WebAssign
CH12-HW04-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
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Current Score : 18 / 18 **Due :** Tuesday, April 24 2012 11:59 PM EDT

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1. 3/3 points | Previous Answers MI3 12.7.X.049

Consider the exponential function e^{-x}. Evaluate this function for the following values of x.

e^{-1} = 0.36788 ✓
e^{-1000} = 0 ✓
$e^{-0.0001}$ = 0.9999 ✓

- *Read the eBook*
- Section 12.7

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2. 2/2 points | Previous Answers MI3 12.7.X.050

At room temperature (293 K), calculate k_BT in joules and eV:

k_BT = 4.0434e-21 ✓ J
k_BT = 2.529125e-2 ✓ eV

- *Read the eBook*
- Section 12.7

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3. 1/1 points | Previous Answers MI3 12.8.X.052

Which of the following statements are true concerning the energy (excluding rest energy) of a mole of helium and a mole of nitrogen (N_2) at room temperature? (The "translational" kinetic energy of one atom or molecule is $(1/2)Mv^2$, where M is the mass of the atom or molecule, and v is the speed of its center of mass.)

- ☐ The helium has more energy because none of the thermal energy is used up in rotational or vibrational excitations.
- ☑ The translational kinetic energy is the same for the helium and the nitrogen.
- ☐ The helium has more energy because the helium atoms move faster.
- ☑ The nitrogen has more energy because rotational and vibrational energy levels may be excited.

✓

- *Read the eBook*
- Section 12.8

4. 1/1 points | Previous Answers MI3 12.7.X.053

Which of the following are true about the Boltzmann factor $e^{-\Delta E/(k_B T)}$, where ΔE is the energy above the ground state?

- [x] Even at high temperature, when many energy levels are excited, the ground state ($\Delta E = 0$) is the most populated state.
- [ ] $e^{-\Delta E/(k_B T)}$ tends to zero as T gets larger and larger.
- [x] $e^{-\Delta E/(k_B T)}$ is small when ΔE is large.
- [x] $e^{-\Delta E/(k_B T)}$ is small at low temperature T.

- *Read the eBook*
- Section 12.7

5. 2/2 points | Previous Answers MI3 12.7.X.058

A gas is made up of diatomic molecules. At temperature T_A, the ratio of the number of molecules in vibrational energy state 2 to the number of molecules in the ground state is measured, and found to be 0.33. The difference in energy between state 2 and the ground state is ΔE_2. Which of the following conclusions is correct?

- ( ) $\Delta E_2 \ll k_B T_A$
- (•) $\Delta E_2 \approx k_B T_A$
- ( ) $\Delta E_2 \gg k_B T_A$

At a different temperature T_B, the ratio is found to be 9e-05. Which of the following is true?

- ( ) $\Delta E_2 \approx k_B T_B$
- (•) $\Delta E_2 \gg k_B T_B$
- ( ) $\Delta E_2 \ll k_B T_B$

- *Read the eBook*
- Section 12.7

6. 3/3 points | Previous Answers MI3 12.8.X.059

Marbles of mass M = 8 grams = 0.008 kg are placed on the floor at room temperature (about 20° C = 293 K). They are of course in thermal equilibrium with their surroundings. What is a typical height above the floor for one of these marbles? That is, for what value of y is $Mgy \approx k_BT$?

typical height ≈ 5.1574e-20 ✓ m

Viruses of mass $M = 5\times10^{-20}$ kg are placed on the floor at room temperature. What is a typical height above the floor for one of these viruses?

typical height ≈ 8.252e-3 ✓ m

Atoms of mass $M = 3\times10^{-26}$ kg are placed on the floor at room temperature. What is a typical height above the floor for one of these atoms?

typical height ≈ 1.375e4 ✓ m

- *Read the eBook*
- Section 12.8

7. 4/4 points | Previous Answers MI3 12.8.P.063

Atmosphere at very high altitudes

In previous work we somewhat arbitrarily considered empty space to start at a height of 50 kilometers above the surface of the Earth.

(a) At this altitude, what is the density of the air as compared to the density at sea-level? (Assume that the temperature at this altitude is 7°C, and the mass of one mole of air is 29 g. Enter your answer as a whole number, rather than a fraction.)

The density of air at 50 km is 446 ✓ times

less than the density at sea-level. ✓

(b) Approximately how many air molecules are there in one cubic centimeter at this altitude?

5.104e16 ✓ molecules/cm^3

(c) At what altitude is the air density one-millionth (10^{-6}) that at sea level? (Assume that the temperature at this altitude is 7°C, and the mass of one mole of air is 29 g.)

113.233 ✓ km

- *Read the eBook*
- Section 12.8

8. 2/2 points | Previous Answers MI3 12.8.P.064

At sufficiently high temperatures, the thermal speeds of gas molecules may be high enough that collisions may ionize a molecule (that is, remove an outer electron). An ionized gas in which each molecule has lost an electron is called a "plasma." Determine approximately the temperature at which air becomes a plasma.

174408 K

- *Read the eBook*
- Section 12.8