MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01T **Fall Term 2004**

Problem Set 1: Kinematics: One Dimensional Motion, Velocity and Acceleration Solutions

Available on-line September 8; Due: September 14 at 4:00 p.m.
Please write your name, class section, table and group number, and the name of the instructor on the top right corner of the first page of your homework solutions. Please place your solutions in the box labeled with your instructor and your table number.

Sept 8
Hour One: Introduction to TEAL
Reading: YF 1.1-1.6

Hour Two: Pre-Test

Sept 10
Hour One: Kinematics: One Dimensional Motion, Velocity and Acceleration
Reading: YF 2.1-2.6

Problem Set 1: Due Tues Sept 14 at 4:00 pm.

Sept 13
Hour One: Experiment 1: Introducing Data Studio; One Dimensional Motion, Velocity and Acceleration; Error Analysis and Statistics.
Reading: Experiment 1

Hour Two: Problem Solving Session 1: One Dimensional Motion
Reading: YF 2.4-2.6

Sept 15
Hour One: Kinematics: Two Dimensional Motion, Velocity and Acceleration
Reading: YF 3.1-3.3

Hour Two: Experiment 2: Projectile Motion
Reading: Experiment 2

Sept 17
Hour One: Problem Solving Session 2: Projectile Motion
Reading: YF 3.3
Problem Set 2: Due Tues Sept 21 at 4:00 pm.

Problem 1: ***Estimation (see section 1.10 in course notes)***

In a recent publication of Nature, Australian scientists determined that during the last ice age (22,000 to 19,000 years ago) the sea level reached its low point, 425 to 440 feet below the present level due to the change of sea water to glacial ice.

a) What approximate volume of ice would this correspond to?

b) If this additional ice were evenly divided between the polar ice caps, estimate how far the northern hemisphere ice sheet would extend southward.

Problem 2: ***Kinematics (see chapter 2 in course notes)***

Two stones are released from rest at a certain height, one after the other.

a) Will the difference in their speeds increase, decrease, or stay the same?

b) Will their separation distance increase, decrease, or stay the same?

c) Will the time interval between the instants at which they hit the ground be smaller than, equal to, or larger than the time interval between the instants of their release?

Problem 3: ***Radians and Estimation (see section 1.11 in course notes)***

a) Hold a dime at arm's length. What angle in radians is subtended by the diameter of the dime?

b) Using your result from part a), estimate the length of the infinite corridor at MIT. In order to do this, choose a reference height at one end of the corridor and estimate its height. Then go to the other end of the corridor and measure what fraction of the diameter of the dime corresponds to your reference height. You can now calculate the length of the corridor by using similar triangles. The length is published by MIT. Can you find the published value?

c) Now use your dime and wait until the moon is out (the moon is new on Sept. 14 so you need to make a measurement as quickly as possible on the quarter moon) to try an estimate the angular diameter of the moon. If you could not measure the moon, recall that during a total eclipse, the moon is almost exactly the same angular diameter as the sun. If it takes the sun two minutes to set (ignore atmospheric distortions), what is the angular diameter of the moon? Once you have this estimate, what additional information would you need in order to estimate the mass of the moon? Make some estimates regarding these additional quantities and then estimate the mass of the moon. Look up the actual value and compare it with your estimate. How did you do?

Problem 4: ***Graphical Analysis: Two Bodies, One Dimensional Motion (see Chapter in course notes)***

A person starts running with a constant velocity trying to catch a streetcar that is initially $2.0 \times 10^1 m$ away from a person and has just started to accelerate from rest with a constant acceleration of $0.9\, m/s^2$. The person runs just fast enough to catch the streetcar and hop on.

a) Describe the strategy you have chosen for solving this problem. You may want to consider the following issues. What does a sketch of the problem look like? What type of coordinate system will you choose? What information can you deduce from a plot of distance vs. time for both the person and the streetcar? What conditions must be satisfied when the person just catches up to the streetcar

b) Now show all your work in answering the following three questions. How long did the person run? What is the velocity of the person when they just caught up to the streetcar? How far did the person run?

Problem 5: ***Experiment One Pre-Lab Question Monday September 13 (read Experiment 1)***

For each of the following three multiple choice questions, briefly explain your reasoning.

a) Square Wave (derivative)

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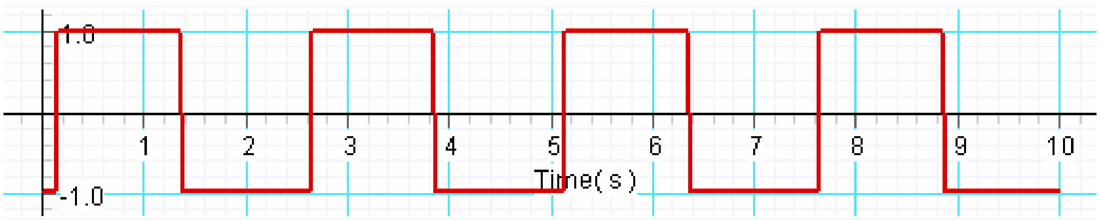
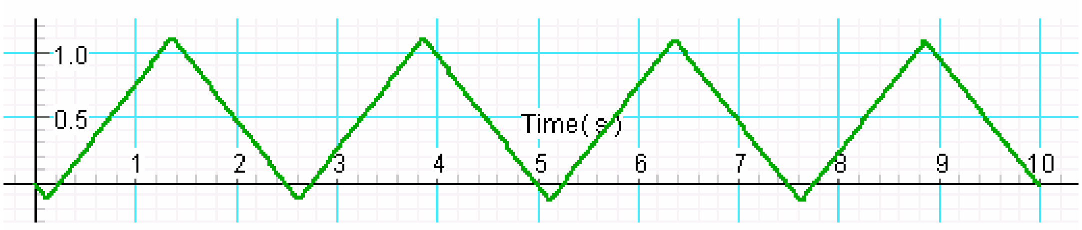


Which of the following graphs below is the derivative of the above square wave ?

1)

Error!



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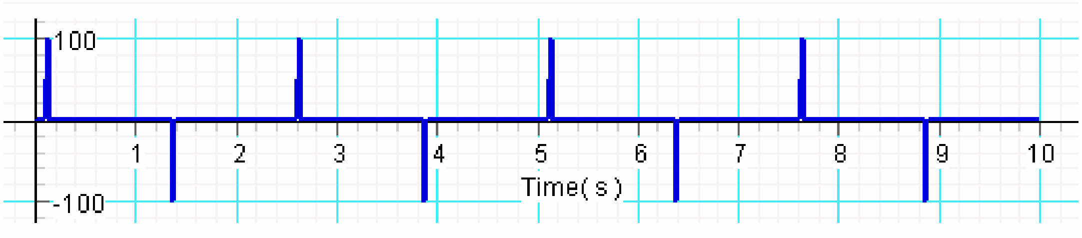

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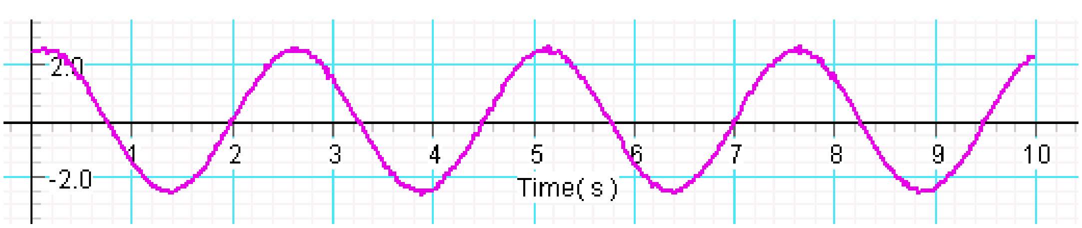

b) Sine Wave (integral)

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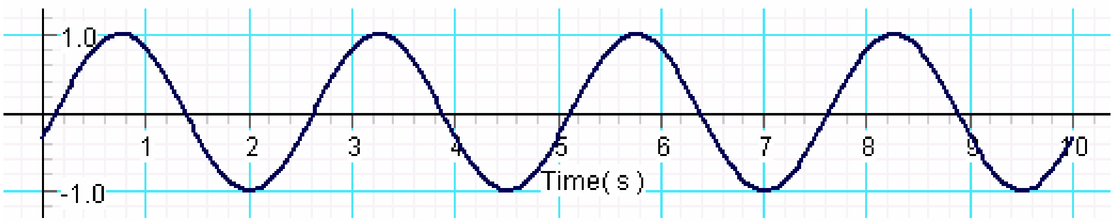
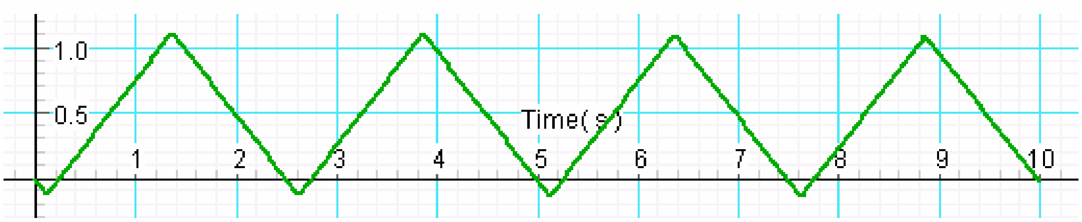


Which of the following graphs below is the integral of the above sine wave ?

1)

Error!



2)

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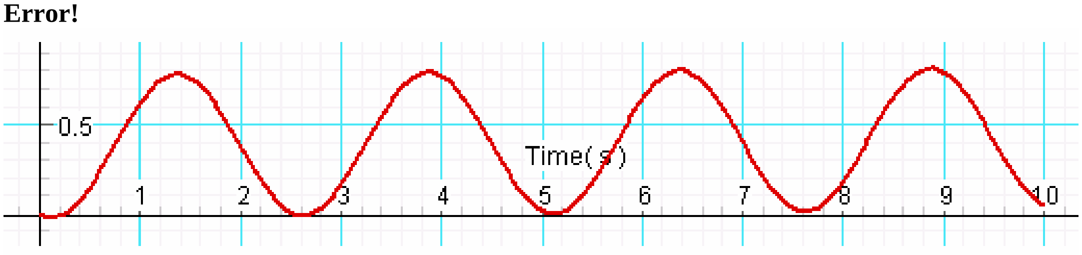

3)

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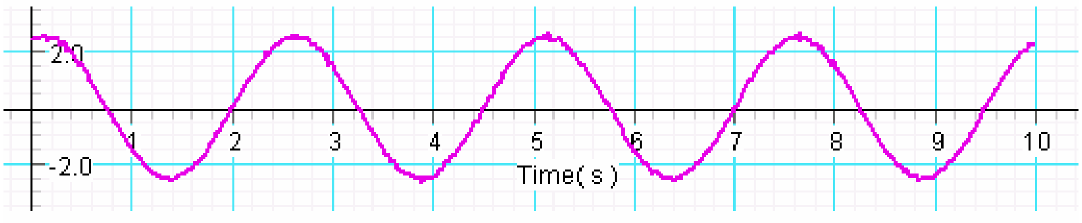

c) Triangle Wave (derivative)

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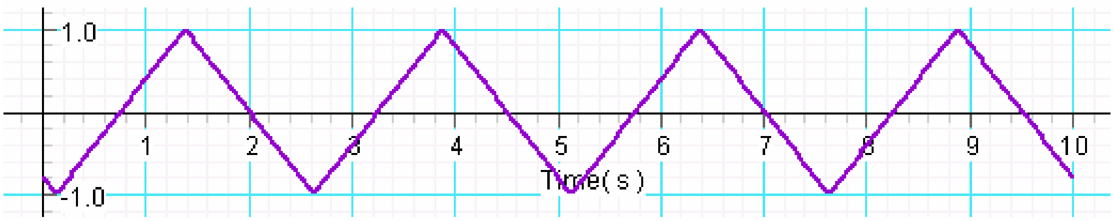
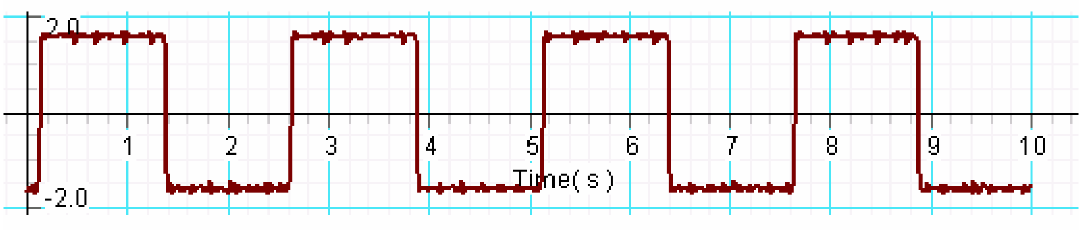


Which of the following graphs below is the derivative of the above triangle wave?

1)

Error!



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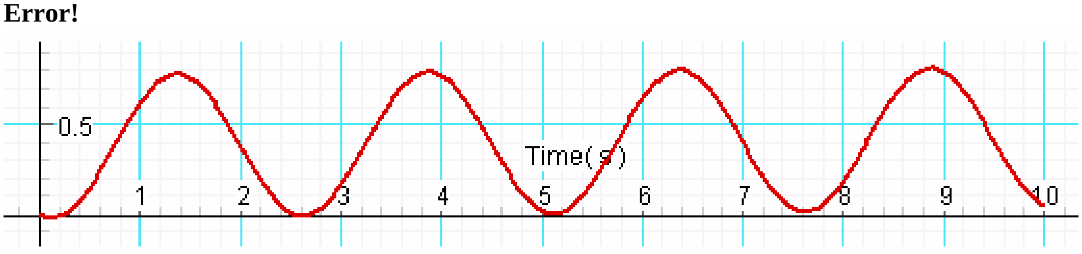

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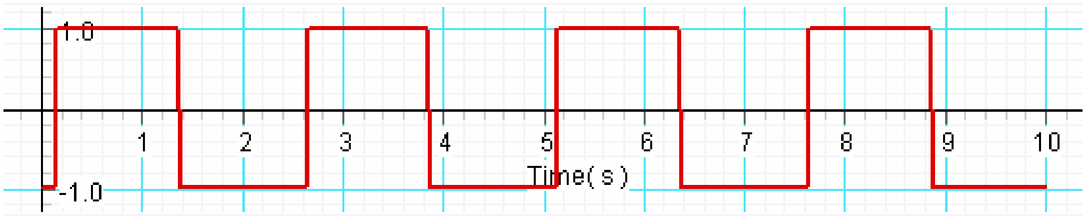

Problem 6: ***Experiment Two Projectile Motion Pre-Lab Question Wednesday September 15 (read Experiment 2)***

Read Experiment 2 before you begin this problem.

In the Experiment 2: Projectile Motion, a ball of diameter is allowed to roll through a tube that makes an angle θ with respect to the horizontal. The ball leaves the tube at a height h above the ground. Just as it leaves the tube, the ball passed a photogate which measures the voltage across a photo-transistor. The width of the graph of voltage vs. time at half maximum is ΔT. The ball has diameter D. Find an expression in terms of the given information for the horizontal distance the ball traveled when it just hits the ground.