PHYS 202 Spring 2024 Test #1 Name: Key

Tf = (9/5) Tc + 32, Tk = Tc + 273 $\Delta T_F = \frac{9}{5}\Delta T_C$ $\Delta T_K = \Delta T_C$

3 pts each

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 ^{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

$4.2K = T_C + 273$
$T_C = -268.8$
$T_F = \frac{9}{5}\times(-268.8)+32$
$= -452$

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

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

$\Delta T_C = 62-(-35) = 97$
$\Delta T_F = \frac{9}{5}\Delta T_C = 174.6$

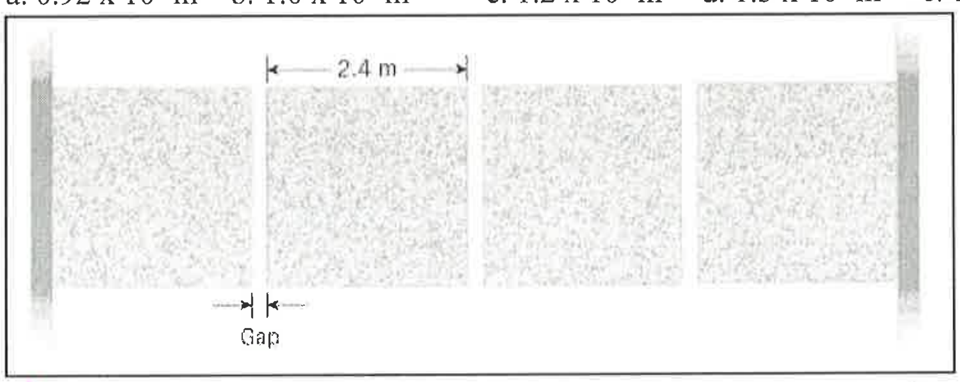
d 4. What is the thermometric property of an ear thermometer?

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:
$\alpha_{steel} = \alpha_{concrete} = 12\times10^{-6}(C^o)^{-1}$, $\alpha_{aluminum} = 23\times10^{-6}(C^o)^{-1}$, $\alpha_{copper} = 17\times10^{-6}(C^o)^{-1}$.

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^o?

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



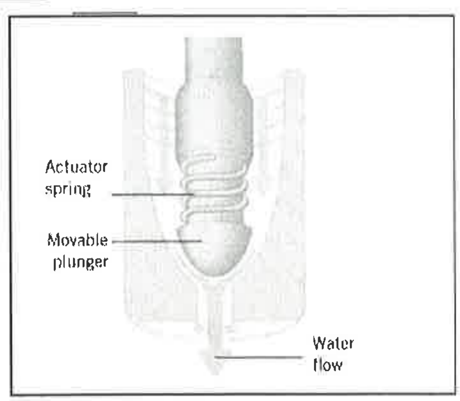
$\Delta L = \alpha L_0 \Delta T$

$3\,Gap = 12\times10^{-6}\times4\times2.4\times32$
$Gap = 0.001228\,m$
$= 1.2\times10^{-3}\,m$

b 6. For the highest accuracy, which of the material is ideal for a tape rule for year-round outdoor use? Less expansion

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: More expansion

Answers for 6 & 7: a. Aluminum b. Steel c. Copper



e 8. 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.

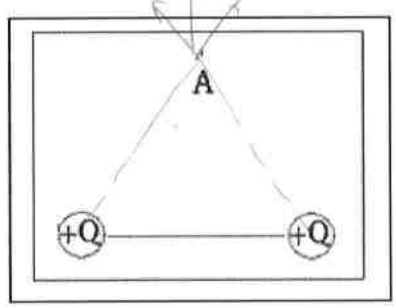
b 9. Suppose you want to heat a gas so that its temperature will be as high as possible. Would you heat it under which one of the following conditions?
a. constant pressure b. constant volume c. constant temperature

e 10. Conductors have free______________.
a. Protons b. Neutrons c. Atoms d. Nucleons e. Electrons

c 11. What is the three dimensional shape of one of the equipotential surfaces for an isolated point charge?
a. plane b. circle c. sphere d. parabola e. ellipse

a 12. An object is charged by induction using a negatively charged rod. What type is the charge on the charged object?
a. Positive b. Negative c. No charge

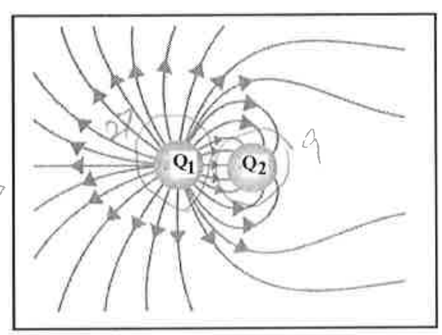
b 13. Two identical charges +Q and +Q with equal magnitudes are located as shown below. Point A is at equal distance from the charges. What is the net electric field at A?
a. Vertical and down b. Vertical and up
c. Horizontal and to the right d. Horizontal and to the left



14-15) Deals with the electric field lines of two charges.
Magnitudes are Q_1 and Q_2 as shown:

a 14. The polarities of the charges are,
a. Q_1 is positive and Q_2 is negative
b. Q_2 is positive and Q_1 is negative
c. Both are positive d. Both are negative

c 15. The ratio Q_1/Q_2 is given by,
a. 1 b. 2 c. 3 d. 4 e. 5



B. How many coulombs of positive charge are there in 2.5 kg of lead? (q_p= +1.6 x 10^{-19}C, N_A= 6.022 x 10^{23})

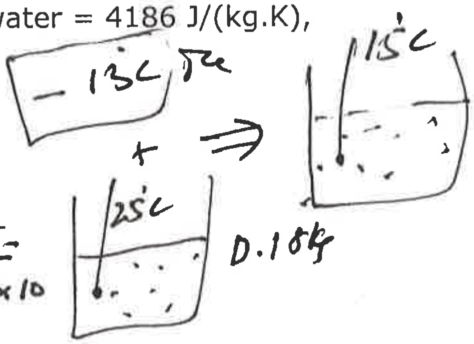
82
Pb
Lead
207.2

7 Proton

5 $\frac{2500}{207.2} \times 6.022\times10^{23} \times 82 \times 1.6\times10^{-19}$ C

9.53×10^{7} C

C. A piece of ice at -13^{0}C is transferred to 180 gram of water at 25^{0}C in an insulated cup with negligible specific heat. The entire ice melts and the final temperature of the water is 15^{0}C. Determine the mass of the ice.
Specific heat of ice = 2000 J/(kg.K), Specific heat of water = 4186 J/(kg.K),
Latent heat of fusion of ice = 33.5 x 10^4 J/kg.



Heat gain by ice = Heat loss by water

10 $MC\Delta T + mL_f + mC\Delta T = MC\Delta T$

$m\times2000\times13 + m\times33.5\times10^4 + m\times4186\times15 = 0.180\times4186\times10$

$m(26000 + 335000 + 62790) = 7534.8$

$m = 0.0178$ kg $= 17.8$ g

PV = nRT, R = 8.31 J/(mol.K) ΔU = Q - W. W= P.ΔV

D. An ideal gas is taken through the three processes (A→B, B→C, and C→A) shown in the drawing. States A and B are at temperature 320 K. V = 0.01 m^3 and P = 10^5 Pa.

1. Determine the number of moles of the gas?

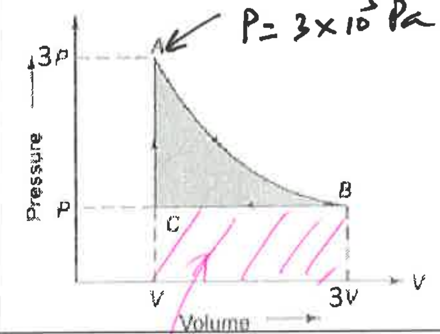
3 $n = \frac{PV}{RT} = \frac{3\times10^5\times0.01}{8.31\times320} = 1.13$ moles

3 2. Name the process **AB** Isothermal **BC** Isobaric & CA Isochoric

3. For the three processes shown in the drawing, fill in the missing entries in the following table. Areas: rectangle = length x width, triangle = 0.5 x base x height.

Isothermal $\Delta U = 0$

9



W = PΔV
= 10^5 × (0.01 − 0.03)
W = −2000 J

Process	ΔU	Q	W
A→B	a. 0	b. 3800 J	3800 J
B→C	-1500 J	d. -3500 J	c. -2000 J
C→A	f. 1500 J	g. 1500 J	e. 0

add

4. Net work for A-> B-> C-> A = 3800 - 2000 = 1800 J

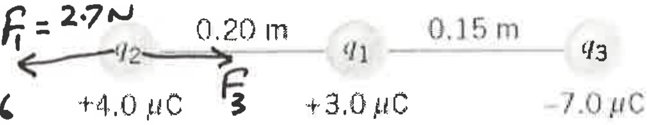
E. Coulomb's law is given by: $F = k\frac{|Q_1||Q_2|}{r^2}$. Coulomb's constant = k = 9 x 10^9 (SI)

2 1. Express the SI unit of the Coulomb's constant: $N \cdot m^2 / C^2$

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.



$F_1 = \frac{k|Q_1||Q_2|}{r^2} = \frac{9\times10^9 \times 3\times10^{-6} \times 4\times10^{-6}}{0.20^2} = F_1 = 2.7N$

9 $F_3 = \frac{k|Q_2||Q_3|}{r^2} = \frac{9\times10^9 \times 4\times10^{-6} \times 7\times10^{-6}}{0.35^2} = 2.06\ N$

2.7N ← q_2 → 2.06N

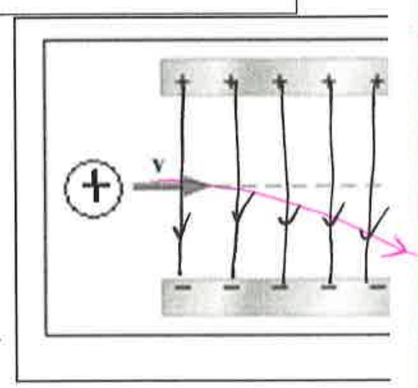
0.64N

net force = ← q_2 ←

= 0.64N

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

F. Figure below shows an alpha particle passing between two charged metal plates that create an electric field of 1250 N/C, perpendicular to the particle's initial horizontal velocity. The horizontal distance it travels in the uniform field is 25 cm and it deflects 3.5 cm vertically.



1 (a) Sketch the electric field between the plates.

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

(c) What is the vertical acceleration of the alpha particle?

[m_α = 6.64 x 10^{-27}kg, q_α = 3.2 x 10^{-19}C]

4 $a = \frac{F}{m} = \frac{qE}{m} = \frac{3.2\times10^{-19} \times 1250}{6.64\times10^{-27}} = 6.02\times10^{10}\ m/s^2$

(d) How long it takes to cross the plates?

↓ $t = ?$ $V_{0y} = 0$, $a_y = 6.02\times10^{10}\ m/s^2$, $y = 0.035m$

$y = V_{0y}t + \frac{1}{2}a_y t^2$

4 $0.035 = \frac{1}{2} \times 6.02\times10^{10} \times t^2 \rightarrow t^2 = \frac{2 \times 0.035}{6.02\times10^{10}} \rightarrow$ $t^2 = 1.16\times10^{-12}\ s^2$

$t = 1.08\times10^{-6}\ s$

(e) What is the initial horizontal velocity of the alpha particle?

→ $x = V_{0x}t + a_x t^2$, $a_x = 0$

4 $V_{0x} = \frac{x}{t} = \frac{0.25}{1.08\times10^{-6}} = 2.3\times10^5\ m/s$