

The acquisition of science competencies using ICT real time experiments COMBLAB

**PENDULUM EXPLORATIONS: BETTER CHOICE?**

One of the ever-popular favourites in the playground is the child swing. Kids love to ride the swings at the playground. Given the following situation: Ann (20kg) and Tom (30kg) argue in front of two child swings (Length 2.4m and 2.5m), who is able to swing faster. Ann worries about her less weight and wants to take the longer swing. Tom agrees assuming that his much greater weight will easily outplay the difference of 10cm according to the length of the two swings.

What is your advice for Tom?

***Before going on, write down your prediction, explain your reasoning and how you could design an experiment to give an appropriate advice to Tom!***

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**A. Preparation**

- 1) Make a pendulum by tying a 100-cm string to a mass. Hold the string in your hand, let the mass swing and find out the time needed for one oscillation by only observing with your eyes.
- 2) Try a different mass on your string. Does the period seem to depend on mass? Discuss the question in your group.
- 3) Does the period seem to depend on the length of the string?
- 4) Does the period seem to depend on the amplitude?

***Describe what parameters seem to influence the period of the oscillation:***

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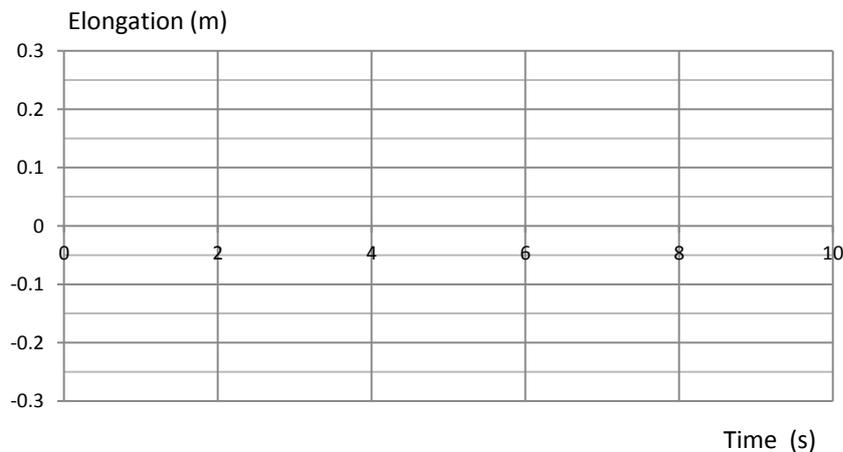
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### B. Observing the experiment and start data collection

#### Preliminary experiments:

- 1) Attach the string to a horizontal rod fixed to a stand and adjust the motion sensor to collect data on distance as a function of time for the swinging pendulum.
- 2) Use 10 seconds for data collection time and collect 20 samples per second.
- 3) Try to predict how the pendulum bob will move and plot the movement of the pendulum bob in the position-time diagram below even before you start the data collection. Elongation zero is the position for the pendulum bob at rest.



- 4) Hold the mass from about  $10^\circ$  from vertical and release. (For a pendulum that is 100 cm long, that corresponds to pulling the bob only about 15 cm to the side.) Make a plot of the movement of the bob with a different colored pencil in the diagram above. Finally, compare your plots and find out the differences.

***Was your prediction correct? What was wrong?***

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### C. Modeling the situation in the laboratory

- 1) Analyze the scatter plot of position vs. time and determine the period of oscillations from the graph.

***Describe how you determined the period of oscillations:***

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- 2) Repeat the data-collection for initial angles of approximately 15 and 20 degrees and explore the effect of the initial angle on the pendulum period.

**Complete the following sentence:**

The initial angle seems to have .....

- 3) Discuss with your group members, which factors basically could influence the period of the pendulum and the velocity of the mass.

**Write down the results of your discussion:**

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- 4) Conduct appropriate controlled experiments which enable you to make final conclusions according to the question which factors affect in what way the period of pendulum oscillations.

**Complete the following sentence:**

The following factors influence the period of the pendulum oscillations: .....

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**D. Show your results**

- 1) Based on your data and observations, what can you conclude about the **effect of the initial angle** on the pendulum period? Do these results agree with your prediction? If not, describe any errors in your reasoning.

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- 2) Based on your data and observations, what can you conclude about the **effect of the pendulum mass** on its period? Do these results agree with your prediction? If not, describe any errors in your reasoning.

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- 3) Based on your data and observations, what can you conclude about the **effect of the length of the pendulum** on its period? Do these results agree with your prediction? If not, describe any errors in your reasoning.

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F1) Explain in your own words which parameters influence the period of a pendulum ?

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1) Comment on the following statements:

a) The longer the pendulum, the more oscillations per second we can observe.

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b) The smaller the mass of the pendulum bob, the more oscillations per second we can observe.

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### E. Summary

Let us look back at our initial question: What should Tom do?

Explain what you recommend Tom and show your reasoning!

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#### Further questions:

a) It was easy for our group to design our own experiment and find an appropriate solution to the given task. Tick a number 1, 2, 3, 4 or 5 (1: strongly agree 5: strongly disagree).

Please explain your answer:

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b) The guidance in the worksheet helped us to perform the experiment and analyze the data in order to understand the physics behind and apply physics concepts to everyday life situations. Please, tick a number 1, 2, 3, 4 or 5 (1: strongly agree 5: strongly disagree).

Please explain your answer:

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