107 學年第一學期 普通物理 B 期末考試題

[Wolfson Ch. 15-19] 2019/01/08, *8:20am – 09:50am*

A

(i)答案卷第一張正面為封面。第一張正、反兩面不要寫任何答案。

(ii)依空格號碼順序在第二張正面寫下所有填充題答案，不要寫計算過程。

(iii)依計算題之題號順序在第二張反面以後寫下演算過程與答案，每題從新的一頁寫起。

(iv)根據題目給的數字，注意答案有效位數。(Please express your answer in significant figures.)

Constants: R = 8.314 J·K^{-1}·mol^{-1}, the fusion heat of water = 334 kJ/kg, Stefan-Boltzmann constant σ: 5.67×10^{-8} W/m^2·K^4, thermal conductivity of copper: 400 W/m·K , thermal conductivity of steel: 80 W/m·K

Part I. Filling the blank (5 points per blank)

• Triatomic gas with specific-heat ratio γ = 4/3 is mixed with 6.0 mol of monatomic gas. If the mixture behaviors like a diatomic gas, the amount of the triatomic gas is 【1】 mol.

• A diatomic molecule is free to move in a tube. The tube diameter is larger than the size of atom but smaller than that of the molecule so that the diatomic molecule can vibrate, but cannot rotate, when it moves along the tube. The degree of freedom of the diatomic molecules in the tube is 【2】.

• Write down the first law of thermodynamics. You have to explain the meaning of the symbols you use.【3】

• A 2.0-L container has 5.0 mol of compressed gas at 17 °C. If the container is discharged into a 58-L vacuum chamber and its temperature remains 17 °C, the energy which becomes unavailable to do work is 【4】 kJ.

• 50.0 g water at 0.00 °C is frozen into ice completely at the same temperature by discharging the transformation heat into the surroundings at –1.00 °C. The change of entropy of the system (H_2O + surroundings) is 【5】 J/K.

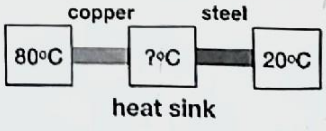
• A heat pump extracts energy from groundwater at 10 °C and transfers it to water at 90 °C to heat a building. If it supplies heat at the rate of 20 kW, the electric power it consumes is 【6】 kW.

• A home freezer operates between – 18 °C and 28 °C. The minimum electrical energy it would take to freeze 500 g of water at 0 °C is 【7】 kJ.

• The side of a copper cube is 10 cm. The coefficient of linear expansion of copper is 1.7×10^{-5} K^{-1}. (a) How much does the length of the side increase due to thermal expansion if it is heated from 20°C to 80°C? 【8】 cm (b) By how much does the volume increase due to thermal expansion 【9】 cm^3.

• The average density of a typical arctic iceberg is 0.90 g/cm^3 , and that of sea water is 1.03 g/cm^3. A sailor found an iceberg with a volume of 1.0×10^9 cm^3 above water surface. Please estimate the total volume of this iceberg 【10】 cm^3

• A copper rod and a steel rod are connected in series between a hot (80°C) and a cold (20°C) reservoir through a heat sink as shown in the figure. Both rods have a uniform cross-sectional area of 0.01 m^2 and a length of 1 m. (a) What is the temperature of the heat sink? 【11】 °C (b)The heat transfer rate between the two reservoirs is 【12】 W/sec.



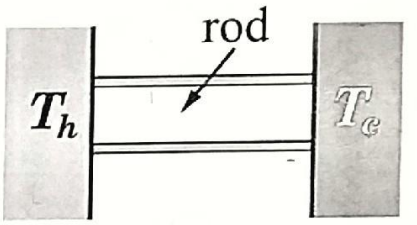
• A black wood stove with surface area 4.6 m^2 is made from cast ion 4.0 mm thick. Its interior wall is at 650°C, while the exterior is at 647°C (a) What is the rate of heat loss by radiation from the stove? 【13】 W (b) The main mechanism to warm the room is 【14】 (conduction, convection or radiation)

• At what temperature will the thermal speed of the air molecule be doubled in comparison with that at 25°C? 【15】

Part II Problems (10 points per problem)

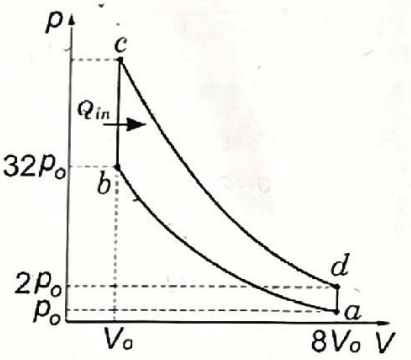
1.

The heat transfer by conduction from a hot reservoir T_h to a cool one T_c is shown in the figure. Heat is transferred in steady state through a uniform thermal insulated rod, resulting in a rate of heat flow H. In a time interval t, find (a) the entropy change in rod ΔS_{rod}, (b) the entropy change of the whole system (two reservoirs and rod) ΔS.



2.

An ideal gas is the working substance in an engine that operates on the cycle $a \rightarrow b \rightarrow c \rightarrow d \rightarrow a$ in the figure. Processes ab and cd are adiabatic and the other two are constant-volume processes. (a) What is the specific-heat ratio γ? (b) What is the engine efficiency $e = W/Q_{in}$, where W is the work done by the engine in one cycle?



3.

(a) A flow runs with a velocity 0.20 m/sec in a pipe with a diameter of 0.10 m. What the flow rate (m^3/sec)?

(b) A venturi flowmeter is as show as the right figure for the liquid with a density ρ. D1 and D2 are the pipe diameters for the two parts of the tube. The height difference of the two gauges is Δh. Find the flow rate.