Oberlin College Physics 103, Fall 2023

Sample Exam

Wednesday, 20 September

There will be a 50-minute exam on Wednesday, 27 September, from 10:00 am to 10:50 am. I recommend that you write in your own words a one-page summary (use both sides) of the most important and most difficult-to-remember equations, principles, and ideas, and bring it to this exam. This is the only written material you may consult while taking the exam. Calculators are permitted, collaboration is not.

Exam topics are motion in one- and two-dimensions, particularly motion with constant acceleration; vectors; measurement, uncertainty, and crater formation.

Sample exam:

(1) A hyperactive squirrel runs on Professor Street. It starts 16 m north of the Wright Laboratory doorway with initial (northward) velocity 6.0 m/s, and it has constant acceleration -2.0 m/s^2 (that is, it accelerates toward the south). (a) When does it turn around? (b) When it passes the Wright Lab doorway going south, how fast is it going?
(*Answer:* (a) 3.0 s [two significant figures]; (b) 10 m/s.)

(2) You are designing clues for a treasure hunt for a child's birthday party. You have already decided the clue will take the form "Walk 42 paces north from the oak tree, turn right by angle θ, then walk 17 paces. You are now above the buried treasure." What angle θ should you choose if you want the treasure to be as far as possible from the oak tree? What angle makes the treasure as close as possible?
(*Answer:* If you draw a sketch you will see instantly that the answers are 0° and 180°.)

(3) In the United States, motor vehicles are often characterized by the time required for the vehicle to accelerate from standing to 60.0 miles per hour. For example, I found these 0 to 60 times at the site zeroto60times.com:

Subaru Forester	8.0 s
Toyota 4Runner	7.7 s
Volkswagen Beetle	7.3 s
Ford Mustang	4.2 s
Tesla Model S	2.2 s

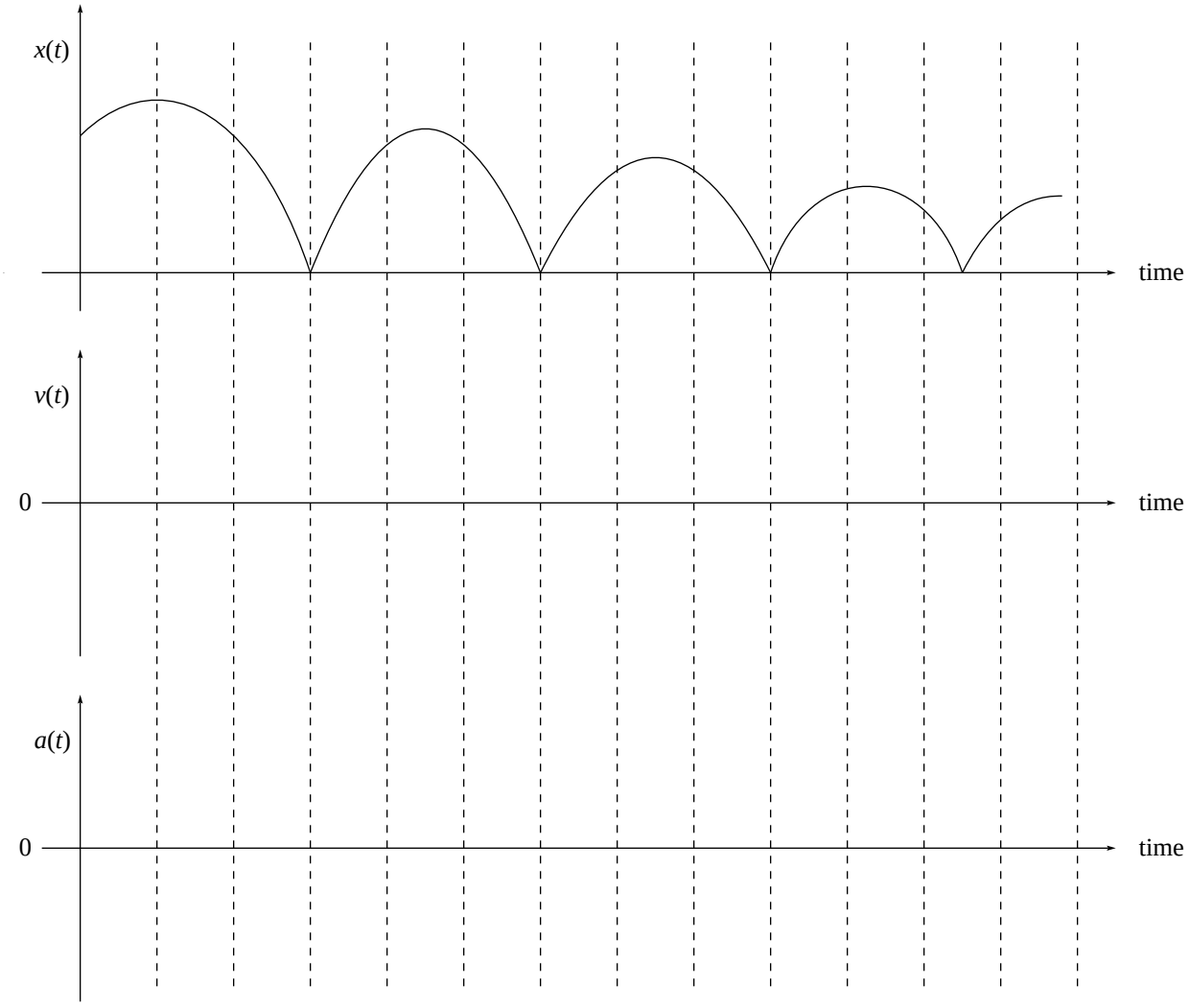
If the acceleration is constant, how far do each of these vehicles travel while speeding up from 0 to 60?
(*Answer:* Don't solve the problem from scratch five times. Instead derive the formula

$$\text{distance} = \frac{\text{time}}{120 \text{ s/mile}}$$

and plug in to find 0.067 mi, 0.064 mi, 0.061 mi, 0.035 mi, and 0.018 mi. Note two significant figures.)

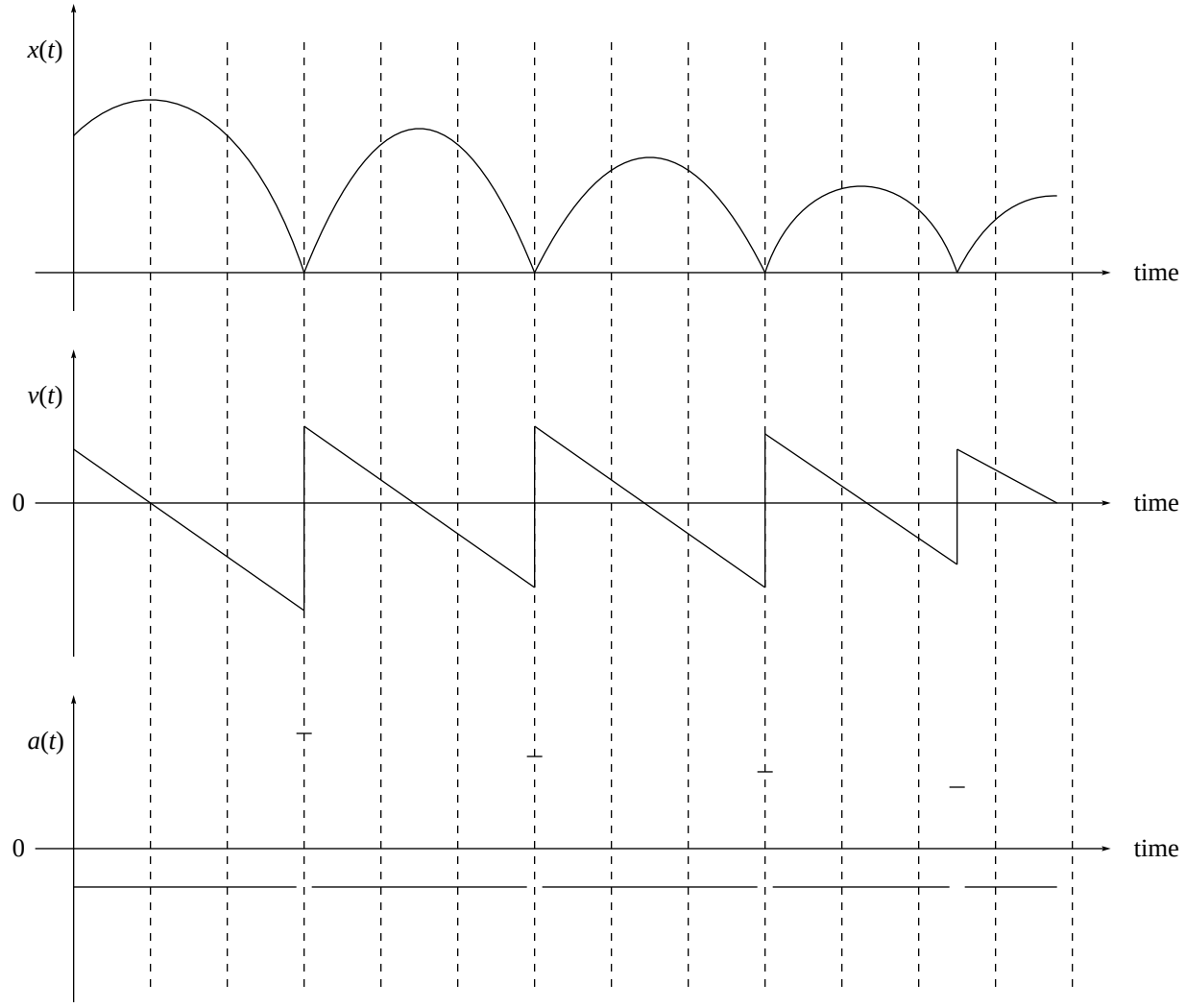
(4) *Bouncing ball.*

The graph below shows position as a function of time for a bouncing ball. Sketch the velocity and the acceleration as functions of time in the space provided. Your two sketches should not be quantitatively precise, but they must be qualitatively appropriate (with, for example, slopes of the correct sign) and they must accurately locate important features such as zeros, maxima, and minima.



I recommend that you attempt this problem, and only then turn the page for my model solution!

Answer:



⟦*Grading:* $v(t)$: 3 points for sawtooth form, 1 point for all slopes the same, 1 point for diminishing height of sawteeth; $a(t)$: 2 points for spike form, 2 points for constant (flat) acceleration while in freefall, 1 point for diminishing height of spikes.⟧