Vectors & Linear Motion Review – 40

One Dimensional Motion

1 The *USS Enterprise* accelerates from rest at 150,000 m/s² for four seconds. How far did the ship travel in that time? How fast is it now going?

$V_i = 0$
$a = 150000$
$t = 4$
$V_f = ?$ $\Delta d = ?$

$V_f = 600,000 m/s$

$\Delta d = 1200000 m$

2 An oil tanker, initially traveling **west** at 18 m/s is accelerated uniformly until it is traveling **east** at 21.6 m/s. The acceleration is 0.20 m/s2 towards the **east**. Compute the total displacement from the tanker's initial position.

$V_i = -18 m/s$
$V_f = 21.6 m/s$
$a = 0.2 m/s^2$
$\Delta d = ?$

$\Delta d = 356.4 m$

3 A corvette can accelerate during high speeds at about 2.0 m/s2. At this rate how long does it take the car to accelerate from 80 m/s to 160 m/s?

$V_i = 80 m/s$
$V_f = 160 m/s$
$a = 2 m/s^2$
$t = ?$

$t = 40 sec$

4 A sprinter who is running a 250 m race accelerates from rest at 7.5 m/s2 for 1.2 s and maintains this speed for the remainder of the race. How far did she travel during this period? What is her velocity now?

$a = 7.5 m/s^2$
$t = 1.2 s$
$V_i = 0$
$\Delta d = ?$ $V_f = ?$

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

$\Delta d = 5.4 m$

$V_f = 9 m/s$

5 A police cruiser is travelling at 20.0 m/s when the officer spies a speeder. The cruiser accelerates at 3.0 m/s2 for 5.0 seconds. How far does it go in this time? What is it's velocity now?

$V_i = 20 m/s$ $a = 3 m/s^2$
$V_f = ?$ $t = 5$
$\Delta d = ?$

$\Delta d = 137.5 m$

$V_f = 35 m/s$

On a 150 m straight sprint, a cyclist accelerates from rest for 4.5 s at 3.8 m/s2. How far did she go? How fast is she going now?

$V_i = 0 m/s$ $\Delta d = ?$
$a = 3.8 m/s^2$ $V_f = ?$
$t = 4.5 s$

$\Delta d = 38.475 m$

$V_f = 17.1 m/s$

Freefall Problems

For years, the tallest tower in the United States was the Phoenix Shot Tower in Baltimore, Maryland. The shot tower was used from 1828 to1892 to make lead shot for pistols and rifles and molded shot for cannons and other instruments of warfare. Molten lead was dropped from the top of the 234-foot (71.3 meter) tall tower into a vat of water. During its free fall, the lead would form a perfectly spherical droplet and solidify. Determine the time of fall and the speed of a lead shot upon hitting the water at the bottom.

$d_i = 71.3\text{m}$

$d_f = 0$

$\Delta d = -71.3\text{m}$ $\quad a = -9.8\ \text{m/s}^2$ $\quad V_i = 0\ \text{m/s}$ $\quad V_f = ?$ $\quad t = ?$

$V_f^2 = V_i^2 + 2ad$

$V_f = -37.38\ \text{m/s}$

$t = 3.81\text{s}$

According to Guinness, the tallest man to have ever lived was Robert Pershing Wadlow of Alton, Illinois. He was last measured in 1940 to be 2.72 meters tall (8 feet, 11 inches). Determine the speed which a quarter would have reached before contact with the ground if dropped from rest from the top of his head. How long would it take for the quarter to reach the ground?

$d_i = 2.72\text{m}$

$\Delta d = -2.72\text{m}$

$d_f = 0\text{m}$

$a = -9.8$ $\quad V_i = 0\ \text{m/s}$ $\quad V_f = ?$ $\quad t = ?$

or $V_f = -7.3\ \text{m/s}$

$t = 0.75\text{s}$

A California Condor is approaching its nest with a large chunk of carrion in its beak. As it approaches, it makes an upward swoop, achieving a momentary **upward** velocity of 12.8 m/s when the carrion falls from its mouth, hitting a cliff outcropping 32.1 m below. Determine the speed of the carrion upon hitting the outcropping. How long did it take to hit the ground?

$d_i = 32.1$

$\Delta d = -32.1\text{m}$

$d_f = 0$

$V_i = 12.8\ \text{m/s}$ $\quad a = -9.8\ \text{m/s}^2$

$V_f = -26.16\ \text{m/s}$

$t = 2.87\text{s}$

During his recent skydiving adventure, Luke Autbeloe was falling at a speed of 10.4 m/s as he approached the ground with his parachute. During an attempt to snap one last photo with his camera, Luke fumbled it from a height of 52.1 m above the ground. Find the time it takes for the camera to hit the ground, and the velocity of the camera when it strikes.

$V_i = -10.4\ \text{m/s}$

$d_i = 52.1\text{m}$

$\Delta d = -52.1\text{m}$

$d_f = 0$

$a = -9.8\ \text{m/s}^2$

$V_f = ? = -24.5\ \text{m/s}$

$t = ? = 2.5\text{s}$

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Chase Problems

A police car stopped at a set of lights has a speeder pass it at 49m/s. If the police car can accelerate at 3.6 m/s2 and begins to move right when it is passed,

(A) how long does it take to catch the speeder? 27.2 s

(B) how far would the police car have to go before it catches the speeder? 1333.89 m

(C) what would be its speed when it caught up with the speeder? Is this speed reasonable? 97.92 m/s no.

C	S
v_i 0	v_i 49
v_f	v_f 49
a 3.6	a 0
t	t
Δd	Δd

C→ $\Delta d = 0t^0 + \frac{1}{2}(3.6)t^2$

$\Delta d = 1.8t^2$

S→ $\Delta d = 49t + \frac{1}{2}(0)t^2$

$\Delta d = 49t$

$1.8t^2 = 49t$

$t = 27.2s$

$\Delta d = 49(27.2) = 1333.89m$

$V_f = 0 + (3.6)(27.2)$

$V_f = 97.92 m/s$

A police car is stopped at a red light. As the light turns green, a diesel truck hurtles past in the next lane traveling at a constant speed of 28 m/sec. If the police car, siren blaring and lights flashing, accelerates at 4 m/sec^2, how many seconds will it take to catch the truck? How far does the chase extend? How fast is the cop going?

C	T
v_i 0	v_i 28 m/s
v_f	v_f 28 m/s
a 4 m/s^2	a 0 m/s^2
t	t
Δd	Δd

C→ $\Delta d = 0t^0 + \frac{1}{2}4t^2$

$\Delta d = 2t^2$

T→ $\Delta d = 28t + \frac{1}{2}0t^2$

$\Delta d = 28t$

$28t = 2t^2$

$14s = t$

$\Delta d = 28(14)$

$\Delta d = 392m$

$V_f = 0 + (4)(14)$

$V_f = 56 m/s$

A police car notices a speeder on the highway at 40m/s. When the speeder is 50m down the road, the police officer accelerates from rest at 1.2m/s2. How long until it catches the speeder? How far does the cop travel? How fast is the police officer going?

C	S
v_i 0	v_i 40
v_f	v_f 40
a 1.2	a 0
t	t
Δd d+50	Δd d

C→ $d + 50 = 0t + \frac{1}{2}(1.2)t^2$

S→ $d = 40t + \frac{1}{2}0t^2$

$40t + 50 = 0.6t^2$

$0.6t^2 - 40t - 50 = 0$

$t = 67.89s$

$d = 40(67.89)$

$d = 2715.6m$ ← speeder

$Cop = d + 50 = 2765.6m$

$V_f = 0 + 1.2(67.89)$ $= 81.468 m/s$

A cheetah stalks a giraffe. The giraffe strolls at an initial speed of 0.92m/s. When the cheetah is 100m *behind*, the giraffe smells her and starts to accelerate at 1.1m/s2. The cheetah accelerates at 3.7m/s^2 from rest. How long until the cheetah catches the giraffe? How far does the chase extend? How fast is the cheetah going? How fast is the giraffe going?

G	C
v_i 0.92	v_i 0
v_f	v_f
a 1.1	a 3.7
t	t
Δd d	Δd d+100

G→ $d = 0.92t + \frac{1}{2}(1.1)t^2$

$d = 0.92t + 0.55t^2$

C→ $d + 100 = 0t^0 + \frac{1}{2}(3.7)t^2$

$d + 100 = 1.85t^2$

$0.92t + 0.55t^2 + 100 = 1.85t^2$

$-0.55t^2 \quad -0.55t^2$

$0.92t + 100 = 1.3t^2$

$-0.92t \quad -100 \quad -0.92t \quad -100$

$1.3t^2 - 0.92t - 100 = 0$

$t = 9.13s$

$V_f = 0 + (3.7)(9.13) = 33.71 m/s$

Cheetah → 33.71 m/s

$d = (0.92)(9.13) + 0.55(9.13)^2$

$d = 54.25m$ ← Giraffe

$154.25m$ ← Cheetah

$V_f = (0.92) + (1.1)(9.13) = 10.96 m/s$

Giraffe → 10.96 m/s