Exercise Thermodynamics I:

Avogadro constant, amount of substance

1. The Avogadro's constant is defined as:
a) the number of molecules in 1 kg of a substance
b) the number of moles in 1 kg of a substance
c) the mass of one mole of perfect gas
d) the mass of one mole of any substance
e) No answer is correct.

2. The Avogadro's constant expresses:
a) mass of 1 mole of a substance
b) number of molecules in 1 kg of a substance
c) number of molecules involved in perfect gas
d) number of molecules in 1 mole of a substance
e) No answer is correct.

3. What is the unit of Avogadro constant?
a) $J \cdot K \cdot mol$ b) $J \cdot mol^{-1}$ c) mol d) it is dimensionless
e) No answer is correct.

4. What is the value of Avogadro constant?
a) $6.022 \cdot 10^{23}\ mol^{-1}$ b) $6.022 \cdot 10^{-23}\ mol^{-1}$ c) $6.022 \cdot 10^{23}$ d) $6.022 \cdot 10^{23}\ mol$
e) No answer is correct.

A. What is the number of molecules present in 1 g of pure water?

B. What is the number of atoms in 1 kg of hydrogen gas?

C. What is the number of atoms in 1 g of osmium tetraoxide? (Os molar mass is 190.2 g)

D. What is the amount of a substance which contains 1 kg of liquid water at normal pressure and temperature of 0 ºC?

E. What is the amount of a substance which contains 1 litre of hydrogen gas at normal pressure and temperature of 0 ºC?

F. What is the amount of a substance which contains 1 kg of glucose?

Ideal gas law

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1. Which is the correct ideal gas law equation?
a) $p \cdot T = n \cdot R \cdot V$ b) $p \cdot V \cdot T = const.$
c) $p \cdot V = R \cdot T$ d) $p \cdot V = R \cdot \ln T_1/T_2$
e) No answer is correct.

2. The term $n \cdot R \cdot T/V$, where n is the number of moles, R the universal gas constant, T Kelvin temperature, and V volume, has the same unit as:
a) pressure b) work c) Avogadro constant
d) Boltzmann constant e) No answer is correct.

3. In the universal gas law, the term pV has the physical dimension (unit) of
a) volume b) pressure c) power d) Avogadro constant
e) No answer is correct.

4. In the universal gas law, the term nRT has the physical dimension (unit) of
a) volume b) pressure c) energy d) Avogadro constant
e) No answer is correct.

5. A reversible thermodynamic process is characterised mainly by:
a) low temperature of the system b) constant pressure in the system
c) isolated state of the system d) no ability to do mechanical (volumetric) work
e) No answer is correct.

6. What is the unit of the molar gas constant?
a) $J \cdot K^{-1} \cdot mol^{-1}$ b) $J \cdot K^{-1} \cdot mol$ c) $J \cdot K^{-1}$ d) $J \cdot K$ e) No answer is correct.

A. What is the pressure of 2 moles of CO_2 in a vessel with a volume of 60 litres at a temperature of 27 °C? (R= 8.3 $J \cdot K^{-1} \cdot mol^{-1}$, T = t + 273)

B. F2-10. What is the pressure of 16 kg of O_2 in a vessel with a volume of 12 m^3 at a temperature of 27 °C? (R= 8.3 $J \cdot K^{-1} \cdot mol^{-1}$, T = t + 273)

Thermodynamic processes

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1. If we increase three times (triple the initial value) the pressure of a perfect gas in a reversible isochoric (V = const.) process, we obtain
a) triple temperature. b) triple volume.
c) no change in temperature. d) a volume decreased to one third.
e) No answer is correct.

2. During the reversible adiabatic expansion of a perfect gas
a) its temperature increases b) its temperature decreases
c) its temperature remains constant d) its temperature is not defined
e) No answer is correct.

3. During reversible adiabatic compression of a perfect gas
a) heat is exchanged between the gas and its surrounding
b) no work is done on the gas c) the volume of the gas increases
d) the pressure of the gas decreases e) No answer is correct.

4. During the reversible isothermal compression of perfect gas
a) no heat is exchanged between the gas and its surrounding
b) the gas does positive work on its surrounding
c) the volume of the gas increases d) the pressure of the gas increases

e) No answer is correct.

5. In an isothermal process, after increasing the pressure of the perfect gas 4-times:
a) temperature decreased to one half b) volume increased 4-times
c) volume decreased to one half d) volume decreased to one fourth
e) No answer is correct.

6. The expression V/T (V is the volume of a perfect gas, T is Kelvin temperature, the number of particles does not change) is a constant in a reversible
a) isothermal process. b) isobaric process.
c) isochoric process. d) adiabatic process.
e) No answer is correct.

7. Identify the process in which an ideal gas does not do any mechanical work.
a) isothermal b) isochoric (V = const.)
c) isobaric d) adiabatic
e) No answer is correct.

8. Identify the process in which an ideal gas does not exchange heat with its surroundings.
a) isothermal b) isochoric (constant volume)
c) isobaric d) adiabatic
e) No answer is correct.

9. In a reversible isobaric expansion of a perfect gas, we can find a decrease in its
a) temperature and density. b) volume and pressure.
c) pressure and temperature. d) density.
e) No answer is correct.

10. The pressure of a gas at a temperature of 300 K was 150 kPa at first. The final temperature of the same amount of gas was 600 K at a pressure of 300 kPa. The only reversible thermodynamic process which allows such a change is:
a) isochoric (isovolumetric) b) isobaric c) isothermal d) adiabatic
e) No answer is correct.

11. If the pressure of an ideal (perfect) gas increases two-times in reversible isothermal process, its
a) temperature increases two-times. b) volume increases two-times.
c) temperature decreases to one half. d) volume does not change.
e) No answer is correct.

A. Original pressure of a perfect gas was 100 Pa, its temperature 300 K, and volume 4 m^3. What amount of substance must be present? ($R = 8.3\ J.K^{-1}.mol^{-1}$)

B. Original volume of a perfect gas was 10 l, its temperature 300 K. The gas was cooled during an isobaric process to 200 K. What is the volume now?

C. Original pressure of a perfect gas was equal to 100 Pa, its volume to 50 l. The gas was isothermally compressed to 0,01 m^3. What is the gas pressure now?

D. Original pressure of a perfect gas was equal to 100 Pa, its temperature 300 K. The gas was heated during an isosteric (isochoric) process to 400 K. What is the pressure now?