一、選擇題(單選題)，請在電腦卡上作答 (每題二分)

1. What is the coefficient on M when the following equation is completed and balanced if M is an alkali metal?
$M_{(s)} + H_2O_{(l)} \rightarrow$
(a) 1; (b) 2; (c) 3; (d) 4.

2. Which one of the following represents a possible set of quantum numbers (in the order n, l, m_l, m_s) for an electron in an atom.
(a) 2, 1, −1, ½; (b) 2,1, 0, 0; (c) 2, 2, 0, ½; (d) 2, 0, 1, −½.

3. Which one of the following ions is responsible for making water "hard"?
(a) Na^+; (b) Al^{3+}; (c) Mg^{2+}; (d) SO_4^{2-}; (e) CO_3^{2-}.

4. Which of the following compound is a hydride?
(a) NH_3; (b) NaH; (c) H_2O; (d) H_2S; (e) HCl.

5. Which of the following metal element is a noble metal?
(a) Al; (b) Fe; (c) Cu; (d) Na; (e) Ag.

6. What volume (in liters) will 1.3 moles of ideal gas occupy at 22°C and 2.5 atm pressure?
(a) 0.079; (b) 0.94; (c) 13; (d) 31; (e) 33.

7. Consider the following reactions.
$AgNO_3(aq) + Zn(s) \rightarrow Ag(s) + Zn(NO_3)_2$
$Zn(NO_3)_2(aq) + Co(s) \rightarrow$ no reaction
$AgNO_3(aq) + Co(s) \rightarrow Co(NO_3)_2(aq) + Ag(s)$
What is the correct order of increasing activity for these metals?
(a) Ag < Zn < Co; (b) Co < Ag < Zn; (c) Co < Zn < Ag; (d) Ag < Co < Zn.

8. Which one of the following metals is the most likely element to form several different positive ions?
(a) Al; (b) Cs; (c) V; (d) Ca; (e) Si.

9. Which one of the following forms of carbon contains only sp^3 hybridized carbon atoms?
(a) diamond; (b) fullerene; (c) carbon nanotube (d) graphite (e) charcoal.

10. Which one of the following simple salts will have a molar conductivity similar to that of $K[AuCl_4]$?
(a) $Al_2(SO_4)_3$; (b) MgI_2; (c) $CaCl_2$; (d) H_3PO_4; (e) KBr.

11. To which class of compounds does the molecule $C_4H_8O_2$ belong?
(a) ketone; (b) alcohol; (c) ether; (d) carboxylic acid; (e) phenol.

12. Liquid, unsaturated oils are chemically converted to solid materials by
(a) hydrogenation; (b) esterification; (c) denaturation; (d) saponification reaction.

13. In acidic solutions, soaps are converted to which of the following materials
(a) insoluble salts; (b) fatty acids; (c) detergents; (d) esters; (e) glycerol.

14 The addition of slaked lime [$Ca(OH)_2$] and aluminum sulfate [$Al_2(SO_4)_3$] to drinking water produces a gelatinous precipitate that is useful in removing (a) suspended matter such as dirt and bacteria; (b) dissolved organics; (c) volatile organic chemicals; (d) hard ions.

15. Ice is less dense than liquid water because it (a) is an ionic material; (b) has a high heat capacity; (c) is less polar than liquid water; (d) has some molecules destroyed as it freezes; (e) has large hexagonal holes in its molecualr arrangement.

16. The primary potential advantage of nuclear power for the generation of electricity is (a) minimal air pollution; (b) decreased reliance on dwindling fossil fuel; (c) no CO_2 emission, lessening its impact on the greenhouse effect; (d) all of these are potential advantages over fossil fuels.

17. How many additional moles of gas would have to be added to a flask containing 2.00 moles of gas at 25°C and 1.00 atm pressure in order to increase the pressure to 1.60 atm under conditions of constant temperature and volume?
(a) 0.80; (b) 1.00; (c) 1.20; (d) 3.20.

18. What is the empirical formula for a compound that is 29% by weight of sodium, 41% of sulfur and 30% of oxygen? ($M.W._{Na} = 23$ and $M.W._S = 32$)
(a) $Na_2S_2O_3$; (b) $NaSO_2$; (c) NaSO; (d) $NaSO_3$.

19. What is the nature of the intermolecular attractive forces that exist among the methanol solvent (CH_3OH) and methane solute (CH_4) molecule?
(a) dipole-dipole interaction; (b) hydrogen bonding; (c) London dispersion forces; (d) ion-dipole interaction; (e) ionic electrostatic interaction.

20. A solution is prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. Calculate the molality of $CaCl_2$ in the solution describe above.
(a) 0.214; (b) 0.57; (c) 2.14; (d) 63.2; (e) 0.63.

21. Which one of the following properties of a liquid is not affected by an increase in intermolecular forces?
(a) viscosity; (b) molecular weight; (c) heat of vaporization; (d) boiling point; (e) vapor pressure.

22. Which one of the following reactions will have a positive value of $\Delta H°$?
(a) $H_2O(l) \rightarrow H_2O(s)$
(b) $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$
(c) $2H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$
(d) $2\ C_4H_{10}(l) + 13\ O_2(g) \rightarrow 8\ CO_2(g) + 10\ H_2O(g)$

23. Which one of the following forms of radiation can penetrate the deepest into body tissue?
(a) alpha; (b) beta; (c) gamma; (d) positron; (e) ultraviolet radiation.

24. Which of the following statements about the halogen family is true? (a) Bromine is obtained by using the chloride ion as the oxidizing agent. (b) Iodine is the strongest oxidizing agent. (c) The halide ions are all oxidizing agents, and the fluoride ion the strongest. (d) The halide ions are more reactive than the halogens. (e) All of the halogens can be obtained by electrolysis of the molten halide salts.

25. In the blast furnace production of iron from its ore, coke serves as (a) a drink; (b) a fuel; (c) a reducing reagent; (d) the slag; (e) both a fuel and a reducing reagent.

26. If the electronic structure of a solid substance consists of a valence band that is completely filled with electrons and there is a large energy gap to the next set of orbitals, then this substance will be a(n): (a) alloy; (b) insulator; (c) conductor; (d) semi-conductor; (e) detector.

27. The correct systematic name of the compound $H_2C=C(CH_3)(CH_2CH_3)$ is
(a) 2-ethyl-1-propene; (b) 1-methyl-1-ethyl-ethylene; (c) 2-ethyl-2-propane; (d) 2-methyl-1-butene; (e) 3-methyl-3-butane.

28. For the reaction between permanganate ion and oxalate ion in basic solution the unbalanced equation is
$MnO_4^- + C_2O_4^{2-} \rightarrow MnO_2(s) + CO_3^{2-}$
When this equation is balanced the number of OH^- ions is
(a) zero; (b) two on the right; (c) two on the left; (d) four on the right; (e) four on the left.

29. The order of increasing ionization energy for the atoms neon, nitrogen, phosphorus, and sodium is
(a) Na < P < N < Ne; (b) N < Ne < Na < P; (c) N < Na < Ne < P; (d) Na < N < P < Ne;
(e) N < Na < P < Ne.

30. Warm dilute nitric acid will oxidize (a) Pt but not Au; (b) Ag but not Pt; (c) Au but not Ag;
(d) Sn but not Cd; (e) Cu but not Ag.

31. A reaction for which the activation energies of the forward and reverse directions are equal in value, suggest that
(a) the stoichiometry is the mechanism; (b) $\Delta H = 0$; (c) $\Delta S = 0$; (d) the order of reaction is 0;
(e) there is no catalyst.

32. For which of the following ionic crystalline solids does the cation-anion bond have the largest amount of covalent character?
(a) CdS; (b) NaBr; (c) SrS; (d) BaO; (e) LiF.

33. Assuming that all volume are additive, how much water should be added to 25.0 mL of 6.0 M HNO_3 to prepare 0.5 M HNO_3 solution?
(a) 350 mL; (b) 325 mL; (c) 300 mL; (d) 275 mL; (e) 225 mL.

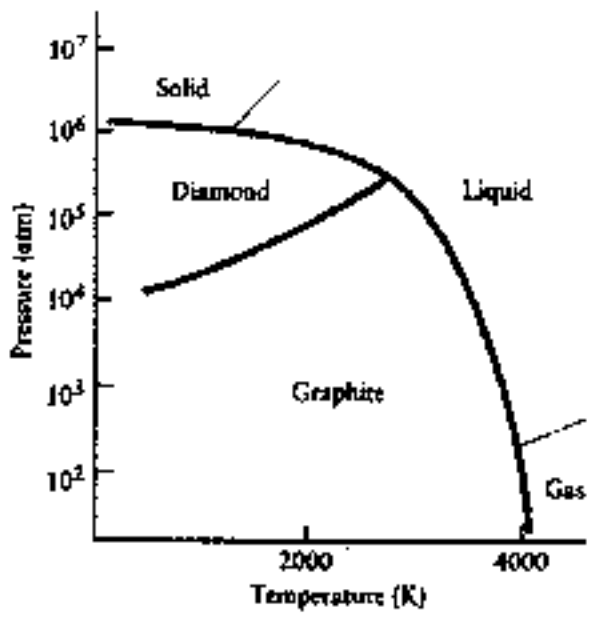
34. A racemic mixture contains (a) equal amounto f cis and trans isomers; (b) both straight-chain and branched-chain alkanes; (c) a catalyst to increase the rate of reaction; (d) equal amount of a primary and a secondary amine; (e) equal amount of a pair of enantiomers.

35. Which of the following statements is not true of diborane? (a) It is an electron-deficient compound. (b) It has two three center bonds. (c) It is a highly reactive oxidizing agent. (d) It is a Lewis acid. (e) It has two different types of hydrogen atoms.

二、問答題：

36. Determine the number of electron pairs on the phosphorous atom in (a) PCl_3, (b) PCl_5, (c) PCl_4^+ and (d) PCl_6^-, and predict their molecular structure. (10%)

37. The phase diagram of carbon indicates the extreme conditions that are needed to form diamonds from graphite. Copy this phase diagram of carbon to your answer sheet and answer the follow questions: (a) At 2,000 K, what is the minimum pressure needed before graphite changes to diamond? (b) What is the minimum temperature at which liquid carbon can exist at pressure below 10,000 atm? (c) At what pressure does graphite melt at 3,000K? (d) Are diamonds stable under normal conditions? If not, why is it that people can wear them without the diamonds having to be compressed and heated? (10%)



38. The properties of beryllium oxide (BeO) distinguish it from the other alkaline earth metal oxides. The most noticeable difference is the amphoteric behavior of BeO, whereas the other alkaline earth oxides are basic. Why is BeO amphoteric ? Please also complete and balance the respective equations upon treatment with an acid H^+ and a base OH^- in aqueous media. (10%)