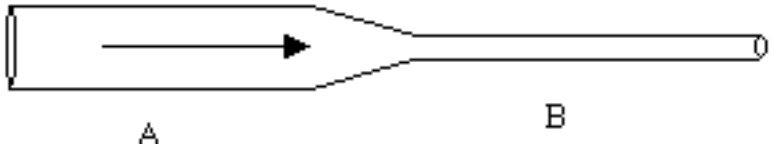
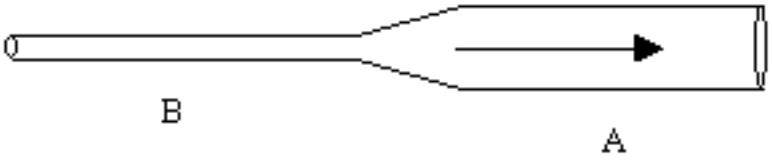
6) The output end of hose A (inner radius 2.4 cm) is attached to hose B, which has a smaller inner radius. The speed of the water in hose A is 5 m/s, and the speed of the water in hose B is measured to be 45 m/s, what is r_B the radius of hose B?



(a) $r_B = 0.4$ cm
(b) $r_B = 1.2$ cm
(c) $r_B = 1.6$ cm
(d) $r_B = 0.8$ cm
(e) $r_B = 0.6$ cm

---

7) The hoses are turned around so that water is running first through B and then through A. If the flow rate of the water is the same as in the above problem, compare the pressures in hose A and hose B.



(a) $P_A < P_B$
(b) $P_A = 2\ P_B$
(c) $P_A > P_B$
(d) $P_A = P_B$
(e) $P_A = P_B/2$

---

8) Suppose you float an ordinary ice-cube in a glass of syrup whose density is 10% greater than that of water, making a mark on the side of the glass to indicate the level of the syrup before the ice melts. What will the level of the liquid will be after the ice has melted?

(a) Slightly above the line
(b) Slightly below the line
(c) At the line (unchanged)
(d) Far below the line
(e) Far above the line

---

9) An aluminum cube that is 200 mm on each side is tied to the end of a string and the block is lowered until it is exactly half submerged, hanging at rest in a tank of pure water. What is the tension T_0 in the string?

(a) $T_0 =$ 69 N
(b) $T_0 =$ 212 N
(c) $T_0 =$ 106 N
(d) $T_0 =$ 172 N
(e) $T_0 =$ 133 N

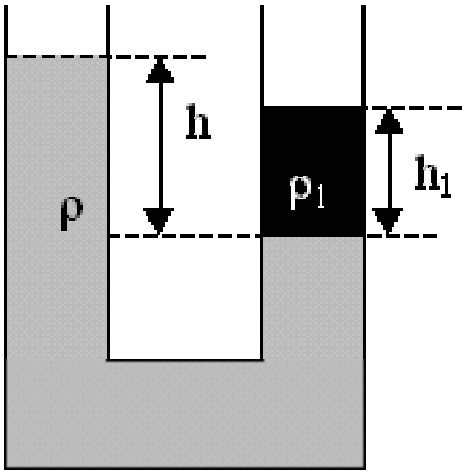
---

10) You have an insulated cup containing 160 g of coffee at a temperature 90 ^{o}C. You add to it 10 g of milk with a temperature of 10 ^{o}C. Assuming the specific heat of the coffee and milk are the same (and equal to that of water), what is the final temperature of the mixture?

(a) 30 ^{o}C
(b) 5 ^{o}C
(c) 84 ^{o}C
(d) 67 ^{o}C
(e) 43 ^{o}C

---

11) A U-shaped tube is open at both ends to the atmosphere. It contains two different liquids. One liquid has density $\rho = 1000$ kg/ m^3. The other liquid has density $\rho_1 = 1200$ kg/ m^3. The height h is 0.30 m (see the figure below, which is not to scale). What is the height h_1?



(a) 0.36 m
(b) 0.20 m
(c) 0.15 m
(d) 0.30 m
(e) 0.25 m

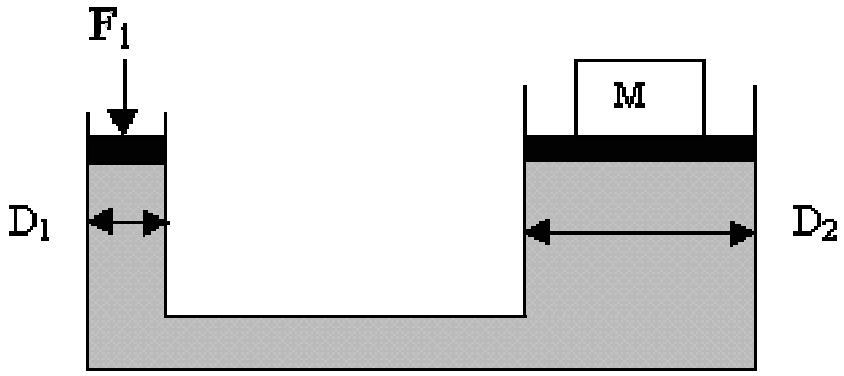
---

12) A submersible *Alvin* is lowered from a ship into the ocean until it reaches the ocean floor at a depth of 5 km. What is the pressure outside *Alvin* at the ocean floor?

(a) 0.51 atm
(b) 77 atm
(c) 508 atm
(d) 491 atm
(e) 9.8×10^8 Pa

---

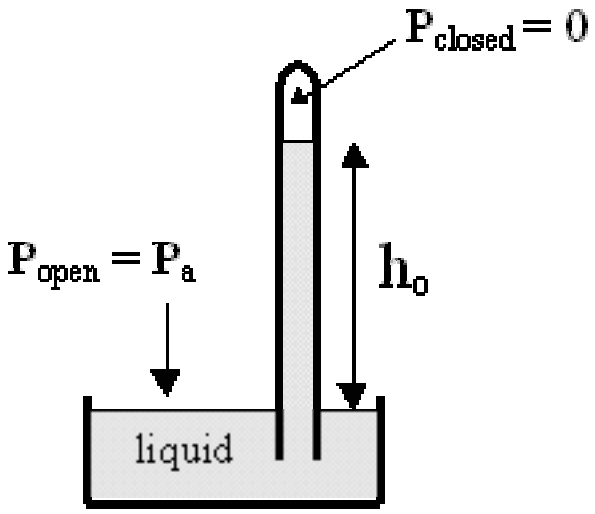
13) A hydraulic lift is used to lift a block of mass M. The block rests on the right massless plunger. A force F_1 is applied to the left massless plunger. The two plungers are at the same height. The diameter of the left cylinder is D_1 and the diameter of the right cylinder is D_2. What force F_1 is required to lift the block?



(a) Mg
(b) Mg (D_1 / D_2)
(c) Mg $(D_1 / D_2)^2$
(d) Mg (D_2 / D_1)
(e) Mg $(D_2 / D_1)^2$

---

14) A barometer is filled with an unknown liquid as shown in the drawing below. The open bottom end of the barometer is exposed to air at atmospheric pressure, and the pressure in the top closed end is 0. The liquid in the closed end rises to a height h_0=1.5 m above the open end. What is the density of the liquid?



(a) 9340 kg/m^3
(b) 3250 kg/ m^3
(c) 7630 kg/ m^3
(d) 6803 kg/ m^3
(e) 2510 kg/ m^3

---

15) Two metal rods, one made from aluminum and the other from steel, have the same initial length (L_o = 5 m) at room temperature (T_o = 20 ^oC). At what temperature T_1 would the aluminum rod be 2 mm longer than the steel rod (assuming that both rods are at the same temperature).

(a) T_1 = -22 ^oC
(b) T_1 = 51 ^oC
(c) T_1 = 31 ^oC
(d) T_1 = 0 ^oC
(e) T_1 = 88 ^oC

---

16) A copper flask with a volume of 150 cm^3 is filled to the brim with olive oil. The coefficient of linear expansion is 17 x 10^{-6} C^{-1} for the flask and the coefficient of volume expansion 680 x 10^{-6} C^{-1} for the olive oil. If the temperature of the system is increased from 6 ^oC to 31 ^oC, how much oil overflows from the flask?

(a) 7.8 cm^3
(b) 15 cm^3
(c) 10 cm^3
(d) 5.2 cm^3
(e) 2.4 cm^3

---

17) A metal cup has mass 120 g and initial temperature 20 ^oC. Into this cup is poured 0.30 kg of water that is initially at a temperature 70 ^oC. The final temperature of the cup-water system is 66 ^oC. Assuming no heat is lost to the surroundings, what is the specific heat of the cup.

(a) 150 J/kg-C
(b) 300 J/kg-C
(c) 460 J/kg-C
(d) 910 J/kg-C
(e) 5200 J/kg-C

---

18) A hot air balloon plus its cargo has a mass of 327 kg and a volume of 687 m^3. The balloon is floating at a constant height above the ground. Given that the density of the surrounding air is 1.27 kg/m^3, what is the density of the hot air inside the balloon?

(a) 0.25 kg/m^3
(b) 0.45 kg/m^3
(c) 0.62 kg/m^3
(d) 0.79 kg/m^3
(e) 1.36 kg/m^3

---

19) A 100 g ice cube having an initial temperature of 0 ^{o}C is put into an insulated cup containing 200 g of water. After a long time, all the ice is melted and the remaining water is at 0 ^{o}C. Assuming no heat flows into or out of the cup, what was the initial temperature of the water?

(a) 40 ^{o}C
(b) 50 ^{o}C
(c) 10 ^{o}C
(d) 20 ^{o}C
(e) 30 ^{o}C

---

20) A molecule of nitrogen (N_2) at 427 ^{o}C has the same speed (rms velocity) as a molecule of He at the temperature:

(a) -173 ^{o}C
(b) -8.4 ^{o}C
(c) 0 ^{o}C
(d) 3.8 ^{o}C
(e) 700 ^{o}C

---

21) Indicate which statement is true:

(a) A person cools most quickly in high relative humidity.

(b) A person cools by radiation only after exercise.

(c) Heat is never transferred *to* an individual by radiation, only *from* the person.

(d) Heat is quickly conducted away from atheletes by conduction through the air.

(e) Perspiration is an example of cooling by convection.

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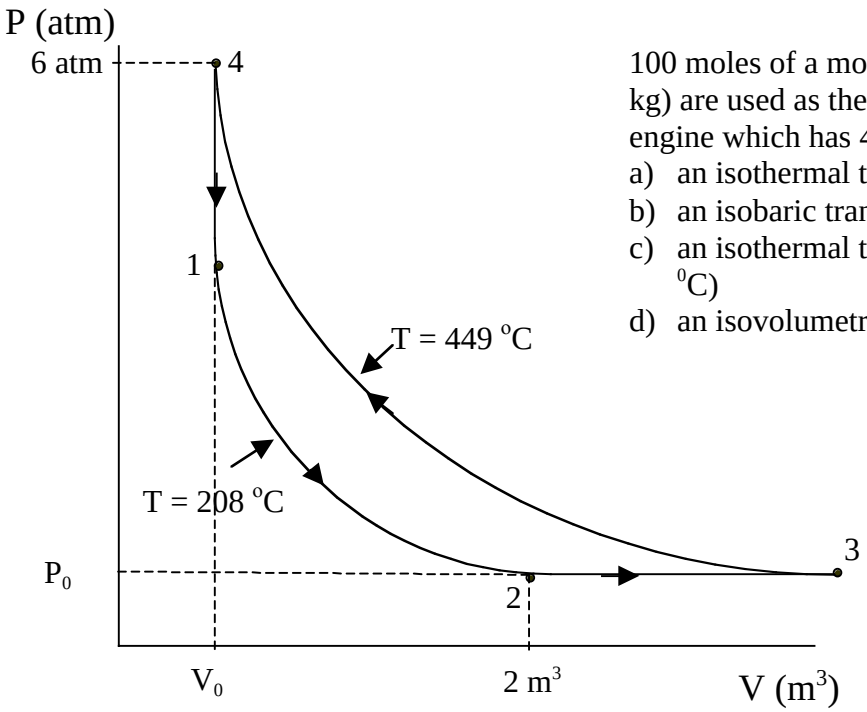
22) Which of the following is not a state of matter (i.e. a phase)?

(a) solid
(b) heat
(c) liquid
(d) plasma
(e) gas

The following three questions are based on the situation below:



100 moles of a monatomic ideal gas (total mass 4 kg) are used as the thermodynamic fluid in a heat engine which has 4 processes in a cycle.

a) an isothermal transition from 1 to 2 (@208 ^{0}C)
b) an isobaric transition from 2 to 3
c) an isothermal transition from 3 to 4 (@(449 ^{0}C)
d) an isovolumetric transition from 4 to 1

23) The Pressure P_0 is

(a) not calculable
(b) 3 atm
(c) 2 atm
(d) 1 atm
(e) 4 atm

24) The volume V_0 is:

(a) not calculable

(b) 1.5 m^3

(c) 1.0 m^3

(d) 2.5 m^3

(e) 0.5 m^3

25) Mark the false statement:

(a) The work done by the gas in going from 4 to 1 is < the work done by the gas going from 1 to 2.

(b) The work done by the gas in one cycle is positive and equal to the area within the cycle.

(c) The work done by the gas in going from 2 to 3 is non-zero.

(d) The work done on the gas is greater than the work done by the gas.

(e) The work done on the gas is greater than the sum of the work done by the gas in going from 1 to 2 plus the work done by the gas in going from 2 to 3.