國立臺灣海洋大學 106學年度研究所碩士班招生考試試題

考試科目：普通化學

系所名稱：生命科學暨生物科技學系碩士班乙組

＊可使用計算器

1. 答案以橫式由左至右書寫。2. 請依題號順序作答。

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2%/pt)

1) One angstrom, symbolized Å, is 10^{-10} m. 1 cm^3 = _____ $Å^3$.

A) 10^{-30} B) 10^{30} C) 10^{24} D) 10^{-9} E) 10^{-24}

2) 1.55 kg/m^3 is equivalent to _____ g/L.

A) 6.83 B) 3.58×10^{12} C) 1.55 D) 1.95×10^{3} E) 1.60×10^{9}

3) Which atom has the smallest number of neutrons?

A) fluorine-19 B) carbon-14 C) neon-20 D) nitrogen-14 E) oxygen-16

4) There are _____ electrons, _____ protons, and _____ neutrons in an atom of $^{132}_{54}Xe$.

A) 54, 54, 78 B) 54, 54, 132 C) 78, 78, 132 D) 132, 132, 54 E) 78, 78, 54

5) What is the coefficient of O_2 when the following equation is completed and balanced?

$$C_4H_8O_2 + O_2 \rightarrow \_\_\_\_\_$$

A) 5 B) 1 C) 3 D) 2 E) 6

6) A compound that is composed of carbon, hydrogen, and oxygen contains 70.6% C, 5.9% H, and 23.5% O by mass. The molecular weight of the compound is 136 amu. What is the molecular formula?

A) C_8H_4O B) $C_9H_{12}O$ C) $C_5H_6O_2$ D) $C_8H_8O_2$ E) C_4H_4O

7) Given the following reactions

$$2NO \rightarrow N_2 + O_2 \quad \Delta H = -180 \text{ kJ}$$

$$2NO + O_2 \rightarrow 2NO_2 \quad \Delta H = -112 \text{ kJ}$$

the enthalpy of the reaction of nitrogen with oxygen to produce nitrogen dioxide

$$N_2 + 2O_2 \rightarrow 2NO_2$$

is _____ kJ.

A) -68 B) 68 C) -146 D) 292 E) -292

8) Which of the following are strong electrolytes?

HCl

$HC_2H_3O_2$

NH_3

KCl

A) HCl, $HC_2H_3O_2$, NH_3, KCl

B) $HC_2H_3O_2$, KCl
C) HCl, NH_3, KCl
D) HCl, $HC_2H_3O_2$, KCl
E) HCl, KCl

9) How many grams of sodium chloride are there in 55.0 mL of a 1.90 M aqueous solution of sodium chloride?
A) 0.105 B) 6.11 C) 6.11×10^3 D) 12.2 E) 3.21

10) The change in the internal energy of a system that absorbs 2,500 J of heat and that does 7,655 J of work on the surroundings is _____ J.
A) 5,155 B) 10,155 C) -5,155 D) -10,155 E) 1.91×10^7

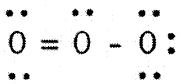
11) The energy (J) required for an electronic transition in a Bohr hydrogen atom from n = 2 to n = 3 is _____ J.
A) 4.00×10^{-19}
B) -3.00×10^{-19}
C) 3.00×10^{-19}
D) 4.60×10^{14}
E) -7.90×10^{-19}

12) The element that corresponds to the electron configuration $1s^2 2s^2 2p^2$ is _____.
A) lithium B) nitrogen C) beryllium D) carbon E) boron

13) The first ionization energies of the elements _____ as you go from left to right across a period of the periodic table, and _____ as you go from the bottom to the top of a group in the table.
A) increase, increase
B) increase, decrease
C) decrease, increase
D) decrease, decrease
E) The first ionization energies of the elements are completely unpredictable.

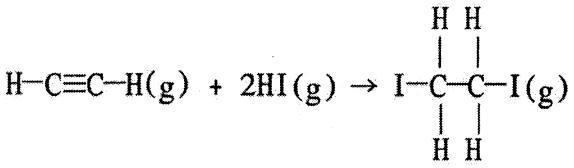
14) Of the following elements, _____ has the most negative electron affinity.
A) Br B) H C) I D) F E) Cl

15) In the resonance form of ozone shown below, the formal charge on the central oxygen atom is _____.



A) +1 B) 0 C) -1 D) +2 E) -2

16) Using the table of average bond energies below, the ΔH for the reaction is _____ kJ.



Bond:	C≡C	C-C	H-I	C-I	C-H
D (kJ/mol):	839	348	299	240	413

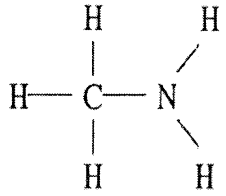
A) +63 B) +160 C) -217 D) -63 E) -160

17) The basis of the VSEPR model of molecular bonding is _____.

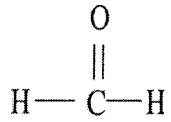
A) hybrid orbitals will form as necessary to, as closely as possible, achieve spherical symmetry
B) regions of electron density in the valence shell of an atom will arrange themselves so as to maximize overlap
C) atomic orbitals of the bonding atoms must overlap for a bond to form
D) electron domains in the valence shell of an atom will arrange themselves so as to minimize repulsions
E) regions of electron density on an atom will organize themselves so as to maximize *s*-character

18) Which one of the following substances will have hydrogen bonding as one of its intermolecular forces?

A)



B)



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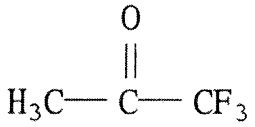
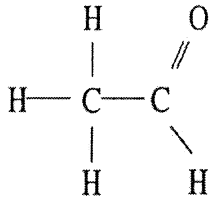
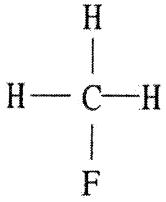


D)



E)



19) Arrange the following gases in order of increasing average molecular speed at 25 °C.

$He,\ O_2,\ CO_2,\ N_2$

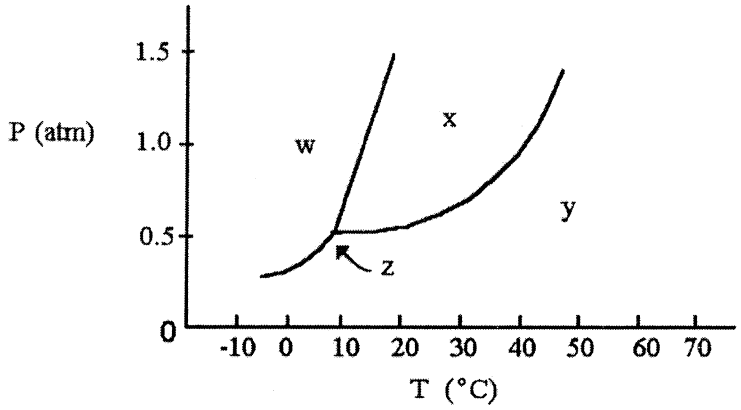
A) $CO_2 < O_2 < N_2 < He$
B) $He < O_2 < N_2 < CO_2$
C) $He < N_2 < O_2 < CO_2$
D) $CO_2 < He < N_2 < O_2$
E) $CO_2 < N_2 < O_2 < He$

20) The hybridization of the carbon atom in carbon dioxide is _____.

A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

21) Sodium bicarbonate is reacted with concentrated hydrochloric acid at 37.0 °C and 1.00 atm. The reaction of 6.00 kg of bicarbonate with excess hydrochloric acid under these conditions will produce _____ L of CO_2.

A) 1.82×10^3 B) 1.09×10^2 C) 8.70×10^2 D) 1.82×10^4 E) 2.85×10^4



22) The phase diagram of a substance is given above. This substance is a _____ at 30 °C and 0.5 atm.

A) supercritical fluid
B) gas
C) liquid
D) solid
E) crystal

23) Crystalline solids differ from amorphous solids in that crystalline solids have _____.

A) no orderly structure
B) appreciable intermolecular attractive forces
C) much larger atoms, molecules, or ions
D) a long-range repeating pattern of atoms, molecules, or ions
E) atoms, molecules, or ions that are close together

24) Inorganic compounds that are semiconductors have an average of _____ valence electrons.

A) 5 B) 1 C) 3 D) 2 E) 4

25) A supersaturated solution _____.

A) is one with a higher concentration than the solubility
B) is one with more than one solute
C) must be in contact with undissolved solid
D) exists only in theory and cannot actually be prepared
E) is one that has been heated

26) Which of the following liquids will have the lowest freezing point?

A) pure H_2O
B) aqueous KF (0.50 m)
C) aqueous FeI_3 (0.24 m)
D) aqueous glucose (0.60 m)
E) aqueous sucrose (0.60 m)

27) The rate law for a reaction is

$$\text{rate} = k[A][B]$$

Which one of the following statements is false?

A) The reaction is first order overall.
B) k is the reaction rate constant
C) The reaction is first order in A.
D) The reaction is first order in [B].
E) If [A] is doubled, the reaction rate will increase by a factor of 2.

28) At elevated temperatures, nitrogen dioxide decomposes to nitrogen oxide and oxygen:

$$NO_2\,(g) \rightarrow NO\,(g) + \frac{1}{2}O_2\,(g)$$

The reaction is second order in NO_2 with a rate constant of $0.543\ M^{-1}s^{-1}$ at $300\ °C$. If the initial $[NO_2]$ is $0.260\ M$, it will take _____ s for the concentration to drop to $0.075\ M$.

A) 17.5 B) 0.0880 C) 3.34 D) 0.299 E) 2.29

29) How is the reaction quotient used to determine whether a system is at equilibrium?

A) At equilibrium, the reaction quotient is undefined.
B) The reaction is at equilibrium when $Q = K_{eq}$.
C) The reaction is at equilibrium when $Q < K_{eq}$.
D) The reaction is at equilibrium when $Q > K_{eq}$.
E) The reaction quotient must be satisfied for equilibrium to be achieved.

Consider the following table of K_{sp} values.

Name	Formula	K_{sp}
Cadmium carbonate	$CdCO_3$	5.2×10^{-12}
Cadmium hydroxide	$Cd(OH)_2$	2.5×10^{-14}
Calcium fluoride	CaF_2	3.9×10^{-11}
Silver iodide	AgI	8.3×10^{-17}
Zinc carbonate	$ZnCO_3$	1.4×10^{-11}

30) Which compound listed below has the greatest molar solubility in water?

A) $CdCO_3$ B) $ZnCO_3$ C) $Cd(OH)_2$ D) AgI E) CaF_2

31) A solution of NaF is added dropwise to a solution that is $0.0122\ M$ in Ba^{2+}. When the concentration of F^- exceeds _____ M, BaF_2 will precipitate. Neglect volume changes. For BaF_2, $K_{sp} = 1.7 \times 10^{-6}$.

A) 2.1×10^{-8} B) 1.4×10^{-4} C) 3.0×10^{-3} D) 1.2×10^{-2} E) 7.0×10^{-5}

32) Consider the following reaction at equilibrium:

$$2C^{O_2}\ (g) \rightleftharpoons 2CO\ (g) + {}^{O_2}\ (g) \quad \Delta H° = -514\ kJ$$

Le Châtelier's principle predicts that removing ^{O_2} (g) to the reaction container will _____.

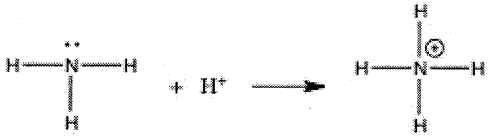
A) increase the partial pressure of CO
B) decrease the partial pressure of CO
C) decrease the value of the equilibrium constant
D) increase the partial pressure of CO_2
E) increase the value of the equilibrium constant

33) Of the acids in the table below, _____ is the strongest acid.

Acid	K_a
HOAc	1.8×10^{-5}
$HCHO_2$	1.8×10^{-4}
HClO	3.0×10^{-8}
HF	6.8×10^{-4}

A) HClO
B) HOAc
C) HOAc and $HCHO_2$
D) HF
E) $HCHO_2$

34) In the gas phase reaction below, NH_3 is acting as a(n) _____ base but <u>not</u> as a(n) _____ base.



A) Arrhenius, Brø nsted-Lowry
B) Arrhenius, Lewis
C) Lewis, Arrhenius
D) Lewis, Brø nsted-Lowry
E) Brø nsted-Lowry, Lewis

35) Which of the following is <u>not</u> one of the 12 principles associated with green chemistry?

A) use of renewable feedstocks
B) less hazardous chemical syntheses
C) distribution of chemical by-products into oceans
D) inherently safer chemistry for accident prevention
E) promotion of the use of catalysts

36) A reaction that is spontaneous as written _____.

A) will proceed without outside intervention
B) has an equilibrium position that lies far to the left
C) is also spontaneous in the reverse direction
D) is very rapid
E) is very slow

37) In the Haber process, ammonia is synthesized from nitrogen and hydrogen:

$$N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$$

$\Delta G°$ at 298 K for this reaction is -33.3 kJ/mol. The value of ΔG at 298 K for a reaction mixture that consists of 1.9 atm N_2, 2.3 atm H_2, and 0.85 atm NH_3 is _____.

A) -8.62×10^3 B) -118.0 C) -4.09×10^3 D) -41.9 E) -1.0

38) Which element is reduced in the reaction below?

$$Fe^{2+} + H^+ + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+} + H_2O$$

A) Cr B) O C) Fe D) H

39) Cathodic protection of a metal pipe against corrosion usually entails _____.

A) attaching a dry cell to reduce any metal ions which might be formed
B) attaching an active metal to make the pipe the cathode in an electrochemical cell
C) coating the pipe with another metal whose standard reduction potential is less negative than that of the pipe
D) attaching an active metal to make the pipe the anode in an electrochemical cell
E) coating the pipe with a fluoropolymer to act as a source of fluoride ion (since the latter is so hard to oxidize)

40) The half-life of a radionuclide _____.

A) gets longer with increased temperature
B) is constant
C) gets shorter with passing time
D) gets shorter with increased temperature
E) gets longer with passing time

41) Which one of the following forms of radiation can penetrate the deepest into body tissue?

A) beta B) proton C) positron D) alpha E) gamma

42) The Haber process is used to make _____ from _____.

A) NO_2, O_2 B) O_2, $KClO_3$ C) NO, N_2 D) HNO_3, N_2 E) NH_3, N_2

43) Complexes containing metals with d^{10} electron configurations are typically colorless because _____.

A) the empty d orbitals absorb all of the visible wavelengths
B) d electrons must be emitted by the complex in order for it to appear colored
C) there are no d electrons to form bonds to ligands
D) a complex must be charged to be colored
E) there is no d electron that can be promoted via the absorption of visible light

44) Based on the crystal-field strengths $Cl^- < F^- < H_2O < NH_3 < H_2NC_2H_4NH_2$, which octahedral Ti (III) complex below has its d-d electronic transition at shortest wavelength?

A) $[Ti(H_2NC_2H_4NH_2)_3]^{3+}$

B) $[Ti(H_2O)_6]^{3+}$

C) $[Ti(NH_3)_6]^{3+}$

D) $[TiF_6]^{3-}$

E) $[TiCl_6]^{3-}$

45) How many chiral centers are there in $CH_3CHClCH_2CH_2CHBrCH_3$?

A) 1 B) 4 C) 2 D) 0 E) 3

46) Consider the following types of compounds:

(i) amino acid
(ii) nitrogen-containing organic base
(iii) phosphoric acid
(iv) five-carbon sugar

From which of the above compounds are the monomers of nucleic acids, called nucleotides, formed?

A) none
B) (i) and (ii)
C) all
D) (ii), (iii), and (iv)
E) (ii) and (iv)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question. (4%/pt)

47) Draw the Lewis structure of ICl_2^+.

48) Water can be formed from the stoichiometric reaction of hydrogen with oxygen:

$$2H_2\,(g) + O_2(g) \rightarrow 2H_2O\,(g)$$

A complete reaction of 5.0 g of O_2 with excess hydrogen produces _____ g of H_2O.