PHYS 202 Spring 2019 Test #1 Name: KEY

$T_F = \frac{9}{5}T_C + 32$ $T_K = T_C + 273.15$

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

C 1. Express the temperature 22°F in K unit?
a. 72 K b. 255 K c. 268 K d. 279 K e. 295 K f. 345K

a 2. What is the difference in C° of the two temperatures, -35°F and 62°F?
a. 54 C° b. 15 C° c. 36 C° d.- 2.7 C° e. 175 C°

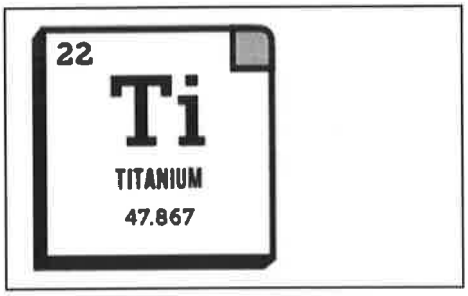
b 3. What is the thermometric property of a thermocouple?
a. Length of a liquid column b. Voltage c. Pressure of a gas
d. Infrared radiation e. Ultraviolet radiation f. Resistance

b 4. The second 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.

e 5. Conductors have free_____.
a. Protons b. Neutrons c. Atoms d. Nucleons e. Electrons

C 6. What is the shape of one of the equipotential surfaces for an isolated point charge?
a. plane b. circle c. sphere d. parabola e. ellipse

a 7. How many coulombs of positive charge are there in 1.5 kg of titanium?
($q_p = +1.6 \times 10^{-19}$C, $N_A = 6.022 \times 10^{23}$)
a. 6.64×10^{7} C b. 3.02×10^{6} C
c. 3.02×10^{7} C d. 6.64×10^{4} C



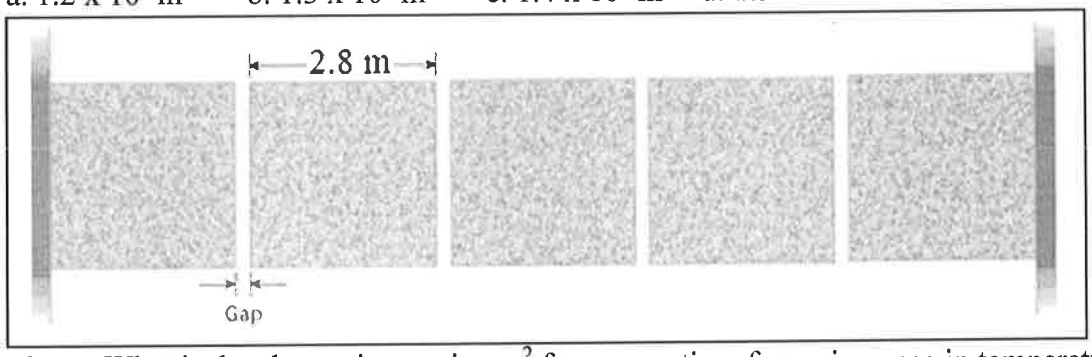
C 8. Suppose you want to heat a gas so that its temperature will be as high as possible. Under which of the following conditions will you heat?
a. constant temperature b. constant pressure c. constant volume

b 9. Which of the following has greater entropy?
a. 1 kg of ice at 0^0C b. 1 kg of water at 0^0C

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

Volume coefficient of expansion of radiator coolant = $\beta = 390 \times 10^{-6}\ (C^o)^{-1}$.
$\Delta L = \alpha L_0 \Delta T$ $\Delta A = 2\alpha A_0 \Delta T$ $\Delta V = \beta V_0 \Delta T$ $\beta = 3\alpha$, for solids.

10-11) Concrete sidewalks are always laid in sections, with gaps between each section. For example, the drawing shows five identical 2.8-m sections, the outer two of which are against immovable walls. The four identical gaps between the sections are provided so that thermal expansion will not create the thermal stress that could lead to cracks.
e 10. What is the minimum gap width necessary to account for an increase in temperature of 38 C°?
a. 1.2×10^{-3}m b. 1.3×10^{-3}m c. 1.4×10^{-3}m d. 1.5×10^{-3}m e. 1.6×10^{-3}m



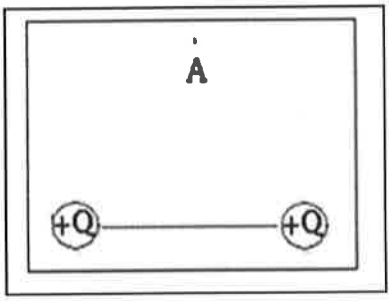
e 11. What is the change in area in cm^2 for one section, for an increase in temperature of 38 C^0?
a. 7.15×10^{-3} cm^2 b. 7.15 cm^2 c. 12.8 cm^2
d. 35.8 cm^2 e. 71.5 cm^2 f. 358 cm^2

12-14) A radiator is made of aluminum and is filled to its 25.0-L capacity when at 10.0°C. What volume of radiator coolant will overflow when the radiator and coolant reach 115^0C?
e 12. What is the change in volume of the coolant?
b 13. What is the change in volume of the radiator?
c 14. What volume of coolant will overflow?
Answers for 12-14:
a. 0.134 L b. 0.181 L c. 0.843 L d. 0.890 L e. 1.024 L f. 1.205 L

a 15. 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 16. 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



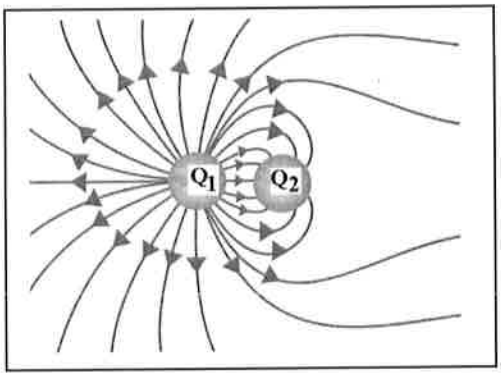
17-18) Deals with the electric field lines of two charges, magnitudes Q_1 and Q_2 as shown:

a 17. 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 18. The ratio Q_1/Q_2 is given by,

a. 1 b. 2 c. 3 d. 4 e. 5

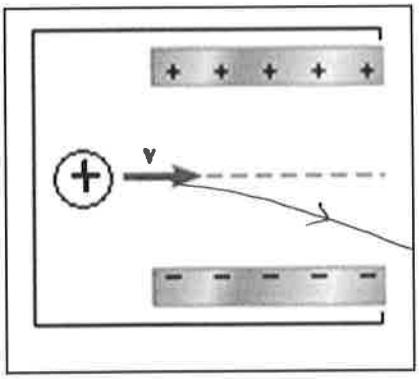


19-20 A positively charged particle of negligible mass is moving horizontally when it enters the region between the plates of a capacitor, as the drawing illustrates.

C 19. The electric field between the plates is:

a. Vertical, pointing up
d. Horizontal, pointing to the right
c. Vertical, pointing down
e. Horizontal, pointing to the left

20. Sketch the subsequent path of the charge particle in the diagram.



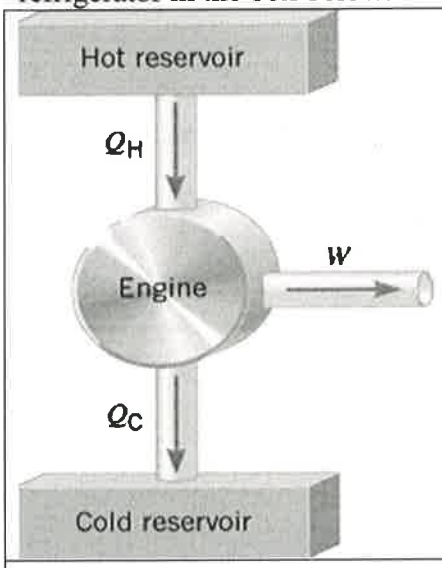
d 21. What is the magnitude and direction (use + for up and - for down) of an electric field that exerts a 4.65×10^{-5}N upward force on a -1.68 μC charge?

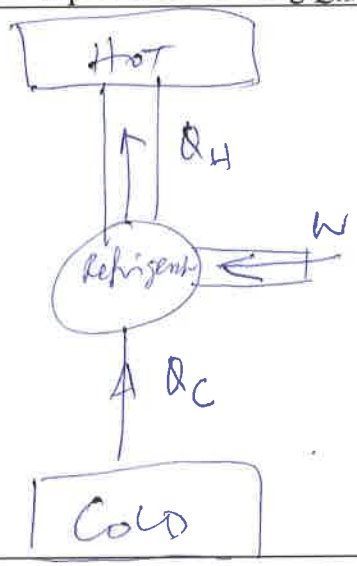
a. 2.77 N/C b. – 2.77 N/C c. 27.7 N/C d. -27.7 N/C e. 7.81 N/C f. -7.81 N/C

A 22. How many electrons are needed to form a charge of -4.6 nC?
Charge on one electron = -1.6×10^{-19}C.

a. 2.9×10^{10} b. 2.9×10^{13} c. 2.9×10^{19} d. 7.4×10^{28} e. 3.2×10^{10} f. 3.5×10^{10}

B. 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_C, *and W.*





Heat Engine	Refrigerator

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

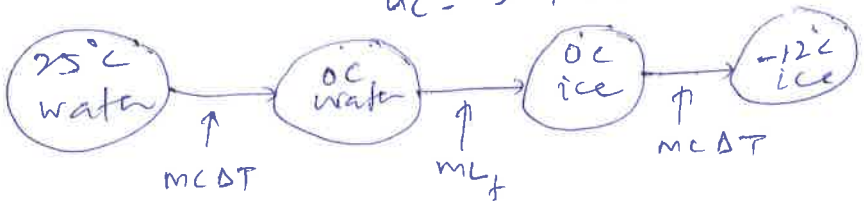
$Q = mc\Delta T$ $\quad Q = mL$ $\quad (COP)_{Refri.} = \frac{Q_C}{W}$

C. The wattage of a commercial ice maker is 125 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 2.40. The water going into the unit has a temperature of 25.0°C, and the ice maker produces ice cubes at - 12.0°C. Ignoring the work needed to keep stored ice from melting, find the maximum amount of ice that the unit can produce in three 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. Specific heat capacity of ice = 2000 J/(Kg.C^0).

$\frac{Q_C}{W} = COP \rightarrow Q_C = COP \times W = COP \times P \times t \quad (P = W/t)$

$Q_C = 2.40 \times 125 \times 3 \times 60 \times 60$

$Q_C = 3240000\,J$



$Q_C = mc\Delta T_{water} + mL_f + mc\Delta T_{ice} = 3240000$

$m[4186 \times 25 + 3.35 \times 10^5 + 2000 \times 12] = 3240000$

$m = \frac{3240000}{4186 \times 25 + 3.35 \times 10^5 + 2000 \times 12} = 6.99\,kg$

$= \frac{3240000}{463650} = 6.99\,kg$

$m_{ice} = 6.99 \simeq 7\,kg$

$\frac{N \cdot m^2}{C^2} = \frac{kg \cdot m \cdot m^2}{s^2 C^2}$

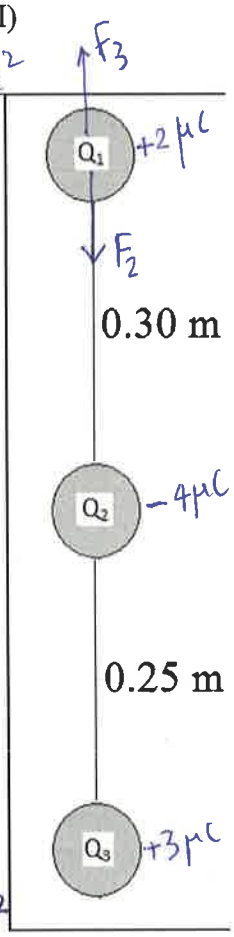
D. Coulomb's law is given by: $F = k\frac{|Q_1||Q_2|}{r^2}$ Coulomb's constant = k = 9 x 10^9 (SI)

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

2. Figure below shows three point charges that lie along the y axis in a vacuum, with no gravity. $Q_1 = +2.0\ \mu C$, $Q_2 = -4.0\ \mu C$, and $Q_3 = +3.0\ \mu C$.

a. Draw a free-body diagram for the charge Q_1.

b. Determine the magnitude and direction of the net electrostatic force on Q_1.



$F_2 = \frac{k|Q_1||Q_2|}{r^2} = \frac{9\times10^9 \times 2\times10^{-6} \times 4\times10^{-6}}{0.30^2} = 0.80\ N \downarrow$

$f_3 = \frac{k|Q_1||Q_3|}{r^2} = \frac{9\times10^9 \times 2\times10^{-6} \times 3\times10^{-6}}{0.55^2} = 0.179 N \uparrow$

net force on $Q_1 = (0.800 - 0.179)\ N \downarrow$

net force = 0.621 N ↓

$\Delta U = Q - W.$ $W = P.\Delta V$ $U = (3/2)nRT$ $PV = nRT$, $R = 8.31$ J/(mol.K).

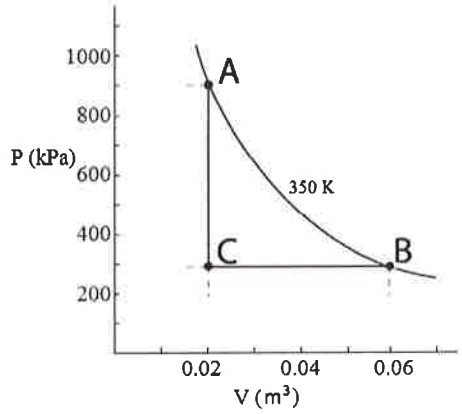
E. An ideal gas is taken through the three processes (A→B, B→C, and C→A) shown in the drawing.

1. Determine the number of moles of the gas? $PV = nRT$, $n = \frac{PV}{RT} = \frac{900\times10^3 \times 0.02}{8.31 \times 350}$

$n = 6.19\ mol$

2. Name the process **AB** isothermal and **BC** isobaric.

3. For the three processes shown in the drawing, fill in the missing entries in the table.



Process	ΔU	Q	W
A→B	a. 0	b. 20,000J	20,000 J
B→C	-18,000 J	d. −30,000J	c. −12000 J
C→A	f. 18,000J	g. 18,000J	e. 0

4. Area of the shaded shape ABC= 8000J