Problem 1:- (The wind is blowing with Velocity that is constant in time)

$$Vx = \frac{dx}{dt} = 0.2x^2 + 0.5y^2 + 20$$

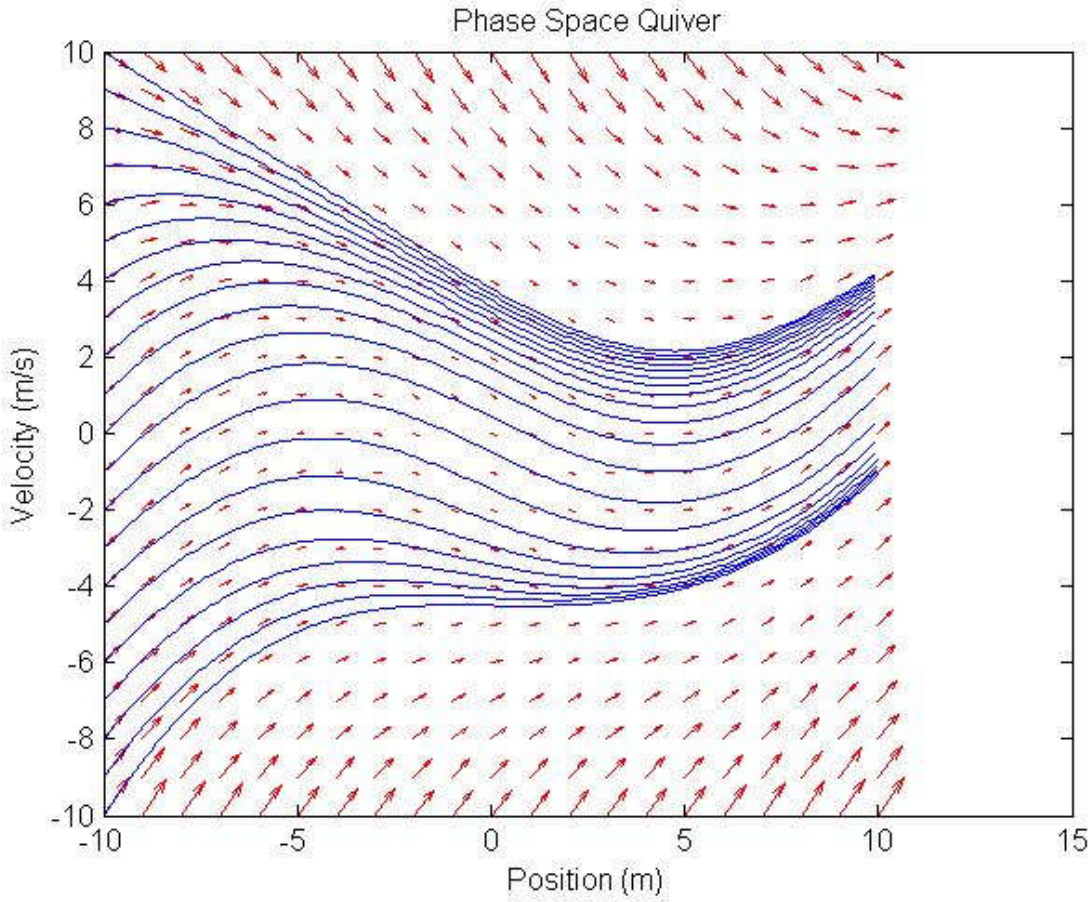
$$Vy = \frac{dy}{dt} = 0.2y^3 + 0.5x^2 \quad 10$$

Where x & y varies from -10 to 10.

MATLAB Code:-

```
%Code 1:
close all;
clear all;

x = -10:1:10 ;
y = -10:1:10 ;

[X,Y] = meshgrid(x,y);
u = 0.2*(X.*X) + 0.5*(Y.*Y) + 20;
v = -0.1*(Y.^3) + 0.5*(X.*X) - 10;

quiver(X,Y,u,v,'r');
startx = ones(1,length(x))*-10;
streamline(X,Y,u,v,startx,y);

xlabel('Position (m)');
ylabel('Velocity (m/s) ');
title('Phase Space Quiver');
```

Output:-


Phase Space Quiver
Velocity (m/s)
Position (m)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-10
-5
0
5
10
15

.

Question:-

1) What physical insight do you get from the plot?
   Velocity Field

2) What does arrows that you produced with the quiver command show at each point?
   Arrow that produced with the quiver command shows **Magnitude & the direction of the velocity at each point**.

3) What does the streamlines show (from a particle dynamics viewpoint)?
   Streamline shows **the path that a particle would follow in this velocity field**.

Problem 2:- (Effect of Gravity)

$$\frac{d^2x}{dt^2} = G\frac{Me}{(x+Re)^2}$$

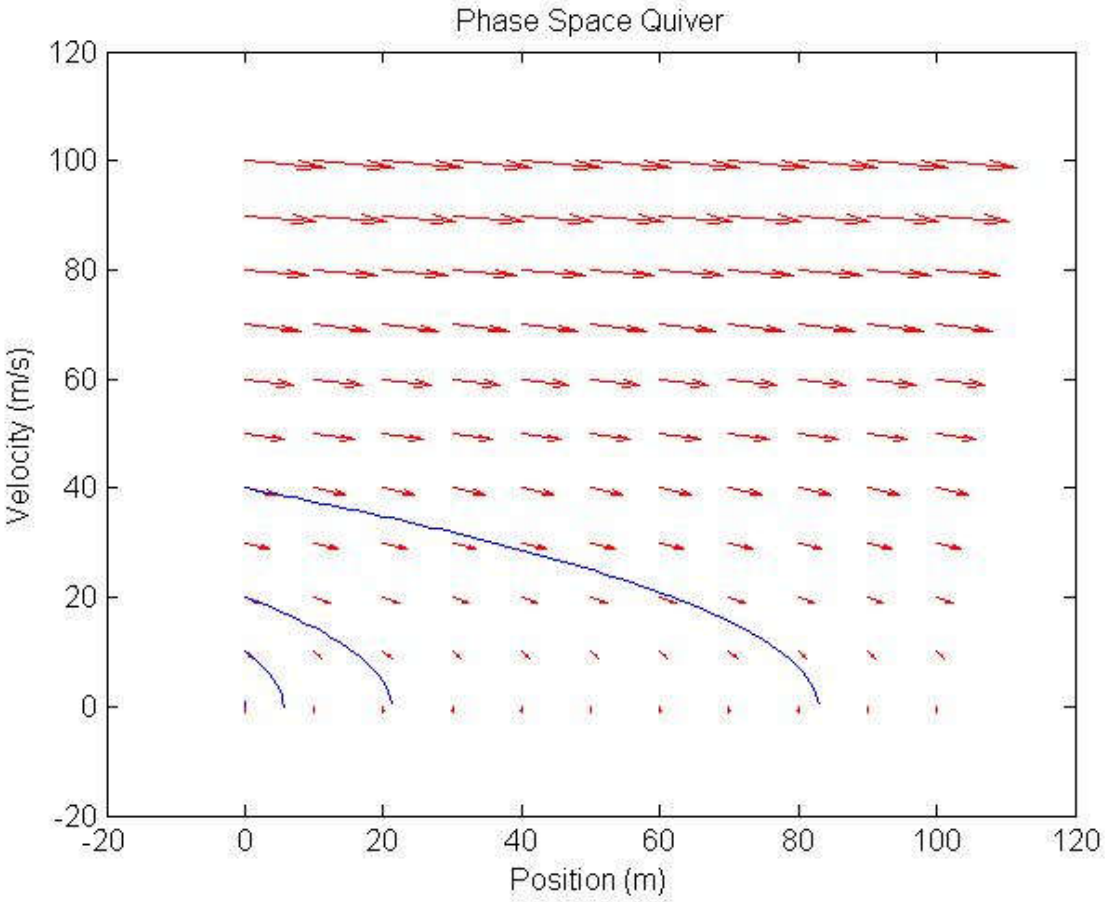
Where Me = 6e24 kg , Re = 6.4e6 m & G = 6.674e-11

1) Throw the ball up at the Speed of 1m/s , 10 m/s & 40 m/s:-

MATLAB Code:-

```
%Code 2:

clear all;
close all;

G =  6.67259e-11 ;
Re = 6.4e6 ;
Me = 6e24 ;

initVelocity = [1,10,20,40];
initX = [0,0,0,0];
x = 0:10:100;
v = 0:10:100;

[X,V] = meshgrid(x,v);
ux = V ;
uv = (-G*Me./( (X+Re).*(X+Re) ) ) ;

quiver(X,V,ux,uv,'r');
streamline(X,V,ux,uv,initX,initVelocity);

xlabel('Position (m)');
ylabel('Velocity (m/s) ');
title('Phase Space Quiver');
```

Output:-

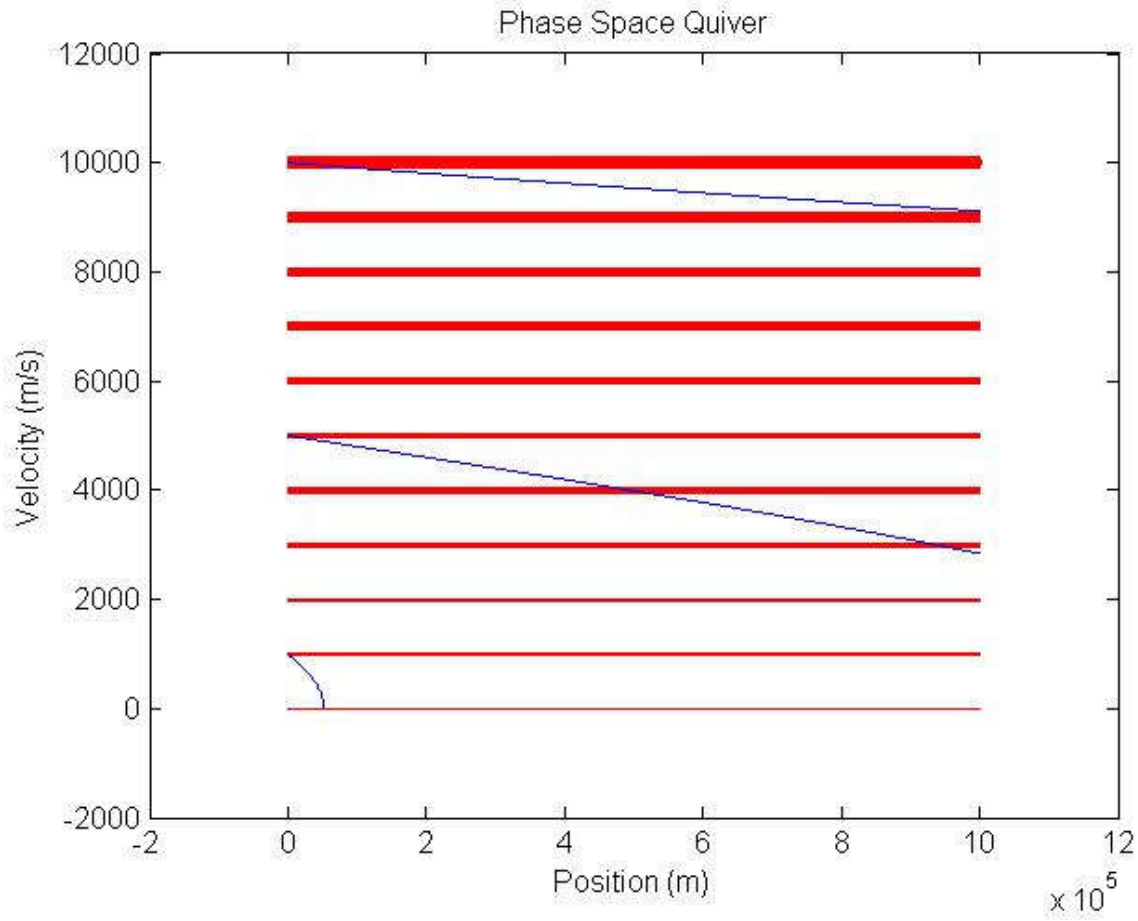

Phase Space Quiver
Velocity (m/s)
Position (m)
120
100
80
60
40
20
0
-20
-20
0
20
40
60
80
100
120

2) Throw the ball up at the Speed of with the Rocket and achieve the Speed of 1000m/s , 5000 m/s & 10,000 m/s.

MATLAB Code:-

```
%Code 2:

clear all;
close all;

G =  6.67259e-11 ;
Re = 6.4e6 ;
Me = 6e24 ;

initVelocity = [1,1000,5000,10000];
initX = [0,0,0,0];

x = 0:1000:1000000;
v = 0:1000:10000;
[X,V] = meshgrid(x,v);
ux = V ;
uv = (-G*Me./( (X+Re).*(X+Re) ) ) ;

quiver(X,V,ux,uv,'r');
streamline(X,V,ux,uv,initX,initVelocity);

xlabel('Position (m)');
ylabel('Velocity (m/s) ');
title('Phase Space Quiver');
```

Output:-


Phase Space Quiver
12000
10000
8000
6000
4000
2000
0
-2000
Velocity (m/s)
-2
0
2
4
6
8
10
12
Position (m)
x 10^5