Maple Assignment Fall 1998 Solution

A motorcyclist starts from rest at x = 0 and accelerates uniformly along a horizontal track. The times taken by the motorcyclist to pass photogates located at 10 meter intervals are measured. The positions (measured in m) of the photogates are x = 0, 10, 20, 30, 40 and 50 and, the motorcycle passes these photogates at the times (measured in s) t = 0, 1.63, 2.33, 2.83, 3.31 and 3.79 respectively.

a) Write down an equation for the distance "x" to each one of the photogates from the origin in terms of the time "t" and the constant acceleration "a1". No Maple is needed here.

We expect them to write: x = xo + (1/2)a1*t^2 or something equivalent to this.

b) Using the fit command in Maple as shown in the sample program, find the straight-line fit of the data to the equation in (a) above. What is the acceleration "a1" ?

c) Plot the data and the straight-line fit on the same graph of "x" versus t2 .

```
> d:={0,10,20,30,40,50};t:={0,1.63,2.33,2.83,3.31,3.79};
```

$$d := \{0, 10, 20, 30, 40, 50\}$$

$$t := \{0, 3.79, 2.33, 2.83, 3.31, 1.63\}$$

```
> tt:={0,1.63^2,2.33^2,2.83^2,3.31^2,3.79^2};
```

$$tt := \{0, 8.0089, 10.9561, 14.3641, 2.6569, 5.4289\}$$

```
> with(stats):
> fit[leastsquare[[d,tt],d=a*tt+b,{a,b}]]([[0,10,20,30,40,50],[0,2.6
  6,5.43,8.01,10.96,14.36]]);
```

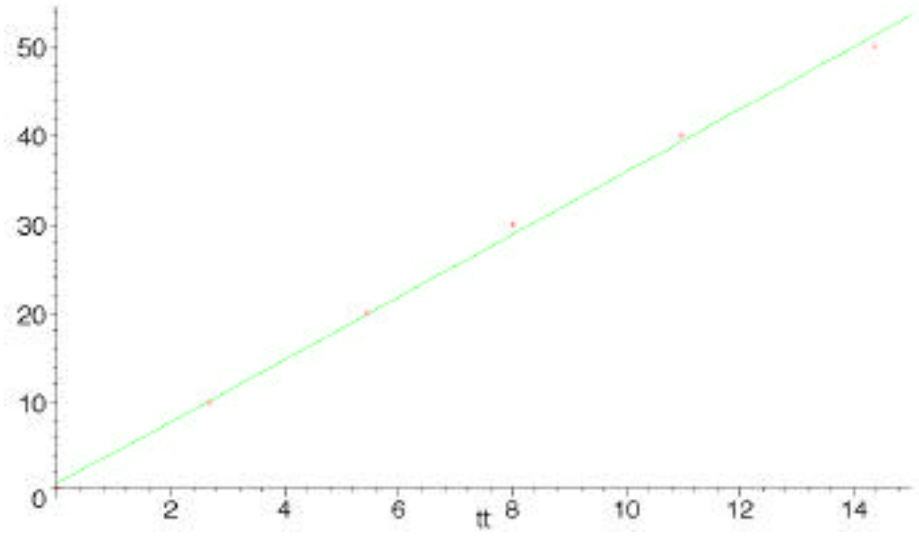
$$d = 3.517680051\ tt + .7162820493$$

The acceleration is a1 = 3.52*2 = , 7.1 m/s^2.

```
> L:=[[0,0],[2.66,10],[5.43,20],[8.01,30],[10.96,40],[14.36,50]];
```

$$L := [[0, 0], [2.66, 10], [5.43, 20], [8.01, 30], [10.96, 40], [14.36, 50]]$$

```
> plot([L,3.518*tt+0.716],tt=0..15,style=[point,line]);
```



A second experiment is conducted on the same motorcyclist traveling with a different constant acceleration "a2" and, the speeds are measured by detectors mounted on posts numbered j = 1, 2, 3, 4, 5, 6. The distance between successive posts is do = 10 m. The first post (j = 1) is located at an unknown position x1 from the origin. Note that v(j) is the speed of the motorcyclist at post number "j". The equation for v2(j) in terms of the speed v(1) at post 1, is given by v2(j) = v2(1) + 2*a'*do*(j – 1) where, v2(1) = 2*a'*x1 .

The speeds (in m/s) are v = 14.0, 18.3, 21.7, 24.6, 27.5 and 30.0 at posts j = 1, 2, 3, 4, 5 and 6 respectively.

d) Using the fit command in Maple as shown in the sample program, find the straight-line fit of the data to the equation v2(j) = v2(1) + 2*a2*do*(j – 1) and find the acceleration "a'" and "x1".

```
> with(stats):
```

```
> fit[leastsquare[[vsq,j],vsq=c1+c2*(j-1),{c1,c2}]]([[196,334.9,470.
  9,605.2,756.3,900],[1,2,3,4,5,6]]);
```

$$vsq = 52.0333334 + 140.5285714\, j$$

So we see that c1 - c2 = 52.03 and c2 = 140.53. Thus c1 =192.6 and c2 = 2*a'*do=140.53. Thus c1 =2*a'*x1= 192.6.

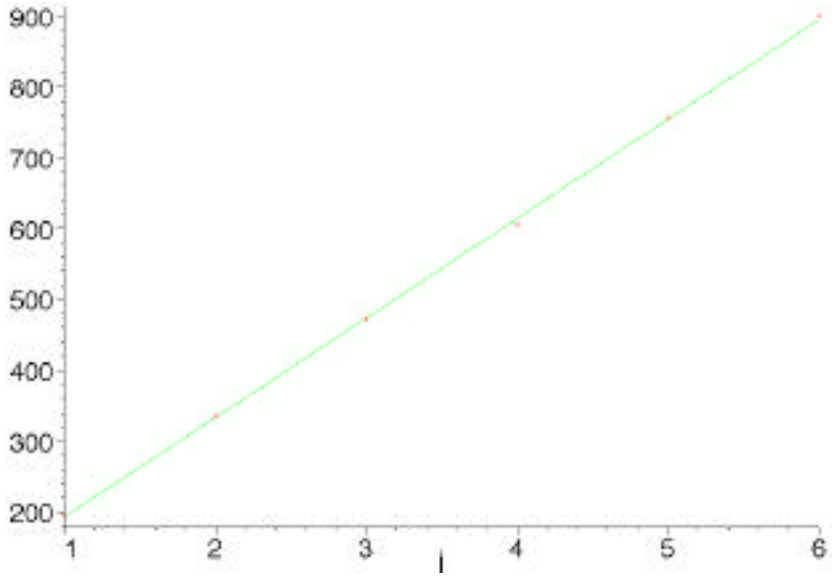
```
> aprime:=140.53/(2*10);x1:=192.6/(2*aprime);
```

$$aprime := 7.026500000$$

$$x1 := 13.70525867$$

```
> vsq:=[[1,196],[2,334.9],[3,470.9],[4,605.2],[5,756.3],[6,900]];
 > plot([vsq,140.5285714*j+52.033333334],j=1..6,style=[point,line]);
```

$$vsq := [[1, 196], [2, 334.9], [3, 470.9], [4, 605.2], [5, 756.3], [6, 900]]$$

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>
```