Constant Acceleration (SUVAT) Calculator Documentation

Overview

Functionality

1. Prompts the user to input SUVAT values
    - The inputs must meet the format:
        - A decimal number for known values
        - A question mark (?) for wanted values
        - A dash (-) for unknown values
2. Checks the inputs meet the valid criteria and prompts the user to retry if invalid
    - The inputs must meet the valid criteria:
        - 3 known value (decimal), 1 want value (?), 1 unknown value (-)
        - 4 known value (decimal), 1 want value (?), 0 unknown value (-)
3. Displays the available equations based on the user input and prompts the user to select one
    - If an unknown value is present, only one 1 of the 5 equations can be used
    - If an unknown values is not present, 4 out of the 5 equations can be used
4. Displays the step-by-step workings for solving the question using the chosen equation
    - The step-by-step breakdown of the question will be different depending on which 1 out of the 5 SUVAT values are wanted (?)
5. Displays the final answer with its respective units

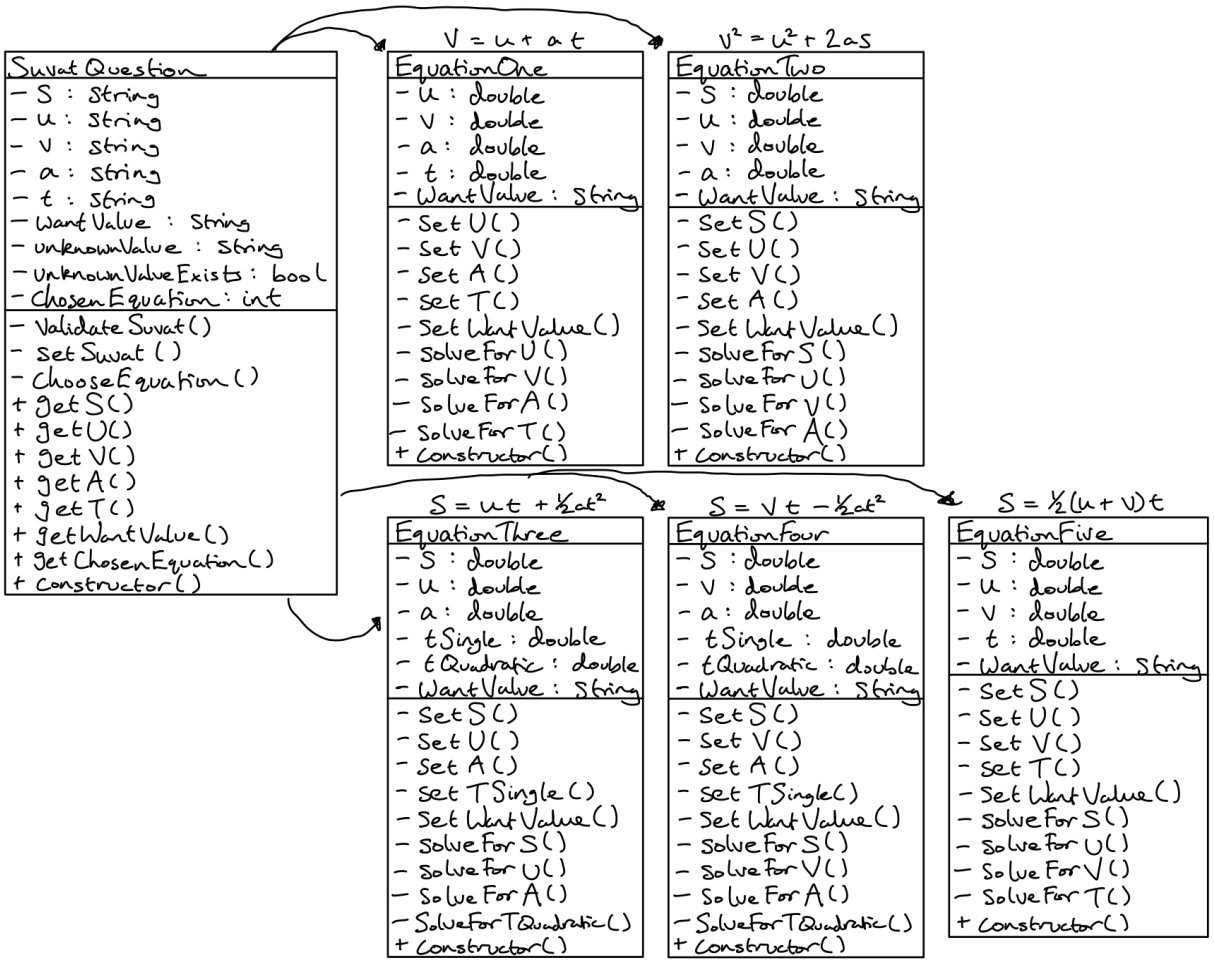
Assumptions

- Assumes that the user inputs the SUVAT values in the correct format
    - A decimal number for known values
    - A question mark (?) for wanted values
    - A dash (-) for unknown values

Designs and Plans

Class Diagram

- All attributes are private (-) for encapsulation and prevention of direct data modification from outside the class
- All getters are public (+) so attributes can be read from outside the class
- All setters are private (-) but they are all called in the constructor functions so they are only run when creating a new object
- “SuvatQuestion” class (Constructor function)
    - Prompts the user to input SUVAT values
    - Calls the “validateSuvat()” method to check that the user’s inputs meet the valid criteria
        - Assigns a boolean value to the “unknownValueExists” attribute
    - Calls the “setSuvat()” method to set the input SUVAT values to their corresponding attributes
        - Assigns the SUVAT values to their respective attributes
        - Assigns the wanted value (?) to the “wantValue” attribute
        - Assigns the unknown value (-) to the “unknownValue” attribute (if it exists)
    - Calls the “chooseEquation()” method to decide which of the 5 equations can be used depending on the user’s input and prompts the user to choose one
        - Assigns the chosen equation to the “chosenEquation” attribute
- “EquationX” class (Constructor function)
    - Takes the user’s inputs from the “SuvatQuestion” class as parameters via the getters
    - Calls the setters to assign the user’s inputs to their respective attributes
    - Calls the solver function depending on the wanted value (?)



Main Function

```
int main() {
  SuvatQuestion newQuestion

  if (newQuestion.getChosenEquation == 1)
    EquationOne newEquationOne

  else if (newQuestion.getChosenEquation == 2)
    EquationTwo newEquationTwo

  else if (newQuestion.getChosenEquation == 3)
    EquationThree newEquationThree

  else if (newQuestion.getChosenEquation == 4)
    EquationFour newEquationFour

  else if (newQuestion.getChosenEquation == 5)
    EquationFive newEquationFive
}
```

Algorithm to Display the Appropriate Equations

Displaying the Appropriate Equations

① $V = u + at$
② $V^2 = u^2 + 2as$
③ $S = ut + \frac{1}{2}at^2$
④ $S = Vt - \frac{1}{2}at^2$
⑤ $S = \frac{1}{2}(u + V)t$

- If unknown value(-) exists:
  - If unknown value(-) = S → Use equation ①
  - If unknown value(-) = U → Use equation ④
  - If unknown value(-) = V → Use equation ③
  - If unknown value(-) = A → Use equation ⑤
  - If unknown value(-) = T → Use equation ②

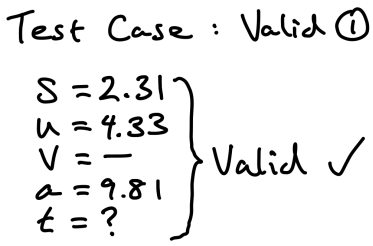
- If unknown value(-) doesn't exist:
  - If want value(?) = S → Use equation ② ③ ④ ⑤
  - If want value(?) = U → Use equation ① ② ③ ⑤
  - If want value(?) = V → Use equation ① ② ④ ⑤
  - If want value(?) = A → Use equation ① ② ③ ④
  - If want value(?) = T → Use equation ① ③ ④ ⑤

Testing and Results

User Input Validation

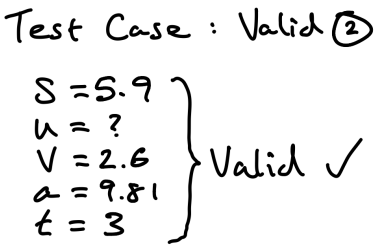
- The inputs must meet the valid criteria:
    1. 3 known value (decimal), 1 want value (?), 1 unknown value (-)
    2. 4 known value (decimal), 1 want value (?), 0 unknown value (-)Test Case 1: Valid

Test Case 1: Valid (1)



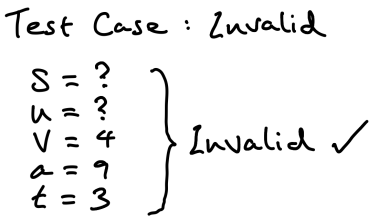

```
Enter numbers for known values, ? for values to find
and - for unknown values.
S = 2.31
U = 4.33
V = -
A = 9.81
T = ?

You can use the following equation(s):
1) S = UT + ½AT²
Press 1 to confirm and continue:
```

Test Case 2: Valid (2)



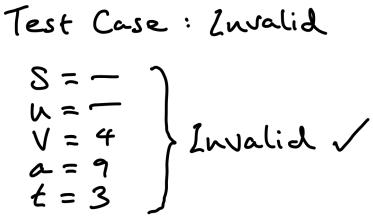

```
Enter numbers for known values, ? for values to find
and - for unknown values.
S = 5.9
U = ?
V = 2.6
A = 9.81
T = 3

You can use the following equation(s):
1) V = U + AT
2) V² = U² + 2AS
3) S = UT + ½AT²
4) S = ½(U + V)T
Press the number of your desired equation to confirm
and continue:
```

Test Case 3: Invalid




```
Enter numbers for known values, ? for values to find
and - for unknown values.
S = ?
U = ?
V = 4
A = 9
T = 3

Your input(s) were invalid. Please try again.
Enter numbers for known values, ? for values to find
and - for unknown values.
S =
```

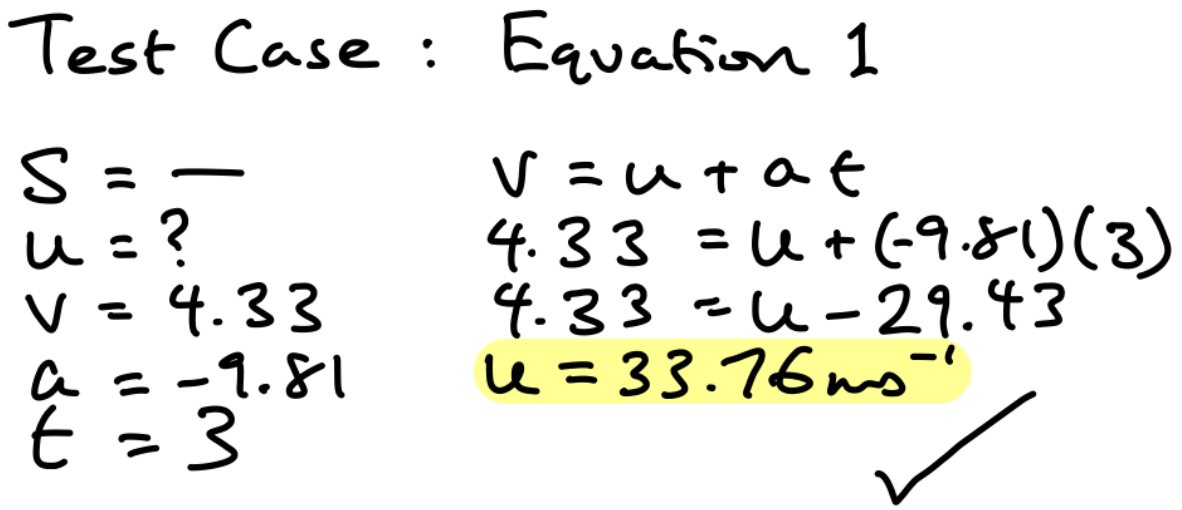
Test Case 4: Invalid




```
Enter numbers for known values, ? for values to find and
 - for unknown values.
S = -
U = -
V = 4
A = 9
T = 3

Your input(s) were invalid. Please try again.
Enter numbers for known values, ? for values to find and
 - for unknown values.
S =
```

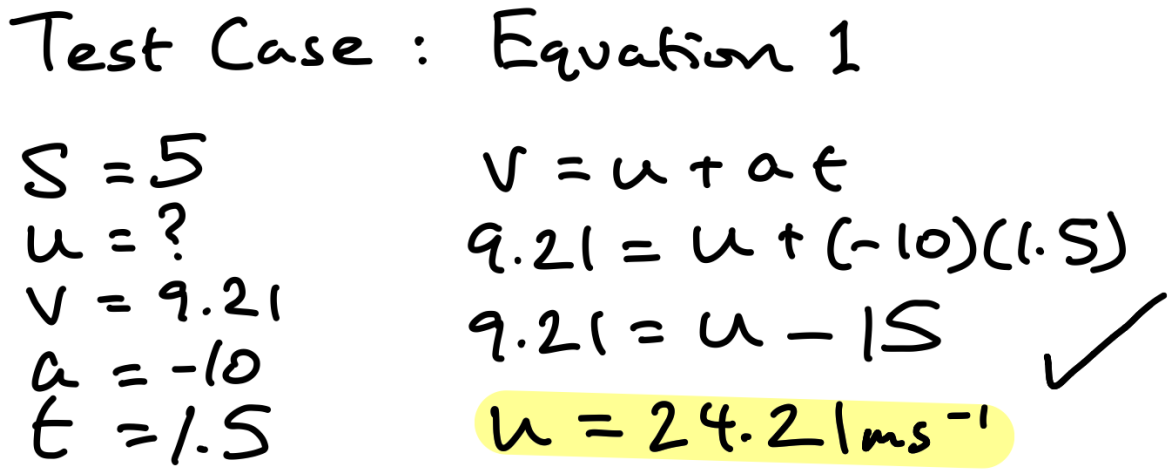
Main Equation Solving Stage

Test Case 1: Equation 1



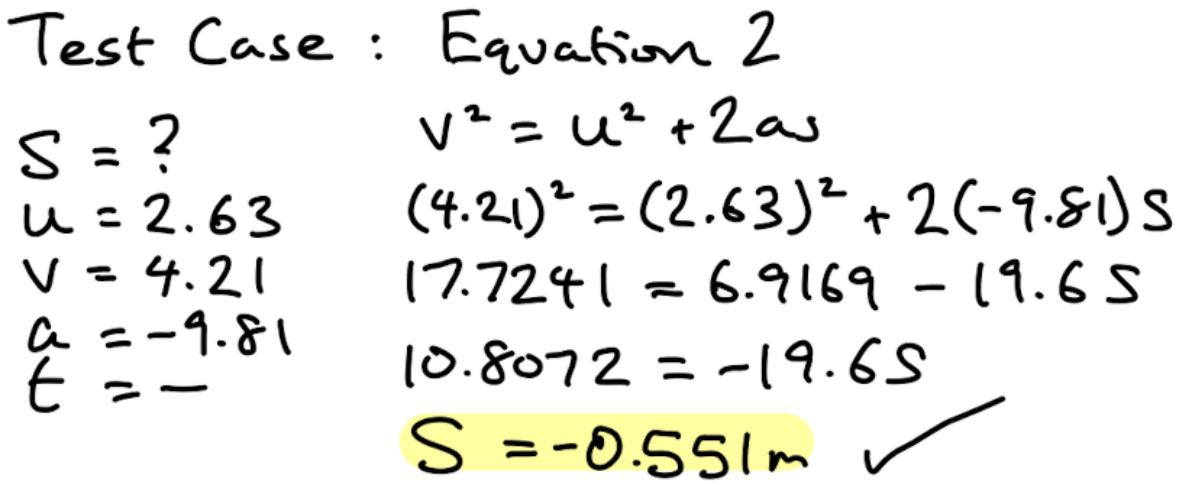

```
Enter numbers for known values, ? for values to find and - for unknown values.
S = -
U = ?
V = 4.33
A = -9.81
T = 3

You can use the following equation(s):
1) V = U + AT
Press 1 to confirm and continue: 1

V = U + AT   <-- Your chosen equation

4.33 = U + (-9.81)(3)   <-- Substitute the numbers

4.33 = U + -29.43   <-- Multiply AT

33.76 = U   <-- Subtract AT on both sides

U = 33.76   <-- Swap around for simplicity

The answer is U = 33.76ms-1
```

Test Case 2: Equation 1




```
Enter numbers for known values, ? for values to find and - for unknown values.
S = 5
U = ?
V = 9.21
A = -10
T = 1.5

You can use the following equation(s):
1) V = U + AT
2) V² = U² + 2AS
3) S = UT + ½AT²
4) S = ½(U + V)T
Press the number of your desired equation to confirm and continue: 1

V = U + AT   <-- Your chosen equation

9.21 = U + (-10)(1.5)   <-- Substitute the numbers

9.21 = U + -15   <-- Multiply AT

24.21 = U   <-- Subtract AT on both sides

U = 24.21   <-- Swap around for simplicity

The answer is U = 24.21ms⁻¹
```

Test Case 3: Equation 2




```
Enter numbers for known values, ? for values to find and - for unknown values.
S = ?
U = 2.63
V = 4.21
A = -9.81
T = -

You can use the following equation(s):
1) V² = U² + 2AS
Press 1 to confirm and continue: 1

V² = U² + 2AS   <-- Your chosen equation

4.21² = 2.63² + 2(-9.81)(S)   <-- Substitute the numbers

17.7241 = 6.9169 + -19.62S   <-- Square V and U and Multiply 2A

10.8072 = -19.62S   <-- Subtract U² on both sides

-19.62S = 10.8072   <-- Swap around for simplicity

S = -0.550826   <-- Divide 2A on both sides

The answer is S = -0.550826m
```

Test Case 4: Equation 2

Test Case : Equation 2

$S = 2$
$u = 4.6$
$v = 5.1$
$a = ?$
$t = 1.2$

$v^2 = u^2 + 2as$

$(5.1)^2 = (4.6)^2 + 2(a)(2)$

$26.01 = 21.16 + 4a$

$4a = 4.85$ ✓

$a = 1.2125 ms^{-2}$

```
Enter numbers for known values, ? for values to find and - for unknown values.
S = 2
U = 4.6
V = 5.1
A = ?
T = 1.2

You can use the following equation(s):
1) V = U + AT
2) V² = U² + 2AS
3) S = UT + ½AT²
4) S = VT - ½AT²
Press the number of your desired equation to confirm and continue: 2

V² = U² + 2AS   <-- Your chosen equation

5.1² = 4.6² + 2(A)(2)   <-- Substitute the numbers

26.01 = 21.16 + 4A   <-- Square V and U and Multiply 2S

4.85 = 4A   <-- Subtract U² on both sides

4A = 4.85   <-- Swap around for simplicity

A = 1.2125   <-- Divide 2S on both sides

The answer is A = 1.2125ms⁻²
```

Test Case 5: Equation 3

Test Case : Equation 3

$S = -2$
$u = 4.2$
$v = -$
$a = -9.81$
$t = ?$

$S = ut + \frac{1}{2}at^2$

$-2 = 4.2t + \frac{1}{2}(-9.81)t^2$

$-2 = 4.2t - 4.905t^2$

$4.905t^2 - 4.2t - 2 = 0$ ✓

$t = 1.1969s, \quad t = -0.3407$

```
Enter numbers for known values, ? for values to find and - for unknown values.
S = -2
U = 4.2
V = -
A = -9.81
T = ?

You can use the following equation(s):
1) S = UT + ½AT²
Press 1 to confirm and continue: 1

S = UT + ½AT²   <-- Your chosen equation

-2 = (4.2)(T) + ½(-9.81)(T)²   <-- Substitute the numbers

-2 = 4.2T + -4.905T²   <-- Multiply UT and ½A

-4.905T² + 4.2T + 2 = 0   <-- Rearrange to quadratic equation format

[USING QUADRATIC FORMULA]

The answers are T = -0.340661s and T = 1.19693s
```

Test Case 6: Equation 3

Test Case : Equation 3

$S = 4.8$
$u = ?$
$v = 7.7$
$a = -9.81$
$t = 1.7$

$S = ut + \frac{1}{2}at^2$

$4.8 = 1.7u + \frac{1}{2}(-9.81)(1.7)^2$

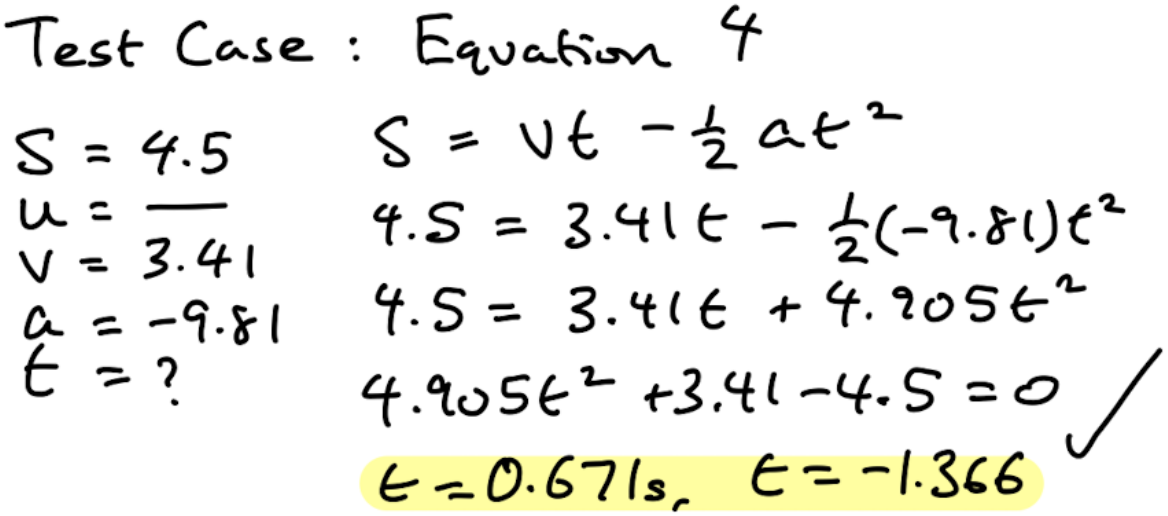
$4.8 = 1.7u - 14.175$

$1.7u = 18.975$

$u = 11.16 ms^{-1}$ ✓

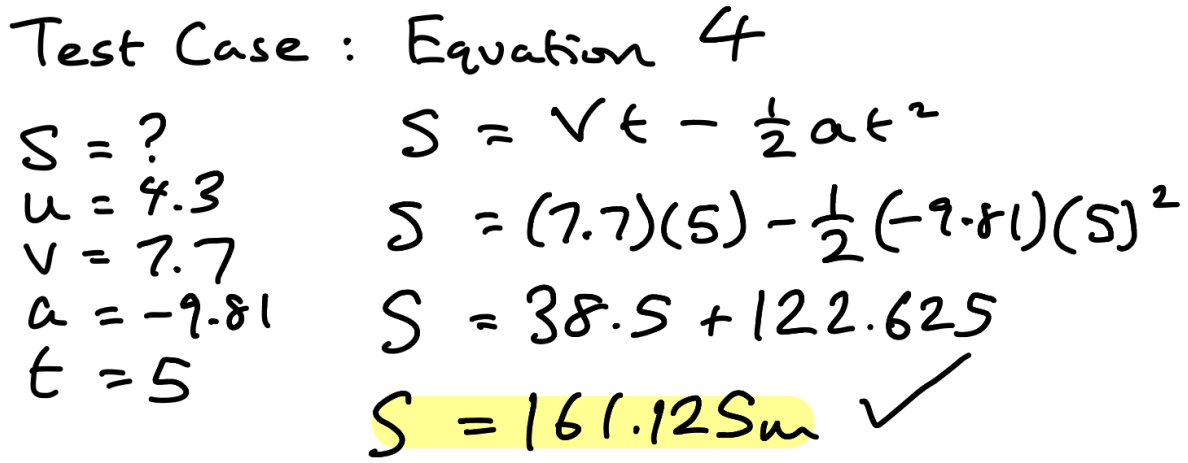
```
Enter numbers for known values, ? for values to find and - for unknown values.
S = 4.8
U = ?
V = 7.7
A = -9.81
T = 1.7

You can use the following equation(s):
1) V = U + AT
2) V² = U² + 2AS
3) S = UT + ½AT²
4) S = ½(U + V)T
Press the number of your desired equation to confirm and continue: 3

S = UT + ½AT²   <-- Your chosen equation

4.8 = (U)(1.7) + ½(-9.81)(1.7)²   <-- Substitute the numbers

4.8 = 1.7U + -14.1754   <-- Multiply UT and ½AT²

18.9754 = 1.7U   <-- Subtract ½AT² on both sides

1.7U = 18.9754   <-- Swap around for simplicity

U = 11.162   <-- Divide T on both sides

The answer is U = 11.162ms⁻¹
```

Test Case 7: Equation 4



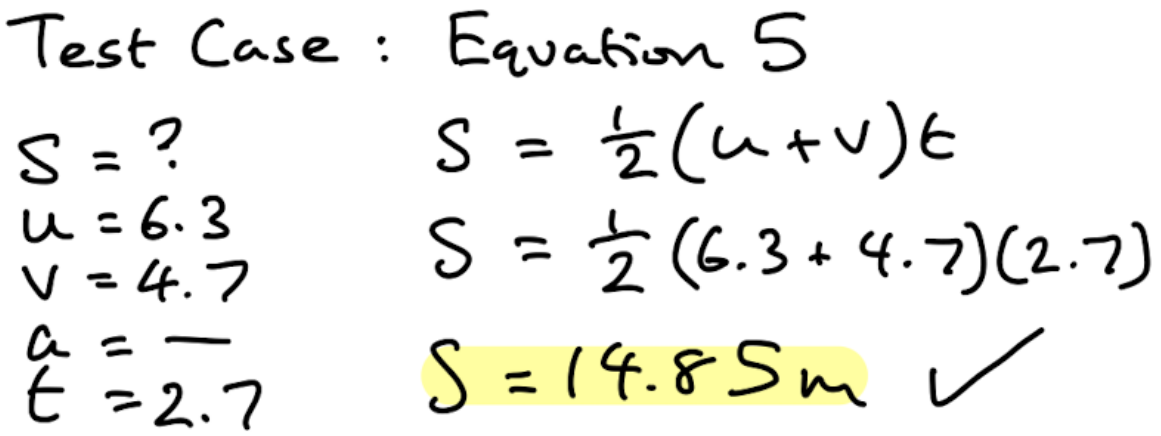

```
Enter numbers for known values, ? for values to find and - for unknown values.
S = 4.5
U = -
V = 3.41
A = -9.81
T = ?

You can use the following equation(s):
1) S = VT - ½AT²
Press 1 to confirm and continue: 1

S = VT - ½AT²   <-- Your chosen equation

4.5 = (3.41)(T) - ½(-9.81)(T)²   <-- Substitute the numbers

4.5 = 3.41T - -4.905T²   <-- Multiply VT and ½A

4.905T² + 3.41T + -4.5 = 0   <-- Rearrange to quadratic equation format

[USING QUADRATIC FORMULA]

The answers are T = 0.671346s and T = -1.36655s
```

Test Case 8: Equation 4



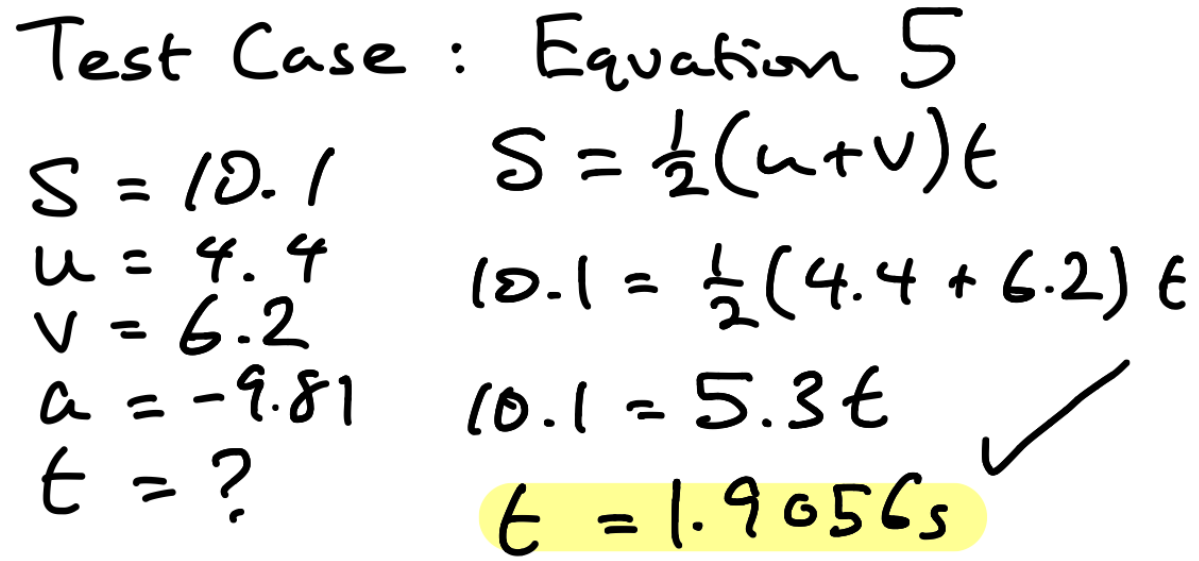

```
Enter numbers for known values, ? for values to find and - for unknown values.
S = ?
U = 4.3
V = 7.7
A = -9.81
T = 5

You can use the following equation(s):
1) V² = U² + 2AS
2) S = UT + ½AT²
3) S = VT - ½AT²
4) S = ½(U + V)T
Press the number of your desired equation to confirm and continue: 3

S = VT - ½AT²   <-- Your chosen equation

S = (7.7)(5) - ½(-9.81)(5)²   <-- Substitute the numbers

S = 38.5 - -122.625   <-- Multiply VT and ½AT²

S = 161.125   <-- Add VT and ½AT²

The answer is S = 161.125m
```

Test Case 9: Equation 5




```
Enter numbers for known values, ? for values to find and - for unknown values.
S = ?
U = 6.3
V = 4.7
A = -
T = 2.7

You can use the following equation(s):
1) S = ½(U + V)T
Press 1 to confirm and continue: 1

S = ½(U + V)T   <-- Your chosen equation

S = ½(6.3 + 4.7)(2.7)   <-- Substitute the numbers

S = ½(11)(2.7)   <-- Add U + V

S = 14.85   <-- Multiply ½(U + V)T

The answer is S = 14.85m
```

Test Case 10: Equation 5




```
Enter numbers for known values, ? for values to find and - for unknown values.
S = 10.1
U = 4.4
V = 6.2
A = -9.81
T = ?

You can use the following equation(s):
1) V = U + AT
2) S = UT + ½AT²
3) S = VT - ½AT²
4) S = ½(U + V)T
Press the number of your desired equation to confirm and continue: 4

S = ½(U + V)T   <-- Your chosen equation

10.1 = ½(4.4 + 6.2)(T)   <-- Substitute the numbers

10.1 = ½(10.6)(T)   <-- Add U + V

10.1 = 5.3T   <-- Multiply ½(U + V)

5.3T = 10.1   <-- Swap around for simplicity

T = 1.90566   <-- Divide ½(U + V) on both sides

The answer is T = 1.90566s
```