ln2=0.693, log2=0.301, log3=0.477, R= 8.314 J/K mol = 1.98 cal /K mol (不得使用計算機)

I. (20%)

The Na^+-K^+ pump is using the free energy of hydrolysis of ATP to actively pump Na^+ outside the cell and K^+ inside the cell. For each ATP hydrolyzed, $3Na^+$ are pumped out, and $2K^+$ are pumped in. An electrical potential difference of -70mV favor transport of positive ions in. The concentration of Na^+ in outside and inside of cell is 160mM and 10mM. The concentration of K^+ in outside and inside of cell is 5mM and 80mM. The chemical potential (μ) is -31.3kJ for ATP hydrolyses (ATP → ADP + P) at 37°C. The concentration of phosphate is 1 and the ratio of ATP to ADP in cells is about 128.

(a) Please write down the net reaction for the Na^+-K^+ pump
(b) Calculate the chemical potential ($\Delta\mu$) per mole for the transport of Na^+ ions out
(c) Calculate the chemical potential ($\Delta\mu$) per mole for the transport of K^+ ions in
(d) Calculate the total free energy (ΔG) for the total ion transport
(e) Calculate the chemical potential ($\Delta\mu$) per mole for the hydrolysis of ATP
(f) What is the total free energy (ΔG) for the net reaction in Na^+-K^+ pump?
(g) Is this mechanism a possible mechanism that does not violate thermodynamic principles?

II. (10%)

(1) Determine a and b in the rate equation

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

given the following

rate, M sec^{-1}	0.04	0.12	0.36	1.08
$[A]_0$, M sec^{-1}	0.5	0.5	1	1
$[B]_0$, M sec^{-1}	0.5	1	0.5	1

(2) Calculate k for this reaction.

III. (10%) Explain the following terms:

(a) Debye-Huckel theory
(b) MALDI
(c) Chromophore
(d) Degeneracy

IV. (60%) Select the one choice that best completes the statement or answer that question. 3 points each, 1 point for incorrect answer.

1. For the half-reaction above, which of the following is correct statement?

$M^+ + e^- \rightarrow M_{(s)}$ $E^o = -10.0V$

(A) M is readily oxidized.
(B) M^+ is readily reduced.
(C) M^+ is a good oxidizing agent.
(D) M is a poor reducing agent.
(E) M is a good oxidizing agent.

2. For which of the following sets of values of ΔH and ΔS will a reaction be spontaneous only at high temperature?

	ΔH(kJ)	ΔS (J/K)
(A)	+80	+10
(B)	+80	-10
(C)	-80	-10
(D)	-80	+10
(E)	0	-10

3. For a triprotic acid, H_3A, K_{a1} is 1.0×10^{-2}, K_{a2} is 1.0×10^{-6}, and K_{a3} is 1.0×10^{-10}. The pH range in which HA^{-2} is the predominant form is a pH between

(A) 1 and 3
(B) 5 and 7
(C) 7 and 9
(D) 9 and 11
(E) 3 and 5

4. At 298K and 1 atmosphere, the closed system shown above is at equilibrium. If the equilibrium is perturbed by isothermally decreasing the volume of the system, which of the following is NOT correct?

$CuO_{2\,(s)} + 1/2\ O_{2\,(g)} \rightleftharpoons 2CuO_{(s)}$ $\Delta H^o = -10kJ$

(A) More products will be present after equilibrium is reestablished.
(B) ΔG Is less than zero for the process of reestablishing equilibrium.
(C) The equilibrium constant, K_{eq} will decrease.
(D) The temperature will remain constant.
(E) ΔG^o will remain unchanged.

5. According to the second law of thermodynamics, which of the following quantities represents the change in a state function?

(A) $T\,q_{rev}$
(B) w_{rev}
(C) q_{rev}
(D) q_{rev}/T
(E) $T\,w_{rev}$

6. One mole of an ideal gas expands isothermally until its volume is doubled. What is the change in Gibbs energy, ΔG for the process?
(A) R ln 1/2
(B) R ln 2
(C) RT ln 1/2
(D) RT ln2
(E) $e^{-2/RT}$

7. If nitrogen gas trapped in a cylinder with a movable position undergoes an adiabatic expansion, which of the following statements is true for the expansion
(A) q = w
(B) w = 2q
(C) ΔU=0
(D) ΔU=w
(E) ΔU=q

8. In which of the following processes is energy transferred into the substance by work (w>0)?
(A) Expansion of a gas against the surroundings
(B) Expansion of a gas into a vacuum
(C) Vaporization of one mole of water at 70°C in an open container
(D) Combustion of ethane in a constant-volume container
(E) Melting of 100 g of ice on a laboratory bench top

9. Which of the following partial derivatives is zero for an ideal gas?
(A) $(\partial U/\partial T)_v$
(B) $(\partial H/\partial T)_p$
(C) $(\partial S/\partial T)_p$
(D) $(\partial U/\partial V)_T$
(E) $(\partial S/\partial V)_T$

10. Although graphite is thermodynamically more stable than diamond at 25°C and 1 atmosphere, a diamond will not transform into graphite, even over a period of thousands of years. Which of the following correctly explains this observation?
(A) ΔH for the reaction C (diamond) → C (graphite) is less than zero.
(B) ΔS for the reaction C (diamond) → C (graphite) is less than zero.
(C) ΔG for the reaction C (diamond) → C (graphite) is less than zero.
(D) The reverse reaction C (diamond) → C (graphite) would proceed relatively quickly.
(E) The reaction C (diamond) → C (graphite) is not observed because it has large activation energy.

11. Which of the following nuclei does not have spin
(A) ^{2}H
(B) ^{12}C
(C) ^{14}N
(D) ^{31}P.

12. The linear plot for a first-order reaction is
(A) c vs. t
(B) ln c vs. t
(C) $1/c$ vs. t
(D) c^2 vs. t

13. The correct unit for a zero-order rate constant is
(A)no units
(B)$time^{-1}$
(C)M $time^{-1}$
(D)M^{-1} $time^{-1}$

14. For the first-order reaction, A → B, $t_{1/2}$ dependent on
(A) 1/[A]
(B)1/[B]
(C)1/k
(D)[A]
(E) [B]
(F) k

15. The term refers to random motion of small particles suspended in a fluid:
(A)Boltzmann
(B) Born-Oppenheimer
(C) Brownian
(D)Bragg motion

16. Which one does describe the population distribution of allowed energy state for the mass-particle?
(A)Boltzmann's
(B)Born-Oppenheimer's
(C)Brownian's
(D)Bragg's distribution law.

17. The _____point for a macromolecule is the pH at which its net charge is zero.
(A)isoelectric
(B)isoioinic
(C)isobestic
(D)isomorphoric

18. Which one has higher energy:
(A) esr
(B) ir
(C) nmr
(D)uv.

19. How many σ bonds are there in N_2?
(A)0
(B)2
(C)4
(D)6.

20. The _____consists of molecular inelastic scattering of monochromatic radiation, whereby the quantum transferred from the incident photon excites a vibrational energy level in the target molecule.
(A)Quantum effect
(B) Raman effect
(C) Cotton effect
(D)Doppler effect.