$$T\left(^oC\right)=\frac{5}{9}\left(T\left(^oF\right)-32\right)$$

$$T\left(K\right)=T\left(^oC\right)+273.15$$

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

$$\Delta V=\beta V_0\Delta T$$

$$Q=mc\Delta T=nC\Delta T$$

$$Q_{F/V}=\pm mL_{F/V}$$

$$H=\frac{dQ}{dt}=k\frac{A}{L}\left(T_H-T_C\right)$$

$$pV=nRT$$

$$K_{tr}=\frac{3}{2}nRT$$

$C_V=\frac{3}{2}R$ ideal monatomic gas

$C_V=\frac{5}{2}R$ ideal diatomic gas w/o vibration

$$W=\int_{V_1}^{V_2}pdV$$

$$\Delta U=Q-W$$

$$e=\frac{W}{Q_H}=1-\left|\frac{Q_C}{Q_H}\right|$$

$$e_{Carnot}=1-\left|\frac{T_C}{T_H}\right|$$

$$\Delta S=\int_1^2\frac{dQ}{T}$$

$$S=k\ln w$$

$$R=8.314\,J/mol\cdot K$$

$$N_A=6.02\times10^{23}\,molecules/mole$$

1 atm = 101 325 N / (m^2)

Physics 161-001 Spring 2012 Exam 1

Name: _____ Box#_____

SHOW ALL WORK!

Multiple Choice (5 points each):

1) A surveyor's 100 ft steel tape is correct at 20°C. On a cold day, at 10°C, the tape has shrunk to 99.98 ft. On a very hot day, at 40°C, the tape indicates a distance of 48.32 ft between two points. The true distance between those points is closest to:

A) 48.33 ft
B) 48.34 ft
C) 48.29 ft
D) 48.30 ft
E) 48.31 ft

2) 125 cm^3 of an ideal gas is at 10°C. It is cooled at constant pressure to 1°C. It will now occupy:

A) 129.6 cm^3
B) 121.0 cm^3
C) 12.5 cm^3
D) 100.0 cm^3
E) 283.0 cm^3

3) The pressure of an ideal gas is halved during a process in which the heat taken in by the gas equals the work done by the gas. As a result, the volume of the gas is:

A) doubled.
B) halved.
C) unchanged.
D) need more information to answer.
E) nonsense, the process is impossible.

4) A heat engine:

A) converts work to an equivalent amount of heat.
B) takes in heat, does work, and rejects heat.
C) uses positive work done on the system to transfer heat from a low temperature reservoir to a high temperature reservoir.
D) converts heat input to an equivalent amount of work.
E) uses positive work done on the system to transfer heat from a high temperature reservoir to a low temperature reservoir.

5) A hot object and a cold object are placed in thermal contact and the combination is isolated. They transfer energy until they reach a common temperature. The change ΔS_h in the entropy of the hot object, the change ΔS_c in the entropy of the cold object and the change ΔS_{total} in the entropy of the combination are:

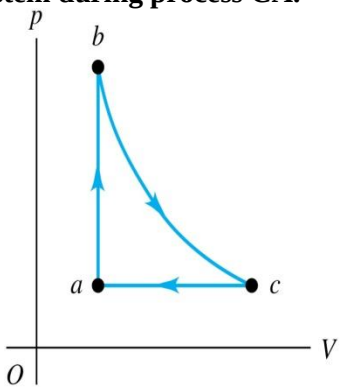
A) $\Delta S_h > 0$, $\Delta S_c < 0$, $\Delta S_{total} < 0$
B) $\Delta S_h > 0$, $\Delta S_c > 0$, $\Delta S_{total} > 0$
C) $\Delta S_h < 0$, $\Delta S_c > 0$, $\Delta S_{total} < 0$
D) $\Delta S_h < 0$, $\Delta S_c > 0$, $\Delta S_{total} > 0$
E) $\Delta S_h > 0$, $\Delta S_c < 0$, $\Delta S_{total} > 0$

6) Two thermodynamic states of an ideal gas have the same internal energy E_{int}. This means that:

A) The entropy of the two states must be the same.
B) The temperatures of the two states must be the same.
C) The pressures of the two states must be the same.
D) The volumes of the two states must be the same.
E) All of the above.

7) An ideal gas in a chamber passes through the cycle shown below. The heat Q_{AB} added during process AB is 35.0J, no heat is transferred during process BC, and the net work done in the cycle is 25.0J. Determine the net heat added to the system during process CA.

A) 10 J
B) 60J
C) 15 J
D) -10J
E) -60J



8) The heat capacity of an object is:

A) the change in its temperature caused by adding 1 J of heat.
B) the ratio in its specific heat to that of water.
C) the amount of heat energy per kilogram needed to raise its temperature by 1 degree C.
D) the amount of heat energy needed to change its state without changing its temperature.
E) the amount of heat energy needed to raise its temperature by 1 degree C.

9) The "Principle of Equipartition of Energy" states that the internal energy of a gas is shared equally:

A) among the molecules
B) between kinetic and potential energy
C) among the relevant degrees of freedom
D) between translational and vibrational kinetic energy
E) between temperature and pressure

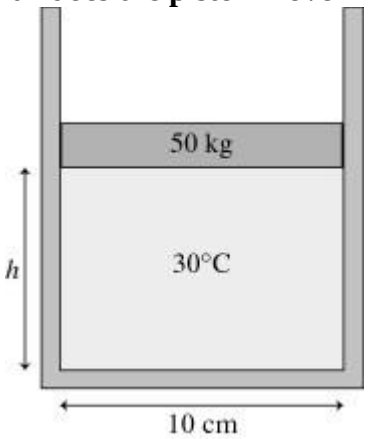
10) A heat conducting rod, 1.2 m long, is made of an aluminum section that is 0.6 m long and a copper section that is 0.6 m long. Both sections have cross-sectional areas of 0.00040 m^2. The aluminum end and the copper end are maintained at temperatures of 20°C and 270°C, respectively. The thermal conductivity of aluminum is 205 W/m·K of copper is 385 W/m·K. The rate at which heat is conducted in the rod is closest to:

A) 15 W.
B) 17 W.
C) 23 W.
D) 19 W.
E) 22 W.

11) The average molecular translational kinetic energy of a gas can be determined by knowing

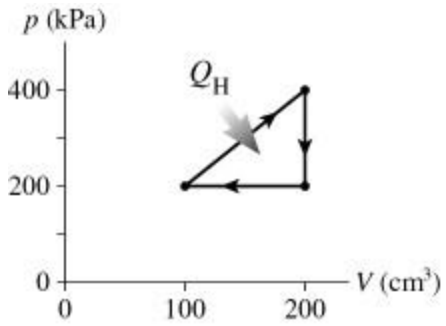
A) only the pressure of the gas.
B) only the number of molecules in the gas.
C) only the volume of the gas.
D) only the temperature of the gas.
E) All of the above quantities must be known to determine the average molecular kinetic energy.

12) The figure shows a 50-kg frictionless cylindrical piston that floats on 0.25 mol of compressed air at 30°C. The cylinder above the piston is open to air at 1 atm. How far does the piston move if the temperature is increased to 300°C?



A) 40 cm
B) 36 cm
C) 44 cm
D) 50 cm
E) 55 cm

13) The graph in the figure shows a cycle for a heat engine for which Q_H = 68 J. What is the thermal efficiency of this engine?

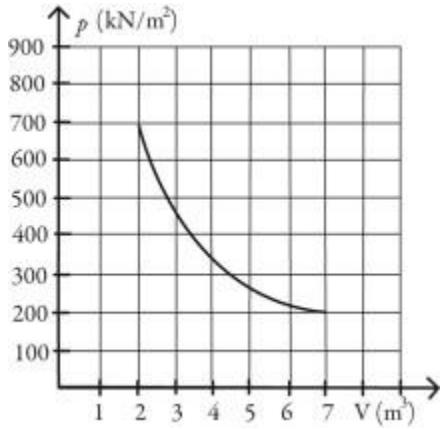


A) 29 %
B) 12 %
C) 7.4 %
D) 15 %
E) 20%

14) A Carnot engine operates between a high temperature reservoir at 428 K and a river with water at 285 K. If it absorbs 2700 J of heat each cycle, how much work per cycle does it perform?

A) 806 J
B) 1798 J
C) 1621 J
D) 902 J
E) 1079 J

15) What is the change in entropy of 6.8 moles of *ideal* monatomic gas that reversibly undergoes the isothermal expansion shown in the figure? The ideal gas constant is R = 8.314 J/(mol·K).



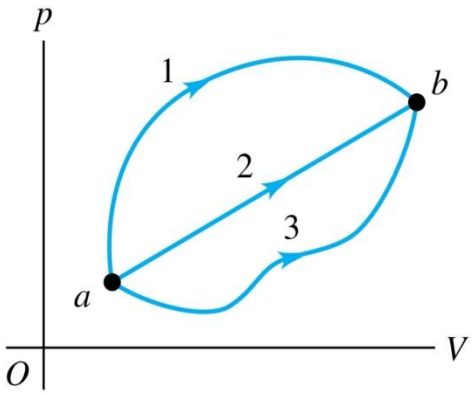
A) 104 J/K
B) 63.1 J/K
C) 70.7 J/K
D) 90.8 J/K
E) 45.2 J/K

16) An engine manufacturer makes the claim that the engine they have developed will, on each cycle, take 100 J of heat out of boiling water at 100 ^{o}C, do mechanical work of 80 J, and exhaust 20 J of heat at 10 ^{o}C. What, if anything, is wrong with this claim?

A) An engine would operate by taking in heat at the lower temperature and exhausting heat at the higher temperature.
B) This engine violates the first law of thermodynamics because 100 J + 20 J ≠ 80 J.
C) The heat exhausted must always be greater than the work done according to the second law of thermodynamics.
D) There is nothing wrong with this claim because 100 J = 80 J + 20 J.
E) The efficiency of this engine is greater than the ideal Carnot cycle efficiency.

17) A system can be taken from state a to state b along any of the three paths shown in the p-V diagram. If state b has greater internal energy than state a, along which path is the absolute value |Q| of the heat transfer the greatest?

A) path 1
B) path 2
C) path 3
D) |Q| is the same for all three paths.
E) not enough information given to decide



18) You have 1.00 mol of an ideal monatomic gas and 1.00 mol of an ideal diatomic gas whose molecules can rotate. Initially both gases are at room temperature. If the same amount of heat flows into each gas, which gas will undergo the greatest increase in temperature?

A) the monatomic gas
B) the diatomic gas
C) Both will undergo the same temperature change.
D) The answer depends on the molar masses of the gases.