國 立 清 華 大 學 命 題 紙

生命科學系

八十七學年度 生物技術所 系(所) 乙(分生組丙,生醫組乙) 組碩士班研究生入學考試

科目 物理化學 科號 1303 (0903,1103) 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

Fill the blank with the appropriate answer. (75%)

1. A system is separated from the rest of the universe by a real or imaginary boundary. The part of the universe outside the boundary is referenced to as __(A)__. If the boundary of a system prevents interaction of the system with the part of the universe outside the boundary, the system is called __(B)__ system. The macroscopic properties of a system are called state variables or theromodynamic coordinates. For example, *enthalpy*, H, is a variable of state defined as H = E + __(C)__.

2. If two closed systems with fixed volumes are brought together so that they are in thermal contact, changes may take place in the properties of both, Eventually a state is reached in which there is no further change, and this is the state of __(D)__.

3. __(E)__ is the excitation of electrons from low-energy orbitals to higher energy orbitals by the absorption of light. Since the energies required to do this are generally much larger than vibrational and rotational energies, this form of spectroscopy uses light in the __(F)__ and even shorter wavelength parts of the spectrum.

4. Work *w* can be positive or negative since work may be done on a system or a system may do work on its surroundings. The IUPAC convention on *w* is that it is __(G)__ when work is done on the system of interest and __(H)__ when the system does work on the surroundings. The work done on a closed system in an __(I)__ process is equal to the increase in internal energy of the system.

5. Thermodynamics deals with interchanges among different forms of energy. The first law states that energy is __(J)__. In 1851, Kelvin summarized a great deal of experience into the following statement : It is impossible to produce work in the surroundings using a cyclic process connected to a single heat reservoir. This statement should be related to the __(K)__ law of thermodynamics.

6. Can diamond be converted spontaneously into graphite (pencil lead) at 25°C and 1 atm? If the reaction **C(*s*, graphite) -> C(*s*, diamond)** has a Gibbs free energy of 2.84 kJ mol^{-1} at 25°C and 1 atm. Ans. __(L)__.

7. The following table shows some enthalpies of noncovalent bonds and interactions

Reaction	Characteristic interaction	$\Delta H°$ (kJ mol^{-1})
Acetone(g) -> acetone(l)	London-van der Waals	-30
$2CH_3OH(g) \rightarrow [H_3C\text{-}O\overset{H}{\cdots\cdots} H\text{-}O\text{-}CH_3](g)$	__(M)__	(1)
$Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$	__(N)__	(2)
$C_3H_6(l) + \infty H_2O(l) \rightarrow C_3H_6(aq)$	Hydrophobic	-10
$2NH_3(g) \rightarrow [H_3N \cdots\cdots H\text{-}NH_2](g)$	hydrogen bond	(3)

Which one has the most negative enthalpy ? $\Delta H°$ (1) or (2) or (3). Answer - __(O)__.

Which one has the least negative enthalpy ? $\Delta H°$ (1) or (2) or (3). Answer - __(P)__.

8. The binding of a small molecule to one site affects the binding of small molecules to other sites. In __(Q)__ binding the first ligand bound makes it easier for the next one to be bound.
9. A chemical reaction can occur when two molecules collide. However, for a reaction to occur the molecules must have enough __(R)__ to break the covalent bonds of the reactants and to form the new bonds of the products. This explains why increasing the __(S)__ of reactants and increasing the __(T)__ nearly always increase the rate of a chemical reaction. The higher __(S)__ mean more collision; the higher __(T)__ provides more __(R)__ per collision and also more collision per second.

10. The sequence of a hexanucleotide (a small fragment of DNA) is self-complementary , which can form dimer by itself:

$$2\ \text{A-A-G-C-T-T} \rightarrow (\text{A-A-G-C-T-T})_2$$

The rate law is of the form : $v = -(d[A]/dt) = k[A_2GCT_2]^2$
This is a __(U)__ order reaction. Its half-life equals __(V)__.

11. The simplest examples of reaction mechanisms are those that involve only a single elementary reaction. In this case the rate law can be written by inspection. For example, if the reaction

$$2NO_2 + 1/2\ O_2 \rightarrow N_2O_5$$

is an elementary reaction, its rate law will be $v =$ __(W)__.

12. What is the electron configuration for Mg^{2+} ? Answer. __(X)__.
How many electrons can enter the following sets of atomic orbitals: 2s, 2p, 3d?
Answer. __(Y)__.

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13. (5%) What is the de Broglie wavelength λ of an electron that has been accelerated through a potential of 100 V? (electron mass, $m = 9.110 \times 10^{-31}$ kg; elcmentary charge, $e = 1.6022 \times 10^{-19}$ C; Plank constant, $h = 6.626 \times 10^{-34}$ Js; Energy, $E = mv^2/2 = p^2/2m$; momentum, $p = h\nu/c = h/\lambda$)

14. (8%) Who won the Nobel prize in Physics 1997? What is the subject of his research? The technique he used can be applied to many fields. Life science is one of the fields he can not miss; he tries to see the structure and dynamics of bioploymers. What molecules did he use in biology field?

15. (12%) Professor Li in the Department of Life Science, National Tsing Hua University, Taiwan, found the oldest animal fossile before the Cambrain explosion. What is your opinion about the impact of his discovery?
One of the problems of fossile research is the determination of the approximate age of the fossile. It is usually determined by following the radioactivity decay. What order of the process is the level of radioactivity decrease? Can you derive the general term of half-life ($t_{1/2}$) for this process?
(For zero-order reaction: $c - c_0 = kt$; For first-order reaction: $[A] = [A]_0 e^{-kt}$; For second-order reaction: $1/[A] - 1/[A]_0 = kt$)