

(元素分子量如下: H=1, D=2, C=12, N=14, O=16, F=19, Na=23, S=32, Cl=35.5, P=31, K=39, Ca=40, Mn=55, Fe=55.85, Br=80, Rb=85.5, I=127, Faraday constant=96485 Cmol<sup>-1</sup>, Gas constant R=8.314 J K<sup>-1</sup> mol<sup>-1</sup>; 5.189 × 10<sup>19</sup> eV K<sup>-1</sup> mol<sup>-1</sup> or 0.082 L atm K<sup>-1</sup> mol<sup>-1</sup>, Plank Constant, h=6.626×10<sup>-34</sup> J·s).

(一) 選擇題，每題兩分 (35 題，共 70 分)。

1. What is the element symbol for Antimony.

A	An	B	At	C	As	D	Sb	E	Sn
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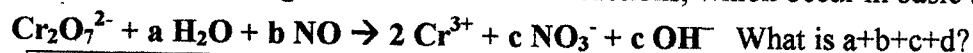
2. The oxidation state of S in sulfurous acid is A. What is A?

A	+2	B	+3	C	+4	D	+5	E	+6
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3. Balance the following reaction (M and N are elements):  $a M^{4+} + b N^{3+} \rightarrow c M^{2+} + d N^{6+}$  What is a+b+c+d?

A	8	B	10	C	12	D	14	E	16
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4. Balance the following oxidation-reduction reactions, which occur in basic solution.



A	<10	B	10	C	11	D	12	E	13
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5. After some NaF was added into a 1.0 M HF solution, how does the pH of this HF solution change?

A	larger	B	smaller	C	unchanged	D	not related
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6. The product is colorless in the dimerization of yellow X gas at 25 °C. If it was found that as the reaction temperature increase, the color of the mixture is getting darker. Is this dimerization reaction an endothermic or exothermic (or not determined) reaction?

A	not related	B	endothermic	C	exothermic	D	not determined
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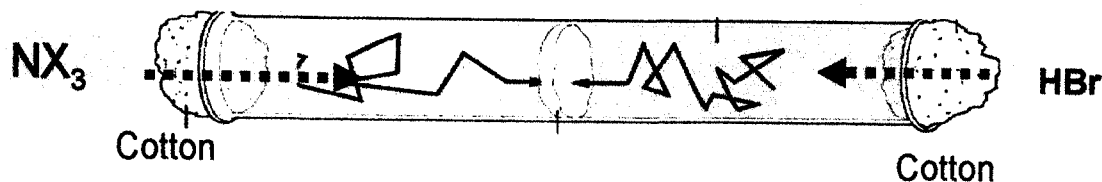
7. At 25°C and 1 atm, 100 g NaN<sub>3</sub> was inflated, calculate the volume (liters) of the N<sub>2</sub> gas released from it.

A	10-30	B	30-70	C	70-110	D	110-140	E	>140
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8. A solution contains 0.10 M HA (if  $K_a=1 \times 10^{-6}$ ) and 0.10 M NaA. Calculate the pH of this solution.

A	3	B	4	C	5	D	6	E	7
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9. For the gas reaction of NX<sub>3</sub> with HBr, if X with average molecule weight of 29 and reaction figure shown below. If no air were present in the reaction tube, what will be the ratio (r) of NX<sub>3</sub>:HBr gas traveling distances to form the white ring of (NX<sub>3</sub>H)<sup>+</sup> Br<sup>-</sup>.



A	0.75-0.85	B	0.85-0.95	C	0.95-1.05	D	1.05-1.15	E	>1.15
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10. If H<sub>3</sub>A is a triprotic acid with  $k_{a1}=1 \times 10^{-4}$ ,  $k_{a2}=1 \times 10^{-9}$ ,  $k_{a3}=1 \times 10^{-13}$ . What the pH of a 1.0 M solution of NaH<sub>2</sub>A.

A	<5	B	5-6	C	6-7	D	7-8	E	>8
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11. Calculate the pH of a 0.10 M (MH)<sup>+</sup> X<sup>-</sup> solution. If the K<sub>b</sub> value for M is 1 × 10<sup>-5</sup>. (M is a compound).

A	<5	B	5-6	C	6-7	D	7-8	E	>8
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參考用

注意：背面有試題

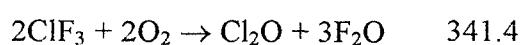
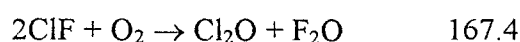
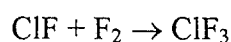
12. For the synthesis of ammonia at 500°C, the equilibrium constant is
- $6.0 \times 10^{-2} \text{ L}^2/\text{mol}^2$
- .

Predict the direction in which the system will shift to reach equilibrium in the following case.

$$[\text{NH}_3]_0 = 1.0 \times 10^{-3} \text{ M}; [\text{N}_2]_0 = 1.0 \times 10^{-5} \text{ M}; [\text{H}_2]_0 = 2.0 \times 10^{-3} \text{ M}$$

A	The ammonia synthesis reaction will go backward.
B	The ammonia synthesis reaction will go forward.
C	The ammonia synthesis reaction is under equilibrium.
D	The ammonia synthesis reaction is under equilibrium and will stop reaction.
E	The ammonia synthesis reaction will not work.

13. At 25°C, the following heats of reaction are known:

 $\Delta H$  (kJ/mol)What is the  $\Delta H$  (kJ/mol) for the following reaction at the same temperature?

A	-217.5	B	-108.7	C	+217.5	D	-130.2	E	none of these
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14. For a second order reaction:
- $a\text{A} \rightarrow \text{products}$

Which equation is true? ( $k$  is rate constant and  $[\text{A}]_0$  is the initial concentration of A)

A	$[\text{A}] = -kt + [\text{A}]_0$
B	$\ln[\text{A}] = -kt + \ln[\text{A}]_0$
C	$\ln[\text{A}] = kt - \ln[\text{A}]_0$
D	$1/[\text{A}] = -kt + 1/[\text{A}]_0$
E	$1/[\text{A}] = kt + 1/[\text{A}]_0$

15. For a certain reaction with rate constant of
- $k_1$
- at temperature
- $T_1$
- and rate constant of
- $k_2$
- at temperature
- $T_2$
- .

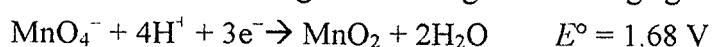
Which equation is true for you to obtain the  $E_a$  (activation energy) of this reaction?

A	$\ln(k_2/k_1) = (E_a/R) * [(1/T_1) + (1/T_2)]$
B	$\ln(k_2/k_1) = -(E_a/R) * [(1/T_1) + (1/T_2)]$
C	$\ln(k_2/k_1) = -(E_a/R) * [(1/T_1) - (1/T_2)]$
D	$\ln(k_2/k_1) = (E_a/R) * [(1/T_1) - (1/T_2)]$
E	All the above four equations are wrong.

16. In which of the following changes is the work done by the system the largest at 25°C?

A	an isothermal reversible expansion of an ideal gas from 1 L to 10 L
B	an isothermal expansion of an ideal gas from 1 L to 10 L against an opposing pressure of 5 atm
C	an isothermal free expansion of an ideal gas from 1 L to 10 L
D	an isothermal expansion of an ideal gas from 1 L to 10 L against an opposing pressure of 1 atm
E	The work is the same for all these processes.

17. Which of the following is the strongest oxidizing agent?



A	$\text{Zn}^{2+}$	B	$\text{I}_2$	C	$\text{MnO}_2$	D	$\text{Zn}$	E	$\text{MnO}_4^-$
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注意：背面有試題

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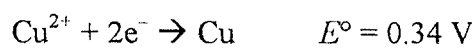
\* 選擇題請在答案卡內作答；  
非選擇題請在答案卷內作答18. In which of the following cases must  $E$  be equal to zero?

I	In any cell at equilibrium
II	In a concentration cell
III	$E^\circ$ can never be equal to zero.

A	II only
B	I and II
C	III
D	I only
E	None of them

參考用

19. You make a cell with a copper electrode in a solution of copper nitrate and a silver electrode in a solution of silver nitrate.

If you could increase the concentration of  $\text{Cu}^{2+}$ , which of the following would be true about the cell potential?

A	It would remain constant.
B	This cannot be determined.
C	It would decrease.
D	It would increase.
E	All the statements are false.

20. Which of the following statements is correct?

A	The system does work on the surroundings when an ideal gas expands against a constant external pressure.
B	The internal energy of a system increases when more work is done by the system than heat is flowing into the system.
C	The internal energy of a system decreases when work is done on the system and heat is flowing into the system.
D	All the statements are true.
E	All the statements are false.

21. For the reaction:  $\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g}) \longrightarrow \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g})$ ,  $H^\circ = 803 \text{ kJ}$ which of the following will increase  $K$ ?

A	decreasing the temperature of system
B	decreasing the number of moles of methane
C	increasing the volume of system
D	increasing the temperature of system
E	none of these

22. From the following list of observations, choose the one that most clearly supports the conclusion that electromagnetic radiation has wave characteristics.

A	diffraction
B	the emission spectrum of hydrogen
C	the scattering of alpha particles by metal foil
D	cathode "rays"
E	the photoelectric effect

注意：背面有試題

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非選擇題請在答案卷內作答

參考用

23. Which of the following is a reasonable criticism of the Bohr model of the atom

A	It shows the electrons to exist outside of the nucleus.
B	It does not adequately predict the ionization energy of the first-energy-level electrons for elements other than hydrogen.
C	It makes no attempt to explain why the negative electron does not eventually fall into the positive nucleus.
D	It does not adequately predict the ionization energy of the valence electron(s) for elements other than hydrogen.
E	It does not adequately predict the line spectrum of hydrogen.

24. Consider the following portion of the energy-level diagram for hydrogen:

$$n = 4 \quad -0.1361 \times 10^{-18} \text{ J}$$

$$n = 3 \quad -0.2420 \times 10^{-18} \text{ J}$$

$$n = 2 \quad -0.5445 \times 10^{-18} \text{ J}$$

$$n = 1 \quad -2.178 \times 10^{-18} \text{ J}$$

For which of the following transitions does the light emitted have the longest wavelength?

A	$n = 2$ to $n = 1$
B	$n = 4$ to $n = 1$
C	$n = 3$ to $n = 2$
D	$n = 4$ to $n = 2$
E	$n = 4$ to $n = 3$

25. The molecule  $\text{XCl}_5^-$  has a square pyramidal shape. Which of the following atoms could be X?

A	O
B	S
C	P
D	Xe
E	At least two of these atoms could be X.

26. Which ion is planar?

A	$\text{ClO}_3^-$
B	$\text{SO}_4^{2-}$
C	$\text{PCl}_4^+$
D	$\text{CO}_3^{2-}$
E	$\text{SCl}_5^-$

27. Which of the following statements is *false*?

A	The carbon-carbon bond in $\text{C}_2^{2-}$ is shorter than the one in $\text{CH}_3\text{CH}_3$ .
B	The carbon-carbon bond in $\text{C}_2^{2-}$ is stronger than the one in $\text{CH}_3\text{CH}_3$ .
C	$\text{C}_2$ is diamagnetic.
D	$\text{C}_2$ is paramagnetic.
E	Two of these statements are false.

注意：背面有試題

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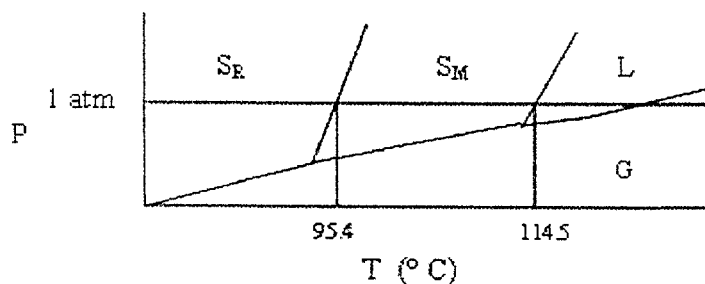
參考用

28. Which of the following statements is true?

A	All antibonding MOs are higher in energy than the atomic orbitals of which they are composed.
B	Electrons are never found in an antibonding MO.
C	Antibonding MOs have electron density mainly outside the space between the two nuclei.
D	None of these statements is true.
E	Two of these statements are true.

29. Of the following homonuclear diatomic molecules, which is paramagnetic?

A	C <sub>2</sub>
B	B <sub>2</sub>
C	F <sub>2</sub>
D	N <sub>2</sub>
E	None of the above

30. Shown below is a phase diagram for sulfur (not drawn to scale). Sulfur can exist in solid modifications, rhombic and monoclinic, denoted by S<sub>R</sub> and S<sub>M</sub>, respectively. Which of the following statements is *incorrect*?

A	At pressures close to 1 atm, rhombic sulfur can be in stable equilibrium with liquid sulfur.
B	Under ordinary atmospheric conditions (at sea level), sulfur does not sublime.
C	This system has two triple points.
D	At a given pressure, there is (at most) one temperature at which rhombic sulfur can exist in equilibrium with monoclinic sulfur.
E	None of these statements is incorrect.

31. A solution contains 1 mol of liquid A and 3 mol of liquid B. The vapor pressure of this solution is 314 torr at 25°C. At 25°C, the vapor pressure of liquid A is 265 torr and the vapor pressure of liquid B is 355 torr. Which of the following is true?

A	This solution exhibits a positive deviation from Raoult's law.
B	This solution is ideal.
C	This solution exhibits a negative deviation from Raoult's law.
D	None of these statements is incorrect.

注意：背面有試題

32. Acetone (mw = 58.08,  $P_{25^\circ\text{C}}^{\circ}=232$  mmHg) and butanone (mw = 72.11,  $P_{25^\circ\text{C}}^{\circ}=100$  mmHg) have the indicated molar masses and vapor pressures. A container holds 1.00 kg of butanone. How much acetone must be added to the butanone to elevate the total vapor pressure over the mixture to 125 mmHg at 25°C?

A	5.313 kg
B	290 g
C	188 g
D	More information needed
E	None of the above

33. Which of the following complexes shows geometric isomerism?

A	$\text{K}[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_4]$
B	$[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2$
C	$[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{SO}_4$
D	$\text{Na}_3[\text{CoCl}_6]$
E	$[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$

34. In the Lewis acid-base model, acids are \_\_\_\_\_ and bases are \_\_\_\_\_.

A	$\text{H}_3\text{O}^+$ donors, $\text{H}_3\text{O}^+$ acceptors
B	$\text{H}^+$ donors, $\text{H}^+$ acceptors
C	electron pair donors, electron pair acceptors
D	$\text{H}_3\text{O}^+$ donors, $\text{OH}^-$ donors
E	electron pair acceptors, electron pair donors

35. Radiocarbon dating is based on which decay process?

A	${}^{14}_6\text{C} \rightarrow {}^{10}_4\text{Be} + \alpha$
B	${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + \beta$
C	${}^{14}_6\text{C} \rightarrow {}^{14}_5\text{B} + \beta^+$
D	All of the above
E	None of the above

注意：背面有試題

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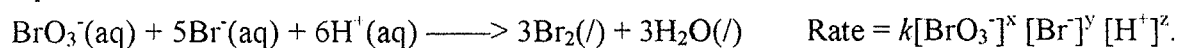
參考用

(二) 簡答與計算題, (5 題, 共 30 分)

1. (10 pts) Name the following elements or compounds in English.

A	Ru	B	W	C	MgBr <sub>2</sub>	D	NO <sub>2</sub>	E	HCl (aq, acid)
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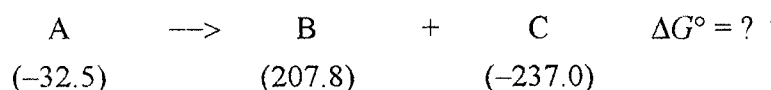
2. (5 pts) The reaction between bromate ions and bromide ions in acidic aqueous solution is given by the following equation:



Using the following four experiment results to determine the orders (x, y, z) for all three reactants. Also calculate the rate constant (2 pts).

Exp	BrO <sub>3</sub> <sup>-</sup> (M)	Br <sup>-</sup> (M)	H <sup>+</sup> (M)	Measured Rate
1	0.2	0.4	0.2	3.2 x 10 <sup>-4</sup>
2	0.4	0.2	0.4	1.28 x 10 <sup>-3</sup>
3	0.4	0.4	0.2	6.4 x 10 <sup>-4</sup>
4	0.2	0.4	0.4	1.28 x 10 <sup>-3</sup>

3. (5 pts) Consider the following hypothetical reaction (at 308 K). Standard free energies, in kJ/mol, are given in parentheses.



What is the value of the equilibrium constant for the reaction at 308 K?

4. (5 pts) Gold (atomic mass = 197 g/mol) is plated from a solution of chlorauric acid, HAuCl<sub>4</sub>; it deposits on the cathode. Calculate the time it takes to deposit 0.65 g of gold, passing a current of 0.14 amperes.

(1 faraday = 96,485 coulombs)

5. (5 pts) Given the following information:

Li(s) → Li(g)	Heat of sublimation of Li(s) = 161 kJ/mol
HCl(g) → H(g) + Cl(g)	Bond energy of HCl = 427 kJ/mol
Li(g) → Li <sup>+</sup> (g) + e <sup>-</sup>	Ionization energy of Li(g) = 520. kJ/mol
Cl(g) + e <sup>-</sup> → Cl <sup>-</sup> (g)	Electron affinity of Cl(g) = -349 kJ/mol
Li <sup>+</sup> (g) + Cl <sup>-</sup> (g) → LiCl(s)	Lattice energy of LiCl(s) = -829 kJ/mol
H <sub>2</sub> (g) → 2H(g)	Bond energy of H <sub>2</sub> = 432 kJ/mol

Calculate the net change in energy for the reaction 2Li(s) + 2HCl(g) → 2LiCl(s) + H<sub>2</sub>(g)