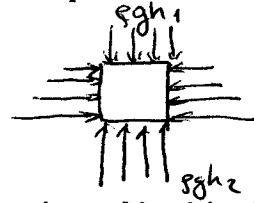
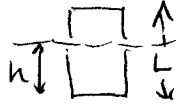


1. A cube 10 cm on each edge is submerged in water. Comparing the various faces (top, bottom, and sides) of the cube, the fluid pressure is
- (a) greatest on the sides of the cube
 - (b) greatest on the top of the cube
 - (c) greatest on the bottom of the cube
 - (d) equal on all six faces of the cube



2. A piece of wood with a density of 0.8 gm/cm^3 floats in a liquid of density 1.2 gm/cm^3 . The fraction of the wood that is beneath the surface of the liquid is

- (a) 80%
- (b) 67%
- (c) 33%
- (d) 25%



$$\rho_{\text{liquid}} A h = \rho_{\text{wood}} A L$$

$$\frac{h}{L} = \frac{\rho_{\text{wood}}}{\rho_{\text{liquid}}} = \frac{0.8}{1.2} = \frac{2}{3}$$

3. The volume flow of blood through the average human aorta is about $90 \text{ cm}^3/\text{s}$. The radius of the human aorta (which is approximately circular in cross section) is about 1 cm. What is the velocity of blood through the aorta?

- (a) 14 cm/s
- (b) 29 cm/s
- (c) 37 cm/s
- (d) 42 cm/s

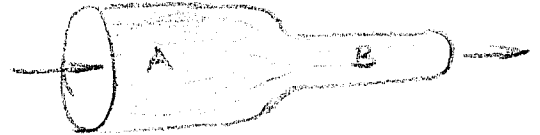
$$\Delta V = A v \Delta t$$

$$v = \frac{\Delta V / \Delta t}{A} = \frac{90 \text{ cm}^3/\text{s}}{\pi (1 \text{ cm})^2} = 28.6 \text{ cm/s}$$

4. Water flows through the reducer pipe shown to the right. The flow is smooth and not turbulent. The static pressure on the walls of the tube is

- (a) less in section A than in section B
- (b) less in section B than in section A
- (c) the same in sections A and B

$$E = P_A + \frac{1}{2} \rho v_A^2 + \rho g h_A = P_B + \frac{1}{2} \rho v_B^2 + \rho g h$$



$$h_A = h_B \quad v_B > v_A \quad ; \quad P_B < P_A$$

5. Heat flow occurs between two bodies in thermal contact when they differ in what property?

- (a) mass
- (b) specific heat
- (c) density
- (d) temperature

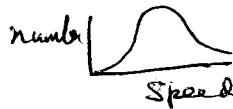
By the definition of heat

6. Ice is known to float on water. This can be understood from the fact that

- (a) the density of ice is greater than the density of water.
- (b) the density of water is greater than the density of ice.
- (c) the latent heat of fusion of ice is negative.
- (d) the specific heat of water is smaller than the specific heat of ice.

7. If the molecules in a container are in thermal equilibrium, it follows that all of the molecules are moving with precisely the same speed.

- (a) True
 (b) False



a distribution of speeds

8. A brass rule is exactly 2.000 m long at 20°C. What is its length at 150 °C? (the coefficient of linear expansion for brass is $1.9 \times 10^{-5}/K$.)

- (a) 1.995 m
 (b) 2.001 m
 (c) 2.003 m
 (d) 2.005 m
 (e) 2.008 m

$$L = L_0 (1 + \alpha \Delta T) = 2.0 + (2)(1.9 \times 10^{-5})(150 - 20) = 2.00494$$

9. The average kinetic energy of the molecules in an ideal gas can be specified knowing ONLY

- (a) the volume of its containing vessel.
 (b) the pressure it exerts on the walls of its containing vessel.
 (c) the temperature of the walls of its containing vessel.
 (d) the number of moles of gas present within the containing vessel.
 (e) the specific heat of the gas.

$$kT \propto \frac{1}{2} m v_{avg}^2$$

10. A steel tank holds 0.2 m³ of air at a pressure of 5 atmospheres. The volume this air would occupy at the same temperature but at a pressure of 1 atmosphere is

- (a) 0.2 m³
 (b) 1 m³
 (c) 5 m³
 (d) 10 m³

$$nRT = p_1 V_1 = p_2 V_2$$

$$\underbrace{(5 \text{ atm})}_{1.0} (0.2 \text{ m}^3) = (1 \text{ atm}) V$$

11. If the gas inside a container of fixed volume is heated to a higher temperature, the pressure increases. The reason for this increase in pressure is that at the higher temperature the molecules have (as compared to the lower temperature)

- (a) more collisions/sec with the wall, but the same momentum imparted to the wall per collision.
 (b) the same number of collisions/sec with the wall, but a larger momentum imparted to the wall per collision.
 (c) both more collisions/sec with the wall and more momentum imparted to the wall per collision.

$$\Delta p \propto m v ; \Delta t \propto L/v ; \frac{\Delta p}{\Delta t} \propto m v^2$$

12. If the gas inside a container is compressed to a smaller volume at a constant temperature, the pressure increases. The reason for this increase in pressure is that at the smaller volume the molecules have (as compared to the larger volume)

- (a) more collisions/sec with the wall, but the same momentum imparted to the wall per collision.
 (b) the same number of collisions/sec with the wall, but larger momentum imparted to the wall per collision. (not if T is same)
 (c) both more collisions/sec with the wall and more momentum imparted to the wall per collision.

13. A container holds equal amounts (by weight) of helium and argon gas at $T = 20^\circ\text{C}$. (Helium has atomic mass 4 and argon has atomic mass 40.)

- (a) The helium atoms have the same average speed as the argon atoms. *(faster since smaller mass)*
 (b) There are equal numbers of helium and argon molecules in the gas. *(more He since lighter)*
 (c) The average speed of the helium atoms is greater than that of the argon atoms. $\frac{1}{2}mV^2 = \frac{1}{2}Mv^2$
 (d) The average speed of the argon atoms is greater than that of the argon atoms.

14. If 1 kg of each of two substances each absorbs the same amount of heat energy, which will undergo the greater change in temperature?

- (a) The substance with the larger specific heat. $\Delta Q = mc\Delta T$
 (b) The substance with the smaller specific heat.

15. Copper has an atomic weight of 64 and silver has an atomic weight of 108. The two metals have different mass specific heats (J/kg/°C), but their molar specific heats (J/mole/°C) are nearly the same. If the same amount of heat were supplied to one kilogram of each of these metals,

- (a) the temperature of the copper would rise more than that of the silver.
 (b) the temperature of the silver would rise more than that of the copper.
 (c) the temperatures of the copper and silver would rise by the same amount.
Silver atoms are heavier, so it takes fewer to make a kg. Thus each silver atom must have more energy than Cu.

16. A 20 g object has what specific heat if its temperature increases by 5°C when 20 cal of heat are transferred to it?

- (a) 0.20 cal/g·°C $\Delta Q = mc\Delta T$
 (b) 0.40 cal/g·°C
 (c) 0.65 cal/g·°C
 (d) 0.85 cal/g·°C
 $c = \frac{\Delta Q}{m\Delta T} = \frac{(20 \text{ cal})}{(20 \text{ gm})(5^\circ\text{C})} = 0.2 \text{ cal/gm}^\circ\text{C}$

17. A sample of 20 g of steam at 100°C is mixed with a sample of 20 grams of ice at 0°C in a thermally insulated enclosure. When the mixture reaches equilibrium it will consist of *assume (b)*

- (a) ice and water at 0°C . $m_i L_f + m_i c (T - 0) = m_s L_v + m_s c (100 - T)$
 (b) water at a temperature between 0 and 100°C .
 (c) water and steam at 100°C . $T = \frac{(20)(540) + (20)(1)(100) - (20)(80)}{(20 + 20)(1)}$
 $= \frac{1}{2}(540 + 100 - 80) = 230^\circ > 100^\circ$

18. A light bulb emits 120 watts of electromagnetic radiation when its tungsten filament is heated to a temperature 4000 K. If the temperature is reduced to 2000 K, the total radiation emitted will be

- (a) 240 watts $\frac{\Delta Q}{\Delta t} \propto T^4$
 (a) 60 watts
 (b) 30 watts
 (c) 15 watts
 (d) 7.5 watts
 $P = (120 \text{ watts}) \left(\frac{2000}{4000}\right)^4 = \frac{120}{16} = 7.5 \text{ watt}$

19. A glass pane 0.4 cm thick has an area of $2 \times 10^4 \text{ cm}^2$. On a winter day the temperature difference between the inside and outside surfaces of the pane is 25°C . What is the rate of heat flow through the window? [The thermal conductivity of glass is $2 \times 10^{-3} \text{ cal}/(\text{s} \cdot \text{cm} \cdot ^\circ\text{C})$.]

- (a) 200 cal/s
(b) 2500 cal/s
(c) 4.0 cal/s
(d) 8.2 cal/s

$$\frac{\Delta Q}{\Delta t} = \frac{kA}{L} \Delta T = \frac{(2 \times 10^{-3} \frac{\text{cal}}{\text{s} \cdot \text{cm} \cdot ^\circ\text{C}})(2 \times 10^4 \text{ cm}^2)}{(0.4 \text{ cm})} (25^\circ\text{C})$$
$$= 2500 \text{ cal/s}$$

20. A nuclear power plant operates by producing a reservoir of heat at 317°C (590 K) and discharges to a lake at a temperature of 27°C (300 K). The maximum possible efficiency of this plant is

- (a) 60%
(b) 57%
(c) 53%
(d) 49%

$$\eta = \frac{T_h - T_c}{T_h} = \frac{590 - 290}{590} = 0.492$$