Black 4 Red 16
Blue 2 Total 22
Black+Blue 6

PR 7 Grav

MC) 1) $F_g = \frac{GMm}{r^2}$ (A) ✓

2) $F_g = \frac{GMm}{r^2} = \frac{GM}{4r^2}$ (d) ✗ c

3) (c) ✓

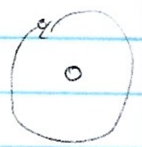
4) $g = \frac{GM}{r^2} = \frac{G(\frac{1}{500}M)}{(\frac{1}{15}r)^2}$

$= \frac{1}{500} \cdot \frac{1}{15} \cdot \frac{1}{15} (9.8 m/s^2)$

(d) $= 0.000087 m/s^2$ (E) ✗

5) (A)? (B)

6) $F_g = F_c = \frac{GMm}{R^2}$



$f = \frac{1}{T}$ $\omega = 2\pi f$

$\omega = \frac{2\pi}{T}$

$F_g = \frac{GMm}{R^2} = F_c$

$= \frac{mv^2}{R}$

$\frac{GM}{R} = v^2$ $v = \frac{2\pi R}{T}$

$\frac{GM}{R} = \frac{4\pi^2 R^2}{T^2}$

$M = \frac{4\pi^2 R^3}{GT^2}$ ✓e (e) or (c) which one is printed wrong

7) F_g F_g 0m ... 4m

$F = \frac{GMm}{r^2}$ $\frac{GMm}{r_1^2} = \frac{G4mm}{r_2^2}$

$r_1 + r_2 = R$

$r_1 = R - r_2$

$\frac{G}{r_1^2} = \frac{4G}{r_2^2}$

$\frac{(R-r_2)^2}{G} = \frac{r_2^2}{4G}$

$R^2 - 2Rr_2 + r_2^2 - \frac{1}{4}r_2^2 = 0$

$\frac{3}{4}r_2^2 - 2Rr_2 + R^2 = 0$

$r_2 = \frac{2R \pm \sqrt{4R^2 - 3R^2}}{\frac{3}{2}}$

$= (2R + R) \cdot \frac{2}{3}, R \cdot \frac{2}{3}$

$= 2R, \frac{2}{3}R$

$r_2 = \frac{2}{3}R$ $r_1 = \frac{1}{3}R$ (e) ✓

8) $\frac{2\pi r_1}{T_1} = \frac{9 \cdot 2\pi r_1}{T_2}$

$\frac{T_2}{9r_1} = \frac{T_1}{r_1}$

$T_2 = 9T_1$?? (A)? (B) ✗

R3 3 R1 1

9) $U = \frac{GMm}{R}$ $KE_f = U_0 = \frac{1}{2} m v_f^2$

$\frac{1}{2} m v_f^2 = \frac{GMm}{(3R)}$

$v_f = \sqrt{\frac{2GM}{3R}}$ (b) (b)

10) ?! × (E)

11) (e)?

FR

1) m_1 - - - - - m_2

a) $F_G = \frac{Gm_1m_2}{r^2} = m_1 a_1$

$a_1 = \frac{Gm_2}{r^2} = \frac{1}{4} \cdot \frac{Gm_2}{R^2}$

~~$a_2 = \frac{1}{4}$~~ b) $a_2 m_2 = \frac{Gm_1m_2}{r^2}$

$a_2 = \frac{1}{4} \frac{Gm_1}{R^2}$ ~

b) ~~$U_0 = \frac{GMm}{R}$~~ ~~$E_0 = E_f$~~

~~$\frac{GM_1m_2}{R} = \frac{Gm_1m_2}{\frac{1}{2}R} + \frac{1}{2} m_1 v^2$~~

~~$\frac{1}{2} m_1 v^2 = \frac{Gm_1m_2}{R} - \frac{2Gm_1m_2}{R}$~~

~~$v^2 = \frac{2Gm_2}{R} - \frac{4Gm_2}{R}$~~

~~$= \sqrt{\frac{-2Gm_2}{R}}$~~ ^

R2

c) $v_f = v_0 + at$

~~$v_f^2 = v_0^2 + 2a\Delta x$~~

~~$v_f = \sqrt{2a\Delta x}$~~

~~$= \sqrt{\frac{2}{4} \frac{Gm_2}{R^2} \cdot \frac{R}{2}}$~~

2) ? ^

1) a) m_1 o———o m_2

$F = \frac{Gm_1m_2}{(\frac{R}{2})^2} = \frac{4Gm_1m_2}{R^2} = m_1 a$

$a = \frac{4Gm_2}{R^2}$ ✓

b) $a_2 = \frac{4Gm_1}{R^2}$ ✓

c) ~~d)~~ e) ~~[illegible]~~

$m_2 > m_1$

$F_{c_1} = \frac{m_1 v^2}{r_1} = \frac{Gm_1m_2}{R^2}$

$\frac{r_1}{v^2} = \frac{R^2}{Gm_2}$

$r_1 = \frac{R^2 v^2}{Gm_2}$ $v = \frac{2\pi r_1}{T}$

$r_1 = \frac{4\pi^2 r_1^2 R^2}{Gm_2 T^2}$ ~~[illegible]~~ 2

$$I = \frac{4\pi^2 r_1 R^2}{G m_2 T^2}$$

$$\boxed{r_1 = \frac{G m_2 T^2}{4\pi^2 R^2}}$$ ~

$$F_{c2} = \frac{m_2 v^2}{r_2} = \frac{G m_1 m_2}{R^2}$$

$$\frac{r_2}{v^2} = \frac{R^2}{G m_1}$$

$$r_2 = \frac{v^2 R^2}{G m_1}$$

$$v = \frac{2\pi r_2}{T}$$

$$r_2 = \frac{4\pi^2 r_2^2 R^2}{G m_1 T^2}$$

$$I = \frac{4\pi^2 r_2 R^2}{G m_1 T^2}$$

$$\boxed{r_2 = \frac{G m_1 T^2}{4\pi^2 R^2}}$$ ~

MC) 2) m=m

$$F_g = \frac{GMM}{R^2} = \frac{G\,mM}{(2R)^2} = \frac{1}{4}\frac{GmM}{R^2}$$

i) c - e) 2)

4) $m_1 \vec{v}_1 + m_2 \vec{v}_2 = 0$ $\quad m_1 v_1 - m_2 v_2 = 0$

$$v_2 = \frac{m_1}{m_2} v_1$$

$$0 - G\frac{m_1 m_2}{R} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 - G\frac{m_1 m_2}{(\frac{R}{2})}$$

$$G\frac{m_2}{R} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 \left(\frac{m_1}{m_2} v_1\right)^2$$

$$G\frac{m_2}{R} = \frac{1}{2}\left(m_1 + m_2\left(\frac{m_1}{m_2}\right)^2\right) v_1^2$$

$$v_1 = m_2 \sqrt{\frac{2G}{(m_1+m_2)m_1 R}}$$ ✓

d) $r_2 = \frac{m_1}{m_2} r_1 = \frac{m_1}{m_2} m_2 \sqrt{\frac{2G}{(m_1+m_2)m_1 R}}$

$$= m_1 \sqrt{\frac{2G}{(m_1+m_2)m_1 R}}$$ ✓

e) $\frac{m_1 v_1^2}{r_1} = G\frac{m_1 m_2}{(r_1+r_2)^2} = \frac{m_2 v_2^2}{r_2}$

$$\frac{m_1 v_1^2}{r_1} = \frac{m_2 v_2^2}{r_2} \qquad v = \frac{2\pi r}{T}$$

$$\frac{m_1}{r_1}\left(\frac{2\pi r_1}{T}\right)^2 = \frac{m_2}{r_2}\left(\frac{2\pi r_2}{T}\right)^2$$

$$m_1 r_1 = m_2 r_2$$

$$\frac{T^2}{(r_1+r_2)^3} = \frac{4\pi^2}{G(m_1+m_2)} \Rightarrow r_1 + r_2 = \sqrt[3]{\frac{G(m_1+m_2)T^2}{4\pi^2}}$$

$$r_1 + r_2 = \sqrt[3]{\frac{G(m_1+m_2)T^2}{4\pi^2}} = r_1 + \frac{m_1}{m_2} r_1$$

$$r_1 = \left(\frac{m_2}{(m_1+m_2)}\right)\left(\frac{G(m_1+m_2)T^2}{4\pi^2}\right)^{1/3}$$

$$r_2 = \left(\frac{m_1}{m_1+m_2}\right)\left(\frac{G(m_1+m_2)T^2}{4\pi^2}\right)^{1/3}$$ ✓

a) $E = -\frac{GmM}{2a}$ $\quad 2a = r_1 + r_2$

also $K_1 = E - U_1 = -\frac{GmM}{r_1+r_2} + \frac{GmM}{r_1}$

$= \frac{GmM}{(r_1+r_2)} \cdot \frac{r_2}{r_1}$

$\frac{1}{2}mv_1^2 = \frac{GmM}{r_1+r_2} \cdot \frac{r_2}{r_1}$

$v_1 = \sqrt{\frac{2GM}{(r_1+r_2)} \frac{r_2}{r_1}}$ ✓

b) $K_2 = E - U_2 = -\frac{GmM}{r_1+r_2} + \frac{GmM}{r_2}$

$= \frac{GmM}{(r_1+r_2)} \cdot \frac{r_1}{r_2}$ $\quad v_2 = \sqrt{\frac{2GMr_1}{(r_1+r_2)r_2}}$ ✓

c) $\frac{v_1}{v_2} = \frac{\sqrt{\frac{2GM}{(r_1+r_2)} \cdot \frac{r_2}{r_1}}}{\sqrt{\frac{2GM}{(r_1+r_2)} \cdot \frac{r_1}{r_2}}} = \frac{r_2}{r_1}$ ✓

d) $L_2 = r_2 m v_2 = r_2 m \sqrt{\frac{2GMr_1}{r_2(r_1+r_2)}}$ ✓

$= m\sqrt{\frac{2GMr_1r_2}{r_1+r_2}}$

e) $a = \frac{1}{2}(r_1+r_2)$ $\quad 2a = r_1 + r_2$

$K_x = E - U_x = -\frac{GmM}{r_1+r_2} + \frac{GmM}{\frac{1}{2}(r_1+r_2)}$

$= \frac{GmM}{r_1+r_2}$ $\quad K_x = \frac{1}{2}mv_x^2$

$v_x = \sqrt{\frac{2GM}{r_1+r_2}}$

f) $\frac{T^2}{a^3} = \frac{4\pi^2}{GM} \Rightarrow T = \sqrt{\frac{4\pi^2 a^3}{GM}}$

$= \sqrt{\frac{4\pi^2(\frac{1}{2}(r_1+r_2))^3}{GM}} = \frac{\pi}{\sqrt{2}}\sqrt{\frac{(r_1+r_2)^3}{GM}}$ ✓

g) $e = \frac{c}{a} = \frac{a-r_1}{a} = \frac{\frac{1}{2}(r_1+r_2)-r_1}{\frac{1}{2}(r_1+r_2)}$

$= \frac{r_2-r_1}{r_2+r_1}$ ✓