p. 303 # 1-9 ANSWERS

1. Natural - always exist naturally occurring i.e. - planet
   Artificial - manmade, put into orbit by human - satellites

2. Microgravity - the environment present when an object is in free fall

3.

3. GPS Satellites - rely on position triangulation.

4. a) Orbit at the same rate as Earth

   b) Appears in the sky at the same time each day

   c) In the same spot all of the time.

5. For a geosynchronous orbit the time is 24 hr = 86400s

$$v = \sqrt{\frac{Gm}{r}} \Rightarrow v^2 = \frac{Gm}{r}$$

But $v = \frac{d}{t} = \frac{2\pi r}{t}$

$$\therefore \left(\frac{2\pi r}{t}\right)^2 = \frac{Gm}{r}$$

$$\frac{4\pi^2 r^2}{t^2} = \frac{Gm}{r}$$

$$r^3 = \frac{Gmt^2}{4\pi^2}$$

$$r = \left(\frac{Gmt^2}{4\pi^2}\right)^{1/3}$$

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$$r = \left(\frac{(6.67\times10^{-11}\ Nm^2/kg^2)(5.98\times10^{24}\ kg)(86400s)^2}{4\pi^2} \right)^{1/3}$$

$$r = 4.2\times10^{7}\ m$$

6. a) $r = 4.5\times10^{9}\ km$
$= 4.5\times10^{12}\ m$
$T = 164.5$ Earth years
$= 164.5(365.25)(24)(60)(60)$
$= 5.191\times10^{9}\ s$
$v = ?$

$$v = \frac{d}{t}$$

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

$$= \frac{2\pi(4.5\times10^{12}\ m)}{5.191\times10^{9}\ s}$$

$$= 5.4\times10^{3}\ m/s$$

b) $m_s = ?$ $v = \sqrt{\frac{Gm_s}{r}} \Rightarrow m_s = \frac{v^2 r}{G}$

$$m_s = \frac{(5.4\times10^{3}\ m/s)^2(4.5\times10^{12}\ m)}{6.67\times10^{-11}\ Nm^2/kg^2}$$

$$= 2.0\times10^{30}\ kg$$

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7. T = 29 Earth years
= 915704005
v = 9.69 km/s
= 9.69×10^3 m/s
r = ?

$$v = \frac{d}{t} = \frac{2\pi r}{T}$$

$$r = \frac{vT}{2\pi}$$

$$= \frac{(9.69 \times 10^3 \text{ m/s})(915704005)}{2\pi}$$

$$= 1.4 \times 10^{12} \text{ m}$$

8. $r = 5.03 \times 10^{11}$ m

a) v = ?
$m_s = 1.99 \times 10^{30}$ kg

$$v = \sqrt{\frac{Gm_s}{r}}$$

$$= \sqrt{\frac{(6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2)(1.99 \times 10^{30} \text{ kg})}{5.03 \times 10^{11} \text{ m}}}$$

$$= 1.62 \times 10^4 \text{ m/s}$$

b) T = ?

$$v = \frac{d}{t} = \frac{2\pi r}{T}$$

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

$$T = \frac{2\pi (5.03 \times 10^{11} \text{ m})}{1.62 \times 10^4 \text{ m/s}}$$

$$T = 195089025 \text{ s} \times \frac{1 \text{ h}}{3600 \text{ s}} \times \frac{1 \text{ d}}{24 \text{ h}} \times \frac{1 \text{ y}}{365.25 \text{ d}}$$

$$= 6.18 \text{ years}$$

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9 $m = 1.99 \times 10^{30}\ kg$
$r = 4.05 \times 10^{12}\ m$
$v = ?$

$$v = \sqrt{\frac{G\,m}{r}}$$

$$v = \sqrt{\frac{(6.67 \times 10^{-11}\ N\,m^2/kg^2)(1.99 \times 10^{30}\ kg)}{4.05 \times 10^{12}\ m}}$$

$$v = 5.43 \times 10^{3}\ m/s$$