Physics 7AW Homework 3 — Theory of Motion in 1D

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Physics 7AW - Introduction to Mechanics, WAT 2020 edition

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1 From what height H would you have to drop an object if you hear it hit the floor a time T after dropping it? Assume speed of sound is v_s

Compare this to problem 1 in homework 2. How are they different? How are they similar?
(For your convenience I will put that problem at the bottom of this homework)

2 A red car and a blue car are at a stop light. When the light turns green, the red car accelerates with acceleration a_R and the blue one accelerates with acceleration a_B. At what time T is the distance between both cars L?
Assume $a_R > a_B$
Note: This problem is to practice using the Big 4 equations but notice now we are not concerned with vertical motion.

3 A particle moves such that its x and y position is defined by

$$y(t) = -3t^2 + t + ln(1738) \tag{1}$$

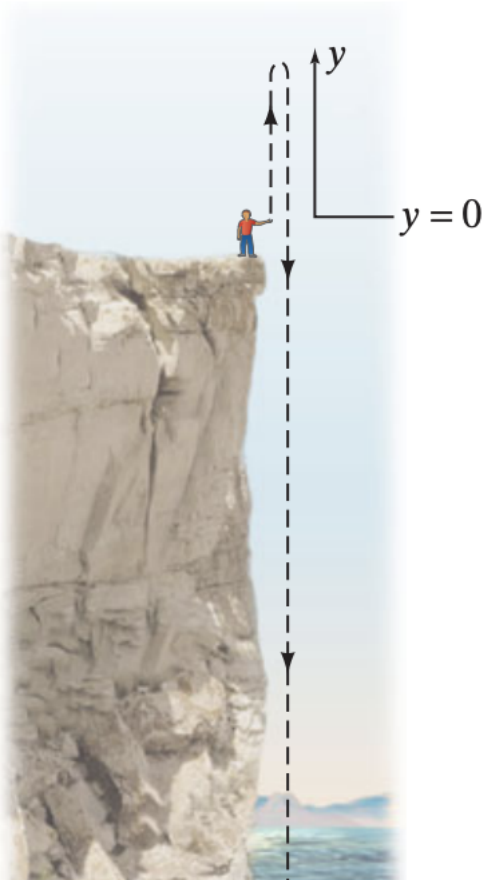
$$x(t) = cos(wt) + e^{(-3wt)} \tag{2}$$

Find
a) $\mathrm{v}_x \, and \, v_y$
b) $a_x \, and \, a_y$
c) What is the speed at t = 0?
d) For what value of t is the particle at its highest position?
e) What is |v| and |a| at t = 0?

Note: This is the only question about the "new" material today. I tried to make it not so bad so we can at least start practicing for 2D motion which is really just doing two 1D motion problems :)

4

Recall the last problem from Homework 2 where a person is on top of a cliff of height H and they throw an object straight up with an initial velocity v_0 where the object then falls down to the bottom of cliff (see figure).



Neglect the size of the person in the photo

a) What is the max height the object reaches?

b) At what velocity does the object hit the floor?

c) How long does it take to hear the object hit the ground? (Of course assuming you hear it... despite not knowing how high the cliff is)

Note: You have solved a problem similar to this one. You found the time it took to hit the ground but with values instead of variables. I could ask you several things like "find T, or H, or v" but its all really the same idea. I give you some information X and you have to use the equations to give me information Y. But with the same information X you can give me Z and information ω. This exercise is to practice finding different information

Do either exercise 5 or 6. You do not have to do both but I would recommend you at least try them both. 5 At t = 0 an object is released from rest at the top of a tall building. At the time t_0 a second object is dropped from the same point.

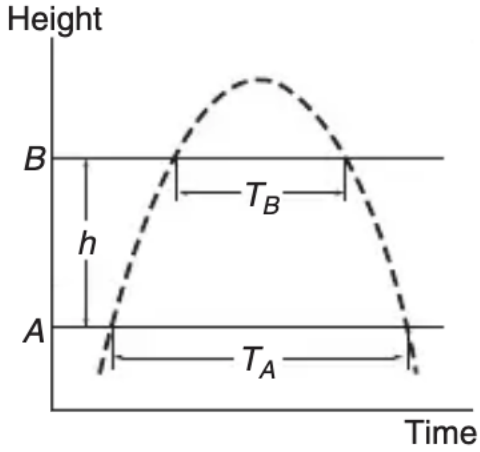
Ignoring air resistance, show that the time at which the objects have a vertical separation L is given by

$$t = \frac{L}{gt_0} + \frac{t_0}{2} \tag{3}$$

How do you interpret this result for $L < \frac{gt_0^2}{2}$?

Note: $t_0 \neq t$. Also this should sorta remind you of problem 2 but in the vertical direction now. They will not have the same answer and, in fact, they look almost unrelated. However if you think about what's happening in both problems there are some similarities: We are interested in when they have some sort of separation L from each other and we are given *a*cceleration either implicitly or explicitly. That is the reason I gave the hint.

6 The acceleration of gravity can be measured by projecting a body upward and measuring the time that it takes to pass two given points in both directions.



Show that if the time the body takes to pass a horizontal line A in both directions is T_A, and the time to go by a second line B in both directions is T_B, then, assuming that the acceleration is constant, its magnitude is

$$g = \frac{8h}{T_A^2 - T_B^2} \tag{4}$$

where h is the height of line B above line A (See picture).

Hint: At the top of the graph v = 0. I'd recommend using this as your starting point i.e $v_0 = 0$, but there's more than one way to solve the problem.

Note: This is strange way to measure the acceleration of gravity, but it uses minimal information to get get i.e we don't even know the initial velocity of the object in question. For most other problems I tell you either v_0 or we say we drop it meaning $v_0 = 0$ so we almost are always given v_0 implicitly if not explicitly.

1 Homework 2 You drop a mic off a cliff from a height H into the ocean. How long does it take for you to hear the splash? Assume speed of sound is v_s
If you already did this in the last homework you do not have to do it again.