PHYS102 – Chapter 18 (Instructor: Dr. Al–Shukri)

1. A glass flask with volume 250 cm^3 is filled with mercury at 25 ºC. How much mercury (in cm^3) overflows when the temperature of the system is raised to 105 ºC (the coefficient of linear expansion of glass is 4.0 $\times 10^{-6}$ K^{-1} and coefficient of volume expansion of mercury is 1.82 $\times 10^{-4}$ K^{-1}).

a. 3.4 b. 1.1 c. 6.5 d. 8.5 e. 7.5

2. How much ice at -12.0 ºC must be added to 500 g of water at 10.0 ºC to cause the resulting mixture to be liquid water at 0 ºC ? (c_{ice} = 2200 J/kg.K, c_{water} = 4200 J/kg.K, Lf = 333 kJ/kg)

a. 0.94 b. 0.75 c. 0.33 d. 0.40 e. 0.50

3. One end of a steel bar is welded to one end of a copper bar. Both bars have the same length and cross sectional area. The free end of the steel bar is maintained at 100 ºC and free end of the copper bar is maintained at 0.0 ºC. Find the temperature (in ºC) of the junction at steady state.(k steel = 50.2 W/m.K; k_{copper} = 385 W/m.K)

a. 11.5 b. 8.5 c. 25 d. 30 e. 5.5

4. A square hole 8.00 cm along each side is cut in a sheet of metal. If the temperature of the sheet is increased by 50 K, the area of the hole increases by 0.11 cm^2. Find the coefficient of linear expansion α of the metal

a. 17.2 x10^{-6} $^oC^{-1}$ b. 10.1 x10^{-6} $^oC^{-1}$
c. 20.2 x10^{-6} $^oC^{-1}$ d. 17.2 x10^{-5} $^oC^{-1}$
e. 19.2 x10^{-5} $^oC^{-1}$

5. Helium condenses into the liquid phase at approximately 4 K. What temperature in degrees Fahrenheit, does this correspond to?

a. –452 b. -269 c. –118 d. -182 e. –484

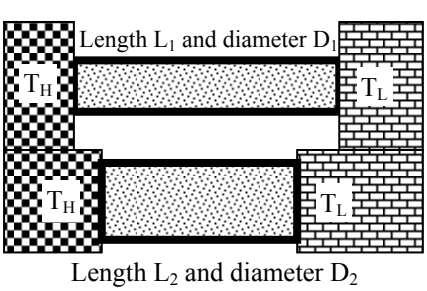
6. A gas is compressed from 600 cm^3 to 200 cm^3 at a constant pressure of 400 kPa. At the same time, 100 J of heat energy is transferred out of gas. What is change in the internal energy (in J) of the gas during this process?

a. 60 b. 100 c. - 60 d. -100 e. 33

7. A 15 g ice cube at 0 °C is placed in an aluminum cup whose initial temperature is 70 ^oC. The system comes to an equilibrium temperature of 20 °C. What is the mass of the cup? (c_{Al} = 900 J/kg.K; $L_{fusion\text{-}ice}$= 333 kJ/kg.K)

a. 140 g b. 100 g c. 75 g d. 50 g e. 120 g

8. Two cylindrical copper rods with different length L_1 and L_2 and different diameters D_1 and D_2 are connected across two heat reservoirs with temperatures T_L= 0 °C and T_H=100 °C (see the **Figure**). In the steady state the heat conduction rate through the rod L_1 is half of that through L_2. If L_1=40 cm and D_2 = 1.2 D_1 , the length L_2 is: (k_{copper} = 385 W/m.K)



a. 29 cm b. 20 cm c. 35 cm
d. 11 cm e. 40 cm

9. The coefficient of linear expansion of steel is 11×10^{-6} per C^o. A steel ball has a volume of 100.00 cm^3 at 0^o C. When heated to 100^o C, its volume (in cm^3) becomes

a. 100.33 b. 100.11 c. 100.22
d. 0.11 e. 0.33

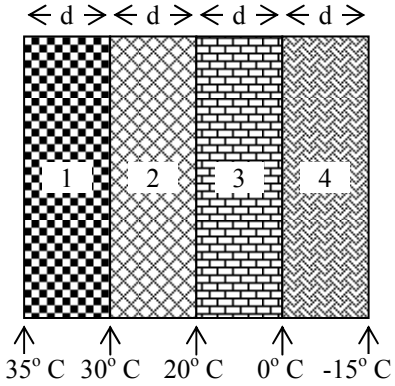
10. Ten grams of ice at – 20^o C is to be changed to steam at 130^o C. The specific heat of water is 1 cal/g C^o, and the specific heats of both ice and steam are 0.5 cal/g C^o. The heat of fusion is 80 cal/g and the heat of vaporization is 540 cal/g. The entire process requires

a. 7450 cal b. 750 cal c. 1250 cal
d. 6950 cal e. 7700 cal

11. According to the first law of thermodynamics, applied to a gas, the change in the internal energy during any process is

a. equal to the heat input plus the work done on the gas.
b. equal to the heat input plus the work done by the gas.
c. equal to the work done on the gas minus the heat input.
d. independent of the heat input.
e. independent of the work done on the gas.

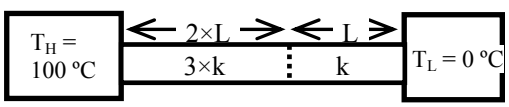
12. The **diagram shows** four slabs of different materials with equal thickness and equal cross sectional area, placed side by side. Heat flows from left to right and steady-state temperatures of the interfaces are given. Rank the materials according to their thermal conductivities, smallest to largest.



a. 3, 4, 2, 1 b. 1, 2, 4, 3 c. 3, 4, 1, 2
d. 1, 2, 3, 4 e. 4, 3, 2, 1

13. A rod is made of two different metals, one piece has length L and thermal conductivity k and the other piece has a length 2×L and thermal conductivity 3×k. The rod is situated between two heat reservoirs as shown in the **Figure**. What is the steady state temperature at the interface of the two pieces ?

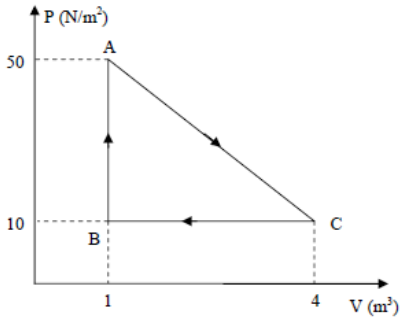
a. 333 K b. 60 K c. 35 K
d. 68 K
e. 0 K



14. Calculate the amount of energy, in J, required to completely melt 130 g of lead initially at 15.0 ºC. Melting point of lead = 328 C, Latent heat of fusion of lead = 2.32×10^4 J/kg, and c_{lead} = 128 J/kg/K.

a. 8.22×10^3 b. 3.02×10^3 c. 5.21×10^3
d. 1.31×10^4 e. 8.25×10^7

15. Gas within a closed chamber undergoes the cycle shown in the **Figure**. Calculate the net heat added to the system in a complete cycle.



a. 60 J b. 73 J
c. 31 J d. 14 J e. 10 J

16. When the temperature of a sphere is raised by 75 ºC the sphere's volume increases by 6.9×10^{-5} m^3. If the original volume is 1.8×10^{-2} m^3, find the coefficient of linear expansion of the sphere.

a. 1.7×10^{-5} ºC^{-1} b. 5.1×10^{-5} ºC^{-1} c. 3.4×10^{-5} ºC^{-1}
d. 9.0×10^{-5} ºC^{-1} e. 2.8×10^{-5} ºC^{-1}

17. Liquid nitrogen boils at temperature of -196 ºC when the pressure is one atmosphere. A silver coin of mass 15 g and temperature 25 ºC is dropped into the liquid. What mass of nitrogen boils off as the coin cools to – 196 ºC. [Take the specific heat of silver = 235 J/kg/K and latent heat of vaporization for liquid nitrogen is 2.0×10^5 J/kg.

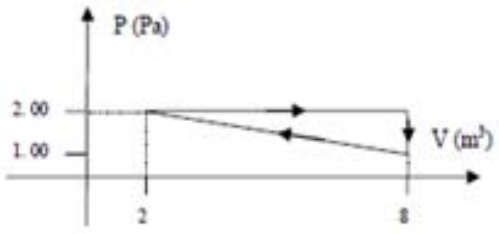
a. 3.90 g b. 8.10 g c. 20.1 g
d. 89.0 g e. 112 g

18. Which of the following statements is True:

a. If two objects are in thermal equilibrium, they must have the same temperature.
b. 272 K is warmer than zero ºC.
c. if an object (A) is warmer than a second object (B) in the Fahrenheit scale then object (B) must be warmer than object (A) in the Celsius scale.
d. When the temperature of an object increases by one ºC it means that it has increased by less than one ºF.
e. The coefficient of linear expansion is the same for all materials.

19. A certain metal rod has a length of 10.00 m at 100.00 ºC and a length of 10.04 m at 773 K. Find its length at zero ºC.

a. 9.99 m
b. 9.00 m
c. 9.83 m
d. 10.01 m
e. 10.03 m



20. In a P-V diagram, a system of an ideal gas goes through the process shown in the **Figure**. How much heat is absorbed after the system goes 100 times through the cycle?

a. 300 J b. 730 J c. 355 J
d. 500 J e. zero

21. Consider a copper slab of thickness L and area of 5.0 m^2. If the conduction rate through the copper slab is 1.2×10^6 J/s and the temperature on the left of the slab is 102 ºC while on the right of the slab it is -12.0 ºC, what must be the thickness of the slab? [Take the coefficient of thermal conductivity of copper as 400 W/(m×K)].

a. 19 cm b. 32 cm c. 25 cm d. 29 cm e. 15 cm

22. 300 grams of water at 25 ºC are added to 100 grams of ice at zero ºC. The final temperature of the mixture is:

a. zero ºC b. 20 ºC c. 15 ºC
d. 5 ºC e. 10 ºC

23. The equation of state of a certain gas is given as $PV^2 = K$, where P is the pressure, V is the volume and K is a constant. Find the work done by the gas if its volume increases from $V_i = 2.0$ m^3 to a final volume $V_f = 4.0$ m^3.

a. K/4 b. 4×K c. K/2 d. K^2 e. $2\times K^2$

24. It is recommended to use a new temperature scale called Z. On Z scale, the boiling point of water is 65.0 ºZ and the freezing point is -15.0 ºZ. To what temperature on the Fahrenheit scale would a temperature of -100 ºZ correspond? [Note: both scales are linear]

a. -159 ºF b. -100 ºF c. -110 ºF
d. -15 ºF e. +15 ºF

25. A 50-g piece of ice at zero ºC is placed in a thermos bottle containing 100 g of water at 6.0 ºC. How many grams of ice will melt?

a. 7.5 g b. 2.0 g c. 50 g d. 17 g e. 3.5 g

26. A cylinder with a frictionless piston contains 200 g of water at 100 ºC. What is the change in internal energy of water when it is converted to steam at 100 ºC at constant pressure of 1.0 atm. [ρ_{steam} = 0.6 kg/m^3, ρ_{water} = 1000 kg/m^3, L_v = 2256 kJ/kg, 1.0 atm = 101 kPa]

a. 418 kJ b. 452 kJ c. 333 kJ
d. 226 kJ e. 113 kJ

27. A system of an ideal gas undergoes the cyclic process shown in the **Figure**. Calculate the work done by the system along the path XY.

a. 90 J b. -90 J
c. 60 J d. -60 J
e. zero