Marking

labs %	lab test (5%)	20
MasteringPhysics%		6***
Tutorial (group work) %		6
Final project		6
PRS (participation only) %		5**
Surveys (participation in both pre-and post-) %		2****
midterm %		10*
final %		45
Total		100

In order to pass the course, you must pass the written (exam and midterm) part and the lab part. People who failed the course will receive a maximum of 45 final score, even if your calculated grade may be higher than 45.

Assignments

1) Mastering Physics Problems
   (course ID:UBC2007P100)

Please check every week; follow the instructions there.

First assignment is due 9am, Tuesday, Sept 18, 2007.

All future assignments will be posted there.

2) WebCT online surveys (pre- and post-course)

UBC physics Pre-Course Test 1

UBC physics Pre-Course Survey

Due Sunday, Sept 16, 2007.

All labs in Hebb 20; all tutorials in Hebb 10.
Phys100 lab manual available online.

Section 102L1D Tue
Lab: 1400-1530pm Tut: 1600-1650pm

Section 102 L1F Wed
Lab: 1400-1530pm Tut: 1600-1650pm

Section 102 L1H Thur
Lab: 1400-1530pm Tut: 1600-1650pm

Section 102 LC1 Tue
Tut: 930-1020am Lab: 1100-1230pm

Section 102 LG1 Thur
Tut: 930-1020am Lab: 1100-1230pm

Textbooks, office hours and link to Phys 100 section102

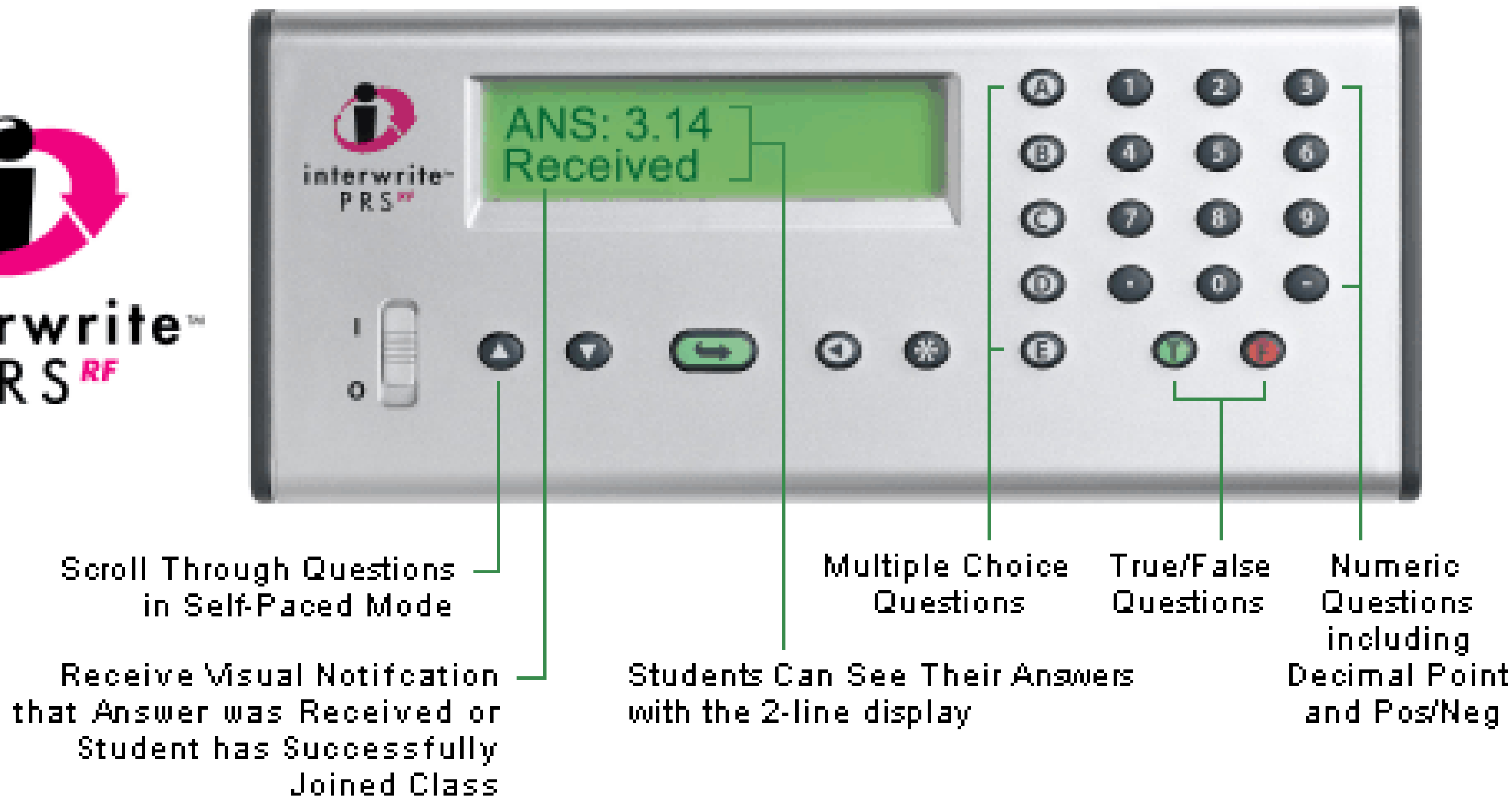
- Vol. 1, Vol 2, and Vol. 4 of Knight
- eText

There will be online instructions on pre-read materials.
Please check before lectures.

My office hours: Monday 200-300pm, Hennings Room 208 resource centre
Or email me for an appointment.

At http://phas.ubc.ca/~phys100, go to “lectures” and click section “102”
for other information.

New PRS RF Clicker



Next Monday, we will start using them.

Phys100 section 102
L2: What to achieve?

1) Understand general physics “laws”

Mathmatically consistent and experimentally tested.

Examples: Energy conservation law, Newton’s law, Coulomb’s law, Faraday’s Law, Maxwell’s Law, Boltzmann’s Law, the Law of quantum mechanics,……

2) Understand the real world using laws/principles

Model the real world using basic laws/principles and analyze quantitatively a physical phenomenon.

Models

- “A model is a simplified description of reality…isolating the essential features, and developing a set of equations that provide an adequate, although not perfect description of reality.”
- “Physics, in particular, attempts to strip a phenomenon down to its barest essentials in order to illustrate the physical principles involved.“

Tools we are going to use

- Mathematics provides an extremely powerful tool to describe theories and to model or simulate reality.

- Experimental techniques including the data acquisition and analysis give us the ways to test theories/models and collect useful information of technologies and sciences.

Examples of basics tools

1) Units and conversion between different units

2) Dimensional analysis

3) Data analysis

---mean values, standard deviations

---curve fitting

---experimental errors and significant figures

Units

- Physical quantities have units. Examples.
- It is very important to use standardized SI units: m, kg, s, N, J, ^oK…. with appropriate prefixes
- We very often see other units such as cm, inches, miles, nautical miles, ft, pounds, ^oC, ^oF, etc.
- Need to convert units in problem sets.

  Examples:
  - 0.5 μm = 5×10^{-7} m.
  - 1 inch = 25.4 mm = .0254 m
- Always check that the units are correct.
- Try to make order-of-magnitude estimates and compare with your calculated results.

Dimensional analysis

Ex: Formula for wavelength of light

A scientist working in the field of applied optics obtained the following formula for the wavelength of light measured by an instrument:

$\lambda = (a^2+b^2/c)/d$

where a, b, c and d are the dimensions (in meters) of the different parts of the instrument.

Q1. Is this formula correct?

1. Yes
2. No
3. Not enough information to decide

Q2. Using an instrument and the formula the scientist obtained 3 different results for the wavelength of light:

1. 0.5×10^{-6}m
2. 0.5 m
3. $.5 \times 10^{-12}$ m

Which one is possibly correct?

Experimental data analysis

- Very important skill: analyzing data.
- Tools: Graphs and statistical methods.
- Relatively simple but powerful: Curve fitting.

Example

Q: Do all objects fall at a same rate?

- Experiment: Release objects from the same height and measure time it takes to hit the ground.
- Repeated measurements
  - show uncertainties of experiments.
  - reduce experimental errors by taking mean value.

Analysis

We can obtain the mean value and the error of the mean value

1) directly from the data (calculator, Excel).

2) using a curve fitting routine on the graph.

- Mean value: $$\mu = \frac{1}{10}\sum_{i=1}^{10} y_i = \frac{1}{10}\left(y_1 + y_2 + \ldots + y_{10}\right)$$

- Errors: σ (standard deviation, or root mean square error, RMSE): $$\sigma^2 = \frac{1}{9 \bullet 10}\sum_{i=1}^{10}\left(y_i - \mu\right)^2$$

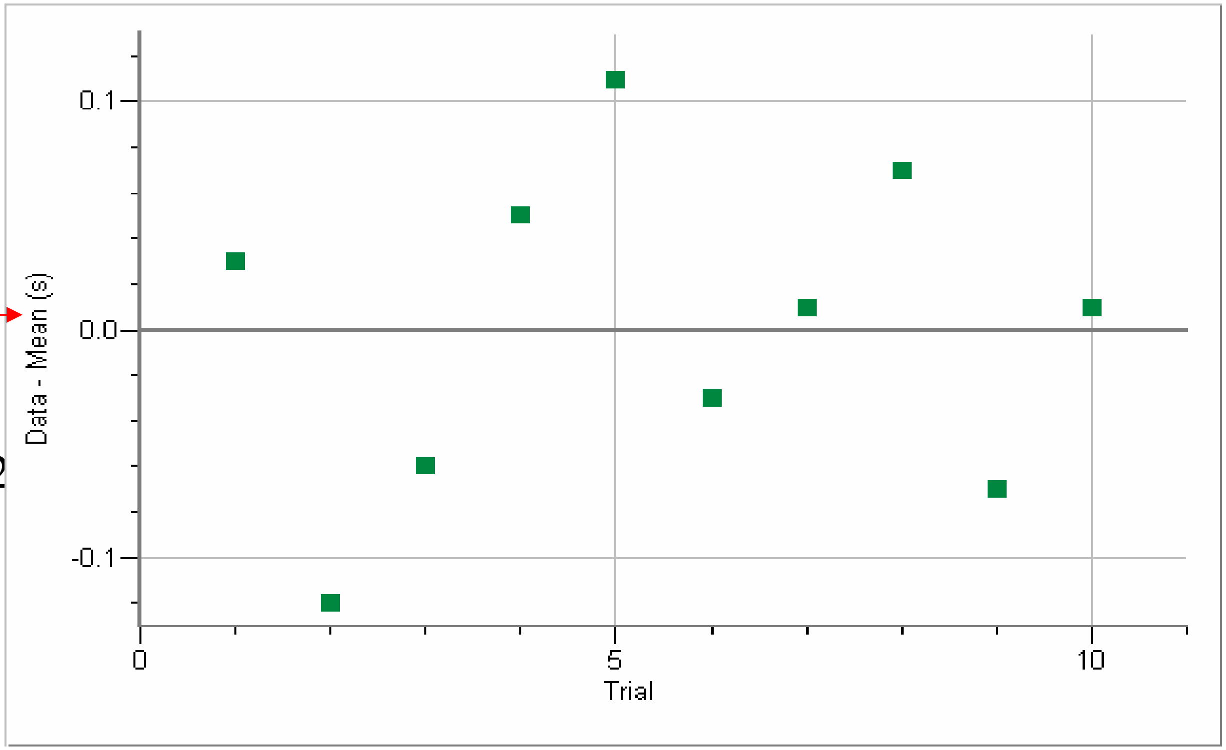
RMSE

- Standard deviations from a arithmetic mean or RMS deviations reflects uncertainties in experiments.
- always positive (due to the square).
- Smaller RMSEs mean smaller uncertainties.

$$Data - Mean:$$

$$(y_i - \mu)$$

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(y_i - \mu)^2$$



Significant Figures

- A distance of 18 cm measured with a ruler is subject to an error of approximately $\pm$ 1 mm. Hence we quote three significant figures: d = 18.0 cm.

- The number of significant figures reflects uncertainties.

- Scientific notations:

  $d = (1.25 \pm 0.01) \times 10^{-6}$ m or (1.25 ± 0.01) μm.

- If you combine quantities, the largest uncertainty determines how many significant figures you quote.

Repeated Measurements

	Data Set	
	Trial	Object A
1	1	2.53
2	2	2.38
3	3	2.44
4	4	2.55
5	5	2.61
6	6	2.47
7	7	2.51
8	8	2.57
9	9	2.43
10	10	2.51
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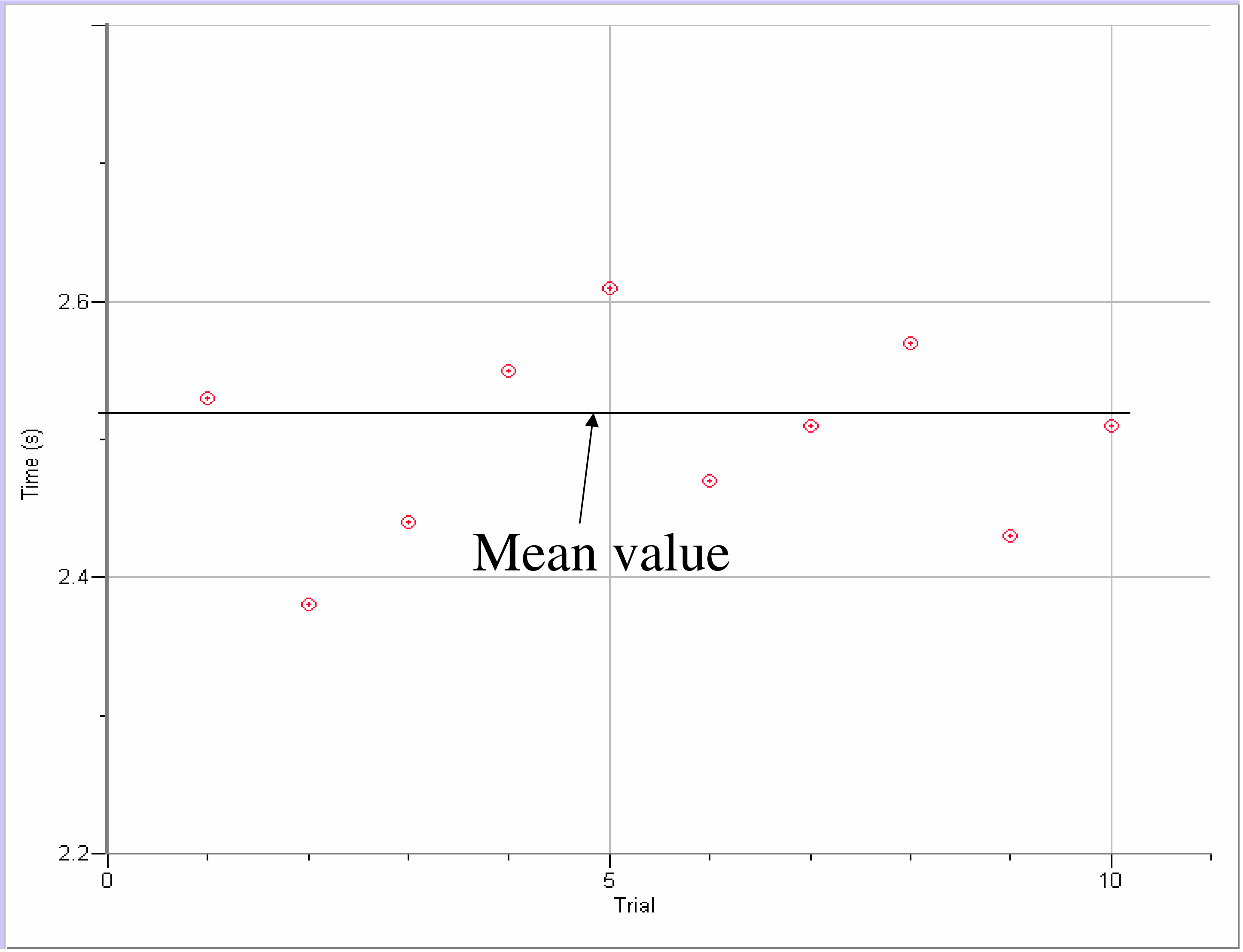
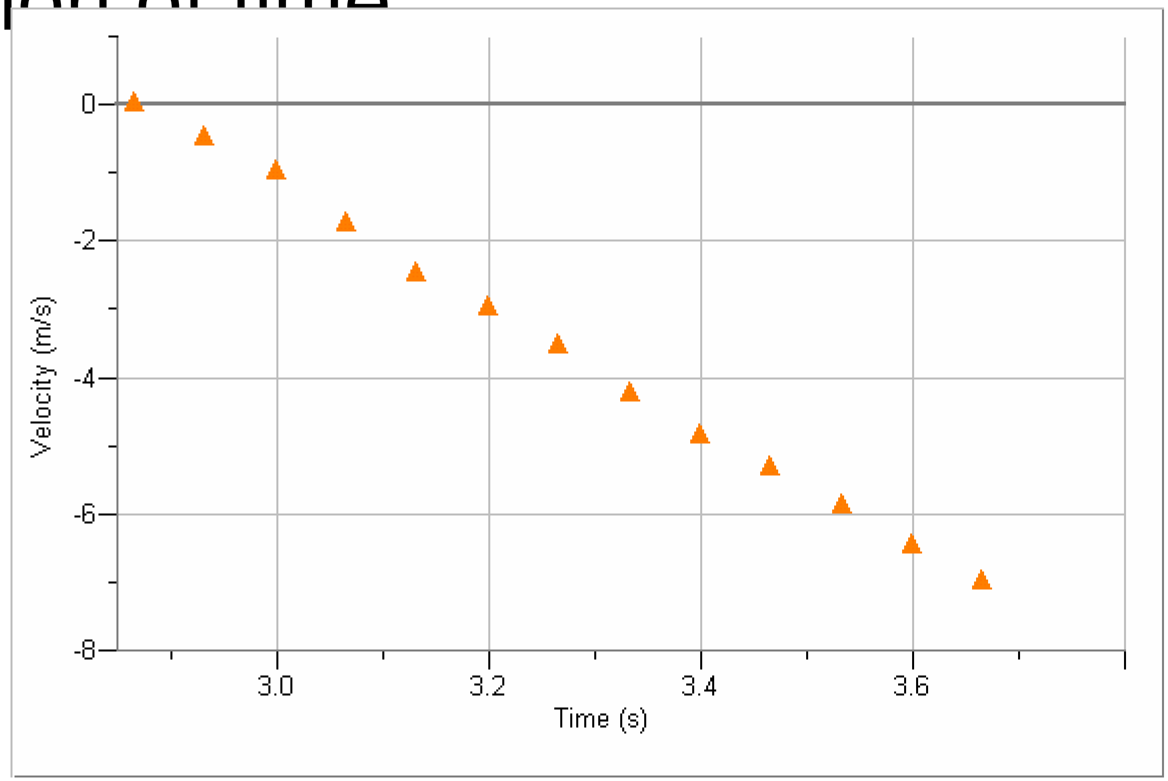


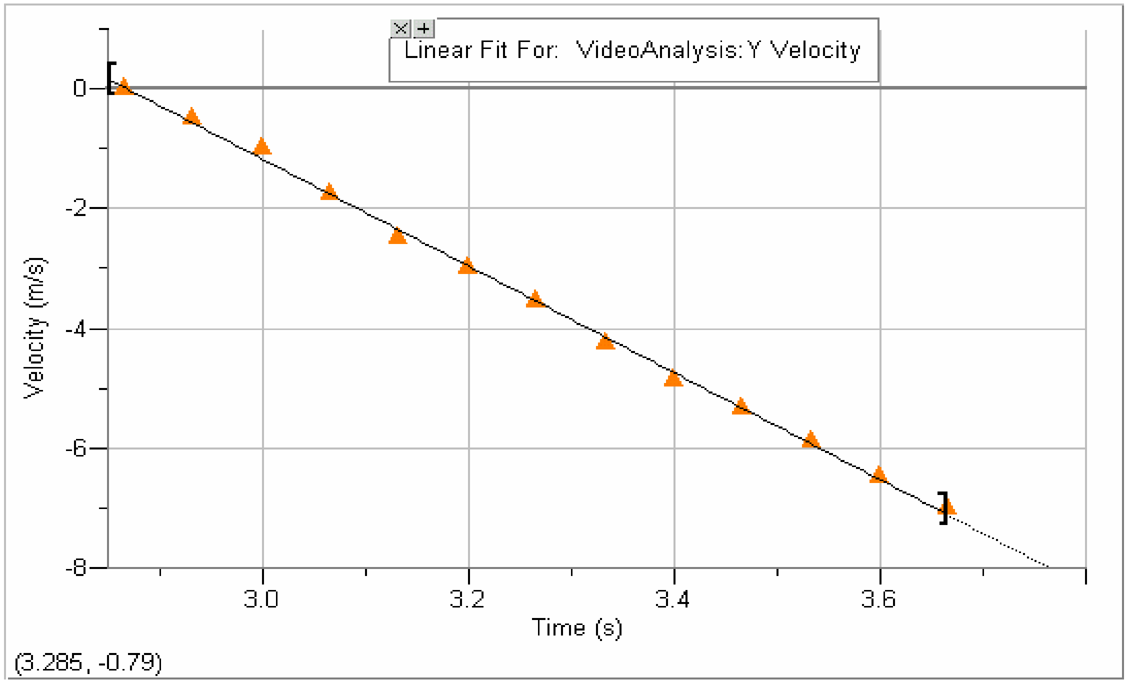
Curve Fitting

- We are often interested in measuring a quantity as a function of another quantity.
- Example: Velocity of a falling object as a function of time.



Example

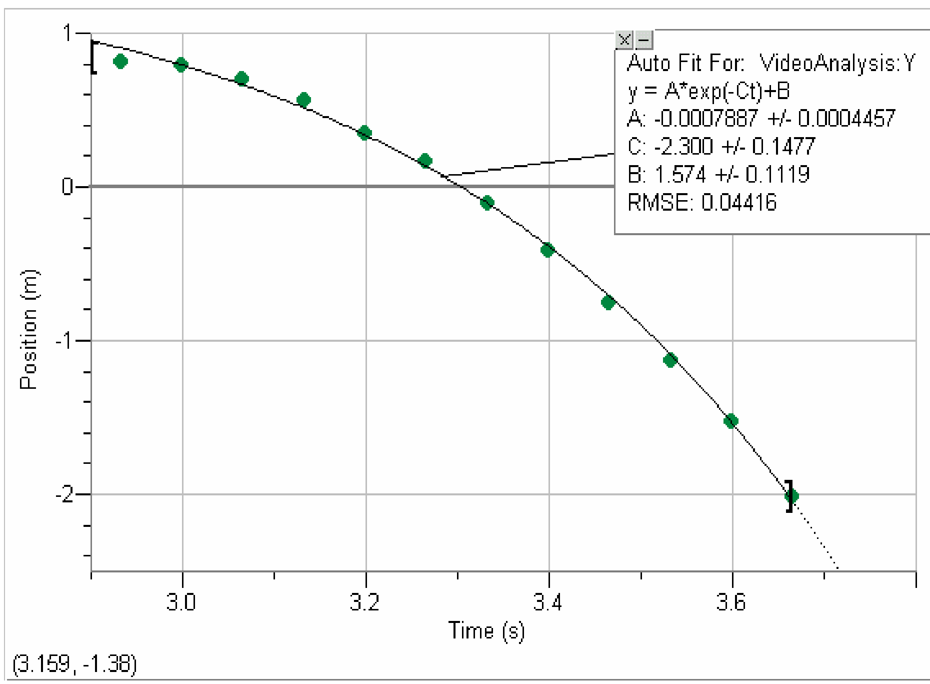
- Hypothesis: Falling objects speed up due to attraction by Earth.
- Data: Velocity increases linearly with time (v is directly proportional to t): v(t) = a • t + b
- Mean value of data not useful here: it's just the average speed.
- Linear regression:
  - yields slope a
  - y-intercept b.
  - Interpretation of a and b?



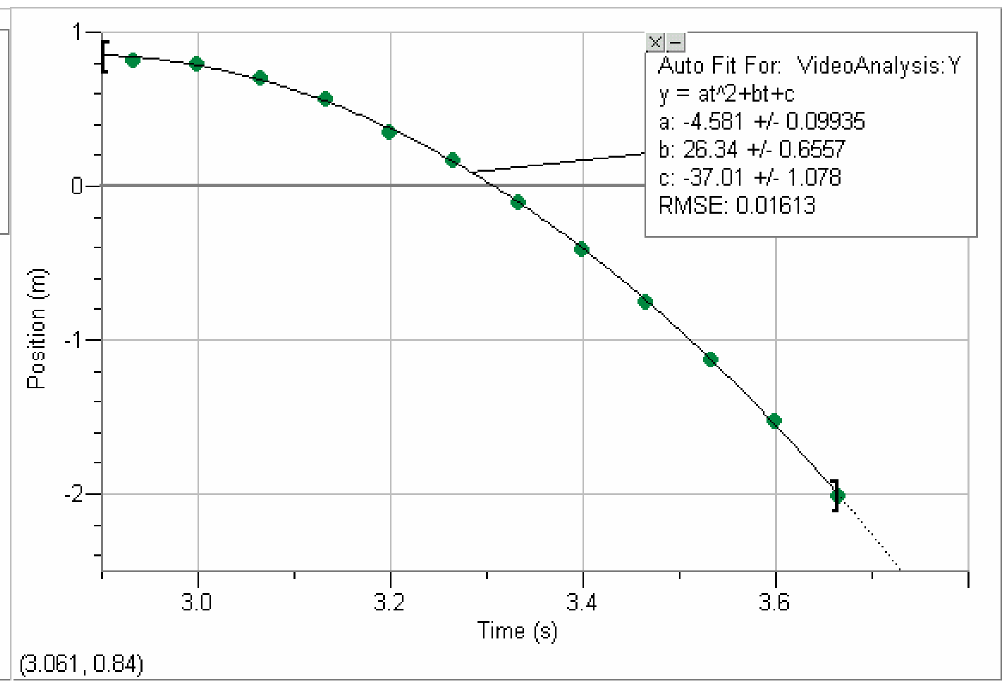
General Curves

- More complicated curves can be fitted.
- Example: position of a falling object as a function of time.
- Correct function?

Exponential function



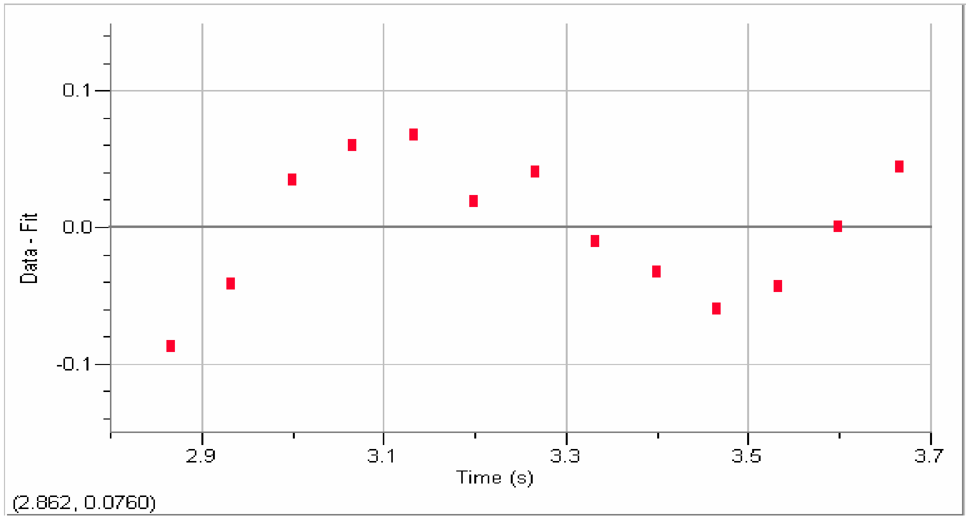
Parabola



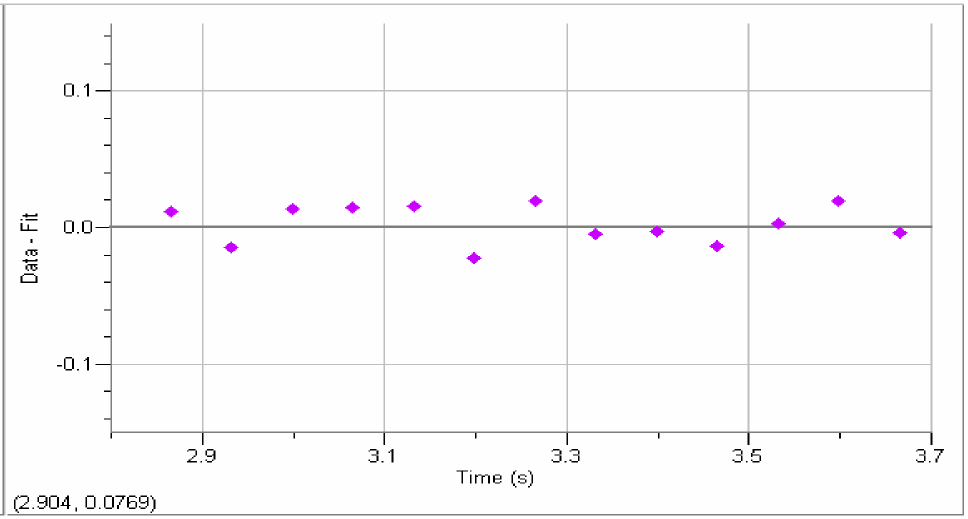
Good Fit Criteria

- Fitting function is reasonable, reflects the physics behind the data.
- RMSE value is minimized. Why RMSE?
- Experimental data randomly distributed around fitted curve.

Data - Fit: Exponential function



Data - Fit: Parabola



Experimental Errors

- Every experiment has uncertainties since no measurement is infinitely precise.
- The knowledge of experimental error is essential for the use of results of a measurement.
- The uncertainty or error is reflected in the way we quote results: The last digit is allowed to change when going from the upper limit to the lower limit of our results.