GIANCOLI HOMEWORK SOLUTIONS
Section 5-6 to 5-7, #28 - 41

28. GIVEN

$h = 12{,}800km = 1.28x10^7 m$

$m = 1350kg$

KNOWN

Since the gravitational force is based on the distance from the center of the attracting body, we must add the height above the surface to the planet's radius to come up with a value of r for the equations

SOLUTION

$r_{earth} = 6.38x10^3 km = 6.38x10^6 m$, inside front cover

$r = r_{earth} + h = 6.38x10^6 m + 1.28x10^7 m = 1.918x10^7 m$

$M_{earth} = 5.98x10^{24} kg$, inside front cover

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

$$F_g = G\frac{Mm}{r^2}$$

$$F_g = \left(6.67x10^{-11}\frac{N\cancel{m^2}}{\cancel{kg^2}}\right)\frac{(5.98x10^{24}\cancel{kg})(1350\cancel{kg})}{(1.918x10^7 m)^2} = 1464N$$

notice how the units cancel out

29. GIVEN

$g = 12.0\, m/s^2$

$m = 21.0kg$

KNOWN

Mass is the same everywhere regardless of the gravitational force, but weight (mg) IS dependent on the gravitational attraction

SOLUTION

a. mass is the same, 21.0 kg, on both the planet and on earth

b. Earth: $F_g = mg = (9.81)(21.0) = 206N$

   Planet: $F_g = mg = (12.0)(21.0) = 252N$

30. GIVEN

$r = 1.74x10^6 m$

$M = 7.35x10^{22} kg$

SOLUTION

$$F_g = \cancel{m}g = G\frac{M\cancel{m}}{r^2}$$

$$g = G\frac{M}{r^2} = (6.67x10^{-11})\frac{(7.35x10^{22})}{(1.74x10^6)^2} = 1.62\,m/s^2$$

31. GIVEN

$r_{planet} = 1.5r_{earth} = (1.5)6.38x10^6 = m$

$M_{planet} = M_{earth} = 5.98x10^{24} kg$

KNOWN

$$F_g = mg = G\frac{Mm}{r^2}$$

$$g = G\frac{M}{r^2}$$

SOLUTION

$$g = G\frac{M}{r^2}$$

$$\frac{g}{(1.5)^2} = G\frac{M}{[(1.5)(r)]^2} = \frac{9.81}{(1.5)^2} = 4.36\,m/s^2$$

32. GIVEN

$r_{planet} = r_{earth} = (1.5)6.38x10^6 = m$

$M_{planet} = (1.66)M_{earth} = (1.66)5.98x10^{24} = 99{,}268 kg$

KNOWN

$$F_g = mg = G\frac{Mm}{r^2}$$

$$g = G\frac{M}{r^2}$$

SOLUTION

$$g = G\frac{M}{r^2}$$

$$(1.66)g = G\frac{(1.66)M}{r^2} = (1.66)(9.81) = 16.3\,m/s^2$$

33. GIVEN

$F_g = 2.5x10^{-10}N$ when $r = 0.25m$

$m_1 + m_2 = 4kg$

$m_1 = 4kg - m_2$

SOLUTION

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$F_g = G\frac{(4 - m_2)m_2}{r^2}$$

$$\frac{F_g r^2}{G} = 4m_2 - {m_2}^2$$

$${m_2}^2 - 4m_2 + \frac{(2.5x10^{-10})(0.25)^2}{(6.67x10^{-11})} = 0$$

$${m_2}^2 - 4m_2 + 0.234 = 0$$

$$m_2 = \frac{-(b) \pm \sqrt{b^2 - 4ac}}{2a}$$

$$m_2 = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(0.234)}}{2(1)} = 3.94{,}0.0594$$

$m_1 = 4 - 3.94 =$ 0.06

$m_1 = 4 - 0.0594 =$ 3.94

34. GIVEN

Nada

KNOWN

$r = r_{earth} + h$

$r_{earth} = 6.38x10^3 km = 6.38x10^6 m$, inside front cover

$M_{earth} = 5.98x10^{24} kg$, inside front cover

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

SOLUTION

a. $@\ h = 3200m$

$r = r_{earth} + h = 6.38x10^6 m + 3200m = 6.3832x10^6 m$

$$g = G\frac{M}{r^2}$$

$$g = (6.67x10^{-11})\frac{(5.98x10^{24})}{(6.3832x10^6)^2} = 9.78\, m/s^2$$

b. $@\ h = 3200km = 3.20x10^6 m$

$r = r_{earth} + h = 6.38x10^6 m + 3.20x10^6 m = 9.58x10^6 m$

$$g = G\frac{M}{r^2}$$

$$g = (6.67x10^{-11})\frac{(5.98x10^{24})}{(9.58x10^6)^2} = 4.35\, m/s^2$$

35. GIVEN

$g_r = (0.1)g$

KNOWN

$g_{surface} = 9.81\, m/s^2$

$M_{earth} = 5.98x10^{24}kg$, inside front cover

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

SOLUTION

$$(0.1)g = G\frac{M}{r^2}$$

$$r^2 = \frac{GM}{(0.1)g}$$

$$r = \sqrt{\frac{GM}{(0.1)g}} = \sqrt{\frac{(6.67x10^{-11})(5.98x10^{24})}{(0.1)(9.81)}} = 2.02x10^7 m$$

36. GIVEN

$m_{star} = 5M_{sun} = 5(1.99x10^{30}) = 9.95x10^{30}kg$, inside front cover

$r = 10{,}000m$

KNOWN

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

SOLUTION

$$g = G\frac{M}{r^2}$$

$$g = (6.67x10^{-11})\frac{(9.95x10^{30})}{(10{,}000)^2} = 6.63x10^{12}\, m/s^2$$

37. GIVEN

$m_{star} = M_{sun} = 1.99x10^{30}kg$, inside front cover

$r_{star} = r_{moon} = 1.74x10^3 km = 1.74x10^6 m$, inside front cover

KNOWN

When they say "same size" we assume same radius and that it is a sphere

SOLUTION

$$g = G\frac{M}{r^2}$$

$$g = (6.67x10^{-11})\frac{(1.99x10^{30})}{(1.74x10^6)^2} = 4.38x10^7\ m/s^2$$

38. GIVEN

$h = 250km = 2.50x10^5m$

KNOWN

Since the gravitational force is based on the distance from the center of the attracting body, we must add the height above the surface to the planet's radius to come up with a value of *r* for the equations

SOLUTION

$r_{earth} = 6.38x10^3km = 6.38x10^6m$, inside front cover

$r = r_{earth} + h = 6.38x10^6m + 2.50x10^5m = 6.63x10^6m$

$M_{earth} = 5.98x10^{24}kg$, inside front cover

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

$g_{surface} = 9.81\ m/s^2$

SOLUTION

$$g = G\frac{M}{r^2}$$

$$g = (6.67x10^{-11})\frac{(5.98x10^{24})}{(6.63x10^6)^2} = 9.07\ m/s^2\left(\frac{1g}{9.81\ m/s^2}\right) = 0.925g's$$

39. ***NOTE: You will see problems of this type several times throughout your physics classes so it is highly advantageous to learn how to do them now!***

GIVEN

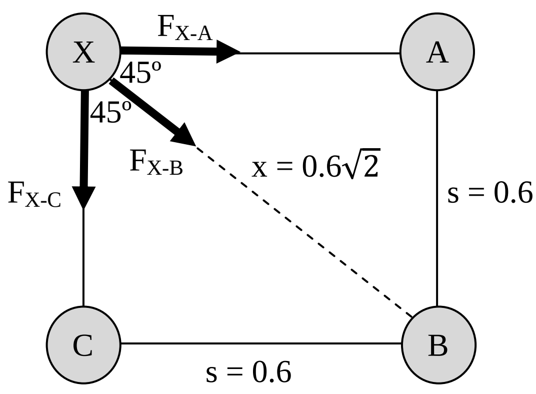
$s = 0.60m$

$m = 9.5kg$

KNOWN

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

$x = \sqrt{s^2 + s^2} = \sqrt{2s^2} = s\sqrt{2}$



SOLUTION

$$F_g = G\frac{mm}{r^2}$$

$$F_{X-A} = F_{X-C} = (6.67x10^{-11})\frac{(9.5)(9.5)}{(0.6)^2} = 1.67x10^{-8}N$$

$$F_{X-B} = (6.67x10^{-11})\frac{(9.5)(9.5)}{(0.6\sqrt{2})^2} = 8.36x10^{-9}N$$

$$F_{X-B_x} = F_{X-B_y} = F_{X-B}\cos 45 = 8.36x10^{-9}\cos 45 = 5.91x10^{-9}$$

$$R_x = F_{X-A} + F_{X-B}\cos 45 = 1.67x10^{-8} + 5.91x10^{-9} = 2.261x10^{-8}$$

$$R_y = F_{X-C} + F_{X-B}\cos 45 = 1.67x10^{-8} + 5.91x10^{-9} = 2.261x10^{-8}$$

$$x = \sqrt{s^2 + s^2} = \sqrt{2s^2} = s\sqrt{2}$$

$$R = R_{x/y}\sqrt{2} = (2.261x10^{-8})\sqrt{2} = 3.20x10^{-8}N$$

Since the components are the same, the resultant will be at a 45° angle, which is along the line joining X and B.

40. GIVEN

$M_V = 0.815M_E$ $\quad r_{V\to Sun} = 108x10^6 km = 108x10^9 m$

$M_E = 5.98x10^{24}kg$ $\quad r_{E\to Sun} = 150x10^6 km = 150x10^9 m$

$M_J = 318M_E$ $\quad r_{J\to Sun} = 778x10^6 km = 778x10^9 m$

$M_S = 95.1M_E$ $\quad r_{S\to Sun} = 1430x10^6 km = 1430x10^9 m$

$M_{Sun} = 1.99x10^{30}kg$ $\quad r_{E\to Sun} = 150x10^6 km = 150x10^9 m$

KNOWN

- You need to find the net force on Earth which we know will be to the right because there are two big planets to the right and a small Venus to the left. But you have to remember to subtract the force of Venus from the other two.
- To find the distance from Earth, take each planet's distance from the Sun and subtract it from the Earth's distance from the Sun.

SOLUTION

a. Net force on the Earth

$$\sum F_g = -F_{g-V} + F_{g-J} + F_{g-S}$$

$$F_g = G\frac{mm}{r^2}$$

$$r_{E\to Venus} = 108x10^9 - 150x10^9 m = -42x10^9$$

$$r_{E\to Jupiter} = 778x10^9 - 150x10^9 m = 628x10^9$$

$$r_{E\to Saturn} = 1430x10^9 - 150x10^9 m = 1280x10^9$$

$$F_{g-V} = (6.67x10^{-11})\frac{(0.815)(5.98x10^{24}kg)^2}{(42x10^9)^2} = 1.10x10^{18}$$

$$F_{g-J} = (6.67x10^{-11})\frac{(318)(5.98x10^{24}kg)^2}{(778x10^9)^2} = 1.92x10^{18}$$

$$F_{g-S} = (6.67x10^{-11})\frac{(95.1)(5.98x10^{24}kg)^2}{(1430x10^9)^2} = 1.38x10^{17}$$

$$\sum F_g = -F_{g-V} + F_{g-J} + F_{g-S} = -1.10x10^{18} + 1.92x10^{18} + 1.38x10^{17} = 9.58x10^{17}N$$

b. Fraction of the Sun's force on the Earth

$$F_{E-Sun} = (6.67x10^{-11})\frac{(1.99x10^{30})(5.98x10^{24}kg)}{(150x10^9)^2} = 3.53x10^{22}N$$

$$\frac{F_{E-Planets}}{F_{E-Sun}} = \frac{9.58x10^{17}}{3.53x10^{22}} = 2.71x10^{-5}$$

41. GIVEN

$g_{Mars} = 0.38g_{Earth}$

$r = 3400km = 3.4x10^6m$

KNOWN

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$, *inside front cover*

$g_{Earth} = 9.81\,m/s^2$

SOLUTION

$$g = G\frac{M}{r^2}$$

$$\frac{0.38g_{Earth}r^2}{G} = M = \frac{(0.38)(9.81)(3.4x10^6)^2}{6.67x10^{-11}} = 6.46x10^{23}kg$$