AP Physics 1 – Summer Assignment

Welcome to AP Physics 1! We are looking forward to having you in class this year and sharing our excitement for physics with you.

AP Physics 1 is an algebra-based course that studies matter and energy in order to understand physical phenomena. This course will enable you to improve your critical thinking, physical intuition, and problem solving skills. Among the topics we will cover this year are: motion, force, energy, momentum, rotation, simple harmonic motion, waves, electricity, and circuits.

The textbook for this course is *College Physics* by Etkina, Gentile, and Van Heuvelen. You will <u>NOT</u> need the textbook to complete the summer assignment and will receive a copy when we return to school.

This summer assignment contains three parts. **Part 1** is a review of science and mathematics topics necessary to be successful in AP Physics 1. Your completed copy of **Part 1 will be collected from you on the first day of class meetings** during the 2023-2024 school year. **Parts 2 and 3** require you to study the concepts and equations of motion and kinematics. Resources for **Parts 2 and 3** are listed on those documents.

Part 1 will be **graded for correctness** and is due **the first day of school in September 2023**, or you will earn a zero. You will take a quiz on the questions from **Part 2** during the first week of school. You will be able to use the copy of your answers you completed over the summer. You will complete the quiz for **Part 2** through OnCourse. Also, on the first day of classes, you will submit your solutions and work for **Part 3**.

- **Digital assignments will only be accepted through the Google platform (Google Docs, Google Slides, etc). For verification that you are submitting your own work, your revision history must show development over time.**
- If students are found to have violated school policy, it "will result in loss of credit for the assignment and may result in further disciplinary action as determined by the high school administration." (CHS Handbook)
- Some examples of violating the academic integrity policy
  - Submitting copied work from classmates
  - Sharing information about formal assessments
  - Plagiarizing from online or text resources
  - Found participating in other means of academic dishonesty
  - Use of an AI tool
    - AI-Generated and Not Edited = AI-Generated Text.
    - AI-Generated and Human Edited = AI-Generated Text.
    - AI Outline, Human Written and heavily AI Edited = AI-Generated Text.

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Name: _____

Part 1: Science and Math Basics

For all problems, show your work in the space below the problem. We are interested in your problem solving method as well as your answer. ***You will be graded on both.***

Base Units

mass	kilogram (kg)
length	meter (m)
time	second (s)
electric current	ampere (A)
temperature	kelvin (K)
amount of substance	mole (mol)
luminous intensity	candela (cd)

Metric Prefixes

mega- (M-)	10^6	1 million
kilo- (k-)	10^3	1 thousand
centi- (c-)	10^{-2}	1 hundredth
milli- (m-)	10^{-3}	1 thousandth
micro- (µ-)	10^{-6}	1 millionth
nano- (n-)	10^{-9}	1 billionth

SI Units – Units are important both in communicating answers and solving problems. Understanding how units relate to each other will help you solve problems and check your answers. Read background information on SI Base Units from the NIST website (http://physics.nist.gov/cuu/Units/units.html).

1. Frequency is given by the following expression: frequency = speed / wavelength
    Determine the base units for frequency. (Hint: wave<u>length</u> is a length measurement.)

2. Speed is given by the following expression: $speed = \frac{distance}{time}$. Determine the base units for speed.

3. Momentum is given by the following expression: $momentum = mass * speed$. Determine the base units for momentum.

4. In Einstein's famous equation E = mc², m is mass, c is the speed of light, and E is energy. Using unit analysis, determine the base units for energy (also called the Joule).

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Dimensional Analysis– Sometimes the units given in a problem or collected in the lab are not the most convenient or useful. It is important to be able to convert from one set of units to another. Use dimensional analysis to solve the following problems. (Take a look at this link for background information if you need it.)
http://www2.ucdsb.on.ca/tiss/stretton/Basic_skills/Dimensional_Analysis_Contents.htm

5. The speed of light, c, is 3.00×10^8 m/s. What is it in mi/hr? Express this in scientific notation. (There are 1609 m in a mile.)

6. How many mg are there in 45 kg?

7. Convert 37 cm^3 to m^3.

8. Convert 1.5×10^5 fathoms/lunar month to meters/second. (1 lunar month lasts 29 days, 12 hours, 44 minutes and 3 seconds.)

9. Order the following measurements from *smallest to largest*. Note that I am *not* asking you if *one* second is longer or shorter than *one* ns, but if 4×10^{-3} s is longer or shorter than 3.6 ns.
   A) 0.008 μs   B) 3.6 ns   C) 3×10^{-10} Ms   D) 4×10^{-3} s

10. If light travels at 3.00×10^8 m/s, how long does it take light from our Sun, 1.5×10^{11} m away, to reach Earth? Express this in minutes.

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Algebraic Equations– Solving algebraic equations is a critical skill required to interpret relationships between physical quantities as well as to solve for a particular value.

11. Solve the following equations for the specified variable.

   a. Solve for a: $\qquad v_f = v_i + at$ _____

   b. Solve for v: $F_c = \dfrac{mv^2}{r}$ _____

   c. Solve for m_1: $\qquad F = \dfrac{Gm_1 m_2}{r^2}$ _____

   d. Solve for g: $\qquad T = 2\pi\sqrt{\dfrac{l}{g}}$ _____

   e. Solve for x: $\qquad E = \dfrac{1}{2}kx^2$ _____

   f. Solve for v_i: $\qquad \Delta x = v_i t + \dfrac{1}{2}a t^2$ _____

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Algebraic Relationships

For the following equations, fill in the blank to explain how the variables relate to each other. For 12-14 use words like increases, decreases, or stays the same.

12. $z = \frac{x}{y}$

        i.   As x increases and y stays constant, z _____.

       ii.   As y increases and x stays constant, z _____.

      iii.   As x increases and z stays constant, y _____.

13. $c = ab$

        i.   As a increases and c stays constant, b _____.

       ii.   As c increases and b stays constant, a _____.

      iii.   As b increases and a stays constant, c _____.

14. $p = m\sqrt{n}$

        i.   As n increases and m stays constant, p _____.

       ii.   As p increases and n stays constant, m _____.

15. $r = \frac{s^2}{t^2}$

        i.   If s is tripled and t stays constant, r is multiplied by _____.

       ii.   If t is doubled and s stays consta

iii.   nt, *r* is multiplied by _____.

Part 2: Multiple Choice

Complete all of the following. You will take a quiz on these same questions during the first week of school. You will be allowed to use this sheet and your answers as a reference.

Helpful resources: The Physics Classroom 1-D Kinematics, Lesson 1-5

1. A quantity that is described by both magnitude and direction is known as a scalar.
    a. True   b. False

2. Which of the following is NOT possible:
    a. distance is not zero and displacement is zero.
    b. distance is zero and displacement is non zero.
    c. distance and displacement are both zero.
    d. distance and displacement are both non zero.

3. An object moving in the +x direction experiences an acceleration of +2.0 m/s^2. This means the object
    a. travels 2.0 m in every second.
    b. is traveling at 2.0 m/s.
    c. is decreasing its velocity by 2.0 m/s every second.
    d. is increasing its velocity by 2.0 m/s every second.

4. A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average velocity?
    a. 2.5 m/s
    b. 5.0 m/s
    c. 10 m/s
    d.   0 m/s

5. A motorist travels 160 km at 80 km/h and 160 km at 100 km/h. What is the average speed of the motorist for this trip?
    a.   84 km/h
    b. 89 km/h
    c. 90 km/h
    d. 91 km/h

6.   If the velocity versus time graph of an object is a horizontal line, the object is
    a. moving with zero acceleration.
    b. moving with constant non-zero acceleration.
    c. at rest.

d. moving with increasing speed.

7. You leave on a 548 mile trip in order to attend a meeting that will start 10.8 hours after you begin your trip. Along the way you plan to stop for dinner. If the fastest you can safely drive is 65 mi/h, what is the longest time you can spend over dinner and still arrive just in time for the meeting?
    a. 2.4 h
    b. 2.6 h
    c. 1.9 h
    d. You can't stop at all.

The graph below represents the position as a function of time of a moving object. Use this graph to answer questions 8 and 9
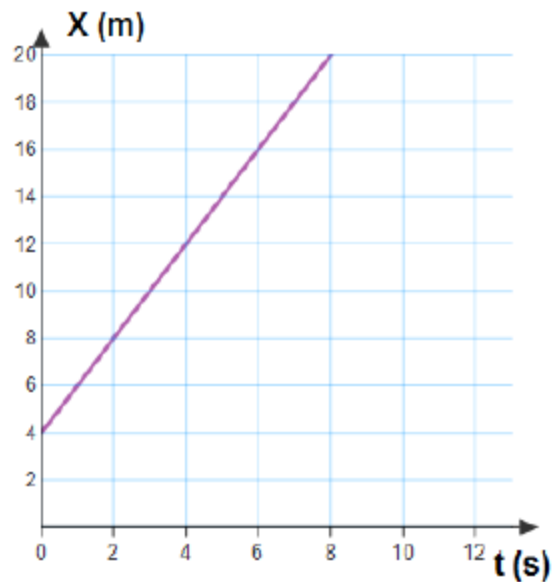
8. What is the initial position of the object?
    a. 2 m
    b. 4 m
    c. 6 m
    d. 8 m
    e. 10 m

9. What is the velocity of the object?
   a. 2 m/s
    b. 2.5 m/s
    c. 4 m/s
    d. 8 m/s

e. 10 m/s

10. Which of the following best describes a situation in which an object has positive velocity and negative acceleration?
    a. Speeding up
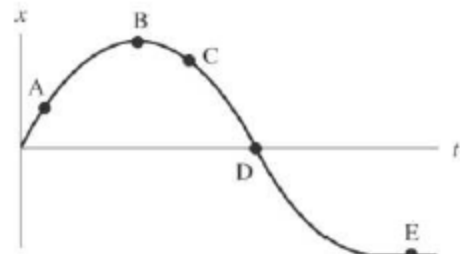   b. Slowing down
    c. Constant speed
    d. At rest

11. A car moves along a straight stretch of road. The following graph shows the car's position as a function of time: At what point(s) is the displacement zero?
    a. A
    b. B
    c. C
    d. D
    e. E
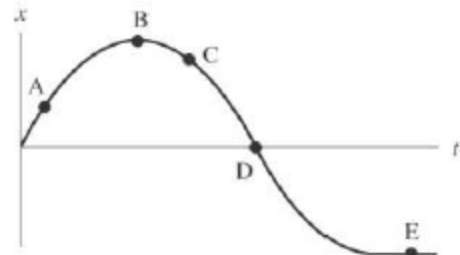
12. A car moves along a straight stretch of road. The following graph shows the car's position as a function of time: At what point(s) is the speed zero?
    a. A
    b. B
    c. C
    d. D
    e. E
    f. B & E

13. When you look at the speedometer in a moving car, you can see the car's
    a. average distance traveled
    b. instantaneous acceleration
    c. average speed
   d. instantaneous speed
    e. average acceleration
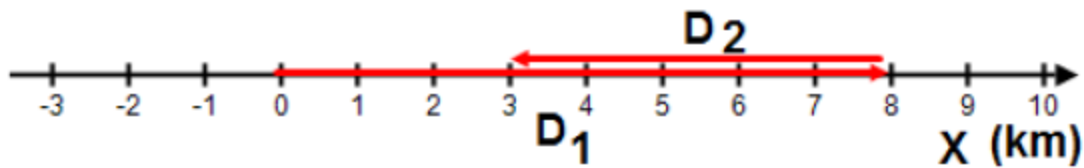
The diagram above illustrates a person who, starting from the origin, walks 8 km east during first day, and 5 km west the next day. Use it to answer questions 14 and 15.

14. What is the net displacement of the person from the initial point in two days?
   a. 6 km, east
   b. 3 km, east
   c. 10 km, west
   d. 5 km, west
   e. 9 km, east

15. What is the traveled distance of the person from the initial point in two days?
   a. 13 km
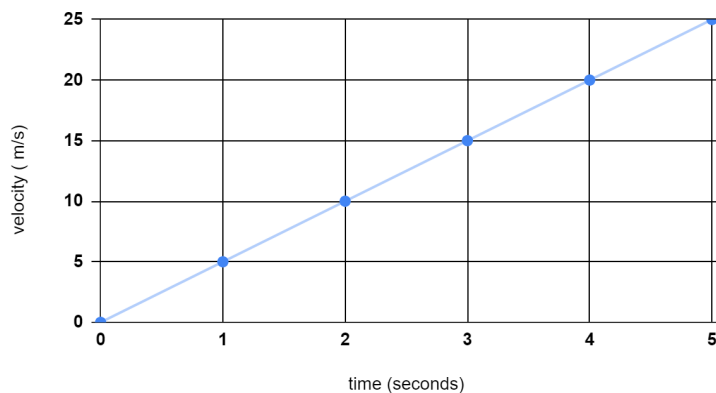   b. 3 km
   c. 10 km
   d. 5 km
   e. 9 km
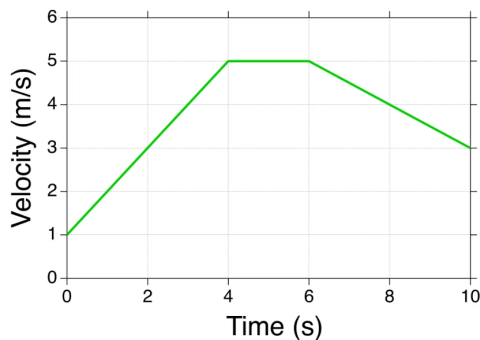
The velocity vs time graph above illustrates the velocity of a car as it passes a speed trap. Use the graph above to answer questions 16-19.

16. What is the initial velocity of the car?
   a. 0 m/s
   b. 1 m/s
   c. 2 m/s
   d. 3 m/s
   e. 5 m/s

17. During which time interval is the car speeding up?
    a. 0-4 seconds
    b. 4-6 seconds
    c. 6-10 seconds
    d. 0-6 seconds
    e. 0-10 seconds

18. During which time interval is the car moving at a constant velocity?
    a. 0-4 seconds
    b. 4-6 seconds
    c. 6-10 seconds
    d. 0-6 seconds
    e. 0-10 seconds

19. During which time interval is the car's acceleration negative?
    a. 0-4 seconds
    b. 4-6 seconds
    c. 6-10 seconds
    d. 0-6 seconds
    e. 0-10 seconds

velocity vs time

time (seconds)

The velocity vs time graph above illustrates the velocity of a car after being stopped at a stop light. Use the graph above to answer questions 20-23.
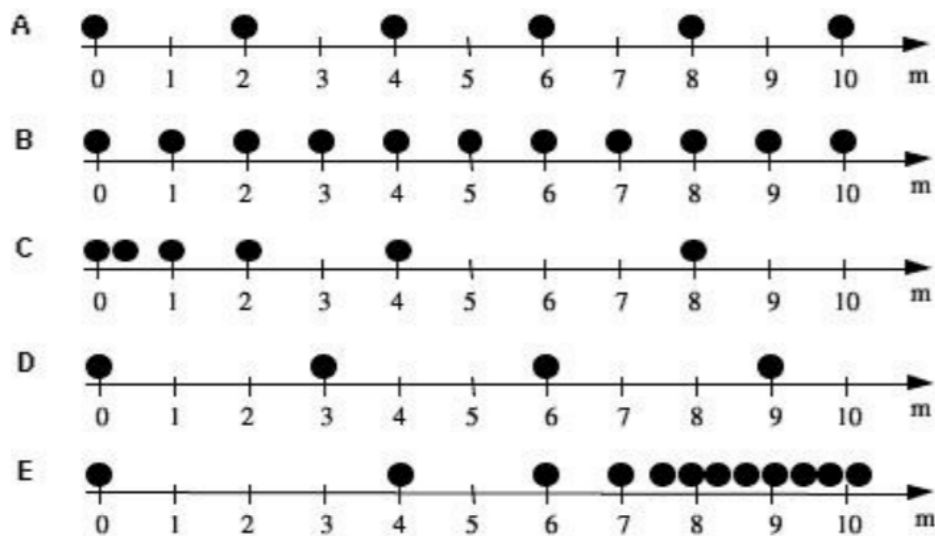
20. What is the initial velocity of the car?
    a. 0 m/s
    b. 5 m/s
    c. 10 m/s
    d. 15 m/s
    e. 20 m/s

21. What is the acceleration of the car from 2-4 seconds?
    a. 5 m/s^2
    b. ⅕ m/s^2
    c. 10 m/s^2
    d. 0 m/s^2
    e. 1/10 m/s^2

22. What is the displacement of the car after 5 seconds?
    a. 25 m
    b. 125 m
    c. 62.5 m
    d. 0 m
    e. 12.5 m

23. Which statement could illustrate the **velocity** at 4 seconds?
    a. 15 m/s East (right)
    b. 15 m/s
    c. 20 m/s
    d. 20 m/s East (right)
    e. 25 m/s

The diagram above illustrates dot diagrams for five different track runners. A dot was recorded every second. Use the diagram to answer questions 24-25.

24. Which track runner has the fastest constant veloicty?
    a. Runner A
    b. Runner B
    c. Runner C
    d. Runner D
    e. Runner E

25. Which track runner is slowing down?
    a. Runner A
    b. Runner B
    c. Runner C
    d. Runner D
    e. Runner E

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Part 3: Problems

Complete each of the following. Show all of your work in a neat and organized manner. Be sure to write out the equations and variables that you use in your work. Circle your answer and be sure to include units. **Part 3** will be collected from you the first day of class.

Helpful resources:
[Step-by-Step Science Kinematics](#) This is a series of 7 youtube videos that explains how to solve kinematics problems.
[The Physics Classroom](#) 1-D kinematics, Lesson 6: Kinematic Equations

1. How far can a car travel in 30 minutes at 44 km/hr?

2. Megan jogs 800 meters east and then turns around and jogs 1200 meters west all in a time of 1000 seconds. Calculate her speed or her velocity? Which is greater? Briefly explain.

3. Maci accelerates a sports car from rest to 35 m/s in 6.4 seconds. What is the magnitude of the car's average acceleration?

4. A world class sprinter can burst out of the blocks to essentially top speed (of about 11.5 m/s) in the first 15.0 meters of the race.
    a. What is the average acceleration of this sprinter?

    b. How long does it take her to reach that speed?

5. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of -5 m/s^2 as it comes to rest.
    a. What is the minimum time from touchdown to full stop for this jet?

    b. What is the shortest runway that could accommodate this jet?

6. An engineer falls asleep while running a train and wakes up just as he passes the station where he was supposed to stop. The train is moving at 28 m/s as it passes the station and it takes him 5.4 seconds to activate the brakes. From the time that the brakes are activated, it takes 7.4 seconds for the train to come to a stop at a uniform rate. How far past the station does the train come to a stop?

7. A speeding motorist travels at 30m/s while it passes a police car (at rest). If the police car begins chasing exactly when the car passes in front of him and accelerates at $6m/s^2$
   a. When will she catch up to the motorist?

   b. How far down the road will they be when the cars paths intersect?

8. A car speeds up from 20m/s to 30m/s over a distance of 50m
   a. The average velocity of the car over this event.

   b. The acceleration of the car.

   c. The time elapsed over the interval.

9. An engineer is to design a runway to accommodate airplanes that must gain a ground speed of 360. km/hr before they can take off. These planes are capable of being accelerated uniformly at the rate of 2.78 m/s^2. How many kilometers long must the runway be?

10. A fully loaded Boeing 747 with all engines at full thrust accelerates at +2.6 m/s^2. Its minimum takeoff speed is 70 m/s. How much time will the plane need to reach its takeoff speed?