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Chapter 2 Motion Along a Straight Line

2.1 Multiple Choice Questions

1) If the fastest you can safely drive is $65\ \text{mi/h}$, what is the longest time you can stop for dinner if you must travel $487\ \text{mi}$ in $9.8\ \text{h}$ total?
A) 2.3 h
B) 2.5 h
C) 1.8 h
D) You can't stop at all.
Answer: A
Var: 50+

2) A car accelerates from $5.0\ \text{m/s}$ to $21\ \text{m/s}$ at a rate of $3.0\ \text{m/s}^2$. How far does it travel while accelerating?
A) 69 m
B) 207 m
C) 41 m
D) 117 m
Answer: A
Var: 50+

3) An airplane needs to reach a velocity of $203.0\ \text{km/h}$ to take off. On a $2000\ \text{m}$ runway, what is the minimum acceleration necessary for the plane to take flight?
A) $0.79\ \text{m/s}^2$
B) $0.87\ \text{m/s}^2$
C) $0.95\ \text{m/s}^2$
D) $1.0\ \text{m/s}^2$

Answer: A
Var: 50+

4) Assuming equal rates of acceleration in both cases, how much further would you travel if braking from 56 mi/h to rest than from 28 mi/h.

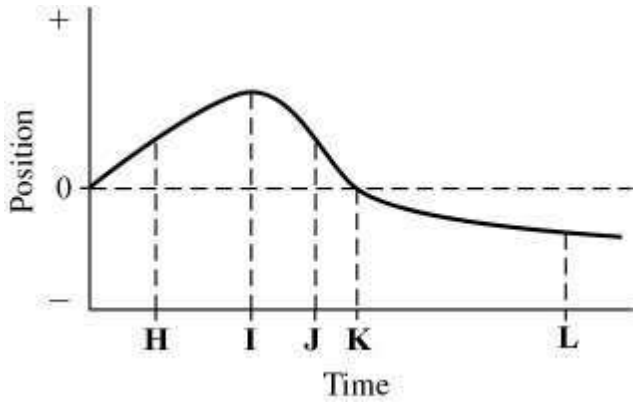
A) 4 times farther
B) 3.2 times farther
C) 4.8 times farther
D) 5.2 times farther
Answer: A
Var: 50+

5) Acceleration is sometimes expressed in multiples of *g*, where $g = 9.8\ \text{m/s}^2$ is the acceleration due to the earth's gravity. In a car crash, the car's velocity may go from $30\ \text{m/s}$ to $0\ \text{m/s}$ in $0.15\ \text{s}$. How many *g*'s are experienced, on average, by the driver?
A) 20 g
B) 14 g
C) 24 g
D) 26 g
Answer: A
Var: 11

6) A baseball is hit with a bat and, as a result, its direction is completely reversed and its speed is doubled. If the actual contact with the bat lasts $0.45\ \text{s}$, what is the ratio of the acceleration to the original velocity?
A) $-6.7\ \text{s}^{-1}$
B) $-4.4\ \text{s}^{-1}$
C) $-2.2\ \text{s}^{-1}$
D) $-0.15\ \text{s}^{-1}$
Answer: A
Var: 50+

Use Figure 2.1 to answer the following question(s).

Figure 2.1



7) The graph in Figure 2.1 shows the position of an object as a function of time. The letters H-L represent particular moments of time. At which moment in time is the speed of the object the highest?
A) J
B) H
C) I
D) K
E) L
Answer: A
Var: 1

8) The graph in Figure 2.1 shows the position of an object as a function of time. The letters H-L represent particular moments of time. At which moment in time is the speed of the object equal to zero?
A) I
B) H
C) J
D) K
E) L
Answer: A
Var: 1

9) A train starts from rest and accelerates uniformly, until it has traveled 5.6 km and acquired a velocity of $42\ \text{m/s}$. The train then moves at a constant velocity of $42\ \text{m/s}$ for 420 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The acceleration during the first 5.6 km of travel is closest to:

A) $0.16\ \text{m/s}^2$

B) $0.14\ \text{m/s}^2$

C) $0.17\ \text{m/s}^2$

D) $0.19\ \text{m/s}^2$

E) $0.20\ \text{m/ s}^2$

Answer: A

Var: 50+

10) A train starts from rest and accelerates uniformly, until it has traveled 2.1 km and acquired a velocity of $24\ \text{m/s}$. The train then moves at a constant velocity of $24\ \text{m/s}$ for 400 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The distance traveled by the train while slowing down, in km, is closest to:

A) 4.4

B) 4.2

C) 4.0

D) 3.8

E) 3.6

Answer: A

Var: 50+

11) A car moving at a velocity of 20 m/s is behind a truck moving at a constant velocity of $18\ \text{m/s}$. When the car is 50 m behind the front of the truck, the car accelerates uniformly at $1.8\ \text{m/s}^2$. The car continues at the same acceleration until it reaches a velocity of $25\ \text{m/s}$, which is the legal speed limit. The car then continues at a constant velocity of $25\ \text{m/s}$, until it passes the front of the truck. The distance the car travels while accelerating, in meters, is closest to:

A) 50

B) 54

C) 58

D) 62

E) 66

Answer: D

Var: 1

12) A motorist makes a trip of 180 miles. For the first 90 miles she drives at a constant speed of 30 mph. At what constant speed must she drive the remaining distance if her average speed for the total trip is to be 40 mph?
A) 45 mph
B) 50 mph
C) 52.5 mph
D) 55 mph
E) 60 mph
Answer: E
Var: 1

13) A racquetball strikes a wall with a speed of 30 m/s and rebounds with a speed of 26 m/s. The collision takes 20 ms. What is the average acceleration of the ball during the collision?
A) zero
B) 200 m/ s^2
C) 2800 m/s^2
D) 1500 m/s^2
E) 1300 m/s^2
Answer: C
Var: 1

14) Which of the following situations is impossible?
A) An object has velocity directed east and acceleration directed west.
B) An object has velocity directed east and acceleration directed east.
C) An object has zero velocity but non-zero acceleration.
D) An object has constant non-zero acceleration and changing velocity.
E) An object has constant non-zero velocity and changing acceleration.
Answer: E
Var: 1

15) A racing car accelerates uniformly from rest along a straight track. This track has markers spaced at equal distances along it from the start, as shown in Figure 2.2. The car reaches a speed of 140 km/h as it passes marker 2.

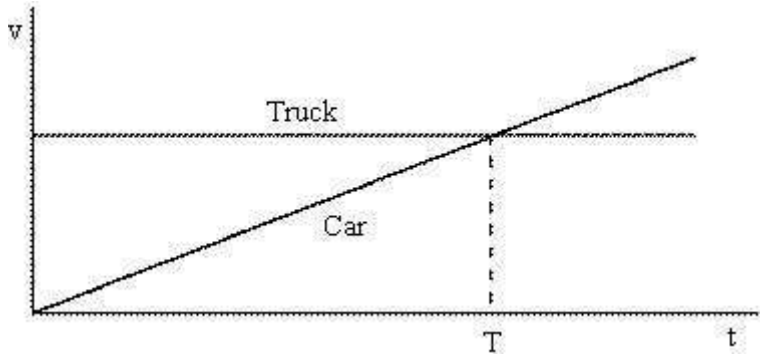
Figure 2.2

Whereabouts on the track was the car when it was travelling at half this speed, i.e. at 70 km/h?
A) Before marker 1
B) At marker 1
C) Between marker 1 and marker 2
Answer: A
Var: 1

16) A stone is thrown vertically upwards, reaches a highest point, and returns to the ground. When the stone is at the **top** of its path, its acceleration
A) is zero.
B) is directed upwards.
C) is directed downwards.
D) changes direction from upwards to downwards.
Answer: C
Var: 1

17) The motions of a car and a truck along a straight road are represented by the velocity-time graphs in Figure 2.3. The two vehicles are initially alongside each other at time t = 0.

Figure 2.3



At time T, what is true of the distances travelled by the vehicles since time t = 0?
A) They will have travelled the same distance.
B) The truck will not have moved.
C) The car will have travelled further than the truck.
D) The truck will have travelled further than the car.
Answer: D
Var: 1

18) Two identical objects A and B fall from rest from different heights to the ground. If object B takes *twice* as long as A to reach the ground, what is the ratio of the heights from which A and B fell? Neglect air resistance.
A) 1 : $\sqrt{2}$
B) 1 : 2
C) 1 : 4
D) 1 : 8
Answer: C
Var: 1

19) A ball is projected upward at time t = 0.0 s, from a point on a roof 60 m above the ground. The ball rises, then falls and strikes the ground. The initial velocity of the ball is 28.4 m/s. Consider all quantities as positive in the upward direction. At time t = 4.3 s, the acceleration of the ball is closest to:
A) zero
B) +5 m/ s^2
C) +10 m/ s^2
D) -5 m/s^2
E) -10 m/s^2
Answer: E
Var: 50+

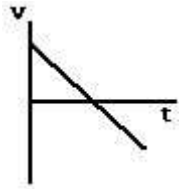
20) A ball is projected upward at time t = 0.0 s, from a point on a roof 10 m above the ground. The ball rises, then falls and strikes the ground. The initial velocity of the ball is 58.5 m/s. Consider all quantities as positive in the upward direction. At time t = 5.97 s, the velocity of the ball is closest to:
A) zero
B) +175 m/s
C) +12 m/s
D) -175 m/s
E) -12 m/s
Answer: A
Var: 50+

21) A ball is projected upward at time t = 0.0 s, from a point on a roof 90 m above the ground. The ball rises, then falls and strikes the ground. The initial velocity of the ball is 80.5 m/s. Consider all quantities as positive in the upward direction. The velocity of the ball when it is 89 m above the ground is closest to:
A) -81 m/s
B) -64 m/s
C) -48 m/s
D) -32 m/s
E) -97 m/s
Answer: A
Var: 50+

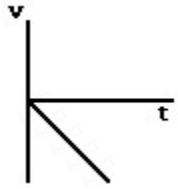
22) A test rocket is fired straight up from rest with a net acceleration of 20 m/s^2. After 4 seconds the motor turns off, but the rocket continues to coast upward. What maximum elevation does the rocket reach?
A) 487 m
B) 327 m
C) 320 m
D) 408 m
E) 160 m
Answer: A
Var: 1

23) A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at $t = 0$. Which of the graphs shown here best represents the velocity of the stone as a function of time?

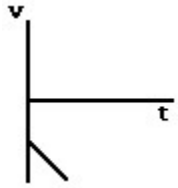
A)



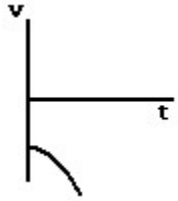
B)



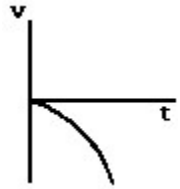
C)



D)



E)



Answer: C
Var: 1

24) A toy rocket is launched vertically from ground level (y = 0 m), at time t = 0.0 s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 64 m and acquired a velocity of 60 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground. The time interval, during which the rocket engine provides upward acceleration, is closest to:
A) 2.1 s
B) 2.3 s
C) 1.9 s
D) 1.7 s
E) 1.5 s
Answer: A
Var: 50+

25) A toy rocket is launched vertically from ground level (y = 0 m), at time t = 0.0 s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 81 m and acquired a velocity of 40 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground. The upward acceleration of the rocket during the burn phase is closest to:
A) 9.9 m/s^2
B) 9.6 m/s^2
C) 9.3 m/s^2
D) 9.0 m/s^2
E) 8.7 m/s^2
Answer: A
Var: 50+

26) A toy rocket is launched vertically from ground level (y = 0 m), at time t = 0.0 s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 49 m and acquired a velocity of 60 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground. The maximum height reached by the rocket is closest to:
A) 233 m
B) 221 m
C) 209 m
D) 244 m
E) 256 m
Answer: A
Var: 50+

Situation 2.1

A rock is projected upward from the surface of the moon, at time t = 0.0 s, with a velocity of 30 m/s. The acceleration due to gravity at the surface of the moon is 1.62 m/s^2.

27) In Situation 2.1, the time when the rock is ascending and at a height of 180 m is closest to:
A) 8 s
B) 12 s
C) 17 s
D) 23 s
E) 30 s
Answer: A
Var: 1

28) In Situation 2.1, the height of the rock when it is descending with a velocity of 20 m/s is closest to:
A) 115 m
B) 125 m
C) 135 m
D) 145 m
E) 155 m
Answer: E
Var: 1

29) A ball is thrown straight upward with a velocity of 18 m/s. How much time passes before the ball strikes the ground? Disregard air resistance.
A) 3.7 s
B) 1.8 s
C) 1.1 s
D) 0.6 s
Answer: A
Var: 31

30) An object is dropped from rest into a pit, and accelerates due to gravity at roughly 10 m/s^2. It hits the ground in 5 seconds. A rock is then dropped from rest into a second pit, and hits the ground in 10 seconds. How much deeper is the second pit, compared to the first pit? Neglect air resistance.
A) four times deeper
B) two times deeper
C) three times deeper
D) five times deeper
Answer: A
Var: 1

2.2 Short Answer Questions

1) A soccer ball is released from rest at the top of a grassy incline. After 6.4 seconds, the ball travels 91 meters. One second later, the ball reaches the bottom of the incline.
a) What was the ball's acceleration? (Assume that the acceleration was constant.)
b) How long was the incline?

Answer: a) 4.4 m/s^2

b) 120 m

Var: 50+

2) A rock is thrown directly upward from the edge of the roof of a building that is 56.3 meters tall. The rock misses the building on its way down, and is observed to strike the ground 4.00 seconds after being thrown. Take the acceleration due to gravity to have magnitude $9.80\ m/s^2$ and neglect any effects of air resistance. With what speed was the rock thrown?

Answer: 5.53 m/s

Var: 50+

3) A package is dropped from a helicopter moving upward at $15\ m/s$. If it takes $18.0\ s$ before the package strikes the ground, how high above the ground was the package when it was released? Neglect air resistance.

Answer: 1300 m

Var: 25

4) At the same moment, one rock is dropped and one is thrown downward with an initial velocity of $29\ m/s$ from the top of a $300\ m$ building. How much earlier does the thrown rock strike the ground? Neglect air resistance.

Answer: 2.4 s

Var: 21

5) Human reaction times are worsened by alcohol. How much further (in feet) would a drunk driver's car travel before he hits the brakes than a sober driver's car? Assume that both are initially traveling at 50.0 mph and their cars have the same acceleration while slowing down, and that the sober driver takes 0.33 s to hit the brakes in a crisis, while the drunk driver takes 1.0 s to do so.

Answer: 49 ft

Var: 1