Physics Midterm – Study Guide **Name: ___________ Section: ___**

Overview:

- The midterm will include content from the Motion Units (constant and uniformly accelerated motion), and ideas covered in recent nightly reading assignments (freefall and net force).
- The midterm exam is constructed from these practice questions included in this study guide, and therefore an ability to solve these questions correctly under testing conditions is a strong indication of how you will perform on the real midterm.
- The midterm will be a 90-minute exam, and will include about 25 multiple-choice questions as well as 18 short answer response questions (some of which will be multi-part questions).
- The exam is purposefully designed so that you will be unable to pass the exam without a solid performance on both the multiple-choice section, *and* the short answer response section.
- Short answer response questions where quantities are to be calculated will be graded using the same rubric supplied by the regents exam. One point will be awarded for showing the appropriate physics equation, with correct substitutions *with units*, and one point will be awarded for showing the correct final result *with units*.
- Just as before, your overall grade will be calculated according to completeness and correctness (mainly a measure of your precision and overall physics problem solving ability), and a standards-based-score.
- Standards will be evaluated on a 3 point scale:
  - **0 pts**: missing, incomplete, or unable to determine (don't leave anything blank – explain what you know).
  - **1 pt:** The student does not understand the physical science content standard being evaluated, or is unable to demonstrate the skill being measured (however, effort was given to do so).
  - **2 pts:** The student is approaching understanding the physical science content standard being evaluated, or is able to demonstrate a developing ability to perform the skill being measured.
  - **3 pts:** The student is meeting the physical science content standard being evaluated, and is able to demonstrate the ability to perform the skill being measured.
  - **+ pts:** The student clearly demonstrates an above and beyond understanding of the content standard being measured, or has clearly mastered the skill being measured. (+ pts would be taken into consideration for rounding a student's overall grade up a letter grade if they are on the border).
- **Skills that will be measured on this midterm:** The student should be able to…
  - Describe the motion of the object (in terms of position, direction of motion, velocity, acceleration, etc.) given a motion graph (*a vs. t*, *v vs. t* or *x vs. t*)
  - Determine the average velocity of an object using the slope of a position versus time (x vs. t) graph.
  - Determine the displacement of an object by finding the area under a velocity versus time (v vs. t) graph.
  - Determine the average acceleration of the object using the slope of a *v vs. t* graph.
  - Draw an *a vs. t*, *v vs. t* or *x vs. t* graph given one of these three graphs. (The student must understand that the slope of *x vs. t* is the velocity, and that the slope of the *v vs. t* graph is the acceleration).
  - Write the mathematical model relating position and time, velocity and time, or acceleration and time given one of these three graphs (must be familiar with graph shapes and their corresponding mathematical expressions).
  - Identify the known and unknown variables in a given physics system

- Select an appropriate physics equation that can be used to find an unknown quantity in a given physics system.
- Apply the rules of algebra to solve a physics equation for the unknown variable.
- Track and combine units algebraically in a calculation to find a correct result that includes the correct units of measure for the quantity that is being found.

Concept: *Displacement*

Definition: $\boxed{\Delta x = x_f - x_i}$

- Displacement is equal to the difference between the final position and the initial position.
- Displacement is a vector (it has both direction and magnitude), and therefore can be negative or positive.
- The absolute value of displacement is only equal to distance when an object has been traveling in a straight line in a constant direction for the entire duration of its motion:
  - $d = |\Delta x|$ *if and only if the object travels in a straight line, and never changes direction.*
- Displacement can be described in 2D by finding the horizontal and vertical components of displacement separately. [e.g. (Δx, Δy), (West/East, North/South), etc.]
- The magnitude of the total displacement, r, in 2D is calculated using the Pythagorean theorem:
  - $r = \sqrt{(\Delta x)^2 + (\Delta y)^2}$
- If a velocity vs. time graph is given, then displacement can also be calculated by finding the total area between the v vs. t curve and the time axis (areas above time axis are considered positive displacement, areas below the time axis are considered negative displacement).
- Displacement is also included in the several other equations of motion, and therefore can be found algebraically using these equations as long as certain physical quantities are known:
  - $\bar{v} = \dfrac{\Delta x}{\Delta t}$
    - With some algebra we find $\boxed{\Delta x = \bar{v}\,\Delta t}$, a.k.a $x_f = x_i + \bar{v}\,\Delta t$.
    - **Note:** $\bar{v}$ and Δt must be known
  - $x_f = x_i + v_i\Delta t + \frac{1}{2}\bar{a}(\Delta t)^2$
    - With some algebra we find $\boxed{\Delta x = v_i\Delta t + \frac{1}{2}\bar{a}(\Delta t)^2}$.
    - **Note:** v_i, $\bar{a}$, and Δt must be known.
  - $v_f^2 = v_i^2 + 2\bar{a}\Delta x$
    - With some algebra we find $\boxed{\Delta x = \dfrac{v_f^2 - v_i^2}{2\bar{a}}}$.
    - **Note:** v_f, v_i, and $\bar{a}$, must be known.
- Displacement is usually measured and calculated in meters, $[\Delta x] = m$.

Concept: *Distance*

Definition: $\boxed{\text{d = the total length of the path of motion, regardless of direction}}$

- Distance is a scalar (it only has magnitude), and therefore can only be positive.
- The distance is only equal to absolute value of the displacement when an object has been traveling in a straight line in a constant direction for the entire duration of its motion:
  - $\boxed{d = |\Delta x|}$ *if and only if the object travels in a straight line, and never changes direction.*
  - *All of the equations and techniques that can be used to find displacement can also be used to find distance as long as the above circumstances are true.*

- If the average speed and the duration of motion are known quantities, then we can use these quantities to determine the distance traveled:
  - $\bar{v} = \frac{d}{\Delta t} \Rightarrow \boxed{d = \bar{v}\,\Delta t}$
- Distance is usually measured and calculated in meters, $[d] = m$.

Concept: *Average Velocity*

Definition: $\boxed{\bar{v} = \frac{\Delta x}{\Delta t}}$

- Average velocity is equal to the total displacement, Δx, which occurred during a given time interval divided by the elapsed time of that interval, $\Delta t = t_f - t_i$.
- The absolute value of the average velocity is the same as the average speed only if the object has been traveling in a straight line in a constant direction for the entire duration of its motion:
  - $\left|\frac{\Delta x}{\Delta t}\right| = \frac{d}{\Delta t}$ *if and only if the object travels in a straight line, and never changes direction.*
- The average velocity for a given time interval, $\Delta t = t_f - t_i$, can be found from an x vs. t graph by calculating the slope of the line that intersects the two points (t_i, x_i) and (t_f, x_f) for that time interval. Note that $Slope_{(x\ vs.\ t)} = \frac{rise}{run} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t} = \bar{v}$ accordingly.
- When acceleration is uniform, $\boxed{\bar{v} = \frac{v_i + v_f}{2}}$.
  - The proof for this expression is left as an exercise. Hooray!
  - Note that with this equation, the initial and final velocity can be used to find the average velocity, and therefore any expression that can be used to find the initial and final velocity can be used with the above expression to find the average velocity, in addition to equations that contain Δx and/or Δt.
    - For example, both $v_f^2 = v_i^2 + 2\bar{a}\Delta x$ and $v_f = v_i + \bar{a}\Delta t$ contain variables your would need to calculate the average velocity.
- Average velocity is usually measured and calculated in meters per second, $[\bar{v}] = m/s$.

Concept: *Instantaneous Velocity*

Definition: The instantaneous velocity is the velocity of an object at a particular instant.

- The instantaneous velocity is a vector (it has both magnitude and direction) and therefore can be either positive or negative.
- The slope of the line that is tangent to the position vs. time curve for an object in motion at a particular instant *t* is equal to the instantaneous velocity of the object at that instant *t*.
- The average velocity and the instantaneous velocity are only equivalent under the following circumstances:
  - When the acceleration is uniform and zero, the average velocity is constant, and therefore in this case $\boxed{\bar{v} = v}$.
  - When the acceleration is uniform and non-zero, the average velocity for a given time interval is equivalent to the instantaneous velocity at the middle-time for that interval.
    - $\boxed{\bar{v} = v_{mid}}$

- The middle time for a time interval $\Delta t = t_f - t_i$ can be found using the midpoint formula: $t_{mid} = \dfrac{t_f + t_i}{2}$.

- Note that in the kinematics equations the variables v_f and v_i are instantaneous velocities. It is therefore possible to algebraically determine the instantaneous velocity at the beginning and/or end of a given time interval using the kinematic equations!
- Instantaneous velocity is usually measured and calculated in meters per second, $[\bar{v}] = {}^{m}\!/_{s}$.

Concept: *Average Speed*

Definition: $\boxed{\bar{v} = \dfrac{d}{\Delta t}}$

- Average speed is equal to the distance traveled, d, during a given time interval, divided by the elapsed time of that interval, $\Delta t = t_f - t_i$.
- Average speed is a scalar quantity (it only has magnitude) and therefore can only be positive.
- Don't be tricked into thinking that average speed is the same as the arithmetic mean of the different speeds that an object travels. To find average speed add up the total distance traveled, and divide that by the total time elapsed.
- The average speed is the same as the absolute value of average velocity only if the object has been traveling in a straight line in a constant direction for the entire duration of its motion:
  - $\dfrac{d}{\Delta t} = \left|\dfrac{\Delta x}{\Delta t}\right|$ *if and only if the object travels in a straight line, and never changes direction.*
- Average speed is usually measured and calculated in meters per second, $[\bar{v}] = {}^{m}\!/_{s}$.

Concept: *Instantaneous Speed*

Definition: The instantaneous speed is the magnitude of the instantaneous velocity.

- Instantaneous speed is a scalar quantity (it is magnitude only) and is therefore always positive.
- Instantaneous speed can only be treated as being equivalent to the instantaneous velocity when the instantaneous velocity is positive.
- Instantaneous speed is usually measured and calculated in meters per second, $[v] = {}^{m}\!/_{s}$.

Concept: *Average Acceleration*

Definition: $\boxed{\bar{a} = \dfrac{\Delta v}{\Delta t}}$

- Average acceleration is equal to the change in velocity, $\Delta v = v_f - v_i$ during a given time interval, divided by the elapsed time of that interval, $\Delta t = t_f - t_i$.
- The average acceleration is a vector (it has both direction and magnitude) and therefore can be positive or negative.
- The average acceleration for a given time interval, $\Delta t = t_f - t_i$, can be found from a *v vs. t* graph by calculating the slope of the line that intersects the two points (t_i, v_i) and (t_f, v_f) for that time interval. Note that $Slope_{(v\ vs.\ t)} = \dfrac{rise}{run} = \dfrac{v_f - v_i}{t_f - t_i} = \dfrac{\Delta v}{\Delta t} = \bar{a}$ accordingly.

- The average acceleration is found in several kinematics equations, which therefore can be used to find the average acceleration algebraically:
    - $x_f = x_i + v_i \Delta t + \frac{1}{2}\bar{a}(\Delta t)^2$
        - With some algebra, we find $\boxed{\bar{a} = \frac{2\cdot(x_f - x_i - v_i\Delta t)}{(\Delta t)^2}}$.
        - Note that x_f, x_i, v_i, and Δt must be known to calculate average acceleration.
    - $v_f^2 = v_i^2 + 2\bar{a}\Delta x$
        - With some algebra, we find $\boxed{\bar{a} = \frac{v_f^2 - v_i^2}{2\Delta x}}$.
        - Note that v_f, v_i, and Δx must be known to calculate average acceleration.
- Average acceleration is usually measured and calculated in meters per second per second, or meters per second squared, $[\bar{a}] = \frac{m/s}{s} = m/s^2$.

Concept: *Instantaneous Acceleration*

Definition: The acceleration of an object at a particular instant *t*.

- The instantaneous acceleration is always equivalent to the average acceleration *when the acceleration is uniform*: $\boxed{\bar{a} = a}$.

Concept: *Freefall and Acceleration due to Gravity*

Definition: An object is undergoing freefall when the only force acting on it is a uniform force of gravity.

- Objects near the surface of the earth that are experiencing freefall are experience a constant acceleration of $\boxed{g = 9.8\, m/s^2}$ towards the ground. The constant g is named *the acceleration due to gravity*.
- The acceleration due to gravity on other planets may be different than that of Earth.
- When dropped objects are released from rest, their initial velocity is $v_i = 0\, m/s$.
- When objects are tossed in a direction opposite that of gravity, their instantaneous velocity at the peak of their trajectory is $v_{peak} = 0\, m/s$, when the velocity is changing vertical direction.
- The entire time an object is in freefall it has a non-zero constant acceleration of *g*, even if the velocity is zero. (Velocity can still be in the process of *changing* even if it is currently zero).
- In some problems, when air resistance *is* taken into account, the object is not considered to be in freefall and a net force that includes both the force of gravity and a drag force must be taken into account.
    - When the gravitational force is equal and opposite to the drag force, the object experiences a net force of zero, and therefore falls with a constant velocity. This velocity is often referred to as the *terminal velocity*. The terminal velocity is determined by the amount of air resistance – objects with higher susceptibility to air resistance have lower terminal velocities.

Practice:

On the exam you will be given the following:

$\bar{a} \equiv \frac{\Delta v}{\Delta t}$ $x_f = x_i + \bar{v}\Delta t$ $v_f = v_i + \bar{a}\Delta t$ $x_f = x_i + v_i\Delta t + \frac{1}{2}\bar{a}(\Delta t)^2$ $v_f^2 = v_i^2 + 2\bar{a}\Delta x$

$g = 9.8\ m/s^2$ $c = 3\times 10^8\ m/s$

Geometry and Trigonometry

Rectangle

$A = bh$

Triangle

$A = \frac{1}{2}bh$

Circle

$A = \pi r^2$

$C = 2\pi r$

A = area

b = base

C = circumference

h = height

r = radius

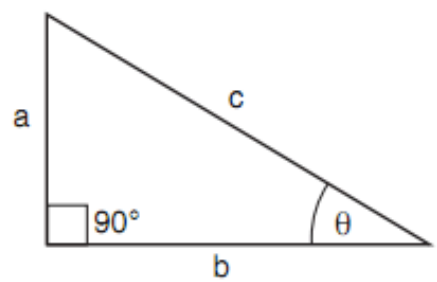
Right Triangle

$c^2 = a^2 + b^2$

$\sin\theta = \frac{a}{c}$

$\cos\theta = \frac{b}{c}$

$\tan\theta = \frac{a}{b}$



Complete all of the following questions for practice as you prepare for the exam. If you are unable to complete the questions, bring them in to go over them with Finney during lunch or after school.

(1) ***Given:*** $\Delta x = v_i\,\Delta t + \frac{1}{2}\bar{a}(\Delta t)^2$, $\bar{a} = \frac{\Delta v}{\Delta t}$, and $\bar{v} = \frac{\Delta x}{\Delta t}$ **Prove:** $\bar{v} = \frac{v_i + v_f}{2}$,

(2) A group of bike riders took a 4.0-hour trip. During the first 3.0 hours, they traveled a total of 50. kilometers, but during the last hour they traveled only 10. kilometers. What was the group's average speed for the entire trip?

1. 15 km/hr
2. 30. km/hr
3. 40. km/hr
4. 60. km/hr

(3) What is the total displacement of a student who walks 3 blocks east, 2 blocks north, 1 block west, and then 2 blocks south?

1. 0
2. 2 blocks east
3. 2 blocks west
4. 8 blocks

(4) A skier starting from rest skis straight down a slope 50. meters long in 5.0 seconds. What is the magnitude of the acceleration of the skier?

1. 20. m/s^2
2. 9.8 m/s^2
3. 5.0 m/s^2
4. 4.0 m/s^2

(5) An object falls freely from rest near the surface of Earth. What is the speed of the object after having fallen a distance at 4.90 meters?

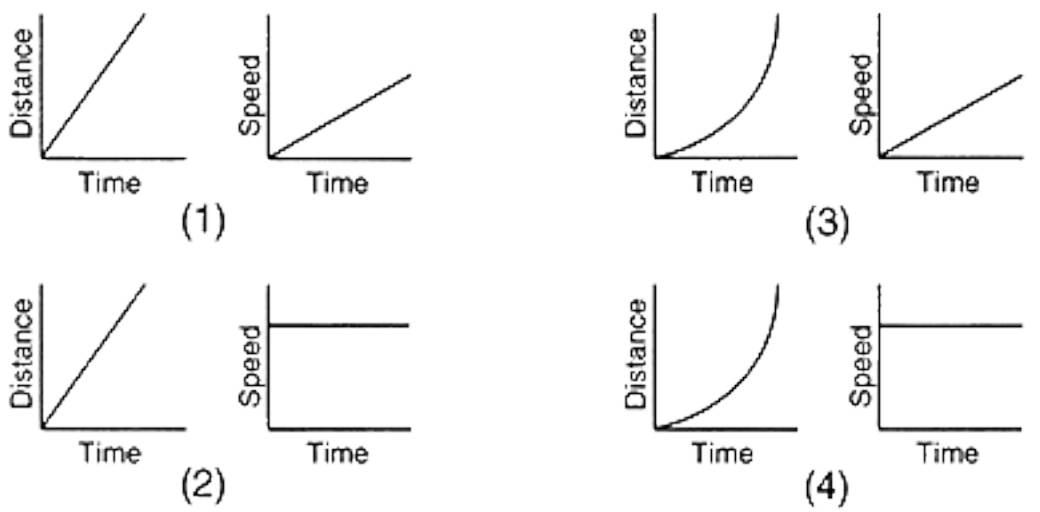
1. 4.90 m/s
2. 9.80 m/s
3. 24.0 m/s
4. 96.1 m/s

(6) Which two terms represent a vector quantity and the scalar quantity of the vector's magnitude, respectively?
1. acceleration and velocity
2. weight and force
3. speed and time
4. displacement and distance

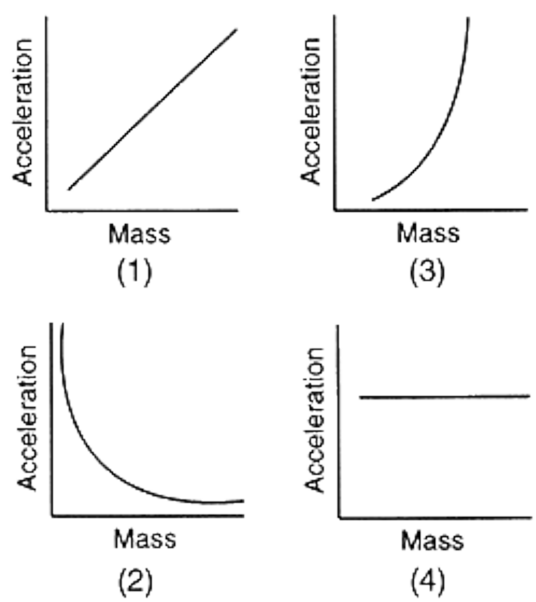
(7) A 4.0-kilogram rock and a 1.0-kilogram stone fall freely from rest from a height of 100 meters. After they fall for 2.0 seconds, the ratio of the rock's speed to the stone's speed is

1. 1:1
2. 1:2
3. 2:1
4. 4:1

(8) Which two graphs represent the motion of an object on which the net force is zero?



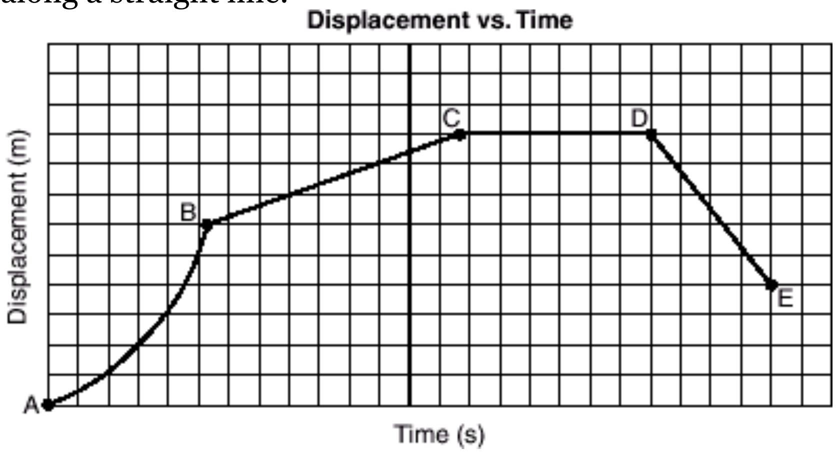
(9) Which graph best represents the relationship between acceleration due to gravity and mass for objects near the surface of Earth? [Neglect air resistance.]



(10) After a model rocket reached its maximum height, it then took 5.0 seconds to return to the launch site. What is the approximate maximum height reached by the rocket? [Neglect air resistance.]

1. 49 m
2. 98 m
3. 120 m
4. 250 m

(11) The displacement-time graph shown represents the motion of a cart initially moving forward along a straight line.



During which interval is the cart moving forward at constant speed?

1. *AB* 2. *BC* 3. *CD* 4. *DE*

(12) A car initially traveling at a speed of 16 meters per second accelerates uniformly to a speed of 20. meters per second over a distance of 36 meters. What is the magnitude of the car's acceleration?

1. 0.11 m/s^2
2. 2.0 m/s^2
3. 0.22 m/s^2
4. 9.0 m/s^2

(13) Velocity is to speed as displacement is to

1. acceleration
2. time
3. momentum
4. distance

(14) A basketball player jumped straight up to grab a rebound. If she was in the air for 0.80 second, how high did she jump?

1. 0.50 m
2. 0.78 m
3. 1.2 m
4. 3.1 m

(15) An object is dropped from rest and falls freely 20. meters to Earth. When is the speed of the object 9.8 meters per second?

1. during the entire first second of its fall
2. at the end of its first second of fall
3. during its entire time of fall
4. after it has fallen 9.8 meters

(16) An astronaut drops a hammer from 2.0 meters above the surface of the Moon. If the acceleration due to gravity on the Moon is 1.62 meters per second^2, how long will it take for the hammer to fall to the Moon's surface?

1. 0.62 s
2. 1.2 s
3. 1.6 s
4. 2.5 s

(17) A rocket initially at rest on the ground lifts off vertically with a constant acceleration of 2.0×10^1 meters per second^2. How long will it take the rocket to reach an altitude of 9.0×10^3 meters?

1. 3.0×10^1 s
2. 4.3×10^1 s
3. 4.5×10^2 s
4. 9.0×10^2 s

(18) An astronaut standing on a platform on the Moon drops a hammer. If the hammer falls 6.0 meters vertically in 2.7 seconds, what is its acceleration?

1. 1.6 m/s^2
2. 2.2 m/s^2
3. 4.4 m/s^2
4. 9.8 m/s^2

(19) The speedometer in a car does *not* measure the car's velocity because velocity is a

1. vector quantity and has a direction associated with it
2. vector quantity and does not have a direction associated with it
3. scalar quantity and has a direction associated with it
4. scalar quantity and does not have a direction associated with it

(20) Approximately how much time does it take light to travel from the Sun to Earth?

1. 2.00×10^{-3} s
2. 1.28×10^0 s
3. 5.00×10^2 s
4. 4.50×10^{19} s

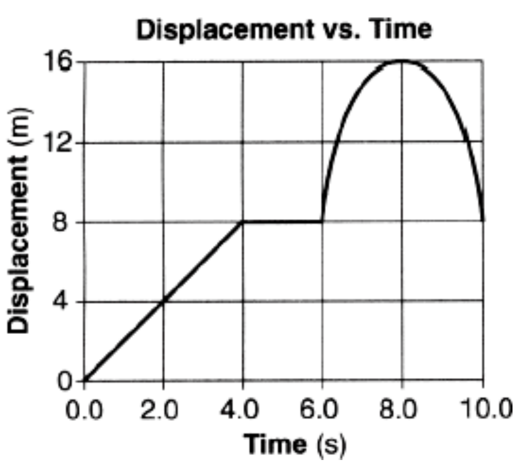
(21) A rock falls from rest a vertical distance of 0.72 meter to the surface of a planet in 0.63 second. The magnitude of the acceleration due to gravity on the planet is

1. 1.1 m/s^2
2. 2.3 m/s^2
3. 3.6 m/s^2
4. 9.8 m/s^2

(22) The speed of an object undergoing constant acceleration increases from 8.0 meters per second to 16.0 meters per second in 10. seconds. How far does the object travel during the 10. seconds?

1. 3.6×10^2 m
2. 1.6×10^2 m
3. 1.2×10^2 m
4. 8.0×10^1 m

(23) The accompanying graph represents the displacement of an object moving in a straight line as a function of time.



What was the total distance traveled by the object during the 10.0-second time interval?

1. 0 m
2. 8 m
3. 16 m
4. 24 m

(24) On a highway, a car is driven 80. kilometers during the first 1.00 hour of travel, 50. kilometers during the next 0.50 hour, and 40. kilometers in the final 0.50 hour. What is the car's average speed for the entire trip?

1. 45 km/h
2. 60. km/h
3. 85 km/h
4. 170 km/h

(25) A high-speed train in Japan travels a distance of 300. kilometers in 3.60 x 10^3 seconds. What is the average speed of this train?

1. 1.20 x 10^{-2} m/s
2. 8.33 x 10^{-2} m/s
3. 12.0 m/s
4. 83.3 m/s

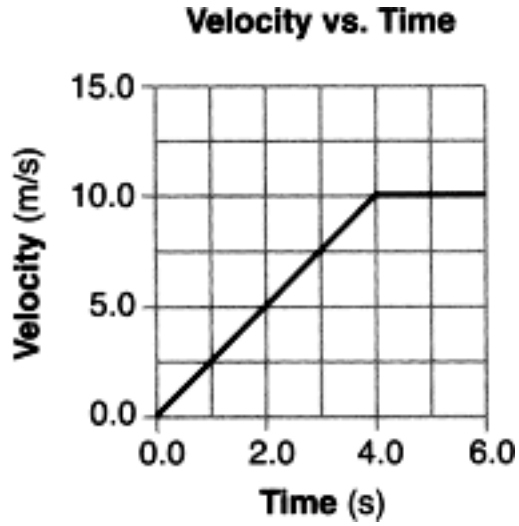
(26) A 25-newton weight falls freely from rest from the roof of a building. What is the total distance the weight falls in the first 1.0 second?

1. 19.6 m
2. 9.8 m
3. 4.9 m
4. 2.5 m

(27) A car traveling on a straight road at 15.0 meters per second accelerates uniformly to a speed of 21.0 meters per second in 12.0 seconds. The total distance traveled by the car in this 12.0-second time interval is

1. 36.0 m
2. 180. m
3. 216 m
4. 252 m

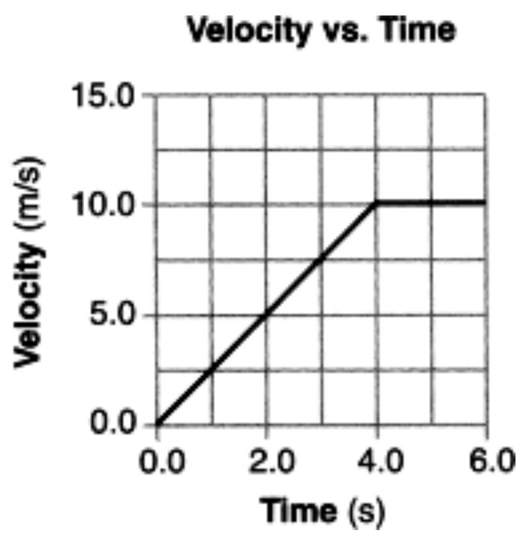
(28) Base your answer on the accompanying graph, which represents the motion of a car during a 6.0-second time interval.



What is the total distance traveled by the car during this 6.0-second interval?

1. 10. m
2. 20. m
3. 40. m
4. 60. m

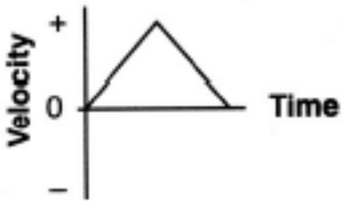
(29) Base your answer on the accompanying graph, which represents the motion of a car during a 6.0-second time interval.



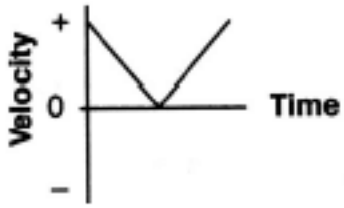
What is the acceleration of the car at t = 5.0 seconds?

1. 0.0 m/s^2
2. 2.0 m/s^2
3. 2.5 m/s^2
4. 10. m/s^2

(30) A student throws a baseball vertically upward and then catches it. If vertically upward is considered to be the positive direction, which graph best represents the relationship between velocity and time for the baseball? [Neglect friction.]

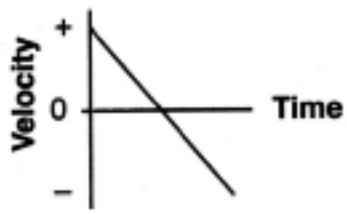


(1)



(3)

(2)



(4)

(31) A 5.0-kilogram sphere, starting from rest, falls freely 22 meters in 3.0 seconds near the surface of a planet. Compared to the acceleration due to gravity near Earth's surface, the acceleration due to gravity near the surface of the planet is approximately

1. the same
2. twice as great
3. one-half as great
4. four times as great

(32) Scalar is to vector as

1. speed is to velocity
2. displacement is to distance
3. displacement is to velocity
4. speed is to distance

(33) If a car accelerates uniformly from rest to 15 meters per second over a distance of 100. meters, the magnitude of the car's acceleration is

1. 0.15 m/s^2
2. 1.1 m/s^2
3. 2.3 m/s^2
4. 6.7 m/s^2

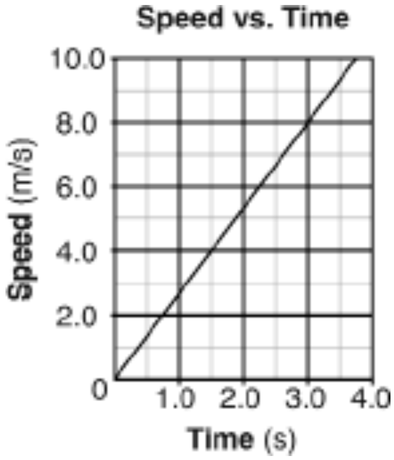
(34) An object accelerates uniformly from 3.0 meters per second east to 8.0 meters per second east in 2.0 seconds. What is the magnitude of the acceleration of the object?

1. 2.5 m/s^2
2. 5.0 m/s^2
3. 5.5 m/s^2
4. 11 m/s^2

(35) A rock is dropped from a bridge. What happens to the magnitude of the acceleration and the speed of the rock as it falls? [Neglect friction.]

1. Both acceleration and speed increase.
2. Both acceleration and speed remain the same.
3. Acceleration increases and speed decreases.
4. Acceleration remains the same and speed increases.

(36) The accompanying graph shows the relationship between the speed and elapsed time for an object falling freely from rest near the surface of a planet.



What is the total distance the object falls during the first 3.0 seconds?

1. 12 m
2. 24 m
3. 44 m
4. 72 m

(37) The speed of a car is increased uniformly from 20. meters per second to 30. meters per second in 4.0 seconds. The magnitude of the car¿s average acceleration in this 4.0-second interval is

1. 0.40 m/s^2
2. 2.5 m/s^2
3. 10. m/s^2
4. 13 m/s^2

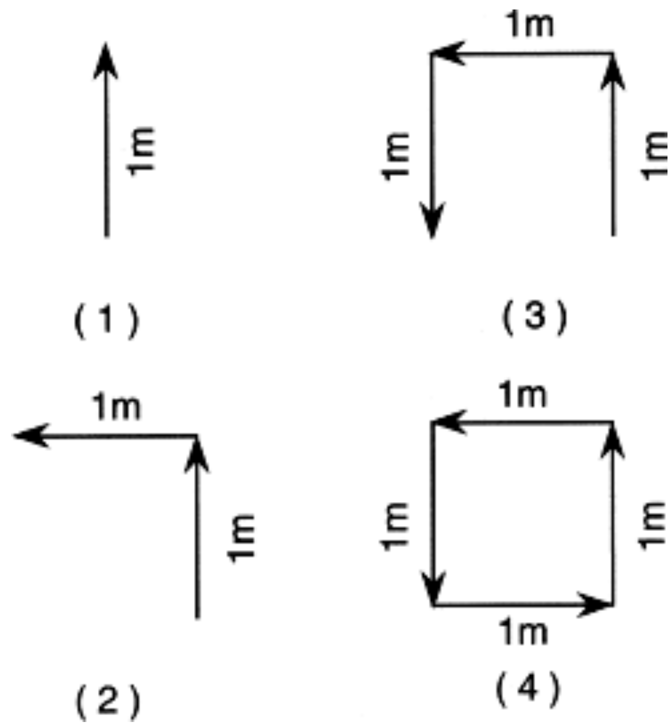
(38) A roller coaster, traveling with an initial speed of 15 meters per second, decelerates uniformly at -7.0 meters per second^2 to a full stop. Approximately how far does the roller coaster travel during its deceleration?

1. 1.0 m
2. 2.0 m
3. 16 m
4. 32 m

(39) In which situation is the net force on the object equal to zero?

1. a satellite moving at constant speed around Earth in a circular orbit
2. an automobile braking to a stop
3. a bicycle moving at constant speed on a straight, level road
4. a pitched baseball being hit by a bat

(40) Which vector diagram represents the greatest magnitude of displacement for an object?



(41) A ball starting from rest accelerates uniformly at 5.0 meters per second^2 as it rolls 40. meters down an incline. How much time is required for the ball to roll the 40. meters?

1. 2.8 s
2. 8.0 s
3. 16 s
4. 4.0 s

(42) The speed of a car is decreased uniformly from 30. meters per second to 10. meters per second in 4.0 seconds. The magnitude of the car's acceleration is

1. 5.0 m/s^2
2. 10. m/s^2
3. 20. m/s^2
4. 40. m/s^2

(43) Objects A and B are dropped from rest near Earth's surface. Object A has mass m and object B has mass $2m$. After 2 seconds of free fall, object A has a speed v and has fallen a distance d. What are the speed and distance of fall of object B after 2 seconds of free fall?

1. speed = $v/2$; distance = $d/2$
2. speed = v; distance = d
3. speed = $v/2$; distance = $2d$
4. speed = $2v$; distance = $2d$

(44) In the accompanying diagram, the upward drag force acting on a parachute is equal in magnitude but opposite in direction to the weight of the parachutist and equipment.

As a result of the forces shown, the parachutist may be moving

1. downward with decreasing speed
2. downward at constant speed
3. upward with decreasing speed
4. upward with constant acceleration

(45) A hiker walks 5.00 kilometers due north and then 7.00 kilometers due east. What is the magnitude of her resultant displacement?

(46) A hiker walks 5.00 kilometers due north and then 7.00 kilometers due east. What total distance has she traveled?

(47) During a 5.0-second interval, an object's velocity changes from 25 meters per second east to 15 meters per second east. Determine the magnitude and direction of the object's acceleration.

(48) A physics class is to design an experiment to determine the acceleration of a student on in-line skates coasting straight down a gentle incline. The incline has a constant slope. The students have tape measures, traffic cones, and stopwatches.

Indicate which equation(s) they should use to determine the student's acceleration.

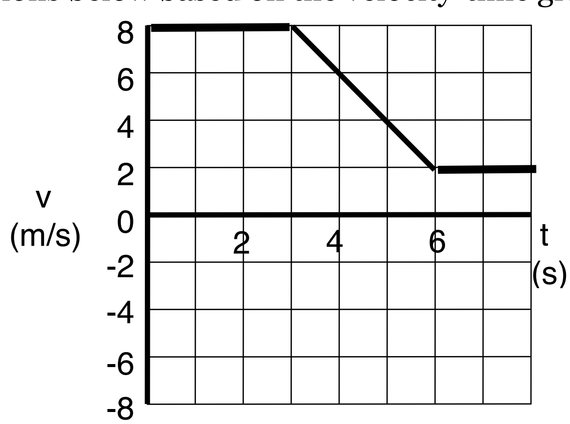
(49) A car traveling at a speed of 13 meters per second accelerates uniformly to a speed of 25 meters per second in 5.0 seconds.

Calculate the magnitude of the acceleration of the car during this 5.0-second time interval. [Show all work, including the equation and substitution with units.]

(50) A car traveling at a speed of 13 meters per second accelerates uniformly to a speed of 25 meters per second in 5.0 seconds.

A truck traveling at a constant speed covers the same total distance as the car in the same 5.0-second time interval. Determine the speed of the truck.

(51) Answer the questions below based on the velocity-time graph shown.



a. Quantitatively describe the motion of the object during the 8 seconds.

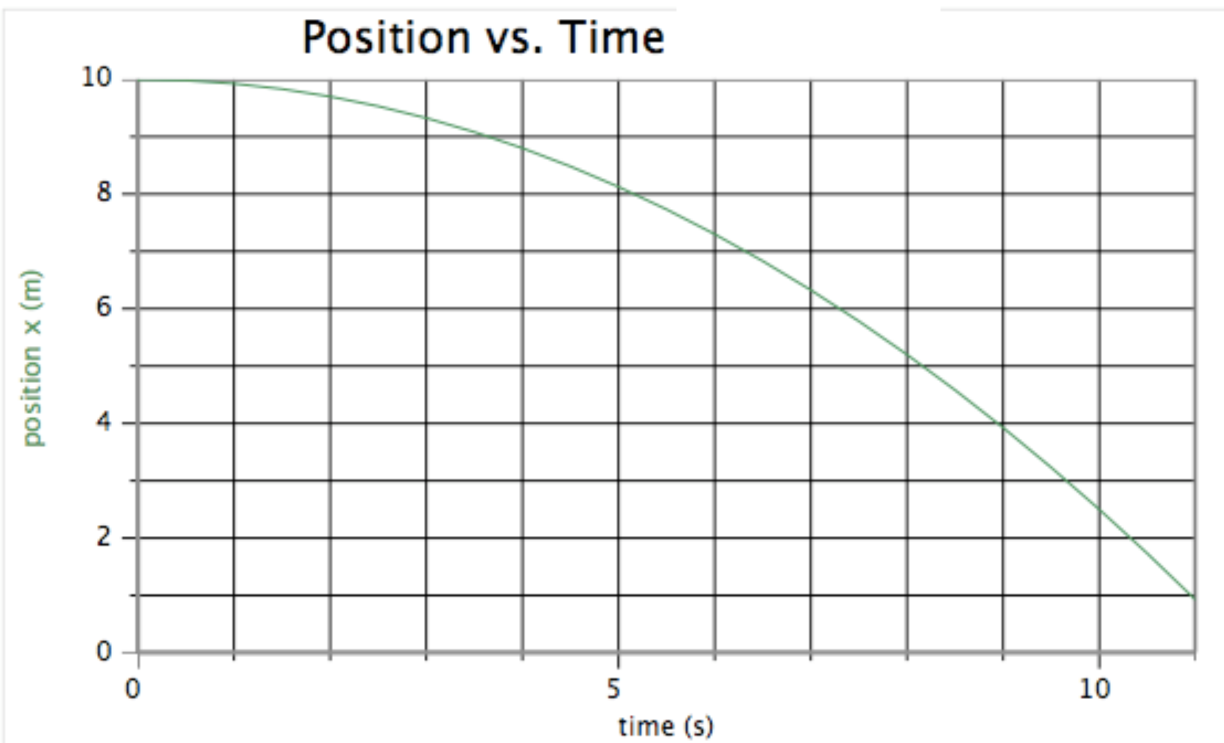
b. Determine the displacement from t = 0s to t = 3 s.

c. Determine the displacement from t = 3 s to t = 6 s.

d. Determine the displacement from t = 2 s to t = 5 s.

e. Determine the object's acceleration at t =4s

(52) Answer the questions below based on the x vs. t graph provided below.



a. Find the **displacement** from t = 3 s to t = 9s.

b. Find the **average velocity** from t = 3 s to t = 9s.

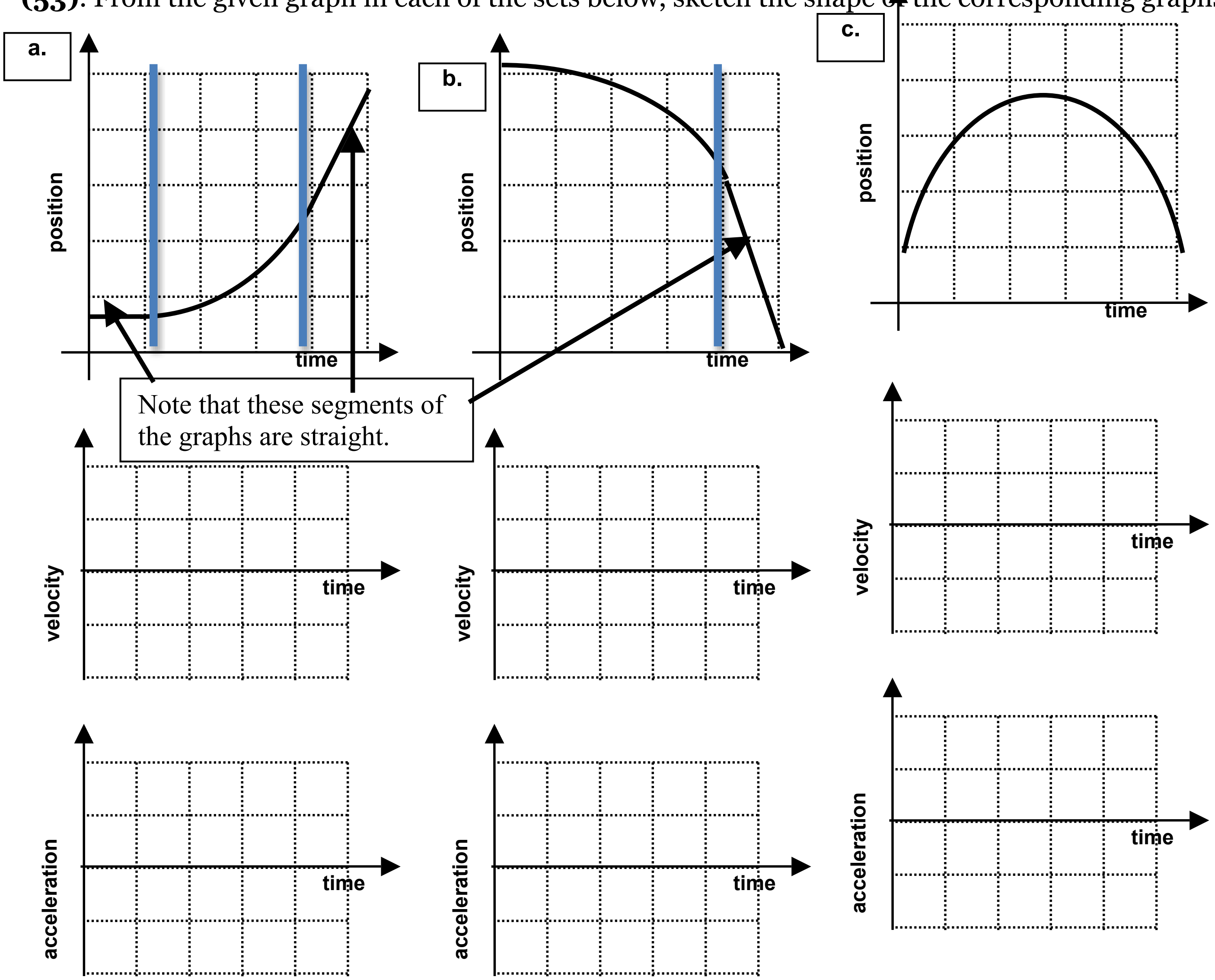
c. At what time will the object's instantaneous velocity equal the average velocity you calculated in part b?

d. Find the **instantaneous velocity** at t = 3 s by drawing a tangent and finding its slope. Show your slope calculation:

e. Find the **instantaneous velocity** at t = 9 s by drawing a tangent and finding its slope. Show your slope calculation:

f. Determine the **average acceleration** from t = 3s to t = 9s.

(53). From the given graph in each of the sets below, sketch the shape of the corresponding graphs.



For each of the following:
a. Make a list of the known and unknown values with units.
b. Choose and write the appropriate equation that relates the known and unknown values.
c. Substitute the known values into the equation, with units, and solve for the unknown value.

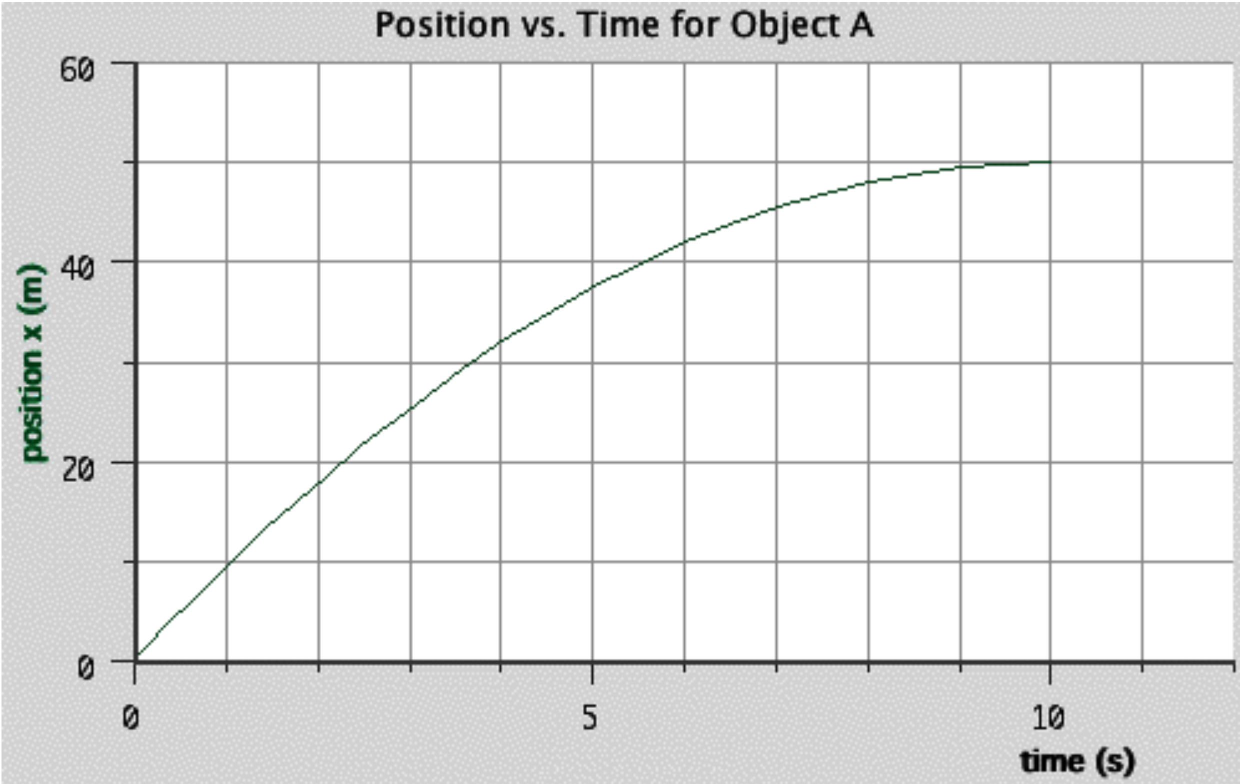
(54) An airplane accelerates down a runway at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before takeoff.

(55) A car starts from rest and accelerates uniformly for a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

(56) Upton Chuck is riding the Giant Drop at Great America and free falls for 2.6 seconds.
a. What will be his final velocity?
b. How far will he fall?

(57) A racecar accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds.
a. Determine the acceleration of the car.
b. Determine the distance traveled.

(58) Use the graph below to answer the given questions.

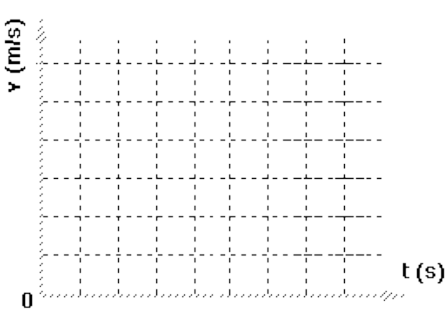


a. Give a written description to describe the motion of this object.

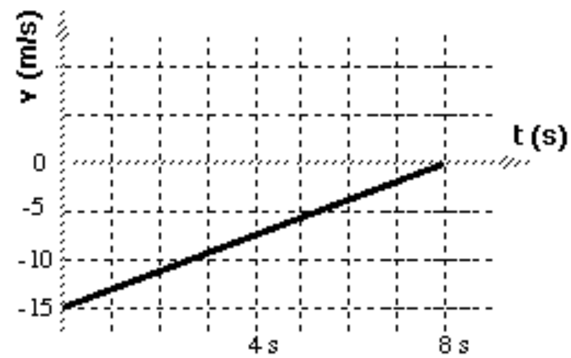
b. Determine the instantaneous velocity of the object at **t** = 2 s and explain how you did it.

c. Assume the initial velocity was 10 m/s; determine the acceleration of the object.

d. Sketch a corresponding velocity time graph for the graph above.



(59) Use the graph to answer the following questions.



a. Describe the motion of the object.

b. Determine the acceleration of the object from the graph.

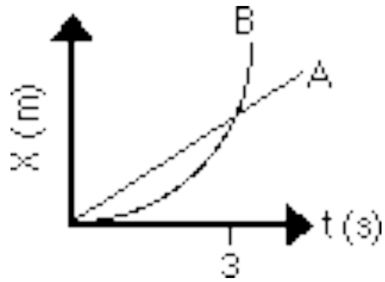
c. Shade the portion of the graph that represents the displacement of the object from 2 to 6 seconds.

d. Use an appropriate mathematical model to calculate the object's displacement from 2 to 6 seconds.

(60) A car, initially at rest, accelerates at a constant rate of 4.0 m/s^2 for 6 s. How fast will the car be traveling at **t** = 6 s?

(61) A tailback initially running at a velocity of 5.0 m/s becomes very tired and slows down at a uniform rate of 0.25 m/s^2. How fast will he be running after going an additional 10 meters?

(62) Using the graph compare the following quantities for objects A and B.
Is A > B, A < B, or A = B.



a. **Displacement** from 0 to 3 s ____________ How do you know?

b. **Displacement** from 0 to 1.5 s ____________ How do you know?

c. **Displacement** from 1.5 to 3 s ____________ How do you know?

d. **Average** velocity from 0 to 3 s ____________ How do you know?

e. **Average** velocity from 0 to 1.5 s ____________ How do you know?

f. **Average** velocity from 1.5 to 3 s ____________ How do you know?

g. **Instantaneous** velocity at 3 s ____________ How do you know?

h. **Instantaneous** velocity at 0 s ____________ How do you know?

i. If the motion of B is uniformly accelerated, at what time will both graphs have exactly the same slope? Explain.

(63) For each of the position vs time graphs shown below, draw the corresponding **v** vs **t**, **a** vs **t** , and motion map.