國 立 宜 蘭 大 學
101 學 年 度 轉 學 招 生 考 試

（考生填寫）
准考證號碼：

化 學 試 題

《作答注意事項》

1. 請先檢查准考證號碼、座位號碼及答案卷號碼是否相符。

2. 考試時間：80 分鐘。

3. 本試卷共有 50 題選擇題，一題 2 分，共計 100 分。

4. 請將答案寫在答案卷上（於本試題上作答者，不予計分）。

5. 考試中禁止使用大哥大或其他通信設備。

6. 考試後，請將試題卷及答案卷一併繳交。

7. 本試卷採雙面影印，請勿漏答。

1. Which of the following statements regarding elements is **incorrect**?
   A) Elements are the simplest building block of matter.
   B) Elements cannot be broken down into simpler substances even by chemical means.
   C) Some elements are not naturally occurring, and have been synthesized by scientists.
   D) As the Greeks had thought, water is an element.
   E) Elements are classified using a periodic table.

2. When the mathematical operation is carried out, how many significant figures should be reported in the answer?
$$(3.225 \times 10^{19}) \times \frac{(0.01)}{(7.3 \times 10^{-3})}$$
   A) 1   B) 2   C) 3   D) 4   E) 5

3. Which of the following statements regarding atomic theory is **incorrect**?
   A) John Dalton's experimental results led to the law of conservation of mass.
   B) Antoine Lavoisier's experiments showed that the mass of the products of a chemical reaction equals the mass of the reacting substances.
   C) When wood is burned, the ashes weigh less than the original wood, but this is not a violation of the law of conservation of matter.
   D) Dalton's atomic theory says that a chemical reaction is a rearrangement of atoms into one or more different chemical substances.
   E) Joseph Proust's findings regarding the reactions between metals and oxygen led to the law of definite proportions.

4. Which of the following statements about Mendeleev's periodic table is **incorrect**?
   A) Mendeleev arranged the known elements in order of increasing relative atomic mass.
   B) He grouped elements with similar properties into columns and rows so that their properties varied in a regular pattern.
   C) He arranged the elements so that they were in increasing atomic number order.
   D) He was able to predict the existence and properties of several elements that were unknown at the time.
   E) Mendeleev developed his table before the discovery of protons.

5. Which set of formulas is correct for the compounds ammonia, nitric acid, and nitrous acid, respectively?
   A) NH_3, HN, HNO   B) NH_4, HNO_2, HNO_3 C) NH_3, HNO_2, HNO_3
   D) NH_3, HNO_3, HNO_2 E) NH_4, HNO_3, HNO_2

6. Which of the following formula/name pairs is **incorrect**?
   A) RbS   rubidium sulfide   B) K_2CO_3 potassium carbonate
   C) $NaClO_4$ sodium chloroxate   D) Fe_2S_3 iron(III) sulfide   E) K_2O potassium oxide

7. Which of the following statements is **incorrect**?
   A) PH_3 has 3 times as many hydrogen atoms as phosphorus atoms.
   B) MgO has an equal number of magnesium ions and oxygen ions.
   C) $BaBr_2$ has half as many barium ions as bromide ions.
   D) N_2O_5 has 2.5 times as many nitrogen atoms as oxygen atoms.
   E) SF_4 has 4 times as many fluorine atoms as sulfur atoms.

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8. Which of the following statements regarding atoms, molecules, and moles is **correct**?
   A) Chemists are inherently lazy, so they weigh substances in order to avoid counting out the atoms or molecules in a sample.
   B) It would be possible for an individual to count out a mole of atoms or molecules if they had a few days to do it.
   C) A single grain of sand has about as many formula units of SiO_2 as there are sand grains on all of the beaches on Earth.
   D) A mole of HCl would have the same mass as a mole of NaCl, since they have the same number of particles.
   E) Since a mole of LiCl has a mass of 42.39 g, the average mass of a LiCl formula unit would be 42.39 mole.

9. In order to prepare a 0.0500 M NaOH solution, to what volume would you dilute 25.0 mL of 2.50 M NaOH?
   A) 1.25×10^3 L   B) 1.25 L   C) 1.25 mL   D) 0.0625 L   E) 0.500 L

10. Butyric acid has a very unpleasant odor.   It is present in some rotting foods, body odor and vomit.   Butyric acid has a molar mass of 88.10 g/mol and consists of 54.53% C, 9.153% H, and 36.32% O.   What is the molecular formula of butyric acid?
    A) $CH_2O_{0.5}$ B) CH_2O C) CH_4O D) C_2H_4O E) $C_4H_8O_2$

11. Write and balance a net ionic equation for the reaction between hydrochloric acid and potassium hydroxide.
    A) $HCl(aq) + KOH(aq)$ $\rightarrow KCl(aq) + H_2O(l)$
    B) $H^+(aq) + O^{2-}(aq) \rightarrow OH^-(aq)$
    C) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
    D) $Cl^-(aq) + OH^+(aq) \rightarrow OHCl(aq)$
    E) $K^+(aq) + Cl^-(aq) \rightarrow KCl(aq)$

12. Would an aqueous solution of CH_3OH contain ions?   If so, indicate the formulas of the ions in the solution.
    A) No, this substance would not form ions in solution.
    B) Yes. $CH_3^+(aq) + OH^-(aq)$ C) Yes. $CH_3^-(aq) + OH^+(aq)$
    D) Yes. $CH_4^+(aq) + O^-(aq)$ E) Yes. $CH_4^{2+}(aq) + O^{2-}(aq)$

13. If solutions of potassium chromate and calcium nitrate are mixed, will a double-displacement reaction occur?   If so, what is the balanced equation for the reaction?
    A) No reaction will occur.
    B) Yes. $K_2CrO_4(aq) + Ca(NO_3)_2(aq) \rightarrow KNO_3(aq) + CaK(s)$
    C) Yes. $K_2CrO_4(aq) + Ca(NO_3)_2(aq) \rightarrow KNO_3(aq) + CaCrO_4(s)$
    D) Yes. $K_2CrO_4(aq) + Ca(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + CaCrO_4(s)$
    E) Yes. $K_2CrO_4(aq) + Ca(NO_3)_2(aq) \rightarrow K_2(NO_3)_2(aq) + CaCrO_4(s)$

14. Predict which of the following reactions will occur?
    (i) $Ni(s)$ + $FeCl_2(aq)$ $\rightarrow$ $NiCl_2(aq)$ + $Fe(s)$
    (ii) $2Al(s)$ + $3NiCl_2(aq)$ $\rightarrow$ $2AlCl_3(aq)$ + $3Ni(s)$
    (iii) $Fe(s)$ + $CuCl_2(aq)$ $\rightarrow$ $FeCl_2(aq)$ + $Cu(s)$
    A) i only   B) ii only   C) iii only   D) ii and iii   E)   All three will occur.

15. If an equal quantity of heat is transferred to 10.0 g samples of liquid water (C = 4.184 J/g°C), concrete (C = 0.88 J/g°C), asphalt (C = 0.920 J/g°C), glass (C = 0.84 J/g°C), and iron (C = 0.448 J/g°C), rank the final temperatures of the samples from least to greatest.
    A) iron < glass < concrete < asphalt < water
    B) water < asphalt < concrete < glass < iron
    C) asphalt < concrete < glass < iron < water
    D) iron < concrete < glass < asphalt < water
    E) water < concrete < asphalt < glass < iron

16. Consider the following reaction: $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(l) + NO(g)$
    How many moles of the excess reactant remain if 4.00 moles of H_2O and 10.00 moles of NO_2 are mixed?
    A) 0.67 mol H_2O B) 2.00 mol NO_2 C) 3.33 mol H_2O D) 6.00 mol NO_2
    E) 8.00 mol NO_2

17. Consider the following reaction.
    $Cr_2O_3(s) +$ $3CCl_4(l) \rightarrow 2CrCl_3(s) + 3COCl_2(g)$
    green   colorless   purple   colorless
    solid   liquid   solid   gas
    When the green solid is mixed with the colorless liquid, the mixture starts to bubble and fume.   When all action has stopped, a wet purple solid remains.   Which substance is the limiting reactant?
    A) Cr_2O_3 B) CCl_4 C) $CrCl_3$ D) $COCl_2$ E)   there is no limiting reactant

18. When mixed, solutions of silver nitrate, $AgNO_3$, and sodium phosphate, Na_3PO_4, will form a precipitate of silver phosphate, Ag_3PO_4. The balanced equation is:
    $3AgNO_3(aq) + Na_3PO_4(aq) \rightarrow$ $Ag_3PO_4(s) + 3NaNO_3(aq)$
    Which of the following statements regarding this reaction is **incorrect**?
    A) 6 moles of $AgNO_3$ will react with 2 moles of Na_3PO_4.
    B) 9 moles of $AgNO_3$ will form 2 moles of Ag_3PO_4, given sufficient Na_3PO_4.
    C) 1.5 moles of $NaNO_3$ will be formed when 0.5 mole of Na_3PO_4 reacts with sufficient $AgNO_3$.
    D) 3 moles of Ag_3PO_4 will be formed when 3 moles of Na_3PO_4 react with sufficient $AgNO_3$.
    E) 2 moles of Na_3PO_4 will react with 6 moles of $AgNO_3$.

19. Which of the following statements regarding the Bohr model of the hydrogen atom is **incorrect**?
    A) Bohr's model shows the electron circling the nucleus in fixed orbits.
    B) In Bohr's model, electrons could exist between orbits.
    C) In Bohr's model, when an electron absorbs energy, it can move to a higher-energy orbit.
    D) In Bohr's model, when an electron emits energy, it can move to a lower-energy orbit.
    E) In Bohr's model, $n = 1$ is the lowest energy orbit.

20. Which ion is expected to be the largest?
    A) O^{2-} B) Mg^{2+} C) Na^+ D) F^- E)   All these ions have the same size.

21. Rank the following elements in order of increasing ionization energy: Al, Ba, O, C
    A) Al < Ba < O < C   B) Ba < Al < O < C   C) Ba < Al < C < O
    D) O < C < Al < Ba   E) C < O < Al < Ba

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22. Rank the following elements in order of increasing atomic size: Al, Ba, O, C
    A) Al < Ba < O < C   B) Ba < Al < O < C   C) Ba < Al < C < O
    D) O < C < Al < Ba   E) C < O < Al < Ba

23. Which of the following is the correct ground state electron configuration for a magnesium
    atom?
    A) $1s^22s^22p^8$ B) $1s^22s^22p^63s^2$ C) $1s^22s^{10}$ D) $1s^22s^22p^63s^23p^2$
    E) $1s^22s^22p^63s^1$

24. Which of the following molecules is polar?
    A) BCl_3 B) NH_3 C) $SiCl_4$ D) CBr_4 E) $BeBr_2$

25. Which of the following statements regarding VSEPR theory is correct?
    A) When counting the number of electron groups on the central atom, a double bond counts as
       two groups.
    B) The trigonal pyramidal shape has three atoms and one unshared pair of electrons on the
       central atom.
    C) The unshared pairs of electrons are unimportant in both the Lewis structure and in VSEPR
       theory.
    D) A trigonal planar molecular shape has four atoms attached to the central atom.
    E) It is not necessary to calculate the number of valence electrons available in a given
       molecule before using VSEPR to predict the shape of that molecule.

26. The correctly drawn Lewis formula for C_2H_2 will have _____.
    A) 4 single bonds   B) 5 single bonds   C) 4 single bonds and 1 double bond
    D) 4 single bonds and 1 triple bond   E) 5 double bonds

27. Identify the main-group element X that could form the compound

    A) C   B) O   C) N   D) F   E) P

28. Which of the following statements regarding covalent bonding is **incorrect**?
    A) In covalent bonding, electrons are shared between two atoms.
    B) Most elements try to acquire an octet of electrons in their valence shell when bonding.
    C) Hydrogen only requires two electrons in its valence shell when bonding.
    D) Covalent bonds occur between a metal and a nonmetal.
    E) It is possible for two atoms to share more than one pair of electrons.

29. Arrange the following bonds in order of increasing polarity: O-H, C-H, F-H, H-H
    A) O-H < C-H < F-H < H-H   B) C-H < O-H < F-H < H-H   C) H-H < C-H < O-H < F-H
    D) C-H < H-H < O-H < F-H   E) H-H < C-H < F-H < O-H

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30. Using periodic trends, arrange the following atoms in order of increasing electronegativity:
    Se, Cl, Mg, Na
    A) Se < Cl < Mg < Na   B) Na < Mg < Cl < Se   C) Mg < Na < Se < Cl
    D) Se < Mg < Na < Cl   E) Na < Mg < Se < Cl

31. Convert 6.25×10^4 Pa to mm Hg.
    A) 0.617 mm Hg   B) 469 mm Hg   C) 4.75×10^7 mm Hg   D) 82.2 mm Hg
    E) 625 mm Hg

32. Which of the following statements is **incorrect**?   (Assume a fixed amount of gas under
    constant temperature conditions.)
    A) Boyle's law says that the volume occupied by a gas is inversely proportional to its pressure.
    B) If the volume of a container of gas is halved, the pressure will be doubled.
    C) If the volume of a container of gas is tripled, the pressure will decrease by a factor of three.
    D) When the volume of a container is increased, the distance between the gas particles
       decreases.
    E) If the pressure on a gas sample is quadrupled, the volume will decrease by a factor of four.

33. Charles's Law states that the volume of a gas held at constant pressure is directly
    proportional to the absolute temperature.   Which of the following is a consequence of
    Charles's Law?
    A) Oxygen cylinders are often used by climbers on Mt. Everest.
    B) Underwater divers often use air cylinders.
    C) Gases can be condensed to liquids at certain temperatures and pressures.
    D) A sealed balloon will rise if the air in it is heated.
    E) Application of sufficient pressure to carbon dioxide gas produces solid dry ice.

34. The pressure volume relationship expressed by Boyle's law can be **explained** by the kinetic
    molecular theory as follows:
    A) When a gas is subjected to more pressure, more of the gas dissolves in a liquid.
    B) When the volume of a gas is decreased, its molecules become closer together, causing more
       frequent collisions with the walls of the container.
    C) The volume of a gas decreases as the pressure applied to the gas increases.
    D) When the volume is decreased, the increased temperature causes the molecules to move
       faster and to hit the walls of the container more frequently.
    E) The pressure of a gas results from its molecules being so close to one another that they
       cause the container walls to bulge.

35. A liter container of CO_2 and a liter container of H_2 are both at 25°C and 1 atm pressure.
    Which of the following statements about these gas samples is true?
    A) The CO_2 and H_2 molecules have the same average velocity.
    B) There are more H_2 molecules than CO_2 molecules.
    C) The average kinetic energy of the CO_2 molecules is greater than that of the H_2 molecules.
    D) The CO_2 molecules on average are moving more slowly than the H_2 molecules.
    E) The masses of the two gas samples are equal.

36. Which substance has the highest melting point?
    A) Mg   B) C_5H_{12} C) Kr   D) SiO_2 (silica)   E) Cl_2

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37. The forces that hold CO_2 together in the solid state are:
    A) ionic bonds.   B) dipole-dipole forces.   C) London dispersion forces only.
    D) covalent bonds.   E) attractions between nuclei and delocalized valence electrons.

38. Which of the following statements regarding the solid state is **incorrect**?
    A) Most polymers, such as rubbers and plastics, are amorphous.
    B) Minerals, such as quartz and amethyst, are crystalline solids.
    C) Solids normally do not flow.
    D) The particles of a solid are held in a rigid, 3-dimensional array.
    E) The arrangement of the particles in a crystal lattice is called *space packing*.

39. Which of the following statements regarding the liquid state is **incorrect**?
    A) Detergents increase the surface tension of water, in order to help it stay in droplet form.
    B) If ice were denser than liquid water, lakes would freeze from the bottom up.
    C) In the summer, one would use a motor oil with a high viscosity rating to better lubricate the
       engine at high temperatures.
    D) A liquid such as $C_{15}H_{32}$ would be expected to be more viscous than C_6H_{14}.
    E) Water rises in a glass capillary tube due to the interactions between the water molecules and
       the glass.

40. What will happen to a blood cell that is placed in pure water?
    A) The cell will shrink because there will be a net flow of water to the outside of the cell.
    B) The cell will shrink because there will be a net flow of electrolytes to the outside of the
       cell.
    C) The cell will expand because there will be a net flow of water to the inside of the cell.
    D) The cell will expand because there will be a net flow of electrolytes to the inside of the cell.
    E) Nothing will happen because the cell is impermeable.

41. In a chemical reaction at constant temperature, the addition of a catalyst
    A) affects the equilibrium constant.
    B) increases the fraction of molecules with high kinetic energy.
    C) provides an alternate reaction pathway with a different activation energy.
    D) decreases the energy released in the chemical reaction.
    E) increases the concentration of the products at equilibrium.

42. Identify *any* intermediates or catalysts in the following two-step reaction:
    $$H_2O_2 + 2Br^- + 2H^+ \rightarrow 2H_2O + Br_2$$
    $$H_2O_2 + Br_2 \rightarrow 2H^+ + O_2 + 2Br^-$$
    A) H_2O_2 is an intermediate.   B) H_2O_2 is a catalyst, Br^- is an intermediate.
    C) Br^- is a catalyst, Br_2 is an intermediate.   D) H^+ is a catalyst.
    E) Br^- and H^+ are catalysts, Br_2 is an intermediate.

43. Which equilibrium constant represents a reaction that is product favored?
    A) $K_{eq} = 0.025$ B) $K_{eq} = 5.2$ C) $K_{eq} = 8.4 \times 10^{-5}$ D) $K_{eq} = 6.3 \times 10^5$
    E) not enough information

44. If Na_2HPO_4 is added to water, what other compound could also be added in order to make a
    buffered solution?
    A) H_3PO_4 B) $NaHPO_4$ C) NaH_2PO_4 D) Na_2PO_3 E) none of these is correct

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45. Select the pair that consists of a base and its conjugate acid *in that order.*
    A) NH_4^+/NH_3 B) HCO_3^-/CO_3^{2-} C) HCO_3^-/H_2CO_3
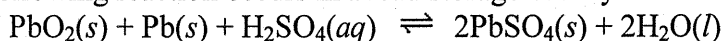   D) H_3PO_4/HPO_4^{2-} E) CO_3^{2-}/CO_2^{2-}

46. Which of the following reactions is **not** an oxidation-reduction reaction?
    A) $C(s) + CO_2(g) \rightarrow CO_2(g)$
    B) $CO(g) + Cl_2(g) \rightarrow COCl_2(g)$
    C) $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$
    D) $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$
    E) $2HI(g) \rightarrow H_2(g) + I_2(g)$

47. In any electrolytic cell, the cathode is the electrode
    A) that attracts anions.
    B) at which electrons are collected from electron donors in the solution.
    C) at which reduction occurs.
    D) at which oxidation occurs.
   E) that is made of graphite.

48. The following reaction occurs in a lead storage battery:
    $$PbO_2(s) + Pb(s) + H_2SO_4(aq) \rightleftharpoons 2PbSO_4(s) + 2H_2O(l)$$
    Which statement is **true**?
   A) The concentration of H_2SO_4 increases as the battery discharges.
    B) Pb is formed at the anode during charging.
    C) PbO_2 is formed at the anode during charging.
    D) The mass of Pb decreases during charging.
    E) The mass of $PbSO_4$ remains constant during charging and discharging.

49. What is the IUPAC name of the compound shown in the figure?
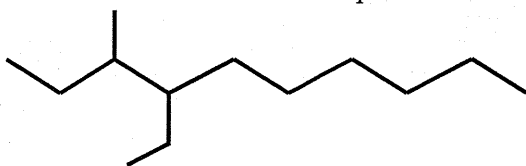
    A) 3-methyl-4-ethyldecane   B) 4-ethyl-3-methyldecane   C) ethyl-methyl-decane
    D) methyl-ethyl-decane   E) 3-methyl-4-propyldecane

50. What is the name of the compound shown in the figure?
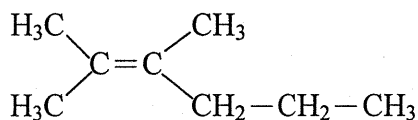
    A) *trans*-2,3-diethyl-2-butene   B) 2,3-dimethyl-2-hexene   C) *cis*-2,3-diethyl-2-butene
    D) *trans*-2,3-dimethyl-2-hexene   E) *trans*-4,5-dimethyl-4-hexene