

Part 1:

a.



b.



c.



Output:

1.A

```
Body: A
Time: 174791.00000568628
Distance: 135000.13074855605

Velocity
min: 0.0
max: 3.9880224313717614
avg: 0.7723517271722472
std: 0.6972413919084001

Acceleration
min: 0.0
max: 5.890336978366025E-4
avg: 2.2815935314584305E-5
std: 5.0965142171731884E-5

Body: B
Time: 174791.00000568628
Distance: 135000.13074855605

Velocity
min: 0.0
max: 3.9880224313717614
avg: 0.7723517271722472
std: 0.6972413919084001

Acceleration
min: 0.0
max: 5.890336978366025E-4
avg: 2.2815935314584305E-5
std: 5.0965142171731884E-5
```

1.B

```
Time: 55282.59999947603
Distance: 134999.662100286

Velocity
min: 0.0
max: 4.46140968889393
avg: 2.441991912492638
std: 0.485868974772321

Acceleration
min: 0.0
max: 20.000011782394722
avg: 8.070173289127822E-5
std: 0.02689899922450438

Body: B
Time: 55282.59999947603
Distance: 134999.662100286

Velocity
min: 0.0
max: 4.46140968889393
avg: 2.441991912492638
std: 0.485868974772321

Acceleration
min: 0.0
max: 20.000011782394722
avg: 8.070173289127822E-5
```

1.C

```
Body: A
Time: 243864.30000970687
Distance: 151098.76999637572

Velocity
min: 0.0
max: 3.999276745984431
avg: 0.6196018441008435
std: 0.6574152411291424

Acceleration
min: -5.890615337733523E-6
max: 2.999988218653016
avg: 1.639959233803053E-5
std: 0.0019215897879386727

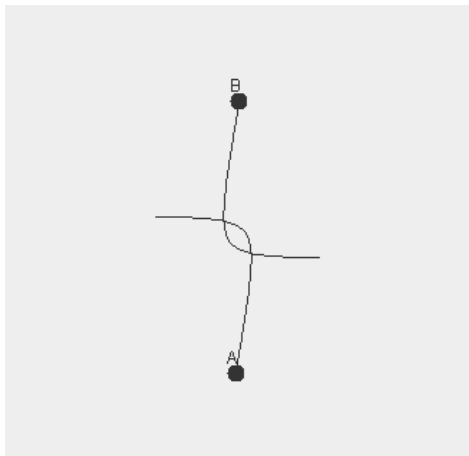
Body: B
Time: 243864.30000970687
Distance: 151098.76999637572

Velocity
min: 0.0
max: 3.999276745984431
avg: 0.6196018441008435
std: 0.6574152411291424

Acceleration
min: -5.890615337733523E-6
max: 2.999988218653016
avg: 1.639959233803053E-5
std: 0.0019215897879386727
```

Part 2:

a.)



To avoid an initial collision A & B must start with at least 70,000 units of distance on the y axis.

Starting 'A' y pos: 35,000

Starting 'B' y pos: -35,000

```
Body: A
Time: 99999.90000133288
Distance: 268114.6611661702

Velocity
min: 0.0
max: 4.3149266293620965
avg: 2.6811492927752583
std: 0.6264303232984583

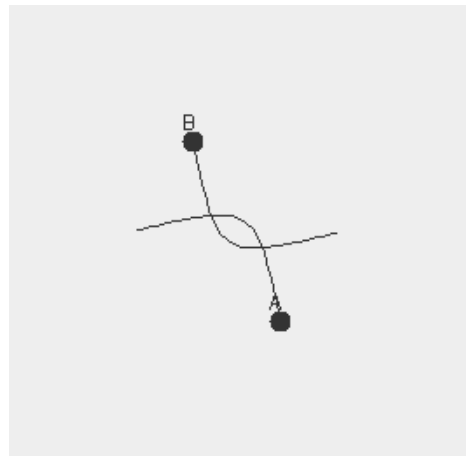
Acceleration
min: -1.5245869421588094E-4
max: 20.000010880176138
avg: 2.287453318159303E-5
std: 0.020000090505573956

Body: B
Time: 99999.90000133288
Distance: 268114.6611661702

Velocity
min: 0.0
max: 4.3149266293620965
avg: 2.6811492927752583
std: 0.6264303232984583

Acceleration
min: -1.5245869421588094E-4
max: 20.000010880176138
avg: 2.287453318159303E-5
std: 0.020000090505573956
```

b.)



To avoid an initial collision A & B must each start with a velocity of 0.5/-0.5 units respectively

```
Body: A
Time: 99999.90000133288
Distance: 270599.06697827345

Velocity
min: 0.0
max: 4.134773335078617
avg: 2.7059933757400425
std: 0.5743978595908162

Acceleration
min: -1.2310949805976524E-4
max: 20.615539558689896
avg: 2.2895973394301228E-5
std: 0.020615593905774516

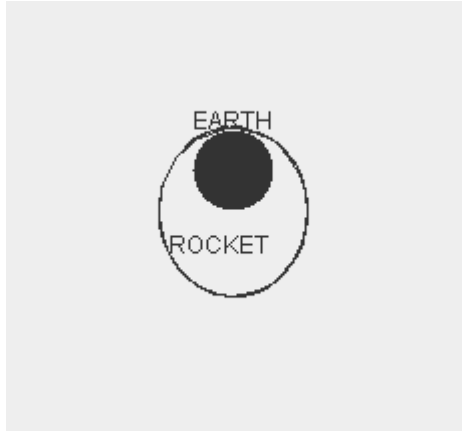
Body: B
Time: 99999.90000133288
Distance: 270599.06697827345

Velocity
min: 0.0
max: 4.134773335078617
avg: 2.7059933757400425
std: 0.5743978595908162

Acceleration
min: -1.2310949805976524E-4
max: 20.615539558689896
avg: 2.2895973394301228E-5
std: 0.020615593905774516
```

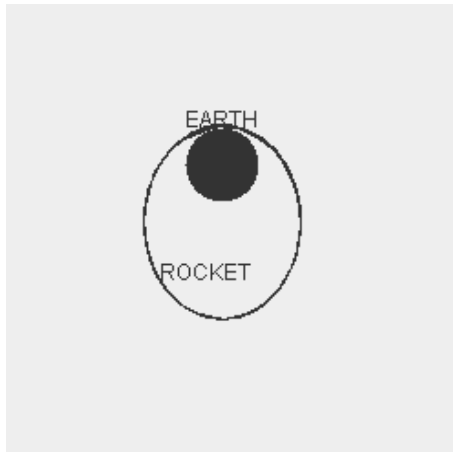
Part 3:

a.)

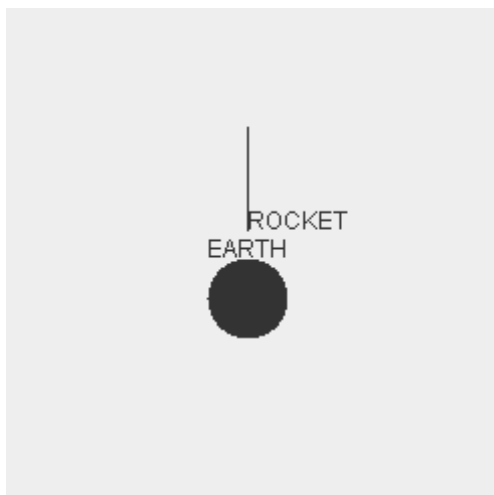


a) The minimum starting velocity(v_x) for the rocket to reach a reasonable orbit is 23 units

b.)



c.)



c) When the rocket is launched directly up at the same velocity, it falls directly back down. This is because it no longer has an x velocity which is the only thing that keeps the rocket in orbit, without it, the rocket inevitably falls due to the earth's gravity

Output:

3.A

```
Body: EARTH
Time: 99999.90000133288
Distance: 2.5309531816663795

Velocity
min: 0.0
max: 3.10434056623209E-5
avg: 2.5309557125883575E-5
std: 7.777196181759513E-6

Acceleration
min: -6.490893893267627E-9
max: 1.2981787821591573E-8
avg: 1.1532777876878436E-10
std: 2.2983946300792593E-9

Body: ROCKET
Time: 99999.90000133288
Distance: 1296257.6787219397

Velocity
min: 0.0
max: 23.00000001066562
avg: 12.962589749636372
std: 4.817006870728195

Acceleration
min: -0.0014605383888834295
max: 230.00000009492527
avg: 2.156221262023216E-4
std: 0.23000114945003672
```

3.B

```
Body: EARTH
Time: 99999.90000133288
Distance: 2.587986156083743

Velocity
min: 0.0
max: 3.0031784236493448E-5
avg: 2.5879887440379924E-5
std: 6.35322046275684E-6

Acceleration
min: -6.490902628140714E-9
max: 1.2981787819016674E-8
avg: 3.0017452639479226E-10
std: 1.7667395313929895E-9

Body: ROCKET
Time: 99999.90000133288
Distance: 1117675.7644929083

Velocity
min: 0.0
max: 40.26274949474518
avg: 11.176768821548931
std: 5.100433137925908

Acceleration
min: -40.2627505807639
max: 250.000000042013
avg: 6.294275294250315E-5
std: 0.26981635620902067
```

3.C

```
Body: EARTH
Time: 49999.8999995529
Distance: 3.2654745920812016

Velocity
min: 0.0
max: 0.0013422833065530532
avg: 6.530962246145295E-5
std: 1.8073633801945682E-4

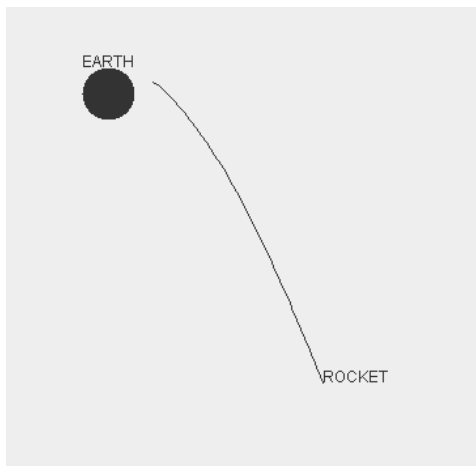
Acceleration
min: -0.0032558885963822073
max: 0.006662467931167373
avg: 1.7119186836335218E-8
std: 1.0797432180635832E-5

Body: ROCKET
Time: 49999.8999995529
Distance: 2429982.615602671

Velocity
min: 0.0
max: 1319.283306552689
avg: 48.59974951198702
std: 179.14740110550426

Acceleration
min: -3255.888596375834
max: 6662.467931163676
avg: 0.016659186836303845
std: 10.802330549035414
```

Part 4:



4) The minimum escape velocity for the rocket was a starting vx of 27 units.

```
Body: EARTH
Time: 99999.90000133288
Distance: 2.3805708682228888
```

```
Velocity
min: 0.0
max: 2.5429115310158194E-5
avg: 2.3805732487644073E-5
std: 3.305973573356871E-6
```

```
Acceleration
min: 0.0
max: 1.29817878162272E-8
avg: 2.5429115310177635E-10
std: 8.781485604168801E-10
```

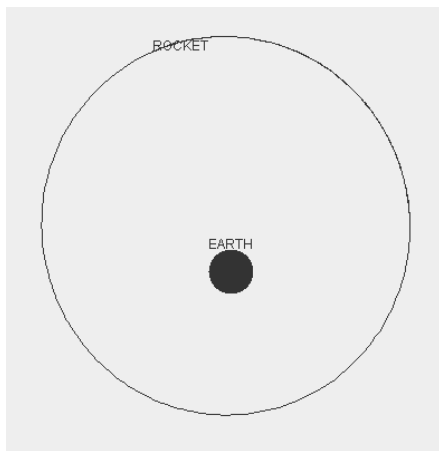
```
Body: ROCKET
Time: 99999.90000133288
Distance: 1056105.4176757634
```

```
Velocity
min: 0.0
max: 26.999999999344286
avg: 10.561064737681605
std: 3.944502930308846
```

```
Acceleration
min: -0.001876724786955039
max: 269.9999999934428
avg: 7.429435549622472E-5
std: 0.27000030151895826
```

Part 5:

a.



```
Body: EARTH
Time: 99999.90000133288
Distance: 0.45227922752102373
```

```
Velocity
min: 0.0
max: 8.109440009799536E-6
avg: 4.522796797946752E-6
std: 2.316697271079433E-6
```

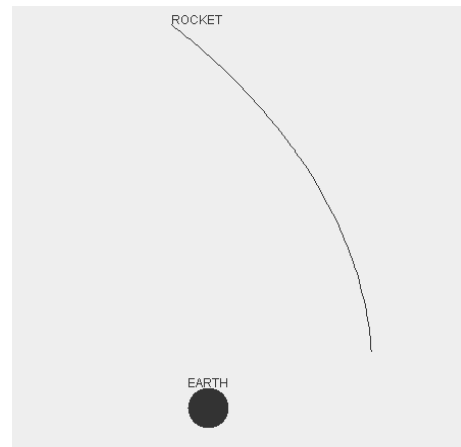
```
Acceleration
min: 0.0
max: 2.3099936470430965E-10
avg: 8.109440009695456E-11
std: 1.642578808720903E-11
```

```
Body: ROCKET
Time: 99999.90000133288
Distance: 597642.4612052027
```

```
Velocity
min: 0.0
max: 6.999994397519404
avg: 5.976430588402957
std: 0.4851381067436555
```

```
Acceleration
min: -2.8013484199007597E-5
max: 69.99994397519404
avg: 5.348951748512165E-5
std: 0.06999992582186354
```

b.



```
Body: EARTH
Time: 99999.90000133288
Distance: 0.3781930756609921
```

```
Velocity
min: 0.0
max: 6.090586384978307E-6
avg: 3.781934538494051E-6
std: 1.7230149986233998E-6
```

```
Acceleration
min: 0.0
max: 2.309993375276852E-10
avg: 6.090586384950062E-11
std: 2.6049633790622695E-11
```

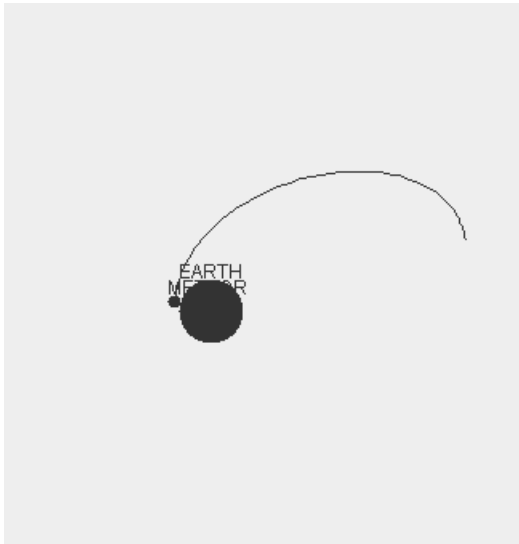
```
Body: ROCKET
Time: 99999.90000133288
Distance: 741676.0179665894
```

```
Velocity
min: 0.0
max: 8.99999439748233
avg: 7.416767596334634
std: 0.875520520086896
```

```
Acceleration
min: -3.4888583542677425E-5
max: 89.9999439748233
avg: 6.054142998283375E-5
std: 0.08999992853978564
```

Part 6:

a.



```
Body: EARTH
Time: 89529.40000072341
Distance: 5070.426963905648
```

```
Velocity
min: 0.0
max: 0.2182485736188216
avg: 0.05663421137486321
std: 0.047957794203271266
```

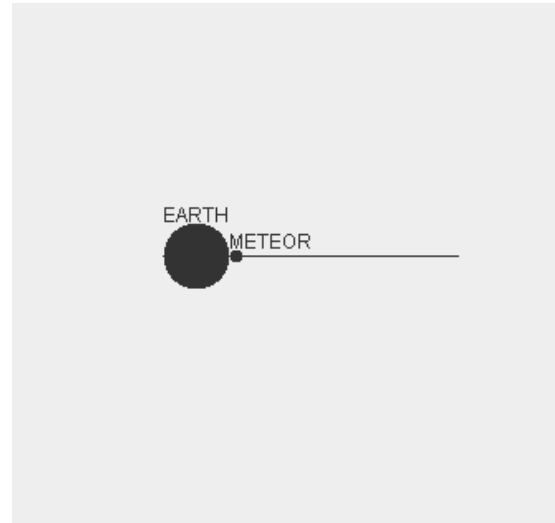
```
Acceleration
min: 0.0
max: 1.4221053864509788E-5
avg: 2.43772805177524E-6
std: 2.915570606544791E-6
```

```
Body: METEOR
Time: 89529.40000072341
Distance: 615368.25084919
```

```
Velocity
min: 0.0
max: 23.7812847338279
avg: 6.873365071632534
std: 4.4758197895757155
```

```
Acceleration
min: -2.8012636477114928E-5
max: 34.99994397497069
avg: 2.656251261647877E-4
std: 0.03699142186984929
```

b.



```
Body: EARTH
Time: 61527.399999385154
Distance: 2698.4251922483054
```

```
Velocity
min: 0.0
max: 0.18794358883315646
avg: 0.043857292722840086
std: 0.037426756112949246
```

```
Acceleration
min: 0.0
max: 4.3632871894818576E-5
avg: 3.054627424084214E-6
std: 4.925196307704621E-6
```

```
Body: METEOR
Time: 61527.399999385154
Distance: 337303.14903139556
```

```
Velocity
min: 0.0
max: 23.492948604303717
avg: 5.4821615903608185
std: 4.678344514118882
```

```
Acceleration
min: 0.0
max: 0.00545411021463714
avg: 3.8182842801311867E-4
std: 6.15649538487574E-4
```

