Project 1

Basketball trajectory simulation

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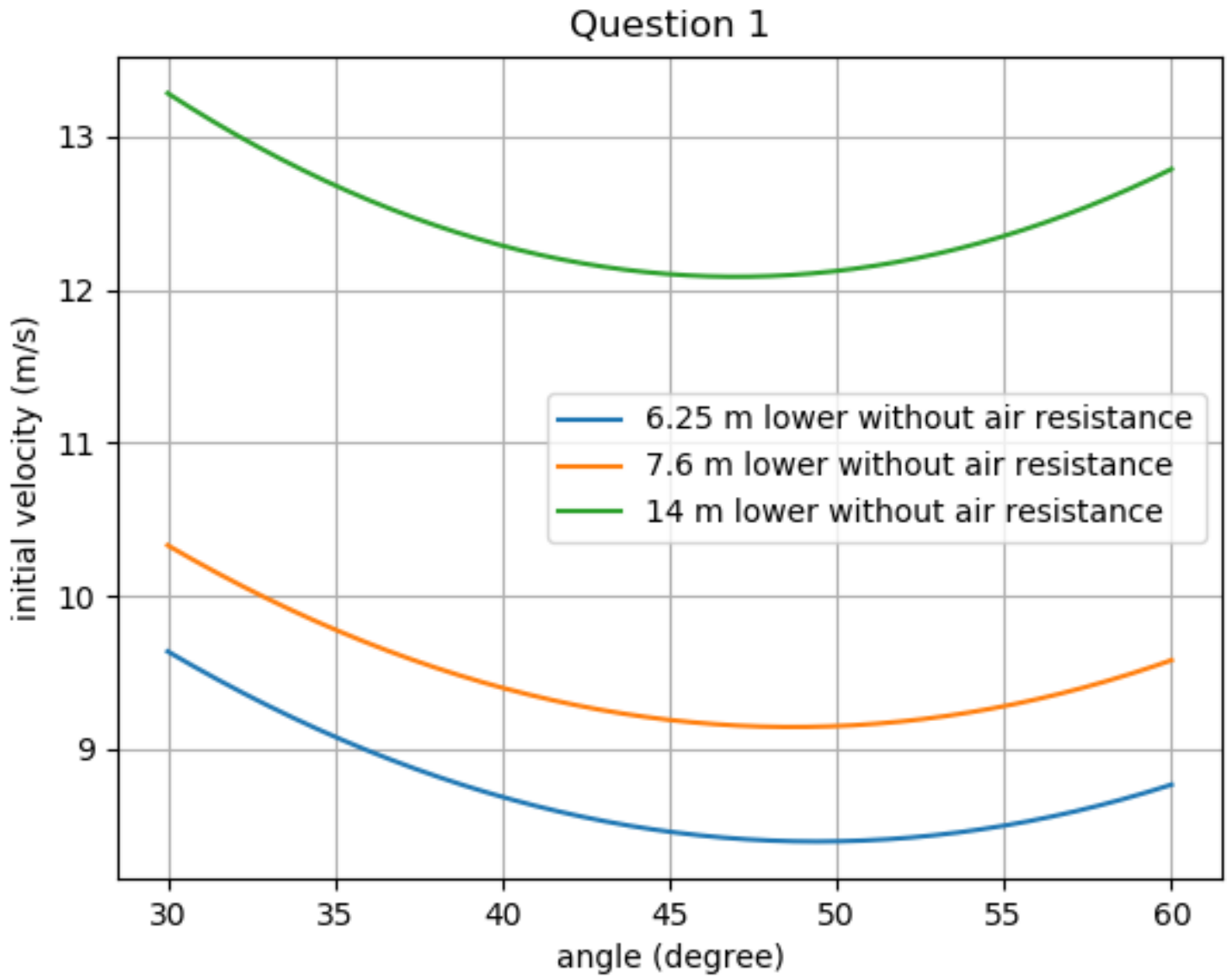
Question 1


Question 1
initial velocity (m/s)
13
12
11
10
9
30
35
40
45
50
55
60
angle (degree)
6.25 m lower without air resistance
7.6 m lower without air resistance
14 m lower without air resistance

Question 1

a)

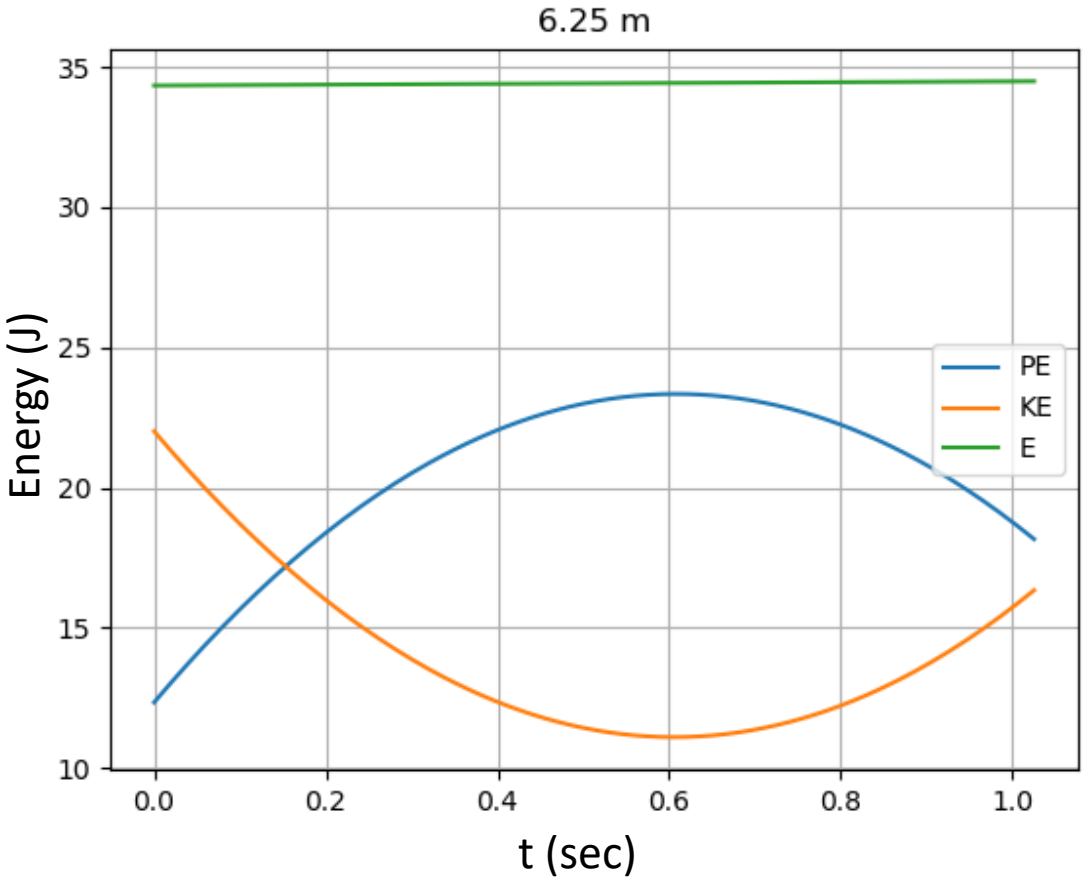
(1) corner(6.25 m): 8.46 $^{m}/_{s}$

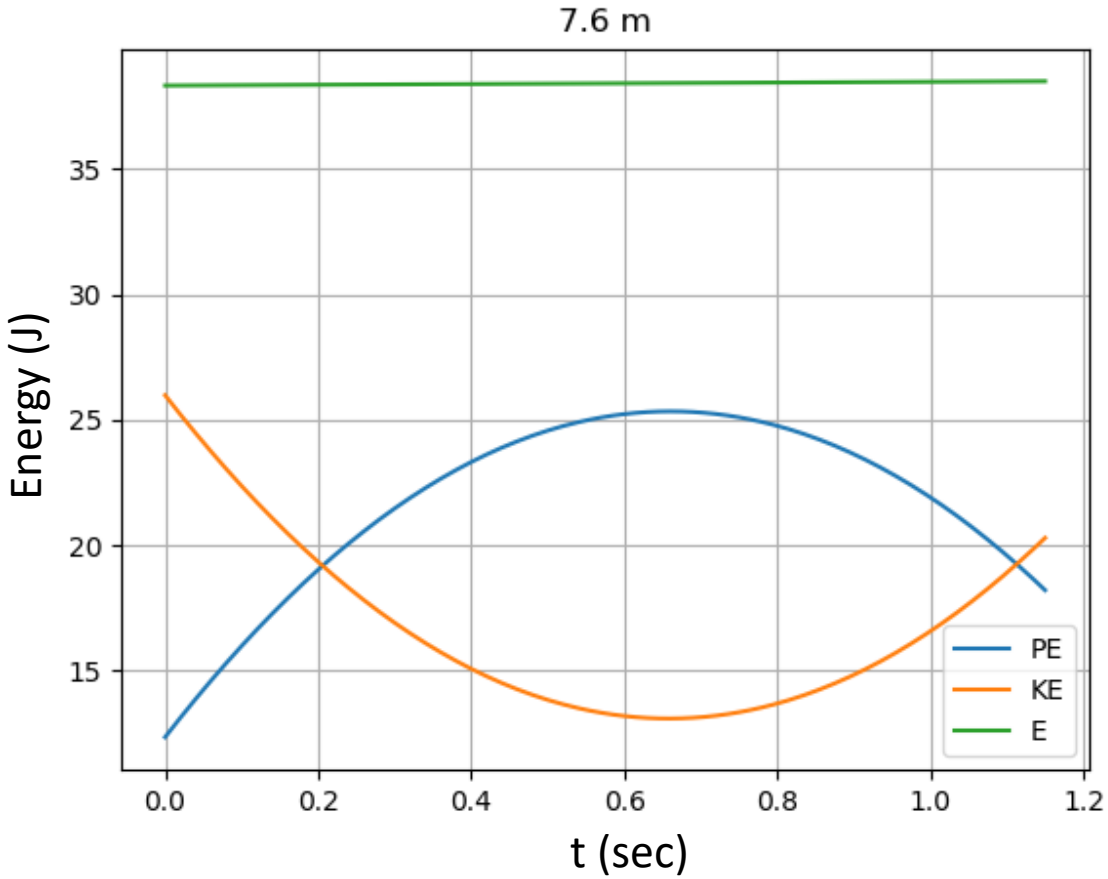
(2) top(7.6 m): 9.19 $^{m}/_{s}$

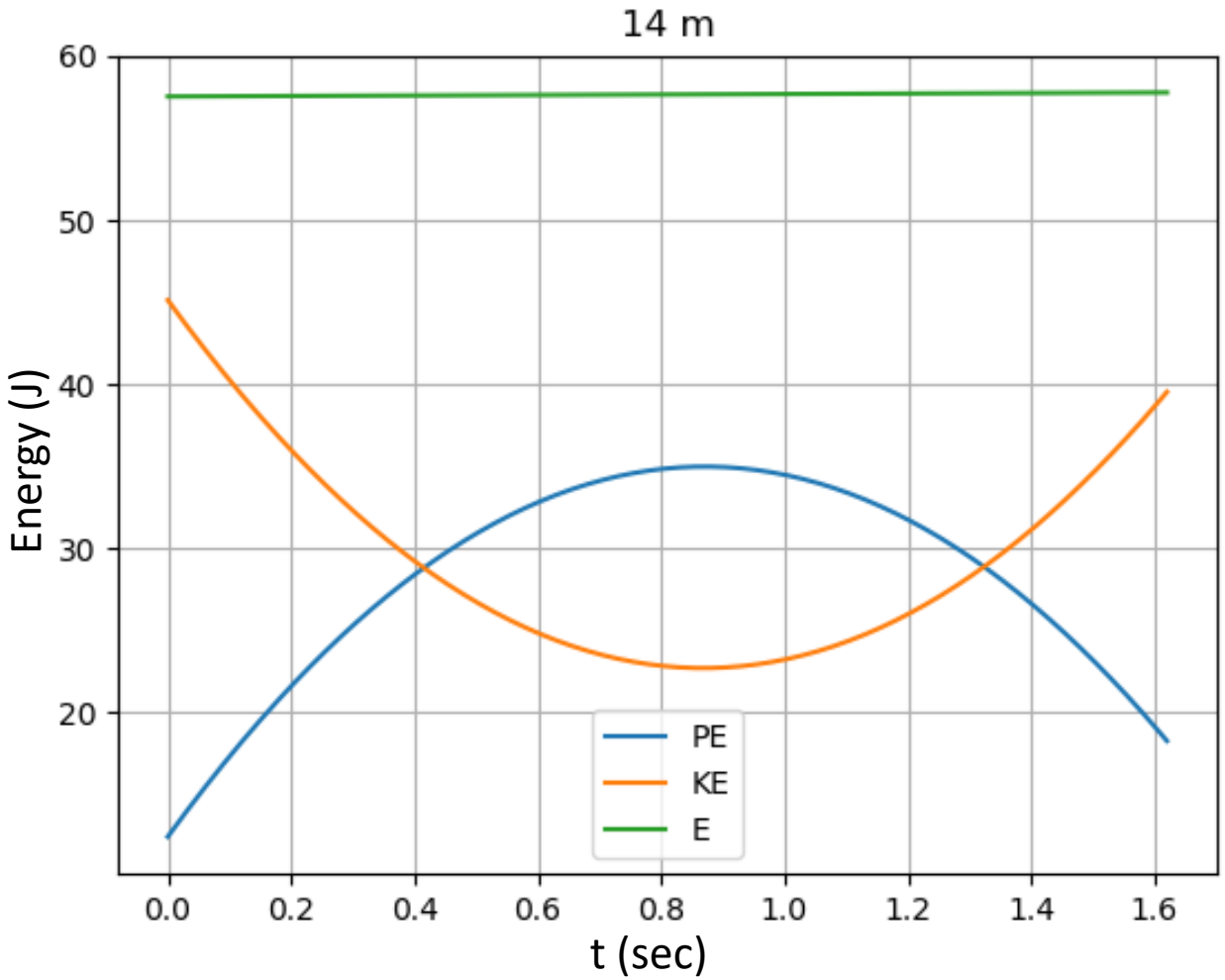
(3) half court(14 m): 12.1 $^{m}/_{s}$

b)

We can validate this simulation using law of conservation of energy.


6.25 m
Energy (J)
t (sec)
PE
KE
E
35
30
25
20
15
10
0.0
0.2
0.4
0.6
0.8
1.0


7.6 m
Energy (J)
t (sec)
PE
KE
E
35
30
25
20
15
0.0
0.2
0.4
0.6
0.8
1.0
1.2

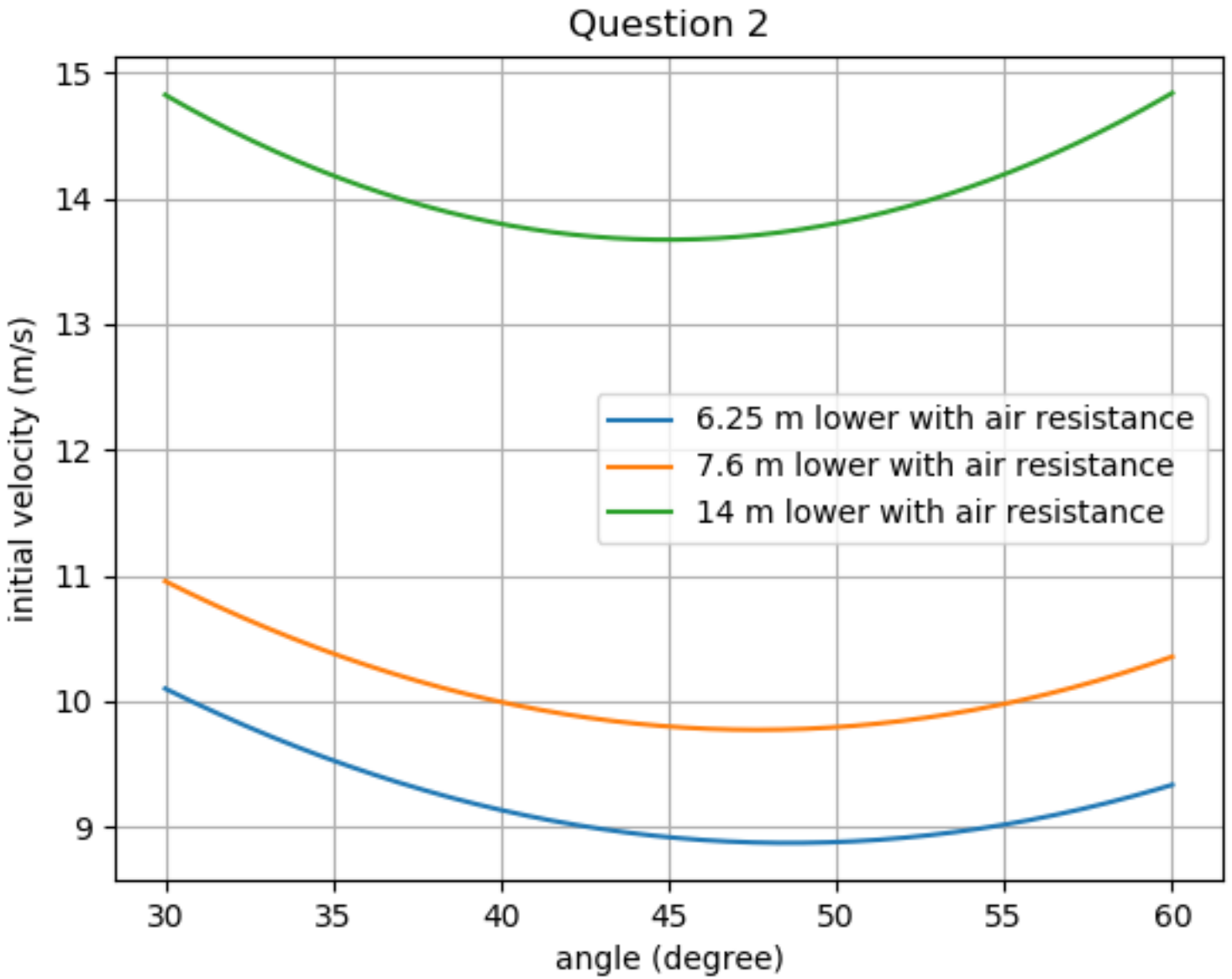

14 m
60
50
40
30
20
Energy (J)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
t (sec)
PE
KE
E

Question 1

c)

Choose three different angles and find the initial velocity that can goal, using curve fit method to find a function which returns the initial velocity when we input the angle. In this way we can find the answer much faster and with more accuracy.

Question 2


Question 2
initial velocity (m/s)
15
14
13
12
11
10
9
30
35
40
45
50
55
60
angle (degree)
6.25 m lower with air resistance
7.6 m lower with air resistance
14 m lower with air resistance

Question 2

a)

(1) corner(6.25 m): 8.92 $^{m}/_{s}$ (+0.46 $^{m}/_{s}$

(2) top(7.6 m): 9.80 $^{m}/_{s}$ (+0.79 $^{m}/_{s}$

(3) half court(14 m): 13.67 $^{m}/_{s}$ (+1.57 $^{m}/_{s}$

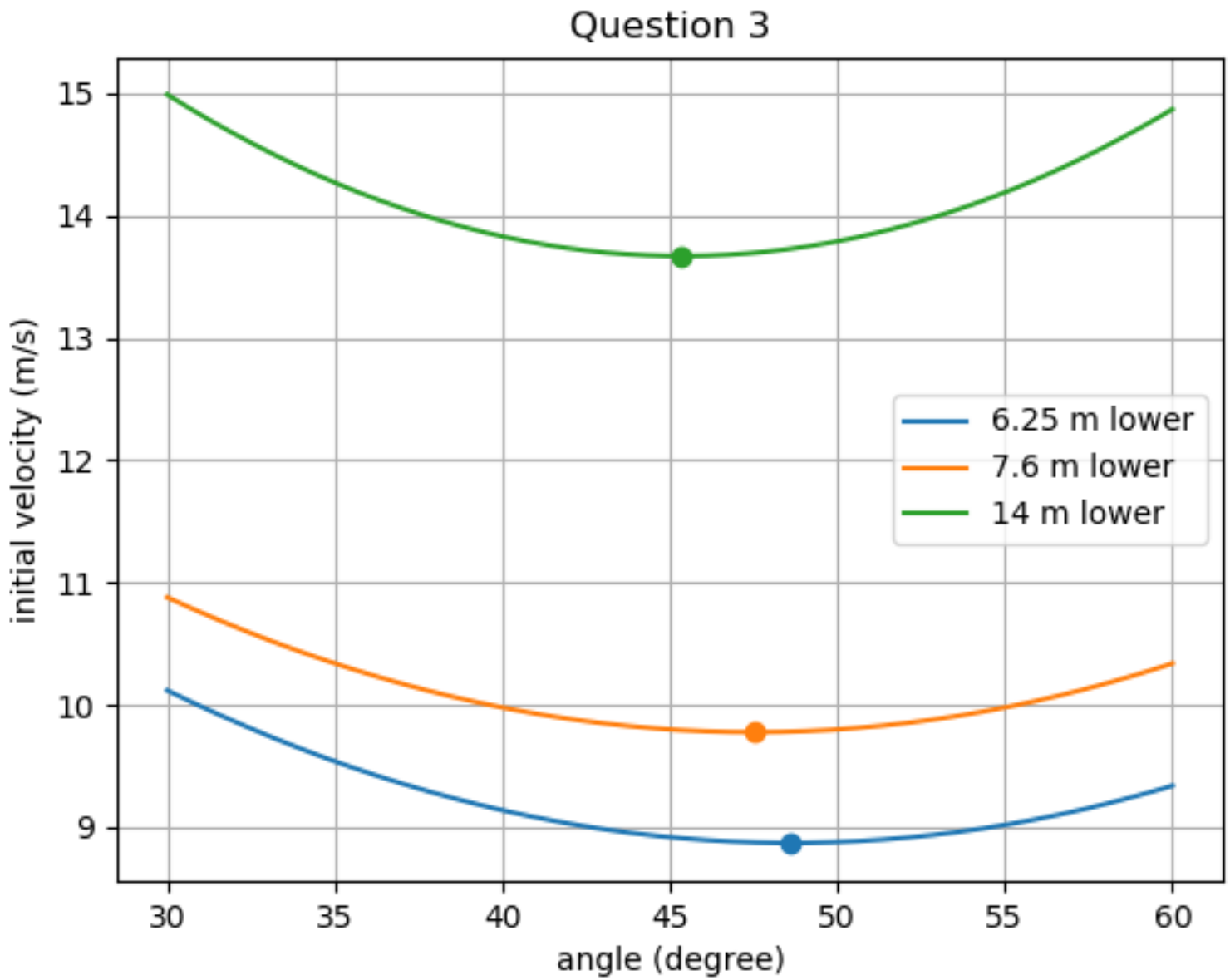
a in Question 1)

(1) corner(6.25 m): 8.46 $^{m}/_{s}$

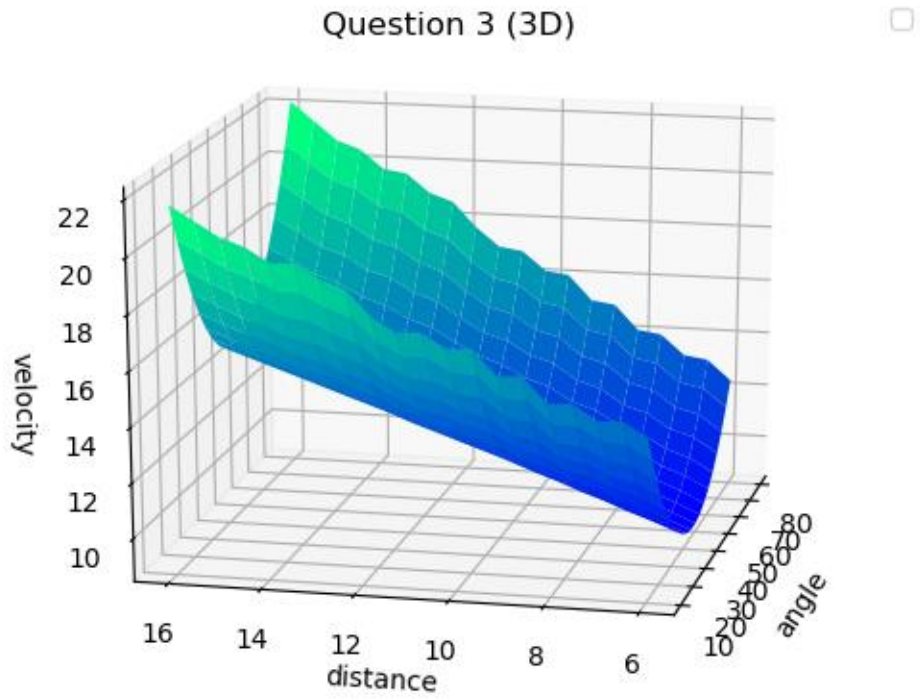
(2) top(7.6 m): 9.19 $^{m}/_{s}$

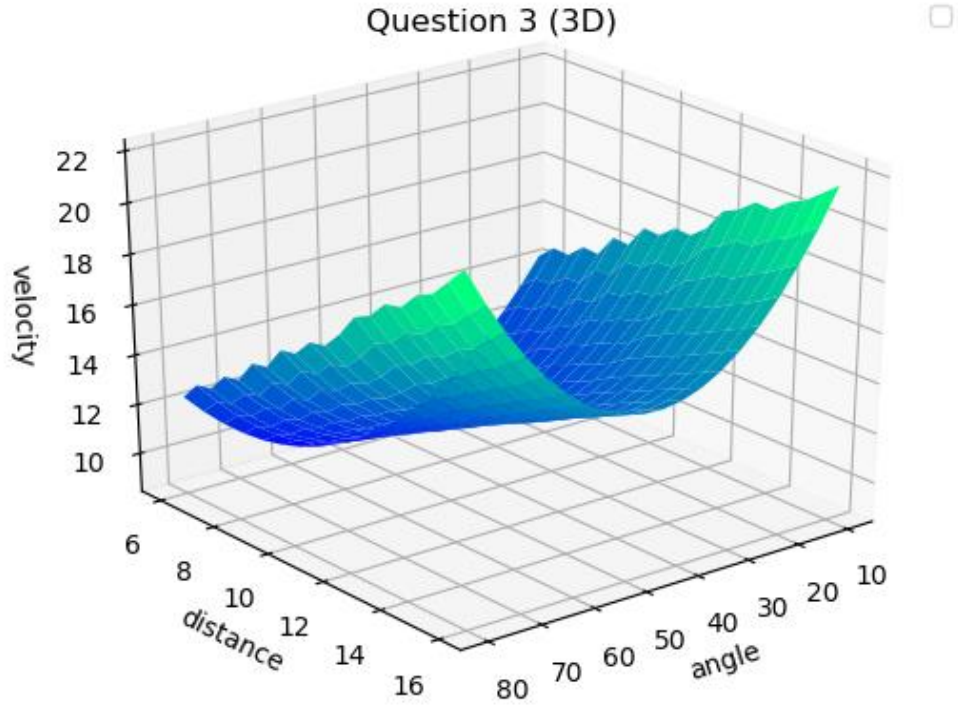
(3) half court(14 m): 12.1 $^{m}/_{s}$

Question 3

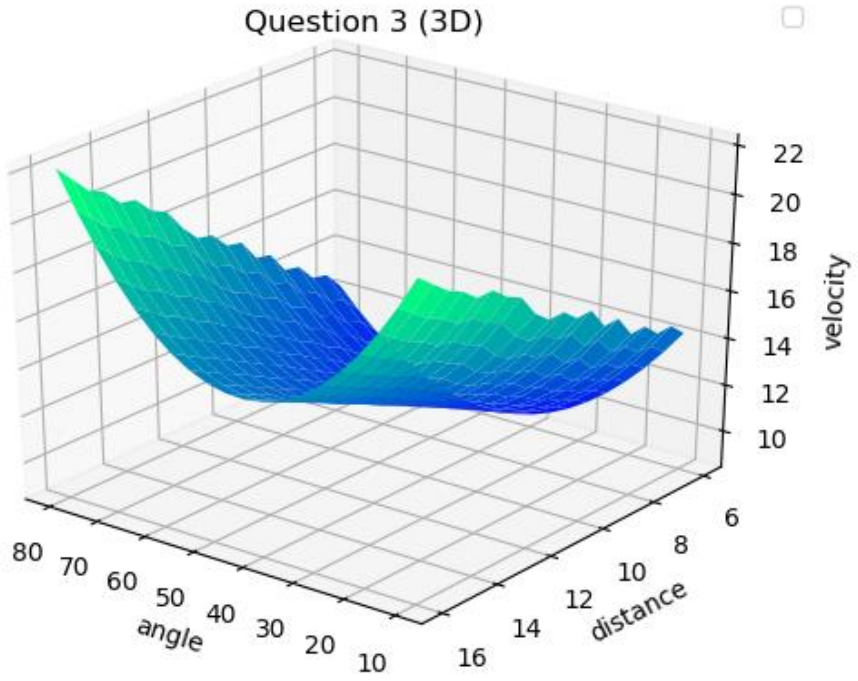

Question 3
initial velocity (m/s)
15
14
13
12
11
10
9
30
35
40
45
50
55
60
angle (degree)
6.25 m lower
7.6 m lower
14 m lower

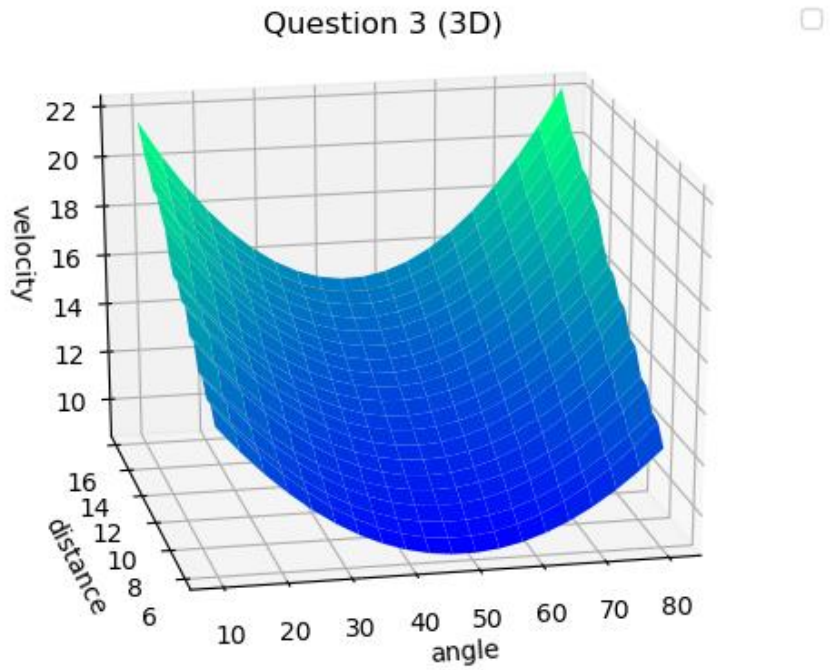
Question 3


Question 3 (3D)
velocity
22
20
18
16
14
12
10
distance
16
14
12
10
8
6
angle
10
20
30
40
50
60
70
80


Question 3 (3D)
velocity
22
20
18
16
14
12
10
distance
6
8
10
12
14
16
angle
80
70
60
50
40
30
20
10

Question 3


Question 3 (3D)
velocity
22
20
18
16
14
12
10
angle
80
70
60
50
40
30
20
10
distance
16
14
12
10
8
6


Question 3 (3D)
velocity
22
20
18
16
14
12
10
distance
16
14
12
10
8
6
angle
10
20
30
40
50
60
70
80

Question 3

a)

(1) corner(6.25 m): 8.87 $^{m}/_{s}$ 48.61º 8.92 $^{m}/_{s}$

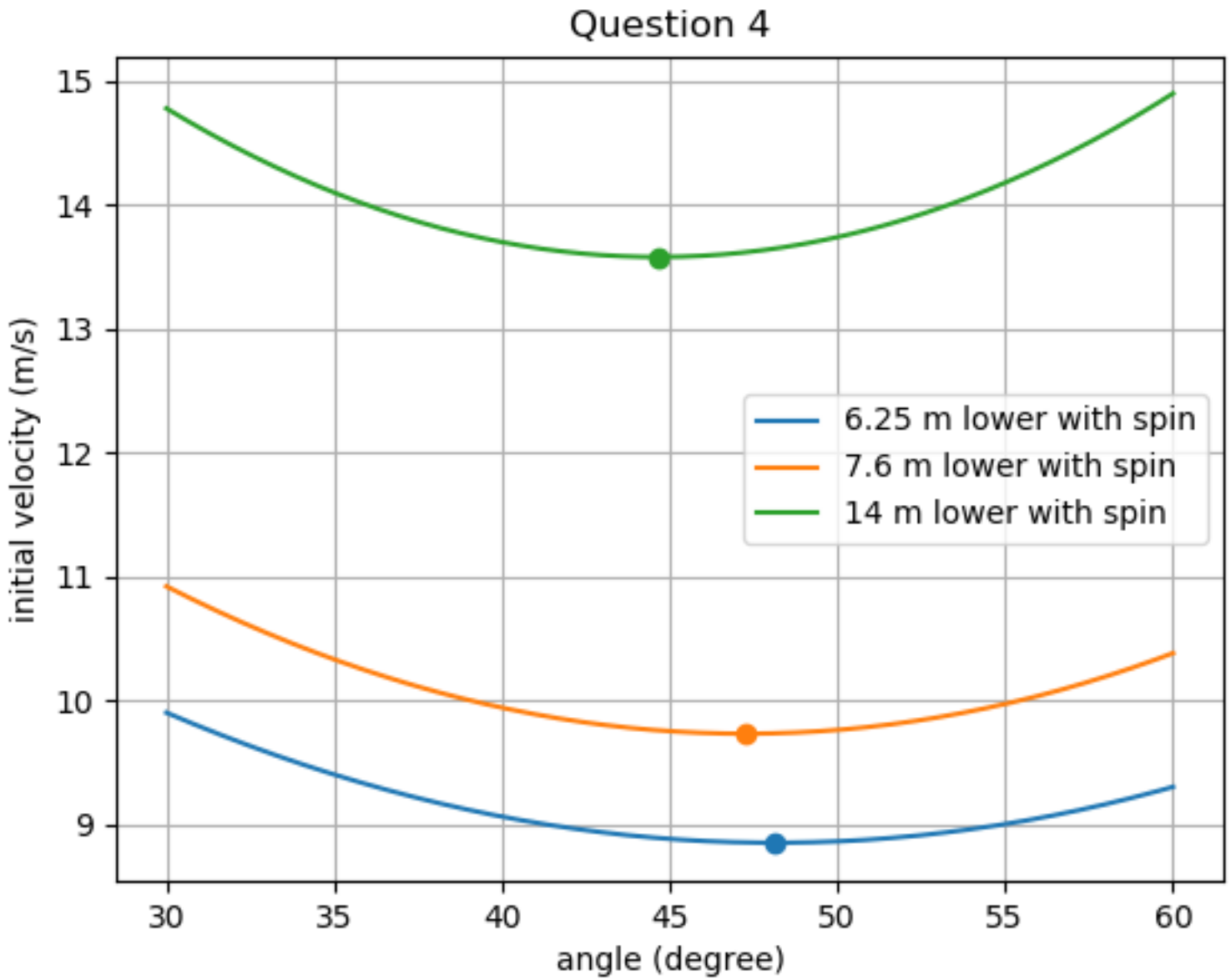
(2) top(7.6 m): 9.78 $^{m}/_{s}$ 47.50º 9.80 $^{m}/_{s}$

(3) half court(14 m): 13.67 $^{m}/_{s}$ 45.36º 13.67 $^{m}/_{s}$

b)

The optimal angle will slightly decrease when shooting further away from the basketball hoop.

Question 4


Question 4
initial velocity (m/s)
angle (degree)
15
14
13
12
11
10
9
30
35
40
45
50
55
60
6.25 m lower with spin
7.6 m lower with spin
14 m lower with spin

Question 4

a)

Q2:

(1) corner(6.25 m): 8.88 $^{m}/_{s}$ 8.92 $^{m}/_{s}$

(2) top(7.6 m): 9.75 $^{m}/_{s}$ 9.80 $^{m}/_{s}$

(3) half court(14 m): 13.58 $^{m}/_{s}$ 13.67 $^{m}/_{s}$

Q3:

(1) corner(6.25 m): 8.85 $^{m}/_{s}$ 48.12º 8.87 $^{m}/_{s}$ 48.61º

(2) top(7.6 m): 9.73 $^{m}/_{s}$ 47.25º 9.78 $^{m}/_{s}$ 47.50º

(3) half court(14 m): 13.58 $^{m}/_{s}$ 44.64º 13.67 $^{m}/_{s}$ 45.36º

Question 4

b)

Back spin makes both optimal angle and optimal velocity lower, thus if shooting with the same angle, back spin makes the velocities required to goal lower.

with back spin	without back spin	with back spin	without back spin
$8.88\ ^{m}/_{s}$	$8.92\ ^{m}/_{s}$	$8.85\ ^{m}/_{s}\ 48.12^{o}$	$8.87\ ^{m}/_{s}\ 48.61^{o}$
$9.75\ ^{m}/_{s}$	$9.80\ ^{m}/_{s}$	$9.73\ ^{m}/_{s}\ 47.25^{o}$	$9.78\ ^{m}/_{s}\ 47.50^{o}$
$13.58\ ^{m}/_{s}$	$13.67\ ^{m}/_{s}$	$13.58\ ^{m}/_{s}\ 44.64^{o}$	$13.67\ ^{m}/_{s}\ 45.36^{o}$

Python code explanation (basketball.py)

```
def shoot(self, v, angle, distance):
v: initial velocity (m/s)
angle: initial angle (degree)
distance: horizontal distance to the rim (m)
return [xlist, ylist, isInRange, self.od]
xlist: list, ball's x coordinate
ylist: list, ball's y coordinate
isInRange: boolean, whether the ball is in the rim or not
self.od: float, distance to rim at the end of the shoot
```

Reference

- Physics-Morris/General-Physics-Lecture https://github.com/Physics-Morris/General-Physics-Lecture
- Andrew Lang and Joerg M Gablonsky. "Modeling Basketball Free Throws" https://digitalshowcase.oru.edu/cgi/viewcontent.cgi?article=1063&context=cose_pub

Source code

https://github.com/pierre0210/Basketball-sim

江育瑄：程式設計
謝孟融：問題分析
吳秉叡：結果討論