1. [3 points] **There is work to submit for this problem. Read it carefully.**

- You may use your one pre-written page of notes, on an 8.5" by 11" standard sheet of paper, with whatever you want handwritten (not typed) on both sides.

- You are not allowed to use any other resources, including calculators, other notes, or the book.

- You may not use any electronic device or the internet, except to access the Zoom meeting for the exam, to access the exam file itself, to submit your work, or to report technological problems via the Google forms we will provide to do so. The one exception is that you may use headphones (e.g. for white noise) if you prefer, though please note that you need to be able to hear when the end of the exam is called in the Zoom meeting.

- You may not use help from any other individuals (other students, tutors, online help forums, etc.), and may not communicate with any other person other about the exam until **8am on Tuesday** (Ann Arbor time).

- The one exception to the above policy is that you may contact the proctors in your exam room via the chat in Zoom if needed.

- Violation of any of the policies above may result in a score of zero for the exam, and, depending on the violation, may result in a failing grade in the course.

As your submission for this problem, you must write "I agree," and write your initials and UMID number to signify that you understand and agree to this policy. By doing this you are attesting that you have not violated this policy.

2. [12 points] Johannes takes a train from Buenos Aires to his countryside ranch, a distance of 1000 kilometers, traveling in a straight line. During the trip to the ranch, the train stops once, at the town of Rivadavia. After Johannes arrives at the ranch he realizes that he left an important book in Buenos Aires, so he returns to the city on an express train, which travels directly back to Buenos Aires on the same track with no stops.

Let $J(t)$ be Johannes's distance from Buenos Aires, in kilometers (km), at time t hours (h) after the train begins moving. Some values of $J(t)$ are shown in the table below.

t	0	3	7	8	9	12	14	16	18
$J(t)$	0	450	650	650	750	950	950	650	0

a. [2 points] How far is Rivadavia from Johannes's countryside ranch? Include units.

b. [2 points] What is the average velocity of the train between $t = 3$ and $t = 7$? Include units.

c. [2 points] Estimate the instantaneous velocity of the train 9 hours into Johannes's trip. Include units.

d. [2 points] For which of the following time intervals is the instantaneous velocity negative at some point in the interval? Give your answer as a list of one or more intervals, or write NONE.

$[8, 12]$ $\qquad\qquad$ $[12, 14]$ $\qquad\qquad$ $[8, 16]$ $\qquad\qquad$ $[14, 18]$

e. [2 points] If the average velocity of the train on its return trip from the ranch to Buenos Aires was 200 km/h, and it arrived in Buenos Aires at exactly $t = 18$, at what time t did the train depart?

f. [2 points] Could the graph of $J(t)$ be concave up for the entire interval $0 \le t \le 7$? *Briefly explain your reasoning.*