Questions

1. Determine the wavelength, frequency and type of electromagnetic radiation of a photon possessing 2.9 x 10^{-19} J of energy.

$$\lambda = \frac{hc}{E} = \frac{(6.63\times10^{-34}\,J\cdot s)(3.00\times10^{8}\,\frac{m}{s})}{2.9\times10^{-19}\,J} = 6.9\times10^{-7}\,m$$

$$f = \frac{E}{h} = \frac{2.9\times10^{-19}\,J}{6.63\times10^{-34}\,J\cdot s} = 4.4\times10^{14}\,Hz \qquad \text{RED}$$

2. Determine how much energy is released when a neutron is completely turned into energy.

$$E = mc^2 = (1.67\times10^{-27}\,kg)(3.00\times10^{8}\,\tfrac{m}{s})^2 = 1.50\times10^{-10}\,J$$

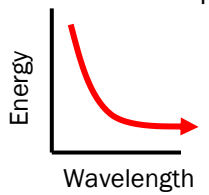
3. How much energy (in eV) is needed to move an electron from level d to level i in a mercury atom?

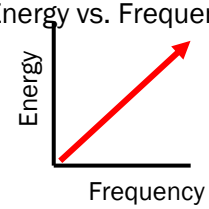
$E_{photon} = E_i - E_f = -4.95\ eV - -1.56\ eV = -3.39\ eV$

4. A particle has a quark composition of *dst* . What charge (in e) does the particle have? What is its classification?

$$\tfrac{-1}{3}e + \tfrac{-1}{3}e + \tfrac{2}{3}e = 0e \qquad \text{Baryon}$$

5. Sketch in the shapes of the following graphs. What is the physical significance of the slope of the Energy vs. Frequency graph?





The slope is equal to Plank's constant

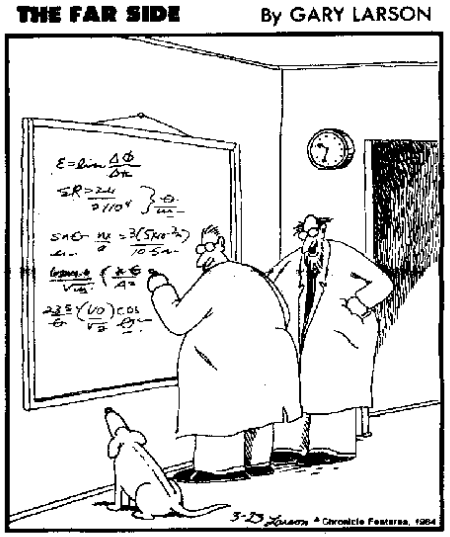
6. A bird, with mass 8.7 kg, is flying with a speed of 3.21 m/s. What is the bird's de Broglie wavelength?

$$\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}\,J\cdot s}{(8.7kg)(3.21\,\frac{m}{s})} = 2.4\times10^{-35}\,m$$

$$p = mv = (8.7kg)(3.21\,\tfrac{m}{s}) = 28\,\tfrac{kg\cdot m}{s}$$

$$\lambda = \frac{h}{p} = \frac{6.63\times10^{-34}\,J\cdot s}{28\,\frac{kg\cdot m}{s}} = 2.4\times10^{-35}\,m$$

Modern Physics



"Ohhhhhhh . . . Look at that, Schuster . . . Dogs are so cute when they try to comprehend quantum mechanics."

Definitions

1. Particle-Wave Duality - model which states that light can exhibit properties of both waves and of particles.
2. Photoelectric Effect - when light shines on a metal surface, the surface emits electrons
3. Photon - a discrete quantity (or "packet") of electromagnetic energy that has momentum, is massless, and travels at the speed of light
4. Emission Spectrum - a unique series of spectral lines emitted by an atomic gas when electrons return to a lower energy state
5. Universal Mass Unit - an atomic mass unit defined as 1 / 12th the mass of an atom of carbon-12
6. Binding Energy - the energy that is required to separate the nucleons in a nucleus into separate, free particles
7. Mass Defect - the difference between the mass of an atom and the sum of the masses of the protons and neutrons that form the nucleus of the atom
8. Quark - the smallest known building blocks of matter
9. Antiparticle - a particle having mass, lifetime, and spin identical to associated particle, but having *opposite* charge

Equations (on Reference Tables)

1. $E=hf=\frac{hc}{\lambda}$

2. $E=mc^2$

3. $E_{photon} = E_i - E_f$

4. 1 u = 931 MeV

5. $h = 6.63 \times 10^{-34}$ Js

Equations (NOT on Reference Tables)

6. $p=\frac{h}{\lambda}$

7. $m_{defect} = m_{proton} + m_{neutron} - m_{nucleus}$

8. $KE = hf - \phi$

Complete the following conversions.

$$2.7\times10^{-19}\text{ J}\left(\frac{1\text{ eV}}{1.60\times10^{-19}\text{ J}}\right) = 1.7 \text{ eV}$$

$$4.0016\text{ u}\left(\frac{931\text{ MeV}}{1\text{u}}\right) = 3730 \text{ MeV}$$

Complete the chart, indicating the equation to be used and the final units for energy when mass is given in the units indicated.

Mass in:	Use equation:	Energy in:
Kilograms (kg)	$E = mc^2$	Joules (J)
Universal mass units (u)	1 u = 931 MeV	Megaelectronvolts (MeV)