

3. (13 points) What is the escape velocity from the surface of the Earth? What is the escape velocity from 1000 km above the surface of the Earth?

$$v_{esc} = \sqrt{\frac{2GM}{r}}$$

from surface

$$v_{esc} = \sqrt{\frac{2(6.67 \times 10^{-11})(6.0 \times 10^{24})}{6.378 \times 10^6}} = 1.12 \times 10^4 \text{ m/s}$$

$$= 11.2 \text{ km/s}$$

from 1000 km up

$$v_{esc} = \sqrt{\frac{2(6.67 \times 10^{-11})(6 \times 10^{24})}{6.378 \times 10^6 + 1.000 \times 10^6}}$$

$$v_{esc} = \sqrt{\frac{2(6.67 \times 10^{-11})(6 \times 10^{24})}{7.378 \times 10^6}} = ~~1.04 \times 10^4 \text{ m/s}~~$$

$$= 10.4 \text{ km/s}$$

4. (12 points) What is light? What is wave-particle duality when applied to light? What do we mean by photons?

Light is an oscillating set of electric & magnetic fields that can be thought of as a wave propagating at $3 \times 10^8 \text{ km/s}$. This is why light is referred to as electromagnetic radiation. As a wave, light can be characterized by a wavelength and a frequency. However, light also exhibits a wave-particle duality which means that when you do an experiment designed to measure light's wave properties, then light exhibits those properties; when you attempt to measure light's particle properties, then it behaves as a particle. When light is thought of as a ~~particle~~ particle, it is called a photon. The weird thing about photons is that they have wavelengths & frequencies, which are usually wave properties.