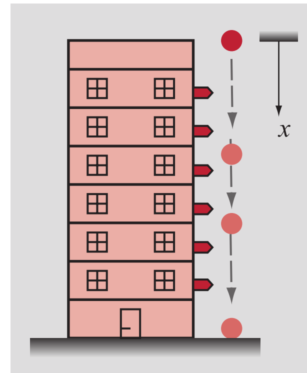
5.6 To measure g (the acceleration due to gravity) the following experiment is carried out. A ball is dropped from the top of a 30-m-tall building. As the object is falling down, its speed v is measured at various heights by sensors that are attached to the building. The data measured in the experiment is given in the table.



x (m)	0	5	10	15	20	25
v (m/s)	0	9.85	14.32	17.63	19.34	22.41

In terms of the coordinates shown in the figure (positive down), the speed of the ball v as a function of the distance x is given by $v^2 = 2gx$. Using linear regression, determine the experimental value of g.

Solution

The equation $v^2 = 2gx$ can be transformed into linear form by setting $Y = v^2$. The resulting equation, $Y = 2gx$, is linear in Y and x with $m = 2g$ and $b = 0$. Therefore, once m is determined, g can be calculating using $g = \frac{m}{2}$. The calculations are done by executing the following MATLAB program (script file):

```
clear all; clc;
x=[0 5 10 15 20 25];
y=[0 9.85 14.32 17.63 19.34 22.41];
Y=y.^2;
X=x;
% Equation 5-13
SX=sum(X);
SY=sum(Y);
SXY=sum(X.*Y);
SXX=sum(X.*X);
% Equation 5-14
n=length(X);
a1=(n*SXY-SX*SY)/(n*SXX-SX^2)
a0=(SXX*SY-SXY*SX)/(n*SXX-SX^2)

m=a1
```

```
b=a0
g=m/2
```

When the program is executed, the following values are displayed in the Command Window:

```
a1 =
   19.7019
a0 =
    1.9170
m =
   19.7019
b =
    1.9170
g =
    9.8510
```

Thus, the measured value of g is 9.8510 m/s^2.