

PHYS101 Lab Final Exam-Solution Set

Department of Physics

Fall 2014/15 - January 26, 2015

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Questions: The answers to the questions are marked in blue:

1. An object of mass $m = 5\text{kg}$ is moving on a horizontal frictionless surface under the application of net force \vec{F} . The measured position of the object at certain instances of time is given in the table below:

| | | | | |
|------------|------|-------|-------|-------|
| $d(m)$ | 0.00 | 10.00 | 20.00 | 28.00 |
| $t(s)$ | 0.00 | 1.00 | 1.34 | 1.73 |
| $t^2(s^2)$ | 0.00 | 1.00 | 1.84 | 2.99 |

Recall that the kinematic equation for the position of a particle with constant acceleration is given as $d = \frac{1}{2}at^2$ and that the equation of the least square line given as $y = mx + c$, with

$$m = \frac{n \sum(xy) - \sum x \sum y}{n \sum x^2 - (\sum x)^2}, \text{ and } c = \frac{\sum y \sum x^2 - \sum x \sum(xy)}{n \sum x^2 - (\sum x)^2}.$$

Find the equation of the least square line for $d(t^2)$ by using the following table.

| $x = t^2(s^2)$ | $y = d(m)$ | $xy = t^2d(s^2m)$ | $x^2 = t^4(s^4)$ |
|-----------------|------------------|---------------------|--------------------|
| 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | 10.00 | 10.00 | 1.00 |
| 1.80 | 20.00 | 36.00 | 3.24 |
| 2.99 | 28.00 | 83.72 | 8.94 |
| $\sum x = 5.79$ | $\sum y = 58.00$ | $\sum(xy) = 129.72$ | $\sum x^2 = 13.18$ |

$$m = \frac{n \sum(xy) - \sum x \sum y}{n \sum x^2 - (\sum x)^2} = \frac{4 \times 129.72 - 5.79 \times 58}{4 \times 13.18 - (5.79)^2} = 9.54$$
$$c = \frac{\sum y \sum x^2 - \sum x \sum(xy)}{n \sum x^2 - (\sum x)^2} = \frac{58 \times 13.18 - 5.79 \times 129.72}{4 \times 13.18 - (5.79)^2} = 0.15$$

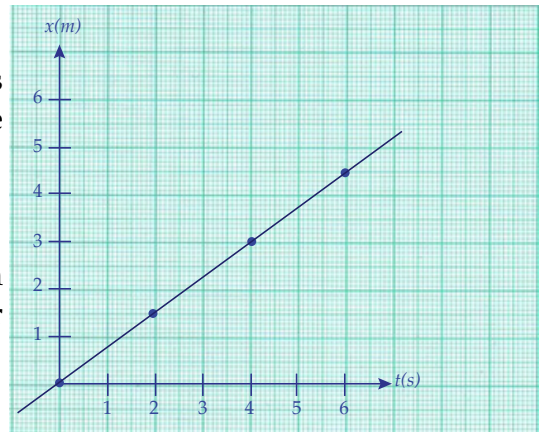
So we get for the least square line:

$$y = 9.54x + 0.15$$

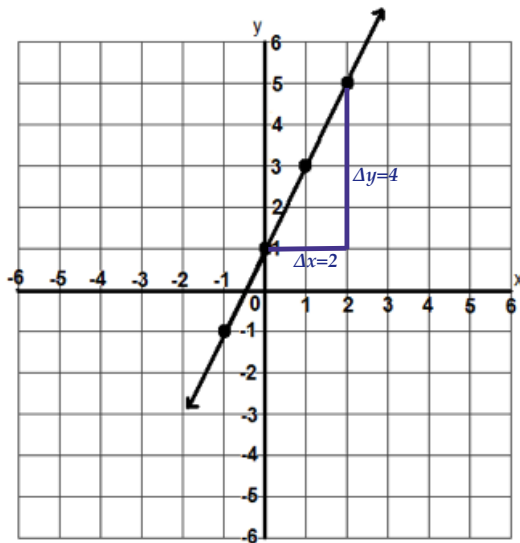
2. In an experiment the motion in x -direction is measured at certain instances of time. The measured values are given in the table below

| | | | | |
|--------|---|-----|---|-----|
| $t(s)$ | 0 | 2 | 4 | 6 |
| $x(m)$ | 0 | 1.5 | 3 | 4.5 |

Please draw the given points into the graph paper at the right and draw the graphics for $x = f(t)$.



3. The graph of the measublue data is given in the figure below. Please find the slope of the line.



The slope can be calculated as

$$m = \frac{\Delta y}{\Delta x} = \frac{4}{2} = 2$$

So we get for the equation of the line

$$y = 2x + 1$$

4. A football player kicks the ball such the balls trajectory is a parabola. The ball hits the ground after 5s at a distance of 25m.

- (a) What is the acceleration of the ball after 2s?

$$\vec{a}(t) = -g\hat{j} = \text{const.}$$

- (b) What is the acceleration of the ball at its highest point?

$$\vec{a}(t) = -g\hat{j} = \text{const.}$$