Physics 7B

DLM 9 Overview

Unit 5: Newtonian Model

Model/Approach: Newton's 2^{nd} Law Model

Act-5.1.3 Newton's 2^{nd} Law Model vs Conservation Models. FNTs of DLM 7 (~50 min)

Learning Goals:

- Get practice using Newton's 2^{nd} law approach to make sense of the behavior of the real behavior of dropped objects
- Develop understanding of the differences between a Newtonian 2^{nd} law approach and a momentum conservation approach and how these relate to energy conservation
- Get practice figuring out which model/approach can be used to answer particular questions about various phenomena.

Model/Approach: Newton's 2^{nd} Law Model

Act-5.1.4 Making sense of motion from graphs and Newton's 2^{nd} law (~70 min)
DLM 8 FNTs

Learning Goals:

- Get practice using Newton's 2^{nd} law approach to make sense of the behavior of the real behavior of dropped objects
- Practice extracting meaning from velocity and acceleration graphs

Announcements

Be sure to use the Physics 7B webpage periodically for new information and material.

Newton's 2nd Law Model vs Conservation Models

A) What kinds of questions can the various models answer?

In Your Small Group discuss the following and put your responses on the board

Your DL instructor will assign each group one of the following tasks:

(Concerning DLM 7 FNTs, #'s 6-8)

1) **Group 1:** a) Decide on your group's answer to **FNT 7**, redraw each graph and explain next to it how you know whether the x-component of the acceleration is positive, negative, or zero.

   b) In each case, is the x-component of the velocity positive or negative?

   c) Does a negative acceleration always mean a decreasing speed? Come up with a relationship between the sign of acceleration and the change in velocity and write this on the board.

2) **Group 2, 4, & 5:** For your group's assigned scenario of **FNT 8**, make a column of three graphs with the top most being position vs. time and the bottom most acceleration vs. time. Line up your graphs so that a vertical line through all three would correspond to the same instant in time in each.

3) **Group 3:** Go to the boards of the SGs working on **FNT 8** and answer **FNT 9** by writing the appropriate equation and naming which model is used. Check the group's graphs and assign them a "grade" for their work; seriously do this.

4) **All groups:** What kinds of questions can the Newtonian 2nd Law Model answer that the conservation models can not answer? Explain why. (Use what you have learned from lecture and/or the Course Notes to help you answer this question.) Give two specific examples.

Whole Class Discussion

Making Sense of Motion from Graphs And Newton's 2nd Law

A. DLM 08 FNT 1

Discuss your group's response to the following prompts and then put your responses up on the board:

1) Describe in words the motion of the object whose velocity is shown in the graph. Practice walking this graph for the whole class presentation.

2) Explain exactly how you can determine the acceleration from a graph of velocity vs time.

3) Construct an acceleration graph from the velocity graph shown in this FNT.

4) Describe in words how the net force on this object changes from one lettered point to the next.

Whole Class Discussion

B. DLM 08 FNT 2

Discuss how you can be sure that the values of the acceleration you determined from the velocity graph in regions (a) and (c) are the correct values according to Newton's 2nd law. Show this "check" on the board. Note: you do not have to put the graph on the board.

Whole Class Discussion

C. DLM 08 FNT 3

Discuss your group's responses to all parts of this FNT and respond to the following prompts:

1) Put your responses to part (a) on the board.

2) Put only the **different** force diagrams on the board for part (c) labeled with all the points each diagram applies to. Make sure everyone in your group understands part (d) and is prepared to share with the class.

3) Make sure everyone in your group understands part (e) and is prepared to share with the class.

Whole Class Discussion

D. DLM 08 FNT 4

Discuss this FNT in your group and put a **concise** explanation on the board.

Whole Class Discussion

E. DLM 08 FNT 5

Discuss this FNT in your group and put the two force diagrams on the board and make sure everyone in your group understands these and is prepared to share with the class.

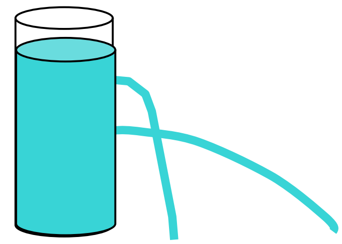
Whole Class Discussion

FNTs:

Introduction to the Steady-State-Energy Model

Note: You will need to read your course notes to be able to answer the following.

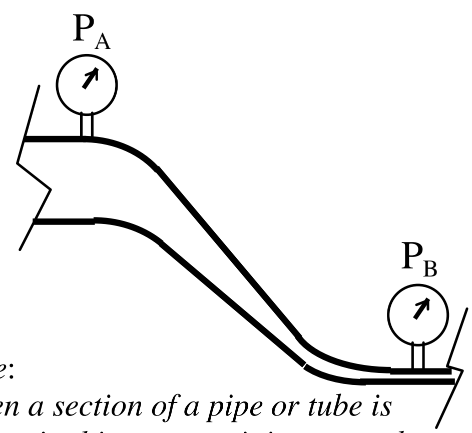
1) Phenomenon: Fluid squirting out of a hole.



a) Picture a bottle filled with water and two holes have been punctured in the sides, one hole a distance above the other. Why does the fluid squirt out of the holes differently?

b) You might have noticed that when you place your thumb in front of the opening of a hose squirting out water the water will squirt out farther. This is similar to a another phenomena: when water is descending from a faucet it will narrow as it falls. Come up with a general rule to explain why these phenomena are similar.

2) Phenomenon: Fluid flowing through a pipe of changing height and size.



Consider the fluid flow situation shown in the diagram. A fluid flows through the section of pipe shown with **minimal dissipation of energy** (very little friction) in the direction of A to B. (The pipe continues in both directions, but only this section is shown in the diagram.) At position A the pipe has cross-sectional area A_A and is at height y_A. At position B it has area A_B and is at height y_B.

There are several interesting questions we might ask about this situation. For example, what can we say about the pressures at points A and B?

Question 1: Is the pressure at point B less than, equal to, or greater than the pressure at point A?
Question 2: Does the pressure difference from A to B depend on which way the fluid is flowing?

Note:
When a section of a pipe or tube is shown in this manner, it is assumed that it is part of a larger fluid circuit, which probably has a pump to keep the fluid flowing continuously. The fluid is assumed to totally fill the tube without voids.

You will return to answer these questions in part 2b which is on the other side.

Continued on the next page…

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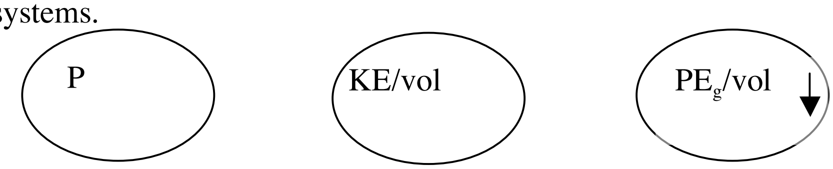
2) (Continued from previous page)

a) You will use what you already know about energy systems and how you can apply conservation of energy. But now, instead of focusing on changes in energy **over time**, we are going to focus on changes in energy density between **positions** along the path that the fluid flows. You will apply the **Energy Density Model** to fluid flow phenomena *to* ***understand*** what is going on in this situation–***to make sense of it***. Your goal is ***to model*** this particular phenomenon using appropriate representations, so that you can readily answer questions such as those suggested in the previous paragraph.
There are three energy-density systems. We represent these exactly the way we represented energy systems.



ΔP_{AtoB} = ??? $\Delta KE/Vol_{AtoB}$ is pos $\Delta PE_g/vol_{AtoB}$ is neg

$$\Delta P_{AtoB} + \Delta KE/vol_{AtoB} + \Delta PE/vol_{AtoB} = 0$$

In this equation we are assuming there are no other energy systems involved and that there are no sources of energy.

Analyze this situation using the energy density model and put it on the board.

Suggestions:

(i) What parameters/indicators determine the magnitude of the various energy-density systems in going from A to B?

(ii) Decide which energy-density systems you absolutely know increase or decrease in going from A to B and show these with vertical arrows on your diagram. How do you know this?

(iii) (a) How does conservation of energy constrain the changes in the various energy-density systems?
(b) What are the implications of this for the change in pressure?

b) Use your analysis from part (a) to now answer the two questions posed on side one.