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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

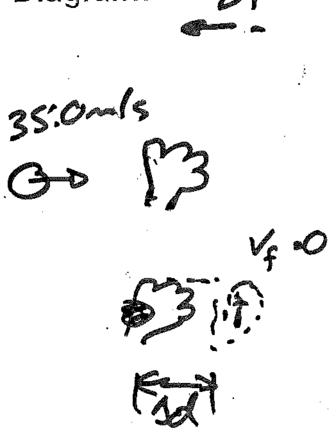
v_f = 0.0 m/s

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 = $-2333.33\ m/s^2$

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 = $-2.3 \times 10^3\ m/s^2$

The acceleration of the ball was $-2.3 \times 10^3\ m/s^2$ *during the time that it was being caught.*

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

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

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

$\Delta d = 0.26\ m$

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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?

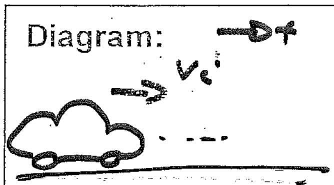
Given information:
V_i = 38.0 m/s
V_f = 100 km/h = 27.778 m/s
~~Δt~~ = ?
a = − 5.0 m/s^2
Δd = ?

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

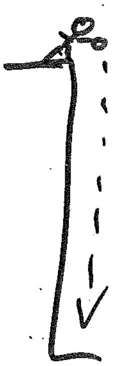
$$\Delta d = \frac{V_f^2 - V_i^2}{2a} = \frac{(27.7778\,m/s)^2 - (38.0\,m/s)^2}{2(-5.0\,m/s^2)}$$

$\boxed{\Delta d = 67\,m}$ (67.2395 m)

Diagram: $\rightarrow +$



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



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

Δt

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

$V_f = a\Delta t + V_i$

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

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?

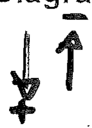
Given information:
V_i = 0.0 m/s
V_f = ?
Δt = 4.5 s
a = g = 9.8 m/s^2
Δd = ?

Solution:

$V_f = at + V_i$
$= (9.8\,m/s^2)(4.5\,s) + 0.0\,m/s$

$\boxed{V_f = 44\,m/s}$ (44.1 m/s)

Diagram:



(b) How high was the cliff?

$\Delta d = \frac{1}{2}at^2 + V_i t$
$= \frac{1}{2}(9.8\,m/s^2)(4.5\,s)^2 + 0.0\,m/s(4.5\,s)$

$\boxed{\Delta d = 99\,m}$

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

Solution:

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

$v_f = 31\,m/s$

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:

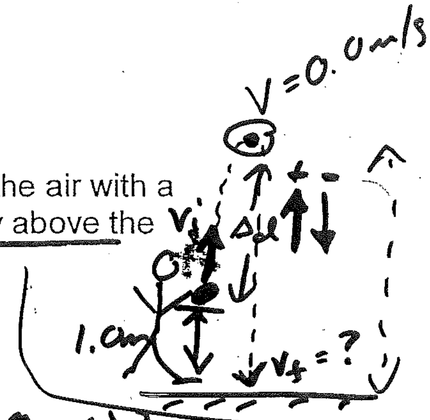
v_i = 3.50 m/s
v_f = 11.40 m/s
Δt = 4.20s
a = x
Δd = ?

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/s²

Δd = ?

Solution:

$$\overset{0}{\cancel{v_f^2}} = 2a\Delta d + v_i^2$$

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

Δd = 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 = ?

Δt = ?

a = −9.8 m/s²

Δd = −1.0 m

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

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

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

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

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

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

∴ t = 1.749 s or −0.117 s (not reasonable (negative time))

∴ t = 1.7 s

8 4. In a panic stop a cars brakes can produce an acceleration of -8.0 m/s². 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 ÷ 3.6 = 27.778 m/s

v_f = 0.0 m/s

Δt = ?

a = −8.0 m/s²

Δd = ?

Solution:

$$\overset{0}{\cancel{v_f^2}} = 2a\Delta d + v_i^2$$

$$\therefore \Delta d = \frac{-v_i^2}{2a} = \frac{-\left(\frac{100}{3.6}\right)^2}{2(-8.0\,m/s^2)}$$

Δd = 48 m

9. (a) $v_i = +18.0\,m/s$

$v_f = 0.0\,m/s$

$\Delta t = ?$

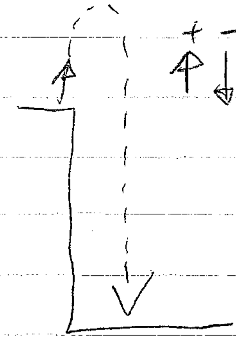
$a = -9.8\,m/s^2$

$\Delta d = x$

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

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

$\Delta t = 1.84\,s$



(b) $v_i = +18.0\,m/s$

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

$\Delta d = ?$

$\Delta t = 8.0\,s$

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

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

$\Delta d = -169.6\,m$

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

10. $v_i = 0.0\,m/s$

$v_f = 100.0\,km/h$

$\Delta t = 40.0\,s$

$\Delta d = ?$

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

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

$\Delta d = 556\,m$

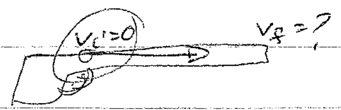
11. $v_i = 0.0\,m/s$

$a = 5.75 \times 10^4\,m/s^2$

$\Delta d = 0.80\,m$

$\Delta t = ?$

$v_f = ?$



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

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

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

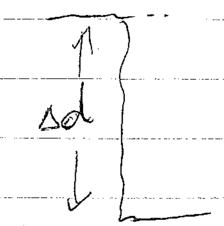
$t = 5.3 \times 10^{-3}\,s$

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

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

$v_f = 3.0 \times 10^2\,m/s$

12.



$+\downarrow\uparrow -$

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

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

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

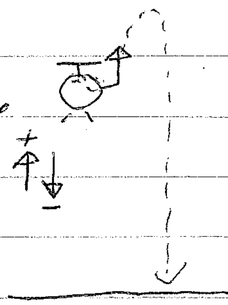
$\Delta d = \frac{(25.0\,m/s)^2 - 0^2}{2(9.8)}$

$\boxed{\Delta d = 31.9\,m}$ ← height

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

$\boxed{t = 2.55\,s}$

13.



$+\uparrow\downarrow -$

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

$\Delta d = \frac{1}{2}at^2 + v_i t$
$= \frac{1}{2}(-9.8\,m/s^2)(10.0\,s)^2 + (5.0\,m/s)(10.0\,s)$

$\Delta d = -440\,m$

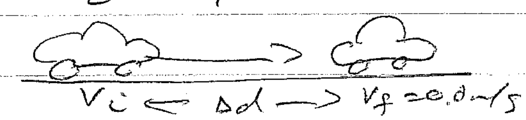
∴ The helicopter was $4.4 \times 10^2\,m$ above the ground

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

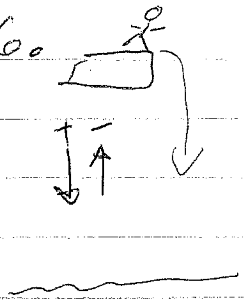
∴ $v_i = \sqrt{v_f^2 - 2a\Delta d}$

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

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

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

$\boxed{t = 4.27\,s}$

16. 

$v_i = 0.0\ m/s$

$a = 9.8\ m/s^2$

$\Delta d = 50.0\ m$

$\Delta t = ?$

$v_f = ?$

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

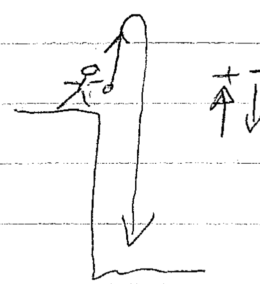
$t = \sqrt{\frac{2\Delta d}{a}} = \sqrt{\frac{2(50.0\ m)}{9.8\ m/s^2}}$

$\boxed{t = 3.19\ s}$

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

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

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

17. 

$v_i = 12.0\ m/s$

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

$\Delta t = 7.5\ s$

$\Delta d = ?$

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

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

$\Delta d = -185.6\ m$

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