Unit 2 → Forces

Newton's First Law

- An object stays at rest or in motion unless acted upon by an unbalanced force
- (F_{net})
- Inertia→Object's stubourness to change
    - Inertia = mass
- Mass (kg)→amount of matter in an object
    - Scalar quantity

Newton's Second Law

- Reference Table: $a = \frac{F_{net}}{m}$
    - Also can be written as $F_{net} = ma$
- Relationships
    - $a \propto F_{net}$
    - $m \propto F_{net}$
    - $a \propto \frac{1}{m}$
    - $m \propto \frac{1}{a}$
- F_{net}→net force (N); unbalanced force; vector quantity
    - $F_{net} = \sum \quad F$
- F_{net} and a are *always in the **same** direction*

Newton's Third Law

- For every action there is an equal and opposite reaction
- Action→who creates the force
- Object→who experiences the force
- Action and reaction pairs are *never the same object*
- Effects of push and pull depend on the mass of object

Force

- Force is a push or pull
- Force acts on an object
- An *agent* causes the push or pull

Mass (m)

- Mass is the measure of the amount of matter in an object
    - Scalar quantity measured in kilograms (kg)

- MASS DOES NOT CHANGE BASED ON LOCATION

Weight (F_g)

- Represented by F_g
- Force of attraction between a planet and an object near its surface
- ALWAYS pulls towards the center of a planet
- ALWAYS attractive
- ALWAYS pulling down on us near the surface of a planet
- CAN change based on location
- Reference table: $g = \frac{F_g}{m}$
    - Can also be written as $F_g = mg$
- F_g→gravitational force (N); vector
- g→acceleration due to gravity ($\frac{m}{s^2}$); vector

Normal Force (F_N)

- F_N→normal force
- Normal→perpendicular
- SUPPORTIVE FORCE between an object and a surface it's in contact with
- F_N= apparent weight
    - What we FEEL as weight is the ground pushing up
- When you are flat on a surface and *not* accelerating up or down
- $F_N = F_g$
- Weightless during free-fall
    - $F_N = 0N$
    - Nothing is supporting us

Friction

- Force caused by contact between 2 objects
- Reference table: $|F_f| \leq \mu|F_N|$
    - F_f→force of friction (N); vectors
    - μ→co-efficent of friction; always less than 1; NO UNITS
        - Motion

        - Materials
        - Lubrication

Kinetic Friction

- Moving friction
- Directed opposite motion
- If you are moving, force of friction is set to some value
    - $F_{f_{kinetic}} = \mu_{kinetic} F_N$
        - $F_f \propto F_N$

Static Friction

- Not moving; stationary
    - Static friction is stationary friction
- Directed opposite intended motion
- If you are *not* moving, your force of static friction will vary
- The harder you push, the harder the force of static friction pushes back
- There is a maximum force of static friction
- Once you reach the max, the object begins to move and transforms to kinetic friction
- $F_{f_{static}} \leq \mu_{static} F_N$

SHOUT IT OUT!!

- ❖ CONSTANT VELOCITY
- ❖ ZERO ACCELERATION
- ❖ $F_{net} = 0N$
- ❖ EQUILIBRIUM

Equilibrium

- Forces are balanced
- Forces add up to 0
    - $\sum \quad F_{net} = 0N$
- Equalibriant
    - The force that creates equilibrium
    - Equal and opposite to the resultant of the forces; you are in balance

Unbalanced Forces

- Elevators
    - Moving in the y-axis
    - Mass and planet are constant
- F_N will vary
    - If $F_N = F_g$
        - Balenced
        - Constant velocity
        - Up or down
    - If $F_N < F_g$
        - We feel lighter
        - Accelerating down
        - F_{net} is down
    - If $F_N > F_g$
        - We feel heavier
        - Accelerating up
        - Moving up or down
        - F_{net} is up

Newton's Laws Quiz

Multiple Choice

1) D
2) A
3) D
4) B
5) A
6) C
7) B
8) C
9) D
10) B

Short Response

11) *5.21* kg
12) *3,240N*
13) *90* kg
14) *4,440N*
15) *-49N*

Newton's Laws Test

Multiple Choice

1) B
2) B
3) D
4) C
5) D
6) C
7) B
8) D
9) A
10) D
11) C
12) A
13) A
14) OMIT
15) OMIT
16) B
17) B
18) A
19) A
20) A

Short Response

21) $140N$
22) $270.66N$
23) $231.5N$
24) $2.61\,m/s^2$
25) OMIT