# Unit 1: Vectors and Kinematics

Content Area: **Science**
Course(s): **Physics/Lab Honors**
Time Period: **6 weeks**
Length: **Weeks**
Status: **Published**

## Unit Overview

This unit covers the concepts of vectors along with graphically and mathematically adding vectors. It then describes how objects move graphically and mathematically in 1 Dimension and 2 Dimension Kinematics. Honors Physics puts a large emphasis on students creating and interpreting motion graphs.

## Transfer

Students will have the opportunity to walk the school hallways while adding their vectors graphically and mathematically to come up with a vector sum. Students will walk in front of a motion sensor in an effort to reproduce either a position vs time or velocity vs time graph.
Students will walk out pretaped vectors on the ground to find a vector sum.

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For more information, read the following article by Grant Wiggins.

http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=60

## Meaning

## Understandings

1) Students will understand how vectors play a role in determining motion.

2) Students will understand the relationship between displacement, velocity, acceleration.

3) Students will understand how the use of trigonometry can be applied in a physics setting.

4) Students will understand how use graphs to completely describe the motion of an object or interpret those

graphs to understand the motion of an object.

## Essential Questions

1) I'm in a train going 50 mph north, I'm walking backwards at 3 mph south, and I throw a ball out the window going west at 25 mph...how fast is that ball actually moving?

2) I want to drop a golf ball on my teachers head...I want it to be moving fast enough to hurt, but not fast enough to cause an injury...how high should I drop it from?

3) If a place kicker in football wants to just barely clear the post every time, how could they calculate how to kick it?

4) During a race, car 1 catches up to and passes car 2. Graphically show on a velocity vs time graph, where these cars are going the same speed and where they physically pass each other.

## Application of Knowledge and Skill

1) Students will be able to calculate the the total displacement they cover despite actually walking a further distance.

2) Students will be able to calculate how far a ball will travel when slung from an 8 foot tall slingshot.

3) Students will be able to us graphs describe a large amount of changing data in a concise graph.

## Students will know...

1) Students will know the difference between a vector and a scalar.

2) Students will know the difference between distance traveled and displacement.

3) Students will know the difference between speed and velocity.

4) Students will know the difference between instantaneous speed and average speed.

5) Students will know the how displacement relates to velocity.

6) Students will know the how velocity changing relates to acceleration

7) Students will know how units affect the presentation of their answer.

8) Students will know how motion is affected differently in the X and Y axis.

9) Students will know how the kinematic equations can interact with each other.

10) Students will know how to "speak the language" of distance vs time, velocity vs time, and acceleration vs time in a graphing situation.

## Students will be skilled at...

1) Graphically and mathematically adding and subtracting vectors.

2) Calculating displacement, velocity, and acceleration using the 3 kinematic equations.

3) Using trigonometry to calculate the motion of an object in 2 dimensions.

4) Graphing motion on a postion, velocity and acceleration graphs

## Academic Vocabulary

| Academic Vocabulary | Application Vocabulary |
|---|---|
| vector | graph |
| scalar | interpret |
| distance | trigonometry |
| displacement | resolve |
| speed | line of best fit |
| velocity | slope |
| acceleration | derivative |
| kinematics | integral |

## Learning Goal 1

SWBAT graphically and mathematically find the sum of multiple vectors in 1 dimension and 2 dimensions.

Proficiency Scale

- SWBAT graphically and mathematically find the sum of multiple vectors in 1 dimension and 2 dimensions.

| | |
|---|---|
| MA.N-VM.A.1 | Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $\|\boldsymbol{v}\|$, $\|\|\boldsymbol{v}\|\|$, $\boldsymbol{v}$). |
| MA.N-VM.B.4 | Add and subtract vectors. |
| MA.N-VM.B.4a | Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. |
| MA.N-VM.B.4b | Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. |
| MA.N-VM.B.4c | Understand vector subtraction $\boldsymbol{v} - w$ as $\boldsymbol{v} + (-w)$, where $-w$ is the additive inverse of $w$, with the same magnitude as $w$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. |
| MA.G-SRT.C | Define trigonometric ratios and solve problems involving right triangles |
| MA.G-SRT.C.8 | Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. |

## Target 1

SWBAT Graphically add and subtract vectors.

- SWBAT Graphically add and subtract vectors.

## Target 2

SWBAT Use trigonometry to mathematically add vectors to find a resultant vector.

- SWBAT Use trigonometry to mathematically add vectors to find a resultant vector.

## Learning Goal 2

SWBAT solve all types of 1-D Kinematic problems and graph all of the processes described quantitatively in either position, velocity, and/or acceleration graph.

Proficiency Scale

- SWBAT solve all types of 1-D Kinematic problems and graph all of the processes described quantitatively in either position, velocity, and/or acceleration graph.

| | |
|---|---|
| MA.N-VM.A.3 | Solve problems involving velocity and other quantities that can be represented by vectors. |
| MA.A-CED.A.4 | Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| MA.A-REI.B.3 | Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. |
| MA.A-SSE.B.3a | Factor a quadratic expression to reveal the zeros of the function it defines. |
| SCI.HS-PS2-1 | Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. |

## Target 1

SWBAT describe the difference between distance traveled/displacement, mathematically calculate both and also explain the difference between speed and velocity.

- SWBAT describe the difference between distance traveled/displacement, mathematically calculate both and also explain the difference between speed and velocity.

## Target 2

SWBAT describe how acceleration relates to a change in velocity and understand what the acceleration due to gravity on the surface of the Earth is.

- SWBAT describe how acceleration relates to a change in velocity and understand what the acceleration due to gravity on the surface of the Earth.

## Target 3

SWBAT Identify which kinematic equation to use in a given situation applied to kinematics in 1-Dimension, along with solving that equation for the correct variable.

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## Target 4

SWBAT graph motion on a position vs. time, velocity vs. time and acceleration vs time graph as well as analyze graphs to interpret the motion that is being described. Students should understand how the slope of

these graphs relates to an adjacent graph.

Note: This will be the major difference in this chapter between Honors and CP Physics. Honors Physics will spend an abundance of time in this chapter going much further into depth with the conceptual understanding of graphing.

- SWBAT graph motion on a position vs. time, velocity vs. time and acceleration vs time graph as well as analyze graphs to interpret the motion that is being described. Students should understand how the slope of these graphs relates to an adjacent graph.

## Target 5

SWBAT Solve kinematic problems involving objects experiencing free fall motion.

- SWBAT Solve kinematic problems involving objects experiencing free fall motion.

## Target 6

SWBAT solve "chase problems" using a system of equations to determine when to moving objects will catch up to one another. Students should be able to graphically describe the solution of this problem showing where the cars have the same speed and the same position.

Note: These problems will be a major difference between CP and Honors Physics. CP Physics will not get into the graphical component of this.

- SWBAT solve "chase problems" using a system of equations to determine when to moving objects will catch up to one another. Students should be able to graphically describe the solution of this problem showing where the cars have the same speed and the same position.

## Learning Goal 3

SWBAT solve all types of 2-D Kinematic problems; conceptually describe the motion of a projectile in 2-D.

Proficiency Scale

- SWBAT solve all types of 2-D Kinematic problems; conceptually describe the motion of a projectile in 2-D

| | |
|---|---|
| MA.N-VM.A.1 | Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $\lvert\boldsymbol{v}\rvert$, $\lvert\lvert\boldsymbol{v}\rvert\rvert$, $\boldsymbol{v}$). |
| MA.N-VM.A.3 | Solve problems involving velocity and other quantities that can be represented by vectors. |
| MA.N-VM.B.4 | Add and subtract vectors. |
| MA.N-VM.B.4a | Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that |

| | |
|---|---|
| | the magnitude of a sum of two vectors is typically not the sum of the magnitudes. |
| MA.N-VM.B.4b | Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. |
| MA.N-VM.B.4c | Understand vector subtraction $\boldsymbol{v} - w$ as $\boldsymbol{v} + (-w)$, where $-w$ is the additive inverse of $w$, with the same magnitude as $w$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. |
| MA.A-CED.A.4 | Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| MA.A-REI.B.3 | Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. |
| MA.A-SSE.B.3a | Factor a quadratic expression to reveal the zeros of the function it defines. |
| MA.G-SRT.C | Define trigonometric ratios and solve problems involving right triangles |
| MA.G-SRT.C.8 | Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. |

## Target 1

SWBAT Describe what projectile motion is and how and why objects move in projectile motion.

- SWBAT Describe what projectile motion is and how and why objects move in projectile motion.

## Target 2

SWBAT mathematically solve 2-D Kinematic problems starting and ending at the same height.

- SWBAT mathematically solve 2-D Kinematic problems starting and ending at the same height.

## Target 3

SWBAT solve 2-D Kinematic problems with objects starting and ending at different heights, using the quadratic formula in certain cases.

Note: Honors Physics will do these problems going from different heights and shooting off on angles. CP Physics will only do these problems shooting off horizontally.

- SWBAT solve 2-D Kinematic problems with objects starting and ending at different heights, using the quadratic formula in certain cases.

## Formative Assessment and Performance Opportunities

Lab Reports

Worksheets

PowerPoints with Notes

Homework and Classwork Activities

Group Activities

In Class Discussion

Do Nows and Closures

Class Polling

Observation

## Summative Assessment

Unit Assessment will be created collaboratively and used for every student in the course. In addition, there will be other assessments in the form of lab reports, pen and paper tests, and quizzes.

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## Accommodations/Modifications

- All instruction, labs, activities, and assessments will be modified and enhanced to adhere to individual student's IEPs and 504s. As well differentiated classroom management strategies will be utilized as to adhere to these students individual plans as well.
- Provide assistance with mathematical calculations as needed.
- Provide review and additional practice for graphs

## Unit Resources

Teacher generated PowerPoints, Notes, Labs and Worksheets

Textbooks

Resource Books

Internet Resources

Computer Based Activities

Projector

Smart Board

Calculators

## 21st Century Life and Careers

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| CRP.K-12.CRP1 | Act as a responsible and contributing citizen and employee. |
| CRP.K-12.CRP2.1 | Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation. |
| CRP.K-12.CRP4.1 | Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome. |
| CRP.K-12.CRP5.1 | Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization. |
| CRP.K-12.CRP6.1 | Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization. |
| CRP.K-12.CRP7.1 | Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation. |
| CRP.K-12.CRP10.1 | Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals. |
| CRP.K-12.CRP12.1 | Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings. |

## Interdisciplinary Connections

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|---|---|
| LA.RST.11-12.1 | Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. |
| LA.RST.11-12.7 | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
| LA.WHST.11-12.9 | Draw evidence from informational texts to support analysis, reflection, and research. |
| MA.N-Q.A.1 | Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. |
| MA.N-Q.A.2 | Define appropriate quantities for the purpose of descriptive modeling. |
| MA.N-Q.A.3 | Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| MA.F-IF.C.7 | Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. |
| MA.K-12.2 | Reason abstractly and quantitatively. |
| MA.K-12.4 | Model with mathematics. |
| MA.A-CED.A.1 | Create equations and inequalities in one variable and use them to solve problems. |
| MA.A-CED.A.2 | Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. |
| MA.A-CED.A.4 | Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| MA.A-SSE.A.1 | Interpret expressions that represent a quantity in terms of its context. |
| MA.A-SSE.B.3 | Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. |