Seminar 1: Lectures 1-2

Answer all questions in your **Workbook** and bring it to **Seminar Class**.

Question 1

A train is moving up a steep slope at constant velocity (see Figure below) when its carriage detached and starts rolling freely along the track. After 5.0 s, the carriage is 30 m behind the train. What is the acceleration of the carriage?

Question 2

An ambulance driver is rushing a patient to hospital. While traveling at 72 km/h, she notices the traffic light at the upcoming intersection has turned amber. To reach the intersection before the light turns red, she must travel 50 m in 2.0 s.

(a) What minimum acceleration must the ambulance have to reach the intersection before the light turns red?

(b) What is the speed of the ambulance when it reaches the intersection?

Question 3

A cyclist sprints at the end of a race to clinch a victory. She has an initial velocity of 11.5 m/s and accelerates at a rate of 0.5 m/s^2 for 7 s.

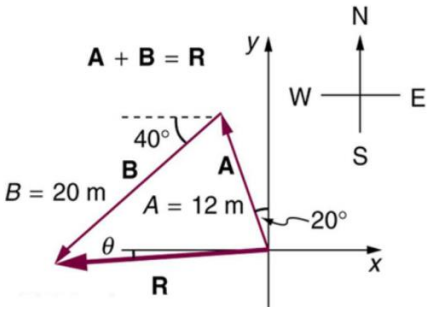
(a) What is her final velocity?

(b) The cyclist continues at this velocity to the finish line. If she is 300 m from the finish line when she starts to accelerate, how much time did she save?

(c) The second-place winner was 5.0 m ahead when the winner started to accelerate, but he was unable to accelerate, and traveled at 11.8 m/s until the finish line. What was the difference in finish time in seconds between the winner and runner-up? How far back was the runner-up when the winner crossed the finish line?

Question 4

Suppose you first walk 12 m in a direction 20º west of north and then 20 m in a direction 40º south of west. How far are you from your starting point, and what is the compass direction of a line connecting your starting point to your final position? (If you represent the two legs of the walk as vector displacements A and B, as in Figure below, then this problem finds their sum R = A + B.



Question 5

A student drove to university from their home and noted that the odometer reading of their car increased by 12.0 km. The trip took 18.0 min.

(a) What was their average speed?

(b) If the straight-line distance from their home to university is 10.3 km in a direction 25.0º south of east, what was their average velocity?

(c) If they returned home by the same route 7 h 30 min after they left, what were their average speed and velocity for the entire trip?

Question 6

An object has a position function $x(t) = 5t\,m$.

(a) What is the velocity as a function of time?

(b) Graph the position function and the velocity function.

Question 7

A particle moves along the x-axis according to

$$x(t) = 10t - 2t^2\ m.$$

(a) What is the particle's instantaneous velocity at $t = 2\ s$ and $t = 3\ s$?

(b) What is the particle's instantaneous speed at these times?

(c) What is the particle's average velocity between $t = 2\ s$ and $t = 3\ s$?

(d) Graph the position function and the velocity function.

Question 8

Freight trains can produce only relatively small accelerations and decelerations.

(a) What is the final velocity of a freight train that accelerates at a rate of $0.05\ m/s^2$ for $8.0\ min$, starting with an initial velocity of $4.0\ m/s$?

(b) If the train slows down at a rate of $0.55\ m/s^2$, how long will it take to come to a stop from this velocity?

(c) How far will it travel in each case?

Extension Questions

Question 9

A body at rest is given an initial uniform acceleration of 8.0 m/s^2 for 30 s after which the acceleration is reduced to 5.0 m/s^2 for the next 20 s. The body maintains the speed attained for 60 s after which it is brought to rest in 20 s.

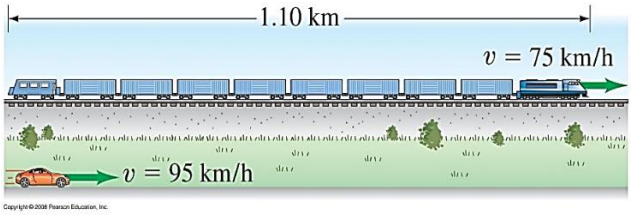
(a) Draw the velocity–time graph of the motion using the information given above.

(b) Using the graph, calculate the:

i) maximum speed attained during the motion
ii) average retardation as the body is being brought to rest
iii) total distance travelled during the first 50 s
iv) average speed during the same interval as in iii)

Question 10

An automobile traveling 95 km/h overtakes a 1.10 km long train traveling in the same direction on a track parallel to the road. If the train's speed is 75 km/h, how long does it take the car to pass it, and how far will the car have travelled in this time? What are the results if the car and train are traveling in opposite directions?



Question 11

(a) A skier is accelerating down a 30° hill at 1.80 m/s^2. What is the vertical component of their acceleration?

(b) How long will it take the skier to reach the bottom of the hill, assuming they starts from rest and accelerates uniformly, with an elevation change is 325 m?