

## Test Questions (FOR FINAL)

- 1 We have proved that a (monatomic) gas exerts a pressure

$$P = \frac{1}{3} \frac{m N \langle v^2 \rangle}{V}$$

on the walls of its container. Show that this implies that each atom carries the kinetic energy  $(\frac{3}{2} k_B T)$  where  $T$  is the temperature of the gas. ( $k_B =$  Boltzmann's constant).

- 2 If you double the temperature of a gas while holding the volume constant what happens to its Pressure (Hint: be careful of using the correct temperature scale)

- 3 Water has the remarkable property that it contracts on cooling as long as  $\theta > 4^\circ\text{C}$  but expands on further lowering of  $\theta$ . How does this conspire to ensure that fish survive even when lakes and oceans freeze (in winter) at high latitudes.

- 4 Explain in your own words the difference between conduction and convection.

5. If you increase the temperature of a surface from  $27^{\circ}\text{C}$  to  $327^{\circ}\text{C}$  by what factor would the amount of radiation emitted by it change? Why?

6. The human body has a temperature of  $37^{\circ}\text{C}$ . If you imagine that it is a cylinder of length  $1.5\text{m}$  and diameter  $0.5\text{m}$  what is the energy loss due to radiation, per sec? Why?  $\sigma = 6 \times 10^{-8} \text{Watt/m}^2/\text{K}^4$   
Assume  $\epsilon = 1$ .

7. Which process of heat transfer is most effective in (i) Solids (ii) Liquids, (iii) Vacuum? Why?

8. Which process is the main determinant of the "wind chill" factor? Why?

9. Why are clear nights colder than cloudy nights?

10. Identify the ways in which a thermodynamic system can change its energy.

11. Why is it possible to write  $Q = mc\Delta T$  for a solid and liquid but not for a gas?

12. Carefully define the thermodynamic processes represented by an (i) isochore, (ii) isobar (iii) isotherm (iv) adiabatic and in each case show the thermodynamic path in a  $P-V$  diagram.

## MORE TEST QUESTIONS (FINAL)

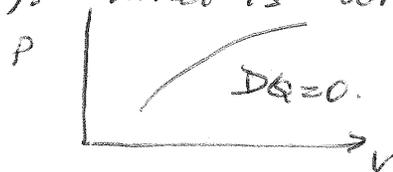
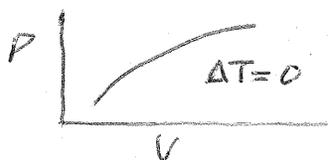
13. A gas changes its pressure from  $P_1$  to  $3P_1$  at a constant volume. In this process a) what is the work done? b) what is the final temperature if the initial temperature was  $27^\circ\text{C}$ .
14. In Prob 1 what is the change in the internal energy if the amount of gas is 3 moles and the gas is a) monatomic. b) diatomic?
15. Why is the specific heat of a Gas at constant pressure always larger than the specific heat at constant volume. (Begin by defining specific heat)

16. The first law of thermodynamics is written as

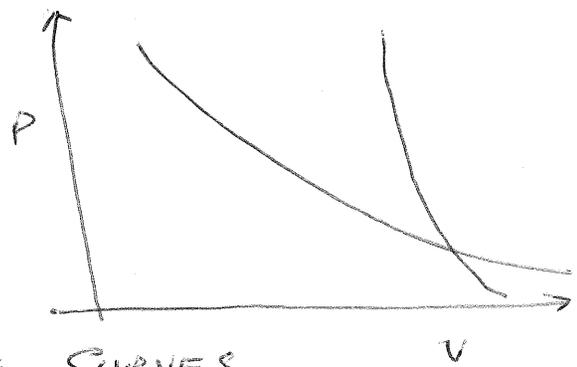
$$dU = \pm DQ \pm DW$$

what is the significance of the two types of "dees" in this equation? (support your answer with a diagram)

17. The diagrams show  $P$  vs  $V$  for a) Isotherm ( $T = \text{const}$ ) b) Adiabatic ( $DQ = 0$ ). What is wrong with them?

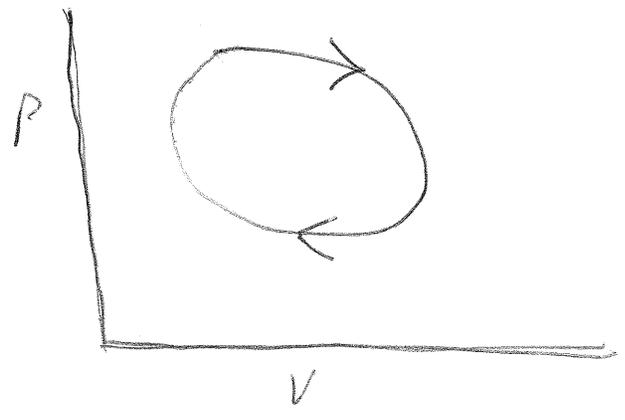


18. The Diagram shows the intersection of an adiabatic ( $DQ=0, PV^{\gamma} = \text{const}, \gamma > 1$ ) and an isotherm ( $\Delta T=0, PV = \text{const}.$ )



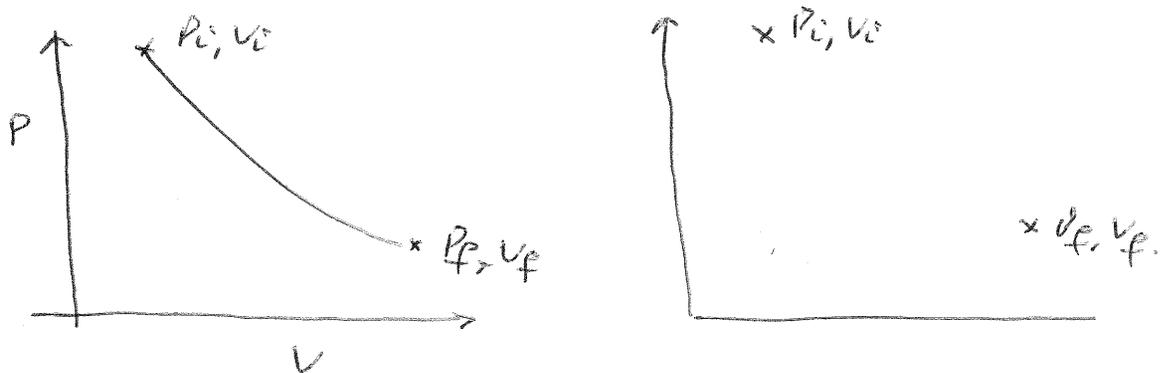
LABEL THE CURVES.

19. For the cyclic process shown, what is the change in internal energy as you go around the cycle twice? In order to perform the cycle do you need to add heat to or subtract heat from the gas? Why?



20. For a planet in circular orbit around the Sun how much work is done by  $\vec{F}_G = -\frac{GM_S M_P \hat{r}}{R_p^2}$  as the planet completes 100 orbits? Why?

21. The pictures show two processes between the same initial  $(P_i, V_i)$  and final  $(P_f, V_f)$  states. What is the difference?



22. One mole of a ~~gas~~ monatomic gas is expanded from a volume of  $2.5 \times 10^{-2} \text{ m}^3$  to  $7.5 \times 10^{-2} \text{ m}^3$  at a constant pressure of  $10^5 \text{ N/m}^2$ .
- What is the work done by the gas?
  - If the initial temperature is  $27^\circ\text{C}$  what is the final temperature?
  - How much heat needs to be added (removed?) from the gas to perform this experiment?

23. At what points on the surface of the Earth is your tangential velocity a) zero b) maximum? Why?

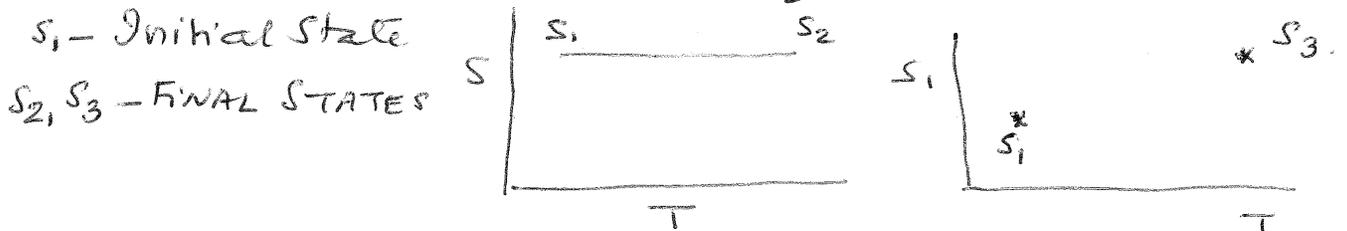
24. In transferring heat from pt. A to pt. B which process is more effective, conduction or convection? Why?

1425 What is ENTROPY?

14. DRAW THE CARNOT CYCLE ON A P-V DIAGRAM AND LABEL EACH OF THE FOUR PROCESSES PRECISELY AND INDICATING WHETHER HEAT IS BEING ADDED OR REMOVED FROM THE "WORKING SUBSTANCE"

1427 REPEAT PROB. 13 BUT NOW USE AN ENTROPY-TEMPERATURE DIAGRAM.

25. The pictures show two adiabatic processes. What is the difference?



29 What does the 2nd Law of Thermodynamics tell you about the change of Entropy in an ADIABATIC PROCESS.

30 Prove that two adiabatics can never intersect.

31. Can two isotherms, isobars or isochores intersect? Justify your answers.