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A

A plate (flat) of mass m falling freely in air with velocity v is subjected to a downward gravitational force and an upward frictional drag force due to air. If the drag force F_D is given by eqn 1

$$F_D = \frac{0.3v^2}{500 + (1.2v)^3} - 0.02v \quad \text{---(1)}$$

and the terminal velocity is reached when the drag force equals the gravitational force equals the gravitational, force, that is, $F_D = mg$ - (2) taking the values of m and g to be 3.5kg and $9.8ms^{-1}$ respectively, using a guess value of $v_0 = 0.5ms^{-1}$ and employing fixed point iteration method, develop a MATLAB program to estimate the terminal velocity. Take the absolute Percentage relative error tolerance to be less than or equal to 1E-11.

Solution

$$F_D = \frac{0.3v^2}{500 + (1.2v)^3} - 0.02v \quad -(1)$$

$$F_D = mg = 3.5 \times 9.8 = 34.3 \quad -(2)$$

Equating eqns (1) and (2)

$$mg = 34.3 = \frac{0.3v^2}{500 + (1.2v)^3} - 0.02v$$

Making v^2 the subject of formula

$$34.3 + 0.02v = \frac{0.3v^2}{500 + (1.2v)^3}$$

$$0.3v^2 = (34.4 + 0.02v) * (500 + (1.2v)^3)$$

$$v^2 = ((34.4 + 0.02v) * (500 + (1.2v)^3))/0.3$$

$$v = \sqrt{((34.4 + 0.02v) * (500 + (1.2v)^3))/0.3}$$

From the question

Initial guess value $v_0 = 0.5m/s$

Absolute % relative error, $\varepsilon_a(i+1) \leq 1E-11$

MATLAB PROGAM CODE

```
1-  Command window
2-  Clear
3-  Clc
4-  Close all
5-  format Short g
6-  Syms V
7-  V=0.5
8-  for i=1: inf
1-      iter(i+1)=1;
10-     V(i+1)=((34.3+(0.02*V(i)))*(sqrt(log(V(i))^3))/0.3)^
                                                    0.5;
11-     Ea(i+1)= abs((V(i+1)-V(i))/V(i+1))*100;
12-     If Ea(i+1)<=1E-11
13-     break
14-     end
15-  end
16- table=[iter' v' Ea']
```

The estimated terminal velocity is 304.07 m s-1

Substituting in eqn (1); $f_D = 34.3005 \approx mg = 34.3$,