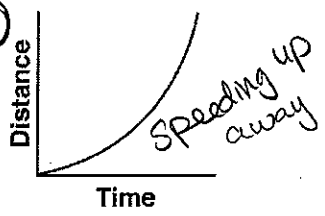
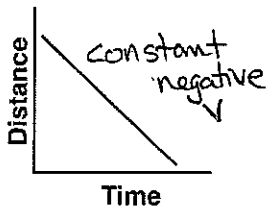
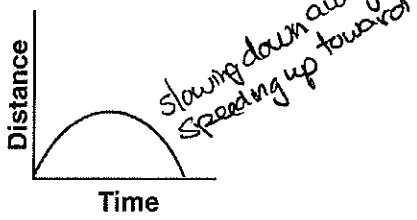
Topic 2A - Uniform Acceleration
Skill 12 - Kinematics Graphs

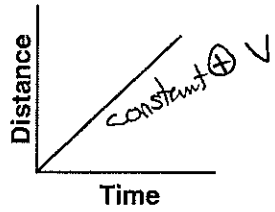
1. A cart travels with a constant nonzero acceleration along a straight line. Which graph best represents the relationship between the distance the cart travels and time of travel?

- non-zero means a # like 5

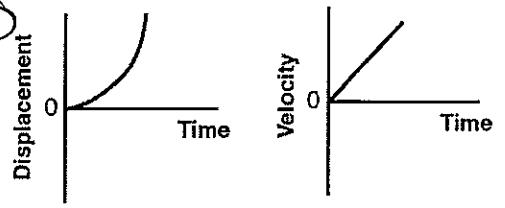
A) 

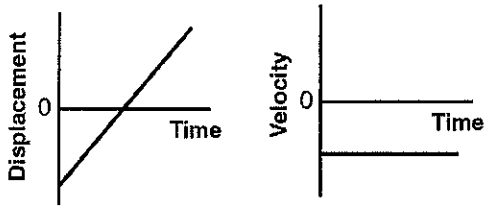
B) 

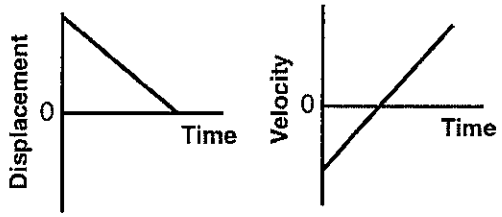
C) 

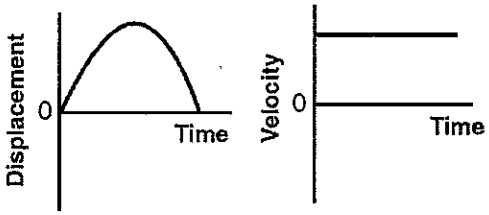
D) 

2. Which pair of graphs represents the same motion of an object?

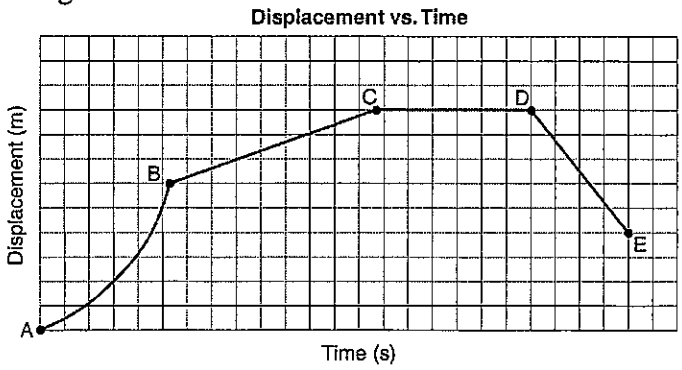
A) 

B) 

C) 

D) 

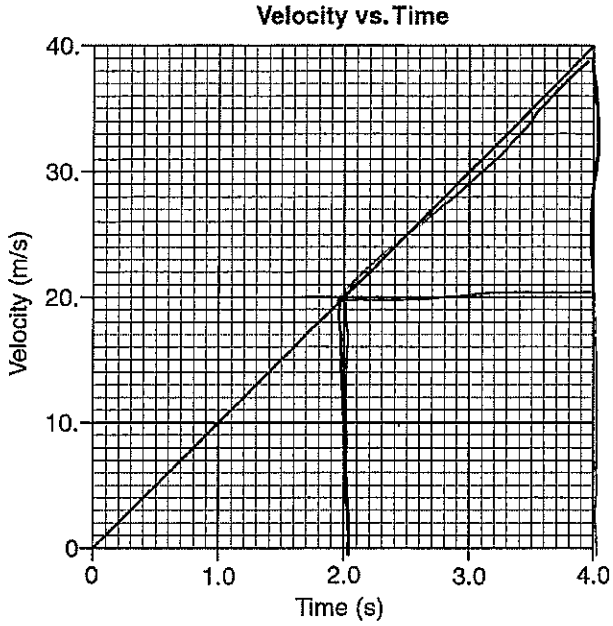
3. The displacement-time graph below represents the motion of a cart initially moving forward along a straight line.



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

A) *AB* B) *BC* C) *CD* D) *DE*

4. The graph below shows the velocity of a race car moving along a straight line as a function of time.



What is the magnitude of the displacement of the car from $t = 2.0$ seconds to $t = 4.0$ seconds?

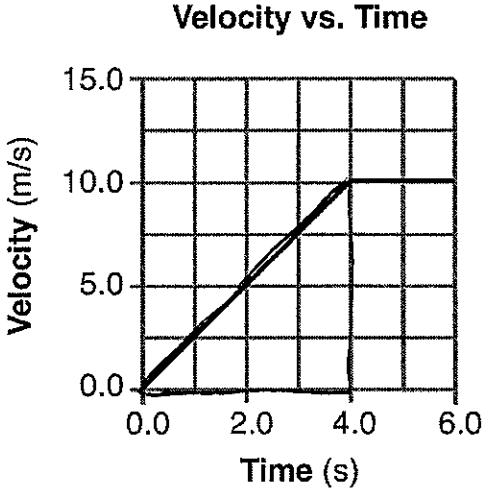
A) 20. m B) 40. m C) 60. m D) 80. m

$d = \bar{v}t = \frac{v_i + v_f}{2} = \left(\frac{20\,m/s + 40\,m/s}{2}\right)(2s)$

$= (30\,m/s)(2s)$

$= 60\,m$

Base your answers to questions **5** and **6** on the graph below, which represents the motion of a car during a 6.0-second time interval.



d = area

d = area of triangle + area rectangle

$d = \frac{1}{2}\Delta v t + \bar{v}t$

$d = \frac{1}{2}(10\,m/s)(4s) + (10\,m/s)(2s)$

$20m \quad + 20m$

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

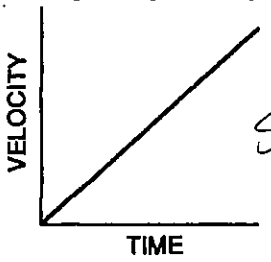
A) 10. m B) 20. m C) 40. m D) 60. m

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

A) 0.0 m/s^2 B) 2.0 m/s^2 C) 2.5 m/s^2 D) 10. m/s^2

acceleration is slope of $\frac{\Delta v}{t}$ so 0

7. The graph below represents the motion of a body moving along a straight line.

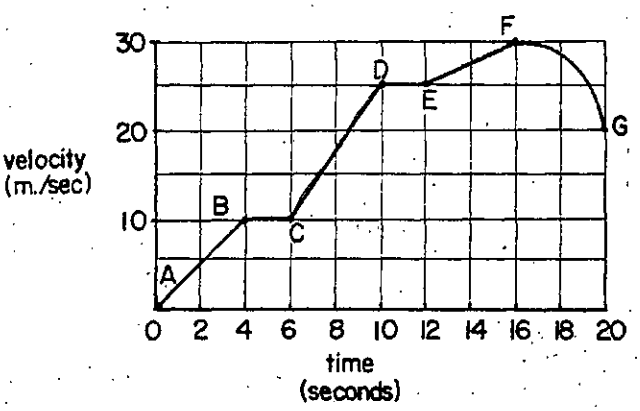


slope is constant

According to the graph, which quantity related to the motion of the body is constant?

A) speed B) velocity
C) acceleration D) displacement

8. Base your answer to the following question on the graph below, which shows the velocity of a 1,500-kilogram car during a 20-second-time interval..



$\bar{V} = \frac{V_i + V_f}{2} = \frac{10\,m/s + 25\,m/s}{2} = \frac{35\,m/s}{2}$

During time interval *CD*, the average velocity of the car is

A) 7.5 m./sec. B) 17.5 m./sec. C) 15 m./sec. D) 35 m./sec.

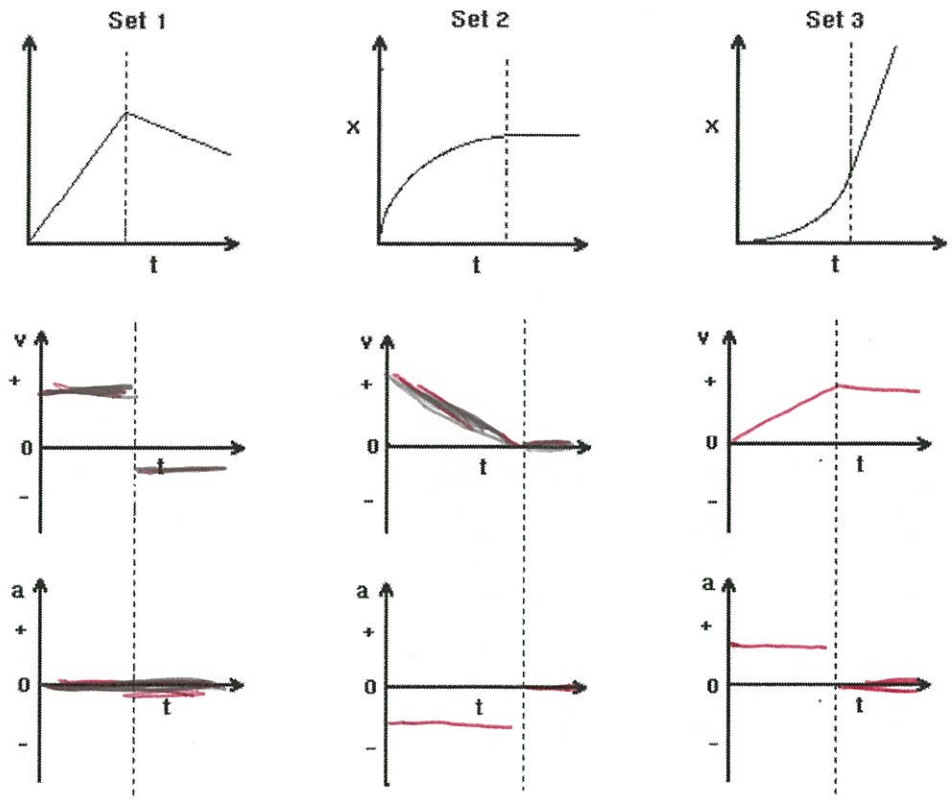
9. Describe the motion of each of the following objects from the dot diagrams. Assume reference point (ie observer) is to the left. (you can use words, a graph or both)

A . . . . . constant

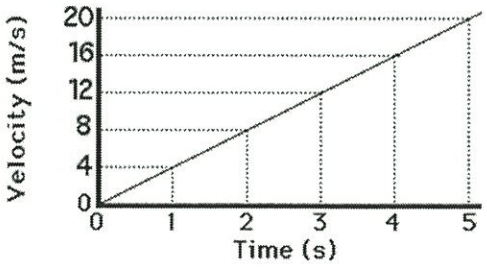
B . . . . . speeding up +a

C . . . . . slowing down -a

9. Below each **position** vs **time** graph sketch the corresponding **velocity** vs **time** and **acceleration** vs **time** graphs.



10. The velocity vs time graph below can be used to find all the kinematics variables.



Use this graph to determine values for each of the following kinematics variables and state what feature of the graph and/or the equation used to calculate.

Initial velocity: 0

Final velocity: 20 m/s

Average velocity: 10 m/s

Change in velocity: 20 m/s (Δy)

Acceleration: $a = \frac{\Delta v}{t}$ = slope

$a = \frac{20\ m/s}{5s} = 4\ m/s^2$

Time: ~~0~~ 5 s

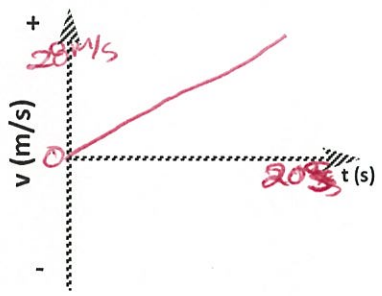
Distance/Displacement: d = area

$= \frac{1}{2}(y)(x)$

$= \frac{1}{2}(\Delta v)(t) = \frac{1}{2}(20\ m/s)(5\ s)$

ie $= \frac{1}{2}at^2$ $= 50\ m$

11. A poorly tuned car can accelerate from rest to a speed of 28 m/s in 20 s.



a) What is the acceleration of the car?

$a = \text{slope} = \frac{\Delta v}{t} = \frac{28\ m/s}{20\ s} = 1.4\ m/s^2$

b) Determine what distance it travels in this time?

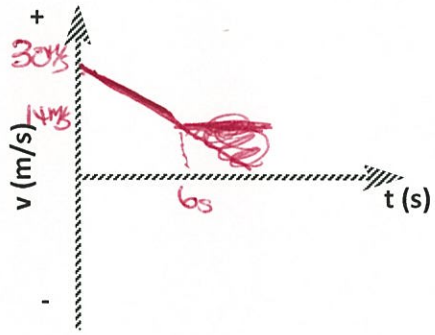
$d = \text{area} = \frac{1}{2} \Delta v\, t$

$= \frac{1}{2}(28\ m/s)(20\ s)$

$= 280\ m$

12. At t = 0 a car has a speed of 30 m/s. At t = 6 s, its speed is 14 m/s.

a) What is its acceleration during this time interval?



$a = \frac{\Delta v}{t} = \frac{v_f - v_i}{t} = \frac{(14\ m/s - 30\ m/s)}{6\ s}$

$a = -2.7\ m/s^2$

b) What is the distance traveled by the car? (Show the equations that you with data substituted from the graph)

$d = \bar{v}\, t = (22\ m/s)(6\ s) = 132\ m$

or $d = \text{area} \triangle + \text{area} \square$

$= \frac{1}{2} \Delta v\, t + v_i t$

$= \frac{1}{2}(+16\ m/s)(6\ s) + 14\ m/s\ (6\ s)$

$= 48\ m + 84\ m = 132\ m$

Skill 13 - Head Problems – Practice

13. A toy RC car accelerates from rest to 10m/s in 2.5 seconds. What is the acceleration of the car? What is the distance travelled by the toy car during this time? (Show your work using mini equations)

Δv	v_i	v_f	$\bar{v}$	d	a	t
10 m/s	0	10 m/s	5 m/s	12.5 m	4 m/s²	2.5 s

$\bar{v} = \frac{v_i + v_f}{2} = \frac{0 + 10\,m/s}{2} = 5\,m/s$

$\Delta v = v_f - v_i = 5\,m/s$

$a = \frac{\Delta v}{t} = \frac{10\,m/s}{2.5\,s} = 4\,m/s^2$

$d = \bar{v}t = (5\,m/s)(2.5\,s) = 12.5\,m$

14. Find the distance covered by an object that accelerates from rest at a rate of 5 m/s^2 for 6 seconds. (Show your work using "mini" equations)

Δv	v_i	v_f	$\bar{v}$	d	a	t
30 m/s	0	30 m/s	15 m/s	?	5 m/s²	6 s

$\Delta v = at = (5\,m/s^2)(6\,s)$

$d = \bar{v}t = (15\,m/s)(6\,s) = 90\,m$

15. Sid E. Slicker is strolling through Central Park when it begins to rain. He increases his speed uniformly from 0.5m/s to 3m/s in a time of 3seconds to escape the deluge. What is Sid's average speed during this time? What is the distance covered during this time?

Δv	v_i	v_f	$\bar{v}$	d	a	t
	.5 m/s	3 m/s	1.75 m/s			3 s

$\bar{v} = \frac{v_i + v_f}{2} = \frac{.5\,m/s + 3\,m/s}{2} = \frac{3.5\,m/s}{2} = 1.75\,m/s$

$d = \bar{v}t = (1.75\,m/s)(3\,s) = 5.25\,m$

16. Dinah Saur accelerates her Segway from rest to 7km/hr over a time of 1 min. What is the average speed of the Segway? What is the distance traveled during that minute?

Δv	v_i	v_f	$\bar{v}$	d	a	t
	0	117m/min	58.5m/min	58.5m		1min

$V = 7\text{km/hr} \times \frac{1\text{ hr}}{60\text{ min}} = \frac{7\text{km}}{60\text{min}} = .117\text{km/min}$ or $\frac{117\text{m}}{\text{min}}$

$d = \bar{v}t = 58.5\text{m}$

Use kinematics equations to solve quantitative problems

17. A mob of roller-skating zombies starts roll down a hill from an initial speed of zero. The hill is 1500m long and will allow the zombies to accelerate uniformly at 2.5m/s^2. How much time do you and your brainy pals at the bottom of the hill have to come up with a plan before zombies arrive? What is the final velocity of the zombies?

$v_i = 0$
$d = 1500\text{m}$
$a = 2.5\text{m/s}^2$
$t = ?$
$v_f = ?$

$d = v_i t + \frac{1}{2}at^2$
$1500\text{m} = 0 + \frac{1}{2}(2.5\text{m/s}^2)(t^2)$
$t = 34.65\text{sec}$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(2.5\text{m/s}^2)(1500\text{m})$
$v_f = \sqrt{7500\text{m}^2/\text{s}^2}$
$v_f = 86.6\text{m/s}$

18. A snowboarder moving at a constant 5m/s reaches a steeper slope and begins to accelerate at 2 m/s^2 for a distance of 300m. What is the speed of the rider when they reach the bottom of the slope?

$v_i = 5\text{m/s}$
$a = 2\text{m/s}^2$
$d = 300\text{m}$
$v_f = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = (5\text{m/s})^2 + 2(2\text{m/s}^2)(300\text{m})$
$v_f = \sqrt{1225\text{m}^2/\text{s}^2}$
$v_f = 35\text{m/s}$

19. A giraffe trotting at 1 m/s spots a lion and accelerates away at 0.5m/s^2 for 2 seconds. What is the distance traveled by the giraffe during this time period?

$v_i = 1\text{m/s}$
$a = .5\text{m/s}^2$
$t = 2\text{s}$
$d = ?$

$d = v_i t + \frac{1}{2}at^2$
$d = (1\text{m/s})(2\text{s}) + \frac{1}{2}(.5\text{m/s}^2)(2\text{s})^2$
$d = 2\text{m} + 1\text{m}$
$d = 3\text{m}$

20. What is the final speed of a shark with an initial velocity of 2m/s that accelerates at 1.5m/s^2 for a distance of 10m?

$V_f = ?$
$V_i = 2\,m/s$
$a = 1.5\,m/s^2$
$d = 10m$

$V_f^2 = V_i^2 + 2ad$
$V_f^2 = (2\,m/s)^2 + 2(1.5\,m/s^2)(10m)$
$V_f^2 = 34\,m^2/s^2$
$V_f = 5.8\,m/s$

Mixed Kinematic Problems:

Use equations or "Head Problems" to solve the problems below. For either method show your work. The grids are a good way to keep track of what you know or what you might be able to find out regardless of method selected.

$$a = \frac{\Delta v}{t} \qquad \bar{v} = \frac{d}{t} \qquad \bar{v} = \frac{v_i + v_f}{2} \qquad v_f = v_i + \Delta v$$

Kinematics equations

$$v_f^2 = v_i^2 + 2ad \qquad v_f = v_i + at \qquad d = v_i t + \frac{1}{2}at^2$$

Reminder (Δv is usually only helpful when the object is not starting from rest)

21. A rocket accelerates upward from rest with a uniform acceleration of 4.0 m/s^2. How far will the rocket have traveled in 8.0 s?

Δv	v_i	v_f	$\bar{v}$	d	a	t
32 m/s	0	32 m/s	16 m/s	?	4 m/s^2	8 s
				128m		

$\Delta v = at = 32\,m/s$
$V_f = V_i + \Delta v = 32\,m/s$
$\bar{V} = \frac{V_i + V_f}{2} = 16\,m/s$
$d = \bar{V}t = 128m$

$d = v_i t + \frac{1}{2}at^2$
$d = \frac{1}{2}(4\,m/s^2)(8s)^2$
$d = 128m$

22. The brakes on a car permit it to decelerate at the rate of -3 m/s^2. What distance is required to stop the car when it is moving 18 m/s?

Δv	v_i	v_f	$\bar{v}$	d	a	t
	18 m/s	0		?	-3	

$V_f^2 = V_i^2 + 2ad$
$0 = (18\,m/s)^2 + 2(-3\,m/s^2)d$
$-324\,m^2/s^2 = -6\,m/s^2 d$
$d = 54m$

23. A solar-powered aircraft starting from rest reaches lift-off speed of 20 m/s in 300 meters. What is the acceleration of the plane?

Δv	v_i	v_f	$\bar{v}$	d	a	t
20 m/s	0	20 m/s	10 m/s	300 m	?	30 s

$V_f^2 = V_i^2 + 2ad$

$(20\ m/s)^2 = 0 + 2a(300m)$

$400\ m^2/s^2 = 600a$

$a = .67\ m/s^2$

24. A motorcycle traveling 30.0 m/s decelerates at the rate of -2.0 m/s^2. What distance does it travel, and what time does it take for the cycle to come to rest?

Δv	v_i	v_f	$\bar{v}$	d	a	t
-30 m/s	30 m/s	0	15 m/s	225 m	-2 m/s	15 s
				?		?

$d = ?$

$V_i = 30\ m/s$

$a = -2\ m/s^2$

$t = ?$

$V_f = 0$

~~$d = V_i t + \frac{1}{2}at^2$~~

$V_f^2 = V_i^2 + 2ad$

$0 = (30\ m/s)^2 + 2(-2\ m/s^2)d$

$0 = 900\ m^2/s^2 + (-4\ m/s^2)d$

$d = 225m$

25. Tests on the new Aston Martin show that it can accelerate from 39.7 m/s to 96.2 m/s in 4.352 seconds. What distance does the car travel in that time? What is the car's acceleration in this period

Δv	v_i	v_f	$\bar{v}$	d	a	t

$V_i = 39.7\ m/s$

$V_f = 96.2\ m/s$

$t = 4.352s$

$d = ?$

$\bar{v} = 67.95\ m/s$

$d = \bar{v}t$

$d = 295.7m$

$a = \frac{\Delta V}{t} = \frac{56.5\ m/s}{4.352s} = 12.98\ m/s^2$

Topic 2A - Uniform Acceleration
Skill 13 - Kinematics Equations

26. A truck, initially traveling at a speed of 22 meters per second, increases speed at a constant rate of 2.4 meters per second ^{2} for 3.2 seconds. What is the total distance traveled by the truck during this 3.2-second time interval?

A) 12 m B) 58 m
C) 70. m D) 83 m

$v_i = 22\ m/s$
$a = 2.4\ m/s^2$
$t = 3.2\ s$
$d = ?$

$d = v_i t + \frac{1}{2}at^2$
$d = (22\ m/s)(3.2\ s) + \frac{1}{2}(2.4\ m/s^2)(3.2\ s)^2$
$d = 82.7\ m$

27. What is the final speed of an object that starts from rest and accelerates uniformly at 4.0 meters per second ^{2} over a distance of 8.0 meters?

A) 8.0 m/s B) 16 m/s
C) 32 m/s D) 64 m/s

$v_f = ?$
$v_i = 0$
$a = 4\ m/s^2$
$d = 8\ m$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(4\ m/s^2)(8\ m)$
$v_f^2 = 64\ m^2/s^2$
$v_f = 8\ m/s$

28. 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

A) 0.15 m/s^2 B) 1.1 m/s^2
C) 2.3 m/s^2 D) 6.7 m/s^2

$v_i = 0$
$v_f = 15\ m/s$
$d = 100\ m$
$a = ?$

$v_f^2 = v_i^2 + 2ad$
$(15\ m/s)^2 = 0^2 + 2a(100\ m)$
$a = 1.125\ m/s^2$

29. 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

A) 36.0 m B) 180. m
C) 216 m D) 252 m

$v_i = 15\ m/s$
$v_f = 21\ m/s$
$t = 12\ s$
$d = ?$

$\bar{v} = 18\ m/s$
$d = \bar{v}t = 216\ m$

30. In a race, a runner traveled 12 meters in 4.0 seconds as she accelerated uniformly from rest. The magnitude of the acceleration of the runner was

A) 0.25 m/s^2 B) 1.5 m/s^2
C) 3.0 m/s^2 D) 48 m/s^2

$d = 12\ m$
$t = 4\ s$
$a = ?$
$v_i = 0$

$d = v_i t + \frac{1}{2}at^2$
$d = \frac{1}{2}at^2$
$12\ m = \frac{1}{2}a(4\ s)^2$
$a = 1.5\ m/s^2$

31. A car, initially traveling east with a speed of 5.0 meters per second, is accelerated uniformly at 2.0 meters per second^2 east for 10. seconds along a straight line. During this 10.-second interval the car travels a total distance of

A) 50. m B) 60. m
C) 1.0×10^2 m D) 1.5×10^2 m

$v_i = 5\ m/s$
$a = 2\ m/s^2$
$t = 10\ s$
$d = ?$

$d = v_i t + \frac{1}{2}at^2$
$d = (5\ m/s)(10\ s) + \frac{1}{2}(2\ m/s^2)(10\ s)^2$
$d = 50\ m + \frac{1}{2}(2\ m/s^2)(100\ s^2)$
$d = 50\ m + 100\ m$
$d = 150\ m$

32. 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?

A) 3.6×10^2 m B) 1.6×10^2 m
C) 1.2×10^2 m D) 8.0×10^1 m

$V_i = 8\ m/s$
$V_f = 16\ m/s$
$t = 10s$
$d = ?$

$d = \bar{v}t$
$d = (12\ m/s)(10s)$
$d = 120m$

33. 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?

A) 3.0×10^1 s B) 4.3×10^1 s
C) 4.5×10^2 s D) 9.0×10^2 s

$V_i = 0$
$a = 20\ m/s^2$
$t = ?$
$d = 9000m$

$d = v_i t + \frac{1}{2}at^2$
$9000m = \frac{1}{2}(20\ m/s^2)t^2$
$t = 30s$

34. 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?

A) 1.0 m B) 2.0 m
C) 16 m D) 32 m

$V_i = 15\ m/s$
$a = -7\ m/s^2$
$d = ?$
$V_f = 0$

$V_f^2 = V_i^2 + 2ad$
$0 = (15\ m/s)^2 + 2(-7\ m/s^2)d$
$d = 16m$

35. A car traveling west in a straight line on a highway decreases its speed from 30.0 meters per second to 23.0 meters per second in 2.00 seconds. The car's average acceleration during this time interval is

A) 3.5 m/s^2 east B) 3.5 m/s^2 west
C) 13 m/s^2 east D) 13 m/s^2 west

$V_i = 30\ m/s$
$V_f = 23\ m/s$
$t = 2s$
$a = ?$

$V_f = V_i + at$
$-23\ m/s = 30\ m/s + a(2s)$
$a = +3.5\ m/s^2$

36. A child riding a bicycle at 15 meters per second accelerates at -3.0 meters per second^2 for 4.0 seconds. What is the child's speed at the end of this 4.0-second interval?

A) 12 m/s B) 27 m/s
C) 3.0 m/s D) 7.0 m/s

$V_i = 15\ m/s$
$a = -3\ m/s^2$
$t = 4s$
$V_f = ?$

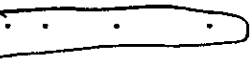
$V_f = V_i + at$
$V_f = 15\ m/s + (-3\ m/s^2)(4s)$
$V_f = 3\ m/s$

37. As a car is driven south in a straight line with *decreasing* speed, the acceleration of the car must be

A) directed northward
B) directed southward
C) zero
D) constant, but not zero

38. Oil drips at 0.4-second intervals from a car that has an oil leak. Which pattern best represents the spacing of oil drops as the car accelerates uniformly from rest?

A)

B) 

C) 

D)

39. An object accelerates uniformly from rest to a speed of 50. meters per second in 5.0 seconds. The average speed of the object during the 5.0-second interval is

A) 5.0 m/s
B) 10. m/s
C) 25 m/s
D) 50. m/s

$V_i = 0$
$V_f = 50\ m/s$
$t = 5s$
$\bar{V} = 25\ m/s$

40. A locomotive starts from rest and accelerates at 0.12 meter per second^2 to a speed of 2.4 meters per second in 20. seconds. This motion could best be described as

A) constant acceleration and ~~constant velocity~~
B) ~~increasing acceleration~~ and ~~constant velocity~~
C) constant acceleration and increasing velocity
D) ~~increasing acceleration~~ and increasing velocity

$V_i = 0$
$a = .12\ m/s^2$
$V_f = 2.4\ m/s$
$t = 20s$