

Chapter 5 – Extra Practice - KEY

1. What is the frequency of a microwave with a wavelength of $3.78 \times 10^{-3} \text{ m}$?

$$c = v\lambda = v = c/\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{3.78 \times 10^{-3} \text{ m}} = 7.94 \times 10^{10} \text{ s}^{-1} \text{ (or Hz)}$$

2. What is the wavelength for a gamma ray with a frequency of $2.65 \times 10^{20} \text{ Hz}$?

$$c = v\lambda = \lambda = c/v = \frac{3.00 \times 10^8 \text{ m s}^{-1}}{2.65 \times 10^{20} \text{ s}^{-1}} = 1.13 \times 10^{-12} \text{ m}$$

3. What is the frequency of an ultraviolet wave with a wavelength of 51.3 nm ?

$$c = v\lambda = v = c/\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{51.3 \times 10^{-8} \text{ m}} = 5.85 \times 10^{14} \text{ s}^{-1} \text{ (or Hz)}$$

4. Calculate the energy (in kJ/mol) of the wave for the FM radio station 96.9 MHz .

$$E = hv = 96.9 \text{ MHz} \left(\frac{1 \times 10^6 \text{ Hz}}{1 \text{ MHz}} \right) \left(\frac{1 \text{ s}^{-1}}{1 \text{ Hz}} \right) \left(\frac{6.626 \times 10^{-34} \text{ Js}}{1000 \text{ J}} \right) \left(\frac{1 \text{ kJ}}{1000 \text{ J}} \right) \left(\frac{6.022 \times 10^{23}}{1 \text{ mol}} \right) = 3.87 \times 10^{-5} \text{ kJ/mol}$$

5. What is the energy (in kJ/mol) of photons of X-rays with a frequency of $1.24 \times 10^{18} \text{ Hz}$?

$$E = hv = 1.24 \times 10^{18} \text{ Hz} \left(\frac{1 \text{ s}^{-1}}{1 \text{ Hz}} \right) \left(\frac{6.626 \times 10^{-34} \text{ Js}}{1000 \text{ J}} \right) \left(\frac{1 \text{ kJ}}{1000 \text{ J}} \right) \left(\frac{6.022 \times 10^{23}}{1 \text{ mol}} \right) = 4.95 \times 10^5 \text{ kJ/mol}$$

6. What is the energy (in kJ/mol) of photons of IR waves with a wavelength of $2.25 \times 10^{-5} \text{ m}$?

$$v = c/\lambda = 3.00 \times 10^8 \text{ m/s} / 2.25 \times 10^{-5} \text{ m} = 1.33 \times 10^{13} \text{ s}^{-1}$$

$$E = hv = \frac{(6.626 \times 10^{-34} \text{ Js}) \left(\frac{1 \text{ kJ}}{1000 \text{ J}} \right) \left(\frac{6.022 \times 10^{23}}{1 \text{ mol}} \right) (1.33 \times 10^{13} \text{ s}^{-1})}{(1000 \text{ J}) \left(\frac{1 \text{ mol}}{1 \text{ mol}} \right)} = 5.31 \text{ kJ/mol}$$

7. What is the frequency of photons with an energy of 56.8 kJ/mol ?

$$v = E/h = \frac{56.8 \text{ kJ} \left(\frac{1 \text{ mol}}{1 \text{ mol}} \right) \left(\frac{1000 \text{ J}}{1000 \text{ J}} \right)}{(1 \text{ mol}) \left(\frac{6.022 \times 10^{23}}{6.022 \times 10^{23}} \right) \left(\frac{6.626 \times 10^{-34} \text{ Js}}{1 \text{ kJ}} \right)} = 1.42 \times 10^{14} \text{ s}^{-1}$$

8. What is the wavelength of photons with an energy of $4.95 \times 10^{-3} \text{ kJ/mol}$?

$$v = E/h = \frac{56.8 \text{ kJ} \left(\frac{1 \text{ mol}}{1 \text{ mol}} \right) \left(\frac{1000 \text{ J}}{1000 \text{ J}} \right)}{(1 \text{ mol}) \left(\frac{6.022 \times 10^{23}}{6.022 \times 10^{23}} \right) \left(\frac{6.626 \times 10^{-34} \text{ Js}}{1 \text{ kJ}} \right)} = 1.42 \times 10^{14} \text{ s}^{-1}$$

$$\lambda = c/v = 3.00 \times 10^8 \text{ m/s} / 1.42 \times 10^{14} \text{ s}^{-1} = 2.11 \times 10^{-6} \text{ m} \text{ or } 2.11 \mu\text{m}$$

9. What is the energy (in kJ/mol) of photons of with a frequency of $3.55 \times 10^{13} \text{ Hz}$?

$$E = hv = 3.55 \times 10^{13} \text{ Hz} \left(\frac{1 \text{ s}^{-1}}{1 \text{ Hz}} \right) \left(\frac{6.626 \times 10^{-34} \text{ Js}}{1000 \text{ J}} \right) \left(\frac{1 \text{ kJ}}{1000 \text{ J}} \right) \left(\frac{6.022 \times 10^{23}}{1 \text{ mol}} \right) = 14.2 \text{ kJ/mol}$$

10. What is the energy (in kJ/mol) of photons of with a wavelength of 968 nm ?

$$v = c/\lambda = 3.00 \times 10^8 \text{ m/s} / 9.68 \times 10^{-7} \text{ m} = 3.10 \times 10^{14} \text{ s}^{-1}$$

$$E = hv = \frac{(6.626 \times 10^{-34} \text{ Js}) \left(\frac{1 \text{ kJ}}{1000 \text{ J}} \right) \left(\frac{6.022 \times 10^{23}}{1 \text{ mol}} \right) (3.10 \times 10^{14} \text{ s}^{-1})}{(1000 \text{ J}) \left(\frac{1 \text{ mol}}{1 \text{ mol}} \right)} = 124 \text{ kJ/mol}$$

11. What is the wavelength of an electron (mass = 9.11×10^{-31} kg) that has been accelerated to 75 % of the speed of light? In what region of the electromagnetic spectrum is this wavelength?

$$m = \frac{h}{\lambda v} \quad \lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}}{(9.11 \times 10^{-31} \text{ kg})(0.75)(3.00 \times 10^8 \text{ m s}^{-1})} = 3.23 \times 10^{-12} \text{ m} = \text{gamma rays}$$

12. What is the de Broglie wavelength (in meters) of a fly weighing 22.5 mg and traveling at 2.56 m/s?

$$m = \frac{h}{\lambda v} \quad \lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}}{(2.25 \times 10^{-5} \text{ kg})(2.56 \text{ m s}^{-1})} = 1.15 \times 10^{-29} \text{ m}$$

13. What is the de Broglie wavelength (in meters) of a pitched baseball with a mass of 123 g and a speed of 92 mph?

$$92 \text{ mph} \left(\frac{1 \text{ hr}}{3600 \text{ s}} \right) \left(\frac{1.61 \text{ km}}{1 \text{ mile}} \right) \left(\frac{1000 \text{ m}}{1 \text{ km}} \right) = 41.1 \text{ m/s}$$

$$m = \frac{h}{\lambda v} \quad \lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}}{(0.123 \text{ kg})(41.1 \text{ m s}^{-1})} = 1.31 \times 10^{-34} \text{ m}$$

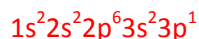
14. What velocity would an electron (mass = 9.11×10^{-31} kg) need for its de Broglie wavelength to be that of green light (550 nm)?

$$m = \frac{h}{\lambda v} \quad v = \frac{h}{\lambda m} = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}}{(5.50 \times 10^{-7} \text{ m})(9.11 \times 10^{-31} \text{ kg})} = 1.32 \times 10^3 \text{ m/s}$$

15. Give the orbital designations of electrons with the following quantum numbers:

- a. $n = 3, l = 0$ 3s
- b. $n = 2, l = 1$ 2p
- c. $n = 4, l = 3$ 4f
- d. $n = 4, l = 2$ 4d

16. Write the full electron configuration for aluminum.



17. Write the noble gas configuration for oxygen. What is the term for having two unpaired electrons in the same subshell?



18. Write the noble gas configuration for the following:

- a. V $[\text{Ar}] 4s^2 3d^3$ _____
- b. Cr $[\text{Ar}] 4s^1 3d^5$ _____
- c. Mn $[\text{Ar}] 4s^2 3d^5$ _____
- d. Fe $[\text{Ar}] 4s^2 3d^6$ _____
- e. Ni $[\text{Ar}] 4s^2 3d^8$ _____
- f. Cu $[\text{Ar}] 4s^1 3d^{10}$ _____
- g. Zn $[\text{Ar}] 4s^2 3d^{10}$ _____