NAME: _____ DATE: _____

PHYSICS

Useful Data:
Molar gas constant R = 8.314 J mol^{-1} K^{-1}
Avogadro's constant = 6.02 x 10^{23} mol^{-1}
Density of water = 1000.0 kg m^{-3}
g = 9.81 N/kg

10.1 HL Ideal Gas Law Questions

1) A 25 x 10^3 cm^3 tank contains 0.280 kg of helium at 24 ^{0}C. The atomic mass of helium is 4.00 g/mol.

a) How many moles of helium are in the tank? **[70 mol]**

b) What is the pressure in the tank in Pascals and in atmospheres? **[6.92 x 10^6 Pa]**

2) Helium gas with a volume of 1.90 x 10^3 cm^3, under a pressure of 2.5 atm and at a temperature of 53.0 ^{0}C, is warmed until both pressure and volume are doubled.

a) What is the final temperature? **[1031 ^{0}C]**

b) How many grams of helium are there? The atomic mass of helium is 4.00 g/mol **[0.71g]**

3) A large cylindrical tank contains 0.750 m^3 of nitrogen gas at 27 ^{0}C and 1.50 x 10^5 Pa (absolute pressure). The tank has a tight fitting piston that allows the volume to be changed.

a) What will be the pressure if the volume is increased to 3.00 m^3 and the temperature is increased to 227 ^{0}C? **[6.25 x 10^4 Pa]**

b) If the molecular mass of nitrogen is 28.0 g/mol, how many mole of nitrogen are present? What is the mass of nitrogen in the tank? **[1.26 kg]**

4) A cylinder of volume 0.20 m^3 contains gas at a pressure of 200 kPa and a temperature of 290 K.

(a) How many moles of gas are there in the cylinder? **[17 mol]**

(b) How many molecules of gas are there in the cylinder? **[1.0 x 10^{25}]**

The relative molar masses of hydrogen and nitrogen are 2 and 28 respectively.

(c) What is the mass of gas if it is (i) hydrogen? **[33 g]**

(ii) nitrogen? **[465 g]**

5) A balloon is filled with air until its volume is 1.50 litres and the pressure is 110 kPa. The temperature is 290 K. Assume that the volume and temperature remain constant.

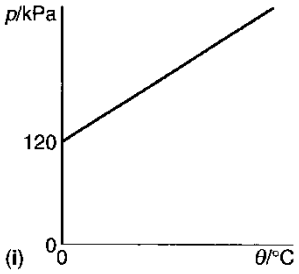
a) How many molecules are there in the balloon? **[4.13 x 10^{22}]**

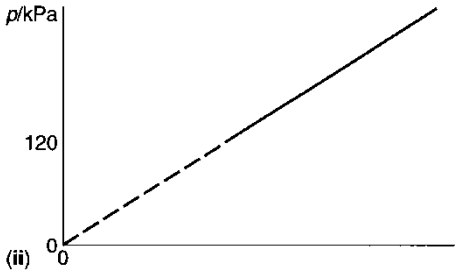
b) How many more molecules must be blown into the balloon to increase its pressure to 115 kPa **[1.88 x 10^{21}]**

6) The diagram shows two graphs which show how the pressure of the same fixed mass of gas, kept at constant volume, varies with temperature.

(a) In (i) is the pressure proportional to the temperature?

(b) In (ii) what would be the label on the x-axis?





7) Graph (i) in the previous question contains some numerical information about the gas. Make a copy of graph (ii) and transfer this information to it. Hence find the pressure of the gas when its temperature is 100°C. **[164 kPa]**

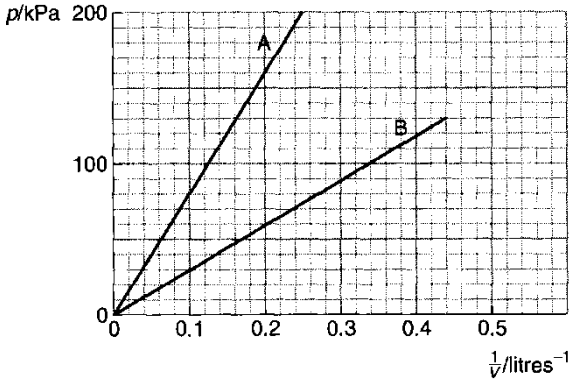
9) The diagram shows two graphs of p against 1/ V for a gas.

(a) What is the gradient of graph A? **[300 Nm]**

(b) If the temperature of the gas was 290 K, what was the amount of gas? **[0.12 mol]**

Graph B is for the same amount of gas at a different temperature.

(c) What was the new temperature? **[773 K]**



10) (a) How many moles of gas are there in the following masses:

(i) 20 g of hydrogen **[10]**

(ii) 20 g of helium **[5.0]**

(iii) 200 g of oxygen? **[6.3]**

(The relative molar masses of hydrogen, helium and oxygen are 2, 4 and 32, respectively.)

(b) If these masses of gas, all at the same temperature, are placed successively in the same container, which will exert the greatest pressure, and which the least? **[(i),(ii)]**

11) A vessel of volume 0.20 m^3 contains a mixture of 2.0 g of hydrogen molecules and 8.0 g of helium molecules. The temperature is 320 K.

(a) Calculate the numbers of moles of each gas. *(The relative molar masses of hydrogen and helium are 2 and 4, respectively).* **[H 1.0 mole, He 2.0 mole]**

(b) What is the total amount of substance (i.e. the number of moles)? **[3 mole]**

(e) What is the pressure in the vessel? **[40 kPa]**

12) A welder using a tank having a volume of 0.0800 m^3 fills it with oxygen (molecular mass = 32.0 g/mol) at a gauge pressure of 4.00 x 10^5 Pa and a temperature of 43.0 ^{0}C. The tank has a small leak, and in time some of the oxygen leaks out. On a day when the temperature is 22 ^{0}C, the gauge pressure of the oxygen in the tank is 3.00 x 10^5 Pa. Find

a) the initial mass of oxygen;

b) the mass of oxygen that has leaked out.

NAME: _____ **DATE:** _____

PHYSICS - Mr. Smith

10.1 Some Basic Gas Law Questions

REMEMBER: $\frac{p_1 v_1}{T_1} = \frac{p_2 v_2}{T_2}$

1) Express the following volumes in m^3:

(a) 1.7 litres

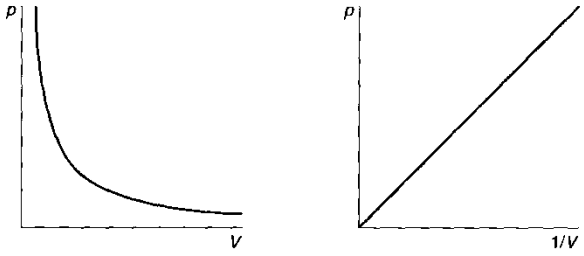
(b) 6.5 cm^3

(c) 3.4 mm^3

2) The diagram shows a graph of p against V, and a graph of p against 1/V, for a fixed mass of gas kept at constant temperature. Copy the graphs and on each sketch a graph for the following separate changes:

(a) a lower temperature and

(b) an increased mass of gas. Label your graphs to make it clear which is which.



3) In an experiment the pressure of a gas and its volume were measured at constant temperature, the following readings were obtained:

p/kPa	**102**	**143**	**178**	**200**	**233**
V/cm^3	**40.5**	**28.7**	**23.4**	**20.7**	**17.8**

Plot graphs of (a) p against V (b) p against 1/V. Does the second graph enable you to say that these measurements show that PV = constant?

4) A party balloon has a volume of 1.50 litres and the pressure of the air in it is 128 kPa. It is squashed so that its volume becomes 1.30 litres.
   (a) How would you try to measure one of these volumes?

   (b) What is the new pressure? **[148 kPa]**

5) At the start of a journey the pressure of the air in a car tyre is 276 kPa and the temperature is 12.0°C. After being driven the pressure is 303 kPa. Assuming that the volume of the air remains constant, what is its temperature now? **[39.9°C]**

6) On a day when atmospheric pressure is 105 kPa, air is pushed into a vehicle tyre until the pressure of the air in it is 360 kPa. If the volume of the inside of the tyre is 0.150 m^3, what volume of air at atmospheric pressure is pushed in, assuming that the volume of the tyre, and the temperature of the air, remain constant?
[0.364 m^3]

7) The tyre in the previous question later warms up from 15°C to 32°C. What does the pressure in the tyre become, assuming that the volume of the tyre remains constant? **[381 kPa]**

8) Some gas occupies a volume of 6.0×10^{-3} m^3 and exerts a pressure of 80 kPa at a temperature of 20°C. What pressure does it exert if, separately
   (a) the temperature is raised to 40°C. **[85 kPa]**

   (b) the volume is halved. **[0.16 MPa]**

   (c) the temperature is raised to 586 K. **[0.16 MPa]**

   (d) the volume becomes 2.5×10^{-3} m^3 **[0.19 MPa]**

   (e) the volume becomes 12×10^{-3} m3 and the temperature becomes 57°C? **[45 kPa]**

9) The volume of one cylinder in a diesel engine is 360 cm^3 and the cylinder contains a mixture of fuel vapour and air at a temperature of 320 K and a pressure of 101 kPa. The volume of the mixture is then reduced to 20 cm^3 and at the same time the temperature rises to 1000 K.
   (a) Calculate the new pressure in the cylinder. **[5.7 Mpa]**

   (b) What assumption have you made?

NAME: _____ DATE: _____

PHYSICS - Mr. Smith

10.1 Thermodynamics Practice Problems

SOURCE: Barron's NY Regents Study Guide, 3rd Edition

46. The absolute temperature of a fixed mass of ideal gas is tripled while its volume remains constant. The ratio of the final pressure of the gas to its initial pressure is
(1) 1 : 1 (2) 1.5 : 1 (3) 3 : 1 (4) 9 : 1

47. As the temperature of a constant volume of an ideal gas is increased, the pressure of the gas will
(1) decrease (2) increase (3) remain the same

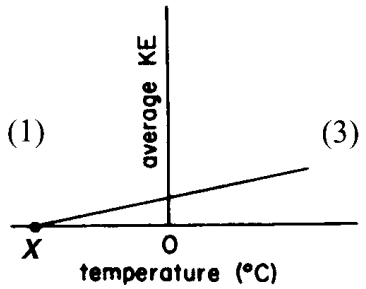
48. If the pressure of a fixed mass of an ideal gas is doubled at a constant temperature, the volume of this gas will be
(1) the same (2) doubled (3) halved (4) quartered

49. An ideal gas occupies 50.0 cubic meters at a temperature of 600. K. If the temperature is lowered to 300. K at constant pressure, the volume occupied by the gas will then be
(1) 25.0 m^3 (2) 100. m^3 (3) 200. m^3 (4) 400. m^3

50. If the pressure on a gas is doubled and its absolute temperature is halved, the volume of the gas will be
(1) quartered (2) doubled (3) unchanged (4) halved

51. A sample of an ideal gas at a temperature of 200 K has an average molecular kinetic energy of E. If the temperature of the gas were lowered to 50 K, the average molecular kinetic energy would change to
(1) $\frac{E}{2}$ (2) $2E$ (3) $\frac{E}{4}$ (4) $4E$

55. The graph below represents the relationship between the average kinetic energy of ideal gas molecules and Celsius temperature.

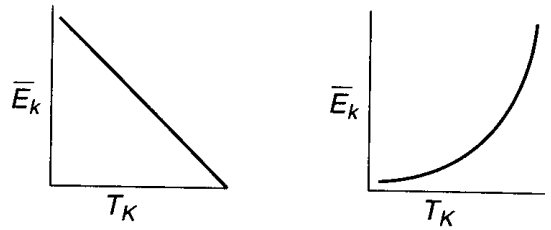


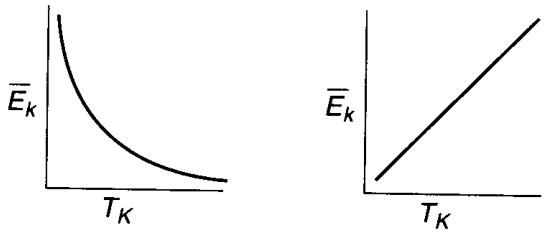
Point x represents a temperature of
(1) 273°C (2) 0°C (3) –100°C (4) –273°C

56. According to the kinetic theory of gases, an ideal gas of low density has relatively large
(1) molecules
(2) energy loss in molecular collisions
(3) forces between molecules
(4) distances between molecules

57. A given mass of gas is enclosed in a rigid container. If the velocity of the gas molecules colliding with the sides of the container increases, the
(1) density of the gas will increase
(2) pressure of the gas will increase
(3) density ot the gas will decrease
(4) pressure of the gas will decrease

58. Which graph best represents the relationship between the absolute temperature (T_K) of an ideal gas and the average kinetic energy ($\overline{E}_k$) of its molecules?





59. The pressure of a gas exerted on the walls of a balloon is produced by
(1) the collisions of the gas molecules with the walls of the balloon
(2) the repulsion between the gas molecules
(3) collisions between the gas molecules
(4) the expansion of the gas molecules

60. A change in the average kinetic energy of the molecules of an object may best be detected by measuring a change in the object's
(1) mass (2) speed (3) weight (4) temperature