × 3.00 = 480 J. The reaction loses that amount, so its heat change is −480 J.

11. For two fictional equations, 2 X → 2 Z has ΔH = −44 kJ, and Y → Z has ΔH = +17 kJ. The values refer to the equations as written. What is ΔH for X → Y?

A. −5 kJ
B. +39 kJ
C. −39 kJ
D. −61 kJ

Correct answer: C. −39 kJ
Halve the first equation to get X → Z at −22 kJ. Reverse the second to get Z → Y at −17 kJ. Add the two changes to get −39 kJ.

12. For a fictional equilibrium 2 X(aq) ⇌ Y(aq), K = 0.80. A snapshot shows [X] = 0.50 M and [Y] = 0.30 M. Using the concentration-based expression, what are Q and the net direction?

A. Q = 1.20, with net change toward Y.
B. Q = 1.20, with net change toward X.
C. Q = 0.60, with net change toward Y.
D. Q = 0.80, with no net change.

Correct answer: B. Q = 1.20, with net change toward X.
Q = [Y]/[X]² = 0.30/(0.50)² = 1.20. Since Q exceeds K, the reverse reaction reduces Q by consuming Y and forming X.

13. A fictional reaction has ΔH° = +36.0 kJ/mol and ΔS° = +90.0 J/(mol·K), assumed constant from 350 to 450 K. Which direction is favored by the sign of ΔG° at each temperature?

A. Forward at 350 K, reverse at 450 K
B. Forward at both temperatures
C. Reverse at both temperatures
D. Reverse at 350 K, forward at 450 K

Correct answer: D. Reverse at 350 K, forward at 450 K
Convert ΔS° to 0.0900 kJ/(mol·K). Then ΔG° = ΔH° − TΔS° is +4.5 kJ/mol at 350 K and −4.5 kJ/mol at 450 K. A negative ΔG° favors the forward direction under standard conditions.

14. A fictional galvanic cell has standard reduction potentials of +0.42 V for half-reaction M (one electron) and −0.31 V for N (two electrons). Which half-reaction occurs as reduction, and what is the standard cell potential?

A. Reduction follows M, and the cell potential is +0.73 V.
B. Reduction follows N, and the cell potential is +0.73 V.
C. Reduction follows M, and the cell potential is +1.15 V.
D. Reduction follows M, and the cell potential is +0.11 V.

Correct answer: A. Reduction follows M, and the cell potential is +0.73 V.
M has the higher reduction potential, so it runs as the reduction at the cathode. Subtract the anode reduction potential: +0.42 − (−0.31) = +0.73 V. The electrode potentials stay the same when the electron counts are balanced.

15. A fictional compound sample contains 3.60 g of A and 4.00 g of B. Their atomic molar masses are 24.0 and 40.0 g/mol, respectively. The compound has a molar mass of 304.0 g/mol. What is its molecular formula?

A. A_4B_6
B. A_3B_2
C. A_6B_4
D. A_9B_6

Correct answer: C. A_6B_4
The sample contains 0.150 mol A and 0.100 mol B, a 3:2 ratio. The empirical formula A_3B_2 corresponds to 152.0 g/mol. Twice that gives A_6B_4.