PHYS 202 Fall 2015 Test #1 Name: KEY

Tf = (9/5) Tc + 32, Tk = Tc + 273 $\Delta L = \alpha L_0 \Delta T$

A) For the following questions write your answers in the space next to the question #.

C 1. Which one of the following temperatures is approximately equal to the typical temperature of a classroom?
a. 373 K b. 23 °F c. 23 °C d. 73 °C e. 73 K

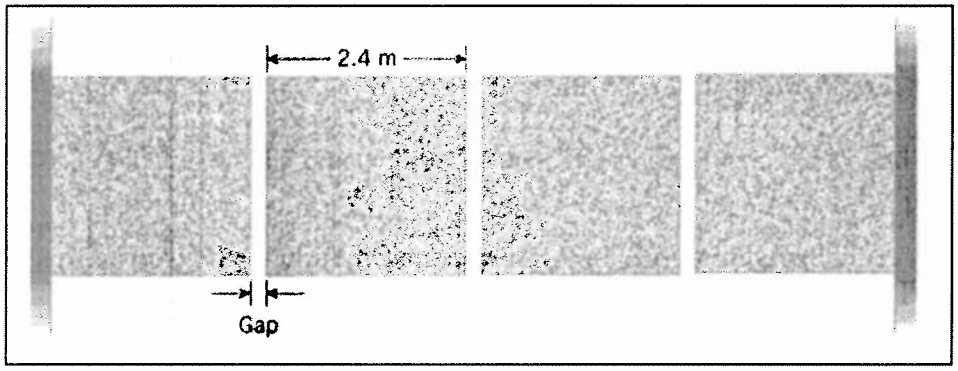
d 2. Express the temperature 4.2 K in °F unit?
a. 39.6 b. – 117 c. – 269 d. – 452 e. – 484

e 3. What is the difference in F° of the two temperatures, -35°C and 62°C?
a. 54 F° b. 15 F° c. 36 F° d.- 2.7 F° e. 175 F°

d 4. What is the thermometric property of an ear thermometer?
a. Length of a liquid column b. Voltage c. Pressure of a gas
d. Infrared radiation e. Ultraviolet radiation

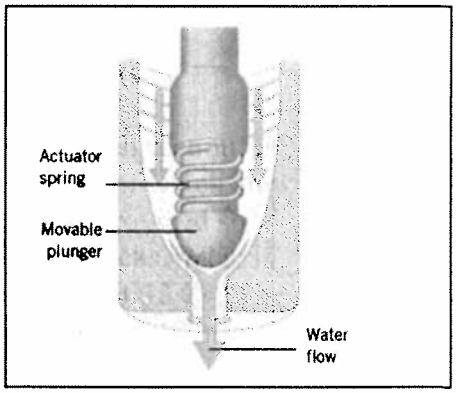
The linear coefficients of thermal expansion are:
$\alpha_{steel} = \alpha_{concrete} = 12x10^{-6}(C^o)^{-1}$, $\alpha_{aluminum} = 23x10^{-6}(C^o)^{-1}$, $\alpha_{copper} = 17x10^{-6}(C^o)^{-1}$.

C 5. Concrete sidewalks are always laid in sections, with gaps between each section. For example, the drawing shows four identical 2.4-m sections, the outer two of which are against immovable walls. The three identical gaps between the sections are provided so that thermal expansion will not create the thermal stress that could lead to cracks. What is the minimum gap width necessary to account for an increase in temperature of 32 C°?
a. 0.92 x 10^{-3}m b. 1.0 x 10^{-3}m c. 1.2 x 10^{-3}m d. 1.3 x 10^{-3}m e. 1.4 x 10^{-3}m



$\Delta L = \alpha L_0 \Delta T$
$3\,Gap = 12\times10^{-6} \times (4\times2.4) \times 32$
$Gap = \frac{12\times10^{-6}\times4\times2.4\times32}{3}$
$= 0.00123\ m$
$= 1.2\times10^{-3}$

b 6. For the highest accuracy, which of the material is ideal for a tape rule for year-round outdoor use?
a 7. Anti-scalding device shown to the right uses actuator spring to block the flow of hot water. For better results the spring should be made of:
Answers for 6 & 7: a. Aluminum b. Steel c. Copper



d 8. All but one of the following statements is true. Which one is not true?

a. A mass (in grams) equal to the molecular mass (in atomic mass units) of a pure substance contains the same number of molecules, no matter what the substance is.

b. One mole of any pure substance contains the same number of molecules.

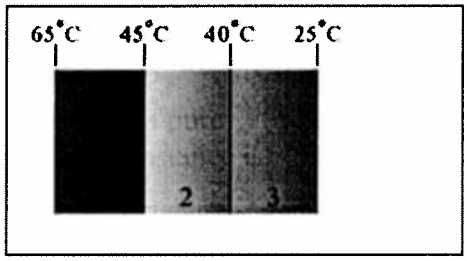
c. Ten grams of a pure substance contains twice as many molecules as five grams of the substance.

d. Ten grams of a pure substance contains the same number of molecules, no matter what the substance is.

e. Avogadro's number of molecules of a pure substance and one mole of the substance have the same mass.

9-10) Heat transfer by conduction is given by: $\frac{Q}{t} = \frac{kA\Delta T}{L}$

The drawing shows a composite slab consisting of three materials through which heat is conducted from left to right. The materials have identical thicknesses and cross-sectional areas.



b 9. What is the direction of heat flow?

a. Right to Left b. Left to Right

b 10. Which one has the highest thermal conductivity?

a. 1 b. 2 c. 3

b 11. Ice is stored in a cubical Styrofoam container with lid (side = 20 cm and thickness = 2 cm) at 0^0C when the outside temperature is 28^0C. How much ice will melt in 2 hours? (Thermal conductivity of Styrofoam = 0.010 J/(s.m.C^0) and latent heat of fusion of ice=33.5×10^4J/Kg).

$Q = \frac{kA\Delta T}{L} \cdot t = mL_f$

$\frac{kA\Delta T \cdot t}{L \cdot L_f} = m$

a. 76-g b. 72-g c. 12-g d. 36-g e. 48-g

a 12. A medium is required for which of the following methods of heat transfer processes?

a. conduction and convection b. conduction and radiation
c. convection and radiation d. radiation

b 13. One way that heat is transferred from place to place inside the human body is by the flow of blood. Which one of the heat transfer processes best describes this action of the blood?

a. conduction b. convection c. radiation

e 14. The third law of thermodynamics is,
a. The law of conservation of energy.
b. Heat flows spontaneously from a substance at a higher temperature to a substance at a lower temperature.
c. Heat flows spontaneously from a substance at a lower temperature to a substance at higher temperature.
d. If two systems individually in thermal equilibrium with a third system, then the two systems are in thermal equilibrium with each other.
e. It is not possible to lower the temperature of any system to absolute zero in a finite number of steps.

b 15. Suppose you want to heat a gas so that its temperature will be as high as possible. Would you heat it under conditions of constant pressure or constant volume?
a. constant pressure b. constant volume

b 16. Which of the following has greater entropy?
a. 1 kg of ice at 0^0C b. 1 kg of water at 0^0C

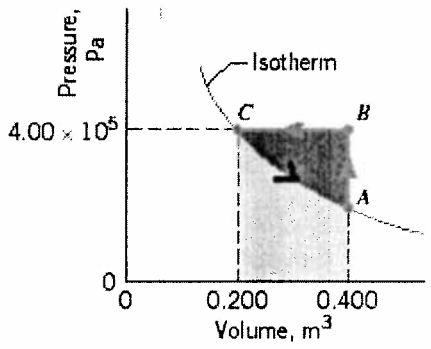
End of MC questions

First Law of thermodynamics: $\Delta U = Q - W$. $W = P.\Delta V$

B. An ideal gas is taken through the three processes (A→B, B→C, and C→A) shown in the drawing, where CA is an isotherm.

1. Name the process **AB** isochoric and **BC** isobaric.

2. For the three processes shown in the drawing, fill in the eight missing entries in the following table.



Process	ΔU	Q	W
A→B	b. +70,000 J	+70,000 J	a. 0
B→C	d. −70,000 J	e. −150,000 J	c. −80,000 J
C→A	f. 0	g. 60,000 J	60,000 J

h. Area of the shaded shape ABC= 20,000 J

Gas constant = R = 8.31 J/mol.K, $N_A = 6.022 \times 10^{23}$.

hydrogen 1 H 1.0079		boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998
lithium 3 Li 6.941	beryllium 4 Be 9.0122	aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453

C. The active ingredient in the allergy medication Claritin contains carbon (C), hydrogen (H), chlorine (Cl), nitrogen (N), and oxygen (O). Its molecular formula is $C_{22}H_{23}Cl\,N_2O_2$. The standard adult dosage utilizes 1.704×10^{19} molecules of this species.

1. What is the molar mass of Claritin?

$22\times12 + 23 + 35.4 + 14\times2 + 16\times2 = 382.4$ g/mol

2. Determine the mass (in grams) of the active ingredient in the standard dosage.

$\frac{1.704\times10^{19}}{6.022\times10^{23}} \times 382.4 = 0.011$ g

D. An apartment has a living room whose dimensions are 2.8 m x 4.5 m x 5.4 m. Assume that the air in the room is composed of 79% nitrogen (N_2) and 21% oxygen (O_2). At a temperature of 20 °C, the pressure is 1.01×10^5 Pa.

1. Calculate the number of moles of air in the apartment.

$PV = nRT \rightarrow n = \frac{PV}{RT} = \frac{1.01\times10^5 \times 2.8\times4.5\times5.4}{8.31\times293.15} = 2821$ mol

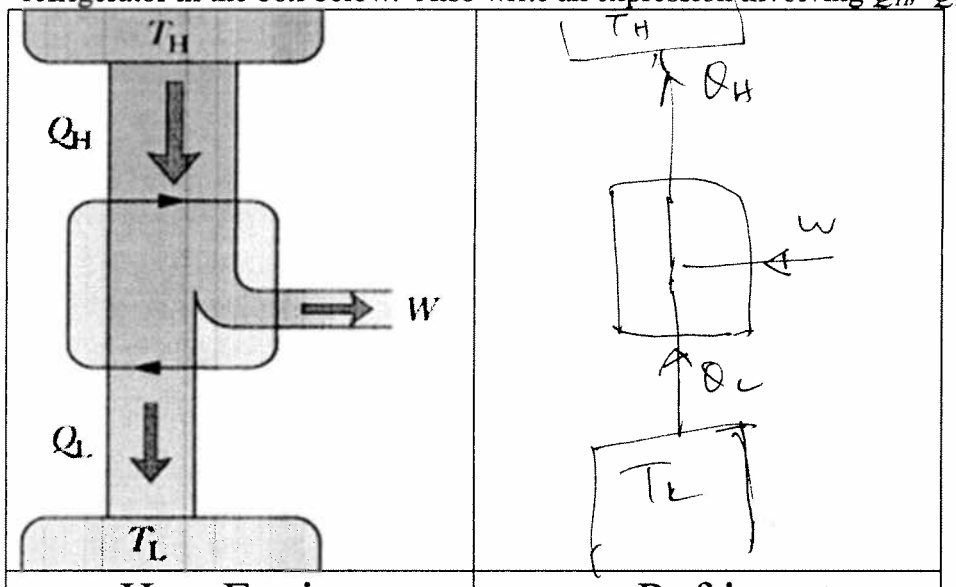
2. Calculate the average molar mass of air.

$M_{air} = 0.79\times28 + 0.21\times32 = 29$ g/mol

3. What is the mass (in grams) of the air in the apartment?

$2821\times29 = 8.2\times10^4$ g = 82 kg

E. Schematic diagram for a heat engine is shown below. Sketch a similar diagram for a refrigerator in the box below. Also write an expression involving Q_H, Q_L, *and W.*

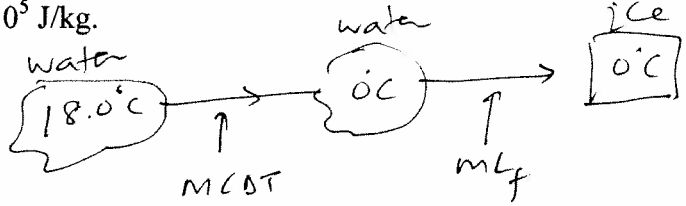


Heat Engine | Refrigerator

Expression involving Q_H, Q_L, *and W.* $Q_H = Q_L + W$

$Q = mc\Delta T$ $\quad Q = mL$ $\quad (COP)_{Refri.} = \frac{Q_C}{W}$

F. The wattage of a commercial ice maker is 175 W and is the rate at which it does work. The ice maker operates just like a refrigerator and has a coefficient of performance of 3.40. The water going into the unit has a temperature of 18.0°C, and the ice maker produces ice cubes at 0.0°C. Ignoring the work needed to keep stored ice from melting, find the maximum amount (in kg) of ice that the unit can produce in four hours of continuous operation. Water has a specific heat capacity 4186 J/(kg·C°) and a latent heat of fusion of 3.35×10^5 J/kg.



$COP = \frac{Q_C}{W}$; $Q_C = 3.4 \cdot W = 175 \times 4 \times 3600$

$Q_C = 3.4 \times 175 \times 4 \times 3600 = 8568000\,J = mC\Delta T + mL_f$

$= m[C\Delta T + L_f]$

$8568000 = m[4186 \times 18 + 3.35 \times 10^5]$

$\frac{8568000}{4186 \times 18 + 3.35 \times 10^5} = m$

$m = 20.9\,kg$