

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

說明：1. 請依序作答並標明題號

2. 計算題必須寫出計算過程，只寫答案不予計分

3. $R=8.314 \text{ J mol}^{-1} \text{ K}^{-1}=1.987 \text{ cal mol}^{-1} \text{ K}^{-1}$

4. 第 6 至 9 題是選擇題

1. The rate constant of the second-order reaction $2\text{HI}_{(g)} \rightarrow \text{H}_{2(g)} + \text{I}_{2(g)}$ is $2.4 \times 10^{-6} \text{ L} \cdot \text{mol}^{-1} \cdot \text{S}^{-1}$ at 575 K and $6.0 \times 10^{-5} \text{ L} \cdot \text{mol}^{-1} \cdot \text{S}^{-1}$ at 630K.

Calculate the activation energy of the reaction. (12%)

2. The radioactive isotope ^{32}P decays by first-order kinetics and has a half-life of 14.3 days. How long does it take for 95.0% of a given sample of ^{32}P to decay? (15%)

3. The treatment of a particle in a one-dimensional box can be extended to a rectangular box of dimensions L_x , L_y , and L_z , yielding in the following expression for energy:

$$E = \frac{h^2}{8m} \left(\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} + \frac{n_z^2}{L_z^2} \right)$$

The three quantum numbers n_x , n_y , and n_z independently can assume only integer values. Describe the degeneracies of all the levels that correspond to quantum numbers having values of 1 or 2. How will these degeneracies change in a box where $L_x \neq L_y \neq L_z$? (10%)

4. Please explain the followings:
- Explain why increasing the temperature increases the rate of a reaction. (5%)
 - Explain why a 3d orbital is higher in energy than a 3s orbital in a multi-electron atom. (5%)

(背面仍有題目,請繼續作答)

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c. In the hydrogen atom what is the physical significance of the state for which $n=\infty$ and $E=0$? (5%)

5. Discuss why a function of the type $A\cos(Lx)$ is not an appropriate solution for the particle in a one-dimensional box. (12%)

(第 6 至第 9 題是選擇題)

6. Consider a gas in a 1.0 L bulb at STP that is connected through a valve to another bulb that is initially evacuated. Then the valve between the two bulbs is opened. The system is insulated and closed. (12%)

a. q is

a) greater than zero, b) equal to zero, c) less than zero

b. ΔH is

a) greater than zero, b) equal to zero, c) less than zero

c. w is

a) greater than zero, b) equal to zero, c) less than zero

d. ΔE is

a) greater than zero, b) equal to zero, c) less than zero

7. In an isothermal (27°C) process, the pressure on 1.00 mol of an ideal gas is suddenly increased from 2.50 atm to 6.50 atm. (18%)
($1\text{L} \cdot \text{atm} = 101.3\text{J}$)

a. calculate q

a) -2.38kJ b) 2.38kJ c) 3.99kJ d) -3.99kJ e) 0

b. calculate w

a) -2.38kJ b) 2.38kJ c) 3.99kJ d) -3.99kJ e) 0

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c. calculate ΔH

a) -2.38kJ b) 2.38kJ c) 3.99kJ d) -3.99kJ e) 0

d. calculate ΔS

a) 13.3 J/K b) -13.3 J/K c) 7.94 J/K d) -7.94 J/K e) 0

e. calculate ΔG

a) 2.38 kJ b) -2.38 kJ c) 3.99 kJ d) -3.99 kJ e) 0

f. calculate ΔS_{univ} .

a) 5.36 J/K b) -5.36 J/K c) -21.2 J/k d) 21.2 J/K e) 0

8. Of energy, work, enthalpy, and heat, how many are state functions?(3%)

a) 0

b) 1

c) 2

d) 3

e) 4

9. Which of the following is always true for a spontaneous at constant temperature?(3%)

a) $\Delta S > 0$

b) $\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} > 0$

c) $\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} = q / T$

d) $\Delta S < q / T$