

1. Which of the following reactions is a disproportionation reaction?

下列反应何者为自身氧化还原反应?

- (A) $\text{Cl}_2(\text{aq}) + 2\text{I}^-(\text{aq}) \longrightarrow \text{I}_2(\text{aq}) + 2\text{Cl}^-(\text{aq})$
 (B) $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \longrightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 (C) $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \longrightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$
 (D) $\text{CaSiO}_3(\text{s}) + 8\text{HF}(\text{aq}) \longrightarrow \text{H}_2\text{SiF}_6(\text{s}) + \text{CaF}_2(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$
 (E) $\text{Cl}_2(\text{g}) + 2\text{NaOH} \longrightarrow \text{NaClO}(\text{aq}) + \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

2. Which of the following ions is the most basic?

下列各物质何者的碱性最强?

- (A) Cl^- (B) H_2PO_4^- (C) CH_3COO^- (D) S_2^- (E) I^-

3. Followings are five titrations of various acid (50.0 mL and 0.10 M) by 0.1 M NaOH. Which titration solution has the highest pH when the titration reaches the equivalent point?

下列各项滴定实验到达当量点时，何者的 pH 最高?

- (A) $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
 (B) $\text{CCl}_3\text{COOH} + \text{NaOH} \rightarrow \text{CCl}_3\text{COONa} + \text{H}_2\text{O}$
 (C) $\text{C}_6\text{H}_5\text{COOH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{COONa} + \text{H}_2\text{O}$
 (D) $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$
 (E) $\text{HCN} + \text{NaOH} \rightarrow \text{NaCN} + \text{H}_2\text{O}$

4. Followings are the quantum number combinations and its sublevel name. Which of these is wrong?

下列是量子数之组合及其轨域名称，其中哪一种是对的?

- (A) $n = 4, l = 2, m_l = +2, 4d$ (B) $n = 4, l = 3, m_l = +2, 4f$
 (C) $n = 3, l = 1, m_l = +2, 3p$ (D) $n = 2, l = 0, m_l = 0, 2s$
 (E) $n = 3, l = 2, m_l = +1, 3d$

5. Which of the following compounds is capable of reducing Cr^{+6} of $\text{K}_2\text{Cr}_2\text{O}_7$ to Cr^{3+} under acidic condition?

下列何者能使 $\text{K}_2\text{Cr}_2\text{O}_7$ 中 Cr^{+6} 在酸性溶液下被还原成 Cr^{3+} ?

- (A) Ferrous Sulfate(硫酸亚铁) (B) Ferric Nitrate(硝酸铁)
 (C) Aluminum sulfate (硫酸铝) (D) Magnesium Chloride(氯化镁)
 (E) Zinc Chloride (氯化锌)

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6. Both the glucose and sodium chloride solutions have identical boiling point. Which of the following statements is correct?
某葡萄糖水溶液与食盐水溶液之沸点相同，则下列叙述何者是正确的？
- (A) Both solutions have same percentage concentration
二者之重量百分率浓度相同
- (B) Both solutions have same molality
二者之重量莫耳浓度相同
- (C) Both solutions have same mole fraction
二者所含之溶质之莫耳分率相同
- (D) Both solutions have same vapor pressure at a given temperature
同温下之蒸气压相同
- (E) All of the above are correct
以上皆是
7. By reacting 0.50 M of BaCl_2 with 0.4 M of CuSO_4 , after the reaction is completed, which of the following ionic concentration is correct?
0.50M 之 BaCl_2 溶液 50ml 与 0.40M 之 CuSO_4 溶液 150ml 相混完全反应后，溶液中各种离子之浓度下列何者正确？
- (A) $[\text{Cu}^{2+}] = 0.30\text{M}$ (B) $[\text{Ba}^{2+}] = 0.050\text{M}$ (C) $[\text{SO}_4^{2-}] = 0.25\text{M}$
(D) $[\text{Cl}^-] = 0.18\text{M}$ (E) $[\text{Ba}^{2+}] = 0.040\text{M}$
8. Which of the following solution shows the best electrical conductivity?
下列何种溶液之导电度最大？
- (A) 1 M of acetic acid solution; 1 M 之 CH_3COOH 溶液
(B) 0.1M of hydrochloric acid solution, 0.1 M 之 HCl 溶液
(C) 0.1 M of sodium chloride solution; 0.1 M 之 NaCl 溶液
(D) 1 M of sodium acetate solution; 1 M 之 CH_3COONa 溶液
(E) 1 M of benzoic acid solution; 1 M 之 $\text{C}_6\text{H}_5\text{COOH}$ 溶液
9. A chemical reaction ($\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$) being in equilibrium at a given temperature, which of the following statements is correct?
在室温下对某一已达到平衡化学反应($\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$)，则下列各项叙述中何者为正确？
- (A) Both the reactants and the products have same concentration
反应物与生成物之浓度相同
- (B) The reactants have gone completion to the products
反应物完全变成生成物
- (C) Both the forward and reverse reactions stopped completely
正向反应与逆向反应均完全停止
- (D) After more A is added, once it reaches equilibrium again, the ratio of $([\text{C}][\text{D}])/([\text{A}][\text{B}])$ does not changes.
当再加入 A 且又达平衡后， $([\text{C}][\text{D}])/([\text{A}][\text{B}])$ 值没改变。
- (E) All of the above are correct.
以上皆是

10. Which of the following statements regarding phosphoric acid, H_3PO_4 , is correct?
下列有关正磷酸 (H_3PO_4) 的叙述何者正确?

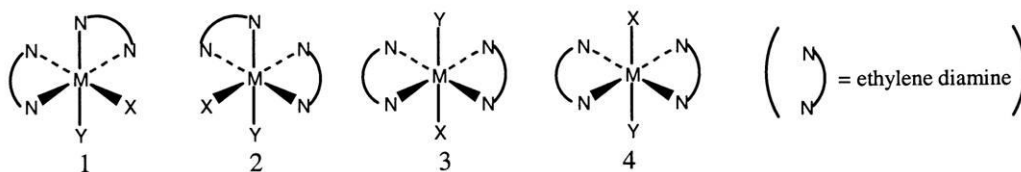
- (A) H_3PO_4 is a good oxidizing agent.
 H_3PO_4 为一很好的氧化剂
- (B) $\text{HPO}_4^{2-}(\text{aq})$ is the conjugate base of $\text{H}_2\text{PO}_4^-(\text{aq})$
对 $\text{H}_2\text{PO}_4^-(\text{aq})$ 而言, $\text{HPO}_4^{2-}(\text{aq})$ 为其共轭酸。
- (C) $\text{H}_3\text{PO}_4(\text{aq})$ is a strong acid
 $\text{H}_3\text{PO}_4(\text{aq})$ 为一强酸
- (D) The dissociation constant, K_a , of $\text{H}_3\text{PO}_4(\text{aq})$ is the same as that of $\text{H}_2\text{PO}_4^-(\text{aq})$
 $\text{H}_3\text{PO}_4(\text{aq})$ 的解离常数 (K_a 值) 和 $\text{H}_2\text{PO}_4^-(\text{aq})$ 的一样。
- (E) All of these are correct
以上皆是。

11. When dissolving blue color K_2CoCl_4 in the water, the solution changes to pink color. Which of the following statement regarding this color change is correct?
 K_2CoCl_4 溶于水中时, 其颜色由蓝色变为粉红色, 关于此变化下列的叙述何者正确?

- (A) The oxidation state of Co has changed
钴之氧化数改变。
- (B) The coordination number has not changed
钴之配位数未变。
- (C) The color changed from the blue to the pink was due to the formation of $\text{Co}(\text{H}_2\text{O})_6^{+2}$
颜色由蓝色变为粉红色, 是因溶于水时有 $\text{Co}(\text{H}_2\text{O})_6^{+2}$ 产生。
- (D) The color change was due to the mutual change of the isomers
颜色的改变是由于异构物互变。
- (E) All of these are correct
以上皆是。

12. Followings are the octahedral structures of a transition metal M coordinates with a bidentate ethylenediamine and two monodentate X and Y. Which of the two structures are optical isomer each other?

列为含有双芽的 ethylenediamine 与单芽的 X, Y 配位基的八面体错合物。
哪两个错合物互为光学异构物 ?



- (A) 1, 2 (B) 1, 3 (C) 1, 4 (D) 3, 4 (E) 2, 3

13. Predict which of the following nuclei is the most stable?
下列五种同位素中那一种最稳定?
- (A) ${}_6\text{C}^{14}$ (B) ${}_7\text{N}^{13}$ (C) ${}_{16}\text{S}^{32}$ (D) ${}_{20}\text{Ne}^{19}$ (E) ${}_3\text{Li}^6$
14. Which of the following compounds is a polar compound?
下列化合物中，何者为极性?
- (A) BF_3 ; 三氟化硼 (B) CF_4 ; 四氟化碳 (C) NF_3 ; 三氟化氮
(D) N_2 ; 氮气 (E) $\text{HC}\equiv\text{CH}$; 乙炔
15. Which of the following compounds is capable of forming intra-molecular hydrogen bond
下列何者最易产生分子内氢键?
- (A) Acetic acid; 醋酸
(B) Ethanol 乙醇
(C) *cis*-butenedioic acid/maleic acid 顺-丁烯二酸
(D) *trans*-butenedioic aci/fumaric acid 反-丁烯二酸
(E) All of these are correct. 以上皆是。
16. A balloon contains 10.0 g of neon gas. With the temperature kept constant, 10.0 g of argon gas is added. What happens?
一汽球内有 10 克的氖气，当温度维持为常数，再加入 10 克的氩气，会发生何事?
- (A) The balloon doubles in volume.
汽球体积膨胀二倍。
(B) The volume of the balloon expands by more than 2 times.
汽球体积膨胀超过二倍
(C) The volume of the balloon expands by less than 2 times.
汽球体积膨胀少于二倍。
(D) The balloon stays the same size, but the pressure increases.
汽球体积不变，但压力增加。
(E) none of these
以上皆非。
17. The kinetic-molecular theory of gases does *not* assume that
对气体分子动力理论，以下何假设为非?
- (A) gases are made up of tiny particles in constant chaotic motion.
气体视为极小的粒子组成，不断做混乱运动。
(B) gas particles are very small compared to the average distance between the particles.
气体粒子相较于粒子间之平均距离是非常小的。
(C) gas particles collide with the walls of their container in elastic collisions.
气体粒子碰撞容器的器壁为弹性碰撞。
(D) the average velocity of gas particles is directly proportional to the absolute temperature.
气体粒子的平均速度与绝对温度成比例关系。
(E) All of these are correct.
以上皆是。

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18. Which metal, Al or Ni, could reduce Zn^{2+} to $Zn(s)$ if placed in a $Zn^{2+}(aq)$ solution?

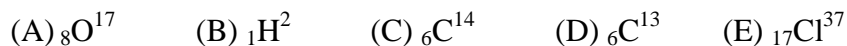
何种金属, Al 或 Ni, 放在 $Zn^{2+}(aq)$ 溶液中, 能将 Zn^{2+} 还原成 $Zn(s)$?



- (A) Al (B) Ni (C) Both Al and Ni would work ; Al 和 Ni 都能
(D) Neither Al nor Ni would work; Al 和 Ni 都不能。
(E) Cannot be determined; 无法决定。
19. A^{2-} , B^{-} , C , D^{+} , and E^{2+} are isoelectronic. Which of the followings shows the correct ionic/atomic radius order?
已知 A^{2-} 、 B^{-} 、 C 、 D^{+} 与 E^{2+} 均为等电子数 (isoelectronic)。下列之离子或原子半径大小顺序, 何者正确?
- (A) $A^{2-} > B^{-} > C > D^{+} > E^{2+}$ (B) $E^{2+} > D^{+} > C > B^{-} > A^{2-}$ (C) $A^{2-} > B^{-} > E > D^{+} > C$
(D) $C > D^{+} > E^{2+} > A^{2-} > B^{-}$ (E) None of these 以上皆非。
20. Which of the following compounds is a superoxide?
下列何者是超氧化物(superoxide):
- (A) CaO (B) KO_2 (C) H_2O_2 (D) $KMnO_4$ (E) Na_2O_2
21. Reacting propene with H_2O under the catalysis of H^{+} , followed by reacting with $KMnO_4$, then what product would you expect?
丙烯与水加催化剂(H^{+})充分作用后, 再加入过锰酸钾反应之后, 产物为何?
- (A) Propyl alcohol; 丙醇 (B) Acetone; 丙酮 (C) Propanal; 丙醛
(D) Propanoic acid; 丙酸 (E) 2-propanol; 二丙醇

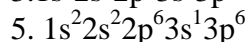
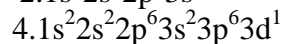
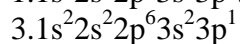
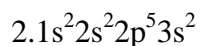
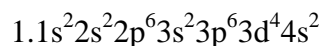
22. Which of the following nuclides is a naturally occurring radioactive isotope?

下列何者是自然界存在的放射性同位素:



23. Followings show five electron configurations. Which of the statements is wrong?

下列 1 到 5 为五种不同原子的电子组态, 则下列叙述, 何者错误?



- (A) 1 is Cr and in excited state; 此原子为铬, 处于激发态。
(B) 2 is Na and in excited state; 此原子为钠, 处于激发态。
(C) 3 is Al and in ground state; 此原子为铝, 处于基态。
(D) 4 is K and in ground state; 此原子为钾, 处于基态。
(E) 5 is Cl and in excited state; 此原子为氯, 处于激发态。

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24. Which of the following compound can be an oxidizing agent and a reducing agent.
下列各项化合物中，何者可以在某一反应中作为还原剂而在另一反应中作为氧化剂
- (A) SO_2 ; 二氧化硫 (B) H_2O_2 ; 氧化氢 (C) HCl ; 氯化氢
(D) HNO_2 ; 亚硝酸 (E) None of these; 以上皆非。

25. Solution A and B were prepared by dissolving 15 g of urea in 1000 g of H_2O and 57 g of sucrose in 500 g of H_2O , respectively. Placed these two solution in a closed container. When both solution reached equilibrium, how many grams of H_2O shifted from which solution to another? Mw of urea is 60 g/mol and Mw of sucrose is 342 g/mol.
兹有水 1000 克中溶解尿素 15 克所成之溶液(A 溶液)，与水 500 克中溶解蔗糖 57 克所成的溶液(B 溶液)，将此二溶液置密闭容器中。当此二溶液达成平衡时，多少克的水由哪一溶液移至哪一溶液?尿素分子量为 60 克/莫耳，蔗糖分子量为 342 克/莫耳。

- (A) 100 g of H_2O shifted from solution A to B
100 克的水由 A 溶液移到 B 溶液。
(B) 100 g of H_2O shifted from solution B to A
100 克的水由 B 溶液移到 A 溶液。
(C) 95 g of H_2O shifted from solution A to B
95 克的水由 A 溶液移到 B 溶液。
(D) 95 g of H_2O shifted from solution B to A
95 克的水由 B 溶液移到 A 溶液。
(E) Not H_2O shifted in this closed system.
没有水由哪一溶液移到哪一溶液。

26. A 100 mL solution contains 0.10 M CH_3COOH and 0.10 M CH_3COONa . And the K_a of CH_3COOH is 1.8×10^{-5} . What is the pH when 1.0 mL of 0.10 M HCl is added to this solution?
100 mL 溶液中含 0.10 M CH_3COOH 和 0.10 M CH_3COONa 。已知 CH_3COOH 之 $K_a = 1.8 \times 10^{-5}$ 。此溶液加入 1.0 mL 之 0.10 M HCl 后，其 pH 值为多少?

- (A) 4.74 (B) 4.75 (C) 4.76 (D) 4.77 (E) 4.78

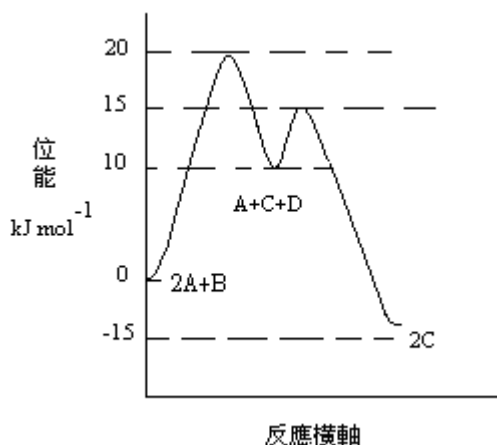
27. The methyl red, an indicator, $K_a = 1 \times 10^{-5}$, appears red color in acid. Its conjugate base In^- , appears yellow color. Place methyl red respectively in a solution with pH 3, 5, and 7; the ratio of $[\text{In}^-] / [\text{HIn}]$ and the color at each pH are represented by A to F, respectively, as shown in the following table. Which representation is wrong?

pH	3	5	7
$[\text{In}^-] / [\text{HIn}]$	A	B	C
Color; 颜色	D	E	F

甲基红(methyl red) 的 $K_a = 1 \times 10^{-5}$ ，其酸性形式 HIn 在水溶液中呈红色，而其共轭碱 In^- 在水溶液中呈黄色。当将甲基红加入于 pH 值各为 3、5 与 7 之水溶液时，其 $[\text{In}^-] / [\text{HIn}]$ 值与颜色分别由 A、B、C、D、E、与 F 代表，如上表所示。则所代表之 $[\text{In}^-] / [\text{HIn}]$ 值或颜色哪一个是不对的?

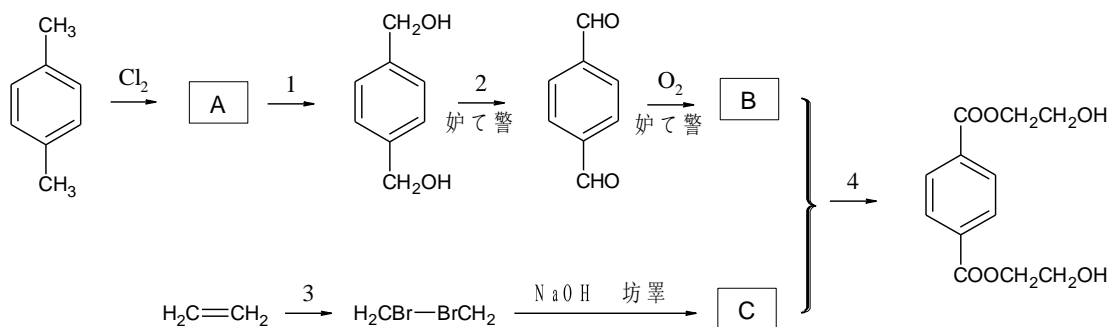
- (A) A is 10^{-2} ; A 值是 10^{-2} (B) B is 2; B 值是 2 (C) C is 10^2 ; C 值是 10^2
(D) D is red; D 是红色的 (E) E is orange; E 是橘色的

28. Following is the plot of potential energy versus reaction progress for a hypothetical reaction. $2A + B$ are reactants, $2C$ are the products. Which of the following statements is wrong?



上图所示为某项假想反应之进行过程中，物系所含物质与位能之关系。 $2A + B$ 为反应物， $2C$ 为产物。下列叙述何者是错的？

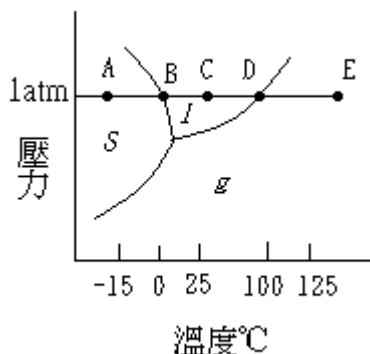
- (A) In terms of the reaction mechanism, the products of the first step reaction are C and D
此反应机构第一步骤之产物为 C 与 D。
- (B) The intermediate of this reaction is D
此反应之中间物为 D。
- (C) The rate limiting step is $A + B \rightarrow C + D$
此反应之速率决定步骤为 $A + B \rightarrow C + D$
- (D) The reaction order is 2
此反应为二级反应。
- (E) The net reaction equation is: $2A + B \rightarrow 2C \quad \Delta H = 15 \text{ kJ mol}^{-1}$
29. Following is a scheme for synthesizing an ester. Which of the following statement is wrong?



以上为一有机合成之流程图，下列叙述何者是错的？

- (A) Compound A is 1,4-bis (chloromethyl) benzene, *para*- $\text{ClCH}_2\text{C}_6\text{H}_4\text{CH}_2\text{Cl}$.
化合物 A 是 α, α' -二氯-对二甲苯, *para*- $\text{ClCH}_2\text{C}_6\text{H}_4\text{CH}_2\text{Cl}$ 。
- (B) The reagent for 1 is $\text{NaOH}/\text{H}_2\text{O}$
反应试剂 1 为 $\text{NaOH}/\text{H}_2\text{O}$ 。
- (C) The reagent for 3 is Br_2 .
反应试剂 3 为溴水。
- (D) Compound C is $\text{HOCH}_2\text{CH}_2\text{OH}$
化合物 C 是乙二醇。
- (E) The reaction for reagent 3 is a reduction reaction
反应试剂 3 是行还原反应。

30. Following is a phase diagram for certain substance. *S* stands for solid, *l* stands for liquid, *g* stands for gas. Which of the following statements is wrong?



上图为某一物质之三相图，*S* 代表固体，*l* 代表液体，*g* 代表气体。下列叙述何者是错误的？

- (A) After the temperature is increased 2°C , the state of B will change to liquid state
在温度上升 2°C 后，B 的状态将变为液态。
- (B) After the temperature is increased 2°C , the state of A will not change.
在温度上升 2°C 后，A 的状态将不会改变。
- (C) After the pressure is increased 5 torr, the state of D will not change.
在压力加大 5 torr 后，D 的状态将不会改变。
- (D) B is in a equilibrium state between solid and liquid
B 是处于固态与液态之平衡状态
- (E) freezing-point of this substance will depress as the pressure increases.
此物质之凝固点会随压力之增加而下降。