

Worksheet – Newton's Laws

First Law

1. True or false – A force is needed to move **False**
2. True or false – A force is needed to start moving **True**
3. True or false – A force is needed to stop moving **True**
4. True or false – A force is needed to change direction **True**

Second Law

5. A force of 120 N on a mass of 4 kg produces an acceleration of
 - a) $a = F/m = 120 \text{ N} / 4 \text{ kg} = 30 \text{ m/s}^2$
6. To accelerate a 400 kg mass at 0.2 m/s^2 requires a force of
 - a) $F = ma = 400 \text{ kg} * 0.2 \text{ m/s}^2 = 80 \text{ N}$
7. If the same force is applied to two different masses, M and 3M, then if the acceleration of the smaller mass is 6 m/s^2 then the acceleration of the larger mass is
 - a) Since the acceleration is inversely proportional to the mass, if the mass is three times larger then the acceleration is three times smaller
 - b) the acceleration is therefore $\frac{1}{3} * 6 \text{ m/s}^2 = 2 \text{ m/s}^2$
8. If a force F is applied to mass M then the acceleration is a. If a force six times larger is applied to the same mass then the acceleration is
 - a) Since the acceleration is directly proportional to the force, if the force is six times larger then the acceleration is also six times larger
 - b) The acceleration is therefore 6a
9. If a force F is applied to mass M then the acceleration is a. If the same force is applied to a mass $2\frac{1}{2}M$ then the acceleration is
 - a) Since the acceleration is inversely proportional to the mass, if the mass is 2.5 times larger then the acceleration is 2.5 times smaller
 - b) the acceleration is therefore $a/2.5 = 0.4a$
10. If a force F is applied to mass M then the acceleration is a. If a force 6F is applied to a mass 4M then the acceleration is
 - a) Increasing the force by a factor of six increases the acceleration by a factor of six, but increasing the mass by a factor of four decreases the acceleration by a factor of 4 at the same time.
 - b) the acceleration is therefore $6 * a / 4 = 1.5 a$

Universal Law of Gravity

11. On the surface of the Earth your mass is 45 kg. What would be your mass if you were twice as far from the center of the Earth? **Your mass wouldn't change. It would still be 45 kg.**
12. On the surface of the Earth your weight is 125 lbs. What would be your weight if you were twice as far from the center of the Earth?
 - a) **If you are twice as far from the center, then r becomes twice as big and r^3 becomes $2^2 = 4$ times as big**
 - b) **since the force of gravity is inversely proportional to r^2 the force of gravity would become four times smaller.**
 - c) **Your weight would therefore become $\frac{1}{4} * 125 \text{ lbs} = 31.25 \text{ lbs}$**
13. On the surface of the Earth your weight is 125 lbs. What would be your weight if you were on the surface of a planet of the same radius but 4 times the mass of the Earth?
 - a) **The force of gravity is directly proportional to the mass of the planet. If the mass is four times larger the force of gravity is also four times larger**
 - b) **your weight would therefore be $4 * 125 \text{ lbs} = 500 \text{ lbs}$.**
14. On the surface of the Earth your weight is 125 lbs. What is your weight if you were on the surface of a planet which has twice the radius but 4 times the mass of the Earth?
 - a) **The force of gravity is directly proportional to the mass of the planet. If the mass is four times larger the force of gravity is also four times larger. But the force of gravity is inversely proportional to r^2 the force of gravity would simultaneously become 2^2 times smaller.**
 - b) **your weight would therefore be $4 * \frac{1}{4} * 125 \text{ lbs} = 125 \text{ lbs}$.**
15. On the surface of the Earth your weight is 125 lbs. What is your weight if you were on the surface of a planet which has $1\frac{1}{2}$ the radius but only $\frac{3}{4}$ times the mass of the Earth?
 - a) **The force of gravity is directly proportional to the mass of the planet. If the mass is changed by a factor of $\frac{3}{4}$ the force of gravity is also changed by a factor of $\frac{3}{4}$. But the force of gravity is inversely proportional to r^2 the force of gravity would simultaneously become $(1\frac{1}{2})^2$ times smaller.**
 - b) **your weight would therefore be $\frac{3}{4} * 125 \text{ lbs} / (1\frac{1}{2})^2 = 41.7 \text{ lbs}$.**