國立臺灣大學97學年度碩士班招生考試試題

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110	111	112						

本試題含單選題 25 題(75 分), 及兩題敘述題(25 分), 總分 100 分

(I). 單選題 (選出最適當的一個答案): 每題答對 3 分, 答錯倒扣 1 分. (答案直接填入"選擇題作答區"內)

1. In Millikan's oil drop experiment, he was able to determine the charge of the electron because
A) each oil drop had only one electron.
B) each oil drop contained an integer number of electrons.
C) each oil drop had an identical charge.
D) the oil drops were too small to be affected by gravity.
E) the oil drops all fell at a constant speed.

2. You have a compound that contains only carbon and hydrogen. If you burn the compound at high temperature in the presence of oxygen it is completely converted to CO_2 and H_2O. When you react 20.0 g of your sample you generate 62.7 g of CO_2 and 25.7 g of H_2O. Which of the following is a possible formula for your compound?
A) C_2H_2 B) C_2H_4 C) C_2H_6 D) C_3H_5 E) C_3H_7

3. In fermentation, sucrose, $C_{12}H_{22}O_{11}$, reacts with water to form ethanol, C_2H_5OH, and carbon dioxide. A balanced chemical equation for this reactions is
A) $C_{12}H_{22}O_{11\,(aq)} + 3\ H_2O_{(l)} \rightarrow 5\ C_2H_5OH_{(aq)} + 2\ CO_{2\,(g)}$
B) $C_{12}H_{22}O_{11\,(aq)} + 7\ H_2O_{(l)} \rightarrow 2\ C_2H_5OH_{(aq)} + 8\ CO_{2\,(g)}$
C) $C_{12}H_{22}O_{11\,(aq)} + 2\ H_2O_{(l)} \rightarrow 6\ C_2H_5OH_{(aq)} + \ CO_{2\,(g)}$
D) $C_{12}H_{22}O_{11\,(aq)} + 2\ H_2O_{(l)} \rightarrow 4\ C_2H_5OH_{(aq)} + 4\ CO_{2\,(g)}$
E) $C_{12}H_{22}O_{11\,(aq)} + \ H_2O_{(l)} \rightarrow 4\ C_2H_5OH_{(aq)} + 4\ CO_{2\,(g)}$

4. A 125.0 g piece of iron is heated to 400 °C and placed in 300.0 g of water at 25 °C. If the specific heat capacities of iron and water are 0.449 $J\text{-}K^{-1}\text{-}g^{-1}$ and 4.184 $J\text{-}K^{-1}\text{-}g^{-1}$ respectively, what will be the final temperature of the water?
A) ~ 32°C B) ~ 42 °C C) ~ 101 °C D) ~ 383 °C E) None of the above

5. In going from a solid to a liquid, the entropy of a system will always
A) incerase.
B) decrease.
C) remain constant so long as the phase transition takes place at a constant temperature.
D) be equal to the logarithm of the new number of microstates available.

6. Molecular crystals are held in lattice sites by
A) covalent bonds.
B) ionic bonds.
C) intermolecular forces.
D) large molecular orbitals that span many lattice sites.
E) covalent bonds and intermolecular forces.

7. When a catalyst is added to a reaction to increase its rate of reaction the
A) activation energy is lowered and ΔG becomes more negative.
B) activation energy is lowered and ΔG remains unchanged.
C) activation energy is raised and ΔG becomes more positive.
D) activation energy is raised and ΔG remains unchanged.

8. Which element listed is the most electronegative?
A) aluminum B) bromine C) chlorine D) iodine E) sodium

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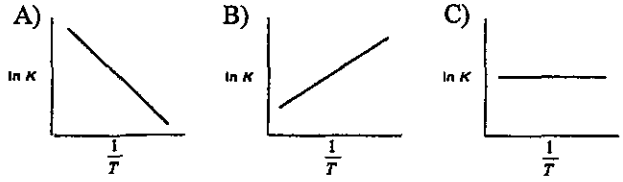
9. Given that $\ln K_{eq} = -\frac{\Delta G^o}{RT}$. Which of the following plot describes an endothermic reaction?



10. Two containers of different sizes have the same number of O_2 gas molecules at the same temperature. Which of the following property is different in these two containers?
A). The velocity distribution
B). The kinetic energy
C). The frequency of which collision occurs
D). The momentum of each molecule

11. Which molecule would be the most acidic?
A) dimethyl ether　B) ethanol　C) phenol　D) water　E) 1-hexanol

12. Which of the following statements is true for *all* first-order reaction?
A) The half-life is independent of the initial concerntration.
B) Only one substance takes part in the reaction.
C) The rate is independent of temperature.
D) The rate is independent of pressure.
E) The rate is independent of the use of catalysts.

13. When a weighed smaple of a weak base such as butylamine is titrated with a standard solution of hydrochloric acid, all of the following can be calculated EXCEPT the
A) number of moles of hydrochloric acid required for the titration
B) number of moles of the base in the sample
C) molecular weight of the base
D) pK_a of hydrochloric acid
E) pK_b of the base

14. Which of the following statements about the group of elements consisting of Li, Na, K, Pb, and Cs is correct?
A) They are all powerful oxidizing agents.
B) They are known as the alkaline earth metals since their hydroxides are strongly basic.
C) Each element differs from the one above it by the presence of one additional electron in the outer energy level of its atoms .
D) They are usually stored under water since they react readily with air.
E) Each has the largest atomic radius of any element in its period.

15. Which of the following halides CANNOT function as Lewis acid?
A) $SnCl_4$　B) $SbCl_5$　C) BF_3　D) CCl_4　E) SiF_4

16. Which of the following phrases is NOT appropriate in decribing molecular orbitals?
A) A linear combination of atomic orbitals
B) Antibonding orbital
C) Sigma (σ) orbital
D) Spherically symmetric orbital
E) Pi (π) orbital

17. When intense red light strikes a sample of Cs metal in a photoelectric effect experiment, no electrons are ejected from the surface. In contrast, exciting the sample with weak blue light causes electrons to be ejected, whose kinetic energy can be measured.
These results are consistent with which of the following conclusions?
A) Red photons have more energy than blue photons.
B) Red photons have less energy than blue photons.
C) Red photons have the same energy than blue photons.

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18. $Ti(H_2O)_6^{3+}$ has how many *d*-electrons?
A) d^0　B) d^1　C) d^2　D) d^3

19. For a group in the periodic table, the elements have in common:
A) the same number of orbitals.
B) the same number of electrons in the highest energy subshell containing electrons.
C) the same number of electrons.
D) the same number of electrons in all subshells.
E) the same number of filled subshells.

20. Electromagnetic radiation of wavelength 285 nm is emitted by magnesium. Which of the following statements are correct for this type of radiation?
A) It has a higher frequency than radiation with wavelength 300 nm
B) It is in the visible region
C) Its wavelength is shorter than that of X-rays
D) It has a greater speed than radiation with wavelength 300 nm

21. Which of the following statements is false?
A) The three p orbitals in a p subshell are mutually perpendicular.
B) There are five d orbitals in every energy level.
C) There are seven f orbitals per energy level starting with the fourth energy level.
D) A set of d orbitals can have a maximum of 10 electrons.
E) The d orbitals in an energy level are always filled after the p orbitals in the same energy level.

22. Consider the following salts. Which one(s) when dissolved in water will produce a basic solution?
1) $NaNO_3$　2) K_2S　3) Na_2CO_3
A) only 2　B) 2 and 3　C) 1 and 2　D) only 3　E) only 1

23. The Kc for the following reaction at 105°C is 2.18×10^{-10}. Given the concentrations $[COCl_2] = 0.240$ M, $[CO] = 6.02 \times 10^{-6}$ M and $[Cl_2] = 5.20 \times 10^{-6}$ M one can conclude that:

$$COCl_2(g) \leftrightarrows CO(g) + Cl_2(g)$$

A) the system is not at equilibrium and the reaction will proceed to the right
B) the system is not at equilibrium and the reaction will proceed to the left
C) the system is at equilibrium and no nnet change will occur

24. Write resonance structures for NO^{2-} and NO^{3-}. Based on these structures one can conclude that
A) both have the same bond length
B) NO^{2-} has shorter bonds than NO^{3-}
C) NO^{2-} has longer bonds than NO^{3-}

25. Which of the following reactions occurs at the fastest rate?
A) one which is endothermic by 5 kcal/mole and has an activation energy of 25 kcal/mole
B) one which is exothermic by 30 kcal/mole and has an activation energy of 30 kcal/mole
C) one which is exothermic by 15 kcal/mole and has an activation energy of 20 kcal/mole
D) one which is endothermic by 10 kcal/mole and has an activation energy of 35 kcal/mole

(II). 敘述題 (共 25 分)

1). (A). Draw the Lewis structure of Cl_2O (4 分), and predict its geometry (4 分).
(B). Both PF_3 and PF_5 are known compounds. NF_3 also exists, but NF_5 does not exist. Provide a reason why NF_5 does not exist, but PF_5 exists (5 分).

2). A biochemist prepares a buffer solution by adding enough Tris, $(OHCH_2)_3NH_2$, and 12 M HCl to give 1.0 liter of a buffer solution whose concentrations are [Tris]= 0.30 M, and $[Tris\text{-}H^+]$= 0.60 M.
(A). Given pKa of Tris is 8.09, calculate the pH of the buffer solution (6 分).
(B). Suppose that 5.0 ml of 12 M HCl is added to 1 liter buffer solution. Calculate the final pH of the solution (6 分). Ignore the volume change of this process.

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