# Chapter 1

# Math Skills

## 1.1 Suggested Time

1 week

## 1.2 Standards and Benchmarks

SI-H-B3, PS-H-A1

## 1.3 Assessment

1. Test
2. Quiz

## 1.4 Objectives

Students should be able to:

1. Solve simple equations for a given variable.

Honors only

2. Solve equations for a given variable involving several methods, including using the quadratic formula and foil methods.
3. Use scientific notation.
4. Use significant digits, physics style.
5. Know the metric prefixes, from nano- through giga-.
6. Do conversions using dimensional analysis.
7. State and use the trigonometric identities: sine, cosine, and tangent.
8. State and use the pythagorean Theorem.
9. Relate radius, diameter, and circumference of a circle.
10. Be able to find the area of the following geometric figures: square, rectangle, triangle, and circle.
11. Know and use the order of operations.
12. Be able to identify the major Greek symbols.

13. Work efficiently with fractions.
14. Identify and use MKS units.
15. Distinguish between fundamental and derived units.

Honors only

16. Identify and use CGS units.
17. Describe the trend of units standards.

# Chapter 2

# Conversions

## 2.1 Suggested Time

3 days

## 2.2 Standards and Benchmarks

PS-H-A1

## 2.3 Assessment

1. Test
2. Quiz

## 2.4 Objectives

Students should be able to:

1. Identify the major metric prefixes

| Prefix | Symbol | Factor |
|---|---|---|
| giga- | G | $10^9$ |
| mega- | M | $10^6$ |
| kilo- | k | $10^3$ |
| centi- | c | $10^{-2}$ |
| milli- | m | $10^{-3}$ |
| micro- | $\mu$ | $10^{-6}$ |
| nano- | n | $10^{-9}$ |
| pico- | p | $10^{-12}$ |

2. Know the major English conversions
   - 1 mi = 5280 ft
   - 1 yd = 3 ft = 36 in
3. Know the major English to metric conversions
   - 1 in = 2.54 cm
   - 1 kg = 2.2 lb (added note: this is a mass to weight conversion - often misused)
4. Know time conversions

- years, weeks, days, hours, minutes, seconds

5. State an unity conversion for any of the above
6. Use dimensional analysis to convert units

# Chapter 3

# Lab Skills

## 3.1 Suggested Time

All year

## 3.2 Standards and Benchmarks

PS-H-A1, SI-H-B3

## 3.3 Assessment

1. Labs
2. Quiz

Students should be able to:

## 3.4 Objectives

1. Plot a set of data on a graph.
2. Identify the following graphing relationships: linear, square, inverse, and no relation.

Honors only

3. Identify the following graphing relationships: square root and exponential.
4. Identify the independent and dependent variable in an experiment.
5. Draw a best fit line for a set of data.
6. Know the equation of a straight line.
7. Define slope.
8. Obtain the slope of a best fit line of a graph.
9. Demonstrate no, negative, positive, and a non constant slope.
10. Define and relate: accuracy, precision, standard deviation, mean, percent error, and fractional percent error.

# Chapter 4

# One Dimensional Kinematics

## 4.1 Suggested Time

2 weeks

## 4.2 Standards and Benchmarks

PS-H-E2, PS-H-E4, SI-H-A4

## 4.3 Assessment

1. Test
2. Quiz
3. Lab - Free Falling Objects
4. Lab - Reaction Time

## 4.4 Objectives

Students should be able to:

1. Define mechanics, dynamics, and kinematics.
2. Understand and use "bar" notation.
3. Distinguish between displacement and distance.
4. Distinguish between instantaneous velocity and average velocity.
5. Compare and contrast speed and velocity.
6. Relate displacement, distance, speed, and velocity.
7. Describe motion using displacement-time, velocity-time, and acceleration-time graphs.
8. Define and relate acceleration to displacement and velocity.
9. Explain the effect of reference frame on ability to judge motion.
10. Distinguish between instantaneous acceleration and average acceleration.

Honors only 11. Define a jerk.

12. Compare and contrast scalar and vector.
13. Use trigonometric functions and Pythagorean Theorem to work with vectors.
14. Define the acceleration due to gravity and what is meant by "g".
15. Calculate displacement, velocity, and acceleration for free falling bodies.

Honors only

16. Use calculator to represent motion.
17. Calculate the minimum length a yellow light should be based on the speed limit.

# Chapter 5

# Graphing Kinematics

## 5.1 Suggested Time

1 week

## 5.2 Standards and Benchmarks

PS-H-E2, PS-H-E4, SI-H-A4

## 5.3 Assessment

1. Test
2. Quiz
3. Lab - Tank and Trolley

## 5.4 Objectives

Students should be able to:

1. Identify the physical quantity associated with the slope of the following graphs: position-time, velocity-time, and acceleration-time.
2. Identify the physical quantity associated with the area under the graph of the following graphs: position-time, velocity-time, and acceleration-time.
3. Find the area under the graph using two methods: "area of shapes" and "count the squares" methods.
4. Identify what relationship is graphed on the position-time, velocity-time, and acceleration-time of an accelerating object.
5. Identify what relationship is graphed on the position-time, velocity-time, and acceleration-time of an object with a constant velocity.
6. Describe what is meant by concave up and concave down.
7. Know the graph of a n accelerating object's x-t graph.
8. Identify the following 5 slopes: positive constant, negative constant, positive non-constant, negative non-constant, and no.

9. Identify the equation for a linear, square, and inverse relationship.
10. Complete time iterations to produce x-t, v-t, a-t graphs.

Honors only

11. Define what is meant by the tangent to a graph.

Honors only

12. Find the slope of the tangent line to the curve.

# Chapter 6

# Vectors

## 6.1 Suggested Time

4 days

## 6.2 Standards and Benchmarks

PS-H-E2

## 6.3 Assessment

1. Test
2. Quiz
3. Lab - Vexing Velocity Vectors

## 6.4 Objectives

Students should be able to:

1. Define and use the basic trigonometric functions: sine, cosine, tangent.
2. Find the inverse of the basic trigonometric functions.
3. Define and use the Pythagorean Theorem.
4. Distinguish between a scalar and a vector.
5. Know the different methods of representing a vector: $\mathbf{v}$ , $\vec{v}$ , etc.
6. Define resultant vector.
7. Describe the process of resolving a vector.
8. Find the resultant vector given two perpendicular or parallel vectors.

Honors only

9. Find the the resultant vector of two non-perpendicular vectors.
10. Add two vectors graphically, using the head to tail method.
11. Add two vectors analytically.

Honors only

12. Understand and use "hat" notation.

Honors only

13. Find the dot product of two vectors.
14. Solve physics problems using vectors.

# Chapter 7

# Two Dimensional Kinematics - Projectile Motion

## 7.1 Suggested Time

2 weeks

## 7.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3

## 7.3 Assessment

1. Test
2. Quiz
3. Lab - Horizontal Projection
4. Lab - Range

## 7.4 Objectives

Students should be able to:

1. Illustrate the independence of horizontal and vertical motion.
2. Define range, time of flight, and maximum height.
3. Identify displacement, velocity, and acceleration at several different points of an object in projectile motion.
4. Describe the trajectory of an object in projectile motion.

Honors only

5. Use quadratic formula to find the time for an object in projectile motion.

Honors only

6. Derive formulas for range, time of flight, and maximum height.

7. Solve problems involving projectile motion.
8. Save shipwrecked victims on an island by dropping supplies.
9. Successfully calculate how to cast a line while fly fishing

# Chapter 8

# Periodic Motion

## 8.1 Suggested Time

2 weeks

## 8.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3

## 8.3 Assessment

1. Test
2. Quiz
3. Lab - Finding Gravity

## 8.4 Objectives

Students should be able to:

1. Define periodic motion, uniform circular motion, and simple harmonic motion.
2. Give examples of period motion, uniform circular motion, and simple harmonic motion.
3. Compare and contrast UCM and SHM.
4. Define frequency and period; know the relationship between the two.
5. Know and use the three equations for UCM to solve physics problems.

Honors only

6. Define and use the equation for angular velocity.

Honors only

7. Derive equations for angular velocity.

8. Know the properties for the vectors of an object in UCM.
9. Define centripetal, as in centripetal acceleration.
10. Define equilibrium and amplitude.
11. Know the properties of the displacement, velocity, and acceleration of an object undergoing SHM.

12. Know the properties of a pendulum.
13. Be able to determine the acceleration due to gravity of an unknown planet using a simple pendulum.
14. Determine the minimum radius a section of street should be based on the speed limit.

Honors only

15. Determine the minimum length a deceleration lane should be to properly get a car off the interstate.

# Chapter 9

# One Dimensional Dynamics

## 9.1 Suggested Time

2 weeks

## 9.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3, ESS-H-D6, PS-H-F2

## 9.3 Assessment

1. Test
2. Quiz
3. Lab - Trolley Lab, Part 2

## 9.4 Objectives

Students should be able to:

1. Compare and contrast mechanics, dynamics, and kinematics.
2. Compare and contrast mass and weight.
3. Compare and contrast inertial mass and gravitational mass.
4. Distinguish between mass and inertia.
5. Identify the MKS unit for mass.
6. Identify the properties of mass.
7. State Newton's three laws of motion.
8. Define the unit of force.
9. Apply Newton's laws in different situations and defend their use.
10. Solve problems with Newton's laws of motion (especially N2)
11. Identify "special forces"
    - weight

- normal
- tension
- friction

12. Draw free body diagrams for a number of situations.
13. Define friction.
14. Define drag force.
15. Define terminal speed.
16. Compare and contrast sliding friction and standard friction.
17. Know the properties of sliding friction.
18. Solve problems including friction.
19. Explain why friction is necessary.
20. Explain anti lock brakes.
21. Demonstrate the principle of equivalence.

Honors only

22. Solve problems using Atwood's machine.

# Chapter 10

# Two Dimensional Dynamics

## 10.1 Suggested Time

2 weeks

## 10.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3, ESS-H-D6, PS-H-F2

## 10.3 Assessment

1. Test
2. Quiz

## 10.4 Objectives

Students should be able to:

1. Resolve force vectors using the trig identities (sin, cos, tan, and Pythagorean Theorem).
2. Define/Compare/Contrast resultant force and equilibrant force.
3. Identify which component of force affects motion.
4. Solve dynamic problems, similar to before, in two dimensions.
    - Solve problems down (or up) and inclined plane.
    - Solve "see-saw" problems, i.e. problems involving torques.
5. Define equilibrium and state the two conditions necessary.
6. Define torque and relate it to force.
7. Define lever arm.
8. Define fulcrum.
9. Define center of mass (center of weight, center of gravity).

# Chapter 11

# Other Forces

## 11.1 Suggested Time

1 week

## 11.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3, ESS-H-D6, PS-H-F2

## 11.3 Assessment

1. Test
2. Quiz

## 11.4 Objectives

Students should be able to:

1. Name the four (three) major forces and briefly describe them.
2. Describe what is meant by the Grand Unified Theory.
3. Identify and apply Kepler's three laws of planetary motion.
4. Describe the history of our understanding of planetary motion and gravity.
5. State and solve problems with Newton's Universal Law of Gravitation.
6. Find the weight of object's under the Earth's surface.
7. Explain why the Earth is not a perfect sphere.
8. Briefly describe Einstein's General Theory of Relativity.

Honors only

9. Use Kepler's third law in math problems.
10. Describe how to "see" black holes.
11. Compare and contrast centripetal and centrifugal force.

Honors only

12. Explain principle of superposition.
13. State Hooke's law.
14. Solve problems with centripetal force and Hooke's law.

# Chapter 12

# Momentum

## 12.1 Suggested Time

1.5 weeks

## 12.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3, ESS-H-D6, PS-H-F2

## 12.3 Assessment

1. Test
2. Quiz

## 12.4 Objectives

Students should be able to:

1. Define momentum.
    - Relate momentum to Newton's second and third laws.
2. Define impulse and relate it to momentum.
    - Use impulse-momentum theorem to explain shock absorbers.
3. State the conservation of momentum law.
4. Solve problems involving conservation of momentum and energy laws.
5. Distinguish between conservative and nonconservative forces.
6. Distinguish internal and external forces.
7. Distinguish kinetic and potential energy.
8. Identify gravitational potential energy.
9. Identify the two types of collisions.
10. Identify the angular analogs to linear dynamics.

11. State the conservation of angular momentum.
12. Explain how the conservation of angular momentum applies to various situations.

Honors only

13. Solve problems involving angular momentum.

# Chapter 13

# Work and Energy

## 13.1 Suggested Time

2.5 weeks

## 13.2 Standards and Benchmarks

PS-H-E1, PS-H-E2, PS-H-E3, ESS-H-D6, PS-H-F2

## 13.3 Assessment

1. Test
2. Quiz
3. Lab - Power
4. Lab - Energy Conservation
5. Project - Design Roller Coaster

## 13.4 Objectives

Students should be able to:

1. State the conservation of energy law.
2. Identify the units for momentum, energy, work, and power.
    - Relate horsepower to watts.
3. Define work, energy, power, and efficiency.
    - Relate the above terms.
4. Solve problems in two dimensions with work/power.

Honors only

5. Solve elastic and inelastic problems in two dimensions.
6. Relate energy and mass.
7. State the work-kinetic energy theorem.
8. Solve problems with the conservation of energy.
9. Explain "Newton's Cradle."

# Chapter 14

# Waves

## 14.1 Suggested Time

2 weeks

## 14.2 Standards and Benchmarks

PS-H-G1, PS-H-G3, SI-H-A5,PS-H-G2,PS-H-G4,SE-H-D1,SE-H-A1,PS-H-D6,PS-H-D7

## 14.3 Assessment

1. Test
2. Quiz
3. Lab - Drill Frequency

## 14.4 Objectives*

Students should be able to:

1. Differentiate between the various types of waves and wave energy.
2. Use problem solving techniques to define and analyze through the characteristics of waves.
3. Demonstrate types of waves through the use of models.
4. Examine the production and parts of a sound wave.
5. Application of sound waves to our environment, music, communications.
6. Relate the effects of sound in personal choices.
7. Examine the nature and properties of light.
8. Examine the application of light waves to our environment, i.e. electromagnetic spectrum
9. Characterize various optical phenomena, including reflection and refraction

# Chapter 15

# Optics

## 15.1 Suggested Time

1.5 weeks

## 15.2 Standards and Benchmarks

PS-H-G1

## 15.3 Assessment

1. Test
2. Quiz
3. Lab - Focal Length

## 15.4 Objectives*

Students should be able to:

1. Identify the various types of mirrors and lenses.
2. Distinguish between concave and convex mirrors and lenses.
3. Identify the properties of objects at different distances in mirrors and lenses.
4. Explain the reflections seen in a spoon.

# Chapter 16

# Electricity and Magnetism

## 16.1 Suggested Time

2.5 weeks

## 16.2 Standards and Benchmarks

PS-H-G2, SI-H-B2, SI-H-A5, SI-H-A7, PS-H-G3

## 16.3 Assessment

1. 2 Tests
2. Quiz
3. Design a circuit
4. Lab - Voltage and Resistance

## 16.4 Objectives*

Students should be able to:

1. Describe and demonstrate static electrical phenomena.
2. Calculate the forces involved in static electricity.
3. Describe and demonstrate magnetic phenomena.
4. Calculate the magnetic forces in magnetic fields.

Honors only

5. Find the cross product of two vectors.
6. Describe the circuit characteristics (AC and DC).
7. Draw and analyze various circuit schematics.
8. Compare and contrast AC and DC circuits.