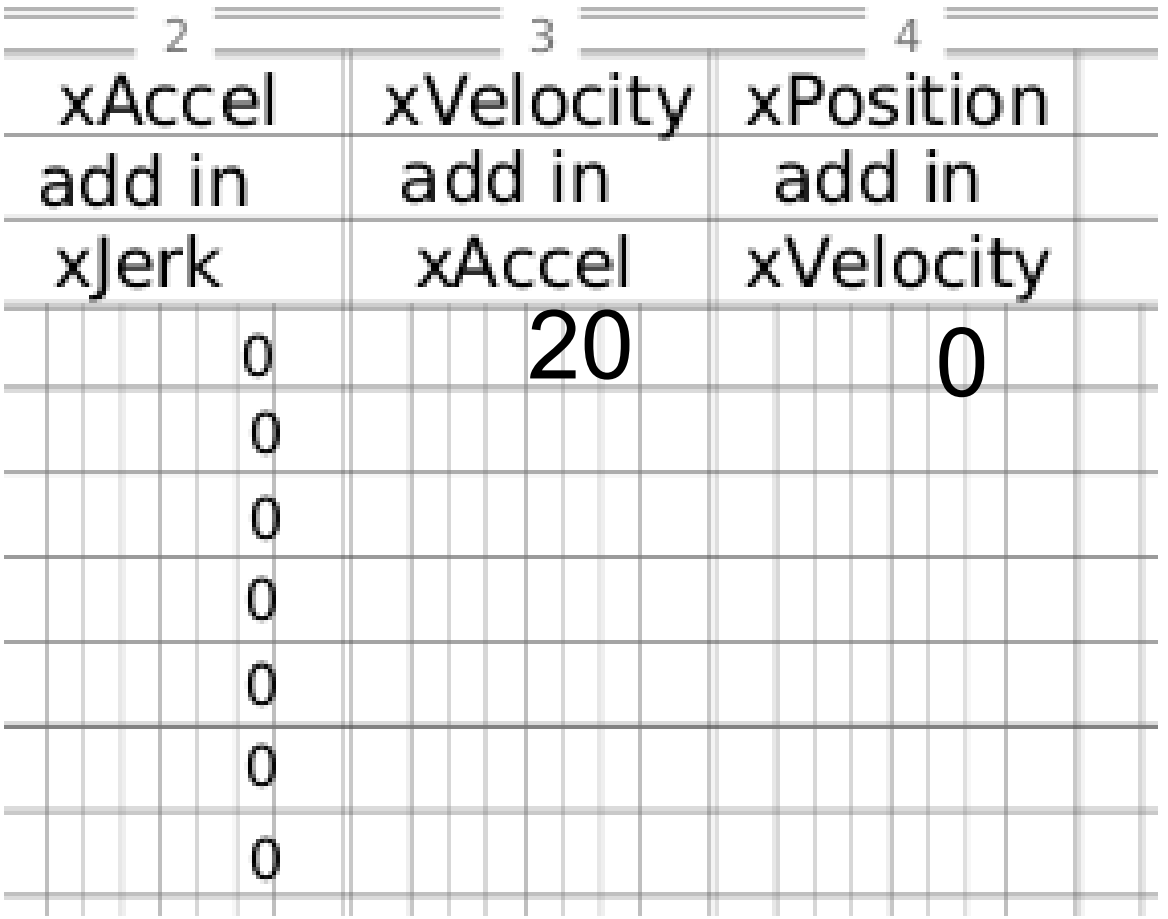
Mathematical Modelling
Physics of projectiles

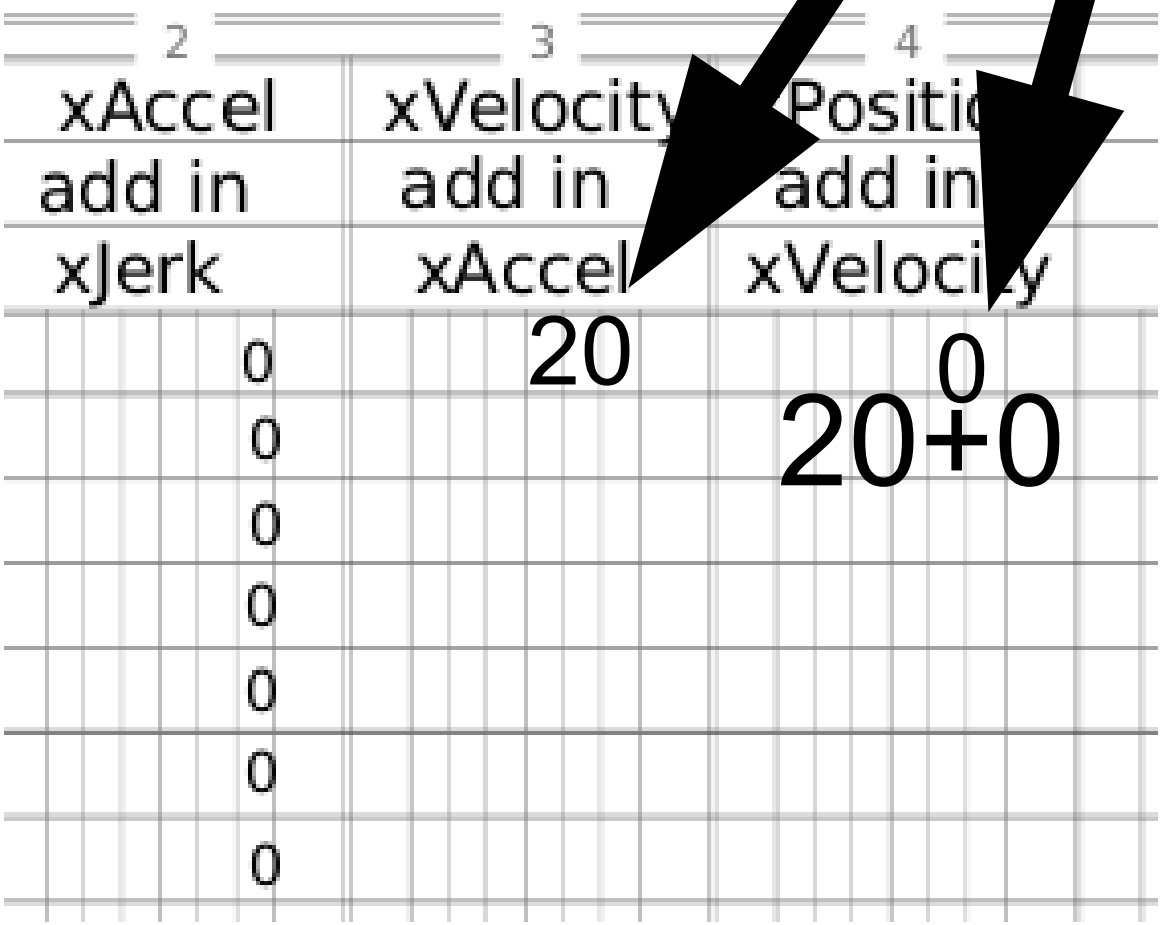
- Assumptions:
  - Vacuum: No air resistance.
  - Uniform gravity: The earth is flat. Gravity is vertical.
  - Newton's laws: No relativity.
- Model:
  - Horizontal motion independent of vertical.
  - Each second, ball moves right 20 meters.
  - We'll deal with vertical motion separately.

(1) Write in initial values from supervisor: xVelocity=20; xPosition=0;

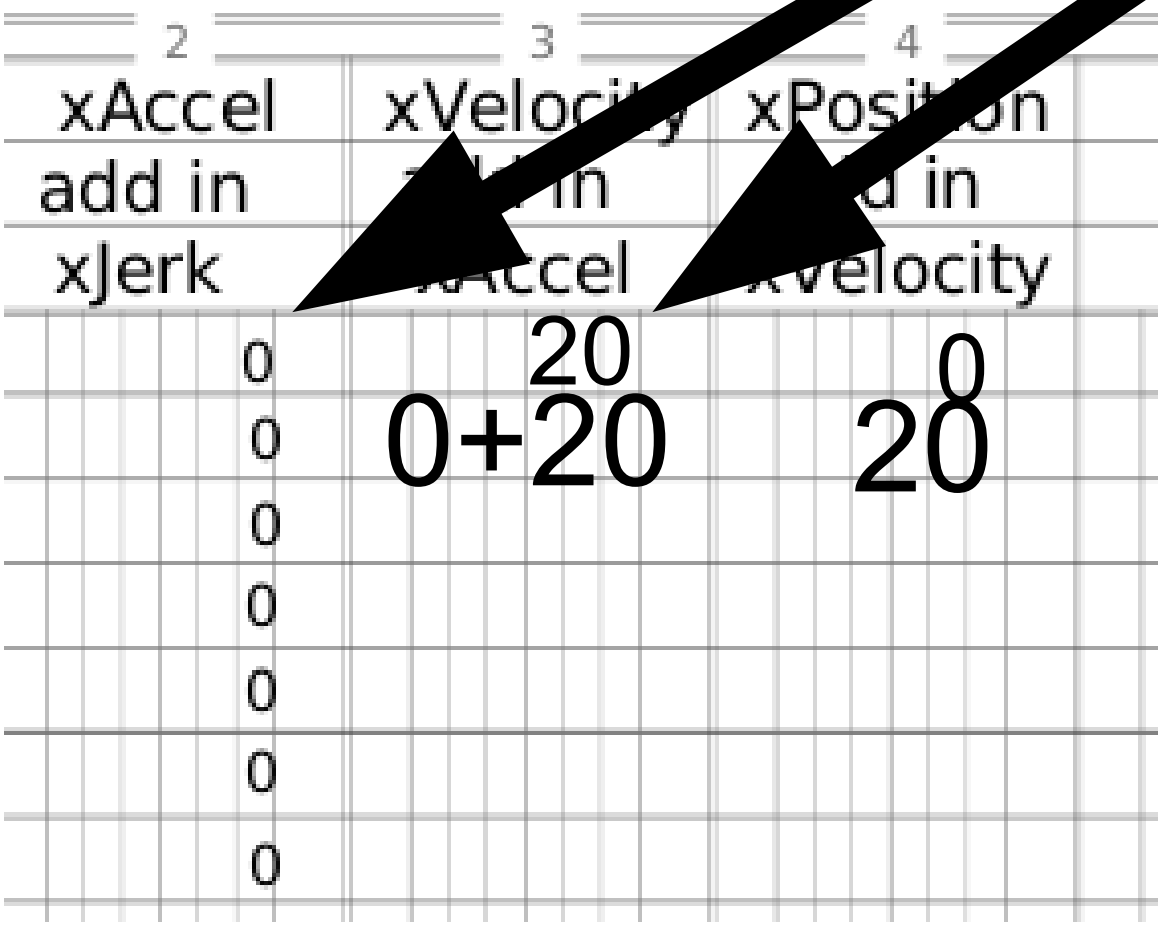


2	3	4
xAccel	xVelocity	xPosition
add in	add in	add in
xJerk	xAccel	xVelocity
0	20	0
0		
0		
0		
0		
0		
0		

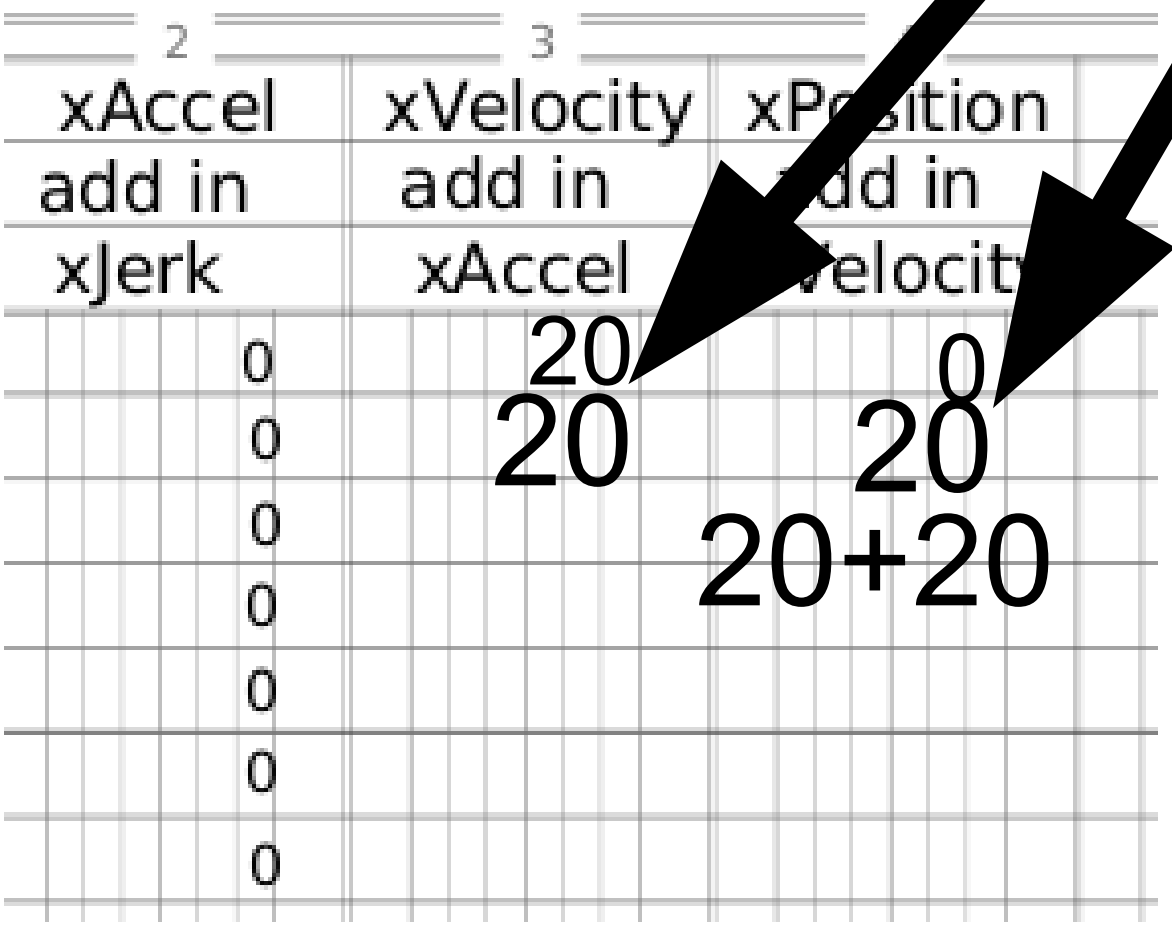
(2)Add # above with # left and above:



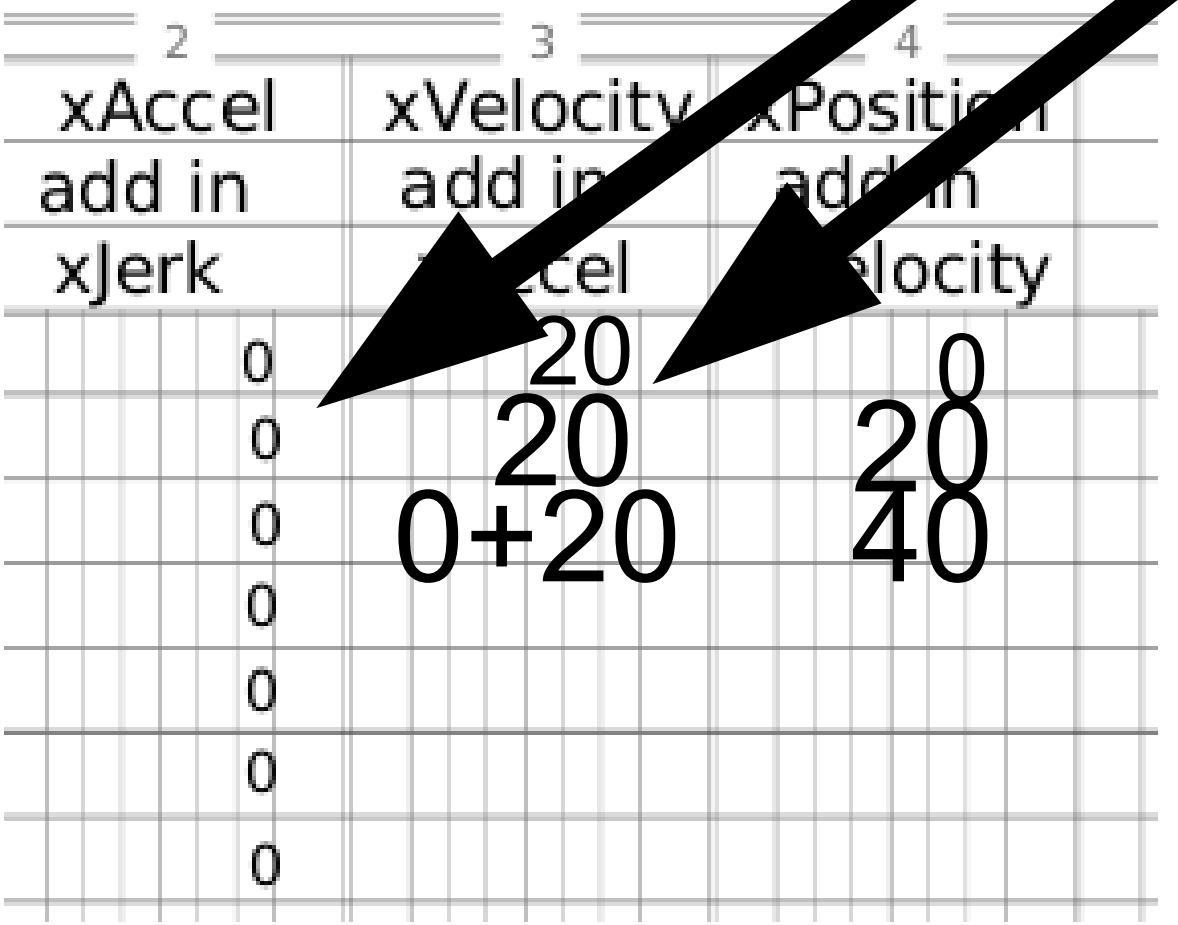
(2)Add # above with # left and above:



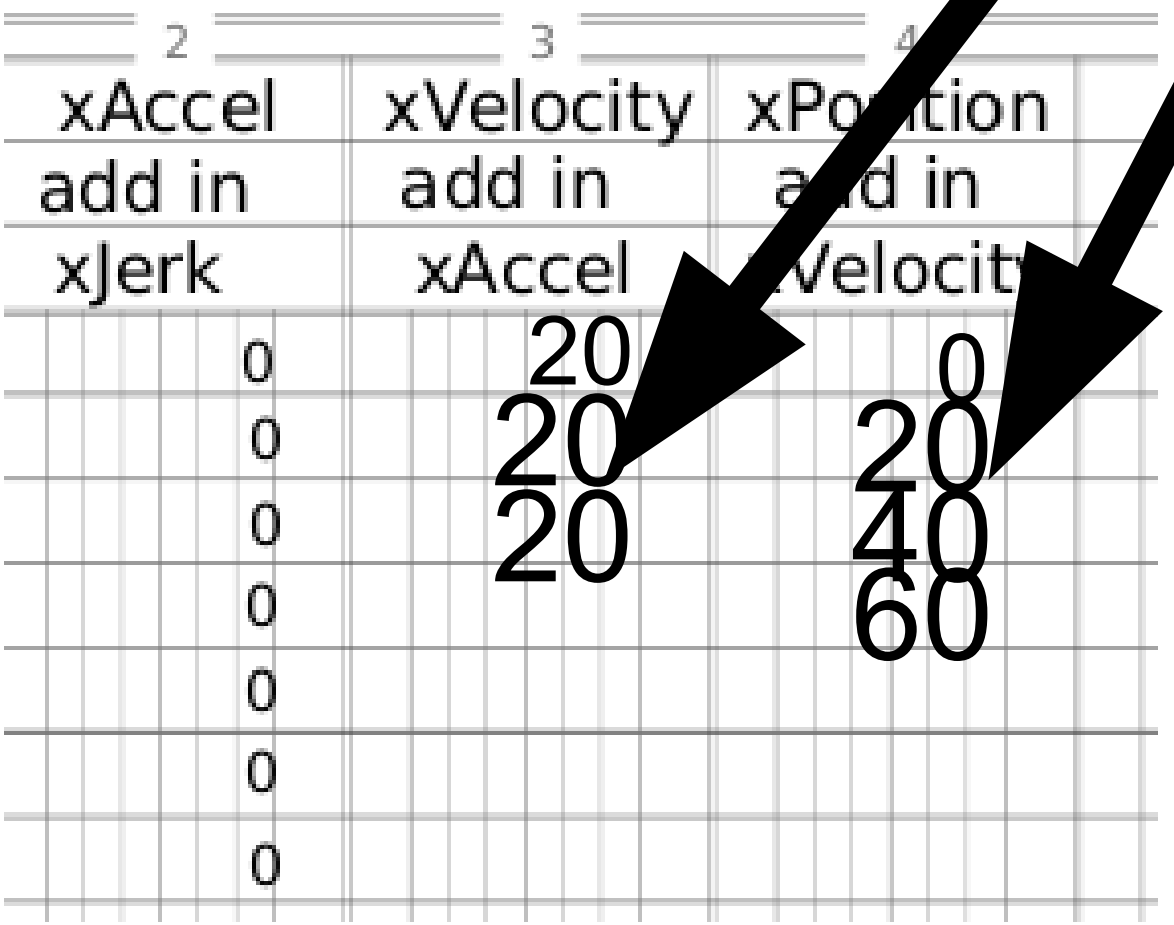
(2)Add # above with # left and above:



(2)Add # above with # left and above:



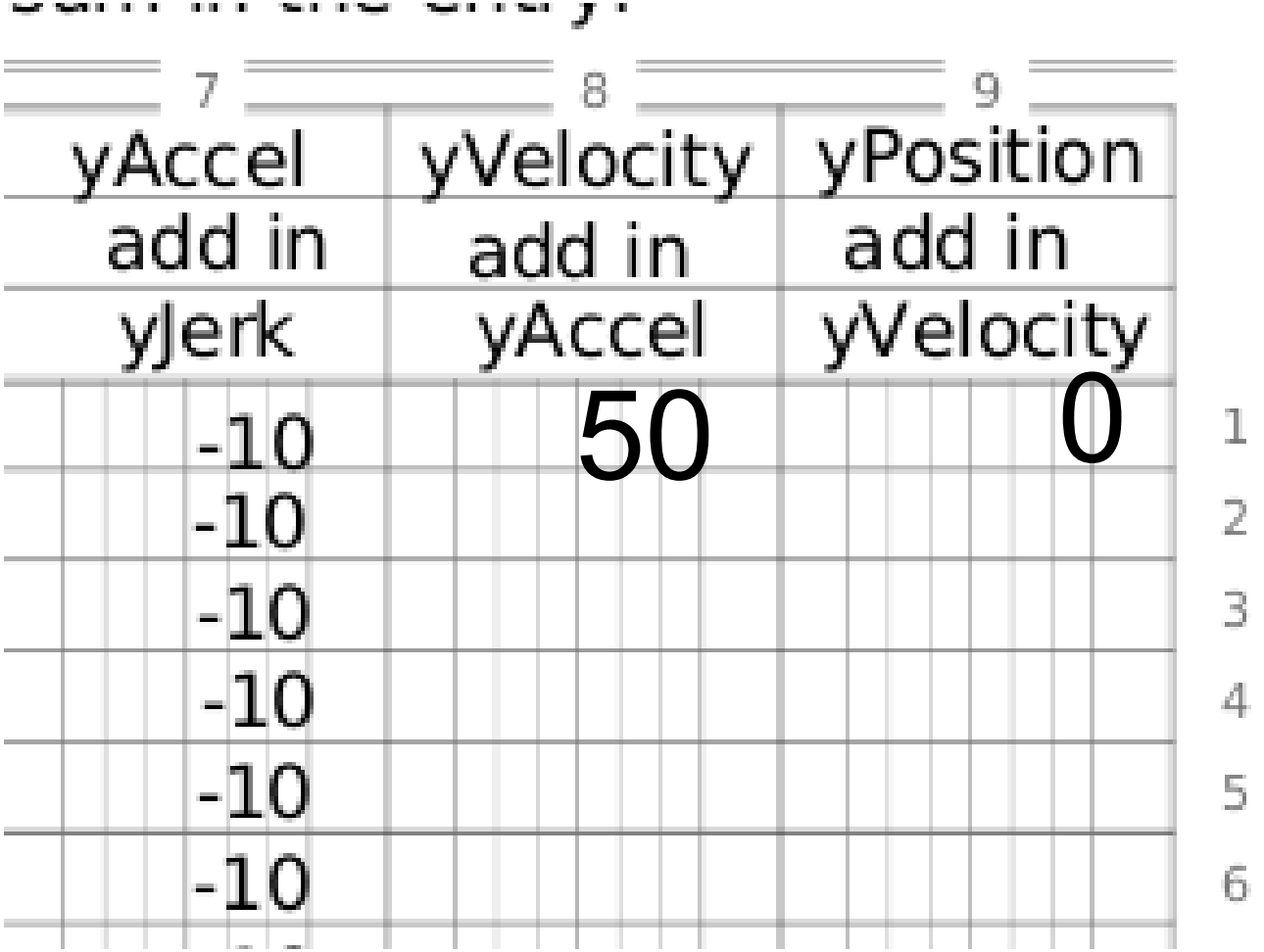
(2)Add # above with # left and above:



Mathematical Modelling
Physics of projectiles

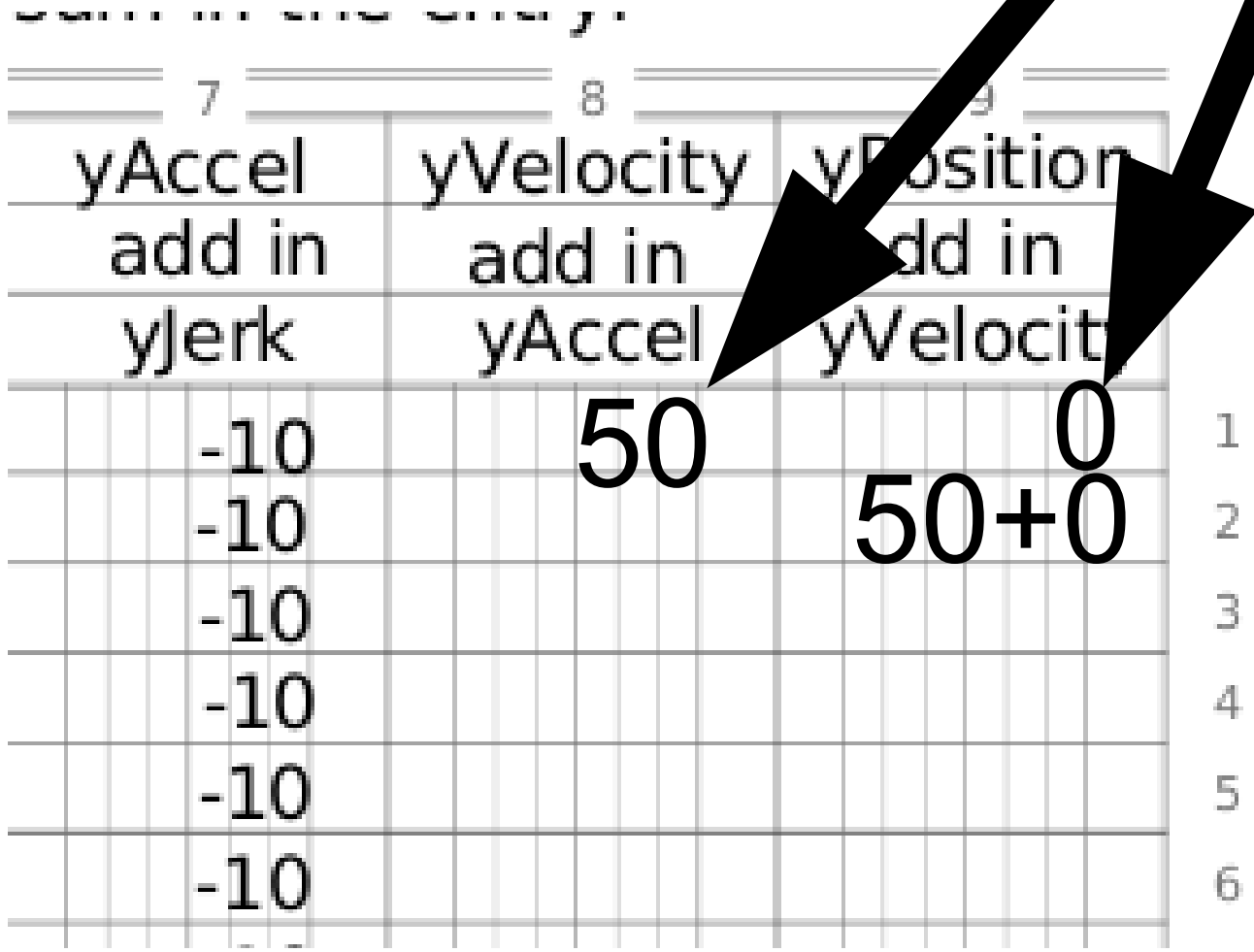
- Assumptions:
  - Vacuum, uniform vertical gravity, no relativity, horizontal motion is independent of vertical motion.
- Vertical Model (Discretized!)
  - Each second, ball moves up by its current vertical velocity (meters/second)
  - During the first second, the vertical velocity is 50 meters/second.
  - Each second, the vertical velocity changes by gravity's acceleration of -10 meters/second/second.
    - So, eventually the ball falls.

(1) Write in initial values from supervisor: yVelocity=50; yPosition=0;



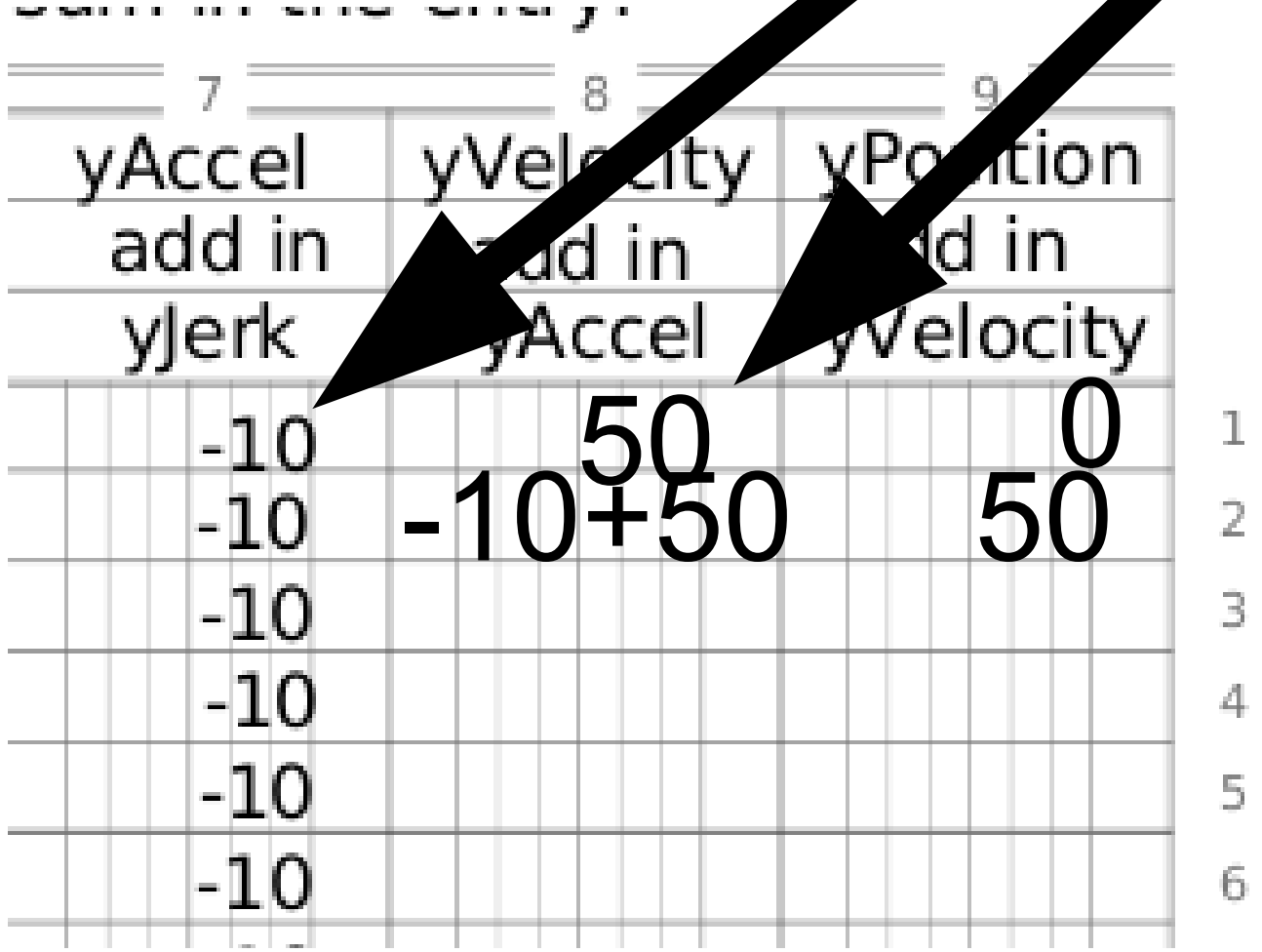
7	8	9	
yAccel	yVelocity	yPosition	
add in	add in	add in	
yJerk	yAccel	yVelocity	
-10	50	0	1
-10			2
-10			3
-10			4
-10			5
-10			6

(2)Add # above with # left and above:

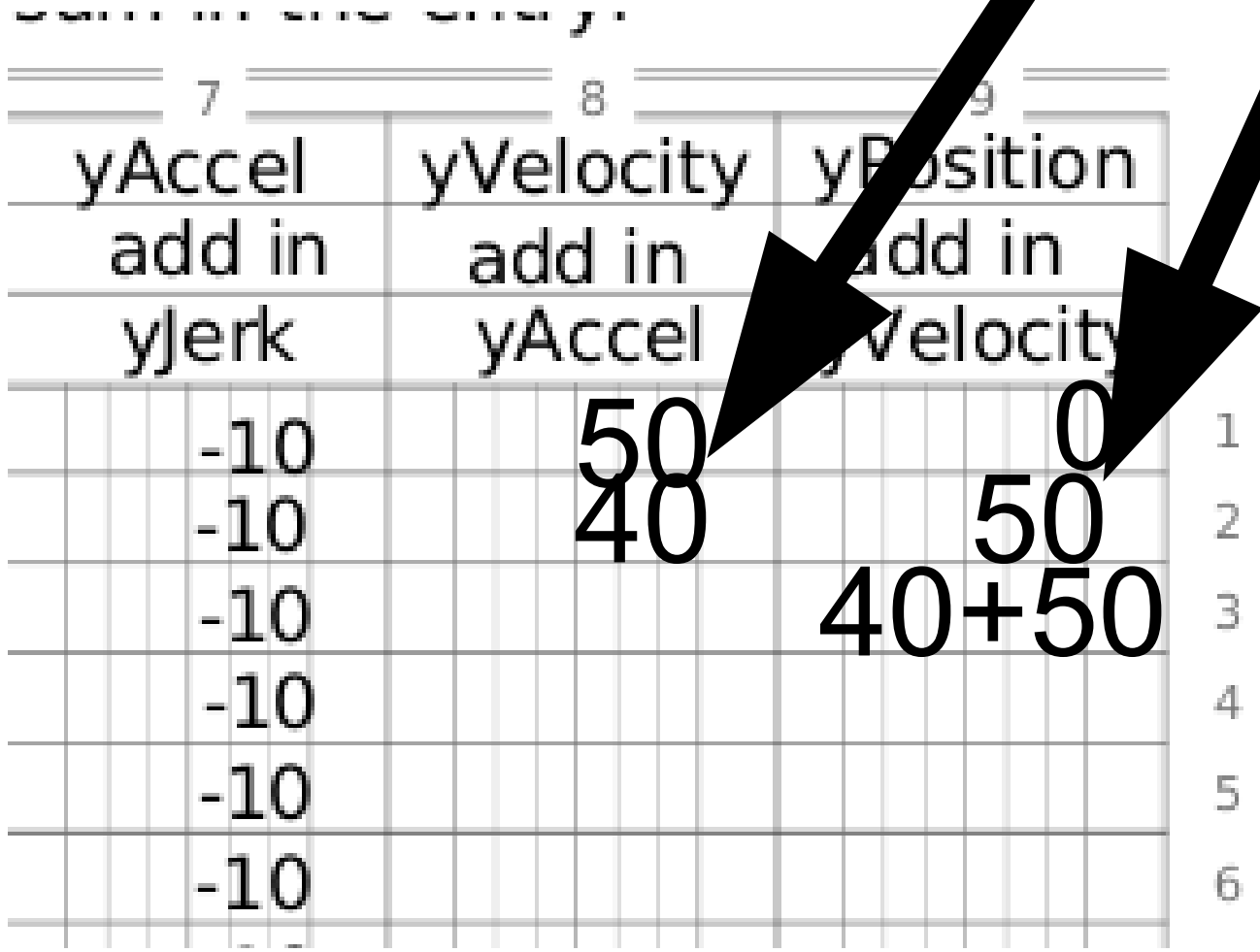


(2)Add # above with # left and above:

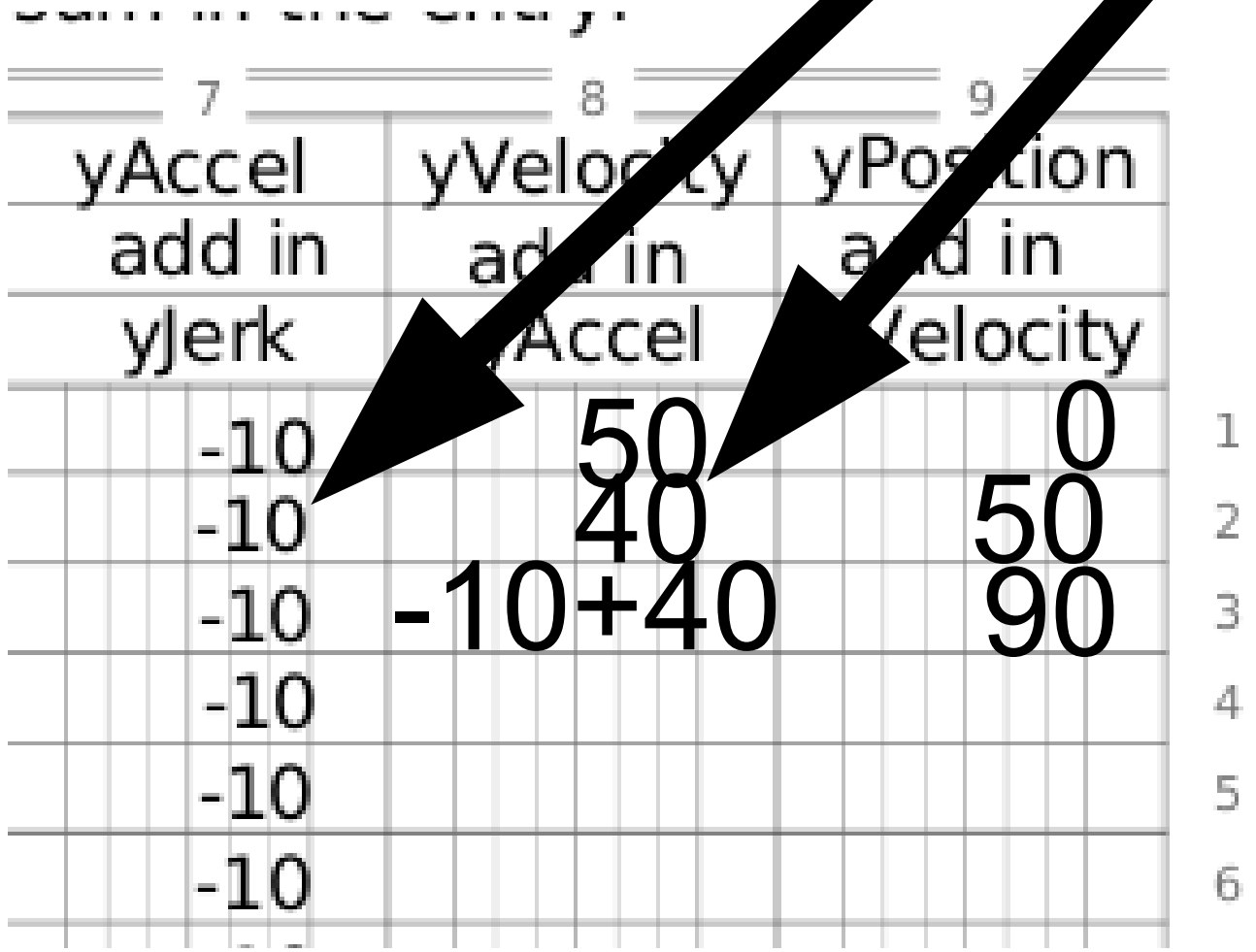
-10+50



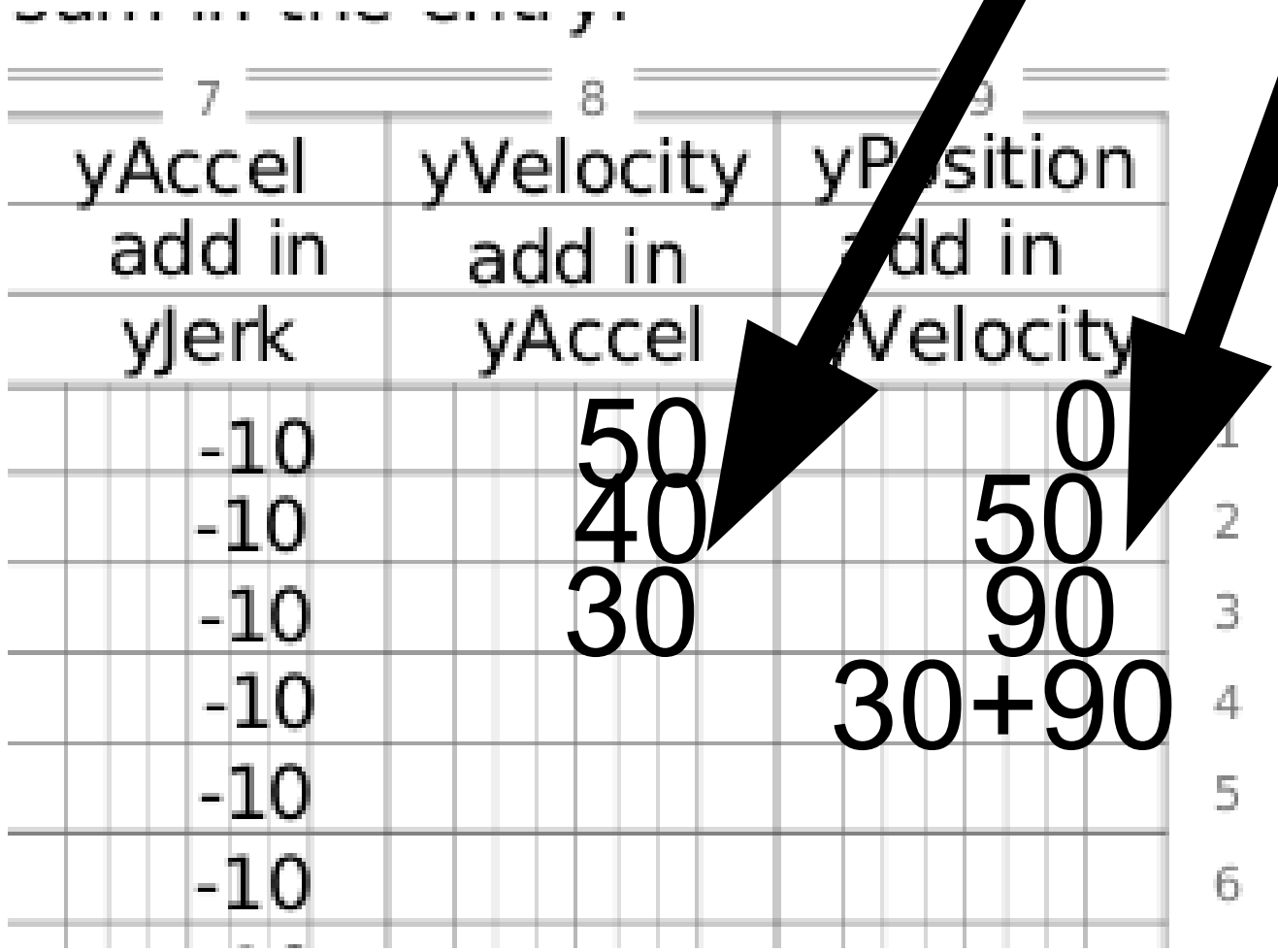
(2)Add # above with # left and above:



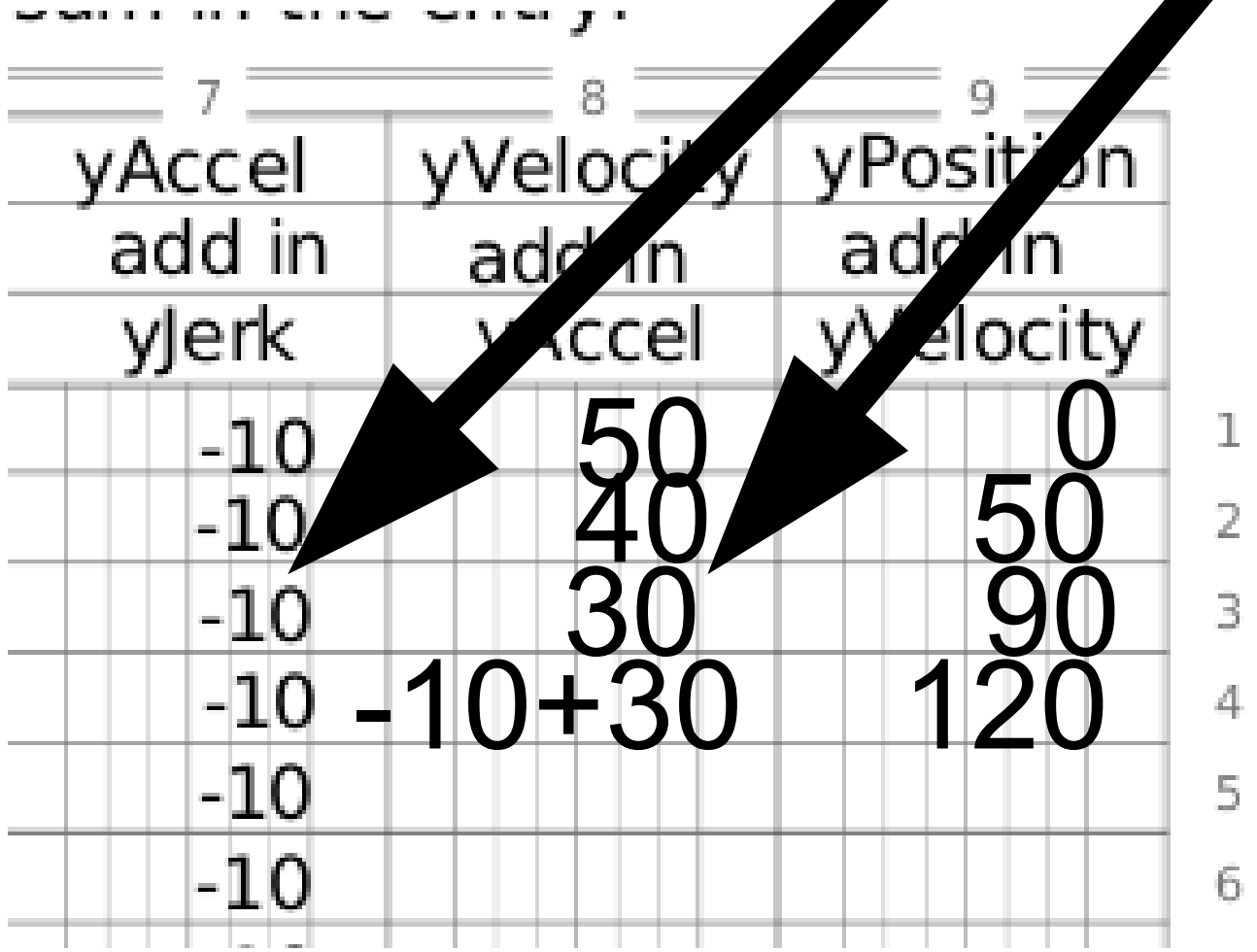
(2)Add # above with # left and above:



(2)Add # above with # left and above:



(2)Add # above with # left and above:



(2)Add # above with # left and above:

7	8	9	
yAccel	yVelocity	yPosition	
add in	add in	add in	
yJerk	yAccel	yVelocity	
-10	50	0	1
-10	40	50	2
-10	30	90	3
-10	20	120	4
-10	10	140	5
-10	0	150	6

0
50
90
120
140
150

Position 0 to position 50
speed was about 50.
Position 50 to position 90
speed was about 40.
Position 90 to position 120
speed was about 30.
Position 120 to position 140
speed was about 20.
Position 140 to position 150
speed was about 10.

What we did: Simulation

- During each second, the ball moves horizontally 20 meters.
- During each second, the ball moves vertically whatever it's current vertical velocity is.
- During each second the ball's current vertical velocity changes by having 10 (meters/second) subtracted.
- THIS IS NOT PERFECTLY ACCURATE!
- But: It's accurate enough AND it's easy to compute with numbers.

Let's do it with only 4 variables Imagine a paper (memory) shortage!

Horizontal

- int xVelocity;
- int xPosition;
- xVelocity = 20;
- xPosition = 0;
- Repeat:

  xPostion = xPosition + xVelocity;

Let's do it with only 4 variables Imagine a paper (memory) shortage!

Vertical

- int yAccel;
- int yVelocity;
- int yPosition;
- yAccel = -10; yVelocity = 50; yPosition=0;
- REPEAT:

  yPostion = yPosition + yVelocity;

  yVelocity = yVelocity + yAccel;

What if you did the two steps within the loop body in reverse order?

Vertical

- int yAccel;
- int yVelocity;
- int yPosition;
- yAccel = -10; yVelocity = 50; yPosition=0;
- REPEAT:

  yVelocity = yVelocity + yAccel;

  yPosition = yPosition + yVelocity;

order is reversed!

yAccel = -10; yVelocity = 50; yPosition=0;

- REPEAT: **(ACTUALLY DO THIS ON PAPER!!)**

  yVelocity = yVelocity + yAccel;

  yPosition = yPosition + yVelocity;

(A)

yPosition

0

50

90

120

(numbers from your spreadsheet)

(B)

yPosition

0

40

70

90

(DIFFERENT numbers from your spreadsheet)