Some constants: \( R = 8.314 \text{J/mole} \cdot \text{K} \quad k = 1.38 \times 10^{-23} \text{J/K} \quad N_A = 6.022 \times 10^{23} \) (to convert: 4.184 J/cal)

For water: \( L_f = 80 \text{cal/gram} \quad L_v = 540 \text{cal/gram} \quad c = 1 \text{cal/gm} \cdot ^\circ \text{C} \)

PHY205s14 Exam 1: Name: __________________________

___ 1. The highest and lowest temperatures ever recorded in the United States are 134ºF (California, 1913) and -80ºF (Alaska, 1971). What are these temperatures in kelvins?
   A) 407 K and 193 K
   B) 330 K and 211 K
   C) 347 K and 228 K
   D) 340 K and 300 K
   E) 365 K and 246 K

___ 2. What mass of He gas occupies 8.5 liters at 0°C and 1 atmosphere? (The molar mass of He = 4.00 g/mol.)
   \( R = 8.314 \text{J/mol} \cdot \text{K} = 1.987 \text{cal/mol} \cdot \text{K} = 0.08206 \text{L atm/mol} \cdot \text{K} \).
   A) 10.5 g
   B) 0.66 g
   C) 2.6 g
   D) 0.38 g
   E) 1.52 g

___ 3. Inside a sphere of radius 12 cm are \( 8.0 \times 10^{23} \) gas molecules at a temperature of 50ºC. What pressure do the gas molecules exert on the inside of the sphere?
   A) \( 650 \times 10^3 \text{Pa} \)
   B) \( 370 \times 10^3 \text{Pa} \)
   C) \( 76.0 \times 10^3 \text{Pa} \)
   D) \( 160 \times 10^3 \text{Pa} \)
   E) \( 490 \times 10^3 \text{Pa} \)

___ 4. A mass of air is at pressure \( P \) and volume \( V \) at 1ºC. When it is made to occupy half this volume at three times this pressure, its temperature becomes approximately
   A) 411ºC
   B) 0.67ºC
   C) 1.5ºC
   D) 6ºC
   E) 411 K

___ 5. A 1 L container contains \( \text{O}_2 \) gas at STP. If the diameter of the \( \text{O}_2 \) molecule is \( 3.75 \times 10^{-10} \text{m} \), the mean free path of the \( \text{O}_2 \) molecule is
   A) \( 5.96 \times 10^{-8} \text{m} \)
   B) \( 6.53 \times 10^{-8} \text{m} \)
   C) \( 4.57 \times 10^{-8} \text{m} \)
   D) \( 6.89 \times 10^{-8} \text{m} \)
   E) \( 7.67 \times 10^{-8} \text{m} \)

___ 6. If both the temperature and the volume of an ideal gas are doubled, the pressure is
   A) increased by a factor of 4.
   B) doubled also.
   C) unchanged.
   D) diminished by a factor of \( \sqrt[4]{4} \).
   E) None of these is correct.

___ 7. An ideal gas whose original temperature and volume are 27ºC and 0.283 m³ undergoes an isobaric expansion. If the final temperature is 87ºC, then the final volume is approximately
   A) 0.0340 m³
   B) 0.0552 m³
   C) 0.170 m³
   D) 0.340 m³
   E) 1.45 m³

___ 8. Body A has twice the mass and three times the specific heat of body B. They are supplied with equal amounts of heat. Body A experiences a temperature change \( \Delta T \). What change in temperature is experienced by body B?
   A) \( \Delta T \)
   B) 3\( \Delta T \)/2
   C) 2\( \Delta T \)/3
   D) 6\( \Delta T \)
   E) \( \Delta T \)/2

___ 9. If the heat given off by 300 g of an alloy as it cools through 50ºC is sufficient to raise the temperature of 300 g of water from 30º to 40ºC, the specific heat of the alloy must be approximately
   A) \( 0.015 \text{cal/g} \cdot ^\circ \text{C} \)
   B) \( 0.10 \text{cal/g} \cdot ^\circ \text{C} \)
   C) \( 0.15 \text{cal/g} \cdot ^\circ \text{C} \)
   D) \( 0.20 \text{cal/g} \cdot ^\circ \text{C} \)
   E) \( 0.50 \text{cal/g} \cdot ^\circ \text{C} \)
10. A small lake has a surface area of 10000 m$^2$. Assuming that the average depth of the lake is 2 m, how much heat is released when the average temperature of the water in the lake drops by 1°C?

A) $8.36 \times 10^7$ J  
B) $8.36 \times 10^8$ J  
C) $2.0 \times 10^9$ J

11. How much internal energy is contained in 1 mole of monatomic gas at STP?

A) zero  
B) 1.13 kJ  
C) 2.26 kJ  
D) 3.40 kJ  
E) 5.65 kJ

12. The pressure of a gas in an isobaric expansion remains constant. In such an expansion,

A) no work is done.  
B) work is done by the gas.  
C) work is done on the gas.  
D) "isobaric" and "expansion" are contradictory terms.  
E) work is or is not done depending on whether the temperature of the gas changes.

13. The equation of state for a certain gas under isothermal conditions is

$$PV = 31.2,$$

where the units are SI. The work done by this gas as its volume increases isothermally from 0.2 m$^3$ to 0.8 m$^3$ is approximately

A) 2.86 J  
B) 28.6 J  
C) 43.3 J  
D) 71.8 J  
E) 115 J

14. A system is said to go through an adiabatic process if, throughout the process,

A) it maintains a constant ratio of pressure to temperature.  
B) it remains at a constant temperature.  
C) it loses no heat to its surroundings and gains none from them.  
D) its total energy increases.  
E) it does no work on its surroundings.

15. The first law of thermodynamics has as its basis the same fundamental principle as

A) the continuity principle.  
B) conservation of energy  
C) Newton's law of universal gravitation.  
D) static equilibrium.  
E) the conservation of linear momentum.
Answer Key

1. B 5(134-32)/9 + 273 = 330K, 5(-80-32)/9 + 273 = 211K
2. E \(1\text{atm}(8.5\text{L})=n(0.08206\text{L atm/mole K})(273\text{K})\), \(n=3974\text{mole}\), \(m=3974\text{mole}(4\text{g/mole})=1.52\text{g}\)
3. E \(V=4\pi(.12\text{m})^3/3=0.007238\text{m}^3\), \(p=8\times10^5(1.38\times10^{-23}\text{J/K})(273+50)/0.007238\text{m}^3=4.93\times10^7\text{Pa}\)
4. E \(274K/PV = T/(3P)(\frac{1}{2}V)\) \(T=1.5(274K)=411K\)
5. A \(\lambda=1/n_0 \sqrt{2 \pi d^2}=kT/P\sqrt{2 \pi d^2} = (1.38\times10^{-23}\text{J/K})(273\text{K})/1.01\times10^5\text{Pa}\sqrt{2 \pi (3.75\times10^{-10}\text{m})^2} = 5.97\times10^{-8}\text{m}\)
6. C \(P_1V_1/T_1 = P_2V_2/T_2\) \(P_2 = P_1\)
7. D \(P(.283\text{m}^3)/(273+27)\text{K}=PV/(273+87)\text{K}\) \(V_2 = .340\text{m}^3\)
8. D \(Q=mc\Delta T = 2m_0(3.3\text{cal/g.C}))(\Delta T) = 6m_0c_\text{A}B\Delta T\) \(Q = m_0c_\text{A}B\Delta T = 6m_0c_\text{A}B\Delta T = 6\Delta T\)
9. D \(300\text{g(C)(50C)}=300\text{g(1cal/g.C)(10C)}\) \(C=2\text{cal/g.C}\)
10. A \(2\times10^3\text{m}^3(1\text{g/cm}^3)(100\text{cm/m})(1\text{cal/g.C})(1\text{C})=2\times10^3\text{cal}(4.184\text{J/cal})=8.36\times10^3\text{J}\)
11. D \(1.5nRT=1.5(1\text{mole})(8.314\text{J/mole K})(273\text{K})=3405\text{J}\)
12. B \(W_\text{by}=p\Delta V\)
13. C \(W=\text{mRTln(V)_2/V_1)} = PV \text{ln(V)_2/V_1)} = 31.2\text{ln}(8/2) = 43.3\text{J}\)
14. C \(Q=0\)
15. B conservation of energy