W1.05

Kinematics [Horizontal]-KEY

(9 / 18 / 03)

1) Unit Conversions: A speed can be expressed as any displacement unit divided by any time unit, regardless of how arcane each unit is. An object is found to be moving along at 1 furlong / fortnight. First, find out (without faculty assistance) how large each unit is. Is a furlong / fortnight a relatively fast or slow speed? Convert 1 furlong / fortnight into cm / sec using dimensional analysis.

Note: 1 furlong=220 yds & 1 yd =91.37 cm AND1 fortnight=2 weeks = 14 days & 1 day = 86,400 s
so 220 * 91.37 cm divided by 14 * 86,400 s = .01663 cm / s

2) World class sprinters run 100 meters in approximately 9.9 seconds, milers run 1 mile (1.6 km) in approximately 3.8 minutes, marathoners run 26.2 miles (42 km) in 2.25 hours, and race walkers complete 50 km in 3.6 hours. Compare their average speeds by converting all four speeds into meters / sec.

Sprinters: 100 m divided by 9.9 s = 10.10 m / s Milers: 1,600 m divided by 228 s = 7.017 m / s
Marathoners: 42,000 m divided by 81,000 s = 5.185 m / s
Walkers: 50,000 m divided by 12,960 s = 3.86 m / s

3) Average speed and Frame-of-Reference: A girl on a motorcycle drives west at an average speed of 15m / s while a truck drives east at an average speed of 35m / s. If they both started at the same place at the same time how far apart are they after 2 minutes? What is their average speed relative to each other? $?s_{GIRL}=v(t)$ so $?s_{GIRL}$= -15 m / s(120 s)= -1,800 m
$?s_{TRUCK}=v(t)$ so $?s_{TRUCK}$= +35 m / s(120 s)= +4,20000 m so 6,000 meters apart
Speed of girl relative to truck is 50 m / s west [every sec the girl moves 50 m west of truck]
Speed of truck relative to girl is 50 m / s east [every sec the truck moves 50 m east of girl]

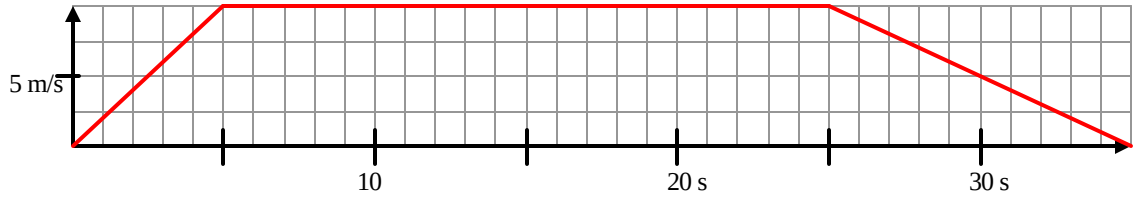
4) Average Speed: When I travel to work every morning I travel for 10 minutes at an average speed of 20 meters / sec and for the next 35 minutes at an average speed of 30 m / s. What is my average speed for the entire trip? (For your information, 30m / s is just a bit over 60mph)

Average speed =total distance divided by total time
Total distance = 20 m / s x 600 s + 30 m / s x 2,100 s = 12,000 m+63,000 m =75,000 m
Total time =600 s + 2,100 s =2,700 s
so avg. speed = 75,000m divide by 2,700 s = 27.8 m / s

5) Average Speed: A man travels 500m at an average speed of 20m / s and 200m at an average speed of 5m / s. How long would it take the man to travel the remaining 1300m of his trip if he wants to average 25m / s for the entire trip (overall)?

total time=total distance divided by avg speed total time=2,000 m divided by 25 m / s = 80 s
$t_{PART\ III}$ = total time – [$t_{PART\ I}$ + $t_{PART\ II}$]
t_{PARTI} = $dist_{PARTI}$ divided by avg $speed_{PARTI}$ =500 m divided by 20 m / s = 25 s
t_{PARTII} = $dist_{PARTII}$ divided by avg $speed_{PARTII}$ =200 m divided by 5 m / s = 40 s
$t_{PART\ III}$ =total time – [$t_{PART\ I}$ + $t_{PART\ II}$] = 80 s – 65 s =15 s

6) Velocity graphs: A bus uniformly increases its speed from 0 to 10m / s in 5 seconds, proceeds at a constant speed (of 10m / s) for 20 seconds and then uniformly slows down from 10m / s to a stop in 10 seconds. Draw a graph showing the speed of the bus as a function of time. Estimate how far the bus went in those 35 seconds.



7) Average speed: A student walks from the Physics lab to the middle school wing and back again. The student averages 6m / s on her way to the middle school (trotting!) and 2m / s on her way back. Is her average speed for the two-way trip less than 4m / s, 4m / s or greater than 4m / s? Write a clear, careful explanation of your reasoning. CHALLENGE-Calculate (exactly) her average speed (this **can** be done!).

Assume one way distance is 12 meters i.e. 2 sec going & 6 sec returning
so avg speed =24 m divided by 8 s =3 m / s