5) In the formula \( v^2 = v_0^2 + 2ax \), what does \( x \) represent?

Answer: The CHANGE in POSITION, which is NOT necessarily the distance gone. Diff:2

11) Refer to the figure:

Based on all the graphical information
A) C and D meet at the same position at \( t = 8 \) s. CAN'T TEL FROM VELOCITY VS TIME GRAPH
B) C and D will meet at the same position at \( t = 10 \) s. CAN'T TELL
C) C and D will never meet at the same position. CAN'T TELL
D) not enough information is given to decide if C and D meet. YES
E) the acceleration of D is negative. IT IS POSITIVE

Answer: D Diff:2

15) Consider the average velocity of an object equal to its instantaneous velocity.
A) This is never true. NO.
B) This is the case only when the velocity is increasing at a constant rate. NO
C) This is always true. NO.
D) This is the case ONLY when the velocity is constant. NOT ALWAYS.
E) This can be true at certain instants. YES

Answer: E Diff:2
12) Refer to the figure:

During the first 8 s
A) C and D are both slowing down. TRUE FROM +5 3/5 TO +2 1/5 AND -5 4/5 TO -2 3/5
B) C and D have constant velocities. SAME SPEED BUT DIFFERENT DIRECTIONS
C) C has the same average velocity as D. BOTH SLOWING
D) C is slowing down, and D is speeding up. POSITIVE
E) the acceleration of D is negative.

Answer: A
Diff: 2

18) Which graph represents a constant non-zero velocity?

A) graph a
B) graph b
C) graph c
D) graph d
E) both graphs a and d

Answer: B
Diff: 2
Acceleration

1) All of the following are scalars, except
   A) mass.
   B) force.  DIRECTION MATTERS.
   C) temperature.
   D) distance.
   E) income.

Answer: B
Diff: 1

2) A car was moving 110. km/hour. (30.6 m/s) \( v_i = 30.6 \text{ m/s} \)
   (a) How long did it take to go 41,038m? \( \Delta x = 41,038 \text{ m} \)
   \( \Delta t = 35 \text{ s} \)
   \( \Delta x = \frac{d}{t} \)
   \( t = \frac{d}{v} = \frac{41,038 \text{ m}}{30.6 \text{ m/s}} \)

Answer: (a) 22.4 min
(b) -0.87 m/s\(^2\)
Diff: 3

3) It is possible to have constant speed, but still be accelerating.

Answer: TRUE (if you are moving in a CIRCLE – your direction would be changing)
Diff: 2

4) It is possible to have zero acceleration, and still be moving.

Answer: TRUE (moving at constant velocity)
Diff: 2

5) Which graph(s) represent(s) zero acceleration?

A) b and c
B) a and b
C) c and d
D) only a
E) only b

Answer: B
Diff: 2
6) A negative velocity, approaching zero, represents a negative acceleration.

Answer: FALSE (It would be a positive acceleration.)
Diff: 2

7) The graph plots the velocity of two cars (A and B) along the same straight road.

Which car reverses direction?
A) Car A
B) Car B
C) insufficient information
D) both cars A & B
E) neither car A nor B

Answer: B
Diff: 2

9) Explain how a POSITIVE acceleration could slow an object down.

Answer: An object which was moving in the negative direction would slow down if its acceleration were positive (a negative acceleration would mean the velocity was getting more negative: it would be speeding up in the negative direction).
Diff: 2

10) If an object is accelerating, it must therefore undergo
A) a decrease in velocity. MAY BE
B) a change in velocity. YES
C) an increase in velocity. MAY BE
D) a change in direction. MAY BE
E) a change in speed. MAY BE

Answer: B (It MAY do A, C, D, or E, but it MUST do B)
Diff: 2
11) A new car manufacturer advertises that their car can go "from zero to sixty in 8 s." This is a description of
A) instantaneous speed.
B) average speed.
C) instantaneous acceleration.
D) average acceleration.

Answer: D
Diff: 2

12) Refer to the figure:

During the first 8 s
A) D always has a greater acceleration than C. NO, C always has a greater acceleration than D.
B) C always has a greater acceleration than D.
C) their accelerations are equal in magnitude, but opposite in sign.
D) their accelerations are equal in magnitude, and equal in sign.
E) D is speeding up while C is slowing down

Answer: C
Diff:2

Kinematic Equations (Constant Acceleration)

2) Eric watches a jet powered truck during an "air-show." It accelerates from rest to 134 m/s in 8.0 seconds. What is the acceleration? Difficult: The acceleration was equivalent to how many "g's"?

\[ a = \frac{\Delta v}{\Delta t} = \frac{134 \text{ m/s} - 0 \text{ m/s}}{8.0 \text{ s}} = \frac{134 \text{ m/s}}{8.0 \text{ s}} \]

Answer: 17. m/s² = (17. m/s²)/(9.8m/s²) = 1.7 g's
Diff: 2

4) Consider a mass initially moving at 7.50 m/s.
   (a) How long does it take to move 3.5 km if it accelerates at 0.550 m/s²)?
   (b) How fast is it moving after this acceleration?

Answer: (a) 100. seconds
(b) 62.5 m/s
Diff:3
6) A bullet moving at 244 m/s strikes a tree and penetrates a distance of 8.34 mm before stopping. What was the average acceleration of the bullet as it slowed?

Answer: \(-3.57 \times 10^6 \text{ m/s}^2\)

7) Which graph represents constant positive acceleration?

a) \(v-t\) graph with \(\alpha = 0\)

b) \(v-t\) graph with \(\alpha = 0\)

c) \(v-t\) graph with \(\alpha = 0\)

d) \(v-t\) graph with \(\alpha = \text{positive}\)

A) graph a  
B) graph b  
C) graph c  
D) graph d  
E) both graphs c and d

Answer: D

8) A car traveling 16.7 m/s accelerates at the rate of 4.0 m/s\(^2\). How much time is required for the car to reach a speed of 25.0 m/s?

\[
\begin{align*}
\Delta x &= \frac{(25.0 \text{ m/s})^2 - (16.7 \text{ m/s})^2}{2 \times 4.0 \text{ m/s}^2} \\
&= 2.1 \text{ s}
\end{align*}
\]

Answer: 2.1 s

9) An auto accelerates from 7.0 m/s at 0.71 m/s\(^2\). It travels a distance of 1.033 km while accelerating.

(a) What is the final speed at the end of that displacement?

(b) How many seconds did it take to accelerate from 7.0 m/s?

\[
\begin{align*}
\Delta x &= \frac{(1.033 \text{ km})^2 - (0.71 \text{ km})^2}{2 \times 0.71 \text{ km/s}^2} \\
&= 7.0 \text{ km/s} \\
\end{align*}
\]

Answer: (a) 39. m/s  
(b) 45. s
10) Can an object's velocity change direction when its acceleration is constant? 
A) Yes, this is possible, and a rock thrown straight up is an example.
B) No, this is not possible because it is always speeding up.
C) Yes, this is possible, and a car that starts from rest, speeds up, slows to a stop, and then 
backs up is an example.
D) No, this is not possible because it is always speeding up or always slowing down, but it can 
ever turn around.

Answer: A
Diff: 2

11) An airplane increases its speed from 100.0 m/s to 160 m/s, at the average rate of 15 m/s². How much time does it take for the complete increase in speed? 

A) 0.25 s  
B) 4.0 s  
(C) 0.0577 s  
D) 17.3 s  
E) 8.0 s

Answer: B
Diff: 2

12) A car traveling 20.0 m/s is able to stop in a distance d. Assuming the same braking force, what distance does this car require to stop when it is traveling twice as fast? 

A) d  
B) 2d  
C) \sqrt{2d}  
D) 4d  
E) 2\sqrt{2d}

Answer: D (Slow Down! It takes four time the distance to stop if you double your speed. Isn't that what your drivers ed teacher taught you?)
Diff: 2

13) A jet fighter plane is launched from a catapult on an aircraft carrier. It reaches a speed of 42 m/s at the end of the catapult, and this requires 2.0 s. Assuming the acceleration is constant, what is the length of the catapult? 

A) 16m  
B) 42m  
C) 24m  
D) 66m  
E) 84m

Answer: B
Diff: 2
15) An astronaut on a strange new planet finds that she can jump up to a maximum height of 27. meters when her initial upward speed is 6.0 m/s. What is the magnitude of the acceleration of gravity on the planet? (hint: find a, but it isn't 9.80 m/s² — that is on Earth at sea level.)

Answer: 0.67 m/s²
Diff: 2

18) Can an object have increasing speed while its acceleration is decreasing?
A) No, this is impossible because of the way in which acceleration is defined.
B) Yes and an example would be an object falling in the absence of air friction.
C) No, because if acceleration is decreasing the object will be slowing down.
D) Yes and an example would be an object released from rest in the presence of air friction.

Answer: D
Diff: 2

20) A ball is released moving straight up at 15. m/s. At some time later it is falling downward at 15. m/s. What was the magnitude of its average velocity over this time period?

A) 0. m/s
B) 30. m/s
C) 15. m/s
D) 7.5 m/s
E) 22. m/s

Answer: A (Note: velocity has a direction!)
Diff: 2

21) A bullet moving horizontally with a speed of 500.0 m/s strikes a sandbag and penetrates a distance of 10.0 cm.

(a) What is the average acceleration of the bullet?
(b) How long does it take to come to rest?

Answer: (a) 1.25 x 10⁶ m/s²
(b) 0.400 ms
Diff: 3

27) Captain Rickard orders his starship to accelerate from rest at "1g" (accel = 9.8 m/s²). How long does it take the starship to reach one-tenth the speed of light if light travels 3.00 x 10⁸ m/s?

Answer: 35. days
Diff: 2
28) A car with good tires on a dry road can slow at about 5.0 m/s² when braking. If the car is traveling at 89 km/h (24.7 m/s):
(a) how long does it take the car to stop under these conditions?
(b) how far does the car travel during this time?

Answer: (a) 4.9 s
(b) 62 m
Diff: 3

31) The accompanying graph plots the velocity of two cars (A and B) along the same straight road.

During the time interval shown, which car is AHEAD?
A) Car A
B) Car B
C) insufficient information

Answer: C
Diff: 2

34) Under what condition is average velocity equal to the average of the object's initial and final velocity?
A) This can only occur if there is no acceleration.
B) The acceleration must be constant.
C) The acceleration must be constantly changing.
D) This can occur only when they are zero.

Answer: B
Diff: 2
36) Which graph represents an object at rest?

A) graph a
B) graph b
C) graph c
D) graph d
E) both graphs a and d

Answer: A
Diff: 2

39) A bullet moving at 244. m/s strikes a tree and penetrates a distance of 8.34 mm before stopping. Assuming a constant acceleration, how long did it take the bullet to stop?

Answer: 68.4 microseconds
Diff: 2

41) A ball is thrown upward at a velocity of 19.8 m/s. What is its velocity after 3.0 s?

A) zero
B) 9.8 m/s upward
C) 9.8 m/s downward
D) 19.8 m/s downward
E) 19.8 m/s upward

Answer: C
Diff: 2

Free Fall

1) Which physical unit is the SI acceleration of gravity?

A) 40 km, SW
B) 32 ft/s²
C) 9.8 m/s²
D) 186,000 mi
E) -120 mi/s

Answer: C
Diff: 1
2) When a ball is thrown straight up, which of the following is zero at its highest point?  
A) acceleration  
B) displacement  
C) velocity

Answer: C (Acceleration is always 9.8 m/s² downward!)  
Diff: 2

3) An object is thrown vertically and accelerates downward at +9.80 m/s² (downward is positive and upward is negative).  
   (a) What is its displacement after 5.00 s if it starts at 2.50 m/s?  
   (b) How fast is it moving after that 5.00 s?

Answer:  
(a) 135. meters  
(b) 46.5 m/s  
Diff: 3

4) When a ball is thrown straight up, the acceleration at its highest point is  
A) upward.  
B) downward.  
C) zero.  
D) horizontal.  
E) minimum.

Answer: B  
Diff: 2

7) The "acceleration of gravity" is 9.8 m/s² everywhere on the surface of the Earth.

Answer: FALSE (It varies depending on the Earth below.)  
Diff: 1

8) A skydiver jumps from a high-flying plane. When she reaches terminal velocity, her velocity  
A) is increasing at a constant rate.  
B) is decreasing.  
C) is essentially zero.  
D) is essentially constant.

Answer: D  
Diff: 1
9) A bullet shot straight up returns to its starting point in 10.0s. Its initial speed was
A) 98 m/s.
B) 49 m/s.
C) 9.8 m/s.
D) 24.5 m/s.
E) 32. ft/s.

Answer: B
Diff: 2

10) A ball is thrown straight up with an initial speed of 36 m/s. How long does it take to return to its starting point?

\[ 0 = v_i - 4.9t^2 \]

Answer: 2.71 seconds
Diff: 2

11) "Big Mike" throws a baseball straight up and it eventually falls back to him. When the ball was at its highest point, what was its velocity and what was its acceleration? (remember to include magnitude and direction)

Answer: Velocity was zero, acceleration was 9.8 m/s² downward.
Diff: 2

12) An object moving under the influence of only gravity is said to be in _________

Answer: free fall
Diff: 1

13) A ball is thrown straight up and returns to its starting point in 8.0 seconds under an acceleration due to gravity. Which of the following is true?
   A) It took less time to rise than to fall.
   B) To compare rise and fall times we need to know the mass of the ball.
   C) It took the same time to rise as it took to fall.
   D) It took longer to rise than to fall.

Answer: C
Diff: 2
14) Contrast Aristotle's predictions concerning free-falling bodies with Galileo's predictions.

Answer: Aristotle said heavier bodies fall faster than light bodies; so if the two were dropped at the same time, the heavier body would strike the ground sooner. Galileo observed that the motion was independent of the body's mass provided air friction was not significant.

Diff: 2

15) When an object is released from rest and falls in the absence of friction, which of the following is true concerning its motion?

A) Its velocity is constant.  
B) The acceleration increases at a constant rate.  
C) Both its acceleration and its velocity are constant.  
D) Neither its acceleration nor its velocity is constant.  
E) Its acceleration is constant.

Answer: E

Diff: 1

17) Consider a heavy object which is thrown straight up, reaches its highest point, and then falls back down to the ground. During what parts of the trajectory was it in "FREEFALL"? (assume here that air friction is negligible)

Answer: During its entire travel during which gravity was the only significant influence on it (it "freely fell" moving up, moving down, and at its motionless highest point).

Diff: 2

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Difficult

19) A can, after having been given a kick, moves up along a smooth hill of ice. It will

A) have a varying acceleration along the hill.  
B) have the same acceleration, both up the hill and down the hill.  
C) have a constant acceleration up the hill, but a different constant acceleration when it comes back down the hill.  
D) travel at constant velocity.

Answer: B

Diff: 2
16) Which physical unit is a fps acceleration?
   A) -120 mi/s
   B) 40 km,SW
   C) 9.8 m/s²
   D) 186,000 mi
   E) 32ft/s²

   Answer: E
   Diff: 1

25) A car starts from rest and accelerates uniformly at 3 m/s². A second car starts from rest 6.0s later at the same point and accelerates uniformly at 5 m/s². How long does it take the second car to overtake the first car?
   A) 24.0 s
   B) 12.2 s
   C) 35.0 s
   D) 18.9 s
   E) 22.7 s

   Answer: E
   Diff: 2

6) A toy rocket is launched upward with a net acceleration of 10 m/s² for 3.0 s. It then slows at the rate of 10 m/s² until it reaches its maximum altitude. How high does it go?
   A) 90m
   B) 30m
   C) 15m
   D) 60m
   E) 45m

   Answer: D

   Diff: 1

29) In a test carried out by a car manufacturer, a test driver is asked to put on his brakes when a warning light is suddenly flashed on in the roadway ahead. When traveling 25 m/s the driver is able to stop in 98 m, and when traveling 10 m/s he is able to stop in 32.5 m. Assuming the driver's reaction time is the same in each case, and that the rate of deceleration when the brakes are applied is independent of speed, determine:
   (a) the driver's reaction time.
   (b) the driver's deceleration.

   Answer: (a) 2.8 s
   (b) 11.2 m/s²

   Diff: 3
23) A car starting from rest moves with constant acceleration of 2 m/s\(^2\) for 10.0 s, then travels with constant speed for another 10.0 s, and then finally slows to a stop with constant acceleration of -2 m/s\(^2\). How far does it travel?

A) 400m  
B) 100m  
C) 500m  
D) 300m  
E) 200m  

Answer: A  
Diff: 2

30) A car slows uniformly and comes to a stop after 10.0 s. The car's average velocity during acceleration was 50 km/h. What was the car's acceleration while slowing down?

A) 10 km/h-s  
B) 5 km/h-s  
C) 9.8 m/s\(^2\)  
D) 8 km/h-s  
E) 4 km/h-s  

Answer: A  
Diff: 3

18) A skydiver jumps from a high-flying plane. When she reaches terminal velocity, her acceleration

A) is essentially zero.  
B) is approximately 9.8 m/s\(^2\) downward.  
C) is in the upward direction.  
D) is approximately 9.8 m/s\(^2\) upward.  

Answer: A  
Diff: 2