AP® Physics B
2002 Sample Student Responses
Form B

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7. (10 points)

An experimenter determines that when a beam of monoenergetic electrons bombards a sample of a pure gas, atoms of the gas are excited if the kinetic energy of each electron in the beam is 3.70 eV or greater.

(a) Determine the deBroglie wavelength of 3.70 eV electrons.

Kinetic energy $= \frac{1}{2} mv^2 = 3.7 \text{ eV}$

$\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = 3.7 \times 1.6 \times 10^{-19}$

$v^2 = 1.299 \times 10^{12}$

$v = 1.14 \times 10^{6} \text{ m/s}$

$\lambda = \frac{h}{p} = \frac{h}{mv}$

$\lambda = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 1.14 \times 10^{6}}$

$= \underline{6.38 \times 10^{-10} \text{ m}}$

(b) Once the gas is excited by 3.70 eV electrons, it emits monochromatic light. Determine the wavelength of this light.

~~The electrons give the electrons in the gas~~

$E = 3.7 \times 1.6 \times 10^{-19}$

$= 5.92 \times 10^{-19}$

$E = hf$

$E = \frac{hc}{\lambda}$

$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{5.92 \times 10^{-19}}$

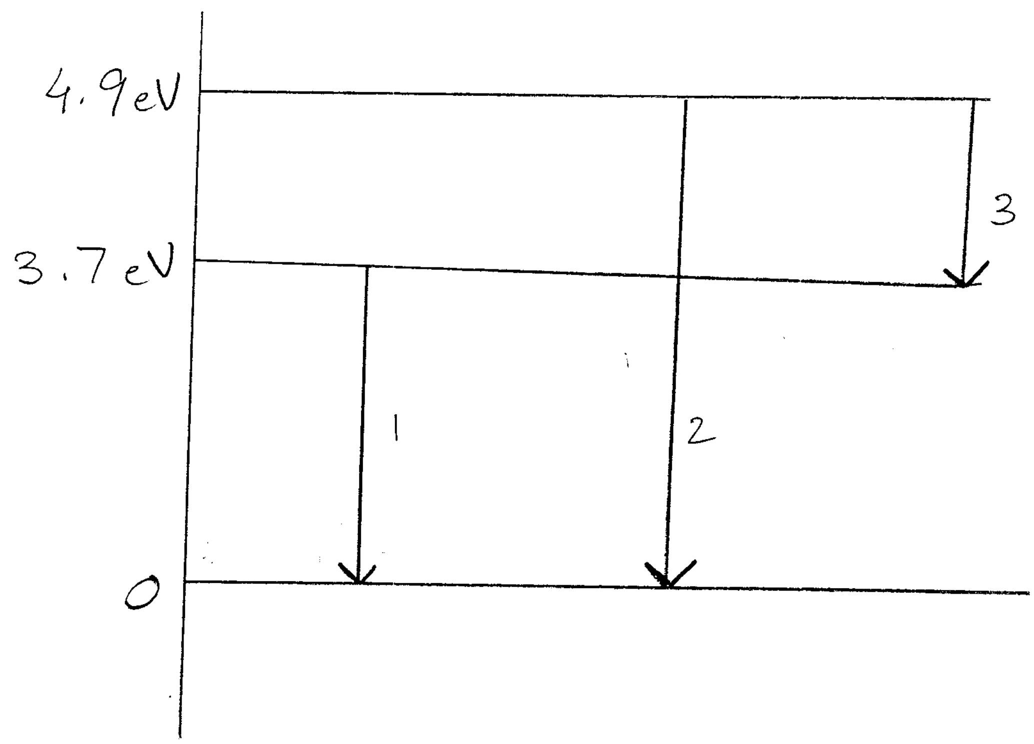
$= \underline{3.36 \times 10^{-7} \text{ m}}$

GO ON TO THE NEXT PAGE.

Experiments reveal that two additional wavelengths are emitted if the beam energy is raised to at least 4.90 eV.

(c) In the space below construct an energy-level diagram consistent with this information and determine the energies of the photons associated with those two additional wavelengths.

$4.9 - 3.7 = 1.2\ eV$



Transition 1 gives photons of 3.7eV of energy

Transition 2 gives photons of 4.9 eV of energy

Transition 3 gives photons of 1.2 eV of energy

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7. (10 points)

An experimenter determines that when a beam of monoenergetic electrons bombards a sample of a pure gas, atoms of the gas are excited if the kinetic energy of each electron in the beam is 3.70 eV or greater.

(a) Determine the deBroglie wavelength of 3.70 eV electrons.

$KE = \frac{1}{2}mv^2$

$KE = 3.70 \times 1.60 \times 10^{-19} = 5.92 \times 10^{-19}\,J$

$\sqrt{\frac{2KE}{m}} = v$

$m = 9.11 \times 10^{-31}\,kg$

$v = \sqrt{\frac{2 \cdot 5.92 \times 10^{-19}}{9.11 \times 10^{-31}}} =$

$v = 1.14 \times 10^{6}\,m/s$

de Broglie wavelength: $\frac{h}{p} = \frac{h}{mv}$

$\frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \cdot 1.14 \times 10^{6}} = 6.38 \times 10^{-10}\,m$

$\boxed{\lambda = 6.38 \times 10^{-10}\,m}$

(b) Once the gas is excited by 3.70 eV electrons, it emits monochromatic light. Determine the wavelength of this light.

$E = hf$

$v = \lambda f \quad f = \frac{v}{\lambda}$

$E = \frac{hv}{\lambda}$

$E = \frac{hc}{\lambda}$

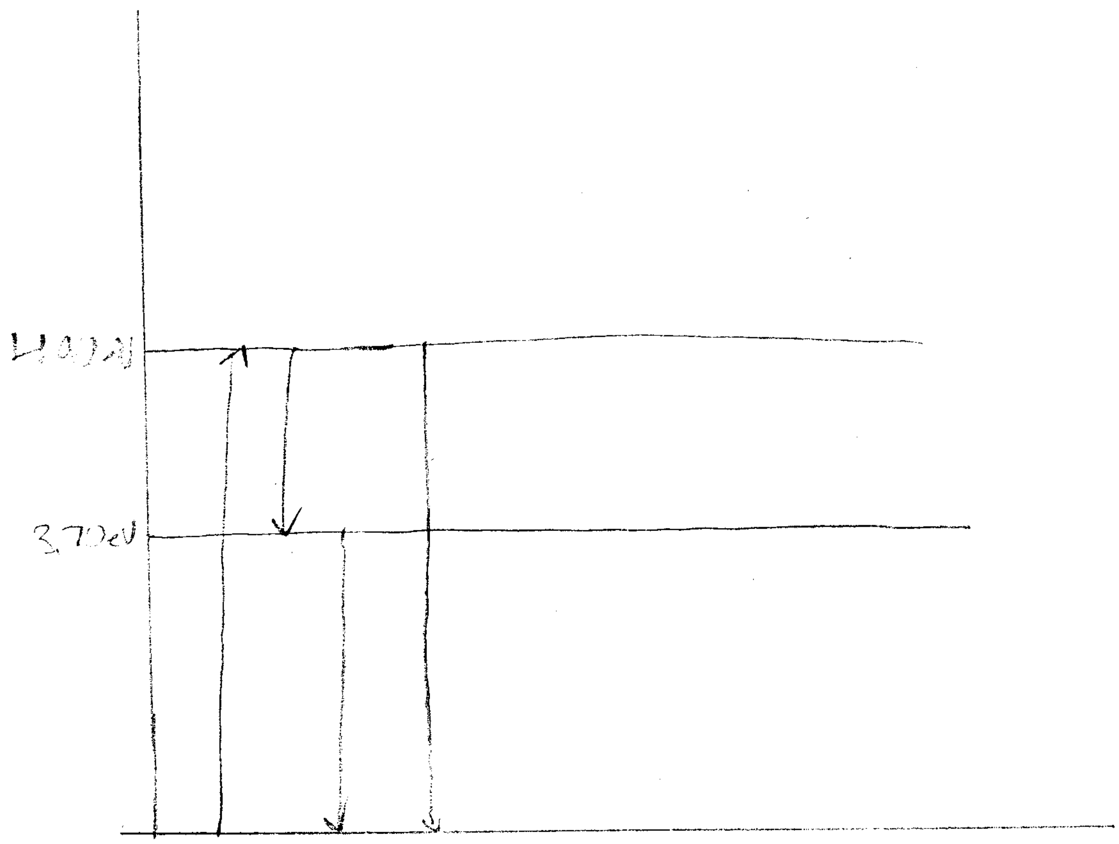
$3.70 = \frac{4.14 \times 10^{-15} \cdot 3.0 \times 10^{8}}{\lambda}$

$\lambda = \boxed{3.36 \times 10^{-7}\,m}$

GO ON TO THE NEXT PAGE.

Experiments reveal that two additional wavelengths are emitted if the beam energy is raised to at least 4.90 eV.

(c) In the space below construct an energy-level diagram consistent with this information and determine the energies of the photons associated with those two additional wavelengths.



$E_1 = 4.90 - 3.70 = 1.2\,eV$

$E_2 = 4.90\,eV$

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