Solutions

Other Kinematic Problems:

1. Fred and Barney are arguing who can throw a rock higher. Barney throws a rock straight up with a velocity of 30 m/s. Unfortunately it hits a pterodactyl that is flying 22 meters above him. At what velocity did the rock hit the pterodactyl?

$v_f^2 = v_i^2 + 2gd$

$v_f = \sqrt{30^2 + 2(-9.8)(22)}$

$v_f = 21.7 m/s$

2. The pterodactyl decides to get even and drops an egg on Barney's head. How many seconds did it take to hit Barney?

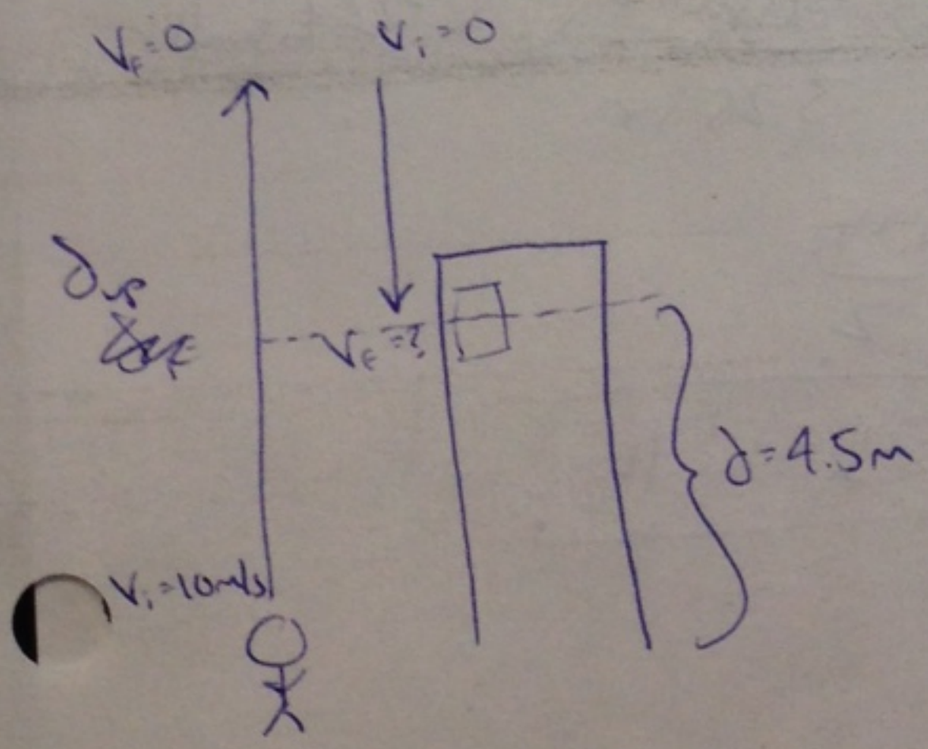
$d = \frac{1}{2}gt^2$

$t = \sqrt{\frac{2d}{g}}$

$t = \sqrt{\frac{2(22)}{9.8}}$

$t = 2.1 s$

3. John forgot to leave his wife's keys in the apartment, so he decided to throw them up to her. She was standing on the balcony 4.5 m above him. He threw the keys up at 10 m/s. She missed them on the way up but caught them on the way down. How long were they in the air for?



① $v_f^2 = v_i^2 + 2gd$

$d = \frac{v_f^2 - v_i^2}{2g}$

$d = \frac{0 - (10)^2}{2(-9.8)}$

$d_{up} = 5.1 m$

② $d_{down} = 5.1 - 4.5$

$d_{down} = 0.6 m$

③ t_1: $v_f = v_i + gt$

$t_1 = \frac{v_f - v_i}{g}$

$t_1 = \frac{-10}{-9.8}$

$t_1 = 1.02 s$

t_2: $d = \frac{1}{2}gt^2$

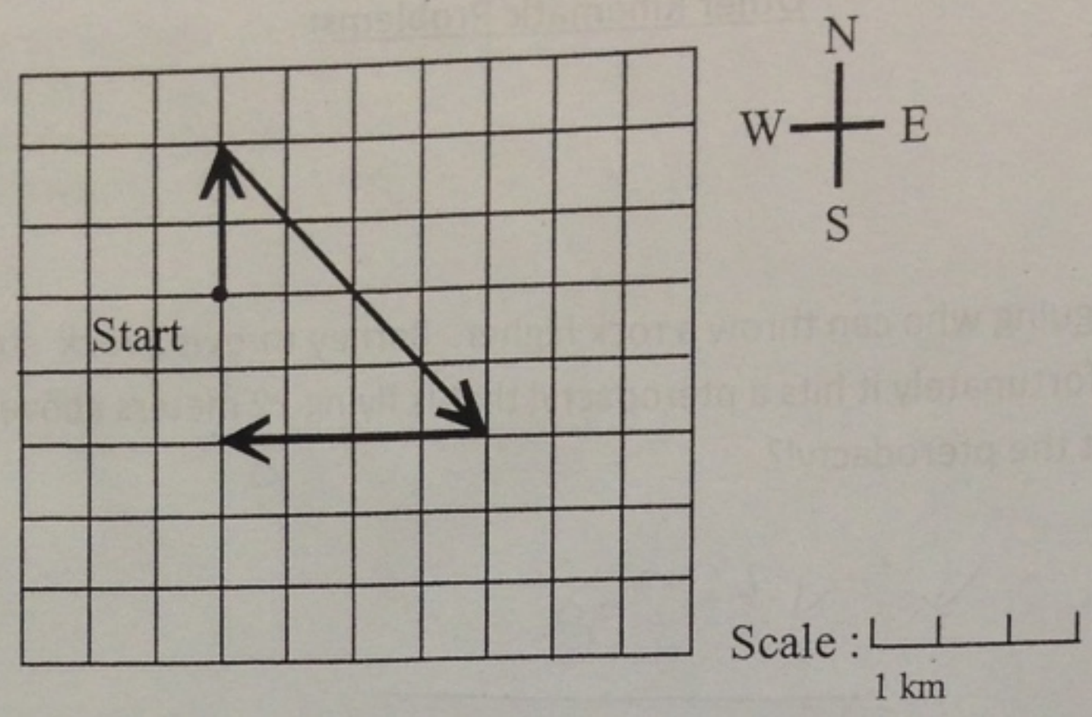
$t_2 = \sqrt{\frac{2d}{g}}$

$t_2 = \sqrt{\frac{2(0.6)}{9.8}}$

$t_2 = 0.35 s$

$t_{total} = 1.37 s$

[4] In a map-reading exercise, a number of students were given the following set of directions: "From your starting point, walk 2.00 km north, then 5.66 km southeast and finally 4.00 km west." This is illustrated in the following vector diagram.



What was their displacement for this trip?

A) 2.00 km north

B) 11.7 km south

C) 2.00 km south

D) 11.7 km west

[5] A cyclist is training for the Montreal Tour de l'Ile. She cycles from home to a provincial park, 80.0 km away in 2½ hours. After a short 15-minute rest, she makes the return trip, taking $3^1/_4$ hours.

What was her average speed for the full training session?

A) 26.7 km/h

B) ~~27.1 km/h~~

C) 27.8 km/h

D) 28.3 km/h

$d_{total} = 160\,km$

$t_{total} = 2.5 + 0.25 + 3.25$

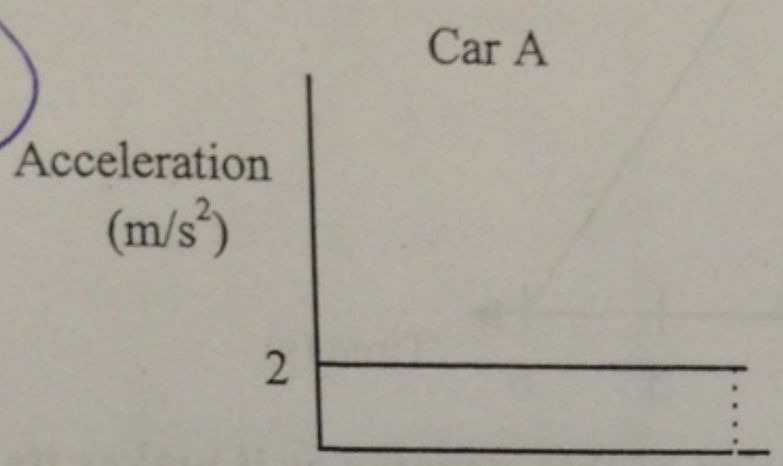
$t_{total} = 6\,hr$

$v_{avg} = \frac{d}{t} = \frac{160\,km}{6\,hr}$ $\quad v_{avg} = 26.7\,km/hr$

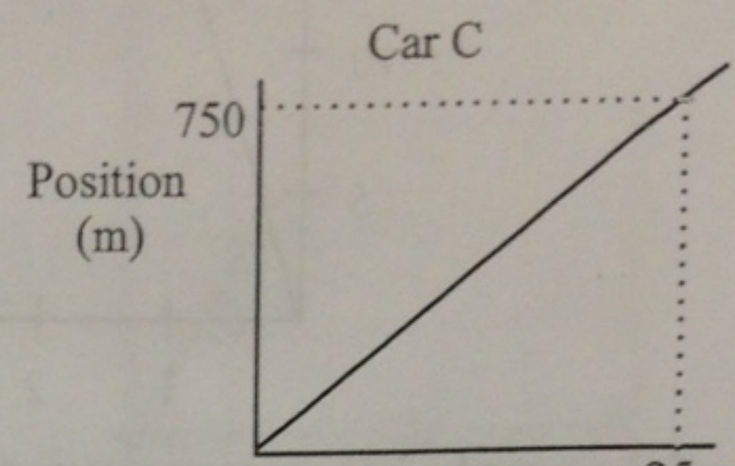
[6] The graphs below describe the motions of four different cars starting from rest.

Which car is travelling the fastest at 25 seconds?

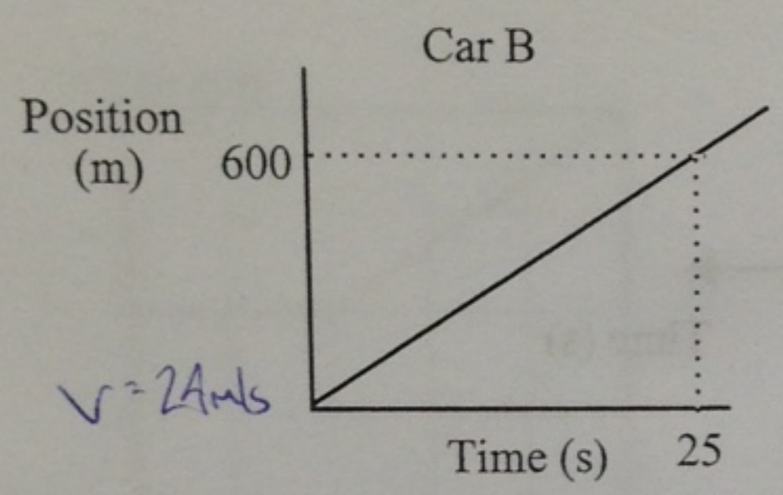
A)



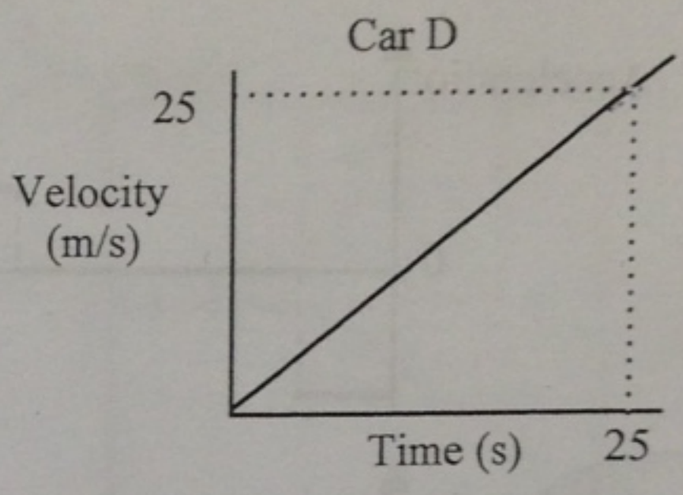
C)



B)

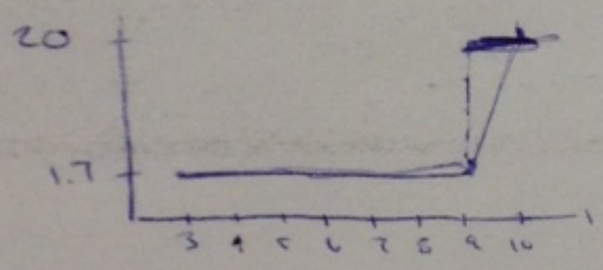


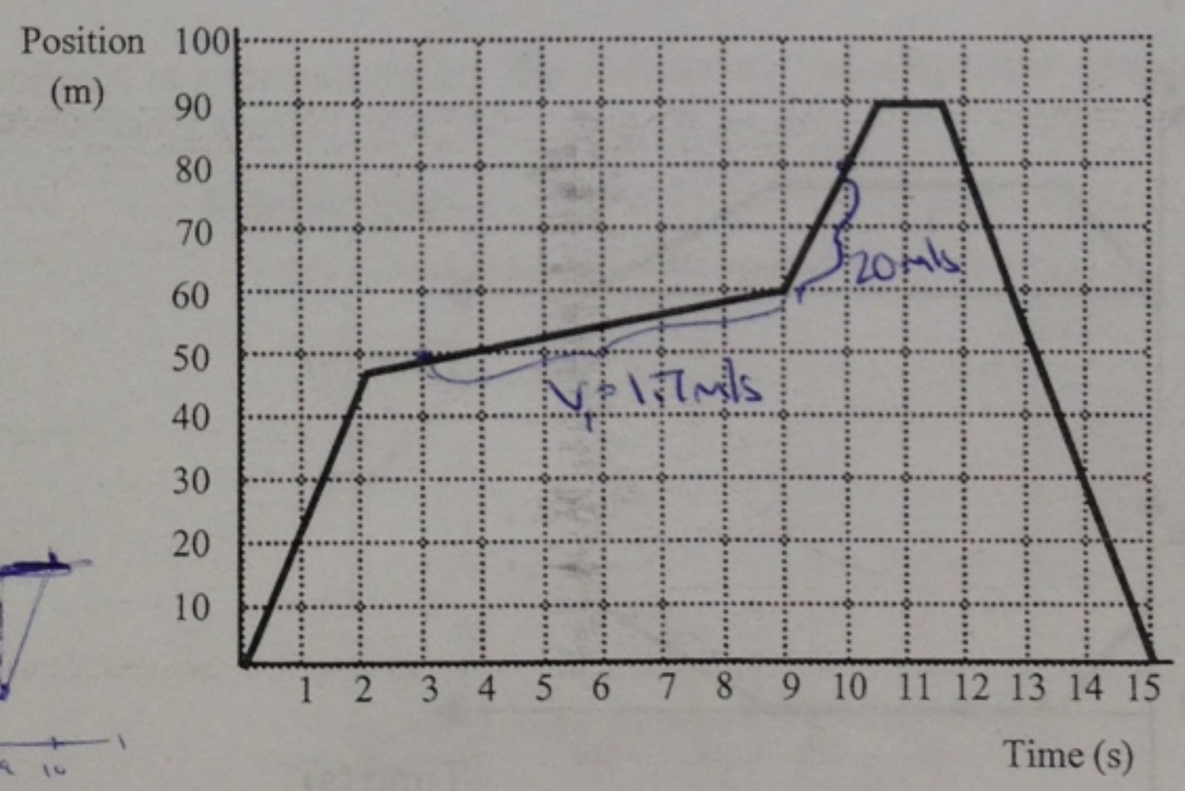
D)



[7] The graph below shows the change of position of a cart through a 15 second interval.

What was the average acceleration of the cart from the 3rd to the 10th second?





$v_1 = \frac{60-50}{9-3}$ $v_2 = \frac{80-60}{10-9}$

$v_1 = 1.7\ m/s$ $v_2 = 20\ m/s$

$a = \frac{v_f - v_i}{t}$

A) 0.60 m/s²

B) 2.6 m/s²

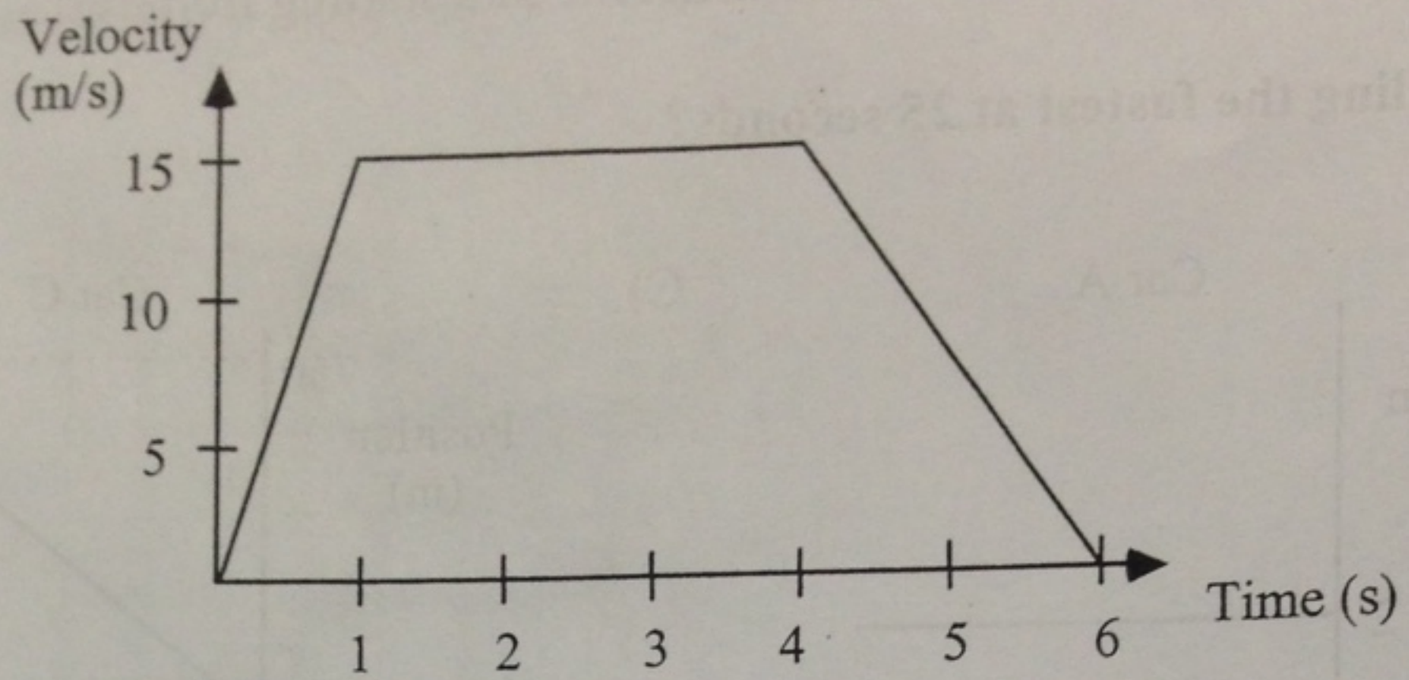
C) 4.3 m/s²

D) 11 m/s²

$a = \frac{20-1.7}{7}$

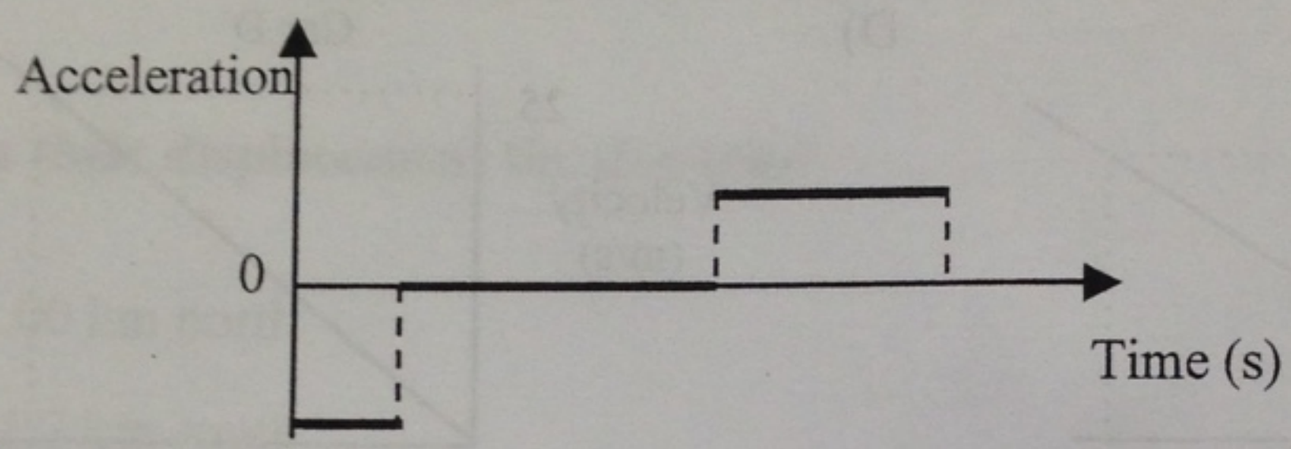
$a = 2.6\ m/s^2$

[8] The following velocity-time graph represents the motion of a panoramic elevator as it makes its way up from the main floor to the top floor of an observation tower.

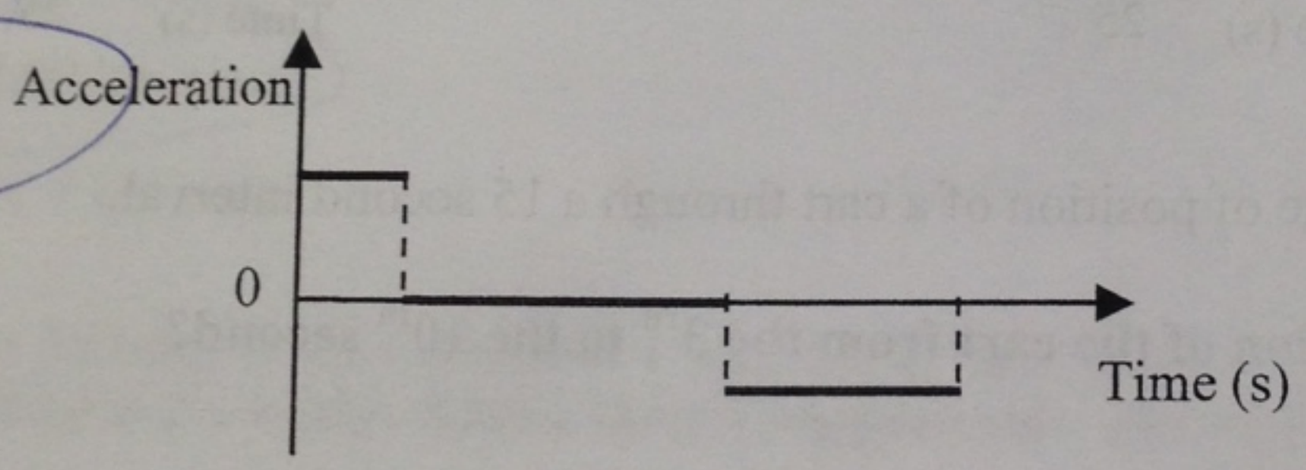


Which of the graphs below represents the acceleration of this elevator as it makes its way up to the top of the tower?

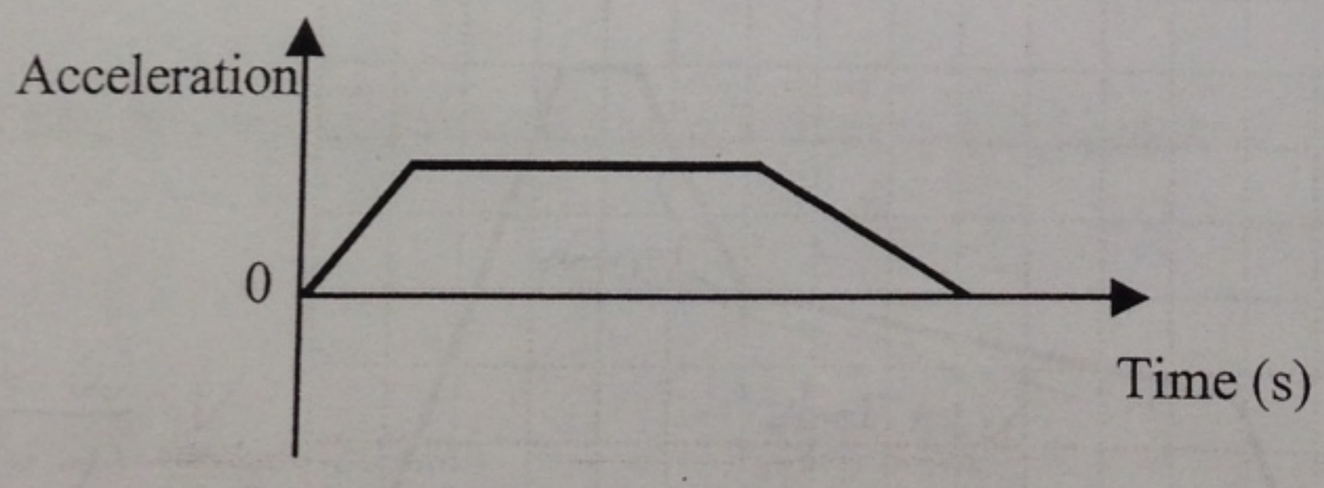
A)



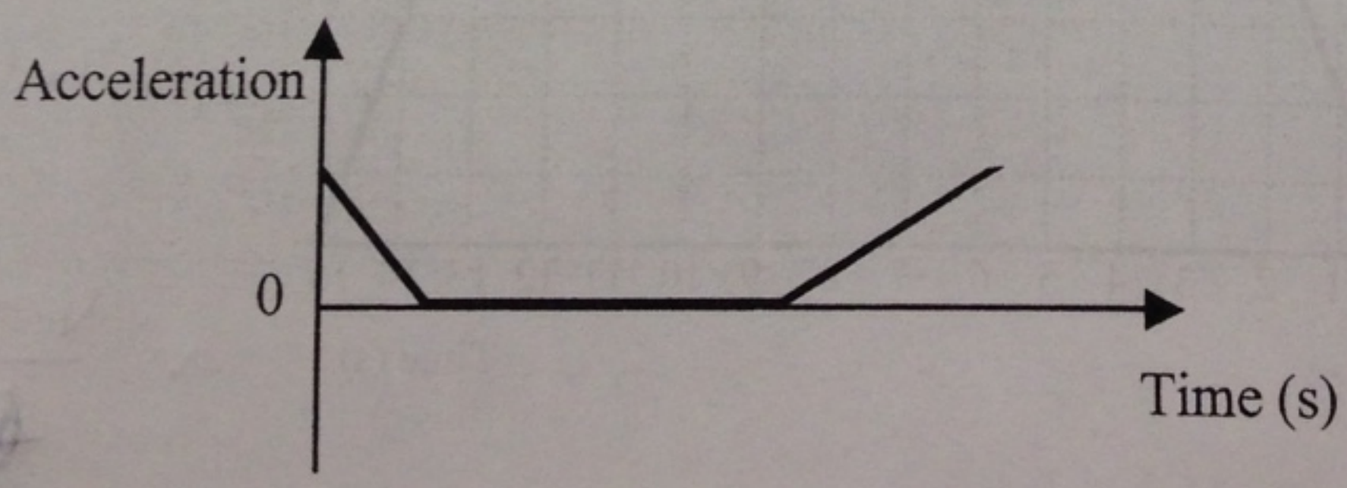
B)



C)

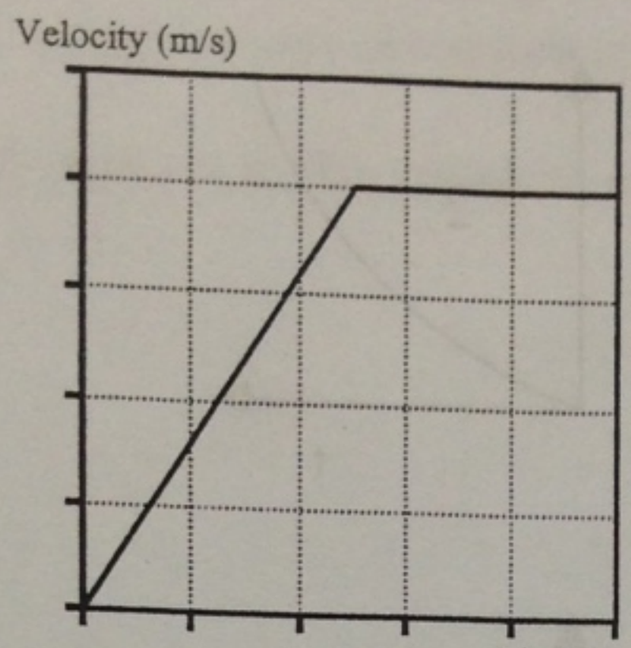


D)

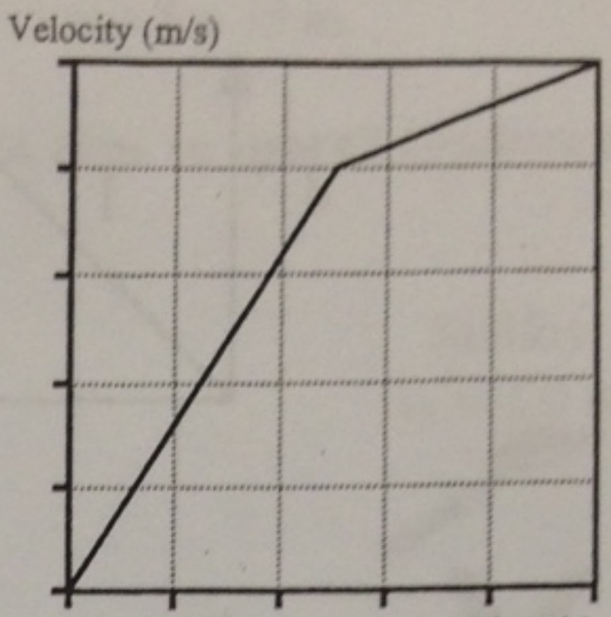


[9] A cart, moving at a constant velocity, encounters a small uphill incline.
Which of the following velocity-time graphs displays the motion correctly?
(Neglect the effects of friction.)

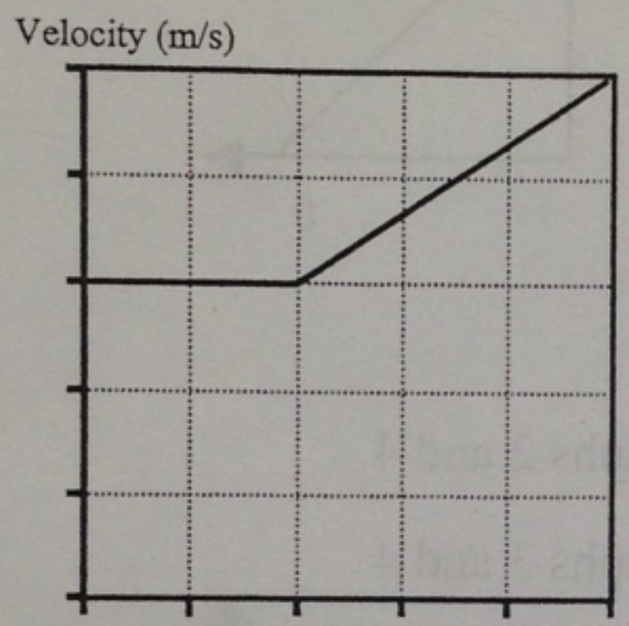
A)



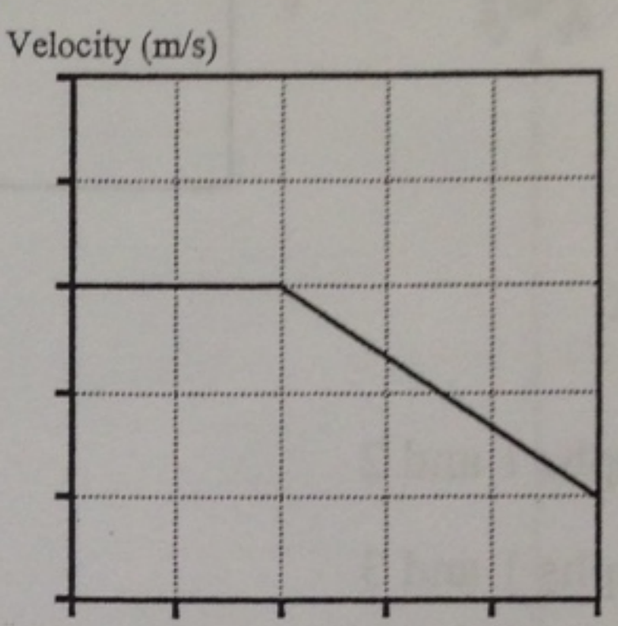
C)



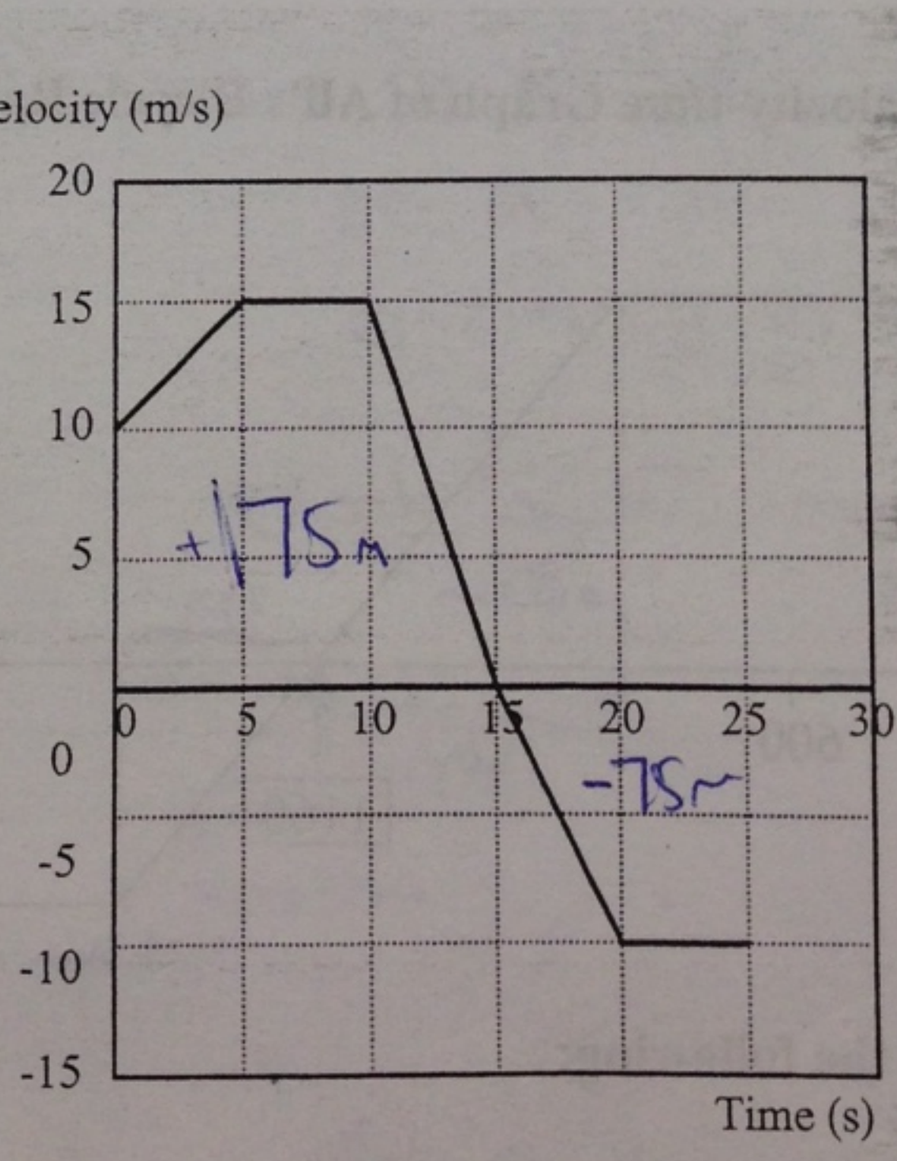
B)



D)



[10] The motion of an object is represented by the following velocity-time graph.

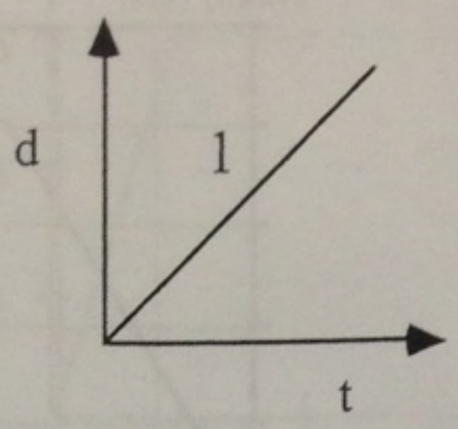


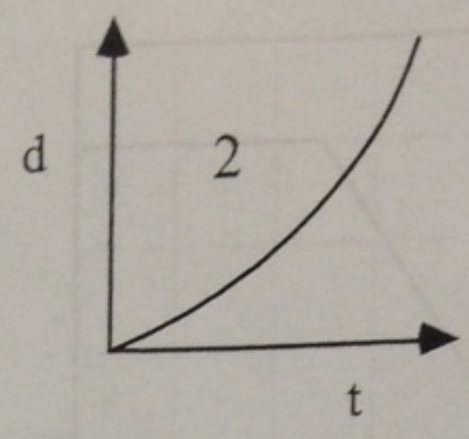
$\vec{d} = 175 - 75$

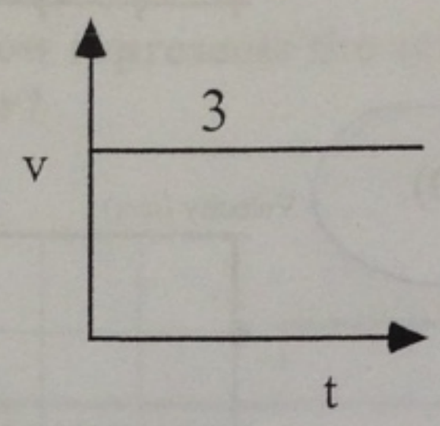
$\vec{d} = 100\,m$

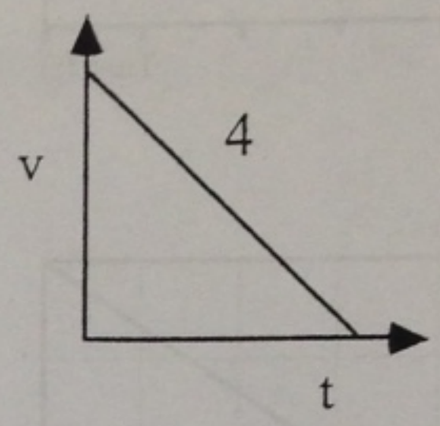
Determine the object's displacement at the end of 25 seconds.

[11] **Which of the following graphs illustrate non-uniform motion?**









A) Graphs 1 and 2

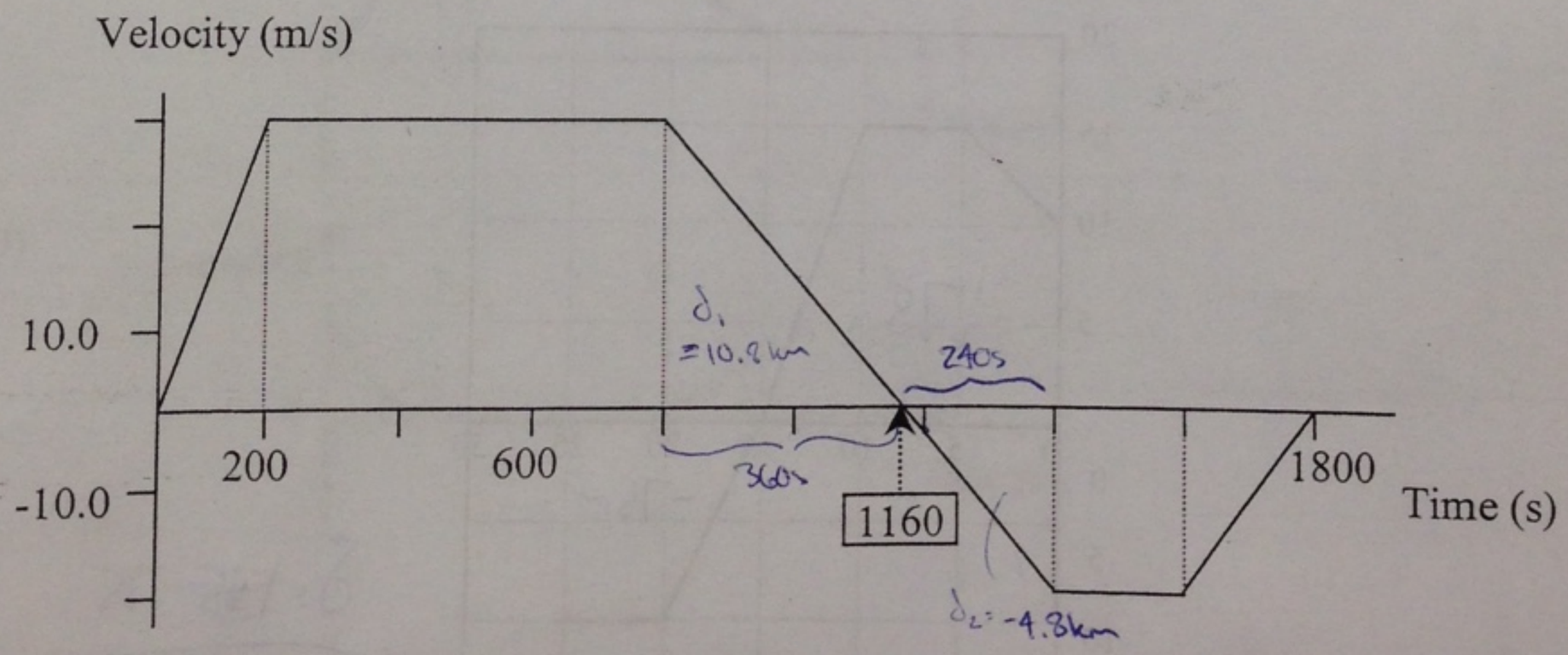
B) Graphs 1 and 3

C) Graphs 2 and 4

D) Graphs 3 and 4

12 Ali is participating in the Tour de l'Île bicycle marathon held each year on the island of Montreal. The following velocity versus time graph represents Ali's course over a period of 1800 seconds.

Velocity-time Graph of Ali's Bicycle Race

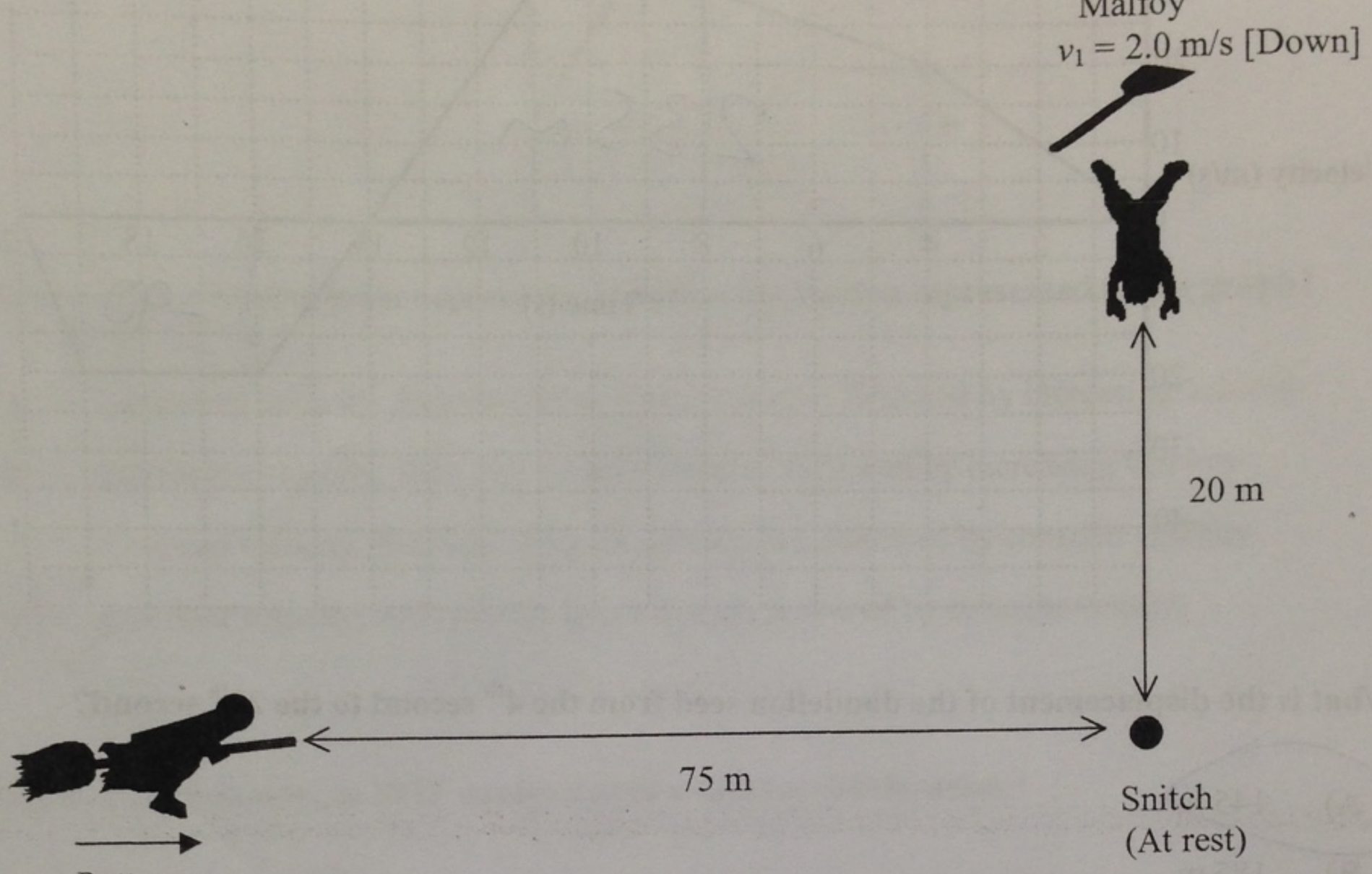


From the graph determine the following:

1. **Ali's acceleration at 400 seconds.** $0 m/s^2$
2. **Ali's acceleration at 1200 seconds.** $-0.08 m/s^2$
3. **Ali's displacement during the period between 800 seconds and 1400 seconds into the ride.** 6 km

[13] During a Quidditch match, Potter and Malfoy are chasing the snitch. Trying to catch the snitch first, Malfoy dives off his broom at 2 m/s [Down], from a height of 20 m from the snitch, while Potter is racing towards the snitch at a constant speed of 25 m/s for 75 m.

Who will make it to the snitch first and with how much time to spare? (*Assume the snitch is at rest.*)



$V_x = \frac{\partial x}{t}$

$t = \frac{\partial x}{V_x}$

$t = \frac{75\text{ m}}{25\text{ m/s}}$

$t = 3\text{s}$

$\partial_y = V_i t + \frac{1}{2} g t^2$

$20 = 2t + 4.9t^2$

$0 = 4.9t^2 + 2t - 20$
$\quad a \quad b \quad c$

$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$t = \frac{-2 + \sqrt{4 - 4(4.9)(20)}}{2(4.9)}$

$t = 1.82\text{s}$

$\partial_y = V_i t + \frac{1}{2} g t^2$

$\partial_y = \frac{1}{2} g t^2$

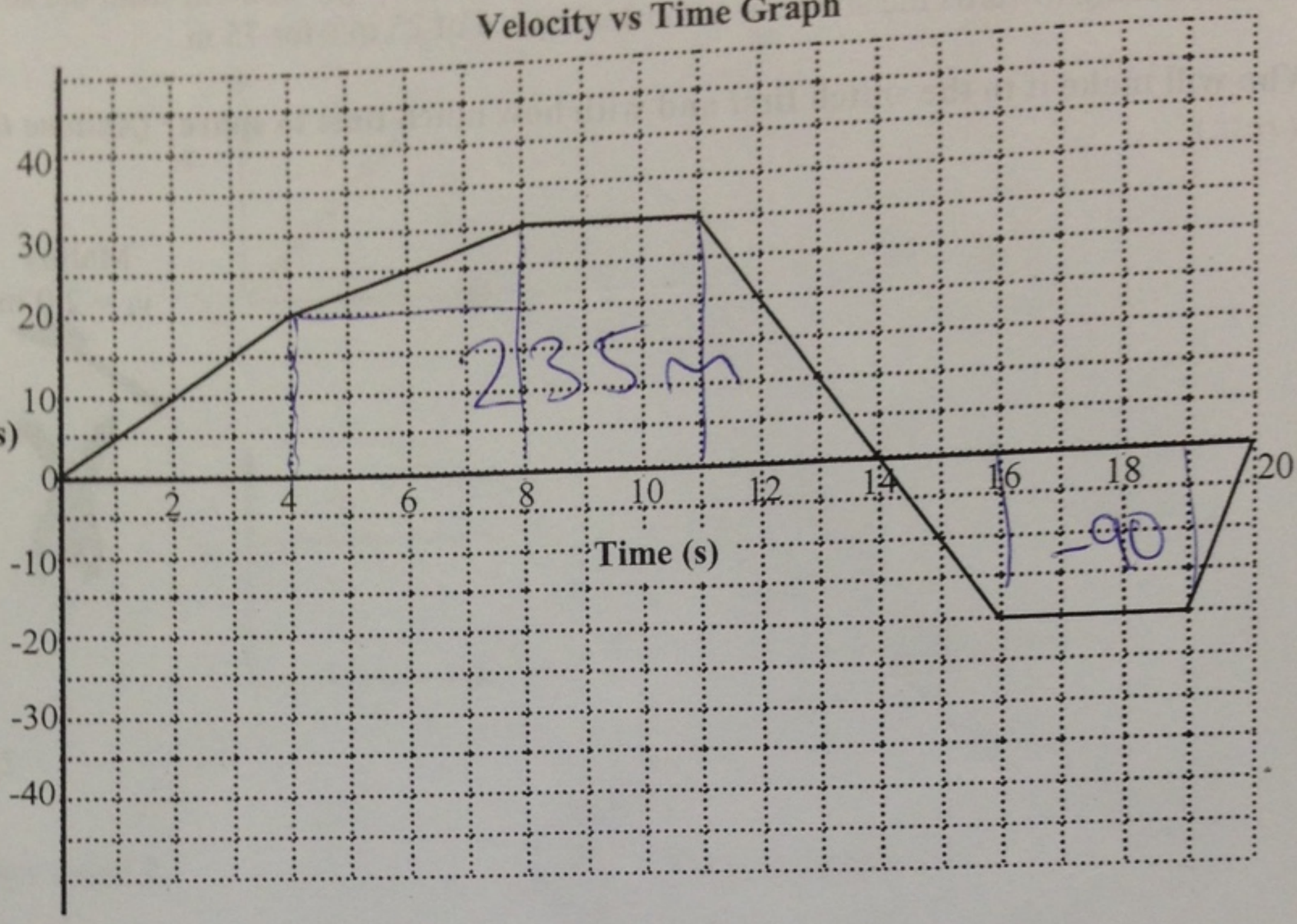
$t = \sqrt{\frac{2\partial_y}{g}}$

$t = \sqrt{\frac{2(20)}{9.8}}$

$t = 2.02\text{s}$

Malfoy with 1.17 s to spare!

[14] The graph below represents the velocity of a dandelion seed blowing in the wind for 20 seconds.



What is the displacement of the dandelion seed from the 4th second to the 20th second?

A) 145 m

B) 185 m

C) 325 m

D) 365 m

15 Laura propels a stone straight up with her slingshot. The stone strikes a tree branch 4.0 m above her. It strikes the branch with a velocity of 5.0 m/s.

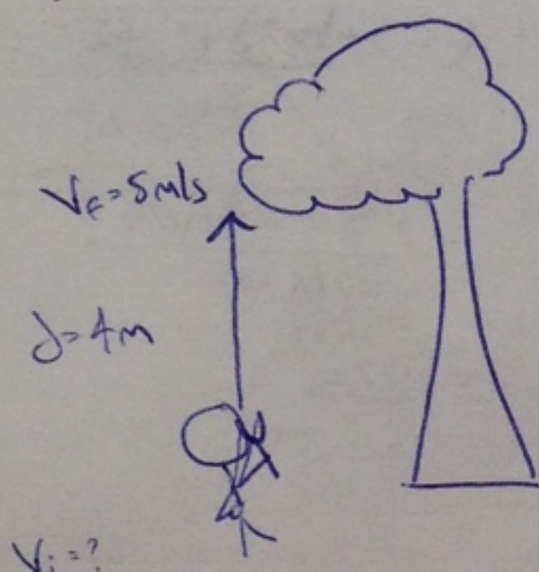
How long does this take?

A) 0.42 s

B) 0.53 s

C) 1.6 s

D) 10 s



① $v_f^2 = v_i^2 + 2gd$

$v_i^2 = v_f^2 - 2gd$

$v_i = \sqrt{v_f^2 - 2gd}$

$v_i = \sqrt{5^2 - 2(-9.8)(4)}$

$v_i = 10.2 m/s$

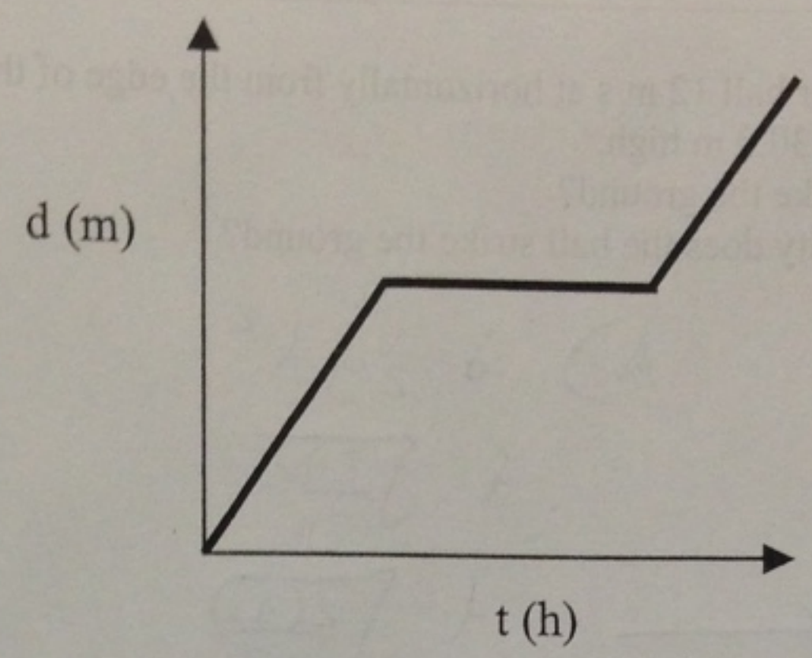
② $v_f = v_i + gt$

$\frac{v_f - v_i}{g} = t$

$\frac{5 - 10.2}{-9.8} = t$

$t = 0.53 s$

[16] Examine the position-time graph below.



Which of the following most accurately describes the motion represented in the graph?

A) Increasing velocity, followed by constant velocity, followed by increasing velocity

B) Increasing velocity, followed by zero velocity, followed by increasing velocity

C) Constant velocity, followed by constant velocity, followed by constant velocity

D) Constant velocity, followed by zero velocity, followed by constant velocity

[17] **Which of the following is NOT equivalent to a unit for acceleration?**

A) $\frac{J/m}{kg}$

B) $\frac{N}{kg}$

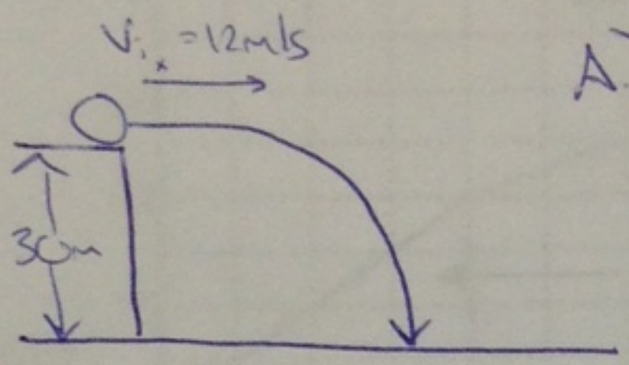
C) $\frac{m}{s^2}$

D) $\frac{kg \cdot m}{s^2}$

Erica kicks a soccer ball 12 m/s at horizontally from the edge of the roof of a building which is 30.0 m high.

a. When does it strike the ground?

b. With what velocity does the ball strike the ground?



A.) $d = \frac{1}{2} g t^2$

$t = \sqrt{\frac{2d}{g}}$

$t = \sqrt{\frac{2(30)}{9.8}}$

$t = 2.47\,s$

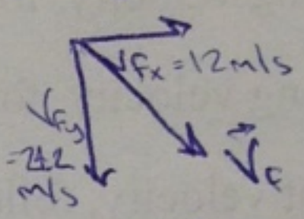
B.) $V_{f_y} = V_{i_y} + gt$ ($V_{i_y} = 0$)

$V_{f_y} = (9.8)(2.47)$

$V_{f_y} = 24.2\,m/s$

Note: $V_{ix} = V_{fx} = 12\,m/s$

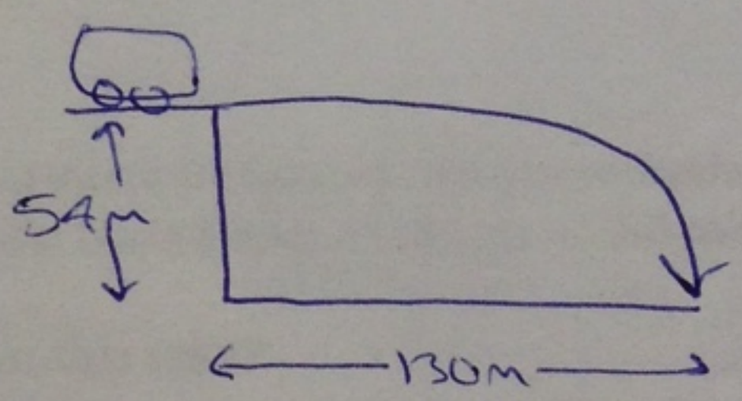
On ground:



$V_f = \sqrt{12^2 + 24.2^2}$

$V_f = 27\,m/s$

A car drives straight off the edge of a cliff that is 54 m high. The police at the scene of the accident note that the point of impact is 130 m from the base of the cliff. How fast was the car traveling when it went over the cliff?



$d_y = \frac{1}{2} g t^2$

$t = \sqrt{\frac{2d_y}{g}}$

$t = \sqrt{\frac{2(54)}{9.8}}$

$t = 3.32\,s$

$d_x = v_x t$

$v_x = \frac{d_x}{t}$

$v_x = \frac{130\,m}{3.32\,s}$

$v_x = 39.1\,m/s$