Physics 11 – Kinematics in 1-D Worksheet

Name: _____

Solve each of the following problems using the format and problem solving procedure outlined in problem #1.

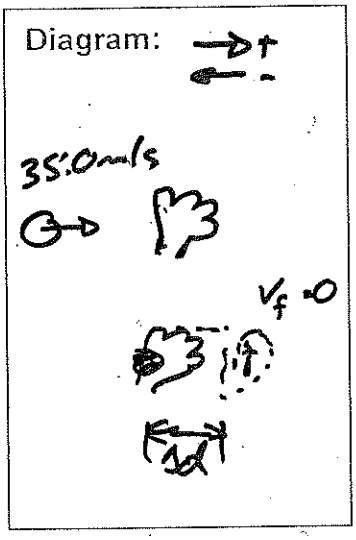
1. A baseball pitcher threw a ball towards the catcher. The instant before it hit the catchers mitt the ball was moving at 35.0 m/s. It took a time of 0.015s from the moment it touched the catchers mitt until it stopped.

a) What was the acceleration of the ball as it was being caught?

Given information:

V_i = 35.0 m/s
v_f = 0.0 m/s
Δt = 0.015 s
a = ? −2333.33 m/s²
Δd = ?

Diagram:



Solution:

i. Equation (in symbols): $v_f = a\Delta t + v_i$

ii. Rearrange equation (unknown variable on left)
a = $\frac{v_f - v_i}{\Delta t}$

iii. Plug numbers (with units) into equation
a = $\frac{0.0\ m/s - 35.0\ m/s}{0.015\ s}$

iv. Solve the equation
a = −2333.33 m/s²

v. Give the solution with appropriate ***UNITS***, and ***SIGNIFICANT DIGITS***. Put a box around your answer, and include a sentence to explain the answer (if necessary for clarity).

a = -2.3×10^3 m/s²

The acceleration of the ball was -2.3×10^3 m/s during the time that it was being caught.

b) How far back did the catchers hand move when she was catching the ball?

$$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$$

$$= \frac{1}{2}(35.0\ m/s + 0.0\ m/s)(0.015\ s)$$

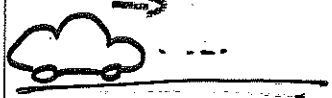
$$\boxed{\Delta d = 0.26\ m}$$

2. The driver of a speeding car travelling at 38.0 m/s on the highway sees a police car and applies the brakes to slow down.

(a) If the cars slows at rate of 5.0 m/s^2, how far will the car have travelled by the time it reaches the speed limit of 100.0 km/h?

Given information:
V_i = 38.0 m/s
V_f = 100 km/h = 27.778 m/s
~~Δt~~ = ?
a = −5.0 m/s^2
Δd = ?

Diagram:



Solution: $V_f^2 = 2a\Delta d + V_i^2$

$$\Delta d = \frac{V_f^2 - V_i^2}{2a} = \frac{(27.7778\ m/s)^2 - (38.0\ m/s)^2}{2(-5.0\ m/s^2)}$$

Δd = 67 m (67.2395 m)

$100\frac{km}{h} = \frac{100 \times 1000\ m}{3600\ s} = \frac{100}{3.6} = 27.777\ldots$

$\frac{m/s}{s} = m/s^2$

Δt

(b) How long will it take to reach the speed of 100.0 km/h?

$V_f = a\Delta t + V_i$

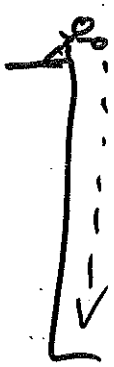
$$\Delta t = \frac{V_f - V_i}{a} = \frac{27.778\ m/s - 38.0\ m/s}{-5.0\ m/s^2} = 2.0\ s$$

3. A 10.0 kg ball dropped off the edge of a cliff hits the ground 4.5 s later.

(a) How fast was the ball going just before it hit the ground?

Given information:
V_i = 0.0 m/s
V_f = ?
Δt = 4.5 s
a = g = 9.8 m/s^2
Δd = ?

Diagram:



Solution:

$V_f = at + V_i$

$= (9.8\ m/s^2)(4.5\ s) + 0.0\ m/s$

V_f = 44 m/s (44.1 m/s)

(b) How high was the cliff?

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

$= \frac{1}{2}(9.8\ m/s^2)(4.5\ s)^2 + 0.0\ m/s(4.5\ s)$

Δd = 99 m

Physics11H - Kinematics in 1-D Worksheet

4. A javelin thrower carrying a spear while running at 6.0 m/s thrusts the spear ahead with an acceleration of 250m/s^2 for 0.10s. What is the speed with which the javelin leaves the throwers hand?

Given information:

v_i = 6.0m/s
v_f = ?
Δt = 0.10s
a = 250m/s^2
Δd = x

Solution:

$v_f = at + v_i$
$= (250 m/s^2)(0.10s) + 6.0 m/s$

$v_f = 31 m/s$

5. (a) If an Olympic cyclist reaches 18.0 m/s from a standing start in 20.0 s, what is his average acceleration?

Given information:

v_i = 0.0 m/s
v_f = 18.0 m/s
Δt = 20.0s
a = ?
Δd = x

Solution:

$a = \frac{v_f - v_i}{\Delta t} = \frac{18.0 m/s - 0.0 m/s}{20.0 s}$

$a = 9.00 \times 10^{-1} m/s^2$

(b) What distance does he travel in that time?

$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$
$= \frac{1}{2}(0.0 m/s + 18.0 m/s)(20.0 s)$

$\Delta d = 1.80 \times 10^2 m$

6. If a skier accelerates steadily down a hill from 3.50 m/s to 11.40 m/s in 4.20 s, what distance does she travel?

Given information:

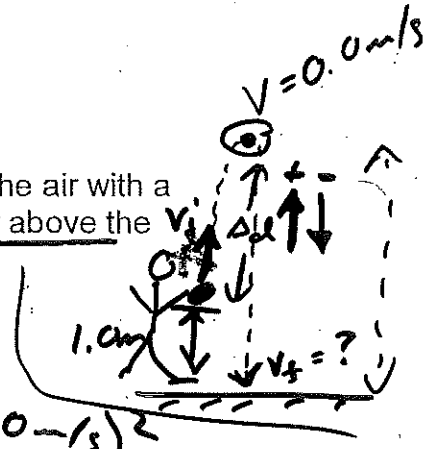
v_i = 3.50 m/s
v_f = 11.40 m/s
Δt = 4.20s
a = x
Δd = ?

Solution:

$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$
$= \frac{1}{2}(3.50 m/s + 11.40 m/s)(4.20 s)$

$\Delta d = 31.3 m$

7 4. a) A frustrated physics student threw his textbook into the air with a speed of 8.0 m/s from a height of 1.0 m. How high did the book fly above the ground before falling down?



Given information:

v_i = 8.0 m/s
v_f = 0.0 m/s
~~Δt = ?~~
a = $-9.8\ m/s^2$
Δd = ?

Solution:

$v_f^2 = 2a\Delta d + v_i^2$

$\Delta d = -\frac{v_i^2}{2a} = \frac{-(8.0\ m/s)^2}{2(-9.8\ m/s^2)}$

$\Delta d = 3.265\ m$ ∴ height above ground = 4.3 m

b) How long was the book in the air before it finally hit the ground?

$v_i = 8.0\ m/s$
$v_f = ?$
$\Delta t = ?$
$a = -9.8\ m/s^2$
$\Delta d = -1.0\ m$

$\Delta d = \frac{1}{2}at^2 + v_i t$

$\therefore 0 = \frac{1}{2}at^2 + v_i t - \Delta d$

$0 = \frac{1}{2}(-9.8)t^2 + (8)t - (-1)$

$0 = -4.9t^2 + 8t + 1$

$t = \frac{-8 \pm \sqrt{8^2 - 4(-4.9)(1)}}{2(-4.9)}$

$t = \frac{-8 \pm 9.1433}{-9.8}$

$\therefore t = 1.749\ s$ or $-0.117\ s$ (not reasonable (negative time))

$\therefore t = 1.7\ s$

8 4. In a panic stop a cars brakes can produce an acceleration of -8.0 m/s^2. If you are driving at 100.0 km/h, what is your minimum stopping distance from the instant you step on the brakes?

Given information:

v_i = 100.0 km/h
v_f = 0.0 m/s
Δt = ?
a = $-8.0\ m/s^2$
Δd = ?

Solution:

$100.0 \div 3.6 = 27.778\ m/s$

$v_f^2 = 2a\Delta d + v_i^2$

$\therefore \Delta d = \frac{-v_i^2}{2a}$

$= \frac{-\left(\frac{100}{3.6}\right)^2}{2(-8.0\ m/s^2)}$

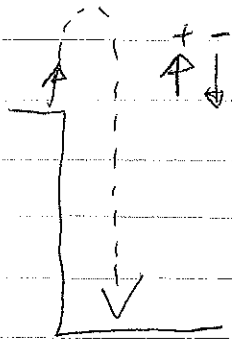
$\Delta d = 48\ m$

9. (a) $v_i = +18.0\ m/s$
$v_f = 0.0\ m/s$
$\Delta t = ?$
$a = -9.8\ m/s^2$
$\Delta d = x$

$\Delta t = \frac{v_f - v_i}{a}$

$= \frac{0.0\ m/s - 18\ m/s}{-9.8\ m/s^2}$

$\boxed{\Delta t = 1.84\ s}$



(b) $v_i = +18.0\ m/s$
$a = -9.8\ m/s^2$
$\Delta d = ?$
$\Delta t = 8.0\ s$

$\Delta d = \frac{1}{2}at^2 + v_i t$

$= \frac{1}{2}(-9.8\ m/s^2)(8.0\ s)^2 + (18.0\ m/s)(8.0\ s)$

$\Delta d = -169.6\ m$

$\therefore$ the cliff is $1.7 \times 10^2\ m$ high

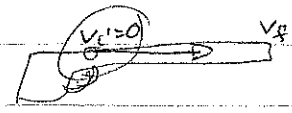
10. $v_i = 0.0\ m/s$
$v_f = 100.0\ km/h$
$\Delta t = 40.0\ s$
$\Delta d = ?$

$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$

$= \frac{1}{2}\left(0.0\ m/s + \left(\frac{100.0}{3.6}\right) m/s\right)(40.0\ s)$

$\boxed{\Delta d = 556\ m}$

11. $v_i = 0.0\ m/s$
$a = 5.75 \times 10^4\ m/s^2$
$\Delta d = 0.80\ m$
$\Delta t = ?$
$v_f = ?$



(a) $\Delta d = \frac{1}{2}at^2 + \cancel{v_i t}$ ($v_i = 0\ m/s$)

$\therefore t = \sqrt{\frac{2\Delta d}{\Delta a}}$

$t = \sqrt{\frac{2(0.80\ m)}{5.74 \times 10^4\ m/s^2}}$

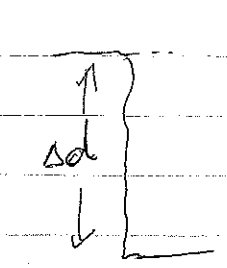
$\boxed{t = 5.3 \times 10^{-3}\ s}$

(b) $v_f^2 = 2a\Delta d + v_i^2$

$v_f = \sqrt{2(5.75 \times 10^4\ m/s^2)(0.80\ m) + (0)}$

$\boxed{v_f = 3.0 \times 10^2\ m/s}$

12.



$v_i = 0.0\ m/s$
$v_f = 25.0\ m/s$
$a = g = 9.8\ m/s^2$
$\Delta d = ?$
$\Delta t = ?$

(a) $v_f^2 = 2a\Delta d + v_i^2$

$\Delta d = \dfrac{v_f^2 - v_i^2}{2a}$

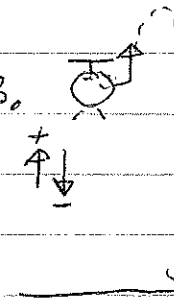
$\Delta d = \dfrac{(25.0\ m/s)^2 - 0^2}{2(9.8)}$

$\boxed{\Delta d = 31.9\ m = \text{height}}$

(b) $t = \dfrac{v_f - v_i}{a} = \dfrac{25.0\ m/s - 0.0\ m/s}{9.8\ m/s^2}$

$\boxed{t = 2.55\ s}$

13.



$v_i = 5.0\ m/s$
$v_f = ?$
$\Delta t = 10.0\ s$
$a = -9.8\ m/s^2$
$\Delta d = ?$

$\Delta d = \frac{1}{2}at^2 + v_i t$

$= \frac{1}{2}(-9.8\ m/s^2)(10.0\ s)^2 + (5.0\ m/s)($

$\Delta d = -440\ m$

$\therefore$ The helicopter was $4.4 \times 10^2\ m$ above the ground

14. $v_i = 0.0\ m/s$
$a = 4.6\ m/s^2$
$t = 6.8\ s$
$v_f = ?$

$v_f = at + v_i$

$= (4.6\ m/s^2)(6.8\ s) + 0.0\ m/s$

$\boxed{v_f = 31\ m/s}$

15. $v_i = ?$
$v_f = 0.0\ m/s$
$\Delta d = 78.0\ m$
$a = -8.54\ m/s^2$
$t = ?$

(a) $v_f^2 = 2a\Delta d + v_i^2$

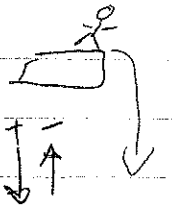
$\therefore v_i = \sqrt{v_f^2 - 2a\Delta d}$

$v_i = \sqrt{0 - 2(-8.54\ m/s^2)(78.0\ m)}$

$\boxed{v_i = 36.5\ m/s}$ (36.49986...

(b) $t = \dfrac{v_f - v_i}{a} = \dfrac{0.0\ m/s - 36.49986...\ m/s}{-8.54\ m/s^2}$

$\boxed{t = 4.27\ s}$

16. 

$v_i = 0.0\ m/s$

$a = 9.8\ m/s^2$

$\Delta d = 50.0\ m$

$\Delta t = ?$

$v_f = ?$

(a) $\Delta d = \frac{1}{2}at^2 + \cancel{v_i t}^{0\ m/s}$

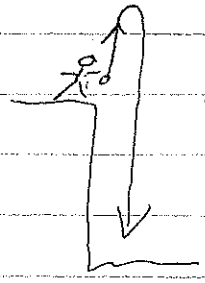
$t = \sqrt{\frac{2\Delta d}{a}} = \sqrt{\frac{2(50.0\ m)}{9.8\ m/s^2}}$

$\boxed{t = 3.19\ s}$

(b) $v_f^2 = \cancel{2a\Delta d}^{0} + \cancel{v_i^2}$

$v_f = \sqrt{2(9.8\ m/s^2)(50.0\ m)}$

$\boxed{v_f = 31.3\ m/s}$

17. 

$v_i = 12.0\ m/s$

$a = -9.8\ m/s^2$

$\Delta t = 7.5\ s$

$\Delta d = ?$

$\Delta d = \frac{1}{2}at^2 + v_i t$

$\Delta d = \frac{1}{2}(-9.8\ m/s^2)(7.5\ s)^2 + (12.0\ m/s)(7.5\ s)$

$\Delta d = -185.6\ m$

$\boxed{\text{so the cliff is } 1.9 \times 10^2\ m \text{ high}}$

Physics 11 – Kinematics in 1-D Worksheet

Name: _____

Solve each of the following problems using the format and problem solving procedure outlined in problem #1.

1. A baseball pitcher threw a ball towards the catcher. The instant before it hit the catchers mitt the ball was moving at 35.0 m/s. It took a time of 0.015s from the moment it touched the catchers mitt until it stopped.

a) What was the acceleration of the ball as it was being caught?

Given information:

V_i = _____

v_f = _____

Δt = _____

a = _____

Δd = _____

Diagram:

Solution:

i. Equation (in symbols):

_____

ii. Rearrange equation (unknown variable on left)

a = _____

iii. Plug numbers (with units) into equation

a = _____

iv. Solve the equation

a = _____

v. Give the solution with appropriate ***UNITS***, and ***SIGNIFICANT DIGITS***. Put a box around your answer, and include a sentence to explain the answer (if necessary for clarity).

a = _____

The acceleration of the ball was _____ during the time that it was being caught.

b) How far back did the catchers hand move when she was catching the ball?

2. The driver of a speeding car travelling at 38.0 m/s on the highway sees a police car and applies the brakes to slow down.

(a) If the cars slows at rate of 5.0 m/s^2, how far will the car have travelled by the time it reaches the speed limit of 100.0 km/h?

Given information:

V_i = _____

v_f = _____

Δt = _____

a = _____

Δd = _____

Diagram:

Solution:

(b) How long will it take to reach the speed of 100.0 km/h?

3. A 10.0 kg ball dropped off the edge of a cliff hits the ground 4.5 s later.

(a) How fast was the ball going just before it hit the ground?

Given information:

V_i = _____

v_f = _____

Δt = _____

a = _____

Δd = _____

Diagram:

Solution:

(b) How high was the cliff?

Physics11H - Kinematics in 1-D Worksheet

4. A javelin thrower carrying a spear while running at 6.0 m/s thrusts the spear ahead with an acceleration of 250m/s^2 for 0.10s. What is the speed with which the javelin leaves the throwers hand?

Given information: **Solution:**

v_i =
v_f =
Δt =
a =
Δd =

5. (a) If an Olympic cyclist reaches 18.0 m/s from a standing start in 20.0 s, what is his average acceleration?

Given information: **Solution:**

v_i =
v_f =
Δt =
a =
Δd =

(b) What distance does he travel in that time?

6. If a skier accelerates steadily down a hill from 3.50 m/s to 11.40 m/s in 4.20 s, what distance does she travel?

Given information: **Solution:**

v_i =
v_f =
Δt =
a =
Δd =

7. a) A frustrated physics student threw his textbook into the air with a speed of 8.0 m/s from a height of 1.0 m. How high did the book fly above the ground before falling down?

Given information: **Solution:**

v_i =
v_f =
Δt =
a =
Δd =

b) How long was the book in the air before it finally hit the ground?

8. In a panic stop a cars brakes can produce an acceleration of -8.0 m/s^2. If you are driving at 100.0 km/h, what is your minimum stopping distance from the instant you step on the brakes?

Given information: **Solution:**

v_i =
v_f =
Δt =
a =
Δd =

[redacted]

COMPLETE THE REMAINING PROBLEMS ON A SEPARATE PIECE OF PAPER. USE THE SAME FORMAT AS IN THE PREVIOUS PROBLEMS.

9~~4~~. A ball is thrown vertically upward off a bridge with a speed of 18.0 m/s.
(a) How long does it take to reach its maximum height?
(b) If the ball hits the water below the bridge 8.0 s after it was thrown, how high is the bridge?

10~~5~~. A car accelerates from rest to 100.0 km/h in a time of 40.0 s. How far does it travel in that time?

11 ~~6~~. A bullet accelerates from rest at 5.75×10^4 m/s^2 while it travels through a 0.80 m long rifle barrel.
(a) How long is the bullet in the barrel?
(b) What is the velocity of the bullet as it leaves the rifle barrel?

12~~7~~. A ball was dropped of a cliff and hit the river below with a speed of 25.0 m/s.
(a) How high was the bridge above the river?
(b) How long did it take the ball to fall?

13 ~~8~~. A helicopter was moving upward at a speed of 5.0 m/s when a child dropped a stone out the window. The stone hit the ground 10.0 s later. How high above the ground was the helicopter at the instant that the stone was dropped?

14 ~~9~~. A boat accelerates from rest at a rate of 4.6 m/s^2 for 6.8 s. How fast will the boat be moving after this time?

15 ~~10~~. Police found skid marks 78.0 m long on a highway showing where a car made an emergency stop.
(a) If the acceleration of the car was - 8.54 m/s^2, how fast was the car going before it tried to stop?
(b) How long did it take to stop?

16 ~~11~~. A bungie jumper steps off a bridge and falls for 50.0 m before the rope starts to slow her down.
(a) How long did it take for her to fall 50.0 m?
(b) What was her velocity the instant before the rope started to slow her fall?

17 ~~12~~. A ball is thrown vertically off a cliff at 12.0 m/s, and hits the ground 7.5 s later. How high is the cliff?