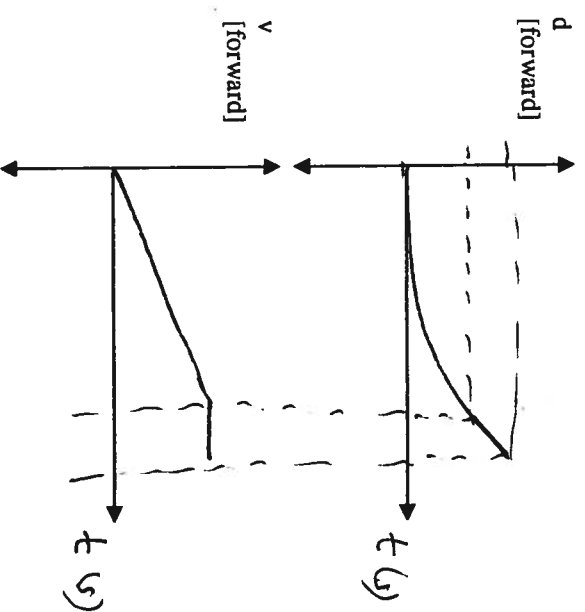


3. Usain Bolt is competing in the 100.0 m sprint at the Indoor World Track and Field Championships. Over the first 70.0 m of the race, he accelerates uniformly from rest at 2.20 m/s^2 , he then runs the remaining 30.0 m of the race at his top speed.

a) Sketch position-time and velocity-time graphs for Usain during this race on the axes provided. Make sure to label your graphs! [4]



b) Find the Usain's top velocity at the end of his acceleration phase. [3]

$$\vec{v}_1 = 0.0 \text{ m/s} \quad \Delta \vec{d} = \vec{v}_2^2 - \vec{v}_1^2 \\ \vec{v}_2 = ? \quad 2\vec{a}$$

$$\Delta \vec{d} = 70.0 \text{ m [F]} \quad \vec{v}_2^2 = \vec{v}_1^2 + 2\vec{a}\Delta \vec{d}$$

$$\vec{a} = 2.20 \text{ m/s}^2 \text{ [F]}$$

$$\vec{v}_2 = \sqrt{0.0 + 2(2.20 \text{ m/s}^2)(70.0 \text{ m})} = 17.5 \text{ m/s [F]}$$

Let $F = +$

c) Find the total time for him to run the race! [4]

$$\Delta t_{\text{total}} = ?$$

$$\Delta t_1 = ? \text{ acceleration phase}$$

$$\Delta t_2 = ? \text{ constant velocity}$$

Phase

$$\Delta d_1 = 70.0 \text{ m [F]}, \vec{a}_1 = 2.20 \text{ m/s}^2 \text{ [F]}$$

$$\Delta d_2 = 30.0 \text{ m [F]}, \vec{v}_2 = 17.5 \text{ m/s [F]}$$

$$\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a}_1 \Delta t^2$$

$$\Delta t_1 = \sqrt{\frac{2\Delta d_1}{a_1}} = \sqrt{\frac{2(70.0)}{(2.20 \text{ m/s}^2)}} = 7.977 \text{ s}$$

$$\Delta t_2 = \frac{\Delta d_2}{\vec{v}_2} = \frac{30.0 \text{ m}}{17.5 \text{ m/s}} = 1.7094 \text{ s}$$

$$\Delta t_{\text{total}} = \Delta t_1 + \Delta t_2 = \underline{\underline{9.69 \text{ s}}}$$

4. A ball rolls up a ramp with an initial velocity of 3.50 m/s [forward]. The average acceleration as the ball rolls up is 4.00 m/s^2 [down the ramp]. Determine the time(s) at which the ball passes through a position 0.50 m [forward] from the bottom [4]

$$v_1 = 3.50 \text{ m/s [F]} \quad \left(\Delta d = \frac{v_2^2 - v_1^2}{2a} = \frac{(0.0)^2 - (3.50 \text{ m/s})^2}{2(-4.00 \text{ m/s}^2)} = 1.50 \text{ m [F]} \right)$$

$$a = 4.00 \text{ m/s}^2$$

$$\Delta d = 0.50 \text{ m [F]}$$

$$\Delta t = ?$$

$$\Delta d = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} \Delta t^2$$

Solve for Δt .

$$0.50 = 3.50 \Delta t + \frac{1}{2}(-4.00) \Delta t^2$$

$$0.50 = 3.50 \Delta t - 2.00 \Delta t^2$$

$$2.00 \Delta t^2 - 3.50 \Delta t + 0.50 = 0$$

$$\Delta t = \frac{3.50 \pm 2.872}{4.00}$$

$$a = 2.00, \quad b = -3.50, \quad c = 0.50 \quad \therefore \Delta t = 0.1569 \text{ s or } 1.593 \text{ s}$$

\therefore it passes the 0.50 m [F] position at 0.16 s on the way up and at 1.59 s on the way down.

5. Two runners, Mickey and Goofy are running a race. Mickey can run at a constant speed of 4.00 m/s while Goofy can run at a constant speed of 3.00 m/s . Mickey gives Goofy a 10.0 second head start, then begins to chase Goofy. Find the distance at which Mickey catches up with Goofy. (Assume that the acceleration phases for both runners are negligible, i.e., they can reach their maximum velocity instantaneously). [4]

$$\vec{v}_m = 4.00 \text{ m/s [F]}$$

$$\vec{v}_g = 3.00 \text{ m/s [F]}$$

$$\Delta t_{\text{head start}} = 10.0 \text{ s}$$

$$\Delta d_2 = ? \quad \left. \begin{array}{l} \Delta d_1 = ? \\ \Delta t_2 = ? \end{array} \right\} \text{ meeting point}$$

$$\text{Let } F = +$$

$$\Delta d_m = v_m \cdot \Delta t$$

$$\Delta d_g = v_g \cdot \Delta t + (3.00 \text{ m}) (10.0 \text{ s})$$

$$\Delta d_m = 4.00 \Delta t$$

$$\Delta d_g = 3.00 \Delta t + 30.0$$

$$\text{Let } \Delta d_m = \Delta d_g \text{ at meeting point}$$

$$4.00 \Delta t = 3.00 \Delta t + 30.0$$

$$4.00 \Delta t - 3.00 \Delta t = 30.0$$

$$\Delta t = 30.0 \text{ s}$$

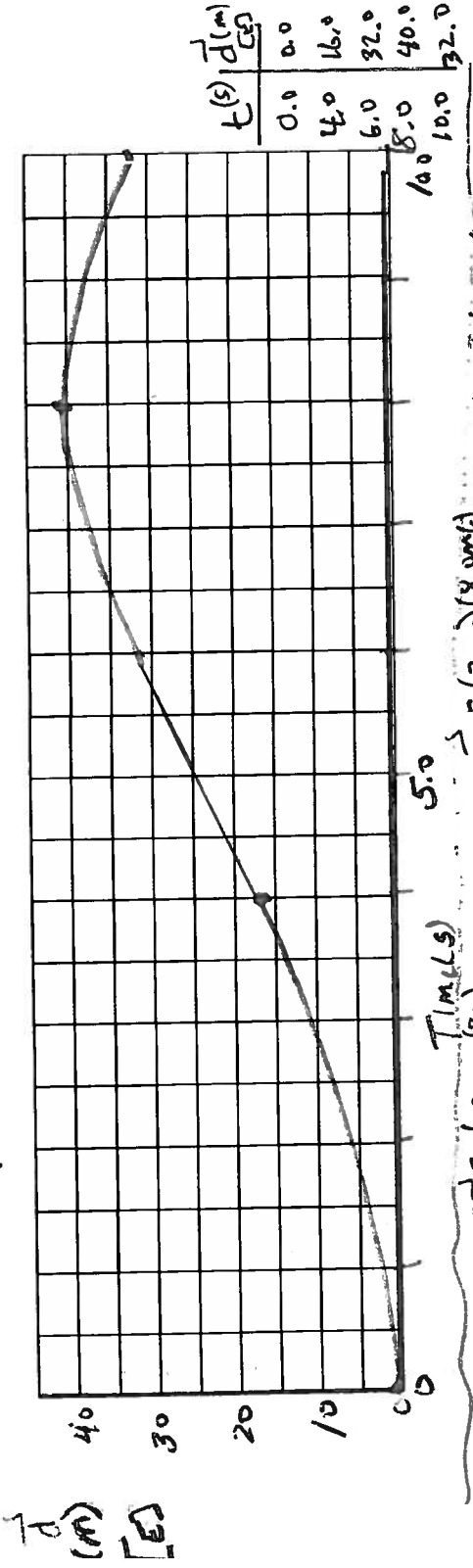
$$\Delta d_m = (4.00 \text{ m/s})(30.0 \text{ s}) = 120.0 \text{ m}$$

\therefore Mickey catches Goofy 120.0 m from his starting point

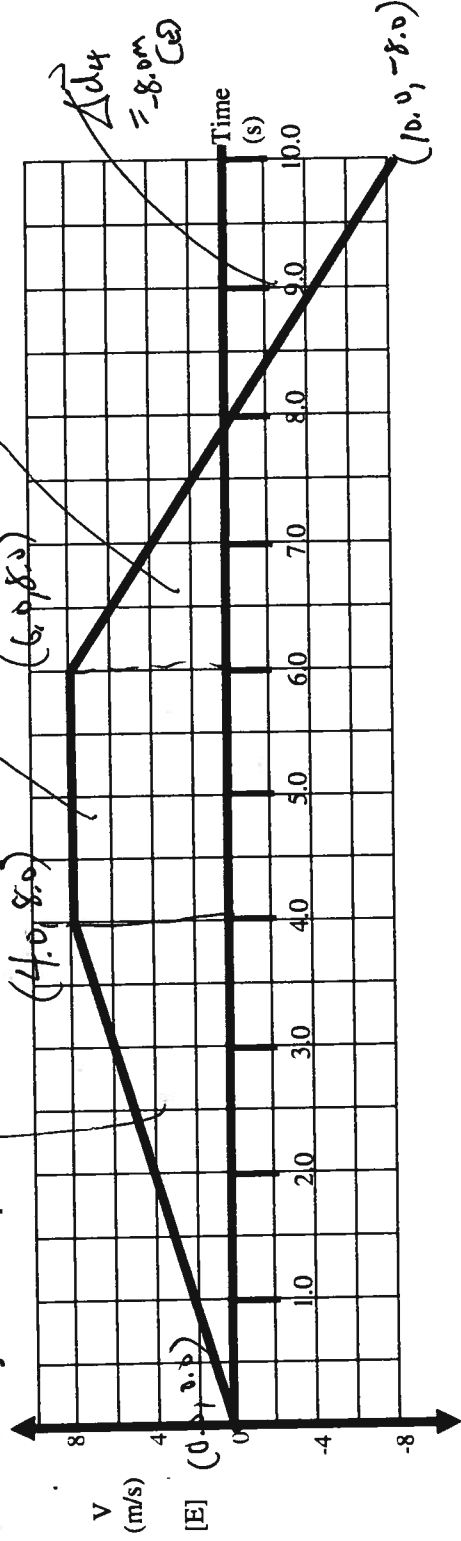
Part C: Graph Analysis [9 marks]

- The motion of a train engine moving along a straight track in a railyard is shown on the velocity-time graph below.
 - Draw the corresponding acceleration-time graph for the train. [3]
 - Assuming that the train starts at the station (origin), draw the corresponding position-time graph. [6]

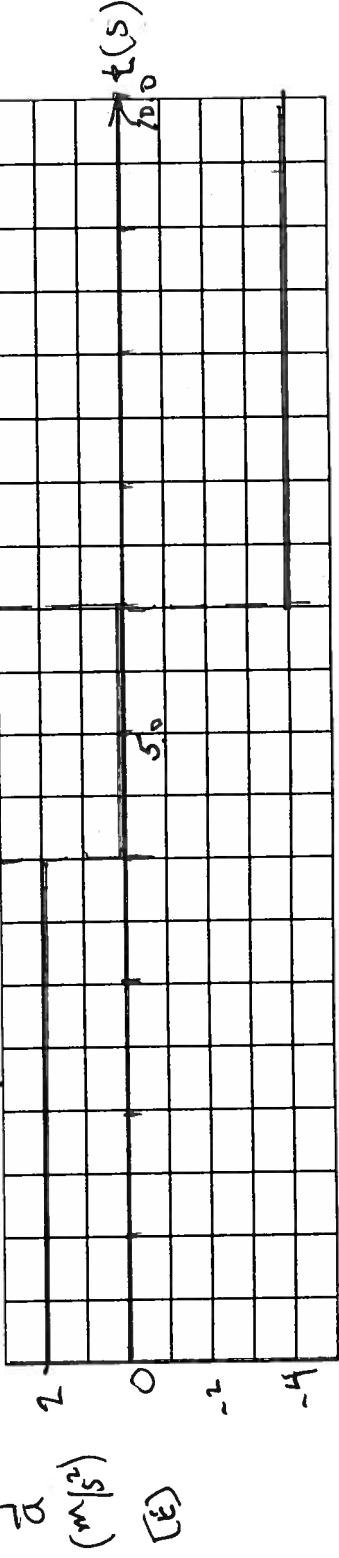
Position-Time Graph:



Velocity-Time Graph:



Acceleration-Time Graph:



$$a_1 = \frac{8.0 - 0.0}{4.0 - 0.0} = 2.0 \text{ m/s}^2$$

$$a_2 = 0.0 \text{ m/s}^2$$

$$a_3 = \frac{-8.0 - 8.0}{10.0 - 6.0} = -2.0 \text{ m/s}^2$$

SPH4U0-Feb. 2013

Kinematics Review Quest-

Name:
Total: /47 marks [K/U]

Useful Equations:

$$v_{av} = \frac{\Delta d}{\Delta t}$$

$$a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{\Delta t}$$

$$\Delta d = v_2 \Delta t - \frac{1}{2} a (\Delta t)^2$$

$$\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2 \quad \Delta d = \frac{v_2^2 - v_1^2}{2a}$$

Part A: Multiple Choice Answers [10 marks]:

Write the letter representing the best answer for each question in the table below:

1	2	3	4	5	6	7	8	9	10
E	E	A	D	B	D	E	A	E	B

Part B: Short Answer and Problem Solving [28 marks]:

- Compare average speed and average velocity when a runner runs completely around an oval track (400.0 m in length) in a time of 2.00 minutes. [4]

$$\Delta d = 400.0 \text{ m}$$

$$\Delta t = 2.00 \text{ minutes} = 120.0 \text{ s}$$

$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{400.0 \text{ m}}{120.0 \text{ s}} = 3.33 \text{ m/s}$$

$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{0.0}{120.0 \text{ s}} = 0.0 \text{ m/s}$$

∴ the average velocity was 0.0 m/s and the average speed was 3.33 m/s.

- After a slapshot, a hockey puck is moving at an initial velocity of 18.0 m/s [forward] towards the goalie. It travels 25.0 m over rough ice reaching a final velocity of 12.0 m/s [Forward] before being stopped by the goalie's stick. Find the acceleration of the puck as it slides along. [5]

$$\vec{v}_1 = 18.0 \text{ m/s [F]}$$

$$\Delta d = 25.0 \text{ m [F]}$$

$$\vec{v}_2 = 12.0 \text{ m/s [F]}$$

$$a = ?$$

$$\Delta d = \frac{v_2^2 - v_1^2}{2a}$$

$$25.0 \text{ m} = \frac{(12.0 \text{ m/s})^2 - (18.0 \text{ m/s})^2}{2a}$$

$$a = -3.60 \text{ m/s}^2$$

∴ the acceleration is 3.60 m/s² [Backward]