AP Physics 2: Kinetic Theory and the Ideal Gas Law

1. A container contains 3.00 moles of oxygen gas at 30.0oC and 2.00 atm. What is the average kinetic energy of a gas molecule?

2. A container contains 5.00 moles of chlorine gas at 30.0oC and 8.00 atm. What is the average kinetic energy of a gas molecule?

3. A container contains 5.47x1023 molecules of nitrogen gas at 30.0oC and 5.50x105Pa. What is the average kinetic energy of a gas molecule?

4. A container contains 3.65x1025 molecules of hydrogen gas at 30.0oC and 999kPa. What is the average kinetic energy of one of the gas molecules?

5. A container contains 3.00 moles of oxygen gas at 30.0oC and 2.00 atm. What is the rms speed of the gas molecules?

6. A container contains 5.00 moles of chlorine gas at 30.0oC and 8.00 atm. What is the rms speed of the gas molecules?

7. A container contains 5.47x1023 molecules of nitrogen gas at 30.0oC and 5.50x105Pa. What is the rms speed of the gas molecules?

8. A container contains 3.65x1025 molecules of hydrogen gas at 30.0oC and 999kPa. What is the rms speed of the gas molecules?

9a. What is the escape velocity for planet Earth?

9b. What is the rms speed of hydrogen gas molecules in the Earth’s atmosphere? (Average atmospheric pressure throughout the entire atmosphere is 40kPa, and the average atmospheric temperature is 10.0oC)

9c. Hydrogen is the most abundant element in the universe. Why is there no hydrogen in the Earth’s atmosphere?

10. A container has 3.00 moles of chlorine gas at 30.0oC and 2.00atm. What is the volume of the container?

11. A container has 2.00 moles of nitrogen gas at 30.0oC and 4.00 atm. What is the volume of the container?

12. The rms speed of the molecules of an ideal gas at temperature T is 900m/s. What is the rms speed of the same molecules in the same sealed) container at 3T?

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13. A 3300kg Cadillac © Escalade © is riding on a set of sswweeeeeet twankie deuces. If you are somehow unaware, ‘twankie deuces’ are 22 inch (56cm) diameter rims. Also ‘sswweeeeeet’ is a superlative intended to describe the high level of quality and style of the aforementioned twankie deuces. The width of the rims is 29.5cm. The tire and wheel together have an overall diameter of 28 inches (71cm). For the purposes of calculation you can assume the wheel/tire is cylindrical. The gauge pressure of each tire is 2.2x105Pa. You may assume that the weight of the Escalade is shared equally among the four tires.

a. What is the area of contact patch for each tire?

b. How many air molecules are in each tire?

14. A cylindrical container has a ‘floating’ lid. This means that the lid is frictionless and is held in place by the gas molecules themselves. The top of the container is open to the atmosphere and the lid sits at a height of 36.0cm from the bottom of the container, at 20.0oC. The lid has a mass of 220g and an 8.00cm radius. How many moles of gas are in the container?

36.0cm

16.0cm

15. A helium balloon escapes from the hand of a child at sea level on a lovely 23.0oC day. The child cries. The balloon rises upward, ever upward, as the child vainly grasps at the empty air, eyes clouded by tears. The balloon rises to a point where the temperature is 5.00oC and the atmospheric pressure is 0.700atm. Find the ratio V/Vo.

16. 0.355L aluminum of gas is at 100.0oC and 101.3kPa. If the container is sealed and the temperature is reduced to 50.0oC, what is the final internal pressure? What is the final gauge pressure? What happens?

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16. 0.355L aluminum can of gas is at 100.0oC and 101.3kPa. If the container is sealed and the temperature is reduced to 50.0oC, what is the final internal pressure? What is the final gauge pressure? What happens?