選擇題　　(1~25題，每題二分)

1. Consider the rate data for the reaction, $2A + 3B \rightarrow$ products.

Initial [A]	Initial [B]	-D[A]/Dt
0.025 M	0.025 M	0.0012 mol min^{-1}
0.050 M	0.025 M	0.0024 mol min^{-1}
0.050 M	0.050 M	0.0024 mol min^{-1}

   What is the rate equation for this reaction?
   (A) k[A]　　　　(B) k[A][B]　　(C) k[A]^2[B]^3　(D) k[B]
   (E) none of the above

2. The gas phase reaction between hydrogen bromide and oxygen is proposed to take place by the following steps.
   1. $HBr + O_2 \rightarrow HO_2Br$　　2. $HO_2Br + HBr \rightarrow 2HOBr$
   3. $HOBr + HBr \rightarrow H_2O + Br_2$
   If the first step is the slowest, what is the rate equation for the reaction?
   (A) k[HOBr][HBr]　　(B) k[HBr][O$_2$]　　(C) k[HO$_2$Br][O$_2$]
   (D) k[HOBr]^2　　　　(E) none of the above

3. The rate equation for the reaction, $A + 2B \rightarrow$ products, is found to be rate = k[A][B]^2. What is the molecularity of the slow step for this reaction?
   (A) unimolecular　　(B) bimolecular　　(C) termolecular
   (D) tetramolecular　(E) none of the above

4. Consider the reaction, $A + B \rightarrow$ products, which has the rate equation, rate = k[A]. The concentration of A falls from 0.050 M to 0.015 M after a period of 20 minutes. What is the value of the rate constant, k, for this reaction?
   (A) 17 min^{-1}　(B) 380 min^{-1}　(C) 2.6 x 10^{-6} min^{-1}　(D) 0.060 min^{-1}
   (E) none of the above

5　Consider the reaction, A + B → products, which has the rate equation, rate = k[A]. The value of the rate constant, k, is 0.079 min^{-1}. How long will it take for the concentration of A to fall from 0.050 M to 0.015 M?
(A) 32 min　　(B) 23 min　　(C) 15 min　　(D) 11 min
(E) none of the above

6　Consider the reaction, A + B → products, which has the rate equation, rate = k[A]. The half-life, $t_{1/2}$, is 43 minutes. What is the value of the rate constant, k, for the reaction?
(A) 0.80 min^{-1}　　(B) 0.42 min^{-1}　　(C) 0.16 min^{-1}　　(D) 62 min^{-1}
(E) none of the above

7　The equilibrium constant for the vapor phase reaction,
$PCl_3 + Cl_2 \leftrightarrow PCl_5$, is 49. If the rate constant for the reverse reaction is 1.5 s^{-1}, what is the rate constant for the forward process?
(A) 33 L mol^{-1} s^{-1}　　(B) 0.87 mol s L^{-1}　　(C) 73.5 L mol^{-1} s^{-1}
(D) 6.8 s^{-1}　　(E) none of the above

8　Which of the following is true?
(A) As the temperature is increased, the primary factor causing an increase in reaction rate is the increase in the number of collisions.
(B) As the temperature is increased, the number of collisions that reach the transition state increases.
(C) For an exothermic reaction, the products always contain more potential energy than the reactants.
(D) The energy of activation is thought to undergo large changes as the temperature is changed.
(E) none of the above

9　Which of the following is true?
(A) A catalyst speeds the approach of a reaction to equilibrium but does not change the equilibrium position.
(B) Homogeneous catalysts exist in a separate phase from the reaction

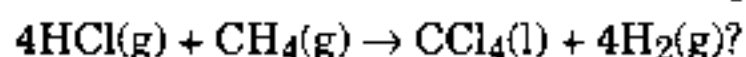medium.

(C) Heterogeneous catalysts are in the same phase as the reaction medium.

(D) An enzyme in solution behaves as a heterogeneous catalyst.

(E) none of the above

10. What is the missing particle for the radioactive decay reaction, $^{15}O \rightarrow \,^{15}N + \underline{}$?

(A) neutron   (B) beta particle   (C) alpha particle

(D) positron   (E) none of the above

11. What is the other product when ^{137}Cs emits a beta particle?

(A) ^{54}Xe (B) ^{133}Sb (C) ^{141}Pr (D) ^{137}Ba

(E) none of the above

12. The shape of a CH_4 molecule is

(A) linear   (B) angular   (C) triangular pyramidal

(D) planar triangular   (E) none of the above

13. The shape of an ammonia molecule, NH_3, is

(A) angular   (B) planar triangular   (C) tetrahedral

(D) triangular pyramidal   (E) none of the above

14. Given: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H° = -32.8$ kJ

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H° = -22.6$ kJ

$CH_4(g) + 2O_2 \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H° = -50.6$ kJ

What is the standard enthalpy of formation for methane?

(A) 4.8 kJ   (B) -4.8 kJ   (C) -40.4 kJ   (D) -60.8 kJ

(E) none of the above

15. Given the following standard enthalpies of formation:

$\Delta H_f°(HCl) = -92.3$ kJ mol^{-1} $\Delta H_f°(CH_4) = -74.5$ kJ mol^{-1}

$\Delta H_f°(CCl_4) = -129.6$ kJ mol^{-1}

What is the standard reaction enthalpy for the reaction,
$4HCl(g) + CH_4(g) \rightarrow CCl_4(l) + 4H_2(g)$?
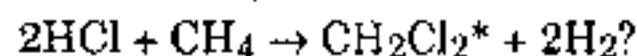(A) 314 kJ   (B) 135 kJ   (C) 412 kJ   (D) 335 kJ
(E) none of the above

16. Consider the reaction, $A \rightarrow B$. If the reaction enthalpy is positive, which of the following statements is true?
   (A) A contains more stored energy than B.
   (B) A and B contain the same internal energy.
   (C) This reaction is endothermic.
   (D) This reaction is exothermic.   (E) none of the above

17. Which of the following is false?
   (A) The heat absorbed or lost when a reaction is carried out at constant pressure is the reaction enthalpy.
   (B) The symbol for enthalpy is "E"?
   (C) The change in internal energy for a system is equal to any heat absorbed by the system plus any work done on the system.
   (D) The total heat content of a system is not measured.
   (E) none of the above

18. Given the following bond energies in kJ mol^{-1}: H-H = 436, H-Cl = 431, H-C =413, C-Cl = 326. What is the approximate reaction enthalpy for the reaction,
$2HCl + CH_4 \rightarrow CH_2Cl_2^* + 2H_2$?
   (A) -164 kJ   (B) 164 kJ   (C) 82 kJ   (D) -82 kJ
   (E) none of the above

19. Assume you have one mole of hydrogen in a sealed container. Which set of conditions will have the highest entropy?
   (A) 22.4 L at 30 °C   (B) 5.8 L at 30 °C   (C) 35 L at 30 °C
   (D) 35 L at 35 °C   (E) 8.6 L at 22 °C

20. Given the standard molar entropies in J mol-1 K-1:
$H_2(g)=130.6$, $HCl(g)=186.8$, $CH_4(g)=186.1$, $CHCl_3(l)=177.8$.
What is the standard entropy change for the reaction,
$3HCl(g) + CH_4(g) \rightarrow CHCl_3(l) + 3H_2(g)$?
(A) -220 J K-1   (B) 220 J K-1   (C) 12 J K-1   (D) 55 J K-1
(E) none of the above

21. Which of the following reactions has a negative change in entropy?
(A) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ (B) $2HgO(s) \rightarrow 2Hg(l) + O_2(g)$
(C) $5H_2(g) + 4C(s) \rightarrow C4H_{10}(g)$ (D) $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$
(E) none of the above

22. If the ΔH_f of carbon dioxide is -393.5 kJ mol-1 and the ΔS_f° at 25.0 °C is
2.9 J mole-1 K-1, what is the ΔG_f° for CO_2 at 25 °C?
(A) -298 kJ mol-1   (B) -325 kJ mol-1   (C) -360 kJ mol-1
(D) -394 kJ mol-1   (E) none of the above

23. The ΔG_f° for cyclobutane is 100 kJ mol-1, and the ΔH_f° is 28.4 kJ mol-1.
What is the ΔS_f° of cyclobutane at 25°C?
(A) 185 J mol-1 K-1   (B) 215 J mol-1 K-1   (C) 265 J mol-1 K-1
(D) 295 J mol-1 K-1   (E) none of the above

24. Under which condition is a reaction always exothermic?
(A) $\Delta G = 0$ (B) $\Delta S = +$ (C) $\Delta G = +$ (D) $\Delta G = -$
(E) none of the above

25. Which of the following is true?
(A) The symbol for the change in free energy is ΔF.
(B) The Gibbs free energy change is equal to ΔS system.
(C) The Gibbs free energy change is equal to $T\Delta S_{surroundings}$.
(D) The Gibbs free enegy change is equal to $-T\Delta S_{total}$.
(E) none of the above

計算及問答題

26. An aqueous solution that is 1.00 M in $AgNO_3$ and 1.00 M in $Fe(NO_3)_2$ is allowed to come to equilibrium. What are the equilibrium values of $[Ag^+]$, $[Fe^{2+}]$ and $[Fe^{3+}]$?

    $$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Fe^{3+}(aq) + Ag(s) \qquad K_c = 2.98$$

    (10%)

27. For the nonequilibrium process $A + B \rightarrow$ products, the rate is first order with respect to A and second order with respect to B. If 1.0 mole each of A and B were introduced into a 1.0 liter vessel, and the initial rate were 1.0×10^{-2} mol/l•sec, calculate the rate when half the reactants have been turned into products . (10%)

28. How many liters of $CH_4(g)$, measured at 23.4°C and 768 mmHg, must be burned to provide the heat needed to vaporize 3.78 liters of water at 100°C? $\Delta H_{combustion} = -8.90 \times 10^2$ kJ/mol for CH_4. For $H_2O(l)$ at 100°C, d=0.958 g/cm^3 and $\Delta H_{vap} = 40.7$ kJ/mol. (10%)

29. For the following groups of elements select the one that has the property noted. (10%)
    (a) The largest atom: Mg, Mn, Mo, Ba, Bi, Br
    (b) The lowest first ionization energy: B, Sr, Al, Br, Mg, Pb
    (c) The most negative electron affinity: As, B, Cl, K, Mg, S
    (d) The largest number of unpaired electrons: F, N, S^{2-}, Mg^{2+}, Sc^{3+}, Ti^{3+}

30. Draw structural formulas for the following organic compounds: (10%)
    (a) 2-butanol
    (b) acetic acid
    (c) 1,4-dichlorobenzene
    (d) 1-butene
    (e) dimethyl ether