Physics 11 H – Kinematics – Feb 7, 2024

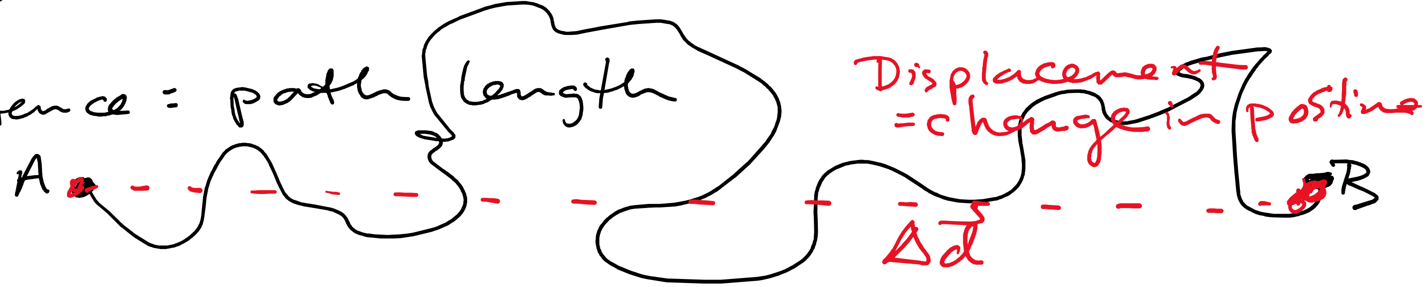
Kinematics: Study of motion without considering the cause of motion (Force). Involves mathematical description of motion.

Dynamics: Study of motion with consideration of the cause of motion (Force)

Variables in kinematics

scalars	vectors
speed = v	velocity: $\vec{v}$
distance = d	displacement = $\vec{d}$
time: t	acceleration: $\vec{a}$

Distance = path length



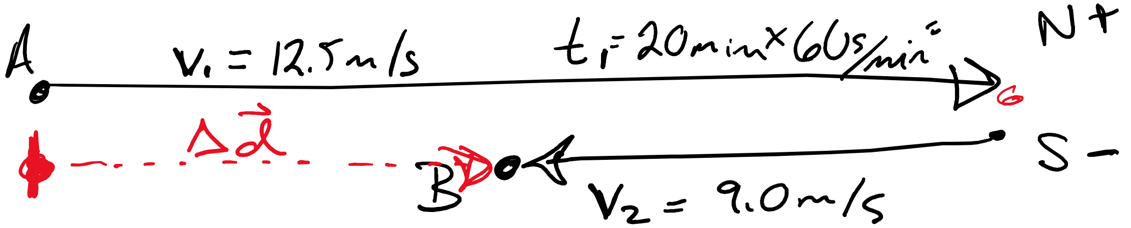
$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\boxed{v = \frac{d}{\Delta t}}$$

$$\text{velocity} = \frac{\text{displacent}}{\text{time}}$$

$$\boxed{\vec{v} = \frac{\Delta \vec{d}}{\Delta t} = \frac{d_f - d_i}{\Delta t}}$$

1.



$t_2 = 10.0\,min \times \frac{60\,s}{min} = \underline{\qquad}\,s$

$$\boxed{d = v \cdot t}$$

(a) $\text{dist} = v_1 t_1 + v_2 t_2$

$= (12.5)(20 \times 60) + (9 \times 10 \times 60)$

$= \underline{20400\ m}$

(b) displacent $\Delta d = \vec{v}_1 t_1 + \vec{v}_2 t_2$

$= (12.5 \times 20 \times 60) + (-9 \times 10 \times 60)$

$= \underline{9600\ m\ [N]}$

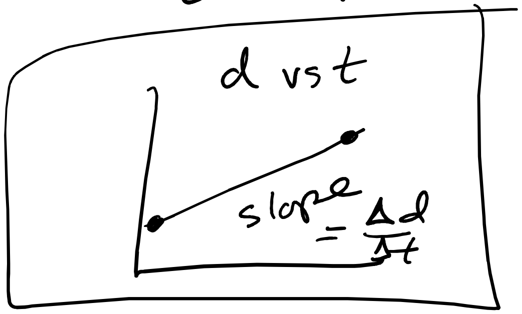
(c) $\text{speed} = \frac{d}{t} = \frac{20400\,m}{(20+10) \times 60\,s} = \boxed{11.33\,m/s}$

(d) $\vec{v} = \frac{\Delta d}{\Delta t} = \frac{9600\,m}{(20+10) \times 60\,s} = \boxed{5.33\,m/s\ [N]}$

2. $v = 45.0 \text{ km/h} = \frac{45 \times 1000 \text{ m}}{3600 \text{ s}} = \frac{45}{3.6} \text{ m/s}$

$d = 6500 \text{ m}$

$t = ?$



$$v = \frac{d}{t}$$

$$\frac{t \cdot v}{v} = \frac{d}{v}$$

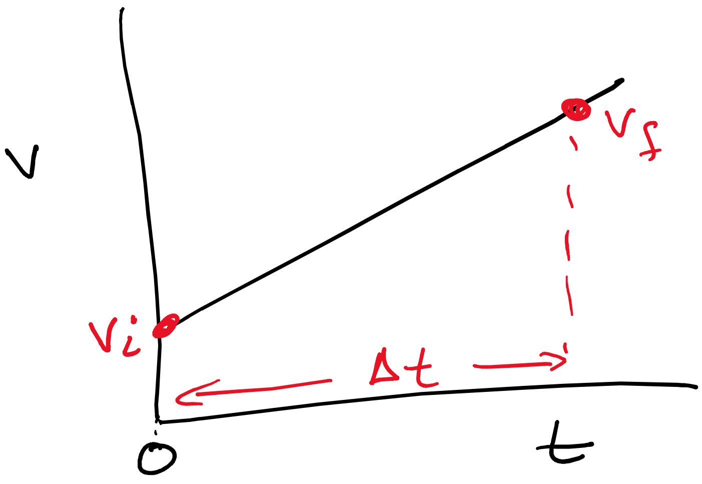
$$t = \frac{d}{v} = \frac{(6500 \text{ m})}{(45/3.6) \text{ m/s}} = \underline{\qquad\qquad} \text{ s}$$

Constant $\vec{a}$

→ 4 <u>kinematics eq'ns</u>

- Slope of $\vec{d}$ vs t graph = $\boxed{\frac{\Delta d}{\Delta t} = \vec{v}}$

$\vec{v}$ vs t



Slope of $\vec{v}$ vs t

$$\boxed{\vec{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}}$$

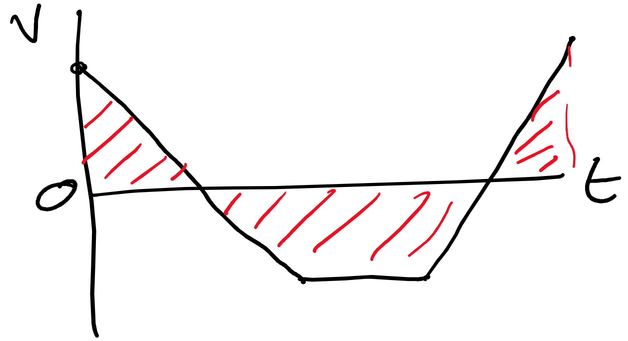
= Rate of change of velocity

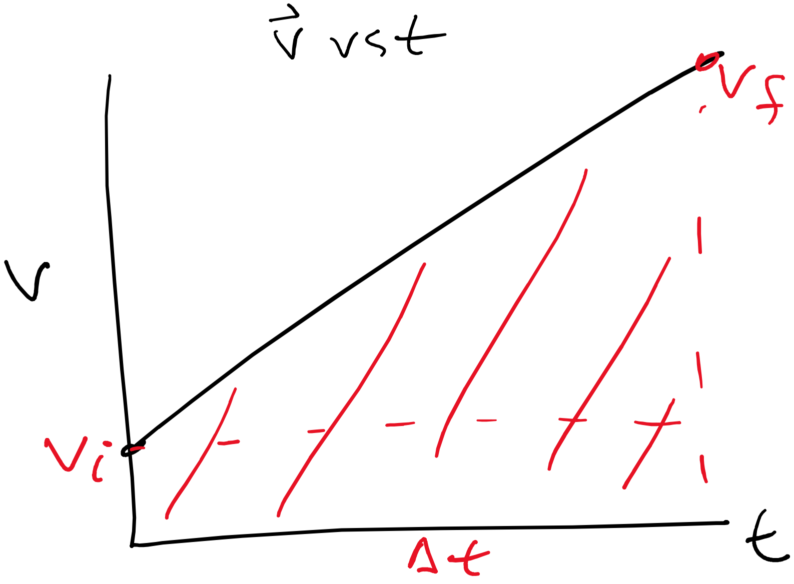
$$\vec{a} \cdot \Delta t = \vec{v}_f - \vec{v}_i$$

Kin eq^n #1

$$\boxed{\vec{v}_f = \vec{a}\,\Delta t + \vec{v}_i}$$

Area under curve = area between the curve (line) and x axis.





$$\underline{\text{area}} = \boxed{\frac{1}{2}(\vec{v}_i + \vec{v}_f)\Delta t = \Delta\vec{d}}$$

$$\underline{\text{units.}} \quad \left(\frac{m}{\cancel{s}}\right)\cancel{s} = \underline{\underline{m}}$$

$$\boxed{\Delta d = \frac{1}{2}(\vec{v}_i + v_f)\Delta t}$$

Kin eqn #2

equation	variables	
	has	missing
$\vec{v}_f = \vec{a}t + \vec{v}_i$	$\vec{v}_i$, $\vec{v}_f$, $\vec{a}$, t	$\Delta\vec{d}$
$\Delta\vec{d} = \frac{1}{2}(\vec{v}_i + \vec{v}_f)\Delta t$	$\vec{v}_i$, $\vec{v}_f$, $\Delta\vec{d}$, t	$\vec{a}$
$\Delta d = \frac{1}{2}\vec{a}\Delta t^2 + \vec{v}_i t$	v_i, Δd, $\vec{a}$, Δt	$\vec{v}_f$
$\vec{v}_f^{\,2} = 2\vec{a}\Delta\vec{d} + \vec{v}_i^{\,2}$	v_i, v_f, $\vec{a}$, $\vec{d}$	Δt

③ $$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$$

$$\Delta d = \frac{1}{2}(v_i + at + v_i)\Delta t$$

$$\Delta d = \frac{1}{2}(2v_i + a\Delta t)\Delta t$$

$$\Delta d = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$\Delta d = \frac{1}{2}at^2 + v_i t$$

$$\Delta t = \left(\frac{v_f - v_i}{a}\right)$$

④ $$\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$$

$$\Delta d = \frac{1}{2}(v_i + v_f)\left(\frac{v_f - v_i}{a}\right)$$

$$2a\Delta d = \cancel{v_i v_f} - v_i^2 + v_f^2 - \cancel{v_i v_f}$$

$$\boxed{v_f^2 = 2a\Delta d + v_i^2}$$

①

$v_i = 35.0 m/s$

$\Delta t = 0.015 s$

$v_f = 0.0 m/s$

$a = ?$

$\Delta d = ?$

(a) $v_f = \underline{a}t + v_i$

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

$$= \frac{0 m/s - 35.0 m/s}{0.015 s}$$

$$a = -2333.33 m/s^2$$

$$\boxed{\vec{a} = -2.3 \times 10^3 m/s^2}$$

$$\frac{\frac{m}{s}}{s} = \frac{m}{s} \times \frac{1}{s}$$

$$= \frac{m}{s^2}$$

(b) $\Delta d = \frac{1}{2}(v_i + v_f)\Delta t$

$$\boxed{\Delta d = 0.26 m}$$

2. $v_i = 38.0 m/s$

$\vec{a} = -5.0 m/s^2$

$v_f = 100 km/h = \left(\frac{100}{3.6}\right) m/s$

$\rightarrow +$

$\leftarrow -$

$\Delta t = ?$

$\Delta d = ?$

$\cancel{\Delta} v_f^2 = 2a\underline{\Delta d} + v_i^2$

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

(b) $v_f = a\underline{t} + v_i$

$$t = \frac{v_f - v_i}{a} = \frac{\left(\frac{100}{3.6}\right) - 38}{-5} = \underline{2.0s}$$

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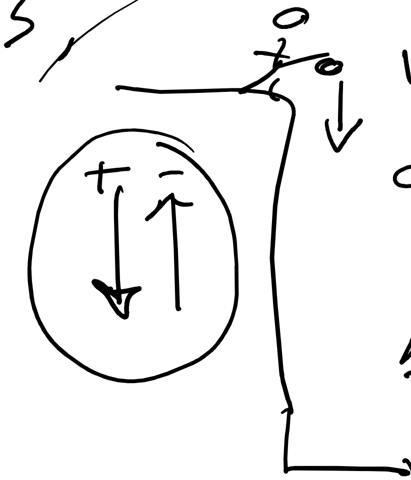


$v_i = 0 m/s$

$a = g = 9.80 m/s^2$

$\Delta t = 4.5 s$

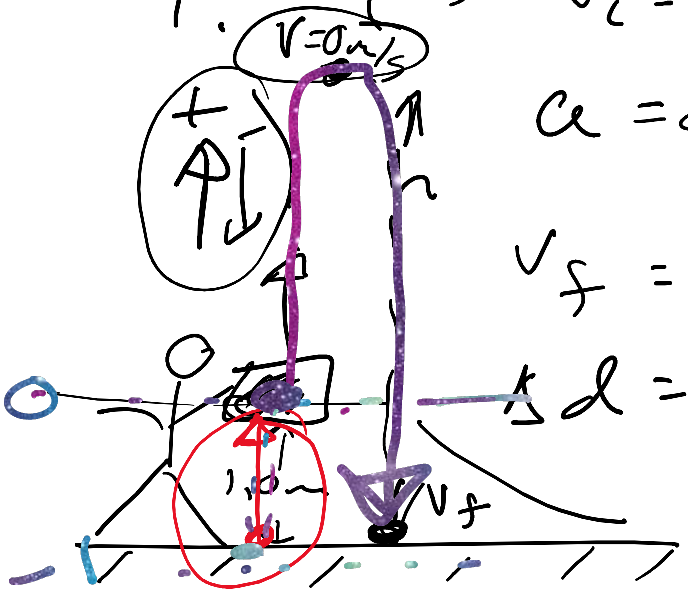
$v_f = ?$

$\Delta d = ?$

$v_f = at + v_i$

$\Delta d = \frac{1}{2}at^2 + v_i t^{\cancel{2}}$

7. (a) $v_i = 8.0 m/s$



$a = g = -9.8 m/s^2$

$v_f = 0.0 m/s$

$\Delta d = ?$

~~Δd~~

$\cancel{v_f^2}^{0} = 2a\underline{\Delta d} + v_i^2$

$$\frac{\cancel{2a}\Delta d}{\cancel{2a}} = \frac{-v_i^2}{2a}$$

$$\Delta d = \frac{-(8)^2}{2(-9.8)} = 3.265m$$

$$\boxed{h = 4.3m}$$

(b) $v_i = 8.0 m/s$

$a = -9.8 m/s^2$

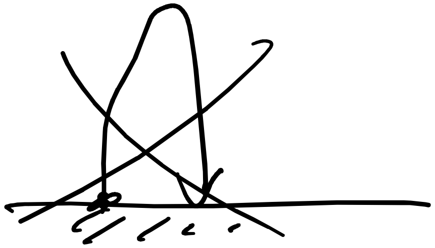
~~$v_f = ?$~~

$\Delta d = -1{,}0\,\text{m}$

$\Delta t = ?$

$$\boxed{\Delta d = \frac{1}{2}at^2 + v_i t}$$

$$0 = \frac{1}{2}at^2 + v_i t - \Delta d$$



$$0 = \frac{1}{2}(-9.8)t^2 + 8t - (-1)$$

$$\boxed{0 = -4.9t^2 + 8t + 1}$$

$$t = \frac{-8 \pm \sqrt{8^2 - 4(-4.9)(1)}}{2(-4.9)}$$

$$\boxed{t = 1{,}7\,\text{s}} \text{ or } \boxed{-0{,}117\,\text{s}}$$