PHYS 202 Spring 2017 Test #1 Name: KEY

$T_F = \frac{9}{5}T_C + 32$ $T_K = T_C + 273$

2pts each Total (38)

A. For the multiple choice questions write your answer in the line 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 ^{0}F c. 23 ^{0}C d. 73 ^{0}C e. 73 K

d 2. Express the temperature 4.2 K in ^{o}F unit?

a. 39.6 b. – 117 c. – 269 d. – 452 e. – 484

e 3. What is the difference in F^o of the two temperatures, -35^{o}C and 62^{o}C?

a. 54 F^0 b. 15 F^0 c. 36 F^0 d. -2.7 F^0 e. 175 F^0

d 4. What is the thermometric property of an ear thermometer?

c 5. What is the thermometric property of a constant volume gas thermometer?

b 6. What is the thermometric property of a thermocouple?

Answers for 4-6

a. Length of a liquid column b. Voltage c. Pressure of a gas

d. Infrared radiation e. Ultraviolet radiation f. Resistance

d 7. The ~~first~~ zeroth law of thermodynamics is,

a 8. The ~~first~~ first law of thermodynamics is,

b 9. The ~~first~~ second law of thermodynamics is,

Answers for 7-9

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.

C 10. Conductors have free______________.

A. Protons B. Neutrons C. Electrons D. Nucleons E. Atoms

c 11. What is the shape of one of the equipotential surfaces for an isolated point charge?

a 12. What is the shape of one of the equipotential surfaces for a parallel plate capacitor?

Answers for 11-12: a. plane b. circle c. sphere d. parabola e. ellipse

c 13. How many coulombs of positive charge are there in 9.5 kg of plutonium, given its atomic mass is 244g and that each plutonium atom has 94 protons?

(q_p= +1.6 x 10^{-19}C, N_A= 6.022 x 10^{23})

a. 3.8 x 10^6 C b. 3.5 x 10^5 C c. 3.5 x 10^8 C d. 5.3 x 10^8 C

The linear coefficients of thermal expansion are:

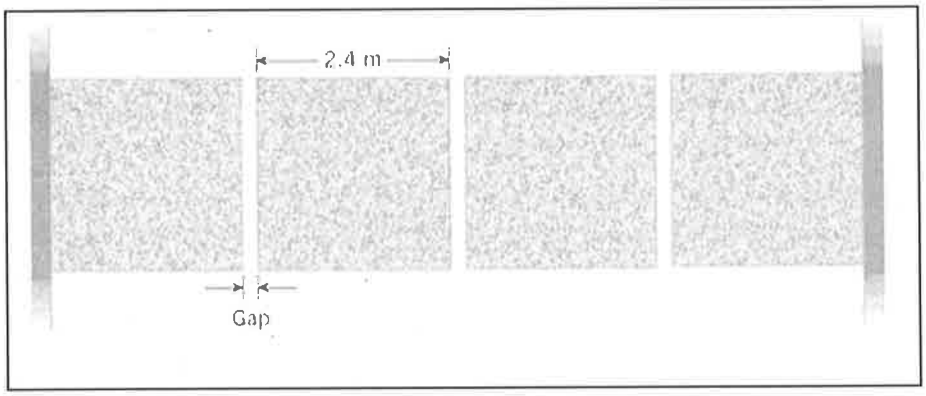
$\alpha_{steel} = \alpha_{concrete} = 12\text{x}10^{-6}(C^o)^{-1}$, $\alpha_{aluminum} = 23\text{x}10^{-6}(C^o)^{-1}$, $\alpha_{copper} = 17\text{x}10^{-6}(C^o)^{-1}$.

Volume coefficient of expansion of radiator coolant = $\beta = 390 \times 10^{-6}\ (C^o)^{-1}$.

$\Delta L = \alpha L_0 \Delta T$ $\qquad \Delta A = 2\alpha A_0 \Delta T$ $\qquad \Delta V = \beta V_0 \Delta T$ $\qquad \beta = 3\alpha$, for solids

C 14. 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



$\Delta L = \alpha L_0 \Delta T$

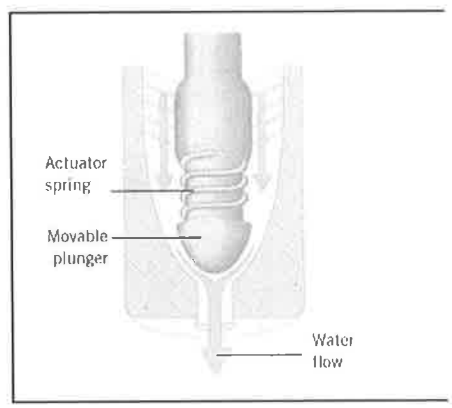
3 Gap = $12\times10^{-6} \times 4\times2.4\times32$

Gap = $\dfrac{12\times10^{-6} \times 4\times2.4\times32}{3}$

Gap = 1.228×10^{-3} m

b 15. For the highest accuracy, which of the material is ideal for a tape rule for year-round outdoor use? Low α preferred.

a 16. 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: high α preferred.



Answers for 15 & 16:

a. Aluminum b. Steel c. Copper

17-19) A radiator is made of copper and is filled to its 22.0-L capacity when at 10.0°C. What volume of radiator coolant will overflow when the radiator and coolant reach 125°C?

b 17. What is the change in volume of the coolant? $\Delta V = \beta V_0 \Delta T = 390\times10^{-6} \times 22L \times 115 = 0.987L$

a 18. What is the change in volume of the radiator? $\Delta V = \beta V_0 \Delta T = 3\times17\times10^{-6} \times 22L \times 115 = 0.129\ L$

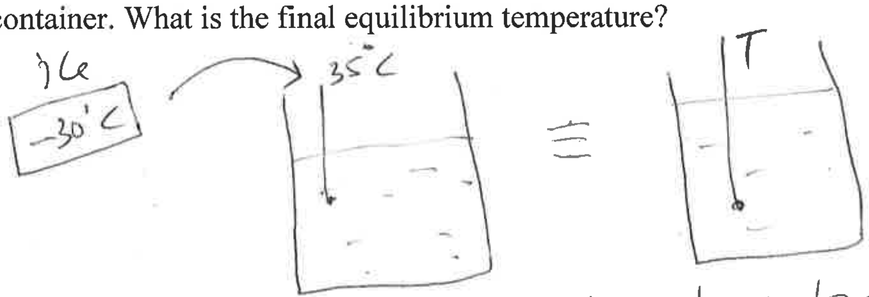
c 19. What volume of coolant will overflow? $0.987 - 0.129 = 0.858L$

Answers for 17-19:

a. 0.129 L b. 0.987 L c. 0.858 L d. 1.12 L e. 0.091 L f. 0.896 L

Specific heat of ice = 0.480 cal/(g.C^0), Latent heat of fusion of ice = 79.7 cal/g,
Specific heat of water = 1.00 cal/(g.C^0) . $Q = mc\Delta T$ Q = mL

(10 pts) B. A 45g ice cube at $-30.0\,°C$ is placed in 350g of $35.0\,°C$ water in a very well-insulated container. What is the final equilibrium temperature?



Heat gain by Ice = Heat loss by water

$mc\Delta T + mL_f + mc\Delta T = mc\Delta T$

$45 \times 0.480 \times 30 + 45 \times 79.7 + 45 \times 1 \times (T-0) = 350 \times 1 \times (35 - T)$

$648 + 3586.5 + 45T = 12250 - 350T$

$350T + 45T = 12250 - 648 - 3586.5$

$395T = 8015.5$

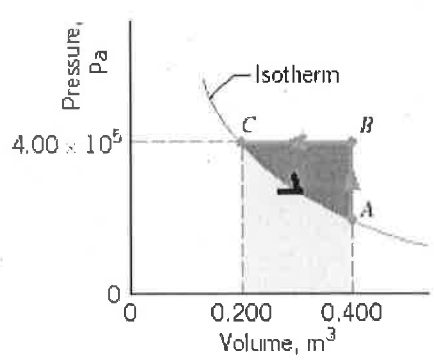
$T = 20.3\,°C$

First Law of thermodynamics: ΔU = Q - W. W= P.ΔV U = (3/2)nRT

(10 pts) C. 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.

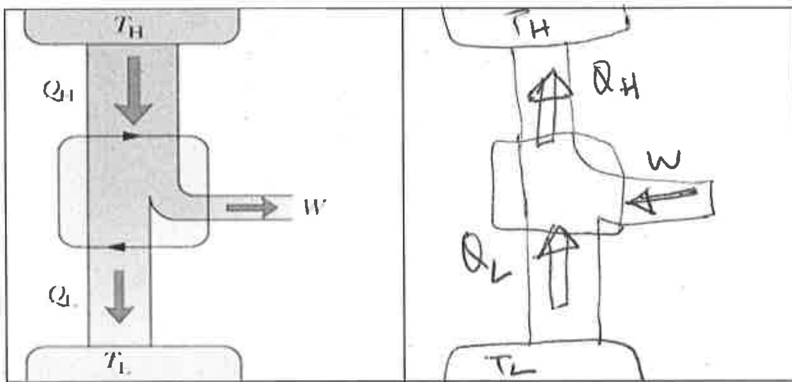
2. For the three processes shown in the drawing, fill in the eight missing entries in the following table.



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. 65,000 J	65,000 J

h. Area of the shaded shape ABC= 15,000 J

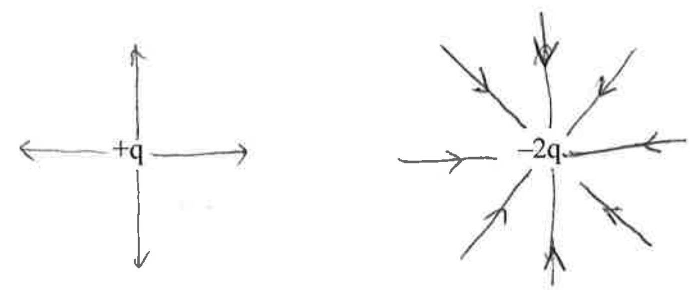
6 pts D. Schematic diagram for a heat engine is shown below. Sketch a similar diagram for a refrigerator in the box below. Also write an expression/equation involving Q_H, Q_L, and W.



Heat Engine | Refrigerator

Expression/equation involving Q_H, Q_L, and W. $Q_H = Q_L + W$

4 pts E. (a) Sketch the electric field lines near a point charge +q. (b) Do the same for a point charge –2q. Both are isolated. not interacting.



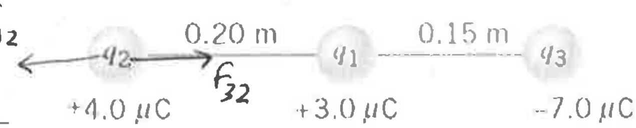
11 pts F. Coulomb's law is given by: $F = k\frac{|Q_1||Q_2|}{r^2}$ Coulomb's constant = k = 9 x 10[9] (SI)

1. Express the SI unit of the Coulomb's constant: $\frac{N \cdot m^2}{C^2} = \frac{kg \cdot m \cdot m^2}{C^2 s^2} = \frac{kg \cdot m^3}{C^2 s^2}$

2. Figure below shows three point charges that lie along the x axis in a vacuum, with no gravity.

a. Draw a free-body diagram for the charge q_2.

b. Determine the magnitude and direction of the net electrostatic force on q_2. ($\mu = 10^{-6}$)



$F_{12} = \frac{k|Q_1||Q_2|}{r^2} = \frac{9\times10^9 \times 3\times10^{-6} \times 4\times10^{-6}}{0.2^2} = 2.7N \leftarrow$

$F_{32} = \frac{k|Q_2||Q_3|}{r^2} = \frac{9\times10^9 \times 4\times10^{-6} \times 7\times10^{-6}}{0.35^2} = 2.06N \rightarrow$

$F_{net} = \leftarrow q_2 = 2.70 - 2.06 = 0.64N$

$0.64N$

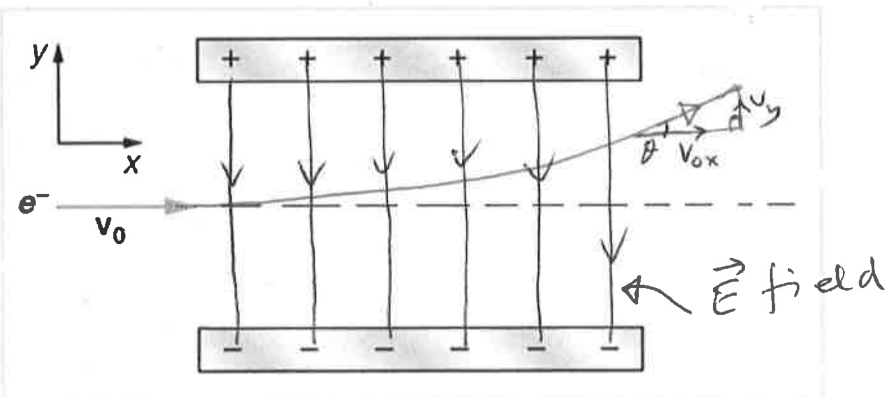
$v = v_0 + at$	$x = \frac{1}{2}(v + v_0)t$	$x = v_0 t + \frac{1}{2}at^2$	$v^2 = v_0^2 + 2ax$	$\vec{F} = m\vec{a}$ $\vec{E} = \frac{\vec{F}}{q}$

21 pts
3 pt each

G. Figure below shows an electron passing between two charged metal plates that create an electric field of 375 N/C, perpendicular to the electron's original horizontal velocity. The initial speed of the electron is 3.00×10^6 m/s, and the horizontal distance it travels in the uniform field is 6.00 cm.

(a) Sketch the electric field between the plates.

(b) Sketch the path of the electron as it travels between the plates and exits.



(c) How long will it take the electron to cross the plates?

$X = V_{ox} t \rightarrow t = \frac{x}{V_{ox}} = \frac{6 \times 10^{-2}}{3 \times 10^{6}} = 2 \times 10^{-8}$ m/s

(d) What is the vertical acceleration of the electron? [$m_e = 9.11 \times 10^{-31}$kg, $|q_e| = 1.6 \times 10^{-19}$C]

$a_y = \frac{F_y}{m} = \frac{q \cdot E_y}{m} = \frac{1.6 \times 10^{-19} \times 375}{9.11 \times 10^{-31}} = 6.6 \times 10^{13}$ m/s²

(e) What is its vertical deflection of the electron?

$\Delta y = V_{oy} t + \frac{1}{2} a_y t^2 = \frac{1}{2} \times 6.6 \times 10^{13} \times (2 \times 10^{-8})^2 = 1.32 \times 10^{-2}$ m $= 1.32$ cm

(V_{oy} = 0)

(f) What is the vertical component of its final velocity?

$V_y = V_{oy} + a_y t = 6.6 \times 10^{13} \times 2 \times 10^{-8} = 1.32 \times 10^{6}$ m/s

(V_{oy} = 0)

(g) At what angle, with the horizontal, does the electron exit?

$\tan\theta = \frac{V_y}{V_{ox}} = \frac{1.32 \times 10^{6}}{3 \times 10^{6}} = 0.44$

$\theta = \tan^{-1}(0.44) = 24^\circ$