**Harold’s High School Physics**

**Cheat Sheet**

25 September 2025

**The 7 Base Units of Measure**

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| --- | --- | --- | --- |
| **Quantity Name** | **Symbol**  **(Value)** | **Metric Units (SI)** | **Imperial Units (English)** |
| **1. Length / Distance** |  | meter () | foot () |
| **2. Mass** |  | kilogram () | slug (or ) |
| **3. Time** |  | second () | |
| **4. Temperature** |  | Kelvin ()  Celsius () | Fahrenheit () |
| **5. Electrical Current** |  | Ampere () | |
| **6. Amount of Substance** |  | mole () | 1 mol ≈ 6.02214076 × 1023 |
| **7. Luminous Intensity** |  | Candela () | |
| **Note**: The 7 base units are mutually independent from each other.  **All** other units of measurement can be derived from them. | | | |

**Derived Units of Measure**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Quantity Name** | **Symbol**  **(Value)** | **Metric Units**  **(SI)** | | **Imperial Units**  **(English)** | |
| **Length / Displacement** |  | meter () |  | foot () |  |
| **Area** |  |  |  |  |  |
| **Volume** |  | liter () |  | fluid ounce (fl) |  |
| **Velocity / Speed** |  |  |  |  |  |
| **Acceleration** |  |  |  |  |  |
| **Impulse** |  |  |  |  |  |
| **Linear Momentum** |  |  |  |  |  |
| **Force** |  | Newton () |  | pound () |  |
| **Energy / Work / Heat** |  | Joule () |  | calorie () |  |
| **Power** |  | Watt () |  | horsepower () |  |

**Constants and Conversions**

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| --- | --- | --- | --- |
| **Constant Name** | **Symbol** | **Metric Units (SI)** | **Imperial Units (English)** |
| **Length** |  |  |  |
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| **Mass** |  |  |  |
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| (standard gravity) |  |
| **Time** |  |  |  |
| **Acceleration** |  |  |  |
| **Earth’s Gravity** |  |  |  |
| **Moon’s Gravity**  (16.6% of Earth’s) |  |  |  |
| **Temperature** |  |  |  |
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| **Force** |  |  |  |
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| **Volume** |  |  | 1.0 |
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| **How to Solve Physics Word Problems** | | | | | |
| **Modified GUESS Method** | | 1. Read 2. Diagram 3. **G**ivens 4. Observations 5. **U**nknowns | 1. **E**quations 2. **S**olve 3. **S**ubstitute 4. Double-Check | | Drum Major Silhouette Stock Illustrations – 48 Drum Major Silhouette Stock  Illustrations, Vectors & Clipart - Dreamstime |
| **Scenario**  A marching band cadet marches on a football field.  First, he marches 10 yards East, then 40 feet North.  What is the shortest distance he must march to return to where he started? | | | | |
| **#** | **Step** | | | **Example** | |
| Person Reading Icon Vector Art, Icons, and Graphics for Free Download | 1. Carefully **read** the problem.  Translate each word of each sentence into math. | | | Reread the problem several times to make sure you did not miss anything. | |
| Cone Clip Art at Clker.com - vector clip art online, royalty free & public  domain | 2. Draw a **diagram**.  Clearly label everything. | | | **a**  **b**  **c**  **N** | |
| **G** | 3. Write down the **givens** as variables with units.  What information did they provide?  Are any of them extraneous? | | | a = 10 yards East  b = 40 feet North | |
| image of Unicode Character 'EYE' (U+1F441) | 4. Calculate **observations** or easily derived information.  Don’t forget unit conversions for consistency. | | |  | |
| **U** | 5. Write down the **unknowns**.  What are they asking for? | | | The shortest distance is a straight line, or the hypotenuse. ‘’.  = \_\_\_\_?\_\_\_\_ <units> | |
| **E** | 6. Recall relevant **equations** and formulas. | | | Since the path marched is a right triangle, we can use the Pythagorean Theorem: | |
| **S** | 7. **Solve** symbolically for the unknown variable.  Reduce algebraically to the simplest form.  Do not substitute until fully solved. | | |  | |
| **S** | 8. **Substitute** the givens into the solved formula.  Use a calculator as needed to calculate the answer. | | | = 30 feet  = 40 feet | |
| **✓✓** | 9. **Double-check** your work.  Ask yourself if the answer is reasonable and makes  sense. Don’t forget the units. Box in your answer. | | | The shortest distance the cadet must march is 50 feet. | |

See also: [GUESS Method](https://physics-network.org/what-is-the-guess-method-for-problem-solving/) for problem-solving.

**Chapter 1: Let’s Move! (Velocity)**

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| --- | --- | --- | --- | --- |
| **Term** | **Equation** | **Description** | | |
| **Vector Quantity** |  | A quantity that includes direction.  (e.g., magnitude and direction) | | |
| **Scalar Quantity** |  | A quantity that does **not** include direction. | | |
| **Friction** |  | A force that resists motion when two bodies are in contact. | | |
| **Inertia** |  | The tendency of a body to resist changes in its velocity. | | |
| **Average Velocity** |  | The average of the velocity over a given time interval. | | |
| **Instantaneous Velocity** |  | The velocity at a given instant in time. | | |
| **Acceleration** |  | A change in an object’s velocity. | | |
|  | | | | |
| **Rulers** | When using a ruler that is marked off in 16ths of an inch, report your answers to a hundredth of an inch. | | | |
| **Units** |  | You must always list the units after the number.  (The units are just as important as the number.) | | |
| **Significant Figures** | 1. All non-zero figures (1, 2, 3, 4, 5, 6, 7, 8, & 9) are significant. 2. A zero (0) is significant if it is between two significant digits. 3. A zero (0) is also significant if it is at the end of the number *and* to the right of the decimal point. | | | |
| **Using SigFigs** | 1. When **adding** and **subtracting** measurements, you must report your answer to the same precision as the least precise number in the problem. 2. When **multiplying** and **dividing** measurements, you must report your answer with the same number of significant figures as the measurement that has the fewest significant figures. 3. There is always some **error** in the last significant figure of a measurement. | | | |
| **Precision vs. Accuracy** | * **Precision:** The consistency and reproducibility of measurements (e.g., 10 decimal places). * **Accuracy:** How close a measurement is to the true or accepted value. | | | |
| **Scientific Notation** | 14,000,000 = 1.4⨯107 = 1.4E7 | | 0.00000014 = 1.4⨯10-7 = 1.4E–7 | |
| **Systematic Errors** | “*Science cannot prove anything.*”  There is always a possibility that our experiments are wrong since they contain systematic errors. | | | |
| **Unit Conversion** (Train Track Method) | 17 years = ? sec   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 17 yr | 365.24 ~~days~~ | 24 hours | 60 min | 60 sec | **536,464,512 sec** | |  | 1 yr | 1 ~~day~~ | 1 hour | 1 min |  | | | | |
| **Prefixes** | |  |  |  |  | | --- | --- | --- | --- | | **Prefix** | **Abbreviation** | **Meaning** | **Scientific** | | giga | G | 1,000,000,000 | 109 | | mega | M | 1,000,000 | 106 | | **kilo** | **k** | **1,000** | **103** | | hector | H | 100 | 102 | | deca | Da | 10 | 101 | | **centi** | **c** | **0.01** | **10-2** | | **milli** | **m** | **0.001** | **10-3** | | micro | μ | 0.000001 | 10-6 | | nano | n | 0.000000001 | 10-9 | | | | |
| **Speed** |  | Speed () is a scalar quantity. | | |
| **Velocity** |  | Velocity () is a vector quantity. | | |
| **Relative Velocity** |  | | | |
| **Unit Consistency** | Before solving a problem, look at the units and make sure they are consistent.  If they are not, convert the inconsistent units before you continue. ( vs. ) | | | |
| **Newton's First Law of Motion**  (Law of Inertia) | An object will remain at rest, or in motion at a constant velocity ( or constant speed in a straight line), unless acted upon by a net external force (). | | | A diagram of a diagram of a reaction  AI-generated content may be incorrect. |
| **Velocity with Acceleration** | * When acceleration and velocity are in the **same** direction , an object’s speed **increases**. * When acceleration and velocity are in **opposite** directions , an object’s speed **decreases**. | | | |
| **Velocity Graph** | A graph showing speed and speed  AI-generated content may be incorrect. | | | |
| **Slope = Velocity** | The slope of a position () versus time () graph is the velocity (). | | | |

**Chapter 2: Force and Acceleration**

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| **Term** | **Equation** | **Description** | |
| **Newton's Second Law of Motion**  (Law of Acceleration) | At any instant of time, the net force on an object is equal to the object's mass multiplied by its acceleration or, equivalently, the rate at which the object's momentum changes with time . | |  |
| **Free Fall** | The motion of an object when the only force acting on it is the force due to gravity . | | |
| **Air Resistance** | The force with which air resists motion through it. | | |
| **Acceleration** |  | A change in an object’s velocity. | |
| **Acceleration Graph** | What information can you determine from a velocity-time graph? How do you  determine this information? | Homework.Study.com | | |
| **Slope = Acceleration** | The slope of a velocity () versus time () graph is the acceleration (). | | |
| **Force** |  | Force () is any interaction that, when unopposed, changes the motion of an object. | |
| **Acceleration** |  |  | |
| **Velocity** |  | Derivation: Solve for , set , then simplify. | |
| **Position**  (Displacement) |  | Displacement () is the area underneath a velocity versus time graph. | |
| **is Constant** | (Jerk/Jolt) | These equations of motion apply **only** when the acceleration () is constant. | |
| **Gravity** |  | The acceleration due to gravity () on the surface of the Earth is the same for all objects.  It is negative () since it is directed downwards . | |
| **Weight vs. Mass** |  | Weight is a force.  Since and on Earth is , then . | |

**Chapter 3: Friction**

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| **Term** | **Equation** | **Description** | |
| **Newton’s Third Law of Motion**  (Law of Action and Reaction) | If object A exerts a force on object B, then B will exert an equal but opposite force on A. | |  |
| **Static Friction ()** | The frictional force between two surfaces that are stationary relative to each other. | | |
| **Kinetic Friction ()** | The frictional force between two surfaces that are moving relative to each other. | | |
| **Tension ()** | A force transmitted through a rope or similar object (e.g., a thread or chain) when it is pulled. | | |
| **Streamlined Shape** | A shape that reduces air resistance. | | |
| **Wind Resistance** | The faster an object moves through the air, the stronger the air resistance. | | |
| **Terminal Velocity** | The maximum velocity attained by a falling object. | | |
| **Normal Force ()** |  | Friction Physics Notes 1 | |
| **Coefficient of Friction ()** | The coefficient of friction is unitless. It represents a percentage of the normal force that is opposing the applied force.  Static friction () is generally larger than kinetic friction ().   |  |  |  | | --- | --- | --- | | **Material** | **Static ()** | **Kinetic ()** | | Zero friction | 0 | 0 | | Ice or grease | 0.15 | 0.03 | | Paper | 0.35 | 0.25 | | Wood | 0.5 | 0.4 | | Rubber | 0.9 | 0.8 | | | |
| **Block and Tackle**  (Pully System) | This may contain: three different types of pendulums are shown with arrows pointing to the same direction and labeled in red | | |

**Chapter 4: Two-Dimensional Vectors**

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| **Term** | **Equation** | **Description** |
| **Vector Anatomy** | An arrow is used to represent a two-dimensional vector.  The length of the arrow is the magnitude (a scalar quantity).  And the counterclockwise angle from the positive x-axis is the direction.  A 3D arrow symbols: ⊙ out of page (+), ⨂ into the page (–). | |
| **Vectors “Float”** | Arrows representing vectors can be moved freely, as long as their length and direction are not changed. | |
| **Hypotenuse** | The longest side of a right triangle. | |
| **Vertical Component** |  | |
| **Horizontal Component** |  | |
| **Angle** |  | |
| **Magnitude** |  | |
| **Vector Addition** | When adding vectors **A** and **B** to get vector **C**: | |
| Image: Adding two-dimensional vectors - Math Insight | |
| **Angles in Degrees** | Degrees (Angles) | |

**Chapter 5: Two-Dimensional Motion**

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| **Term** | **Equation** | **Description** |
| **Projectile** | An object that has an initial velocity () but experiences only the force of gravity (). | |
| **Parabolic Motion** | Motion along a parabolic path, which is exhibited by projectiles. | |
| **Dimensions** | Two-dimensional (2D) situations can often be analyzed as two one-dimensional (2x 1D) situations. Time (*t*) spans all dimensions. | |
| **Orthoganal** | In two-dimensional (2D) motion, perpendicular () components of the motion operate independently. | |
| **Graph Orientation** | The way we define the angle makes motion up () and motion to the right () (or to the east) positive (+).  These are the best definitions to use with our one-dimensional (1D) motion equations. | |
| **Projectile Motion** | Image result for physics parabolic ball problem  2 | |
|  | **Horizontal (x-axis)** | **Vertical (y-axis)** |
| **Position Equations** |  |  |
| **Velocity Equations** |  |  |
| **Range Equations** |  |  |
| **Air Resistance** | Assume no air/wind resistance (drag).  (If we factor in air/wind resistance, then differential calculus is needed.) | Mathematical Modelling: Modelling the Spread of Diseases with SIRD Model |

**Chapter 6: Newton’s Second Law and Two-Dimensional Motion**

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| **Term** | **Equation** | **Description** |
| **Translational Equilibrium** | The state in which the net force () acting on an object is equal to zero (0). | |
| **Static Translational Equilibrium** | The state in which an object is in translational equilibrium and **is not** moving (). | |
| **Dynamic Translational Equilibrium** | The state in which an object is in translational equilibrium and **is** moving (). | |
| **Accelerometer** | A device that measures acceleration (). | |
| **Axis of Rotation** | An imaginary line around which all points of a rotating body move in circles. | |
| **Lever Arm** | The distance between the axis of rotation and the force used to produce rotational motion. | |
| **Rotational Equilibrium** | Force () causes changes in translational motion, while  torque () causes changes in rotational motion. | |
| **Tension** | Tension () is a force. | |
| **Gravity Components** | On an incline whose angle () is defined relative to the horizontal, the component of the force due to gravity:   * Parallel to the incline is * Perpendicular to the incline is . | |
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| **Coefficient of Friction** |  |  |
| **Torque** |  |  |
| **Rigid Bodies** |  |  |
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**Chapter 7: Uniform Circular Motion and Gravity**

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| **Term** | **Equation** | **Description** |
| **Centripetal Force** | A force directed to the center of a circle. | |
| **Period ()** | The time it takes to complete one full cycle. | |
| **Frequency ()** | The number of cycles that can be completed every second. | |
| **Gravity ()** | The acceleration of the attractive force that exists between all physical objects that have mass. | |
| **Satellite** | A body that orbits another body. | |
| **Frequency** |  | 7.1: Electromagnetic Energy - Chemistry LibreTexts |
| **Speed** |  |  |
| **Centripetal Force** |  |  |
| **Centripetal Acceleration** |  |  |
| **Gravitational Force** |  | Gravitational force | bartleby |
| **Gravitational Constant ()** |  |  |
| **Kepler’s Laws**  (of planetary motion) | **1. Orbits**: All planets move in elliptical orbits, with the sun at one focal point. |  |
| **2. Areas**: A line that connects a planet to the sun sweeps out equal areas in equal time intervals. | ELI5: Kepler's Second Law : r/explainlikeimfive |
| **3. Periods**: The square of a planet’s period is proportional to the cube of its orbit’s semi-major axis. |  |

**Chapter 8: Energy**

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| **Term** | **Equation** | **Description** |
| **Energy** |  | The ability to do work. |
| **Work** |  | The magnitude of an object’s displacement times the parallel component of the applied force. |
| When a body does work, it **loses** energy.  When a body is worked on, it **gains** energy. |
| **Potential Energy (PE)** |  | Energy that is stored but not currently doing work. |
| Potential energy is **relative**, so it must be defined relative to a reference point. |
| **Kinetic Energy (KE)** |  | Energy in the form of motion. |
| **Total Energy (TE)** |  | |
| **The First Law of Thermodynamics** | Energy () cannot be created or destroyed. It can only change forms. | |
| **Power** |  | The amount of energy converted or transferred per unit time. |
| **Units** |  | Joules ()  () |
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|  | Watt ()  () |
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**Chapter 9: Momentum and Its Conservation**

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| **Term** | **Equation** | **Description** |
| **Momentum** |  | |
| **Law of Momentum Conservation** |  | |
| **Elastic Collision** |  | |
| **Inelastic Collision** |  | |
| **Law of Angular Momentum Conservation** |  | |
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**Chapter 10: Periodic Motion**

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| **Term** | **Equation** | **Description** |
| **Periodic Motion** |  | |
| **Hooke’s Law** |  | |
| **Amplitude** |  | |
| **Simple Harmonic Motion** |  | |
| **Damped Harmonic Motion** |  | |
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**Chapter 11: Sound and Light**

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| **Term** | **Equation** | **Description** |
| **Oscillations** |  | |
| **Transverse Wave** |  | |
| **Wavelength** |  | |
| **Longitudinal Wave** |  | |
| **Doppler Effect** |  | |
| **Sonic Waves** |  | |
| **Ultrasonic Waves** |  | |
| **Infrasonic Waves** |  | |
| **Timbre** |  | |
| **Wave-Particle Duality** |  | |
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**Chapter 12: Optics**

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| **Term** | **Equation** | **Description** |
| **Law of Reflection** |  | |
| **Virtual Image** |  | |
| **Real Image** |  | |
| **Refraction** |  | |
| **Spherical Aberration** |  | |
| **Chromatic Aberration** |  | |
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**Chapter 13: The Electrostatic Force**

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| **Term** | **Equation** | **Description** |
| **Electrostatic Force** |  | |
| **Triboelectric Charging** |  | |
| **Charging by Conduction** |  | |
| **Charging by Induction** |  | |
| **Conductor** |  | |
| **Insulator** |  | |
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**Chapter 14: Electricity Has Potential!**

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| **Term** | **Equation** | **Description** |
| **Electric Potential** |  | |
| **Electron Volt** |  | |
| **Capacitor** |  | |
| **Capacitance** |  | |
| **Electric Permittivity ()** |  | |
| **Ground (Electrical)** |  | |
| **Law of Charge Conservation** |  | |
| **Electric Current** |  | |
| **Electric Circuit** |  | |
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**Chapter 15: Electric Circuits**

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| **Term** | **Equation** | **Description** |
| **Drift Velocity** |  | |
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| **Resistor** |  |  |
| **Battery**  (Voltage source) |  |  |
| **Fuse** |  |  |
| **Capacitor** |  |  |
| **Switch** |  |  |
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**Chapter 16: Magnetism**

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| **Term** | **Equation** | **Description** |
| **Basic Law of Magnetism** |  | |
| **Magnetic Permeability ()** |  | |
| **Right-Hand Rule** |  | |
| **Diamagnetic Substance** |  | |
| **Paramagnetic Substance** |  | |
| **Ferromagnetic Substance** |  | |
| **Faraday’s Law of Magnetic Induction** |  | |
| **Electromotive Force** |  | |
| **Alternating Current** |  | |
| **Direct Current** |  | |
| **Rectifier** |  | |
| **Inverter** |  | |
| **Lenz’s Law** |  | |
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**Sources**

These chapters and content are from the textbook:

* Dr. Jay L. Wile (2023). [Discovering Design with Physics](https://www.amazon.com/Discovering-Design-Physics-School-Science/dp/B0C9XMQVZJ/ref=sr_1_3), 1st Edition.