Name_____ Per____

REVIEW SHEET – GRAVITY AND CIRCLES

1. Read Chapter 7, sections 1-3
2. **Terms to know**: uniform circular motion, cycle, period, linear (tangential) velocity, centripetal force, centripetal acceleration, universal gravitational constant, inverse square law, gravitational field strength, satellite, weightlessness.

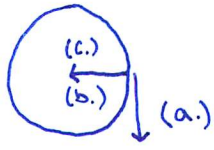
3. State: Newton's Law of Universal Gravitation.

$F = \frac{GMM}{r^2}$ → towards eachother M=masses

4. Define: *gravitational field strength*
the gravitational force exerted per unit mass on a small/point mass

5. For an object in uniform circular motion, describe the direction of its:

   a) instantaneous (linear, tangential) velocity
   tangent to circle in the direction of motion
   b) centripetal force
   inward towards center of circle
   c) centripetal acceleration
   inward towards center



6. State a formula for each quantity in question #4.

7. A race car travels around a circular track at a constant speed. What happens to the centripetal acceleration of the car if:

   a) the speed doubles? $a = \frac{v^2}{r}$ a increased by factor of 4
   b) the radius decreases to half the initial value? $a = \frac{v^2}{r}$ a increased by factor of 2 since r is in denomonator
   c) the mass of the car doubles?
   no change

8. Calculate the force holding the Earth in orbit around the Sun.

$$F = \frac{GM_E M_S}{(R_{E/S})^2} = \frac{(6.67\times10^{-11}\ \frac{Nm^2}{kg^2})(5.97\times10^{24}\ kg)(1.99\times10^{30}\ kg)}{(1.5\times10^{11}\ m)^2} = 3.52\times10^{27}\ N$$

9. What happens to the gravitation force of attraction between two masses when:

   a) the distance between the two masses is doubled? $\times\frac{1}{4}$
   b) the distance between the two masses is halved? $\times 4$
   c) the mass of both objects is doubled? $\times 4$
   d) the mass of one object is halved $\times\frac{1}{2}$

10. Calculate the gravitational field strength on the surface of the Moon.

$$g = \frac{GM_m}{(R_m)^2} = \frac{(6.67\times10^{-11}\ \frac{Nm^2}{kg^2})(7.35\times10^{22}\ kg)}{(1.74\times10^{6}\ m)^2} = 1.62\ m/s^2$$

11. Use your answer to question #9 to calculate your weight on the surface of the Moon.

$m \approx 70\ kg$ $F_g = mg = (70\ kg)(1.62\ m/s^2) = 113\ N$

Name_____ Per____

12. Are astronauts in the space shuttle really "weightless"? Why do they appear so?

no, they are falling at the same rate as the shuttle, so in relation to the shuttle, they appear weightless

13. A student in lab twirls a rubber stopper on a 0.7 m string around in a circle overhead. If the rubber stopper is revolved 15 times in 3.74 seconds and had a mass of 7.2 g, calculate:

a) its period

$$T = \frac{\text{seconds}}{\text{cycle}} = \frac{3.74\text{s}}{15} = \boxed{0.25\text{s}}$$

b) its speed

$$v = \frac{2\pi r}{T} = \frac{2\pi(0.7\text{m})}{0.25\text{s}} = \boxed{17.6\ \text{m/s}}$$

c) its centripetal acceleration

$$a = \frac{v^2}{r} = \frac{(17.6\ \text{m/s})^2}{(0.7\text{m})} = \boxed{443\ \text{m/s}^2} \quad \text{(inward)}$$

d) the tension in the string.

$$\Sigma F = \frac{mv^2}{r} = ma = (.0072\text{kg})(443\ \text{m/s}^2) = \boxed{3.2\text{N}}$$

14. Calculate the average speed of Pluto in its orbit around the Sun.

$$\Sigma F = \frac{mv^2}{r} \qquad r = 5.91 \times 10^{12}\text{m}$$

$$\frac{GMm}{r^2} = \frac{mv^2}{r} \qquad v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67\times10^{-11}\frac{\text{Nm}^2}{\text{kg}^2})(1.99\times10^{30}\text{kg})}{(5.91\times10^{12}\text{m})}} = \boxed{4.7\times10^3\ \text{m/s}}$$

15. Compare the tension in the rope of a motionless and a swinging pendulum.

tension is greater for a swinging pendulum

16. What are the two names and the two formulas for "F_g"?

weight, force of gravity: mg, $\frac{GMm}{r^2}$

17. What are the two names and the two formulas for "g"?

gravitational field strength, accl. due to gravity: $\frac{F_g}{m}$, $\frac{GM}{r^2}$

18. What is the name and value of "G"?

universal gravitational constant, $6.67\times10^{-11}\ \text{Nm}^2/\text{kg}^2$

19. If a scale is in an elevator, when will it read

a) normal?

rest or constant velocity

b) greater than normal?

upward acceleration

c) less than normal?

downward acceleration

ANSWER KEY:

7. 3.5×10^{22} N
9. 1.62 m/s^2
12. (a) 0.25 s (b) 17.6 m/s (c) 443 m/s^2 (d) 3.2 N
13. 4.7×10^3 m/s