

Name:

KEY

Date:

Section

C

D

F

The Masters School

Mr. Alex Rawson

DOBBS

Physics



Position and Velocity II

1. The British woman who won the NYC marathon this year, Paula Radcliffe, also holds the world marathon record, 2 h 15 m 25 s. The marathon distance is 42.195 km, or 26.2 miles. Determine her average speed in m/s AND minutes/mile of a runner achieving this record.

$$2 \text{ hrs } 15 \text{ min } 25 \text{ sec} = 8125 \text{ sec}$$

$$V_{\text{avg}} = \frac{\Delta x}{\Delta t} = \frac{42,195 \text{ m}}{8125 \text{ sec}} = 5.19 \text{ m/sec}$$

$$V_{\text{avg}} = \frac{\Delta x (\text{miles})}{\Delta t (\text{min})} = \frac{26.2}{135.4} = .1934 \text{ miles/min}$$

$$\frac{1}{\text{ANS}} = 5.17 \text{ min/mile}$$



2. Runner A is initially 5.0 km west of a flagpole, and is running with a constant velocity of 3.5 km/h due east. Runner B is initially 4.0 km east of the flagpole and is running with a constant velocity of 2.5 km due west. Where are the runners in relation to the flagpole when their paths cross? Give a displacement in kilometers.

$\Delta x_A = 5.25$
 $\Delta x_B = 3.75$
 5 km
 4 km
 0.25 km
 $3.5 \text{ km/h} = V_A \rightarrow$
 $\Delta x_A = ?$
 Δt_A
 $\Delta t_A = \Delta t_B$
 $V_B = 2.5 \text{ km/h} \leftarrow$
 $\Delta x_B = ?$
 Δt_B
 $V = \frac{\Delta x}{\Delta t} \therefore \Delta t = \frac{\Delta x}{V} = \frac{\Delta x_{\text{tot}}}{V_{\text{tot}}} = \frac{\Delta x_A + \Delta x_B}{V_A + V_B} = \frac{9 \text{ km}}{6 \text{ km/h}} = 1.5 \text{ hrs}$
 $\Delta x_A = V_A \Delta t_A = (3.5 \text{ km/h})(1.5 \text{ hrs}) = 5.25 \text{ km}$
 $\Delta x_B = V_B \Delta t_B = (2.5 \text{ km/h})(1.5 \text{ hrs}) = 3.75 \text{ km}$
 $\text{Final Answer} = .25 \text{ km East of flagpole}$

3. A tortoise can run with a speed of .16 m/s, and a hare can run exactly 15 times as fast. In a race, they both start at the same time, but the hare stops to rest for 2.00 min. If the tortoise wins by 20 cm
- a. How long does the race take? Give your answer in seconds, you should get an answer between 100 – 150 seconds.

$$V_T = .16 \text{ m/s} \quad V_H = 2.4 \text{ m/s}$$

$$V = \frac{\Delta X}{\Delta t} \therefore \Delta X_T = V_T \Delta t_T \quad \Delta X_H = V_H \Delta t_H$$

ΔX_T : displacement of tortoise
 Δt_T : amount of time the tortoise ran for
 ΔX_H : displacement of hare, distance hare ran
 Δt_H : amount of time the hare ran for
 V_H : velocity of hare

★ At end of race, tortoise wins by 20 cm, so

$$\Delta X_T = \Delta X_H + .2 \text{ m}$$

$$\Delta X_T = \Delta X_H + .2 \text{ m}$$

At end of race, tortoise has run for 2 min longer than the hare, so

$$\Delta t_T = \Delta t_H + 120 \text{ sec}$$

$$\Delta t_H = \Delta t_T - 120 \text{ s}$$

Find Δt_T (Algebraic method)

$$\Delta X_T = \Delta X_H + .2 \text{ m}$$

$$V = \frac{\Delta X}{\Delta t}$$

$$V_T \Delta t_T = V_H \Delta t_H + .2 \text{ m}$$

$$V_T \Delta t_T = V_H (\Delta t_T - 120 \text{ s}) + .2 \text{ m}$$

↙ distribute

$$V_T \Delta t_T = V_H \Delta t_T - (V_H)(120 \text{ s}) + .2 \text{ m}$$

↖

(Factor)

$$V_T \Delta t_T - V_H \Delta t_T = -(V_H)(120 \text{ s}) + .2 \text{ m}$$

$$\Delta t_T (V_T - V_H) = -(V_H)(120 \text{ s}) + .2 \text{ m}$$

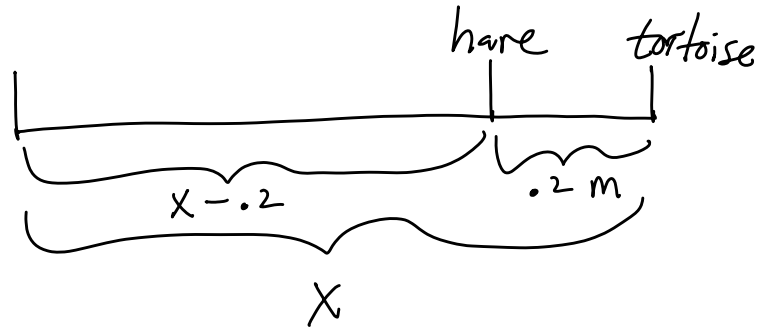
$$\Delta t_T = \frac{-(V_H)(120 \text{ s}) + .2 \text{ m}}{V_T - V_H} = 128 \text{ seconds}$$

$$\Delta X_{\text{race}} = \Delta X_T = V_T \Delta t_T = (.16)(128) = 20.48 \text{ m}$$

A tortoise can run with a speed of .16 m/s, and a hare can run exactly 15 times as fast. In a race, they both start at the same time, but the hare stops to rest for 2.00 min. If the tortoise wins by 20 cm,

- a. How long does the race take? Give your answer in seconds, you should get an answer between 100 – 150 seconds.

Jillian's Method



Velocity of tortoise = .16 m/s

$$V = \frac{\Delta X}{\Delta t}$$

$$.16 = \frac{X}{T}$$

Set X 's equal

$$X = .16T$$

$$X = .16T$$

Velocity of hare = 2.4 m/s

$$V = \frac{\Delta X}{\Delta t}$$

$$2.4 = \frac{X - .2}{T - 120}$$

at end of race,
hare has gone .2m
less than tortoise

at end of race,
hare has ran for
120 seconds less than
tortoise has ran

$$X - .2 = 2.4(T - 120)$$

$$X - .2 = 2.4T - 288$$

$$X = 2.4T - 278.2$$

$$.16T = 2.4T - 278.2$$

Solve for T

$$2.24T = 278.2$$

$$T = 128.4\text{ s}$$