**Science Reviewer**

**Forces and Motion**

**Definition of Terms:**

* **Measurement** – A way of comparing certain attribute of an object.
* **Direct Measurement** – Taking a measurement using standard tools or instruments **directly on the object** being measured.
* Measuring the **length of a table** using a **ruler or tape measure**.
* Measuring **temperature** using a **thermometer**.
* Measuring **mass** using a **weighing scale**.
* Measuring **time** using a **stopwatch** or **clock**.
* Measuring **voltage** directly with a **voltmeter**.
* **Indirect Measurement** – Obtaining a measurement by **calculating or estimating** it using formulas, proportions or comparisons, especially when direct measurement is not possible.
* Finding the **height of a building** by using **shadow le**ngth and **applying similar triangles**.
* Measuring the **distance across a river** by applying **trigonometry** (e.g., using the Law of Sines).
* Calculating **area or volume** using measurements of length and width (e.g., area = length × width).
* Estimating **the speed of a moving** object using **distance ÷ time**.
* Using **Pythagorean Theorem** to find the diagonal of a **rectangle** when only length and width are measured.
* **Graphical Methods** – Graphical methods involve **drawing** vectors **to scale** and using **geometry** to find results.
* **Analytical Methods** – Analytical methods use **mathematical formulas** to calculate magnitude and direction of vectors.

**Physical Quantities:**

* **Scalar** – **A scalar** is a quantity that is described by **magnitude only** (just a number and unit, no direction).
* Speed (e.g., 60 km/h)
* Mass (e.g., 5 kg)
* Temperature (e.g., 30°C)
* Time (e.g., 10 seconds)
* **Vector** – **A** **vector** is a **quantity** that both **magnitude and direction.**
* Velocity (e.g., 60 km/h north)
* Force (e.g., 10 N to the right)
* Acceleration (e.g., 5 m/s² upward)
* Displacement (e.g., 20 meters east)
* **Resultant** – A **resultant** **vector** is a **single** **vector** that has the **same** **effect** as **two** or **more** **vectors** **combined**.
* If you walk 3 meters north and then 4 meters east, your **resultant displacement** is the **diagonal** between those two directions — found using the **Pythagorean Theorem**:

* **Arrow** –An arrow is used to represent a vector.
* **Length** – **Magnitude** (how big or strong the quantity is). A longer arrow means a greater value.
* **Direction the Arrow Points** – Direction of the vector. For example, an arrow pointing up shows upward force or movement.
* **Tail** – Starting point of the vector
* **Head** – Direction where the vector ends or acts.

**How to Read Compass-Based Angles:**

* In physics and navigation, directions are often given in the form:
* This structure provides both **magnitude of deviation** (in degrees) and a **reference axis** (cardinal direction). To correctly interpret this kind of direction, it's important to understand what each part of the phrase signifies.
* When you hear something like “**25 degrees North of East**,” it means you start from **the East direction** and then turn **25 degrees toward the Nort**h. You're not starting from the North — you're moving from East in the direction **toward North**.
* All angles are measured **counterclockwise from East**, unless otherwise specified.
* How to Interpret the Direction:
* **Step 1**: **Identify the base direction** (the one after the word "of"). This is your starting axis.
* **Step** 2: Locate **the angle** and determine how far to rotate.
* **Step** 3: Determine **the direction of rotation** toward the first direction (the one before "of").
* **Step** 4: Apply **the angle rotation** starting from the base direction, toward the specified direction.
* **Step 5:** The result is a unique direction somewhere between the base and the turn direction.

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| * **General Format** - [angle] [direction 1] of [direction 2] * This means **you start from [Direction 2]**, then **rotate [X degrees] toward [Direction 1]**. * If you are turning **clockwise** from the base direction, you **add** the angle to the base direction. * If you are turning **counterclockwise** from the base direction, you **subtract** the angle from the base direction. | | **Direction:** | **Angle:** |
| **Example 1:** 25° North of East   * Start from **East** (90°) * Turn **25° toward North** (upward) * Final angle = | **Example:** 30° East of North   * Start from **North** (0°) * Turn **30° toward East** (right) * Final angle = | East | 0° or 360° |
| North | 90° |
| West | 180° |
| South | 270° |

**Graphical Method:**

* **Triangle Method** - Vectors are placed head-to-tail; the resultant connects start to end.
* **Step 1:** Draw the first vector to scale in the correct direction.
* **Step 2**: At the **tip of the first**, draw the second vector starting from there.
* **Step 3**: Draw the **resultant vector** (R) from the **start of the first** to the **end of the second**.
* **Step 4**: Measure length and angle of resultant (if needed).
* **Application**: Used when two vectors (e.g., force or velocity) act in different directions. It helps find the single equivalent (resultant) vector.
* **Parallelogram Method** - Two vectors originate from the same point; the diagonal is the resultant.
* **Step 1**: Draw both vectors to scale from a common origin.
* **Step 2**: Draw lines parallel to each vector to form a parallelogram.
* **Step 3**: Draw the diagonal from the common origin to the opposite corner; this is the resultant.
* **Step 4**: Measure the diagonal’s length and angle (if needed).
* **Application**: Commonly used in physics when two forces act simultaneously on the same object from one point.
* **Polygon Method** - Multiple vectors are connected head-to-tail; resultant connects start to final tip.
* **Step 1**: Draw the first vector to scale in its direction.
* **Step 2**: From the tip of the previous vector, draw the next vector.
* **Step 3**: Continue connecting all vectors head-to-tail.
* **Step 4**: Draw the resultant vector from the start of the first to the tip of the last vector.
* **Application**: Used when more than two forces or velocities act sequentially on a body. This method simplifies complex vector addition.

**Analytical Method:**

* **Pythagorean Theorem** – Used when vectors form a right triangle (90° angle between them).
* **Step 1**: Square the magnitudes of the two perpendicular vectors.
* **Step 2**: Add the squares together.
* **Step 3**: Take the square root of the sum to find the resultant.
* **Step 4**: Use trigonometry (e.g., tan⁻¹) to find direction if needed.
* **Application:** When motion occurs in two perpendicular directions, such as moving east and then north. Helps find the total displacement or net force.

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* **Law of Sines** - Used when a triangle has **non-right angles**.
* **Step 1**: Use the formula

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* **Step 2**: Rearrange the equation to solve for unknown sides or angles.
* **Step 3**: Apply known values and solve using a calculator.
* **Step 4**: Use it when angle-side relationships are known (SAS or ASA cases).
* **Application**: Helps solve vector triangles when you don’t have a right angle, such as when two forces act at an arbitrary angle.
* **Law of Cosines** – Used when you know two sides and the included angle.
* **Step 1:** Use the formula

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* **Step 2**: Plug in the magnitudes of the vectors and the angle between them.
* **Step 3**: Compute the value of by solving the equation, whereas is the resultant vector.
* **Step 4**: Use inverse cosine to find angle (if needed).
* **Application**: Perfect for non-right triangle vector problems, like two forces pulling at a specific angle that’s not 90°.

**Types of Motion:**

* Movement of an object defines as a continuous change of a place or position.
* **Rectilinear Motion** – Rectilinear motion is the movement of an object along a **perfectly straight path**, where its position **changes** in a **single** **dimension** over time, such as **a car moving down a straight road** or a **ball dropped vertically**.
* **Curvilinear Motion** – Curvilinear motion refers to the **motion of an object along a curved path** in space, where **both the direction and possibly the speed continuously change**, like a **stone** thrown in a **parabolic** **arc** or a **car turning around** a bend.
* **Angular Motion** – Angular motion describes the **rotation of a body around a fixed point or axis**, with **its position defined by angles** rather than linear distance, such as the **swinging of a clock** **hand** or the **motion of a seesaw**.
* **Rotational Motion** – Rotational motion is **the circular movement of all points on a body around a fixed central axis**, where **each point traces a circular path** and **maintains a constant distance** **from the axis**, like a **spinning fan** or a **rotating wheel**.
* **Oscillatory or Harmonic Motion** – Oscillatory or harmonic motion is **repetitive back-and-forth movement** **around a central equilibrium position**, typically under a restoring force proportional to displacement, as seen in a **swinging pendulum** or a **vibrating guitar string**.

**Fundamental Branches of Motion Study:**

* **Mechanics** – Mechanics is the **branch of physics** that **studies** the **motion of objects** and the **forces** that **cause** or **change** this **motion**, including concepts like **displacement**, **force**, **mass**, and **energy**.
* **Kinematics** – Kinematics is the **study of how objects move**, focusing on **position**, **velocity**, and **acceleration**, **without** **considering** the **forces** that **cause** the **motion**.

**Reference Frame:**

* **Reference Frame** – A reference frame is a **fixed** or **moving point of view** (often with a coordinate system) from **which** an **observer measures** and **describes the motion of objects**, like watching a **train move from a platform** versus **inside the train**.

**Describing Motion Through Position:**

* **Distance** – Distance is the **total length** of the **actual path traveled by an object** during motion, **regardless of direction**, and is **always a positive scalar** quantity.

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| **Distance Formula:** |

* **Displacement** – Displacement is the **shortest straight-line distance** between an **object’s initial and final positions**, including **direction**, making it a **vector** quantity that can be **positive**, **negative**, or **zero**.

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| **Displacement:**  **s** = displacement (m)  **u** = initial velocity (m/s)  **a** = acceleration (m/s²)  **t** = time of travel (s) | **Or** |

**Rate of Motion and Directional Change**

* **Speed** – Speed is **the rate at which an object covers distance over time**, **without** considering **direction**, and is measured in units like **meters per second (m/s).**
* **Average Speed** – Average speed is the total distance traveled divided by the total time taken, giving an overall rate of motion without regard to varying speeds or direction.
* **Instantaneous Speed** – Instantaneous speed is the speed of an object at a specific moment in time, like what a car’s speedometer shows at any given instant.

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| **Speed Formula**   * **Speed** = how fast an object moves, without direction (scalar) * **Distance (d)** = total path length traveled (m) * **Time (t)** = total time taken for the motion (s) |  |

* **Velocity** – Velocity is **the rate of change of displacement over time** **and includes both magnitude (speed) and direction**, making it a **vector quantity**.
* **Final Velocity** – Final velocity is the **velocity of an object at the end of a time interval**, after it has accelerated or decelerated.
* **Average Velocity** – Average velocity is the **total displacement** divided by the **total time taken**, showing the overall rate and direction of motion.

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| **Velocity Formula:**   * **Velocity (v)** = rate of change of displacement with direction (vector) * **Displacement (s)** = shortest straight-line distance between start and end points, with direction (m) * **Time (t)** = duration of motion (s) | |  |
| **Final Velocity Formula:**  **Vi** = initial velocity  **a** = acceleration  **t** = time  **Vf** = final velocity | **Or** | |
| **Average Velocity Formula:**   * **Note:** Different from average speed (which uses distance instead of displacement). | | |

* **Acceleration** – Acceleration is the **rate of change of velocity with respect to time**, describing how quickly an object speeds up, slows down, or changes direction.

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| **Acceleration Formula:**  **a** = acceleration (rate of velocity change) (m/s²)  **v** = final velocity (m/s)  **u** = initial velocity (m/s)  **t** = time taken for change (s) | **Or** |

* **Deceleration** - Deceleration is a type of acceleration where the velocity of an **object decreases over time**, meaning the object is slowing down.

**Measuring Speed Over Time:**

* **Average Speed** – Average speed is **the total distance traveled divided by the total time taken**, giving an **overall rate of motion** without regard to varying speeds or direction.
* **Instantaneous Speed** – Instantaneous speed is **the speed of an object** at a **specific moment in time**, like what a **car’s speedometer shows** at any given instant.

**Newtons First Law of Motion:**

* **Inertia –** From Galileo’s initial idea, Isaac Newton developed the concept of Inertia which states:*“An object at rest remains at rest and that an object in constant motion remains to be in that state of motion unless acted upon by an external force.”*
* Objects do not accelerate on their own; instead, a net external force acts on them to oppose the tendency of resistance to that the objects with accelerate.
* Inertia is a property that is possessed by any material that has mass. The more massive an object is, the more inertia it has.
* Mass is commonly interchanged with weight but they are two different quantities
* **Mass**: Amount of matter an object contains.

1. Scalar and constant
2. Uses kilograms (kg) as a unit of measurement

* **Weight**: Amount of gravitational force than an object experiences.

1. Vector and non-constant
2. Uses newton (N) as a unit of measurement

* On Earth, mass and weight are directly proportional to each other. If the mass of an object is doubled, it’s weight will also be doubled. If its mass is halved, it’s weight will also be halved. But does not mean they are the same.

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| **Equation:** | **Other Information**:   * If the pull of gravity changes, its mass does not. |
| **Equation Simplified:** | **Equation Example:** |

* Mass remains to be constant for any object regardless of location, but weight changes depending on gravity.

**Laws of Motion**

**Newtons First Law (ADHD Version)**:

* Newton's first law, the law of inertia, states that a stationary object remains to be at rest or an object moving at constant velocity continues to be moving at constant speed and direction unless imposed by an external force that gives a net unbalanced force.
* Mass is a measure of inertia. The greater the mass of an object, the greater it resists changes in its state of motion.
* Weight is the product of mass and acceleration due to gravity.

**Newtons Second Law of Motion:**

* **Acceleration** -Acceleration is directly proportional to net force, and both should have the same direction; and is inversely proportional to inertia or the mass.
* **Net Force**: The sum of all forces acting on an object.
* When a net force acts on an object, the object Newtons Second Law, or the law of acceleration, investigates the relationship between force and mass in the object’s acceleration.

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| **Equation:** | **Equation Simplified:** |

**The Following Concepts are Derived from Equation Simplified:**

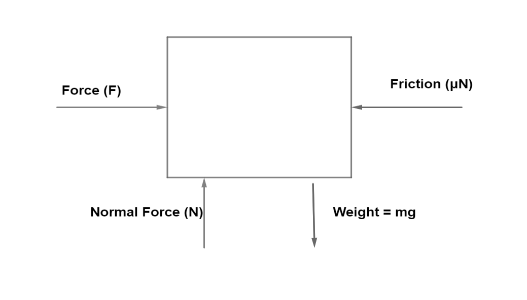
* When the forces are balanced, the net force is zero; hence, acceleration is also zero. On the other hand, a nonzero net force causes acceleration.
* The direction of the net force is the same as the direction of the acceleration. Since the net force causes the acceleration, wherever the net force points, that is where the change in velocity follows. If the direction of the net force is in the same direction as motion, then the object accelerates. The acceleration decreases if the net force is opposite the direction of motion.
* The amount of net force is directly proportional to the acceleration. This means that the higher the net force acting on an object, the more it accelerates. Acceleration is the effect of the net force.
* The more massive an object is, the more it resists changes in motion. Thus, more mass means lower acceleration. The amount of matter an object contains can significantly influence the tendency of that object to change its course of motion.
* Rearranging the variables, you get:
* The units used are as follows:

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| **Net Force:** | **Mass:** | **Acceleration:** |
| * Kilogram meter per second squared (kg m/s2) * Newton (N) | * Kilogram (kg) | * Meter per second squared (m/s2) |

**Newtons Second Law of Motion: (ADHD Version):**

* The second law, the law of acceleration, describes the result of the presence of net force on an object, which is acceleration. The direction of the net force and acceleration are the same, and both are directly proportional. The second law is mathematically expressed as
* A free-body diagram (FBD) is used to draw, using accurate scaling, all the forces acting on the object.
* Forces in an FBD include weight, normal force, tension force, applied force, and frictional force. For a constant acceleration system, the second law expression is used to expand the equation, which is used in the analysis.

**Free Body Diagram:**

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* Used to visualize force and its magnitude and direction.
* **Frictional Force ()** – Force that arcs when surfaces slide or tend to slide over one another.
* **Static Friction** – When force is applied and the object gets disturbed even if it does move.
* **Kinetic Friction** – Type of friction that opposes motion.
* To determine friction, the following formula is used:

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| **Formula:** | **Symbols Definition:** |

* **Balanced Forces** – Equal forces acting that act on the object in opposite directions.
* **Tension (T)** – Force transmitted through cables, strings, and ropes.

**Newtons Third Law of Motion**

* **Interaction or Action** - *“For every action, there is an equal and opposite reaction.”*
* **Action Force**: A pair of forces.
* **Reaction Force**: Is present in interacting objects.
* When two objects interact, the first object exerts a force (action force) on the second object. Similarly, the second object also applies a force that is equal in magnitude but in the opposite direction (reaction force).

**Examples of Action-Reaction Pairs:**

* A rocket pushing on the gas: gas pushing on the rocket.
* Tires pushing on the ground, ground pushing on the tires.
* Gloves pushing on the face, face pushing on the gloves.
* A bird hitting the windshield of a car, windshield hitting the bird.

**Newtons Third Law of Motion (ADHD Version):**

* The law of interaction stats that for every action force, there is an equal and opposite reaction force.
* The action-reaction forces are parts of a single interaction.

Todo list

* Units of measurements in acceleration and other things
* Explain every formula
* Give detailed explanations of each formula