Q- Neutron stars are extremely dense objects with a mass comparable to the mass of the sun but a radius of only several thousand meters. Consider a neutron star of mass $M = 1.99*10^{30}$ kg and a radius of $R = 10.2$ km.
(a) What is the gravitational acceleration near the surface of the star?
(b) If an incredibly heat-resistant object was dropped near the surface of the star, how fast would it be going after it had fallen a distance of $h = 1.5$ m?
(c) Assuming uniform density, how much would 1.2 cubic centimeters of neutron star material weigh on the surface of the earth?

(a) The gravitational acceleration at the surface of a spherical body is given by

$$g = - GM/R^2 = - 6.67*10^{-11}*1.99*10^{30}/(10.2*10^3)^2 = - 1.276*10^{12} \text{ m/s}^2.$$

Or $g = - 1.276*10^{12}$ m/s^2

(b) If an incredibly heat resistant object was dropped near the surface of the star, how fast would it be going after it had fallen a distance of $h = 1.5$ m?

The velocity of the object is given by the equation

$$[v^2 = u^2 + 2gh]$$

Or $v^2 = 0 + 2(1.276*10^{12})*1.5 = 3.827*10^{12}$

Gives $v = 1956365.12$ m/s

Or $v = 1.956*10^6$ m/s

(c) Assuming uniform density, how much would 1.2 cubic centimeters of neutron star material weigh on the surface of the earth?

The mass of the star $M = 1.99*10^{30}$ kg

The volume of the star $V = (4/3)\pi R^3 = (4/3)*3.14*(10200)^3 = 4.443*10^{12}$ m^3.

Hence the density of the material of the star is given by

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$d = M/V = 1.99*10^{30}/(4.443*10^{12}) = 4.479*10^{17}$ kg/m^3.

And mass of 1.2 cubic cm = $1.2*10^{-6}$ m^3 volume is

Or $m = 4.479*10^{17}*1.2*10^{-6} = 5.375*10^{11}$ kg

And its weight

$W = mg = 5.375*10^{11}*9.8 = 5.267*10^{12}$ N

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