Two protons are a distance of 8e-9m apart. What is the electric potential energy of the system.

$$U_g = \frac{1}{4\pi\epsilon}\frac{Q_1 Q_2}{r}$$

Remember that the charge of e is 1.6e-19 C

$= 2.88e\text{-}20\ J$

If the two protons move closer together, the potential energy will ___.

Increase

A proton and electron are a distance of 8e-9m apart. What is the electric potential energy of the system?

Negative of the first answer.

$U_g = -2.88e\text{-}20\ J$

If the proton and electron move closer together the potential energy ___.

Decreases.

In a location in outer space far from all other objects, a nucleus whose mass is 3.355192e-25 kg and which is initially at rest undergoes spontaneous "alpha" decay. The original nucleus disappears, and two new particles appear: a He-4 nucleus of mass 6.640678e-27 kg (an "alpha particle" consisting of two protons and two neutrons) and a new nucleus of mass 3.288706e-25 kg. These new particles move far away from each other, because they repel each other electrically (both are positively charged).

Because the calculations involve the small difference of (comparatively) large numbers, you need to keep 7 significant figures in your calculations, and you need to use the more accurate value for the speed of light, 2.99792e8 m/s.

Choose all particles as the system.
Initial state: Original nucleus, at rest.
Final state: Alpha particle + new nucleus, far from each other.

What is the rest energy of the original nucleus?

$E_i = mc^2$

$= 3.355e-25$ J

What is the rest energy of the two new particle?

$E_f = E_a + E_n$

$= c^2(m_a + m_n)$

$= 3.015e-8$ J

What is the sum of kinetic energy of the system

$K = E_f - E_i$

$= 7.120e-13$ J

Use energy conservation to find the final speed of a basketball dropped from a height of 2.02m.

$\Delta E = W$

$W = E_f - E_i$

$W = \cancel{U_f} + \cancel{K_f} - \cancel{U_f} - K_f$

$$F_g d = \cancel{+}\frac{1}{2} m v^2$$

$$v^2 = \frac{2F_g d}{m}$$

$$v^2 = \frac{2g\cancel{m}d}{\cancel{m}}$$

$$v^2 = 2gd$$

$$v = \sqrt{2gd}$$

$$= 6.292 \text{ m/s}$$

A commet is in an elliptical orbit around the Sun. Its closest approach to the sun is a distance of 4.6e10m at which point its speed is 9.4e4 m/s. Its farthest distance from the sun is far from the orbit of Pluto. What is its speed when it is 6e12m from the sun.

$$U_i + K_i = \cancel{U_f} + K_f$$

$$-\frac{G\cancel{M_c}M_s}{r_i} + \frac{1}{2}\cancel{M_c}V_i^2 = \frac{1}{2}\cancel{M_c}V_f^2$$

$$V_f^2 = -\frac{2GM_s}{r} + V_i^2$$

$$V_f = \sqrt{-\frac{2GM_s}{r_i} + V_i^2}$$

$$= 55151 \text{ m/s}$$

The radius of Juipter is 7.15e7m and has a mass of 1.9e27 kg. An object is launched straight up from the surface.

What initial speed is needed so that when the object is far from Juipter its speed is 2.35e4?

$$E_f = E_i + W$$

$r_i = 7.15e7m$ $M_J = 1.9e27kg$

$V_f = 2.35e4 \frac{m}{s}$

$$\cancel{U_f} + K_f = U_i + K_i + 0$$

$$\frac{1}{2}\cancel{M_o}V_f^2 = -\frac{GM_J\cancel{M_o}}{r_i} + \frac{1}{2}\cancel{M_o}V_i^2$$

$$\frac{1}{2}V_f^2 = -\frac{GM_J}{r_i} + \frac{1}{2}V_i^2$$

$$V_i^2 = \frac{2GM_J}{r_i} + V_f^2$$

$$V_i = \sqrt{\frac{2GM_J}{r_i} + V_f^2}$$

$$= 64133 \text{ m/s}$$

What is the escape velocity?

$$V_i = \sqrt{\frac{2GM_J}{r_i} \cancel{+ V_f^2}}$$

$$= 59672 \text{ m/s}$$