Gravitational Potential Energy Again

Gravitational Potential Energy

From grade 11, we know GPE from the equation E = mgh. This only works near the surface of Earth. If we travel far from the surface, Earth's gravitational pull becomes weaker. To take this into account, we need to use a new equation:

$$E_g = -\frac{Gm_1m_2}{r}$$

where: -E_g is gravitational energy in J

-G is the gravitational constant of 6.67×10^{-11} Jm/kg^2
-m is the mass of an object in kg
-r distance between centers of the two objects (m)

This equation is only for situations that involve:
-distances high above Earth's surface (where the gravity becomes weaker)
-between two objects (where one is NOT Earth)

Ex1. How much gravitational potential energy is between two watermelons (m = 1.25kg) that are 0.45m apart?

Ex2. Say we wanted to find the value of g at the international space station. We can use the equation above to do this: (knowing $m_e = 5.98 \times 10^{24}$kg, $r_e = 6.38 \times 10^6$m, h = 450km)

Escape Velocity

Escape velocity is the speed needed for an object to overcome a planet's gravitational pull. We can derive a single equation to determine the escape velocity for a certain body using energy arguments (where the initial position will be on the surface of a planet and the final position will be at infinity):

*Note: At infinity, the r term in E_g is extremely large, thus reducing the expression to zero. At infinity, we can safely say that there is no more gravitational pull from the planet, so we will set E_k at infinity also equal to zero (to find the minimum amount of escape velocity).

Ex1. Find the escape velocity for Earth ($m_e = 5.98 \times 10^{24}$kg, $r_e = 6.38 \times 10^{6}$m)

a) On the surface of Earth

b) On the International Space Station (450 000m above the surface of Earth)

Ex2. a) What velocity would the moon need to escape Earth's gravitational pull? (Distance from Earth to moon is 384 403 km)

b) What is the actual velocity of the moon? (One period = 27.321 582 days)