STUDY QUESTIONS #4 — *ANSWERS*

Review of Compound Fractions (for those who are a little rusty....)

1: in the **numerator**

in general: $\frac{1/a}{b} = \frac{1}{a \times b}$ also written as: $\frac{1}{a\,b}$

for example: $\frac{1/2}{5} = \frac{1}{2 \times 5} = \frac{1}{10}$

test yourself:

$\frac{1/5}{5} = \frac{1}{5 \times 5} = \frac{1}{25}$

$\frac{5/2}{10} = \frac{5}{2 \times 10} = \frac{5}{20} = \frac{1}{4}$

$\frac{2/3}{4} = \frac{2}{3 \times 4} = \frac{2}{12} = \frac{1}{6}$

$\frac{5/1}{1} = \frac{5}{1 \times 1} = \frac{5}{1} = 5$

2: in the **denominator**

in general: $\frac{1}{a/b} = \frac{b}{a}$

for example: $\frac{5}{1/2} = \frac{2 \times 5}{1} = \frac{10}{1} = 10$

test yourself:

$\frac{5}{1/5} = \frac{5 \times 5}{1} = 25$

$\frac{10}{5/2} = \frac{10 \times 2}{5} = \frac{20}{5} = 4$

$\frac{4}{2/3} = \frac{4 \times 3}{2} = \frac{12}{2} = 6$

$\frac{1}{5/1} = \frac{1 \times 1}{5} = \frac{1}{5}$

3. in both the **numerator and denominator**:

in general: $\frac{a/b}{c/d} = \frac{a \times d}{b \times c}$ also written as: $\frac{a\,d}{b\,c}$

for example: $\frac{2/5}{3/2} = \frac{2 \times 2}{5 \times 3} = \frac{4}{15}$

test yourself:

$\frac{2/5}{1/4} = \frac{2 \times 4}{1 \times 5} = \frac{8}{5}$

$\frac{1/3}{5/2} = \frac{1 \times 2}{3 \times 5} = \frac{2}{15}$

$\frac{5/4}{2/3} = \frac{5 \times 3}{2 \times 4} = \frac{15}{8}$

$\frac{5/1}{5/1} = \frac{5 \times 1}{5 \times 1} = \frac{5}{5} = 1$

THE FORCE OF GRAVITY

1. $$F_{\substack{gravity \\ on\,mars}} = \frac{mM_{mars}G}{R_{mars}^2} = \frac{m\frac{1}{10}M_eG}{\left(\frac{1}{2}R_e\right)^2} = \frac{\frac{1}{10}}{\frac{1}{4}}\left[\frac{mM_eG}{R_e^2}\right] = \frac{4}{10}\left[\frac{mM_eG}{R_e^2}\right] = \frac{2}{5}\,F_{\substack{gravity \\ on\,earth}}$$

2. Escape velocity to leave a planet does not depend on the mass of what you want to launch. Escape velocity depends only on the planet's mass and radius. Therefore, both you and the rocket would each need to reach a velocity of at least 11.2 km/s to go into deep space. However, it would require a much greater force to bring the rocket to 11.2 km/s than it would to launch yourself alone to 11.2 km/s. This is because force depends on the product of masses, the rocket and earth or you and earth, and the rocket is a lot more massive than you are.

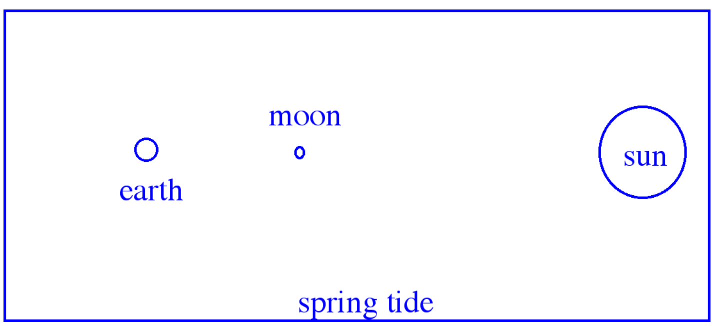
3.

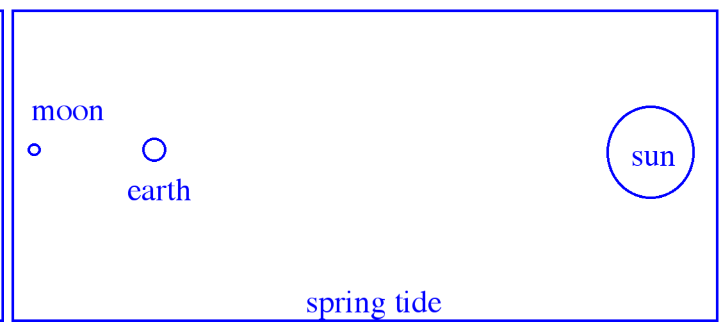
$$v_{escMars} = \sqrt{\frac{2M_{mars}G}{R_{mars}}} = \sqrt{\frac{2\left(\frac{1}{10}M_{earth}\right)G}{\frac{1}{2}R_{earth}}} = \sqrt{\frac{\frac{1}{10}}{\frac{1}{2}}\frac{2M_{earth}G}{R_{earth}}} = \sqrt{\frac{\frac{1}{10}}{\frac{1}{2}}} \times \sqrt{\frac{2M_{earth}G}{R_{earth}}} = \sqrt{\frac{2}{10}} \times v_{escEarth}$$

$$\boxed{v_{esc\,Mars} = \sqrt{\frac{1}{5}} \times v_{esc\,Earth}}$$ or, $$\boxed{v_{esc\,Mars} \text{ is } \sqrt{5} \text{ times less than } v_{esc\,Earth}}$$

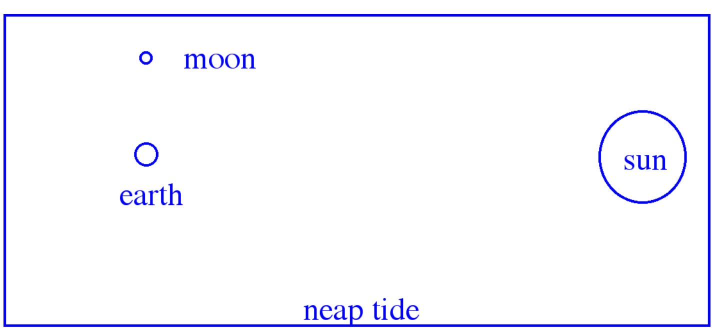
THE TIDES

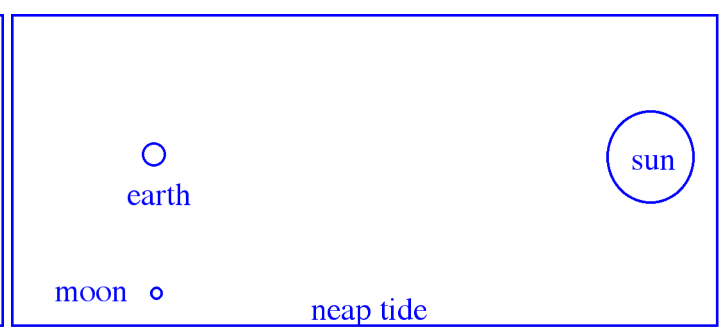
1. A tide is the distortion that is caused by the gravitational force of one body on another being stronger on one side of the body than the other side.



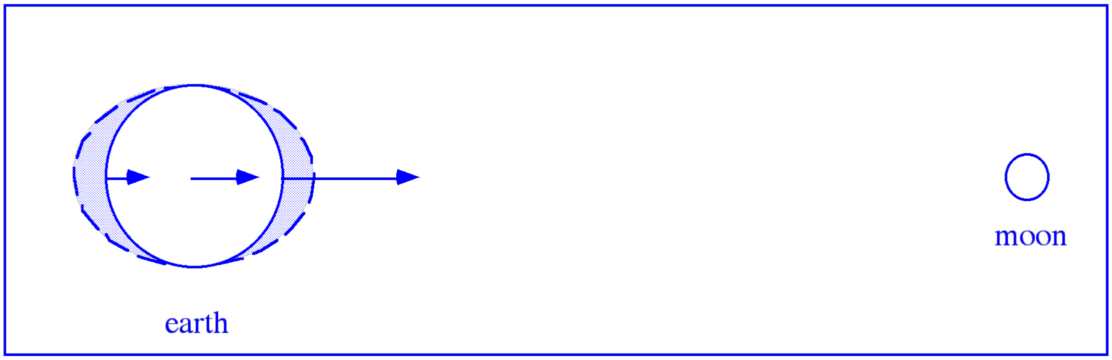


2. spring tides (highest high tides and lowest lows) occur during new (left) and full moons (right).



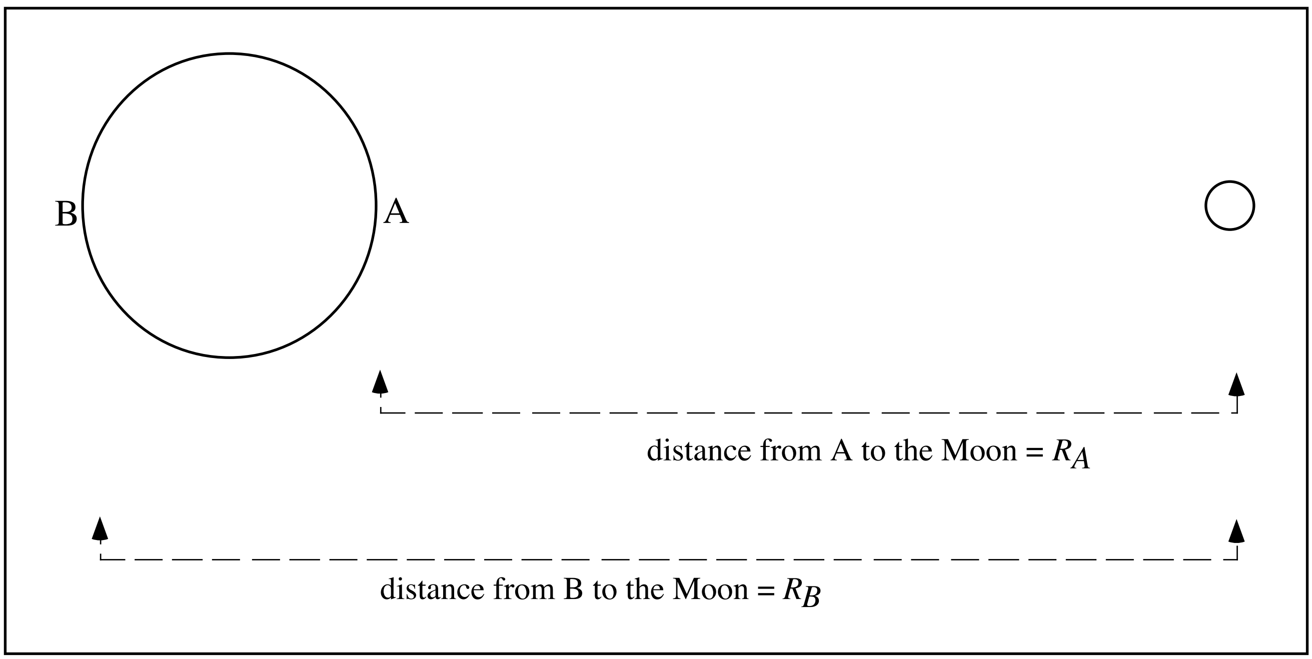


3. neap tides (the lowest high tides and the highest low tides) occur during the 1st (left) and 3rd quarter moons (right).



4. The side of the earth that is nearest the moon experiences the greatest pull and therefore the greatest distortion. The the center of earth is pulled more than the far side of earth, and so essentially the earth is pulled away from the water on the side farthest from the moon.

5. Earth rotates through two high tides and two low tides every day.



6.

$$\frac{F_{\text{at point B}}}{F_{\text{at point A}}} = \frac{\dfrac{m_{moon} M_e G}{R_B^2}}{\dfrac{m_{moon} M_e G}{R_A^2}} = \frac{\dfrac{1}{R_B^2}}{\dfrac{1}{R_A^2}} = \frac{R_A^2}{R_B^2} = \frac{(300{,}000)^2}{(312{,}748)^2} = 0.92$$

which is **92%**

So, the **force of gravity of the moon at point B is 92% of the force at point A**.

7. Tidal lock is the state where one body's orbital period equals its rotation period. Tidal lock occurs because the tides caused by one body on the other distort the body's shape, causing friction and therefore the rotation period slows. Our moon is in tidal lock with earth.

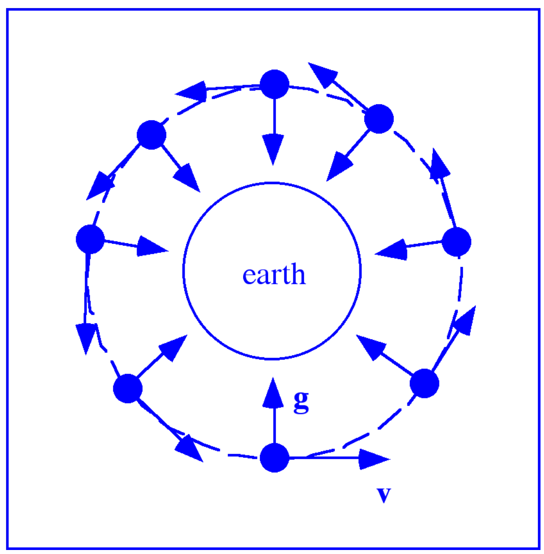
8. Yes! The **range** of the force of gravity that one body produces is infinite (meaning even your mass produces a gravitational force that can be felt across the universe, although it is *very* small!)

9. Anything in orbit falls around the object it is orbiting. To do so, it must have a speed that is just precisely fast enough so that it misses hitting the earth as the earth pulls it down.

10. Weight is due to the force of gravity. Weight is the force you feel when the gravity of earth (or any other thing you're standing on) pulls on you so that you feel it.

11. While orbiting the earth in the space shuttle, the astronauts do not feel the force of gravity that would let them feel their weight because they are continuously falling. If you jumped off a cliff, on the way down you would not feel your weight. Yet for both the cases of the astronaut and your falling off a cliff, the force of earth's gravity is accelerating you down.

12. At each position, gravity pulls toward the center of the earth and the velocity is at right angles to the gravity. Since gravity does not affect velocity in the horizontal direction, the satellite does not need to run its engines once it is in orbit! The satellite is, however, being accelerated (see how the direction of the velocity changes) by the gravity of the earth. Earth's gravity accelerates the satellite TOWARD earth.



ORIGIN OF THE SOLAR SYSTEM

1. The Oort Cloud is a spherical shell of icy material and comets which is about 20,000 AU, surrounding our solar system. It is the left over material from the great cloud of gas from which the sun and planets formed.

2. a few: planets all revolve around the sun in the same direction; all planets (with an exception) rotate on their axes in the same direction; rocky planets are found in the inner solar system whereas the gas giants are found in the outer solar system; all the planets revolve around the sun in the same plane; there is left over debris

3. gravity

4. A star performs fusion of elements, planets do not.
5. fusion is the coming together of nuclei of atoms to form new elements
6. fusion releases enough energy pushing outward that the collapse due to gravity is halted. A star performs a careful balancing act between gravity pulling in and pressure (fueled by fusion) pushing out.
7. H and He (hydrogen and helium)
8. H and He are very light elements, and at the temperature of earth, they have an average velocity that is much greater than the escape velocity of the earth, so earth can't hold onto them. Jupiter's escape velocity (61 km/s) is greater than the average velocity of its H and He and so Jupiter has no trouble hanging onto H and He. Jupiter's escape velocity is so large because of its mass and radius.
9. The escape velocity of the moon is only 2.3 km/s, way below the average velocity that gases would have on its surface.