選擇題，共40題，每題2.5分，共100分，答錯不倒扣。請在答案卷上作答。

1. Which of the following pairs can be used to illustrate the law of multiple proportions?

(a) SO and SO_2, (b) CO and $CaCo_3$, (c) H_2O and $C_{12}H_{22}O_{11}$, (d) H_2SO_4 and H_2S, (e) KCl and $KClO_2$.

2. $^{40}_{20}Ca^{2+}$ has

(a) 20 protons, 20 neutrons, and 18 electrons.
(b) 22 protons, 20 neutrons, and 20 electrons.
(c) 20 protons, 22 neutrons, and 18 electrons.
(d) 22 protons, 18 neutrons, and 18 electrons.
(e) 20 protons, 20 neutrons, and 22 electrons.

3. Which of the following are incorrectly paired?

(a) K, alkali metal, (b) Ba, alkaline earth metal, (c) O, halogen, (d) Ne, noble gas, (e) Ni, transition metal.

4. Iron is biologically important in the transport of oxygen by red blood cells from the lungs to the various organs of the body. In the blood of an adult human, there are approximately 2.60×10^{13} red blood cells with a total of 2.90 g of iron. On the average, how many iron atoms are present in each red blood cell? (molar mass (Fe) = 55.85 g)

(a) 8.33×10^{-10}, (b) 1.20×10^9, (c) 3.12×10^{22}, (d) 2.60×10^{13}, (e) 5.19×10^{-2}.

5. Phosphorus has the molecular formula P_4 and sulfur has the molecular formula S_8. How many grams of phosphorus contain the same number of molecules as 6.41 g of sulfur?

(a) 3.10 g, (b) 3.21 g, (c) 6.19 g, (d) 6.41 g, (e) none of these.

6. A compound is composed of element X and hydrogen. Analysis shows the compound to be 80% X by mass, with three times as many hydrogen atoms as X atoms per molecule. Which element is element X?

(a) He, (b) C, (c) F, (d) S, (e) none of these.

7. A 230.-mL sample of a 0.275 M solution is left on a hot plate overnight; the following morning the solution is 1.10 M. What volume of solvent has evaporated from the 0.275 M solution?

(a) 58.0 mL, (b) 63.3 mL, (c) 172 mL, (d) 230. mL, (e) 288 mL.

8. The interaction between solute particles and water molecules, which tends to cause a salt to fall apart in water, is called

(a) hydration, (b) polarization, (c) dispersion, (d) coagulation, (e) conductivity.

9. A solution contains the ions Ag^+, Pb^{2+}, and Ni^{2+}. Dilute solutions of $NaCl$, Na_2SO_4, and Na_2S are available to separate the positive ions from each other. In order to effect separation, the solutions should be added in which order?

(a) Na_2SO_4, $NaCl$, Na_2S, (b) Na_2SO_4, Na_2S, $NaCl$, (c) Na_2S, $NaCl$, Na_2SO_4, (d) $NaCl$, Na_2S, Na_2SO_4, (e) $NaCl$, Na_2SO_4, Na_2S.

10. A gas sample is held at constant pressure. The gas occupies 3.62 L of volume when the temperature is 21.6°C. Determine the temperature at which the volume of the gas is 3.45 L.

(a) 309 K, (b) 281 K, (c) 20.6 K, (d) 294 K, (e) 326 K.

11. Gaseous C_2H_4 reacts with O_2 according to the following equation:

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$
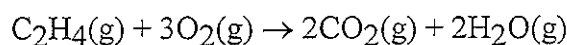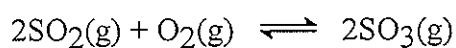
What volume of oxygen at STP is needed to react with 1.50 mol of C_2H_4?

(a) 4.50 L, (b) 33.6 L, (c) 67.2 L, (d) 101 L, (e) Not enough information is given to solve the problem.

12. Consider the following reaction: $CS_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2S(g)$
The equilibrium constant K is 0.28 at 900°C. What is K_p at this temperature?

(a) 7.0 x 10^{-5}, (b) 6.0 x 10^{-5}, (c) 5.0 x 10^{-5}, (d) 4.0 x 10^{-5}, (e) 3.0 x 10^{-5}.

13. Consider the reaction:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

at constant temperature. Initially a container is filled with pure $SO_3(g)$ at a pressure of 2 atm, after which equilibrium is reached. If y is the partial pressure of O_2 at equilibrium, the value of K_p is:

(a) $\dfrac{(2-2y)^2}{(y^2)(2y)}$, (b) $\dfrac{(2-y)^2}{(y^2)(y/2)}$, (c) $\dfrac{(2-y)^2}{(2y)^2(y)}$, (d) $\dfrac{(2-2y)^2}{(2y)^2(y)}$, (e) none of these.

14. For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container.

$$A(g) + 2B(g) \rightleftharpoons C(g)$$
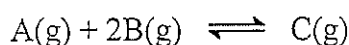
At equilibrium, the concentration of A is 0.300 mol/L. What is the value of K?

(a) 0.043, (b) 0.146, (c) 0.253, (d) 0.300, (e) 0.589.

15. A solution of 8.0 M formic acid (HCOOH) is 0.47% ionized. What is the K_a of formic acid?

(a) 3.4 x 10^{-8}, (b) 6.9 x 10^{-6}, (c) 1.8 x 10^{-4}, (d) 3.8 x 10^{-2}, (e) need more data.

16. How many moles of HCl need to be added to 150.0 mL of 0.50M NaZ to have a solution with a pH of 6.50? (K_a of HZ is 2.3 x 10^{-5}). Assume negligible volume of the HCl.

(a) 6.8 x 10^{-3}, (b) 7.5 x 10^{-2}, (c) 5.0 x 10^{-1}, (d) 1.0 x 10^{-3}, (e) none of these.

17. Solubility Products (K_{sp})

|	
$BaSO_4$	1.5 x 10^{-9}
CoS	5.0 x 10^{-22}
$PbSO_4$	1.3 x 10^{-8}
AgBr	5.0 x 10^{-13}

Which of the following compounds is the most soluble (in moles/liter)?

(a) $BaSO_4$, (b) CoS, (c) $PbSO_4$, (d) AgBr, (e) $BaCO_3$.

18. Consider a rigid insulated box containing 20.0 g of He(g) at 25.0°C and 1.00 atm in one compartment and 20.0 g of $N_2(g)$ at 115.0°C and 2.00 atm in the other compartment. These compartments are connected by a partition which transmits heat. What will be the final temperature in the box at thermal equilibrium? (C_v(He) = 12.5 J/K mol, $C_v(N_2)$ = 20.7 J/K mol)

(a) 42.2°C, (b) 58.9°C, (c) 70.0°C, (d) 81.0°C, (e) none of these.

19. Consider the reaction:

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l); \Delta H = -1.37 \times 10^3 \text{ kJ}$$
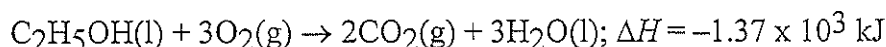
Consider the following propositions:

I. The reaction is endothermic
II. The reaction is exothermic.
III. The enthalpy term would be different if the water formed was gaseous.

Which of these propositions is (are) true?

(a) I, (b) II, (c) III, (d) I, II, (e) II, III.

20. A bomb calorimeter has a heat capacity of 2.47 kJ/K. When a 0.105-g sample of ethylene (C_2H_4) was burned in this calorimeter, the temperature increased by 2.14 K. Calculate the energy of combustion for one mole of ethylene.

(a) −5.29 kJ, (b) −50.3 kJ, (c) −572 kJ, (d) −661 kJ, (e) −1.41 x 10^3 kJ.

21. A two-bulbed flask contains seven particles. What is the probability of finding all seven particles on the left side?

(a) 3.1%, (b) 0.93%, (c) 0.78%, (d) 0.32%, (e) 0.13%.

22. The heat of vaporization for 1.0 mole of water at 100°C and 1.0 atm is 40.6 kJ/mol. Calculate ΔS for the process $H_2O(l) \rightarrow H_2O(g)$ at 100°C.

(a) 109 J/K mol, (b) −109 J/K mol, (c) 406 J/K mol, (d) −406 J/K mol, (e) none of these.

23. For a particular chemical reaction

$$\Delta H = 5.5 \text{ kJ and } \Delta S = -25 \text{ J/K}$$

Under what temperature condition is the reaction spontaneous?

(a) When $T < -220$ K.
(b) When $T < 220$ K.
(c) When $T > 220$ K.
(d) The reaction is spontaneous at all temperatures.
(e) The reaction is not spontaneous at any temperature.

24. How many electrons are transferred in the following reaction?

$$2ClO_3^- + 12H^+ + 10I^- \rightarrow 5I_2 + Cl_2 + 6H_2O$$
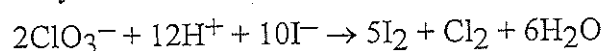
(a) 2, (b) 4, (c) 8, (d) 10, (e) 15.

25. A cell is set up with copper and lead electrodes in contact with $CuSO_4$(aq) and $Pb(NO_3)_2$(aq), respectively, at 25°C. The standard reduction potentials are:

$$Pb^{2+} + 2e^- \rightarrow Pb \quad E° = -0.13 \text{ V}$$
$$Cu^{2+} + 2e^- \rightarrow Cu \quad E° = +0.34 \text{ V}$$
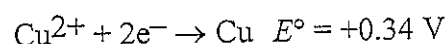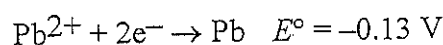
If the Pb^{2+} and Cu^{2+} are each 1.0 M, the potential of the cell, in volts, is:

(a) 0.46, (b) 0.92, (c) 0.22, (d) 0.58, (e) none of these.

26. The galvanic cell described by $Zn(s) \mid Zn^{2+}(aq) \mid\mid Cu^{2+}(aq) \mid Cu(s)$ has a standard cell potential of 1.101 volts. Given that $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ has an oxidation potential of 0.762 volts, determine the reduction potential for Cu^{2+}.

(a) −1.863 V, (b) 1.863 V, (c) −0.339 V, (d) 0.339 V, (e) none of these.

27. Determine $\Delta G°$ for a cell that utilizes the following reaction:

$$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(l)$$
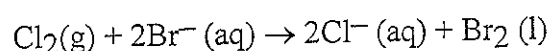
The standard reduction for the chlorine gas is 1.360 volts and the standard reduction for the bromine liquid is 1.077 volts.

(a) 471 kJ, (b) 236 kJ, (c) 27.3 kJ, (d) 54.6 kJ, (e) 82.5 kJ.

28. The energy of the light emitted when a hydrogen electron goes from $n = 2$ to $n = 1$ is what fraction of its ground-state ionization energy?

(a) 3/4, (b) 1/2, (c) 1/4, (d) 1/8, (e) 1/9.

29. How many electrons in an atom can have the quantum numbers $n = 3$, $l = 2$?

(a) 2, (b) 5, (c) 10, (d) 18, (e) 6.

30. Which of the following combinations of quantum numbers do *not* represent permissible solutions of the Schrödinger equation for the electron in the hydrogen atom (i.e., which combination of quantum numbers is *not* allowed)?

	n	l	m	s (or m_s)
Option 1:	9	8	−4	1/2
Option 2:	8	2	2	1/2
Option 3:	6	−5	−1	1/2
Option 4:	6	5	−5	1/2
Option 5:	All are allowed.			

(a) Option 1, (b) Option 2, (c) Option 3, (d) Option 4, (e) Option 5.

31. How many of the following molecules possess dipole moments?

BH_3, CH_4, PCl_5, H_2O, HF, H_2

(a) 1, (b) 2, (c) 3, (d) 4, (e) 5.

32. Calculate the lattice energy for LiF(s) given the following:

sublimation energy for Li(s)	+166 kJ/mol
ΔH_f for F(g)	+77 kJ/mol
first ionization energy of Li(g)	+520. kJ/mol
electron affinity of F(g)	−328 kJ/mol
enthalpy of formation of LiF(s)	−617 kJ/mol

(a) 285 kJ/mol, (b) −650. kJ/mol, (c) 800. kJ/mol, (d) −1047 kJ/mol, (e) None of these.
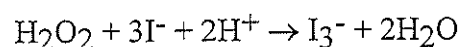
33. The hybridization of the central atom in ClF_2^+ is:

(a) sp, (b) sp^2, (c) sp^3, (d) dsp^3, (e) d^2sp^3.

34. For how many of the following does the bond order decrease if you add one electron to the neutral molecule?

B_2, C_2, P_2, F_2

(a) 0, (b) 1, (c) 2, (d) 3, (e) 4.

35. Consider the following data concerning the equation:

$$H_2O_2 + 3I^- + 2H^+ \rightarrow I_3^- + 2H_2O$$

	$[H_2O_2]$	$[I^-]$	$[H^+]$	rate
I	0.100 M	5.00×10^{-4} M	1.00×10^{-2} M	0.137 M/sec
II.	0.100 M	1.00×10^{-3} M	1.00×10^{-2} M	0.268 M/sec
III.	0.200 M	1.00×10^{-3} M	1.00×10^{-2} M	0.542 M/sec
IV.	0.400 M	1.00×10^{-3} M	2.00×10^{-2} M	1.084 M/sec

The rate law for this reaction is

(a) rate = $k[H_2O_2][I^-][H^+]$, (b) rate = $k[H_2O_2]^2[I^-]^2[H^+]^2$, (c) rate = $k[I^-][H^+]$, (d) rate = $k[H_2O_2][H^+]$, (e) rate = $k[H_2O_2][I^-]$.

36. The following questions refer to the reaction $2A_2 + B_2 \rightarrow 2C$. The following mechanism has been proposed:

　　step 1 (very slow)　　　　　$A_2 + B_2 \rightarrow R + C$
　　step 2 (slow)　　　　　　　$A_2 + R \rightarrow C$

According to the proposed mechanism, what should the overall rate law be?

(a) rate = $k[A_2]^2$, (b) rate = $k[A_2]$, (c) rate = $k[A_2][B_2]$, (d) rate = $k[A_2][R]$, (e) rate = $k[R]^2$.

37. In which of the following groups of substances would dispersion forces be the only significant factors in determining boiling points?

　　　　　I. Cl_2　　　II. HF　　　III. Ne　　　IV. KNO_2　　　V. CCl_4

(a) I, III, V, (b) I, II, III, (c) II, IV, (d) II, V, (e) III, IV, V.

38. Aluminum metal crystallizes in a face-centered cubic structure. The relationship between the radius of an Al atom (r) and the length of an edge of the unit cell (E) is:

(a) $r = E/2$, (b) $r = (\sqrt{2}/4)\ E$, (c) $r = (\sqrt{3}/4)\ E$, (d) $r = 2E$, (e) $r = 4E$.

39. Which of the following complexes shows geometric isomerism?

(a) $[Co(NH_3)_5Cl]SO_4$, (b) $[Co(NH_3)_6]Cl_3$, (c) $[Co(NH_3)_5Cl]Cl_2$, (d) $K[Co(NH_3)_2Cl_4]$, (e) none of these.

40. Fluoride ion ranks low in the spectrochemical series and produces a weak crystal field in complex ions. Based on this information, predict the number of unpaired electrons in CoF_6^{3-}.

(a) 0, (b) 1, (c) 2, (d) 3, (e) 4.