

# #1 Gravitation

Equations:  $F = Gm_1m_2/r^2$

$g = GM/r^2$

$v_{\text{esc}} = \sqrt{2GM/R}$

$G=6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$

- 1) If the mass of Earth was three times its present mass, then what would be true about the force of attraction between the Earth and the Sun in the same orbital radius?
- 2) If the Earth had twice the radius but the same mass, then what would be true about the force of gravity that you would have felt on Earth?
- 3) If you had twice the mass you have now, and were orbiting in a spacecraft that was at an altitude of twice the radius of the Earth, what gravitational force would you feel compared to now?
- 4) What is the gravitational force between the Sun and Saturn if the mass of the sun is  $2.0 \times 10^{30} \text{ kg}$ , the mass of Saturn is  $5.71 \times 10^{26} \text{ kg}$ , and the distance between them is  $1.427 \times 10^{12} \text{ m}$ ?
- 5) Using the info from the previous question, what is the force of gravity that Saturn exerts on a 75kg person on Earth if when Saturn is at it closest it is  $1.2774 \times 10^{12} \text{ km}$  away?
- 6) What is the acceleration due to gravity on Saturn if its radius is  $6 \times 10^4 \text{ km}$ ? What if you were an Earth's radius
- 7) What acceleration due to gravity does a 100.kg person exert on a 2.5kg weight that is 3.2m away? What force of gravity exists between them?
- 8) What is the escape speed required to leave the Earth's atmosphere if the mass of the Earth is  $5.98 \times 10^{24} \text{ m/s}$  and the radius of the Earth is  $6.38 \times 10^6 \text{ km}$ ?
- 9) What escape speed would be needed to escape from a black hole if it had a mass of  $4.2 \times 10^{31} \text{ kg}$ , and you were a distance of  $5.2 \times 10^4 \text{ m}$  away? If you were light and traveled at  $3 \times 10^8 \text{ m/s}$ , would you get away?

## Answers

- 1) It would be three times as much.
- 2) It would have been 4 times smaller.
- 3) It would be half as much.
- 4)  $3.74 \times 10^{22} \text{ N}$
- 5)  $1.75 \times 10^{-12} \text{ N}$
- 6)  $10.58 \text{ m/s}^2$
- 7)  $6.51 \times 10^{-10} \text{ m/s}^2$ ,  $1.63 \times 10^{-9} \text{ N}$
- 8)  $353.6 \text{ m/s}$
- 9)  $3.28 \times 10^8 \text{ m/s}$ , nope!