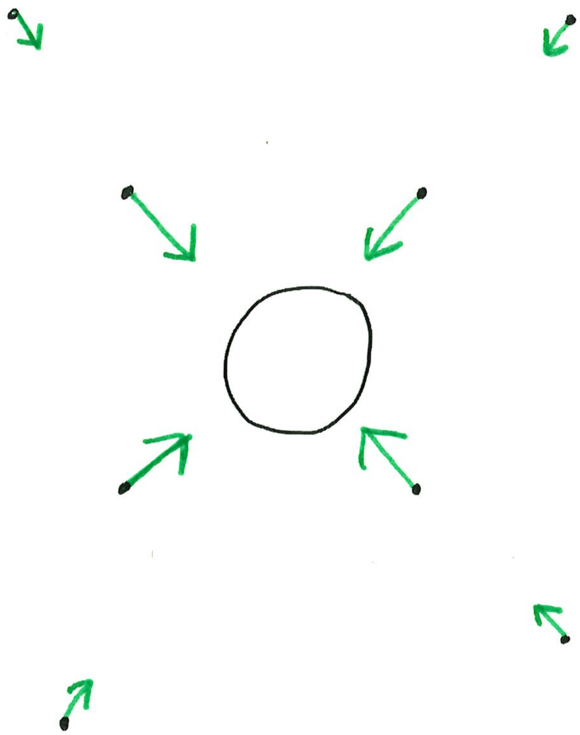
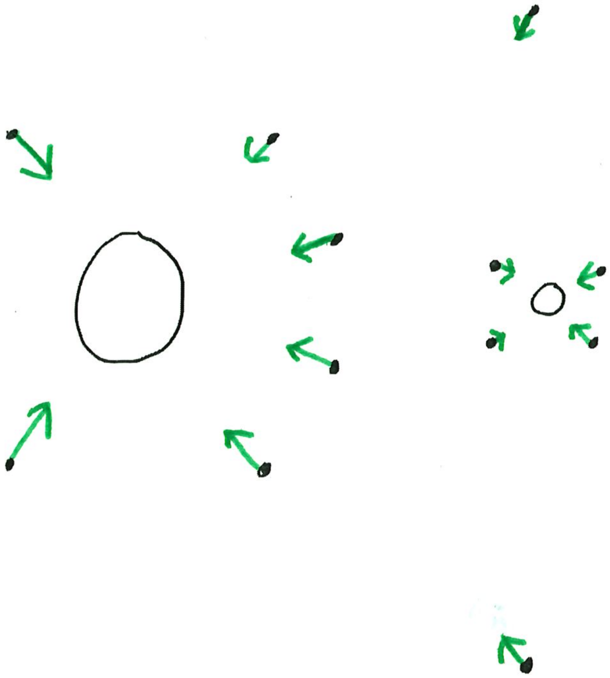
ravity Fields Practice

Name:______________________________

1. Roughly sketch the gravity field acting at each dot around a planet with arrows where the direction of the arrow indicates the direction of the field, and the length of the arrow the relative strength of the field.



2. Roughly sketch the gravity field acting at each dot around a planet and it's moon with arrows where the direction of the arrow indicates the direction of the field, and the length of the arrow the relative strength of the field.



Gravity Fields Practice Name:______________________________

3. The mass of Mars is $6.39 \times 10^{\overset{23}{39}}$ kg and its radius is 3389.5 km. ← 3389500 m
   a. Determine the strength of the gravity field on the surface of Mars.

$$g = \frac{Gm}{r^2} = \frac{6.674\times10^{-11} \times 6.39\times10^{23}}{(3389500\,m)^2}$$

$$= \boxed{3.71\,m/s^2}$$

   b. Determine how long it would take an object to fall from a height of 1.0m to the ground on Mars.

Use $d = v_0 t + \frac{1}{2}at^2$

$a = 3.71\,m/s^2$

$v_0 = 0$

$d = 1.0\,m$

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2\times1.0\,m}{3.71\,m/s^2}}$$

$$= \boxed{0.73\,sec}$$

4. The mass of Pluto is 1.2×10^{22} kg, and its radius is 1185 km.
   a. Determine the strength of the gravity field on the surface of Pluto.

$$g = \frac{Gm}{r^2} = \frac{6.674\times10^{-11} \times 1.2\times10^{22}}{1185000^2}$$

$$= 0.57\,m/s^2$$

   b. Determine how long it would take an object to fall from a height of 1.0 m to the ground on Pluto.

$$t = \sqrt{\frac{2\times1.0\,m}{0.57\,m/s^2}}$$

$$= \boxed{\cancel{2.5\text{ seconds}}}$$

1.9 sec

Gravity Fields Practice Name:______________________________

5. A neutron star is an incredibly dense object, a typical neutron star has a radius of about 10.0 km, a mass of 2.8×10^{30} kg.
   a. Determine the strength of the gravity field on the surface of a neutron star.

$$g = \frac{Gm}{r^2} = \frac{6.674\times10^{-11} \times 2.8\times10^{30}}{10000^2}$$

$$= 1.87\times10^{12}$$

$$\simeq 1.9\times10^{12}\ m/s^2$$

   b. Determine how long it would take an object to fall from a height of 1.0 m to the ground on the surface of a neutron star.

$$t = \sqrt{\frac{2\times1.0m}{1.87\times10^{12} m/s}} = \boxed{1.0\times10^{-6}\ sec}$$

   c. How much energy would it take to lift a 5.0 kg object from the surface of the neutron star to a height of 1.0 m?

$$E_p = mgh = 5.0kg \times 1.87\times10^{12} N/kg \times 1.0m$$

$$= 9.35\times10^{12}\ J$$

Gravity Fields Practice Name:______________________________

6. Earth has a mass of 5.97×10^{24} kg and a radius of 6371 km.
    a. What is the strength of Earth's gravity field 1500 km **above** the surface?

$$r = 6371\,Km + 1500\,Km = 7871\,Km \times \frac{1000m}{1\,Km} = 7871000m$$

$$g = \frac{Gm}{r^2} = 6.43\,\frac{N}{kg}$$

    b. How far above the surface is the gravity field strength 1.5 N/kg?

$$g = \frac{Gm}{r^2} \rightarrow r = \sqrt{\frac{Gm}{g}} = \sqrt{\frac{6.674 \times 10^{-11} \times 5.97 \times 10^{24}}{1.5}}$$

$$= 16298012\,m$$

$$-\ 6371000m$$

$$= \boxed{9927012m}$$

7. The mass of a planet is 5.62×10^{23} kg. The strength of the gravity field on the surface is 4.3 N/kg. What is the radius of the planet?

$$g = \frac{Gm}{r^2} \rightarrow r = \sqrt{\frac{6.674 \times 10^{-11} \times 5.62 \times 10^{23}}{4.3}}$$

= ~~8~~ 2953432m

$$\approx 2953\,Km$$

Gravity Fields Practice Name:______________________________

8. A planet orbits a star of mass 4.6×10^{30} kg at a radius of 2.4×10^{10} metres.
   a. What is the strength of the gravity field acting on the planet from the star?

$$g = \frac{Gm}{r^2} = 0.5330 \, \frac{N}{kg}$$

   b. What is the centripetal acceleration of the planet?

$$a_c = g = 0.5330 \, m/s^2$$

   c. What is the length of the planet's year?

$$a_c = \frac{4\pi^2 r}{T^2} \rightarrow T = \sqrt{\frac{4\pi^2(2.4\times10^{10})}{0.5330}}$$

$$= 1\,333\,281 \text{ sec}$$

$$\div \; 60$$

$$22\,221 \text{ min}$$

$$\div \; 60$$

$$370 \text{ hr}$$

$$\div \; 24$$

$$\boxed{15 \text{ days}}$$

   ~~d. What is the mass of the planet?~~

Gravity Fields Practice Name:______________________________

9. The Earth has a mass of 5.97×10^{24} kg and a radius of 6371 km. A satellite orbits the Earth every 3.0 hours. How high **above** the surface of Earth planet is the satellite orbiting?

✓ $\times 3600 = 10800$ sec

$a_c = g$

$$\frac{4\pi^2 r}{T^2} = \frac{Gm}{r^2} \rightarrow r^3 = \frac{GmT^2}{4\pi^2}$$

$$r = \sqrt[3]{\frac{GmT^2}{4\pi^2}} = \begin{array}{r} 10\,558\,837 \text{ m} \\ -\ 6371000 \\ \hline \boxed{4\,187\,837 \text{ m} \text{ above}} \end{array}$$

10. A geostationary orbit is one where a satellite orbits at the same rate the Earth turns. This causes the satellite to always be in the same place in the sky for people on the planet, so a satellite dish can be pointed at the satellite and doesn't have to be constantly readjusted. How high above the Earth should a satellite be placed so it is in geostationary orbit?

$$T = 24 \text{hours} \times \frac{3600 \text{ sec}}{1 \text{hr}} = 86400 \text{ sec}$$

$a_c = g$

$$\frac{4\pi^2 r}{T^2} = \frac{Gm}{r^2} \rightarrow r = \sqrt[3]{\frac{GmT^2}{4\pi^2}} = \begin{array}{r} 42\,235\,349 \text{ m} \\ -\ 6371\,000 \text{ m} \\ \hline 35\,864\,349 \text{ m} \end{array}$$

≈ ~~36000 km~~

$\approx \boxed{35900 \text{ km}}$