F7AMBAF – Sample Quiz (2020/2021)

6 January 2021

1. Calculate the temperature of a blackbody if the spectral distribution peaks at (a) gamma rays, $\lambda = 1.50 \times 10^{-14}$ m; (b) x rays, 1.50 nm; (c) red light, 640 nm; (d) broadcast television waves, $\lambda = 1.00$ m; and (e) AM radio waves, $\lambda = 204$ m.

   http://kfe.fjfi.cvut.cz/ sinor/tmp/edu/f7ambaf/mp/mp3.pdf, Problem 14 (page 37)

   Solution: (a) $T = 2.898 \times 10^{-3}$ m.K$/\lambda_{max} = 2.898 \times 10^{-3}$ m.K$/(1.50 \times 10^{-14}$ m$) = \ldots$

2. What is the maximum wavelength of incident light that can produce photoelectrons from silver ($\phi = 4.64$ eV)? What will be the maximum kinetic energy of the photoelectrons if the wavelength is halved?

   http://kfe.fjfi.cvut.cz/ sinor/tmp/edu/f7ambaf/mp/mp3.pdf, Problem 29 (page 38)

   Solution: $E = hc/\lambda_{max} = \phi \Rightarrow \lambda_{max} = hc/\phi = 1240$ eV. nm$/(4.64$ eV$) = 267$ nm.

   $E = hc/(\lambda_{max}/2) = \phi + E_{kin} \Rightarrow E_{kin} = 2\,hc/\lambda_{max} - \phi = \phi$.

3. What is the binding energy of the electron in the ground state of (a) deuterium, (b) He^+, and (c) Be^{+++}?

   http://kfe.fjfi.cvut.cz/ sinor/tmp/edu/f7ambaf/mp/mp4.pdf, Problem 25 (page 32)

   Solution: $E_n == -E_0 Z^2/n^2$, $n = 1$, (a) $Z = 1$, (b) $Z = 2$, (c) $Z = 4$.

4. We learned that a particle (ideal gas) in thermal equilibrium with its surroundings has a kinetic energy of 3kT/2. Calculate the de Broglie wavelength for (a) a neutron at room temperature (300 K) and (b) a "cold" neutron at 77 K (liquid nitrogen).

   http://kfe.fjfi.cvut.cz/ sinor/tmp/edu/f7ambaf/mp/mp5.pdf, Example 5.3 (page 14)

5. Give the electron configuration and the nl value of the electrons in the subshells for the $_{35}$Br.

   Solution: $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^5$

6. A brass sphere has a diameter of 4 cm at 15 °C. How much do you need to increase its temperature in order for the sphere not to fit in a hole of 4.04 cm in diameter?
   Linear thermal expansion coefficient of brass: $\alpha = 2.10^{-5}$ K^{-1}.

   http://physicstasks.eu/2115/thermal-expansion-of-brass-balls

7. We poured 1.2 l of water at 15 °C in a 2000 W kettle. When the water started to boil, the kettle turned off.
   a) How long would the heating take in the ideal case?
   b) In fact, the heating took about 30 s longer. What does that imply? (Efficiency of the kettle.)

   http://physicstasks.eu/2114/heating-of-water-in-electric-kettle

8. In a vessel, whose volume is 1 l, there is a gas, which is a compound of oxygen and nitrogen. The gas's mass is 1 g, gas's temperature is 17 °C and pressure of the gas is 31.7 kPa. Determine the chemical formula (and name of the compound).

   http://physicstasks.eu/1798/unknown-nitrogen-oxide

9. Ideal gas of a volume of $1\,\mathrm{m}^3$ at initial pressure of $200\,\mathrm{kPa}$ is expanding isothermally to occupy double of its initial volume. Determine the work performed by the gas during expansion, final pressure and the amount of heat supplied to the gas.

   http://physicstasks.eu/2179/work,-pressure-and-heat-of-the-air-during-isothermal-expansion

10. An initial volume of oxygen is 5 l and its pressure is 100 kPa. First the oxygen was isobarically heated to the double volume, then we have isochorically increased the pressure four times its initial pressure. Determine the work performed by the gas, the heat we had to supply to the gas and its internal energy difference.

    http://physicstasks.eu/1796/work,-heat-and-the-internal-energy-difference-of-oxygen