Capítulo VIII

Actividad 8.1 (página 195)

1) $F = \frac{G m_1 m_2}{r^2} \Rightarrow r = \sqrt{\frac{G \cdot m_1 m_2}{F}}$

$$r = \sqrt{\frac{(6{,}67 \times 10^{-11}\ N \cdot m^2/kg^2)(7{,}34 \times 10^{22}\ kg)(80\ kg)}{2{,}56 \times 10^{-3}\ N}}$$

$$\boxed{r = 3{,}91 \times 10^{8}\ m} \quad R/$$

2) $m_{Pedro} = \frac{P_{Pedro}}{g} = \frac{600N}{9{,}8 m/s^2} = 61{,}22\ kg$

$m_{María} = \frac{P_{María}}{g} = \frac{500N}{9{,}8 m/s^2} = 51{,}02\ kg$

$$F = \frac{G m_1 m_2}{r^2} = \frac{(6{,}67 \times 10^{-11}\ kg m^2/kg^2)(61{,}22\ kg)(51{,}02\ kg)}{(2{,}0\ m)^2}$$

$F = 5{,}21 \times 10^{-8}\ N$ R/

3) $$F = \frac{G m_1 m_2}{r^2} = \frac{(6{,}67 \times 10^{-11}\ kg m^4/kg^2)(3{,}33 \times 10^{23}\ kg)(5{,}98 \times 10^{24}\ kg)}{(2{,}41 \times 10^{9}\ m)^2}$$

$F = 2{,}29 \times 10^{19}\ N$ R/

4) Si cada masa se reduce a la mitad, la fuerza gravitatoria se reduce a la cuarta parte, ya que fuerza y producto de las masas son directamente proporcionales

$$F = \frac{4{,}20 \times 10^{6}\ N}{4} = \boxed{1{,}05 \times 10^{6}\ N} \quad R/$$

5) $g = \frac{6m}{r^2} = \frac{(6,67\times10^{-11}\ N\,m^2/kg^2)(1,9\times10^{27}\ kg)}{(7,06\times10^{7}\ m)^2}$

$g = 25,4\ m/s^2$ R/

6) $F = \frac{6 m_1 m_2}{r^2}$ $\quad m_2 = \frac{F r^2}{6 m_1} = \frac{(5,83\times10^{2}\ N)(25\ m)^2}{(6,67\times10^{-4}\ N\,m^2/kg^2)(267\ kg)}$

$m_2 = 2,05\times10^{13}\ kg$ R/

7) $m = \frac{P}{g} = \frac{600\ N}{9,8\ m/s^2} = 61,2\ kg$

$g = \frac{6M}{(R+h)^2} = \frac{(6,67\times10^{-4}\ N\,m^2/kg^2)(5,98\times10^{24}\ kg)}{(6,37\times10^{6}\ m + 2\times10^{5}\ m)^2}$

$g = 9,24\ m/s^2$ $\quad P = mg = (61,2\ kg)(9,24\ m/s^2)$

$P = 566\ N$ R/

) $F = \frac{6 m_1 m_2}{r^2}$ $\quad r = \sqrt{\frac{6 m_1 m_2}{F}}$

$r = \sqrt{\frac{(6,67\times10^{-11}\ N\,m^2/kg^2)(10\ kg)(8\ kg)}{8,54\times10^{-12}\ N}} = 25\ m$ R/

) $g = \frac{6M}{(R+h)^2} \Rightarrow (R+h)^2 = \frac{6M}{g} \Rightarrow (R+h) = \sqrt{\frac{6M}{g}}$

$h = \sqrt{\frac{6M}{g}} - R = \sqrt{\frac{6,67\times10^{-11}\ kg\,m^2/kg^2}{4,9\ m/s^2}} - 6,37\times10^{6}\ m$

$h = 2,25\times10^{6}\ m$ R/

10) $F = \frac{6 m_1 \cdot m_2}{(R+h)^2}$

$F = \frac{(6,67\times10^{-11}\ N\cdot m^2/kg^2)(5,98\times10^{24}\ kg)(3,5\times10^{3}\ kg)}{(6,37\times10^{6}\ m + 3,6\times10^{6}\ m)^2}$

$F = 1,40\times10^{4}\ N$ R/

11) $g = \frac{GM}{(R+3R)^2}$ $\quad h = 3R$

$$g = \frac{GM}{(4R)^2} = \frac{(6{,}67\times10^{-11}\ N\,m^2/kg^2)(5{,}98\times10^{24}\ kg)}{[4\cdot(6{,}37\times10^{6}\ m)]^2}$$

$$\boxed{g = 0{,}614\ m/s^2} \quad R/$$

Repaso de conceptos.

I. Parte: 1V - 2F - 3F - 4F - 5V - 6F - 7F
8V - 9F - 10F - 11V

II. Parte:

1) c $\quad r = \sqrt{\frac{GM}{g}} = \sqrt{\frac{(6{,}67\times10^{-11}\ N\,m^2/kg^2)(5{,}98\times10^{24}\ kg)}{4{,}10\ m/s^2}}$

$r = 9{,}62\times10^{6}\ m$

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2) a

$$F = \frac{G\,m_T\,m_A}{r^2} \qquad m_A = \frac{F\,r^2}{G\,m_T}$$

$$m_A = \frac{(4{,}97\ N)(3{,}83\times10^{7}\ m)^2}{(6{,}67\times10^{-11}\ N\,m^2/kg^2)(5{,}98\times10^{24}\ kg)} = 18{,}3\ kg$$

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3) c $\quad g = \frac{GM}{(R+h)^2} \Rightarrow g = \frac{GM}{(R+2R)^2} = \frac{GM}{(3R)^2}$

$$3R = \sqrt{\frac{GM}{g}} \Rightarrow R = \frac{1}{3}\sqrt{\frac{GM}{g}}$$

$$R = \frac{1}{3}\sqrt{\frac{(6{,}67\times10^{-11}\ N\,m^2/kg^2)(6{,}42\times10^{23}\ kg)}{0{,}410\ m/s^2}}$$

$$= 3{,}41\times10^{6}\ m$$

(15)

4) a $r = \sqrt{\frac{G m_1 m_2}{F}} = \sqrt{\frac{(6,67 \times 10^{-11} N m^2/kg^2)(2kg)(5kg)}{6,67 \times 10^{-12} N}} = 10m$

5) a

6) b $g = \frac{(6,67 \times 10^{-11} kg\,m^2/kg^2)(5,98 \times 10^{24} kg)}{\left(\frac{6,37 \times 10^6 m}{3}\right)^2} = 8,9 \frac{m}{s^2}$

7) $g = \frac{GM}{r^2}$ $\quad M = \frac{gr^2}{G} = \frac{(2,35 \times 10^{10} m/s^2)(2,39 \times 10^7 m)^2}{6,67 \times 10^{-11} N\,m^2/kg^2}$

$M = 2,20 \times 10^{25} kg$

8) a

9) a $F = \frac{G m_1 m_2}{r^2} = \frac{G m_1 m_2}{(R+6R)^2} = \frac{G m_1 m_2}{(7R)^2}$

$F = \frac{(6,67 \times 10^{-11} N \cdot m^2/kg^2)(5,98 \times 10^{24} kg)(18,3 kg)}{[7(6,37 \times 10^6 m)]^2}$

$F = 3,67 N$

10) a $F = \frac{G m^2}{r^2} \Rightarrow m = \sqrt{\frac{F \cdot r^2}{G}}$

$m = \sqrt{\frac{5,1 \times 10^{-42} N \cdot (7,6 \times 10^{-6} m)^2}{6,67 \times 10^{-11} N \cdot m^2/kg^2}}$

$m = 2,10 \times 10^{-21} kg$

11) c

12) d

13) b

14) d

15) b

$$F = \frac{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)(500\ kg)(1000\ kg)}{(24\ m)^2}$$

$$F = 5,8 \times 10^{-8}\ N$$

16) c

$$r = \sqrt{\frac{GM}{g}} = \sqrt{\frac{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)(8,67 \times 10^{25}\ kg)}{10,5\ m/s^2}}$$

$$r = 2,35 \times 10^7\ m$$

17) d

$$g = \frac{GM}{(R+4R)^2} = \frac{GM}{(5R)^2} =$$

$$g = \frac{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)(1,90 \times 10^{27}\ kg)}{(5 \cdot 7,15 \times 10^7\ m)^2} = 0,992\ m/s^2$$

19) d

F es inversamente proporcional al cuadrado de "r"

18) d

cuando la distancia es $3r \rightarrow F$. Para llegar a $4F$ $3r$ debe reducirse a la mitad o sea $\frac{3r}{2} = 1,5\ r$

20) a $g = \frac{GM}{r^2}$ $\Rightarrow$ $r^2 = \frac{GM}{g}$

$r = \sqrt{\frac{GM}{g}}$ $\Rightarrow$ $r = \sqrt{\frac{GM}{g}}$

$r = \sqrt{\frac{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)(5,98 \times 10^{24}\ kg)}{4,9\ m/s^2}}$

$r = 9,02 \times 10^6\ m$

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21) b $g = \frac{GM}{r^2}$ $\Rightarrow$ $M = \frac{gr^2}{G} = \frac{(3,10\ m/s^2)(3,40 \times 10^6\ m)}{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)}$

$M = 1,89 \times 10^{17}\ kg$

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22) c $F = \frac{(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)(1,56 \times 10^{30}\ kg)^2}{(9,34 \times 10^4\ m)^2}$

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23) c $F = \frac{4,20 \times 10^6\ N}{4} = 1,05 \times 10^6\ N$ (proporcionalidad directa)

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24) c) $m_2 = 3m_1$

$F = \frac{G m_1 \cdot 3m_1}{r^2} = \frac{3G m_1^2}{r^2}$

$m_1 = \sqrt{\frac{F \cdot r^2}{3G}} = \sqrt{\frac{(2,81 \times 10^{-4}\ N)(0,8\ m)^2}{3\,(6,67 \times 10^{-11}\ N \cdot m^2/kg^2)}} = 3\ kg$

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25) a $g = \frac{GM}{(R+5R)^2} = \frac{GM}{(6R)^2}$

$g = \frac{(6,67 \times 10^{-11}\ N\ m^2/kg^2)(5,98 \times 10^{24}\ kg)}{(6 \cdot 6,37 \times 10^6\ m)^2}$

$g = 0,273\ m/s^2$

II. Parte.

1) $m = \frac{4000N}{9,8 m/s^2} = 408,16 kg$

$g = \frac{GM}{(R+h)^2} = \frac{(6,67 \times 10^{-11} N \cdot m^2/kg^2)(6,42 \times 10^{23} kg)}{(3,4 \times 10^6 m + 6,0 \times 10^6 m)^2} = 0,485 m/s^2$

$P_{Marte} = mg = (408,16 kg)(0,485 m/s^2) = \boxed{198 N}$ R/

2) $g = \frac{GM}{r^2} = \frac{(6,67 \times 10^{-11} Nm^2/kg^2)(2,0 \times 10^{30} kg)}{(7,46 \times 10^{10} m)^2} = 0,02 m/s^2$

3) $m = \frac{P}{g} = \frac{6000N}{9,8 m/s^2} = 612,2 kg$

$g_M = \frac{GM}{r^2} = \frac{(6,67 \times 10^{-4} Nm^2/kg^2)(6,4 \times 10^{23} kg)}{(3,4 \times 10^6 m)^2} = 3,7 m/s^2$

$P = mg = (612,2 kg)(3,7 m/s^2)$

$P = 2265,14 N$ R/

4) $g = 9,8 \times \frac{30}{100} = 2,94 m/s^2$

$g = \frac{GM}{(R+h)^2}$ $\quad h = \sqrt{\frac{GM}{g}} - R$

$h = \sqrt{\frac{(6,67 \times 10^{-4} Nm^2/kg^2)(5,98 \times 10^{24} kg)}{2,94 m/s^2}} - 6,37 \times 10^6 m$

$h = 5,28 \times 10^6 m$ R/

5) $m = \frac{P}{g} = \frac{(750N)}{4,8m/s^2} = 76,53\,kg$

$g = \frac{GM}{(R+H)^2} = \frac{GM}{(R+2R)^2} = \frac{GM}{(3R)^2}$

$g = \frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(5,98\times10^{24}kg)}{(3\cdot 6,37\times10^6 m)^2} = 1,09m/s^2$

$P = mg = (76,53kg)(1,09m/s^2) = 83,42N$ R/

6) La fuerza disminuiría a la novena parte

7) $g = \frac{GM}{(R+H)^2} = \frac{GM}{(R+3R)^2} = \frac{GM}{(4R)^2}$

$g = \frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(4,83\times10^{24}kg)}{(4\cdot 6,05\times10^6 m)^2} = 0,55m/s^2$

8) $F = G\frac{m_1 m_2}{r^2}$

$F = \frac{(6,67\times10^{-11}\,N\,kg^2/m^2)(65\,kg)(5,98\times10^{24}kg)}{(6,37\times10^6 m)^2}$

$F = 638,9N$ R/

9) $P = mg = (65kg)(9,83m/s^2) = 638,9N$

No hay diferencia. Calcular el peso de un cuerpo, o calcula la fuerza de atracción gravitatoria entre el cuerpo y la Tierra, es lo mismo.

10)

h(m)	r = R + h	g (m/s²)
0	$6{,}37 \times 10^6$ m	9,83
R	$1{,}27 \times 10^6$ m	2,46
2R	$1{,}91 \times 10^7$ m	1,09
4R	$3{,}19 \times 10^7$ m	0,39

11) $m_2 = 3m_1 = 3m$

$$F = \frac{G \cdot m \cdot 3m}{r^2} \Rightarrow F = \frac{3Gm^2}{r^2} \Rightarrow m = \sqrt{\frac{Fr^2}{3G}}$$

$$m = \sqrt{\frac{(2{,}001 \times 10^{-8}\,N)(50m)^2}{3(6{,}67 \times 10^{-11}\,Nm^2/kg^2)}} = 500kg$$

$m_1 = 500kg \quad m_2 = 1500kg$

12) $F = \frac{G m_1 m_2}{r^2}$. $r = \sqrt{\frac{G m_1 m_2}{F}}$

$$r = \sqrt{\frac{(6{,}67 \times 10^{-11}\,N\,m^2/kg^2)(4{,}87 \times 10^{24}kg)(3{,}30 \times 10^{23}kg)}{(4{,}2 \times 10^{16}\,N)}}$$

$r = 5{,}05 \times 10^{10}$ m

✓ Si se reduce "r" a la mitad, la fuerza aumenta 4 veces → $F = 1{,}68 \times 10^{17}$ N

13) $g = \frac{GM}{(R+2R)^2} = \frac{GM}{(3R)^2} = \frac{(6{,}67 \times 10^{-11}\,Nm^2/kg^2)(6{,}4 \times 10^{23}kg)}{(3 \cdot 3{,}4 \times 10^6 m)^2}$

$g = 0{,}41 m/s^2 \quad m = \frac{P}{g} = \frac{42{,}3N}{0{,}41 m/s^2} = 103{,}17kg$

✓ Tierra

$$g = \frac{GM}{(3R)^2} = \frac{(6{,}67 \times 10^{-11}\,Nm^2/kg^2)(5{,}98 \times 10^{24}kg)}{(3 \cdot 6{,}37 \times 10^6 m)^2}$$

$g = 1{,}09 m/s^2$. $P = mg = (103{,}17kg)(1{,}09 m/s^2)$

$P = 112{,}45\,N$ RI

14) $g = \frac{GM}{r^2}$ $\quad r = \sqrt{\frac{GM}{g}}^{1} = \sqrt{\frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(5,98\times10^{24}\,kg)}{1,6\,m/s^2}}^{1}$

$r = 1,58\times10^{7}\,m$ R/

15) $F = \frac{G m_1 \cdot 5m_1}{r^2} \Rightarrow F = \frac{5G m_1^2}{r^2}$

$m_1 = \sqrt{\frac{F r^2}{5G}}^{1} \Rightarrow m_1 = \sqrt{\frac{(9,26\times10^{-8}\,N)(12\,m)^2}{5\cdot(6,67\times10^{-11}\,N\,m^2/kg^2)}}^{1}$

$m_1 = 200\,kg \quad m_2 = 1000\,kg$ R/

$F = \frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(200\,kg)(1000\,kg)}{(5\,m)^2}$

$F = 5,34\times10^{-7}\,N$ R/

16) $h = \sqrt{\frac{GM}{g}}^{1} = R$ $\quad \therefore$

$h = \sqrt{\frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(5,98\times10^{24}\,kg)}{2\,m/s^2}}^{1} - 6,37\times10^{6}\,m$

$h = 1,15\times10^{6}\,m$ R/

17) $F = \frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(1,9\times10^{23}\,kg)(4,8\times10^{22}\,kg)}{(6,71\times10^{8}\,m)^2}$

$F = 1,35\times10^{22}\,N$ R/

18) $m = \frac{P}{g} = \frac{(200\,N)}{1,6\,m/s^2} = 1,25\times10^{2}\,kg$

$g_E = \frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(4,8\times10^{22}\,kg)}{(1,57\times10^{6}\,m)^2} = 1,3\,m/s^2$

$P = mg = (1,25\times10^{2}\,kg)(1,3\,m/s^2) = 162,5\,N$ R/

19) $20\%\,g = 9,8\,m/s^2 \cdot \frac{20}{100} = 1,84\,m/s^2$

$r = \sqrt{\frac{GM}{g}}^{1} = \sqrt{\frac{(6,67\times10^{-11}\,N\,m^2/kg^2)(5,98\times10^{24}\,kg)}{1,84\,m/s^2}}^{1} = 7,13\times10^{6}\,m$ R/

8.2

8) $h = \frac{3}{5}R$

$$g = \frac{GM}{(R+h)^2} = \frac{6M}{\left(R+\frac{3}{5}R\right)^2} = \frac{6M}{\left(\frac{8}{5}\cdot R\right)^2}$$

$$g = \frac{(6{,}67\times10^{-11}\ N\,m^2/kg^2)\,(7{,}34\times10^{22}\ kg)}{\left(\frac{8}{5}\cdot 1{,}74\times10^{6}\ m\right)^2} = 0{,}66\ m/s^2 \quad R/$$

Trabajo extraclase.

I Parte

1) a la 7) pág 182 a pág 185 del texto.

8) La distancia aumentó a 4r.

9) c, Si r aumenta a 1,5r, F disminuye a $\frac{F}{(1,5)^2} = 0{,}44F$

10) d Si r aumenta a 5r, "g" disminuye a $\frac{g}{5^2} = \frac{g}{25}$

II Parte.

1) $g_1 = \frac{6m}{(R+h_1)^2}$ $\quad h_1 = \sqrt{\frac{6m}{g}} - R$

$$h_1 = \sqrt{\frac{6{,}67\times10^{-11}\cdot 5{,}98\times10^{24}\ kg}{6{,}7\ m/s^2}} - 6{,}37\times10^{6}\ m$$

✓ $h_1 = 1{,}35\times10^{6}\ m$

✓ $h_2 = 3{,}26\times10^{6}\ m$

$\Delta h = 1{,}91\times10^{6}\ m$ R/

2) $m = \frac{P}{g} = \frac{784\,N}{9{,}8\,m/s^2} = 80\,kg$ $\quad g = \frac{(6{,}67\times10^{-11}\,\frac{N m^2}{kg^2})(6{,}4\times10^{23}\,kg)}{(3{,}4\times10^{6}\,m + 2\times10^{6}\,m)^2}$

$g = 1{,}46\,m/s^2$

$P = (80\,kg)(1{,}46\,m/s^2) = 117\,N$ R/

3) $g = \frac{GM}{(R+h)^2} \Rightarrow h = \sqrt{\frac{GM}{g}} - R$ $\quad g = \frac{8{,}9\,m/s^2}{4} = 2{,}23\,\frac{m}{s^2}$

$h = \sqrt{\frac{(6{,}67\times10^{-11}\,N\,m^2/kg^2)(4{,}83\times10^{24}\,kg)}{2{,}23\,m/s^2}} - 6{,}05\times10^{6}\,m$

$h = 5{,}97\times10^{6}\,m$ R/

4) $g = \frac{GM}{(R+h)^2} = \frac{GM}{(R+2R)^2} = \frac{GM}{(3R)^2}$

$g = \frac{(6{,}67\times10^{-11}\,N\,m^2/kg^2)(8{,}67\times10^{25}\,kg)}{[3(2{,}34\times10^{7}\,m)]^2} = 1{,}17\,m/s^2$ R/

5) $g_T = \frac{(6{,}67\times10^{-11}\,N\,m^2/kg^2)(5{,}98\times10^{24}\,kg)}{[3(6{,}37\times10^{6}\,m)]^2} = 1{,}09\,m/s^2$

$m = \frac{P}{g} = \frac{25\,N}{1{,}09\,m/s^2} = 22{,}94\,kg$

$g_L = \frac{(6{,}67\times10^{-11}\,N\,m^2/kg^2)(7{,}34\times10^{22}\,kg)}{[3(1{,}74\times10^{6}\,m)]^2} = 0{,}18\,m/s^2$

* Léase a una altura de 2 radios lunares sobre la superficie de la Luna.

$P = (22{,}94\,kg)(0{,}18\,m/s^2) = 4{,}13\,N$ R/

6) Mimas $g = \frac{(6,67\times10^{-11}\ N m^2/kg^2)(3,8\times10^{19}\ kg)}{(196\times10^3\ m)^2} = 0,07\ \frac{m}{s^2}$

Rea $g = \frac{(6,67\times10^{-11}\ N m^2/kg^2)(2,49\times10^{21}\ kg)}{(765\times10^3\ m)^2} = 0,28\ \frac{m}{s^2}$

Luna $g = \frac{(6,67\times10^{-11}\ N m^2/kg^2)(7,34\times10^{22}\ kg)}{(1740\times10^3\ m)^2} = 1,62\ \frac{m}{s^2}$

g Mimas < g Rea < g Luna.

Capítulo IX

Actividad 9-1 (página 213)

1) $V = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{V} = \frac{2\pi(100m)}{4,00m/s} = 157s.$

$\#\ \text{vueltas} = \frac{785s}{157s} = 5\ \text{vueltas}.$ R/

2) $V = \frac{2\pi r}{T} = \frac{2\pi(5,0m)}{15s} = 2,09\ m/s.$ R/

3) $F_c = m \cdot a_c = \frac{m v^2}{r}$

$V = \frac{2\pi r}{T} = \frac{2\pi(1,50m)}{0,628s} = 15,0\ m/s$

$F_c = \frac{(0,40kg)(15,0\ m/s)^2}{1,50m} = \boxed{60\ N}$ R/

4) a) $V = \sqrt{\frac{(6,67\times10^{-11}\ N\cdot m^2/kg^2)(1,9\times10^{27}\ kg)}{(6,9\times10^7 m + 3\times10^6 m)}}$

$V = 4,20\times10^4\ m/s$

b) $T = \frac{2\pi(6,9\times10^7 m + 3\times10^6 m)}{4,20\times10^4\ m/s} = 1,08\times10^4\ s$