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Chemistry
01/12/2012

Name: ________________________________ Seat#: _____

Period: _______ Date: _______________________________

Gas Math Problems Worksheet: Open-Ended

DIRECTIONS: Show all your work for each of the following problems on a separate sheet or sheets of paper.

1. The air inside a tennis ball in a sinking cruise ship is initially at 200 kPa and occupies 400 mL. What will its volume be when the ship has sunk enough that the pressure has gone up to 18000 kPa? Assume that the temperature remains constant.
2. Joannie is driving up into the mountains to have a picnic. The air inside an airtight bag of potato chips in her backpack is initially at 100 kPa and has a volume of 800 mL. What will its volume be when she has driven up to an altitude where the pressure is only 60 kPa? Assume that the temperature remains constant.
3. A man is pumping up the tires in his bicycle. With each stroke of the pump, he reduces the volume in the pump from 600 mL to 30 mL. Before he pushes down on the pump, the pressure is 100 kPa. What will the pressure be when he has pushed down on the pump and reduced the volume to the lower size? Assume that the temperature remains constant
4. A man in a hot air balloon has a gas bladder filled with 600 mL of air when on the ground, where the pressure is 700 mmHg. He rises up into the sky, and the bladder swells up to a volume of 4000 mL. What is the pressure at the higher altitude? Assume that temperature remains constant.
5. Professor Cryopithecus pours liquid nitrogen onto a balloon, causing it to shrivel from 480 mL to 60 mL. If the balloon was at 127^{o}C before he poured the liquid nitrogen on the balloon, what temperature must the balloon have had after he poured the liquid nitrogen onto it? Assume constant pressure.
6. Bernie, the village pyromaniac, fills a hefty bag with a mixture of methane and pure oxygen. Before he lights it on fire, its temperature is 27^{o}C, and its volume is 30 L. Judging from the size of the fireball produced by the explosion, the gases expanded to a volume of 1200 L. What was the temperature of the gases in the fireball? Assume that the pressure in the fireball at its maximum size was equal to the pressure of the gas before it exploded.
7. The gases in a cylinder of a methane-burning engine take up 70 cc and are at 327^{o}C before combusting. After the spark plug fires, the gases explode and reach a temperature of 2727^{o}C. To what volume should the gases expand? Assume constant pressure.
8. Mike the maniac recieves a porcelain elephant for his birthday. As he unpacks the gift, he decides to put the bubble wrap protecting the elephant in his liquid helium-cooled freezer. Before he puts the bubble wrap in the freezer, each bubble has a volume of 0.6 mL, at a temperature of 27^{o}C. What will the volume of each bubble be if he lets the bubble wrap cool down to –223^{o}C? Assume that pressure remains constant.
9. Professor F. Idiothead runs out of hair spray. The gases in the hair spray can are at a temperature of 27^{o}C and a pressure of 30 lbs/in^{2}. The professor knows that if he heats up the can, it will cause a pressure increase that will make the last bits of hair spray come out better. What he doesn't know is that if the gases in the can reach a pressure of 90 lbs/in^{2}, the can will explode, ruining his hair-do. To what temperature must the gases be raised in order for the can to explode? Assume constant volume.

10. Space Cadet Katrina wants to keep some leaking poison gases from escaping from the science lab on her space station. She knows that if she can reduce the pressure of the air in the lab, it will help keep bad air from flowing out into the rest of the station. She can not manipulate the pressure directly, but she can control the air conditioning remotely. The pressure in the lab is currently 20 lbs/in^2 and the temperature is 27^oC. She won't feel safe until she reduces the pressure to 8 lbs/in^2. To what temperature must she cool the lab? Assume constant volume.

11. Forest Ranger Steve wants to cook some creamed corn, but he forgot his pots and pans. He puts his unopened can of creamed corn directly into the campfire. The heat of the fire increases the temperature in the can from 27^oC to 2727^oC, but it also increases the pressure in the can from 700 mmHg to a high enough pressure to make the can explode and shoot high into the air. At what pressure did this occur? Assume constant volume.

12. Maybelline Cousteau's backup oxygen tank reads 900 mmHg while on her boat, where the temperature is 27^oC. However, she knows that when she dives down to the bottom of an unexplored methane lake on a recently-discovered moon of Neptune, the temperature will drop down to –183^oC. What will the pressure in her backup tank be at that temperature? Assume constant volume.

13. A partially-inflated weather balloon has a volume of 800 m^3, an internal pressure of 15 psi, and a temperature of 300 K when on the ground. After the balloon rises to a very high altitude, the pressure is 10 psi and the temperature is 100 K. What will its volume be at that higher altitude?

14. A bubble of methane forms very slowly at the bottom of a swamp in winter and then rises to the surface. At the bottom of the swamp, where the temperature is 275 K, the bubble is 5 mL in size. When it reaches the surface of the water, it has expanded to a size of 180 mL, where the pressure is 1 atm and the temperature is 300 K. What was the original pressure of the gas inside the bubble, when it was on the bottom of the swamp?

15. Space Marine Mario crash-lands his recon cruiser in a molten sulfur lake on uncharted planet PU187, and quickly sinks to the bottom of the lake. In his heavy battle armor, he can take the heat and has plenty of air to breathe, but he can not float to the surface to escape. He realizes that his inflatable life raft can lift him to the top of the lake. He grabs the life raft, blasts a hole in the bottom of the cruiser, and swims out once his vehicle has filled with molten sulfur. Standing on the bottom of the lake, he inflates the liferaft. At the bottom of the lake, he estimates the volume of the liferaft to be 300 L, and the pressure gauge on the raft reads 21 atm, but the liferaft pulls him up toward the surface of the lake before he can read the temperature. At the surface, the pressure gauge on the raft reads 3 atm, his suit's computer tells him that the temperature of the molten suflur is 200 K, and the liferaft appears to have a volume of 200 L. What was the temperature of the bottom of the lake?

Gas Math Problems Worksheet: Open-Ended
Answer Section

PROBLEM

1. ANS:
   v2 = 4.444444444444 mL

   PTS: 1 STA: 4c TOP: Boyle's Law
2. ANS:
   v2 = 1333.33333333333 mL

   PTS: 1 STA: 4c TOP: Boyle's Law
3. ANS:
   p2 = 2000 kPa

   PTS: 1 STA: 4c TOP: Boyle's Law
4. ANS:
   p2 = 105 mmHg

   PTS: 1 STA: 4c TOP: Boyle's Law
5. ANS:
   (t1 = 400 K = 127^{o}C)
   t2 = 50 K = –223^{o}C

   PTS: 1 STA: 4c TOP: Charles' Law
6. ANS:
   (t1 = 300 K = 27^{o}C)
   t2 = 12000 K = 11727^{o}C

   PTS: 1 STA: 4c TOP: Charles' Law
7. ANS:
   (t1 = 600 K = 327^{o}C)
   (t2 = 3000 K = 2727^{o}C)
   v2 = 350 cc

   PTS: 1 STA: 4c TOP: Charles' Law
8. ANS:
   (t1 = 300 K = 27^{o}C)
   (t2 = 50 K = –223^{o}C)
   v2 = 0.1 mL

   PTS: 1 STA: 4c TOP: Charles' Law

9. ANS:
(t1 = 300 K = 27°C)
(t2 = 900 K = 627°C)

PTS: 1 STA: 4c TOP: Guy-Lussac's Law

10. ANS:
(t1 = 300 K = 27°C)
(t2 = 120 K = –153°C)

PTS: 1 STA: 4c TOP: Guy-Lussac's Law

11. ANS:
(t1 = 300 K = 27°C)
(t2 = 3000 K = 2727°C)
p2 = 7000 mmHg

PTS: 1 STA: 4c TOP: Guy-Lussac's Law

12. ANS:
(t1 = 300 K = 27°C)
(t2 = 90 K = –183°C)
p2 = 270 mmHg

PTS: 1 STA: 4c TOP: Guy-Lussac's Law

13. ANS:
v2 = 400 m^3

PTS: 1 STA: 4c TOP: Combined Gas Law

14. ANS:
p1 = 33 atm

PTS: 1 STA: 4c TOP: Combined Gas Law

15. ANS:
t1 = 2100 K

PTS: 1 STA: 4c TOP: Combined Gas Law