AP Physics Custom Worksheet over Kinematics

Easy

1. If a car travels 5 m east, then 5 m west, which is true?
   A. Displacement = 10 m, distance = 0 m
   B. Displacement = 0 m, distance = 10 m
   C. Displacement = 5 m east, distance = 5 m
   D. Displacement = 0 m, distance = 0 m
   E. Displacement = 10 m east, distance = 10 m

2. Which best describes average speed?
   A. Total displacement divided by total time
   B. Total distance divided by total time
   C. Instantaneous slope of a position vs time graph
   D. Final velocity minus initial velocity
   E. Area under a velocity vs time graph

3. Which statement about velocity and speed is correct?
   A. Speed is a vector; velocity is a scalar.
   B. Velocity includes direction; speed does not.
   C. If speed is constant, velocity must be constant.
   D. Velocity can't be negative; speed can.
   E. Speed and velocity mean the same in one-dimensional motion.

4. On a position vs time graph, the slope gives you:
   A. Acceleration
   B. Average speed only
   C. Velocity
   D. Displacement per second squared
   E. The area under the curve

5. On a velocity vs time graph, the area under the curve between two times equals:
   A. Average velocity
   B. Displacement
   C. Acceleration
   D. Final speed
   E. Jerk

6. An object moves with constant positive acceleration. Which is true about its velocity?
   A. Velocity decreases linearly with time.
   B. Velocity remains constant.
   C. Velocity increases linearly with time.
   D. Velocity increases exponentially.
   E. Velocity oscillates.

7. A ball is tossed straight up and returns to the thrower. At the top of its path, its instantaneous velocity is:
   A. Maximum and upward
   B. Zero
   C. Maximum and downward
   D. Equal to acceleration
   E. Undefined

8. Neglecting air resistance, acceleration of a projectile near Earth's surface:
   A. Points toward the Earth and is constant
   B. Points upward and is constant
   C. Depends on the horizontal velocity
   D. Is zero at maximum height
   E. Changes sign halfway through

9. A runner changes direction while maintaining constant speed. Which is true?
   A. Acceleration is zero.
   B. Acceleration is nonzero because direction changes.
   C. Velocity is zero.
   D. Average velocity equals speed.
   E. No net force acts on the runner.

10. Two objects dropped from rest at the same height (no air resistance). One has greater mass. Which hits first?
    A. The heavier one
    B. The lighter one
    C. They hit at the same time
    D. The one with larger surface area
    E. It depends on initial speed

11. If the velocity of an object is increasing in the negative direction (i.e., becoming more negative), what is the acceleration?
    A. Positive

B. Negative
C. Zero
D. Could be positive or negative — insufficient info
E. Acceleration equals velocity

12. A position vs time graph is a straight line with positive slope. Which is true?
A. Object at rest
B. Constant velocity to the right
C. Constant acceleration to the right
D. Speed increasing
E. Velocity changing direction

13. A velocity vs time graph is a horizontal line at v = 3 m/s. Acceleration is:
A. 3 m/s^2
B. 0 m/s^2
C. Increasing
D. -3 m/s^2
E. Undefined

14. If acceleration is zero, which must be true?
A. Velocity is zero
B. Velocity is constant
C. Position is constant
D. Speed is increasing
E. Jerk is nonzero

15. Two cars have same average speed but different average velocities. Why?
A. They traveled different total distances.
B. They took different time intervals.
C. They had different directions of motion (different displacements).
D. One had variable acceleration.
E. One was moving and the other was stationary.

16. A ball is thrown horizontally off a cliff. Which is true about horizontal motion?
A. Horizontal acceleration equals g downward.
B. Horizontal velocity increases with time.
C. Horizontal velocity remains constant (neglecting air resistance).
D. Horizontal displacement is independent of initial horizontal velocity.
E. Horizontal motion determines time to hit the ground.

17. For the same thrown speed, launching at 30° vs 60° (above horizontal) — neglect air resistance — which has the greater range?
    A. 30°
    B. 60°
    C. They have equal range
    D. 45° always gives the same result as both
    E. Cannot determine without speed

18. Which statement about instantaneous velocity is true?
    A. It's the average velocity over the entire motion.
    B. It's the derivative (slope) of position with respect to time at that instant.
    C. It is the same as average speed.
    D. It is the area under the position vs time graph.
    E. It always equals acceleration times time.

19. A car slows from +20 m/s to +10 m/s. Which is true about displacement during slowing (same time interval as some other event)?
    A. Displacement is negative.
    B. Displacement is zero.
    C. Displacement is in the positive direction.
    D. Displacement equals change in velocity.
    E. Displacement equals acceleration.

20. Two identical projectiles are launched with same speed; one at 0° (horizontal) off a cliff, one at 45° from the same cliff. Which reaches ground first? (Neglect air resistance.)
    A. The horizontal launch
    B. The 45° launch
    C. They land at same time
    D. Depends on cliff height
    E. Depends on speed

21. On a velocity vs time graph, a line with negative slope crossing from positive to negative velocity indicates:
    A. Speeding up in the positive direction
    B. A change in direction (velocity sign change)
    C. Constant speed
    D. No displacement
    E. Constant acceleration positive

22. Which best describes "displacement"?
    A. The total length of the path traveled
    B. The shortest distance and direction from initial to final position
    C. Always positive
    D. Scalar measure of motion
    E. Unrelated to position

23. If an object's velocity is zero but acceleration is nonzero, what is happening?
    A. Object remains at rest forever
    B. Object is momentarily at rest and about to change velocity (turnaround point)
    C. Net force is zero
    D. Speed is constant
    E. Time is frozen

24. A ball thrown vertically upward returns to same level as thrown. Compare speeds at launch and landing (neglect air resistance).
    A. Launch speed > landing speed
    B. Launch speed < landing speed
    C. Launch speed = landing speed
    D. Cannot compare without time
    E. They are equal only if thrown slowly

25. Acceleration due to gravity (g) is best described as:
    A. A variable that depends on object mass
    B. A constant vector pointing downward near Earth's surface
    C. A speeding-up quantity only
    D. Zero in free fall
    E. Measured in meters

26. Which of these is NOT a kinematic quantity?
    A. Position
    B. Velocity
    C. Acceleration
    D. Mass
    E. Displacement

27. In one-dimensional motion, which pair are vectors?
    A. Speed and time
    B. Distance and speed
    C. Displacement and velocity

D. Mass and distance
E. Time and speed

28. Two cars travel along the same straight road. Car A has constant speed, Car B has constant acceleration. Which statement must be possible?
A. Car A and B have equal velocities at all times.
B. Car B's velocity changes with time while Car A's does not.
C. Car B's speed is constant.
D. Car A is accelerating.
E. Car A's displacement is zero.

29. A position vs time curve is concave up. What does that tell you about acceleration?
A. Acceleration is zero
B. Acceleration is positive
C. Acceleration is negative
D. Velocity is zero
E. Displacement is decreasing

30. A toy car rolls down a frictionless ramp and then across a level surface (no friction). Which is true about its horizontal speed after it reaches the level surface?
A. It continues to increase because of gravity.
B. It remains constant.
C. It decreases due to lack of gravity component.
D. It reverses direction.
E. It must stop.

31. Two identical balls are thrown with same speed — one straight up, one straight horizontally. Which has larger maximum vertical displacement above starting point?
A. The one thrown horizontally
B. The one thrown upward
C. Both have same vertical displacement
D. Depends on their masses
E. Depends on gravity value

32. Which graph shows constant acceleration?
A. Position vs time: straight line
B. Velocity vs time: straight, nonzero slope
C. Velocity vs time: horizontal line
D. Position vs time: horizontal line

E. Acceleration vs time: parabola

33. If the acceleration vector is opposite the velocity vector, the object is:
    A. Speeding up
    B. Slowing down
    C. Turning without changing speed
    D. At constant speed
    E. Moving in a circle

34. For projectile motion, horizontal and vertical motions are:
    A. Dependent — horizontal affects vertical time
    B. Independent — vertical motion ignores horizontal velocity (neglect air drag)
    C. Both governed by same acceleration in same direction
    D. Both have zero acceleration
    E. Not separable

35. A graph shows velocity increasing linearly from 0 to 10 m/s in 5 s. Which is true?
    A. Acceleration is constant and positive
    B. Acceleration is zero
    C. Acceleration is negative
    D. Velocity is constant
    E. Displacement is zero

36. A ball rolling on level ground slows down due to friction. Which describes acceleration?
    A. Acceleration is zero because speed is decreasing slowly
    B. Acceleration is opposite the direction of motion
    C. Acceleration is in the same direction as motion
    D. Acceleration must be upward
    E. Acceleration has no relation to force

37. Two cars travel in opposite directions; each has speed 20 m/s. Which has greater velocity magnitude?
    A. The one going east
    B. The one going west
    C. Both have same magnitude of velocity (but opposite directions)
    D. Cannot compare without time
    E. Depends on their accelerations

38. A particle moves in one dimension with velocity $v(t) = 0$ at $t = 0$, and acceleration $a(t) > 0$ for $t > 0$. Which is true for $t>0$?

A. Velocity becomes negative
B. Velocity remains zero
C. Velocity becomes positive and increases
D. Position decreases
E. Acceleration must become zero later

39. A car travels around a circular track at constant speed. Which is true?
A. Its acceleration is zero.
B. Its velocity is constant.
C. Its acceleration points toward the center of the circle.
D. Its speed changes continuously.
E. No net force acts on it.

40. The slope of a velocity vs time graph gives you:
A. Displacement
B. Acceleration
C. Jerk
D. Position
E. Distance

41. Two runners start at the same point. Runner A runs 100 m east and stops. Runner B runs 50 m east, turns around, runs 50 m west, and stops. Which statement is true?
A. Both ran same distance and same displacement.
B. Both had same displacement but different distances.
C. Both had same distance but different displacements.
D. Runner B had larger displacement.
E. Runner A had zero displacement.

42. A ball thrown upward reaches max height at t1. Which of these is correct at t1?
A. Velocity is upward and maximum
B. Acceleration is zero
C. Velocity is zero and acceleration is downward ($\approx -g$)
D. Acceleration is upward
E. Jerk is zero so motion stops

43. Consider a car with velocity changing sign from positive to negative. Which must have occurred?
A. It instantaneously stopped ($v=0$) at some time.
B. It passed through infinite acceleration.
C. It teleported.

D. Its displacement was zero.
E. No change in direction occurred.

44. A position vs time graph shows a curve that flattens out at later times (slope decreases toward zero). Which is happening?
A. Speed is increasing
B. Speed is decreasing (approaching zero)
C. Acceleration is positive and large
D. Object reversed direction earlier
E. Displacement becomes negative

45. Which best describes "instantaneous acceleration"?
A. Total change in velocity over total time
B. Derivative of velocity with respect to time at an instant
C. Average velocity over a long time
D. Slope of position vs time graph
E. Area under velocity vs time

46. A stone is dropped and another stone is thrown downward with some initial speed from same height at same time (no air resistance). Which hits first?
A. The dropped stone
B. The thrown stone
C. They hit at same time
D. Depends on the height
E. Depends on their masses

47. Which is true for an object moving at constant velocity?
A. Net force is zero.
B. Net force is nonzero.
C. Acceleration is nonzero.
D. Speed must be zero.
E. Velocity direction changes.

48. A car's velocity is +30 m/s at t = 0 and acceleration is -3 m/s² constant. When will it stop? (Conceptual — you don't need to compute a number)
A. It never stops.
B. It stops at some positive time when velocity reaches zero.
C. It stops only if displacement is zero.
D. It cannot stop because acceleration is constant.

E. It reverses immediately.

49. Which describes "average velocity" over a time interval?
    A. Displacement divided by that time interval
    B. Total distance divided by that time interval
    C. Final speed divided by time
    D. Always equal to instantaneous velocity at the midpoint
    E. Product of average speed and time

50. A flashlight on a moving train shines forward. From the ground observer's frame (nonrelativistic approximation), the light's horizontal component of velocity:
    A. Adds to the train's speed (classical addition)
    B. Is always exactly c ± train speed (relativistic — ignore here)
    C. This question mixes relativity so is invalid for AP Physics 1 — simply choose none of these
    D. For AP Physics 1 purposes, we treat light separately and avoid this scenario
    E. Not appropriate to include in kinematics — eliminate the question

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Answer Key

1. B
2. B
3. B
4. C
5. B
6. C
7. B
8. A

9. B

10. C

11. B

12. B

13. B

14. B

15. C

16. C

17. C

18. B

19. C

20. A

21. B

22. B

23. B

24. C

25. B

26. D

27. C

28. B

29. B

30. B

31. B

32. B

33. B

34. B

35. A

36. B

37. C

38. C

39. C

40. B

41. C

42. C

43. A

44. B

45. B

46. B

47. A

48. B

49. A

50. E

Medium Difficulty

1. Two cars travel along the same straight line. Car A's velocity is +10 m/s and its acceleration is +2 m/s². Car B's velocity is +10 m/s and its acceleration is −2 m/s². Which statement is correct?
   A. Both cars' speeds are increasing.
   B. A's speed is increasing and B's speed is decreasing.
   C. A's speed is decreasing and B's speed is increasing.
   D. Both cars have zero net force.
   E. Both cars must change direction soon.

2. A ball is thrown straight upward. At the instant it passes through a point on its way up, its kinetic energy equals its potential energy. Which is true the instant after that point (still on the way up, neglect air resistance)?
   A. Speed increases, acceleration upward.
   B. Speed increases, acceleration downward.
   C. Speed decreases, acceleration downward.
   D. Speed stays same, acceleration zero.
   E. Speed decreases, acceleration upward.

3. On a velocity vs time graph you see a curve that crosses the time axis (velocity goes from positive to negative) with constant negative slope. Which is true?
   A. The object instantaneously teleported through zero displacement.
   B. The object changes direction once and had constant acceleration.
   C. The object's speed was zero the whole time.
   D. The displacement over that interval must be zero.
   E. Acceleration changed sign at the crossing.

4. Two projectiles are launched from the same point at the same speed: one at 20° and one at 70° above horizontal (no air). Which is true about their flight times and ranges?
   A. The 20° one has the longer flight time and shorter range.
   B. The 70° one has the longer flight time and shorter range.
   C. They have the same flight time and same range.
   D. The 20° one has longer flight time and longer range.

E. Cannot compare without speed value.

5. A particle moves around a circle at **constant speed**. Which must be true?
   A. Net force is zero.
   B. Velocity is constant.
   C. Acceleration is perpendicular to velocity and points to the center.
   D. Its tangential acceleration is positive.
   E. Its kinetic energy is changing.

6. If a particle's position vs time graph is linear with a negative slope, which of the following is true?
   A. It has constant negative acceleration.
   B. It has zero velocity.
   C. It moves at constant velocity in the negative direction.
   D. Its speed increases in time.
   E. Its displacement is zero.

7. Two objects start from rest and undergo identical constant accelerations. After 5 s, object A has a velocity 20 m/s, while object B has 30 m/s. Which statement is correct?
   A. Acceleration of A is larger than B.
   B. The acceleration of B is larger than A.
   C. The accelerations are equal; the initial conditions must differ.
   D. The motion violates kinematics (impossible).
   E. One of them moved backwards.

8. A car moves to the right and at some instant has velocity +8 m/s and acceleration −3 m/s². Which is true about speed at that instant?
   A. Speed is increasing.
   B. Speed is decreasing.
   C. Speed equals acceleration.
   D. Speed is zero.
   E. Car must reverse direction immediately.

9. Which one of these is **not** implied by "average velocity equals average speed" over an interval?
   A. Motion was in a single direction (no reversals).
   B. Displacement magnitude equals distance traveled.
   C. Instantaneous velocity never changed sign during the interval.
   D. Instantaneous acceleration must have been zero the whole interval.

E. Net displacement divided by time equals total distance divided by time.

10. An object moves along x with velocity decreasing from +12 m/s to −4 m/s. Which must be true about acceleration?
    A. Acceleration is zero.
    B. Acceleration is positive.
    C. Acceleration is negative.
    D. Acceleration changed sign multiple times.
    E. You cannot determine sign of acceleration from this alone.

11. A stone is thrown horizontally from a cliff. Neglecting air resistance, which statement is correct?
    A. The vertical component of velocity is constant.
    B. The horizontal acceleration is g downward.
    C. The horizontal velocity is constant while vertical velocity changes at rate g.
    D. The time to hit depends on the horizontal speed.
    E. The range is independent of launch height.

12. A ball is tossed upward from ground with some speed. If you measure its speed at two different heights on the way up and the magnitudes are different, which is necessarily true?
    A. Between those heights the acceleration changed.
    B. Gravity is not constant.
    C. Mechanical energy is not conserved (air resistance or nonconservative forces).
    D. The ball must have passed maximum height between those points.
    E. The velocities correspond to two different times but not necessarily nonconservative forces.

13. For motion in one dimension, which statement about v(t) and x(t) is correct?
    A. If v(t) is constant then x(t) is linear.
    B. If x(t) is linear then acceleration is nonzero.
    C. If x(t) is quadratic then acceleration is time-dependent.
    D. If v(t) has zero area under it, displacement is nonzero.
    E. If acceleration is linear in time, v(t) is constant.

14. A car's velocity is described by $v(t) = 5 - 0.5t$ (m/s). At $t = 10$ s which is true?
    A. Car is still moving forward (positive velocity).
    B. Car has come to rest.
    C. Car's speed is increasing.
    D. Car has reversed direction earlier than $t = 10$ s.

E. Acceleration becomes positive after 10 s.

15. Two objects are projected simultaneously from the same height with the same speed. One is launched straight up, the other at 60° above horizontal. Neglecting air resistance: which hits the ground first?
    A. Straight up hits first.
    B. 60° projectile hits first.
    C. They land at the same time.
    D. Depends on mass.
    E. Depends on speed.

16. Which statement is true about using the kinematic relation v2=v02+2aΔxv^2 = v_0^2 + 2a\Delta xv2=v02+2aΔx?
    A. It requires time explicitly to solve problems.
    B. It holds only when acceleration varies linearly.
    C. It connects speeds and displacement without time and assumes constant acceleration.
    D. It gives displacement directly if acceleration is zero.
    E. It is only valid in rotational motion.

17. A car travels in +x, momentarily stops, then goes negative x. Regarding instantaneous acceleration at the instant it stopped, which is always true?
    A. Acceleration must be zero.
    B. Acceleration is necessarily positive.
    C. Acceleration is necessarily negative.
    D. Acceleration is nonzero (could be either sign).
    E. Acceleration is undefined at that instant.

18. A particle moves so that its position function is concave down for t>0. Which is necessarily true for t>0?
    A. Velocity is negative.
    B. Acceleration is positive.
    C. Acceleration is negative.
    D. Speed is increasing.
    E. Position is decreasing.

19. A train moves with constantly increasing speed in the forward direction. Which of the following must be true?
    A. Velocity is decreasing.
    B. Acceleration is forward (same direction as velocity).
    C. Net force is zero.

D. Average velocity equals instantaneous velocity always.
E. Distance travelled per second is constant.

20. Which is the best interpretation of "instantaneous velocity"?
A. Average velocity over the whole trip.
B. The derivative of position with respect to time at that instant.
C. Displacement divided by total time.
D. Area under acceleration vs time curve.
E. Slope of velocity vs time graph.

21. Two objects have identical position vs time graphs (same curve) but different masses. Which is true?
A. Their velocities and accelerations are identical functions of time.
B. Their accelerations differ since masses differ.
C. Their velocities are different because heavier object moves slower.
D. Kinematics cannot determine velocity from position vs time.
E. Mass affects only displacement not velocity.

22. Which scenario violates statement "acceleration = net force / mass"?
A. Object in free fall neglecting air resistance.
B. Object moving at constant velocity on frictionless surface.
C. Object with zero net force but changing direction in circular motion.
D. Object accelerating because of unbalanced forces.
E. None — the statement always holds (Newton's 2nd law).

23. A velocity vs time graph shows two segments: first constant positive v, then a triangular ramp to a larger positive v. Which can be inferred?
A. Average acceleration over ramp is zero.
B. During ramp there is net positive acceleration.
C. Displacement over ramp is zero.
D. The object reversed direction during ramp.
E. Jerk must be negative.

24. For projectile motion on level ground (no drag), which launch angle gives maximum horizontal range for a given speed?
A. 30°
B. 37°
C. 45°
D. 53°

E. 60°

25. If a body has acceleration vector always perpendicular to its instantaneous velocity vector, which is necessarily true?
    A. Speed is constant.
    B. Speed is increasing.
    C. The body must be at rest.
    D. The body has zero centripetal acceleration.
    E. Velocity and acceleration are parallel.

Quantitative (26–50) — use kinematic equations (harder; many require combining equations)

Note: use v=v0+atv = v_0 + a tv=v0+at, x=x0+v0t+12at2x = x_0 + v_0 t + \tfrac12 a t^2x=x0+v0t+21at2, v2=v02+2aΔxv^2 = v_0^2 + 2 a \Delta xv2=v02+2aΔx, and projectile time/range relations as needed.

26. A car moving at **5.0 m/s** speeds up uniformly to **25.0 m/s** in **8.00 s**. What **distance** does it travel during this interval?
    A. 100 m
    B. 120 m
    C. 160 m
    D. 80 m
    E. 200 m

27. A projectile is launched at **20.0 m/s** at **30.0°** above horizontal (take g=9.80 m/s2g=9.80\ \mathrm{m/s^2}g=9.80 m/s2). What is its **time of flight** until it lands back at launch height?
    A. 1.02 s
    B. 1.41 s
    C. 2.04 s
    D. 2.50 s
    E. 3.00 s

28. A car decelerates uniformly at −2.0 m/s2−2.0\ \mathrm{m/s^2}−2.0 m/s2 and comes to rest after travelling **10.0 m**. What was its **initial speed** (just before braking)?
    A. 4.0 m/s
    B. 5.0 m/s

C. 6.32 m/s
D. 10.0 m/s
E. 14.1 m/s

29. A rock is thrown straight up with initial speed **30.0 m/s**. Neglecting air resistance, to what **maximum height** above launch (in m) does it rise? (Use g=9.80g=9.80g=9.80.)
A. 22.9 m
B. 30.6 m
C. 45.9 m
D. 61.2 m
E. 91.8 m

30. Two identical cars travel at 20.0 m/s. Car A brakes with constant acceleration −4.00 m/s²; Car B brakes with −2.00 m/s². Which is true?
A. A and B stop at same time and same distance.
B. A stops sooner and travels a shorter distance than B.
C. B stops sooner and travels shorter distance than A.
D. A stops sooner but travels further than B.
E. Both stop at same time but different distances.

31. From the top of a cliff **80.0 m** high, one rock is dropped (initial speed 0), another is thrown downward at **10.0 m/s**. Which hits first, and by how much (approx)?
A. Dropped rock hits first by 0.90 s
B. Thrown rock hits first by 0.90 s
C. They hit simultaneously
D. Thrown rock hits first by 0.25 s
E. Dropped rock hits first by 0.25 s

32. A particle moves along x with x(t)=4t2−3t+2x(t)=4t^2 -3t +2x(t)=4t2−3t+2 (x in meters, t in seconds). What are its velocity at t=3.00 st=3.00\ \mathrm{s}t=3.00 s and its acceleration?
A. v = 12 m/s, a = 4 m/s²
B. v = 21 m/s, a = 8 m/s²
C. v = 9 m/s, a = 4 m/s²
D. v = 21 m/s, a = 4 m/s²
E. v = 12 m/s, a = 8 m/s²

33. An object's velocity is given by v(t)=10−2tv(t)=10-2tv(t)=10−2t (m/s). At what time does it stop, and what displacement occurs between t=0t=0t=0 and t=4t=4t=4 s?
A. stops at 4 s; displacement 24 m

B. stops at 5 s; displacement 24 m
C. stops at 5 s; displacement 30 m
D. stops at 10 s; displacement 40 m
E. stops at 4 s; displacement 20 m

34. A bullet is fired **horizontally** from a 100.0 m cliff with horizontal speed **300 m/s**. Neglect air resistance. How far horizontally does it travel before hitting the ground?
A. 450 m
B. 900 m
C. 1355 m
D. 2400 m
E. 3000 m

35. A car starts at v0=15.0 m/sv_0=15.0\ \mathrm{m/s}v0=15.0 m/s, accelerates at +3.00 m/s2+3.00\ \mathrm{m/s^2}+3.00 m/s2 for 4.00 s, then immediately decelerates at −6.00 m/s2-6.00\ \mathrm{m/s^2}−6.00 m/s2 to a stop. What total distance did it travel during this entire process?
A. 124.5 m
B. 144.75 m
C. 168.0 m
D. 84.0 m
E. 60.75 m

36. Car A starts from rest with constant acceleration 2.00 m/s22.00\ \mathrm{m/s^2}2.00 m/s2. Car B moves at constant speed 10.0 m/s10.0\ \mathrm{m/s}10.0 m/s. How long until A catches B (starting together at t=0)?
A. 2.0 s
B. 5.0 s
C. 10.0 s
D. 20.0 s
E. They never meet.

37. A skier launches off a ramp at **12.0 m/s** at **40.0°** above horizontal (level landing). What is the approximate **maximum height** above launch? (Use g=9.80g=9.80g=9.80.)
A. 1.2 m
B. 3.04 m
C. 6.0 m
D. 9.4 m
E. 12.1 m

38. A car with initial velocity +20.0 m/s applies brakes at −5.00 m/s² for 3.00 s. What is its speed after braking and how far did it move during braking?
    A. 5.0 m/s; 37.5 m
    B. 5.0 m/s; 15.0 m
    C. −5.0 m/s; 37.5 m
    D. 0 m/s; 60.0 m
    E. 20.0 m/s; 60.0 m

39. A particle at t=0t=0t=0 is at x0=10.0 mx_0=10.0\ \mathrm{m}x0=10.0 m with v0=−8.0 m/sv_0=-8.0\ \mathrm{m/s}v0=−8.0 m/s and acceleration +2.00 m/s2+2.00\ \mathrm{m/s^2}+2.00 m/s2. When (positive times) does it pass the origin (x=0x=0x=0)?
    A. t = 0.85 s only
    B. t = 1.55 s only
    C. t = 6.45 s only
    D. t = 1.55 s and 6.45 s
    E. It never passes x=0

40. Two stones are released at the same instant: Stone A is thrown upward at 20.0 m/s from ground level; Stone B is thrown downward from a 30.0 m tall tower with speed 5.00 m/s downward. Which hits the ground first (assume level ground at base of tower and g=9.80g=9.80g=9.80)?
    A. Stone A hits first.
    B. Stone B hits first.
    C. They hit simultaneously.
    D. Depends on horizontal motion (not given).
    E. Neither will ever hit (nonsense).

41. Velocity as a function of time is v(t)=4t2−12t+9v(t)=4t^2 -12t +9v(t)=4t2−12t+9 (m/s). What is acceleration at t=1.00t=1.00t=1.00 s and displacement from t=0t=0t=0 to t=2.00t=2.00t=2.00 s?
    A. a(1)=−4 m/s²; Δx = 4.667 m
    B. a(1)=−4 m/s²; Δx = 8.000 m
    C. a(1)=4 m/s²; Δx = 4.667 m
    D. a(1)=4 m/s²; Δx = 12.000 m
    E. a(1)=−8 m/s²; Δx = 4.667 m

42. A ball dropped from rest reaches the ground in **3.00 s**. From what height was it released? (Take g=9.80g=9.80g=9.80.)
    A. 29.4 m
    B. 44.1 m

C. 58.8 m
D. 88.2 m
E. 9.8 m

43. A car travelling at 25.0 m/s brakes uniformly to a stop in 5.00 s. What is its acceleration and stopping distance?
A. a = −4.00 m/s²; d = 50.0 m
B. a = −5.00 m/s²; d = 62.5 m
C. a = −2.50 m/s²; d = 100 m
D. a = −5.00 m/s²; d = 31.3 m
E. a = −3.00 m/s²; d = 104.2 m

44. A projectile is launched at **40.0 m/s** at **53.0°** above horizontal. Using g=9.80g=9.80g=9.80, what is the time to reach maximum height and that max height?
A. t_max = 1.95 s; h_max = 38.0 m
B. t_max = 2.50 s; h_max = 45.0 m
C. t_max = 3.26 s; h_max = 52.07 m
D. t_max = 4.00 s; h_max = 80.0 m
E. t_max = 1.00 s; h_max = 10.0 m

45. An object starts from rest and undergoes constant acceleration and travels 100.0 m in 5.00 s. What is the acceleration?
A. 4.00 m/s²
B. 6.00 m/s²
C. 8.00 m/s²
D. 10.0 m/s²
E. 2.00 m/s²

46. A car accelerates from rest at 3.00 m/s² for 4.00 s and then decelerates uniformly at −2.00 m/s² for 6.00 s. What is its final speed and total distance travelled?
A. v_final = 12.0 m/s; total d = 48.0 m
B. v_final = 0 m/s; total d = 60.0 m
C. v_final = 0 m/s; total d = 36.0 m
D. v_final = 6.0 m/s; total d = 60.0 m
E. v_final = 12.0 m/s; total d = 60.0 m

47. Acceleration is time-dependent: a(t)=6ta(t)=6ta(t)=6t (m/s²) and v(0)=2.0 m/sv(0)=2.0\ \mathrm{m/s}v(0)=2.0 m/s. What is v(t)v(t)v(t) and the displacement from 0 to 2.00 s?
A. v(t)=6t+2v(t)=6t+2v(t)=6t+2; Δx = 16 m
B. v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2; Δx = 12 m

C. $v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2$; $\Delta x = 8$ m
D. $v(t)=6t+2v(t)=6t+2v(t)=6t+2$; $\Delta x = 12$ m
E. $v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2$; $\Delta x = 24$ m

48. A car with initial speed 10.0 m/s accelerates at 4.00 m/s². After what time does it pass a point 100.0 m ahead of the start? (Positive root only.)
A. 2.50 s
B. 3.33 s
C. 4.00 s
D. 5.00 s
E. 6.67 s

49. Two cars are 200.0 m apart and approach each other: A at 30.0 m/s, B at 20.0 m/s (head-on). How long until collision and how far does A travel before collision?
A. 2.00 s; A goes 60.0 m
B. 4.00 s; A goes 120.0 m
C. 4.00 s; A goes 80.0 m
D. 6.67 s; A goes 200.0 m
E. 5.00 s; A goes 150.0 m

50. A ball is thrown upward from the top of a 20.0 m building with initial speed 15.0 m/s upward. Neglect air resistance. When does it hit the ground (positive root)?
A. 2.03 s
B. 3.00 s
C. 4.06 s
D. 5.50 s
E. 1.00 s

Answer Key (correct letter for each question)

1. B
2. C
3. B
4. B

5. C
6. C
7. B
8. B
9. D
10. C
11. C
12. C
13. A
14. B
15. A
16. C
17. D
18. C
19. B
20. B
21. A
22. E
23. B
24. C

25. A

26. B

27. C

28. C

29. C

30. B

31. B

32. B

33. B

34. C

35. B

36. C

37. B

38. A

39. D

40. B

41. A

42. B

43. B

44. C

45. C

46. B

47. B

48. C

49. B

50. C

Hard

1. Two cars travel on the same straight road in the +x direction. Both have instantaneous speed 10.0 m/s. Car A has acceleration +2.0 m/s²; Car B has acceleration −2.0 m/s². Which statement is correct right now?
   A. Both cars' speeds are increasing.
   B. A's speed is increasing and B's speed is decreasing.
   C. A's speed is decreasing and B's speed is increasing.
   D. Both cars have zero net force.
   E. Both cars must reverse direction within the next 5 s.

2. A ball is thrown vertically upward. At some moment on the way up its kinetic energy equals its gravitational potential energy (relative to the launch point). Immediately after that moment (still going up, ignore air resistance), which is true?
   A. Speed increases and acceleration is upward.
   B. Speed increases and acceleration is downward.
   C. Speed decreases and acceleration is downward.
   D. Speed is constant and acceleration is zero.
   E. Speed decreases and acceleration is upward.

3. On a velocity-vs-time graph you observe a straight line crossing the time axis (velocity changes from + to −) with constant negative slope. Which can you conclude?
   A. The object teleported through zero displacement.
   B. The object changed direction exactly once and had constant acceleration.
   C. The object's speed was zero for an interval.
   D. The displacement over that interval is zero.

E. Acceleration changed sign at the crossing instant.

4. Two projectiles are launched from the same point with identical speeds: one at 20° above horizontal, one at 70° above horizontal (no air resistance). Which is true?
   A. The 20° launch has longer flight time and shorter range.
   B. The 70° launch has longer flight time and the same horizontal range as the 20° launch.
   C. They have equal flight times and equal ranges.
   D. The 20° launch has longer flight time and longer range.
   E. Range and flight time cannot be compared without the speed value.

5. A particle moves in a circle at constant speed. Which statement must be true?
   A. Net force is zero.
   B. Velocity (vector) is constant.
   C. Acceleration is perpendicular to velocity and points to the center.
   D. Tangential acceleration is positive.
   E. Kinetic energy is changing.

6. The position versus time plot for an object is a straight line with negative slope. Which is correct?
   A. Constant negative acceleration.
   B. The object is at rest.
   C. The object moves at constant velocity in the negative direction.
   D. Speed is increasing.
   E. Net displacement is zero.

7. Two objects start from rest and both undergo constant acceleration for 5.00 s. After 5.00 s their speeds are 20.0 m/s (object A) and 30.0 m/s (object B). Which is true?
   A. A's acceleration is larger than B's.
   B. B's acceleration is larger than A's.
   C. Their accelerations are equal — initial conditions must differ.
   D. The situation is impossible under constant acceleration.
   E. One object must have been moving backward.

8. A car moves to the right; at an instant it has velocity +8.0 m/s and acceleration −3.0 m/s². Which is true about its speed at that instant?
   A. Speed is increasing.
   B. Speed is decreasing.
   C. Speed equals acceleration (in magnitude).
   D. Speed is zero.

E. The car must reverse direction immediately.

9. Which statement is **not** implied by "average velocity equals average speed" over a time interval?
   A. The object did not reverse direction during the interval.
   B. The magnitude of displacement equals distance traveled.
   C. Instantaneous velocity never changed sign during the interval.
   D. Acceleration was zero for the whole interval.
   E. Displacement divided by time equals total distance divided by time.

10. An object's velocity along +x falls from +12 m/s to −4 m/s over some interval. Which must be true about its acceleration over that interval (sign)?
   A. Acceleration is zero.
   B. Acceleration is positive.
   C. Acceleration is negative.
   D. Acceleration changed sign multiple times.
   E. You cannot determine the sign of acceleration from only the velocities.

11. A stone is thrown horizontally from the cliff top (neglect air resistance). Which statement is correct?
   A. The vertical component of velocity is constant in time.
   B. The horizontal acceleration equals g downward.
   C. The horizontal velocity is constant while the vertical velocity changes at rate g.
   D. Time to hit the ground depends on horizontal speed.
   E. Horizontal displacement is independent of launch height.

12. A ball is tossed upward. You observe it twice at the same height (on the way up) but measure two different speeds at those two instants. Which is necessarily true (assume your height measurements are accurate)?
   A. Gravity changed in the interval.
   B. Acceleration was zero between those heights.
   C. Nonconservative forces (e.g., air resistance) must be acting.
   D. The ball passed the same height three or more times.
   E. The two measurements must have been simultaneous.

13. For one-dimensional motion, which statement is always correct?
   A. If v(t) is constant then x(t) is a linear function of t.
   B. If x(t) is linear then acceleration is nonzero.
   C. If x(t) is quadratic then acceleration must be time-dependent.
   D. If v(t) has zero area under it over an interval, displacement is nonzero.

E. If acceleration is linear in time, v(t) is constant.

14. A car's velocity is v(t) = 5.0 − 0.5 t (m/s). At t = 10.0 s which statement is correct?
    A. The car is still moving forward (positive velocity).
    B. The car has come to rest.
    C. Its speed is increasing at that instant.
    D. The car reversed direction earlier than t = 10 s.
    E. Acceleration becomes positive after t = 10 s.

15. Two projectiles are launched simultaneously from the same height with equal speeds: one straight up, the other at 60° above horizontal (no air). Which lands first?
    A. The one launched straight up.
    B. The 60° projectile.
    C. They land simultaneously.
    D. The result depends on mass.
    E. It depends on launch speed magnitude.

16. Which of the following is the best interpretation of the kinematic relation v2=v02+2aΔxv^2 = v_0^2 + 2a\Delta xv2=v02+2aΔx?
    A. It requires explicit time to solve motion.
    B. It holds only if acceleration varies linearly.
    C. It connects speeds and displacement without time, assuming constant acceleration.
    D. It gives displacement directly if acceleration is zero.
    E. It is valid only for rotational motion.

17. A particle moves in +x, momentarily stops and then moves in −x. At the instant its velocity is zero, which statement is always true about acceleration?
    A. Acceleration must be zero at that instant.
    B. Acceleration must be positive at that instant.
    C. Acceleration must be negative at that instant.
    D. Acceleration could be zero, positive, or negative — its value cannot be determined without more information.
    E. Acceleration is undefined at that instant.

18. For t > 0 a particle's position function is concave down (concavity < 0). Which is necessarily true for t > 0?
    A. Velocity is negative.
    B. Acceleration is positive.
    C. Acceleration is negative.
    D. Speed is increasing.

E. Position is decreasing.

19. A train's speed increases continuously in the forward direction. Which must be true?
    A. Its velocity magnitude is decreasing.
    B. Its acceleration is forward (same direction as velocity).
    C. Net force on it is zero.
    D. Instantaneous velocity equals average velocity at all times.
    E. Distance traveled per second is constant.

20. Which is the best single description of instantaneous velocity?
    A. Average velocity for the entire trip.
    B. The derivative of position with respect to time at that instant.
    C. Displacement divided by total trip time.
    D. The area under an acceleration vs time curve.
    E. The slope of a velocity vs time graph.

21. Two objects have identical position vs time graphs x(t)x(t)x(t), but different masses. Which is true about their kinematics?
    A. Their velocities and accelerations are identical functions of time.
    B. Their accelerations differ because their masses differ.
    C. The heavier object must have lower velocities.
    D. Kinematics alone cannot determine velocity from a position vs time graph.
    E. Mass affects only displacement, not velocity.

22. Which scenario would contradict Newton's second law a=Fnet/ma = F_{\text{net}}/ma=Fnet/m (interpreting Fnet as total applied force)?
    A. Object in free fall (neglect air resistance).
    B. Object moving at constant velocity on a frictionless surface.
    C. Object experiencing changing direction in uniform circular motion with zero net force.
    D. Object accelerating due to unbalanced forces.
    E. None — Newton's second law always applies (in an inertial frame).

23. A velocity vs time graph shows a segment of constant positive vvv followed by a linear ramp up to a larger positive vvv. What is true about the ramp segment?
    A. Average acceleration over the ramp is zero.
    B. There is net positive acceleration during the ramp.
    C. The displacement during the ramp is zero.
    D. The object reversed direction during the ramp.

E. The jerk (rate of change of acceleration) must be negative.

24. For projectile motion on horizontal ground with fixed launch speed, which launch angle gives maximum horizontal range (no air)?
    A. 30°
    B. 37°
    C. 45°
    D. 53°
    E. 60°

25. If an object's acceleration vector is always perpendicular to its instantaneous velocity vector, which must be true?
    A. The object's speed is constant.
    B. Its speed is increasing.
    C. The object must be at rest.
    D. The object has zero centripetal acceleration.
    E. Velocity and acceleration are parallel.

Part II — Quantitative (26–50)

Use standard kinematic relations for constant acceleration problems: v=v0+atv=v_0+atv=v0+at, x=x0+v0t+12at2x=x_0+v_0 t + \tfrac12 a t^2x=x0+v0t+21at2, v2=v02+2aΔxv^2=v_0^2+2a\Delta xv2=v02+2aΔx, projectile relations, and algebraic manipulation. g = 9.80 m/s² when needed.

26. A car accelerates uniformly from 8.0 m/s8.0\ \mathrm{m/s}8.0 m/s to 28.0 m/s28.0\ \mathrm{m/s}28.0 m/s in 10.0 s10.0\ \mathrm{s}10.0 s. What distance does it travel during this interval?
    A. 160 m
    B. 180 m
    C. 200 m
    D. 140 m
    E. 220 m

27. A projectile is launched at 50.0 m/s50.0\ \mathrm{m/s}50.0 m/s at 37.0◦37.0^\circ37.0◦ above horizontal. What is its maximum height above the launch point? (Take g=9.80 m/s2g=9.80\ \mathrm{m/s^2}g=9.80 m/s2.)
    A. 41.1 m

B. 46.2 m
C. 50.0 m
D. 57.3 m
E. 62.8 m

28. Two vehicles start from rest 200.0 m apart on a straight line and accelerate toward each other. Car A: aA=+2.00 m/s2a_A=+2.00\ \mathrm{m/s^2}aA=+2.00 m/s2 (from x=0). Car B: aB=+8.00 m/s2a_B=+8.00\ \mathrm{m/s^2}aB=+8.00 m/s2 (from x=200 m, moving toward decreasing x). When do they meet and how far does A travel before collision?
    A. Meet at t≈4.0t\approx 4.0t≈4.0 s; A travels 16 m
    B. Meet at t≈8.0t\approx 8.0t≈8.0 s; A travels 64 m
    C. Meet at t≈6.3246t\approx 6.3246t≈6.3246 s; A travels 40.0 m
    D. Meet at t≈5.0t\approx 5.0t≈5.0 s; A travels 25.0 m
    E. They never meet under constant acceleration

29. A particle's velocity is v(t)=12−3tv(t)=12 - 3tv(t)=12−3t (m/s). What is the displacement from t=0t=0t=0 to when the particle stops?
    A. 18.0 m
    B. 24.0 m
    C. 30.0 m
    D. 36.0 m
    E. 12.0 m

30. A car traveling at 30.0 m/s brakes uniformly to rest in a distance of 150.0 m. What are its acceleration and the time to stop?
    A. $a = -2.00\ \text{m/s}^2$; $t = 15.0$ s
    B. $a = -3.00\ \text{m/s}^2$; $t = 10.0$ s
    C. $a = -4.00\ \text{m/s}^2$; $t = 7.5$ s
    D. $a = -5.00\ \text{m/s}^2$; $t = 6.0$ s
    E. $a = -1.50\ \text{m/s}^2$; $t = 20.0$ s

31. From the top of a cliff you throw one rock straight down with initial speed 10.0 m/s from height 80.0 m; simultaneously you drop another rock from rest. Which hits first and by approximately how long?
    A. Dropped rock hits first by ≈0.90 s
    B. Thrown rock hits first by ≈0.90 s
    C. They hit simultaneously
    D. Thrown rock hits first by ≈0.25 s

E. Dropped rock hits first by ≈0.25 s

32. A particle starts at rest. It accelerates at +3.00 m/s2+3.00\ \mathrm{m/s^2}+3.00 m/s2 for 4.00 s, then immediately at −6.00 m/s2-6.00\ \mathrm{m/s^2}−6.00 m/s2 until it stops. What total distance does it travel?
A. 24.0 m
B. 30.0 m
C. 36.0 m
D. 48.0 m
E. 60.0 m

33. A projectile is launched horizontally from a height of 80.0 m with horizontal speed 20.0 m/s. How long is it in the air and how far horizontally does it travel before hitting the ground?
A. $t \approx 2.86$ s; $x \approx 57.2$ m
B. $t \approx 3.61$ s; $x \approx 72.1$ m
C. $t \approx 4.04$ s; $x \approx 80.8$ m
D. $t \approx 5.07$ s; $x \approx 101.4$ m
E. $t \approx 1.43$ s; $x \approx 28.6$ m

34. A car starts from rest and travels 100.0 m in 4.00 s with constant acceleration. What is its acceleration and final speed?
A. $a = 8.00$ m/s²; $v_f = 32.0$ m/s
B. $a = 10.0$ m/s²; $v_f = 40.0$ m/s
C. $a = 12.5$ m/s²; $v_f = 50.0$ m/s
D. $a = 6.25$ m/s²; $v_f = 25.0$ m/s
E. $a = 5.00$ m/s²; $v_f = 20.0$ m/s

35. Two objects are released simultaneously: A is thrown vertically upward from ground with speed 20.0 m/s; B is dropped from a tower of height 45.0 m. Which hits the ground first?
A. A hits first.
B. B hits first.
C. They land simultaneously.
D. Depends on air resistance (insufficient data).
E. They never hit.

36. Car A starts from rest with constant acceleration 2.00 m/s22.00\ \mathrm{m/s^2}2.00 m/s2. Car B moves ahead at constant 10.0 m/s (starting together at t=0). How long until A catches B (positive time)?
A. 2.00 s

B. 5.00 s
C. 10.0 s
D. 20.0 s
E. They never meet.

37. A skier launches off a ramp at 12.0 m/s at 40.0° above horizontal (level landing). What is the maximum height above the launch point? (Use g = 9.80 m/s².)
A. 1.20 m
B. 3.04 m
C. 6.00 m
D. 9.40 m
E. 12.1 m

38. A car with initial speed 20.0 m/s applies brakes producing a constant acceleration of −5.00 m/s² for 3.00 s. What is its speed after braking and how far did it travel during those 3.00 s?
A. v = 5.0 m/s; d = 37.5 m
B. v = 5.0 m/s; d = 15.0 m
C. v = −5.0 m/s; d = 37.5 m
D. v = 0 m/s; d = 60.0 m
E. v = 20.0 m/s; d = 60.0 m

39. A particle at t=0t=0t=0 is at x0=10.0 mx_0=10.0\ \mathrm{m}x0=10.0 m with v0=−8.0 m/sv_0=-8.0\ \mathrm{m/s}v0=−8.0 m/s and constant acceleration a=+2.00 m/s2a=+2.00\ \mathrm{m/s^2}a=+2.00 m/s2. At what positive times does it pass the origin x=0x=0x=0?
A. t≈0.85t\approx 0.85t≈0.85 s only
B. t≈1.55t\approx 1.55t≈1.55 s only
C. t≈6.45t\approx 6.45t≈6.45 s only
D. t≈1.55t\approx 1.55t≈1.55 s and t≈6.45t\approx 6.45t≈6.45 s
E. It never passes x = 0

40. Two stones are released at the same instant: Stone A is thrown upward at 20.0 m/s from ground level; Stone B is thrown downward from a 30.0 m tall tower at 5.00 m/s downward. Which hits the ground first?
A. Stone A
B. Stone B
C. They hit simultaneously
D. Not determined (need horizontal speeds)

E. They never hit

41. v(t)=4t2−12t+9v(t)=4t^2 -12t +9v(t)=4t2−12t+9 (m/s). What is a(1)a(1)a(1) (m/s²) and the displacement from t=0t=0t=0 to t=2.00t=2.00t=2.00 s?
    A. a(1) = −4.0 m/s²; Δx = 4.667 m
    B. a(1) = −4.0 m/s²; Δx = 8.000 m
    C. a(1) = +4.0 m/s²; Δx = 4.667 m
    D. a(1) = +4.0 m/s²; Δx = 12.000 m
    E. a(1) = −8.0 m/s²; Δx = 4.667 m

42. A ball is dropped from rest and reaches the ground in 3.00 s. From what height was it released? (Use g = 9.80 m/s².)
    A. 29.4 m
    B. 44.1 m
    C. 58.8 m
    D. 88.2 m
    E. 9.8 m

43. A car traveling at 25.0 m/s brakes uniformly to a stop in 5.00 s. What is the acceleration and stopping distance?
    A. a = −4.00 m/s²; d = 50.0 m
    B. a = −5.00 m/s²; d = 62.5 m
    C. a = −2.50 m/s²; d = 100 m
    D. a = −5.00 m/s²; d = 31.3 m
    E. a = −3.00 m/s²; d = 104.2 m

44. A projectile is launched at 40.0 m/s at 53.0° above horizontal. What is the time to reach maximum height and the maximum height? (g = 9.80 m/s²)
    A. t_max = 1.95 s; h_max = 38.0 m
    B. t_max = 2.50 s; h_max = 45.0 m
    C. t_max = 3.26 s; h_max = 52.1 m
    D. t_max = 4.00 s; h_max = 80.0 m
    E. t_max = 1.00 s; h_max = 10.0 m

45. An object starts from rest and undergoes constant acceleration, covering 100.0 m in 5.00 s. What is the acceleration?
    A. 4.00 m/s²
    B. 6.00 m/s²
    C. 8.00 m/s²
    D. 10.0 m/s²

E. 2.00 m/s²

46. A car accelerates from rest at 3.00 m/s² for 4.00 s then decelerates uniformly at −2.00 m/s² for 6.00 s. What is its final speed and total distance travelled?
A. v_final = 12.0 m/s; total d = 48.0 m
B. v_final = 0.0 m/s; total d = 60.0 m
C. v_final = 0.0 m/s; total d = 36.0 m
D. v_final = 6.0 m/s; total d = 60.0 m
E. v_final = 12.0 m/s; total d = 60.0 m

47. The acceleration is time dependent: a(t)=6ta(t) = 6ta(t)=6t (m/s²) and v(0)=2.0 m/sv(0)=2.0\ \mathrm{m/s}v(0)=2.0 m/s. What is v(t)v(t)v(t) and the displacement from t=0t=0t=0 to t=2.00 st=2.00\ \mathrm{s}t=2.00 s?
A. v(t)=6t+2v(t)=6t+2v(t)=6t+2; Δx = 16.0 m
B. v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2; Δx = 12.0 m
C. v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2; Δx = 8.0 m
D. v(t)=6t+2v(t)=6t+2v(t)=6t+2; Δx = 12.0 m
E. v(t)=3t2+2v(t)=3t^2+2v(t)=3t2+2; Δx = 24.0 m

48. A car with initial speed 10.0 m/s10.0\ \mathrm{m/s}10.0 m/s accelerates at 4.00 m/s24.00\ \mathrm{m/s^2}4.00 m/s2. After what time does it pass a point 100.0 m ahead of the start (positive root)?
A. 2.50 s
B. 3.33 s
C. 4.00 s
D. 5.00 s
E. 6.67 s

49. Two cars are 200.0 m apart and head directly toward each other: A at 30.0 m/s, B at 20.0 m/s. How long until collision and how far does A travel before collision?
A. 2.00 s; A travels 60.0 m
B. 4.00 s; A travels 120.0 m
C. 4.00 s; A travels 80.0 m
D. 6.67 s; A travels 200.0 m
E. 5.00 s; A travels 150.0 m

50. A ball is thrown upward from the top of a 20.0-m building with initial speed 15.0 m/s upward. Neglect air resistance. When does it hit the ground (positive root)?
A. 2.03 s
B. 3.00 s

C. 4.06 s
D. 5.50 s
E. 1.00 s

Answer Key (all correct letters)

1. B
2. C
3. B
4. B
5. C
6. C
7. B
8. B
9. D
10. C
11. C
12. C
13. A
14. B
15. B

16. C

17. D

18. C

19. B

20. B

21. A

22. E

23. B

24. C

25. A

26. B

27. B

28. C

29. B

30. B

31. B

32. C

33. C

34. C

35. B

36. C

37. B

38. A

39. D

40. B

41. A

42. B

43. B

44. C

45. C

46. B

47. B

48. D

49. B

50. C