**Physical Chemistry (I) Examination Paper**

**1. *pVT* relation and Thermal properties of substances**

**I Choice (1 point for each, totally 30 points)**

1. Which one of the following three sets of properties is all extensive properties?

A：*U*、*S*、*H* B：*p、* *、T* C*：U、S、V*m

1. When using the amount of the substance, the basic unit must be specified. Which one of the followings is not correct?

A : 1 mol (1/3 AlCl3) B: 1 mol Cu2+ C: 1 mol (2Al3+)

1. The volume of a gas at a certain pressure and temperature is 8 dm3 , according to the EOS of ideal gases, the volume should be 10 dm3, then the compressibility factor is

A：1 B：0.8 C： 1.25

1. Which one of the following statements is correct?  
   A: *Z* of a real gas can’t be equal to 1  
   B: *Z* of the ideal gas must be equal to 1  
   C: A gas that its *Z* equals to 1 must be the ideal gas
2. When the pressure approaches to zero, *Z*s of all gases at various temperatures equal to   
   A: 1 B: 0 C: No way to confirm
3. For the compressibility factor of a real gas, which one of the following statements is incorrect?  
   A: *Z* is the function of the pressure and temperature   
   B: *Z* is only the function of the pressure   
   C: when the temperature is fixed, *Z* is the function of the pressure
4. The slope of plotting of *Z* against *p* when *p* approaches to 0 (∂*Z/*∂*p*)*T*,*p*→0 is smaller than zero at lower temperatures and greater than zero at higher temperatures, there must be a temperature in between where it equals zero. This temperature with (∂*Z/*∂*p*)*T*,*p*→0 =0 is called   
   A: The Boyle temperature

B: The critical temperature

C: The boiling temperature

1. The equation of state of a gas is: *pV*m=*A*+*Bp*+*Cp*2+…; where the parameters of *A, B, C*... are the functions of temperature. At 400K, the parameter *A* equals to   
   A: 3325.6 B: 4325.6 C: not sure
2. When the pressure changes, which one of the flowing properties don’t change   
   A: *T*c B: *T*b  C: *V*m
3. If the pure gas can be liquefied by compression at an ordinary temperature, the temperature must below the   
   A: the condensation point B: the triple point C: the critical point
4. By solving the Van der Waals Equation at a fixed *T* and *p*, we get three roots for *V*ms: 0.0523, 0.2534, and 2.9523 m3·mol-1. Which one is the saturated liquid molar volume?  
   A: 0.0523 m3·mol-1 B: 0.2534 m3·mol-1 C: 2.9523 m3·mol-1
5. When substance A has equal *T*r and *p*r with substance B. According to the principle of the Corresponding State, which one of the following conclusions is incorrect   
   A : *V*A = *V*B  B: *V*rA = *V*rB  C: *Z*A = *Z*B
6. At the critical point, which one of the following statements is incorrect?  
   A: *Z*c of the ideal gas is equal to 1  
   B: *Z*c of the Van der Waals gas is equal to 0.375  
   C: *Z*c of the Van der Waals gas is equal to 1
7. 2 dm3 of the Van der Waals gas at 106Pa expand adiabatically in vacuum until the pressure reduces to. In this process, *W* 0  
    A: > B: = C: <
8. The requirement for the volumetric work equals  is .

A: no limitation： B: *p = p*ext = fixed value： C: *p = p*ext

16. The statement of ‘An isolated system is a system with a constant thermodynamic energy’ is .

A: True B: False C: No way to confirm

17. When the reaction of C(s)+O2(g)=CO(g) is taken place under isochoric and adiabatic conditions, Δ*U* 0.

A: > B: < C: =

18. Macroscopically, for any matter, *H* *U*.

A: > B: < C: =

19. When the temperature of 1 mol monatomic ideal gas increases from 300K to 400K in an isochoric process, Δ*U*=1247.2J. If the temperature of the same gas raises from 350K to 450K in an isobaric process, Δ*H*= .

A：1247.2 J； B：1658.4 J； C：2078.7 J

20. A reaction happens in an adiabatic cylinder with a non-friction plunger. In an isobaric process, when the temperature raises from *T*1 to 2*T*1, and the volume raises from *V*1 to 2*V*1, which one of the followings is correct?

A：,； B： ,； C： ,.

21. When the temperature of 1 mol substance A increases from 300 K to 400 K in an isobaric process, the heat absorbed is 2645 J. If the heating process has neither a chemical reaction nor a phase transition, = in this temperature range.

A：26.45； B：2645； C：undetermined

22. Defining the standard molar enthalpy of vaporization as *a*, the standard molar enthalpy of fusion as *b*, the standard molar enthalpy of sublimation as *c*, the relationship between them is .

A: *c=a-b* B: *c=b-a* C: *c=a+b*

23. The reaction CH4(g)＋CO2(g)＝2CO(g)＋2H2(g) begins with the same amount of CH4(g) and CO2(g) of 1.5 mol and without any other substances. When the extent of reaction is 0.8 mol, the amounts of all substances in the system are .

A：；

B：；

C：

24. At 298.15 K, the standard molar enthalpy of the reactionis, and that of the reactionis. Then the standard molar enthalpy of the reaction:  is .

A：2+；B：-；C：2-

25. Under a certain temperature, which of the following relationships is correct?

A：；

B：；

C：

26. Which of the following statements is false?

A. The standard molar enthalpy of combustion of H2(g) equals to the standard molar enthalpy of formation of H2O(l);

B. The standard molar enthalpy of combustion of H2(g) equals to the standard molar enthalpy of formation of H2O(g);

C. The Standard molar enthalpy of combustion is dependent with the aggregation state of matter.

27. Which one of the following statements is true?

A. The standard molar enthalpies of combustion of C (graphite) and C (diamond) are equal;

B. The standard molar enthalpy of combustion of C (diamond) equals to the standard molar enthalpy of formation of CO2 (g);  
C. The standard molar enthalpy of combustion of C (graphite) equals to the standard molar enthalpy of formation of CO2 (g).

1. At a certain temperature, the standard molar enthalpies of combustion of CH3OH(l) and CH3OH(g) are Δ*H*1 and Δ*H*2 . The standard molar enthalpy of vaporization of CH3OH at this temperature is

A：； B：； C：

29. At a certain temperature, if the amount of gaseous substance increases after a chemical reaction, Δr*H*m ­\_\_\_\_\_\_\_Δr*U*m. (Suppose the gases are of the ideal gas)

A：> B：= C：<

1. For the reaction of , the value of = *RT.*

A：1.5 B：0.5 C： -1.5

**II (10 points, 5 points for each)**

1. At 300 K, a steel cylinder is filled with gas of which the pressure is 1.8 MPa. When some of the gas is released from the cylinder to a vacuumed container with a volume of 20 L, the pressure of the cylinder decreases to 1.6 MPa, and of the container is 0.1MPa. Suppose the gas is an ideal gas, calculate the volume of the steel cylinder.

2. At 298 K, the standard molar enthalpy of combustion of C2H5OH(l) is . The standard molar enthalpies of formation of CO2(g) and H2O(l) are -393.5 and -285.8kJ⬝mol-1. Calculate the standard molar enthalpy of formation of C2H5OH (l) at 298 K.

**III (10 points)**

At 25℃, the standard molar enthalpy of vaporization of  is . Based on the following thermal data, calculate:

1. The standard molar enthalpy of formation of C2H2(g);

2. The standard molar enthalpies of formation of CH2­CHCN(l) and CH2­CHCN(g);

3. The standard molar enthalpies of reaction of HCN(g)+ C2H2(g)= CH2CHCN(g).

Given that at 25℃:

|  |  |  |
| --- | --- | --- |
| Substance |  |  |
|  | −1759.5 | - |
| C(graphite) | −393.5 | - |
|  | −285.8 | - |
|  | −1299.6 | - |
|  | - | 135.1 |

**IV (10 points)**

The standard molar enthalpy of vaporization of H2O(l) at 25℃ is 40.66kJ­·mol-1. Calculate  of the reactionat 600 K. Given that

|  |  |  |
| --- | --- | --- |
| Substance |  |  |
|  | -283.0 | 30.50 |
|  |  | 36.31 |
|  | -285.8 | 29.33 |
|  | 0 | 46.25 |

**V (10 points)**

Calculate the isobaric heat effectand the isochoric heat effectof the reactionat 225℃.

Given that at 25℃ and.

In the temperature range of 25 - 225℃, and . All the gases can be considered as the ideal gas.

**VI (10 points)**

At 300 K and 101.325 kPa, there are 1 mol CO and 0.5 mol pure O2 in a container with a constant volume. Estimate how high the temperature and the pressure of the product of CO2 will be when CO is in complete combustion. Given that at 300 K and 101.325 kPa, the reaction releases the heat of 281.58 kJ, and the isochoric heat capacity of CO2 is. (Assume that the gas at high temperature conforms to the ideal gas law)

**VII (10 points)**

At 298.15 K, the combustion of 5.27 g methanol in an isochoric process releases the heat of 119.50 kJ. Given that the molar mass of methanol is 32.04×10-3 kg­·mol-1, ，. Calculate

1. the standard molar enthalpy of combustion of CH3OH(l) .

2. of CH3OH(l) by using the standard molar enthalpies of formation of H2O(l) and CO2(g).

3. If the enthalpy of vaporization of the methanol is 35.27 kJ·mol-1, calculate of CH3OH(g).

**VIII (10 points)**

Calculate the highest temperature that can reach when C2H2 and O­2 react at 25℃ under a constant pressure. The products of the reaction are CO2(g) and H2O(g). Given that

|  |  |  |
| --- | --- | --- |
| Substance |  |  |
|  | 226.73 |  |
|  |  |  |
|  | -393.51 |  |
|  | -241.84 |  |