

國立高雄大學

111 學年度第一學期

理學院

普通化學會考

December 24, 2022 (Wed.)

9:30 ~ 11:30

姓名：_____ 學號：_____

— 考試注意事項 —

考試時間：120分鐘

總分：100分

作答方式：

- 請使用原子筆或簽字筆於「答案卷」上作答。
- 未依規定於答案卷作答以致無法辨識答案者，其後果由考生自行負責。
- 答案卷每人一張，不得要求增補。
- 選擇題共 32 題，均為單選題。
1-28 題，每題 3 分；29-32 題，每題 4 分。
- 試卷請繳回。

參考資料

一、元素週期表

PERIODIC TABLE OF THE ELEMENTS																	
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

二、常數

$$R = 8.314 \text{ J/mol}\cdot\text{K} = 0.08206 \text{ L}\cdot\text{atm/K}\cdot\text{mol}; \text{ Avogadro's number} = 6.022 \times 10^{23}; 1 \text{ atm} = 101325 \text{ Pa}$$

選擇題 (1-28 題，每題 3 分；29-32 題，每題 4 分)

(B) 1. Which of the following statements is/are true of molecular orbital?

1. A bonding molecular orbital is lower in energy than the atomic orbitals of which it is composed.
2. Electrons in a bonding molecular orbital favor the separated atoms.
3. An antibonding molecular orbital is higher in energy than the atomic orbitals of which it is composed.

- (A) 1 only
(B) 1 and 3
(C) 2 only
(D) 2 and 3
(E) 3 only

(B) 2. Bromine exists naturally as a mixture of bromine-79 and bromine-81 isotopes. An atom of bromine-79 contains

- (A) 79 protons, 79 electrons, and 35 neutrons.
(B) 35 protons, 44 neutrons, and 35 electrons.
(C) 44 protons, 44 electrons, and 35 neutrons.
(D) 34 protons and 35 electrons only.
(E) 35 protons, 79 neutrons, and 35 electrons.

(E) 3. Which of the following statements is(are) true?

Oxidation and reduction

- I. cannot occur independently of each other.
- II. accompany all chemical changes.
- III. describe the loss and gain of electron(s), respectively.
- IV. result in a change in the oxidation states of the species involved.

- (A) I only
(B) II only
(C) III only
(D) IV only
(E) I, III, and IV

(B) 4. If four orbitals on one atom overlap four orbitals on a second atom, how many molecular orbitals will form?

- (A) 1
(B) 8
(C) 4
(D) 16
(E) none of these

- (A) 5. Identify the following unbalanced reactions $\text{AgNO}_3 + \text{KCl} \rightarrow \text{AgCl} + \text{KNO}_3$ using the following choices:
- (A) Precipitation reaction
 - (B) Acid-base reaction
 - (C) Oxidation-reduction reaction
 - (D) Combustion reaction
 - (E) More than one of answers a-d apply.
- (D) 6. Which of the following statements is incorrect?
- (A) A molecule with very polar bonds can be nonpolar.
 - (B) Ionic bonding results from the transfer of electrons from one atom to another.
 - (C) Dipole moments result from the unequal distribution of electrons in a molecule.
 - (D) Linear molecules cannot have a net dipole moment.
 - (E) The electrons in a polar bond are found nearer to the more electronegative element.
- (A) 7. What is the hybridization of the central atom in SF_3 ?
- (A) dsp^3
 - (B) sp^3
 - (C) d^2sp^3
 - (D) sp
 - (E) sp^2
- (C) 8. Vibrational transitions in molecules typically require energies that correspond to the _____ region of the electromagnetic spectrum.
- (A) visible
 - (B) microwave
 - (C) IR
 - (D) X-ray
 - (E) UV
- (D) 9. What is the hybridization of C in the molecule CO?
- (A) dsp^3
 - (B) sp^2
 - (C) d^2sp^3
 - (D) sp
 - (E) sp^3
- (E) 10. The _____ is defined as the change in energy that takes place when separated gaseous ions are packed together to form an ionic solid.
- (A) atomic binding energy
 - (B) bond energy
 - (C) band gap energy
 - (D) ionization energy
 - (E) lattice energy

- (E) 11. Atoms that are sp^3 hybridized form ____ pi bond(s).
- (A) 1
 - (B) 4
 - (C) 2
 - (D) 3
 - (E) 0
- (D) 12. The electron pair in a C–F bond could be considered
- (A) an inadequate model because the bond is ionic.
 - (B) closer to C because carbon has a lower electronegativity than fluorine.
 - (C) closer to C because carbon has a larger radius and thus exerts greater control over the shared electron pair.
 - (D) closer to F because fluorine has a higher electronegativity than carbon.
 - (E) centrally located directly between the C and F.
- (D) 13. The configuration $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2py})^1(\pi_{2px})^1$ is the molecular orbital description for the ground state of which of the following species?
- (A) Be_2
 - (B) Li_2^+
 - (C) B_2^{2-}
 - (D) B_2
 - (E) C_2
- (C) 14. How many electrons can be described by the quantum number $n = 3$?
- (A) 32
 - (B) 2
 - (C) 18
 - (D) 8
 - (E) 10
- (A) 15. Identify the true statement(s) about acids and bases.
1. An acid is a substance that produces H^+ ions when it is dissolved in water.
 2. A base is a substance that produces OH^- ions when dissolved in water.
 3. An acid that dissociates completely in aqueous solution is called a weak acid.
 4. A base that dissociates completely in aqueous solution is called a weak base.
- (A) 1 and 2
 - (B) 1 and 3
 - (C) 3 and 4
 - (D) 2 and 4
 - (E) 1, 2, 3, and 4

(A) 16. Which of the following molecules has a dipole moment?

- (A) SF₄
- (B) CF₄
- (C) XeF₄
- (D) All of these have a dipole moment.
- (E) None of these has a dipole moment.

(E) 17. Which of the following statements is/are true of water?

1. An individual water molecule is V-shaped, with an H–O–H angle of about 105°.
2. The O–H bonds in a water molecule are ionic bonds.
3. Polar and ionic substances are more soluble in water than nonpolar substances.

- (A) 1 only (B) 2 only (C) 3 only (D) 1 and 2 (E) 1 and 3

(B) 18. As the number of bonds between two carbon atoms increases, which one of the following decreases?

- (A) the number of electrons between the carbon atoms
- (B) the bond length
- (C) the bond energy
- (D) all of these
- (E) none of these

(B) 19. Which of the following compounds contains only one unshared pair of valence electrons?

- (A) NaCl
- (B) NH₃
- (C) BeF₃
- (D) CH₄
- (E) H₂O

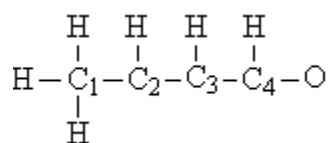
(A) 20. In which groups do all the elements have the same number of valence electrons?

- (A) O, S, Se
- (B) N, As, Se
- (C) Ag, Cd, Ar
- (D) Na, Ca, Ba
- (E) N, O, Br

(D) 21. Of the following, which molecule has the largest bond angle?

- (A) O₃ (B) H₂S (C) OF₂ (D) XeF (E) PCl₃

(D) 22. Consider the compound crotonaldehyde, whose skeleton is

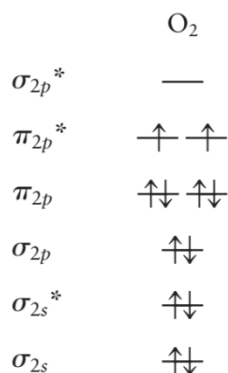


Which carbon in this molecule has tetrahedral bonding?

- (A) 2 (B) 3 (C) 4 (D) 1 (E) All have tetrahedral bonding.

- (A) 23. An element with the electron configuration $[\text{Xe}]4f^{14}5d^76s^2$ would belong to which class on the periodic table?
- (A) transition elements
 - (B) alkaline earth elements
 - (C) rare earth elements
 - (D) halogens
 - (E) none of these
- (E) 24. Place the elements Ge, S, and Ne in order of increasing atomic radius.
- (A) Ge, Ne, S
 - (B) S, Ne, Ge
 - (C) S, Ge, Ne
 - (D) Ge, S, Ne
 - (E) Ne, S, Ge
- (A) 25. Which is the highest occupied energy orbital in a silicon atom?
- (A) 3p (B) 3d (C) 3s (D) 2s (E) 1s
- (D) 26. What is the electron configuration for the chromium (Cr) atom?
- (A) $[\text{Kr}] 4s^1 3d^5$
 - (B) $[\text{Ar}] 4s^2 3d^4$
 - (C) $[\text{Kr}] 4s^2 3d^4$
 - (D) $[\text{Ar}] 4s^1 3d^5$
 - (E) none of these
- (E) 27. Which of the following combinations of quantum numbers is *not* allowed?
- (Combinations are listed as follows: $n, l, m_{(l)}, m_{(s)}$)
- (A) 4 0 0 $-1/2$
 - (B) 5 3 1 $-1/2$
 - (C) 4 1 1 $1/2$
 - (D) 3 1 0 $1/2$
 - (E) 3 3 0 $-1/2$
- (B) 28. Of the following elements, which has occupied d orbitals in its ground-state neutral atoms?
- (A) Al (B) Ba (C) Ca (D) P (E) Cl

(D) 29. Which charge(s) of O_2 would give a bond order of 2.5?

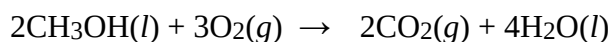


- (A) +2 (B) -2 (C) -1 (D) +1 (E) +3 (F) 0

(C) 30. When the equation $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$ is balanced with the smallest set of integers, the sum of the coefficients is

- (A) 28 (B) 33 (C) 47 (D) 4 (E) 40

(C) 31. The combustion of methanol takes place according to the reaction



Calculate ΔH for the combustion of 1 mol of methanol under standard conditions.

Use the following standard enthalpies of formation:

$$\Delta H^\circ_f \text{ for } CH_3OH(l) = -238.5 \text{ kJ/mol}$$

$$\Delta H^\circ_f \text{ for } CO_2(g) = -393.5 \text{ kJ/mol}$$

$$\Delta H^\circ_f \text{ for } H_2O(l) = -285.6 \text{ kJ/mol}$$

- (A) -1452.4 kJ/mol
 (B) +1452.4 kJ/mol
 (C) -726.2 kJ/mol
 (D) +726.2 kJ/mol
 (E) none of these

(A) 32. 1.00 mL of a $3.50 \times 10^{-4} M$ solution of oleic acid is diluted with 9.00 mL of petroleum ether, forming solution A. 2.00 mL of solution A is diluted with 8.00 mL of petroleum ether, forming solution B. How many grams of oleic acid are in 5.00 mL of solution B? (molar mass for oleic acid = 282 g/mol)

- (A) $9.87 \times 10^{-6} \text{ g}$
 (B) $4.94 \times 10^{-5} \text{ g}$
 (C) $4.94 \times 10^{-4} \text{ g}$
 (D) $1.97 \times 10^{-6} \text{ g}$
 (E) $7.00 \times 10^{-6} \text{ g}$