NAME: **DATE:** **AP CHEMISTRY: U1L4**

Calculating Ionization Energy

Do Now

1. Convert the following from J to kJ.
   a. 12, 345 J

   b. 1003.2 J

   c. 354, 600 J

2. Convert the following from kJ to J.
   a. 1.65 kJ

   b. 1,600 kJ

   c. 3.65 kJ

3. Convert the following from nanometers to meters.
   a. 564 nm

   b. 366 nm

4. Convert the following from meters to nanometers.
   a. 6.33×10^{-7} m

   b. 755×10^{-9} m

5. 755×10^{-9} m Convert the following from kJ/mol to kJ/particle: 633 kJ/mol.

6. Calculator Check: Complete the following calculations using your calculator. Place a check mark next to the correct answer to indicate that you are using your calculator correctly.
   a. $6.636 \times 10^{-34} \cdot 0.234 = 1.55 \times 10^{-34}$
   b. $3 \times 10^{8} \cdot 6.022 \times 10^{23} = 1.81 \times 10^{32}$
   c. $3 \times 10^{8} \cdot 3.54 \times 10^{-7} = 106.2$

Example Problem 1[1]:

A laser emits light that has a frequency of $4.69 \times 10^{14}\ s^{-1}$.

a. What is the energy of one photon of this radiation?
b. If the laser emits a pulse containing 5.0×10^{17} photons of this radiation, what is the total energy of that pulse?
c. If the laser emits 1.3×10^{-2} J of energy during a pulse, how many photons are emitted?

Example Problem 2[2]:

One type of sunburn occurs on exposure to UV light of wavelength in the vicinity of 325 nm.

a. What is the energy of a photon of this wavelength?
b. What is the energy of a mole of these photons?
c. How many photons are in a 1.00 kJ burst of this radiation?

Example Problem 3[3]:

A lamp is emitting light that has a wavelength of 336 nm, and the manufacturers are concerned that this wavelength is in the vicinity of UV light, which may be harmful to users. They have access to the following information. Do the manufacturers have a reason to worry?

Region of Electromagnetic Spectrum	Frequency Range (s^{-1})
Infrared (IR)	1×10^{12} to 4×10^{14}
Ultraviolet/visible (UV/vis)	4×10^{14} to 5×10^{16}
X-rays	5×10^{16} to 1×10^{19}
Gamma rays	$> 1 \times 10^{19}$

Practice[45]:

1. An electron transition from a higher to a lower energy level in an atom results in a release of energy of 39.45 kJ/mole. What region of the electromagnetic spectrum is this radiation associated with? Justify your answer with a calculation.

2. The energy required to remove an electron from metal X is $\Delta E = 3.31 \times 10^{-20}$ J. Calculate the maximum wavelength of light that can eject an electron from metal X.

3. A green laser pointer emits light with a wavelength of 532 nm.
   a. What is the frequency of this light?
   b. What is the energy of one of these photons?

4. A diode laser emits a wavelength of 987 nm.
   a. In what portion of the electromagnetic spectrum is this radiation found?
   b. All of its output energy is absorbed in a detector that measures a total energy of 0.52 J over a period of 32 s. How many photons per second are being emitted by the laser?

5. A stellar object is emitting radiation at 3.55 mm.
   a. What range of the electromagnetic spectrum does this radiation belong to?
   b. If a detector is capturing 3.0×10^8 photon per second at this wavelength, what is the total energy of the photons detected in 1.0 hour?

6. Molybdenum must absorb radiation with a minimum frequency of 1.09×10^{15} s^{-1} before it can eject an electron from its surface.
   a. What is the minimum energy needed to eject an electron?
   b. What wavelength of radiation will provide a photon of this energy?

7. Titanium metal requires a photon with a minimum energy of 6.94×10^{-19} J to emit an electron.
   a. What is the minimum frequency of light necessary to emit electrons from titanium?
   b. What is the wavelength of this light?
   c. Is it possible to eject electrons from titanium metal using visible light?
   d. What is the maximum number of electrons that can be freed by a burst of light whose total energy is 200 μJ?

Exit Ticket[6]:

The first ionization energy of Na is 495 kJ mol^{-1}.

1. Calculate the minimum wavelength of light required to ionize a single Na atom.

Region of Electromagnetic Spectrum	Frequency Range (s^{-1})
Infrared (IR)	1×10^{12} to 4×10^{14}
Ultraviolet/visible (UV/vis)	4×10^{14} to 5×10^{16}
X-rays	5×10^{16} to 1×10^{19}
Gamma rays	$> 1 \times 10^{19}$

2. Which region of the electromagnetic spectrum does the light from #1 fall in?

3. 15.0 g of Na atoms are hit with light that has a total energy of 563 kJ. Will this light be sufficient to ionize all the Na atoms present? Justify your answer with a calculation.

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