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PHYS 202 Spring 2018 Test #1 Name: KEY

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

3 pts each

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

$4.2 = \frac{9}{5}T_C + 32 \rightarrow T_C = -15.4^\circ C$

$T_K = T_C + 273$

$= -15.4 + 273$

$T_K = 257.55$

b 1. Express the temperature 4.2°F in the K unit?

a. 223 b. 258 c. 275 d. 277 e. 313

c 2. What is the difference in C° of the two temperatures, -45°F and 63°F?

a. 42 b. 10 c. 60 d.- 7.8 e. 194

$\Delta T_F = 63 - (-45) = 108$

$\Delta T_C = \frac{5}{9}\Delta T_F = 60$

g 3. What is the thermometric property of a resistance thermometer?

c 4. What is the thermometric property of a constant volume gas thermometer?

Answers for 3 & 4

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

d. Infrared radiation e. Ultraviolet radiation f. Resistance

d 5. The zeroth law of thermodynamics is,

e 6. The third law of thermodynamics is,

Answers for 5 & 6

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.

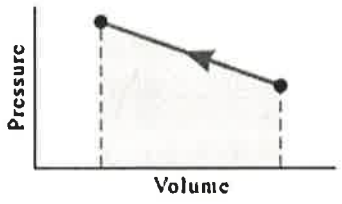
d. If two systems individually in thermal equilibrium with a third system, then the two systems are in thermal equilibrium with each other.

e. It is not possible to lower the temperature of any system to absolute zero in a finite number of steps.

b 7. 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 8. The drawing shows a pressure-volume graph for a gas being compressed. The area under the curve represents _____

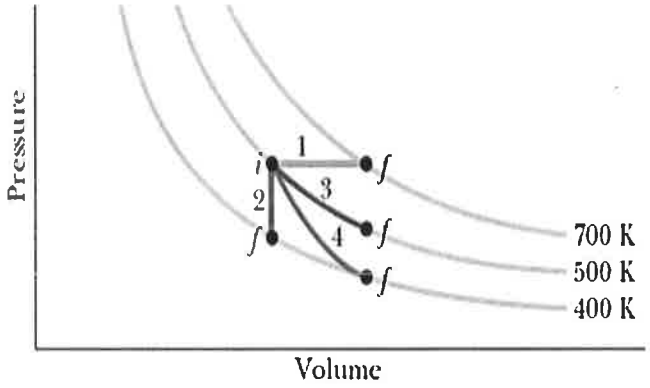


a. the change in the internal energy of the gas.
b. the work done *by* the gas.
c. the work done *on* the gas.
d. the heat gained by the gas.
e. the heat lost by the gas.

__e__ 9. In thermodynamics the collection of objects upon which attention is being focused is called the ***system,*** while everything else in the environment is called the ***surroundings.*** What is the system for an automobile engine?
a. Engine b. Radiator c. Wheels d. Body e. burning gasoline/air mixture

__a__ 10. Walls that permit heat to flow through them are called,
a. *diathermal walls* b. *adiabatic walls.*

__c__ 11. Identify the isothermal expansion below:
__d__ 12. Identify the adiabatic expansion below:
Answers for 11 & 12
a. 1 b. 2 c. 3 d. 4



__b__ 13. 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

__c__ 14. Conductors have free_____.
A. Protons B. Neutrons C. Electrons D. Nucleons E. Atoms

__A__ 15. An object is charged by contact using a positively charged rod. What type is the charge on the charged object?
__B__ 16. An object is charged by induction using a positively charged rod. What type is the charge on the charged object?
Answers for 15 -16:
A. Positive B. Negative C. No charge

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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

8 B. 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 18.0-L capacity at 5.0 °C. What volume of radiator fluid will overflow when the radiator and fluid reach their 95.0°C operating temperature?

Radiator fluid's volume coefficient of expansion is $\beta = 400 \times 10^{-6}/°C$

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

3 $\Delta V_{coolant} = \beta V_0 \Delta T = 400 \times 10^{-6} \times 18 \times (95-5) = 0.648\,L$

3 $\Delta V_{radiator} = 3\alpha V_0 \Delta T = 3 \times 17 \times 10^{-6} \times 18 \times (95-5) = 0.0826\,L$

Overflow = 0.648 − 0.0826

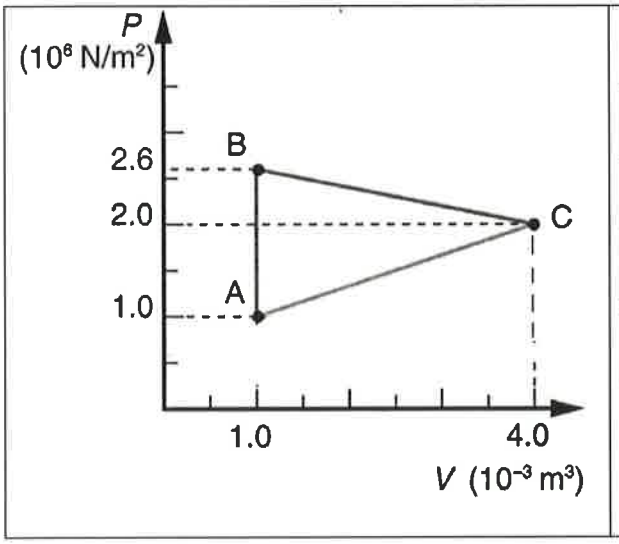
2 overflow = 0.565 L

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

1. Name the process **AB** Isochoric or Isovolumetric

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

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



Process	W	Q	ΔU
A→B	a. 0	+2,500 J	b. 2500 J
B→C	c. 6900 J	d. 10,000 J	+3100 J
C→A	e. −4500 J	g. −10,100 J	f. −5600 J

$W_{C\to A} = -[REC. + TRIAN.]$

$= -[1 \times 10^{6} \times 3 \times 10^{-3} + \frac{1}{2} \times 1 \times 10^{6} \times 3 \times 10^{-3}]$

$= -[3000 + 1500] = -4500\,J$

$W_{B\to C} = REC. + TRIAN.$

$= 3 \times 10^{-3} \times 2 \times 10^{6} + \frac{1}{2} \times 0.6 \times 10^{6} \times 3 \times 10^{-3}$

$= 6000 + 900$

$= 6900\,J$

D. $Q = mc\Delta T$ $Q = mL$

(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)

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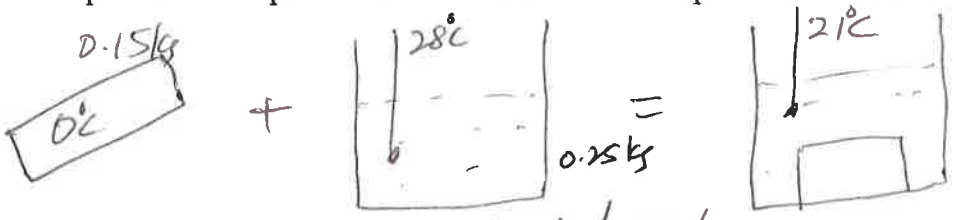
D1. An unknown metal alloy of mass 0.15 kg is submerged in ice-water mixture until the metal reaches the freezing point of water. This metal is quickly transferred to 0.25 kg of water at 28°C. The final equilibrium temperature is 21°C. Determine the specific heat of the unknown metal?



Heat gain by Metal = Heat loss by water

$mc\Delta T = mc\Delta T$

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

$C = \frac{0.25 \times 4186 \times 7}{0.15 \times 21} = 2326$

$C = 2326 \frac{J}{kg.K}$

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D2. 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 3 significant figures.

$Q = mc\Delta T + mL_f$

$Q = 35 \times 2000 \times 15 + 35 \times 33.5 \times 10^4$

$Q = 1050000 + 11725000$

$Q = 12775000 J$

$Q = 12.775 MJ$

$Q = 12.8 MJ$

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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/equation involving Q_H, Q_L, *and W.*

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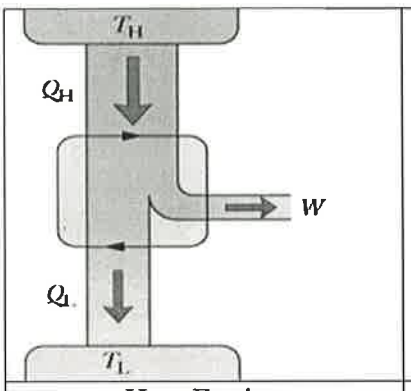
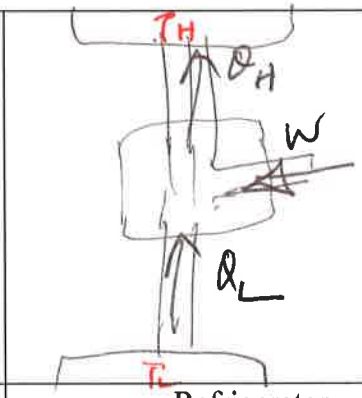
Heat Engine	Refrigerator	Expression/equation involving Q_H, Q_L, *and W.*
		$Q_H = Q_L + W$

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

1. Express the SI unit of the Coulomb's constant: $\frac{N \cdot m^2}{C^2} = \frac{kg \cdot \frac{m}{s^2} \cdot m^2}{C^2} = \frac{kg \cdot m^3}{s^2 C^2}$ 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_3.

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

2

$$F_{31} = \frac{k|Q_3||Q_1|}{r^2} = \frac{9\times10^9 \times 7\times10^{-6} \times 5\times10^{-6}}{0.5^2} = 1.26\ N \leftarrow$$ 3

$$F_{32} = \frac{k|Q_3||Q_2|}{r^2} = \frac{9\times10^9 \times 7\times10^{-6} \times 3\times10^{-6}}{0.3^2} = 2.1\ N \rightarrow$$ 3

$$F_{3\,net} = (2.1 - 1.26)\ N \rightarrow$$ 3

$$F_{3\,net} = 0.84\ N \rightarrow$$