PHYS 202 Spring 2022 Test #1 Name: Key

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

45 A. Select the correct answer for the following multiple-choice questions and write your answer in the line next to the question number.

$-67 = \frac{9}{5}T_C + 32$

e 1. Express the temperature - 67°F in the K unit?
a. 254 b. 258 c. 328 d. 292 e. 218 $-67-32 = \frac{9}{5}T_C$

b 2. What is the difference in F° of the two temperatures, -15°C and 9°F? $-99 = \frac{9}{5}T_C \rightarrow T_C = -55$
a. 2 b. 4 c. 5 d. 6 e. 24 $T_K = -55 + 273$

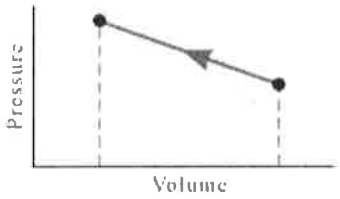
$T_F = \frac{9}{5}(-15) + 32 = 5°F$ $T_K = 218$

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

d 4. The zeroth 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 5. 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

c 6. The drawing shows a pressure-volume graph for a gas being compressed. The area under the curve represents _____



a. the change in the internal energy of the gas.
b. the work done *by* the gas.
c. the work done *on* the gas.
d. the heat gained by the gas.
e. the heat lost by the gas.

b 7. Which one of the following is the correct order of the four strokes of the internal combustion gasoline engine:
a. Power, Intake, Compression, Exhaust b. Intake, Compression, Power, Exhaust
c. Intake, Power, Compression, Exhaust d. Compression, Intake, Power, Exhaust
e. Exhaust, Compression, Intake, Power f. Exhaust, Power, Intake, Compression

A 8. An object is charged by contact using a positively charged rod. What type is the charge on the charged object?

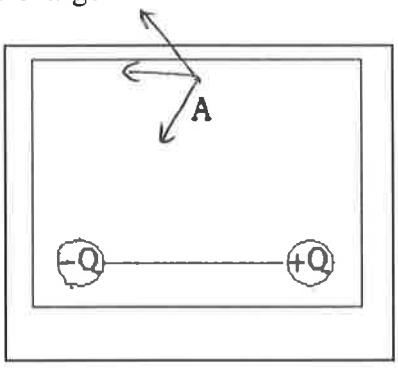
A 9. An object is charged by induction using a negatively charged rod. What type is the charge on the charged object?

Answers for 8 -9: A. Positive B. Negative C. No charge

D 10. Two 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



11-12) Deals with the electric field lines of two charges, magnitudes A and B as shown:

C 11. The polarities of the charges are,

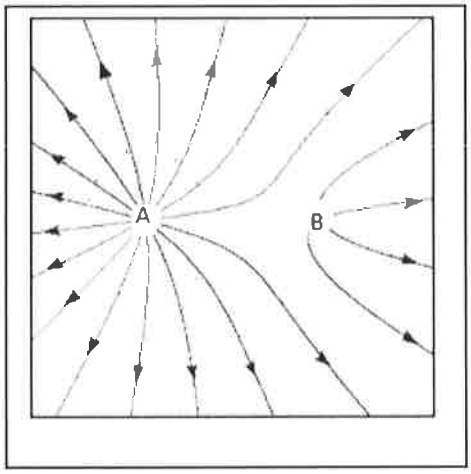
a. A is positive and B is negative

b. B is positive and A is negative

c. Both are positive d. Both are negative

d 12. The ratio A/B is given by,

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



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

13-15) Most automobiles have a coolant reservoir to catch radiator fluid that may overflow when the engine is hot. A radiator is made of copper and is filled to its 17.0-L capacity at 10.0 ^{0}C. The operating temperature of the radiator and fluid is 92.0 ^{0}C.

Radiator fluid's volume coefficient of expansion is $\beta = 400\times10^{-6}/°C$

The linear coefficient of thermal expansion for copper is: $\alpha_{copper} = 17\text{x}10^{-6}(C^o)^{-1}$

e 13. What is the change in volume of the coolant? $\Delta V = \beta V_0 \Delta T = 400\times10^{-6} \times 17 \times 82 = 0.558$

b 14. What is the change in volume of the radiator? $\Delta V = 3\alpha V_0 \Delta T = 3\times17\times10^{-6}\times17\times82 = 0.071$

c 15. What volume of radiator fluid will overflow? $0.558 - 0.071$

Answers for 13-15

a. 0.0.024L b. 0.071L c. 0.487L d. 0.534L e. 0.558L f. 0.629L

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

2

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

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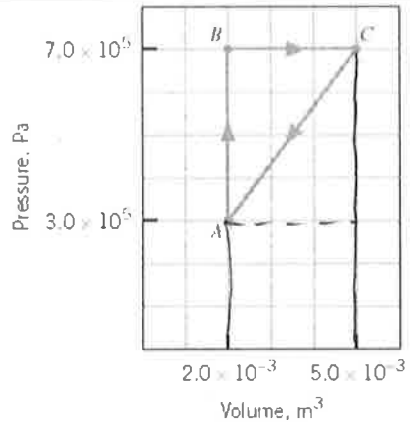

B→C: $7\times10^5 \times 3\times10^{-3} = 2100$

Process	W	Q	ΔU
A→B	a. 0	+2,500 J	b. 2500 J
B→C	c. 2100 J	d. 5600 J	+3500 J
C→A	e. −1500 J	g. −7500 J	f. −6000 J

C→A: $3\times10^5 \times 3\times10^{-3} + \frac{1}{2} \times 3\times10^{-3} \times 4\times10^5$
$= 900 + 600 = 1500$

C. $Q = mc\Delta T$ $\quad Q = mL$

Specific heat of water = 4186 J/(kg.K), Specific heat of ice = 2000 J/(kg.K), Latent heat of fusion of ice = 33.5 x 10^4 J/kg.

C1. Researchers are developing heated airport runways to melt ice and snow quickly to avoid long delays. How much heat is necessary to melt 35 kg of ice at -15°C? Express your answer in MJ with 2 significant figures.

6

$Q = mc\Delta T + mL_f$

$Q = 35 \times 2000 \times (0-(-15)) + 35 \times 33.5 \times 10^4$

$Q = 35 \times 2000 \times 15 + 35 \times 335 \times 10^4$

$Q = 1{,}050{,}000 + 11725000$

$Q = (1.05 + 11.7)$ MJ $= 13$ MJ

C2. An unknown metal alloy of mass 0.15 kg is submerged in ice-water mixture until the metal reaches the freezing point of water. This metal is quickly transferred to 0.25 kg of water at 28°C. The final equilibrium temperature is 21°C. Determine the specific heat of the unknown metal?

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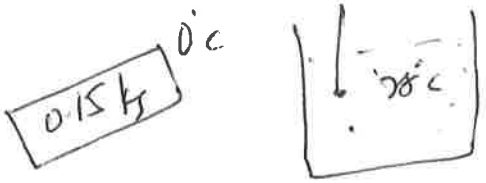
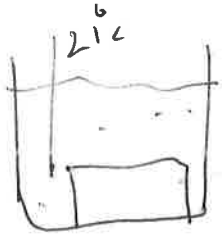




Heat gain by metal = Heat loss by water

$mc\Delta T = mc\Delta T$

$0.15 \times C \times (21-0) = 0.25 \times 4186 \times (28-21)$

$0.15 \times C \times 21 = 0.25 \times 4186 \times 7$

$C = \frac{0.25 \times 4186 \times 7}{0.15 \times 21} = 2325$ J/kg K

$C_m = 2325 \frac{J}{kg.K}$

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

2 1. Express the SI unit of the Coulomb's constant: Nm^2/C^2

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

2 a. Draw a free-body diagram for the charge q_3.

b. Determine the magnitude and direction of the net electrostatic force on q_3.

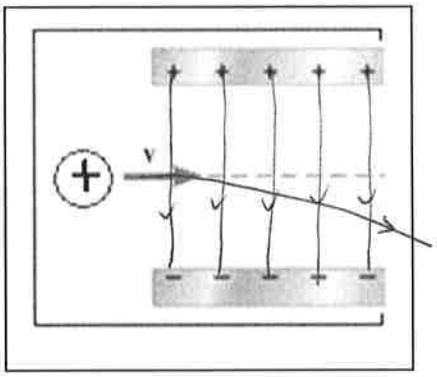
4 $F_1 = \frac{k|Q_1||Q_3|}{r^2} = \frac{9\times10^9 \times 5\times10^{-6} \times 7\times10^{-6}}{0.5^2} = 1.26\,N \leftarrow$

4 $F_2 = \frac{k|Q_2||Q_3|}{r^2} = \frac{9\times10^9 \times 3\times10^{-6} \times 7\times10^{-6}}{0.3^2} = 2.10\,N \rightarrow$

2 net force = $(2.10 - 1.26) \rightarrow$

net force on q_3 = $0.84\,N \rightarrow$

E. Figure below shows an alpha particle passing between two charged metal plates that create an electric field of 2.0×10^{25} N/C, perpendicular to the particle's initial horizontal velocity. The initial speed of the particle is 2.2×10^6 m/s, and the horizontal distance it travels in the uniform field is 9.0 cm.



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

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

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

3 $x = vt, \quad t = \frac{x}{v} = \frac{9\times10^{-2}}{2.2\times10^6} = 4.09\times10^{-8}\,s$

(d) What is the vertical acceleration of the alpha particle? [$m_\alpha = 6.64 \times 10^{-7}$kg, $q_\alpha = 3.2 \times 10^{-19}$C]

3 $a = \frac{F}{m} = \frac{qE}{m} = \frac{3.2\times10^{-19} \times 2\times10^{25}}{6.64\times10^{-7}} = 0.964\times10^{13}\ m/s^2$

$a = 9.64\times10^{12}\ m/s^2$

(e) What is the vertical deflection of the alpha particle?

3 $y = v_{0y}t + \frac{1}{2}a_y t^2$

$= 0 + \frac{1}{2} \times 9.64\times10^{12} \times (4.09\times10^{-8})^2 = 80.6\times10^{-4}\,m$

$y = 8.06\times10^{-3}\,m = 0.806\,cm$