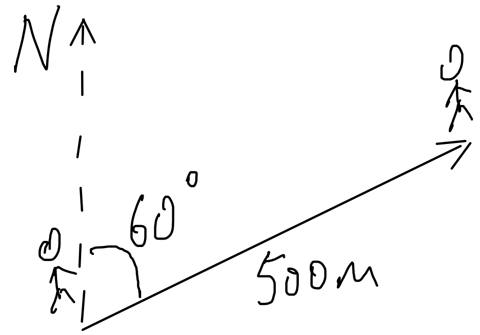
Displacement, velocity, acceleration

Dr. K.M. Hock

Displacement - distance & direction (vector)

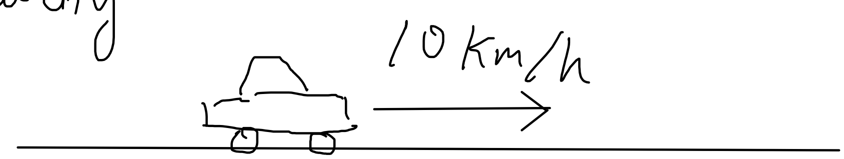
e.g.



Full description

500 m,
bearing 060°

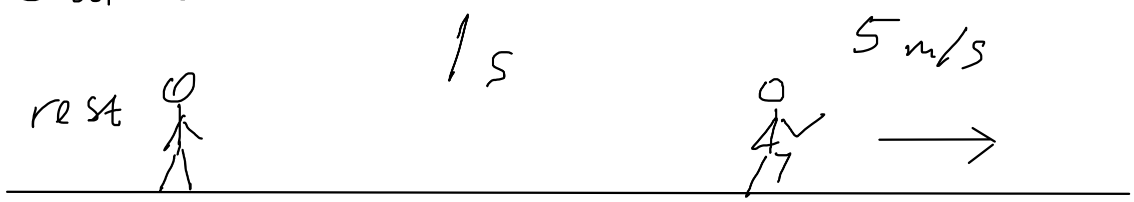
Velocity (vector)



e.g. 10 km/h, to the right.

Speed: just 10 km/h (leave out direction info).

Acceleration. (vector)



rate of change of velocity

$$= \frac{\text{final} - \text{initial velocity}}{\text{time taken}}$$

$$= \frac{5\ m/s}{1\ s} = 5\ m/s^2 \text{ to the right.}$$

use graphical methods to represent distance travelled, displacement, speed, velocity and acceleration

Graphs

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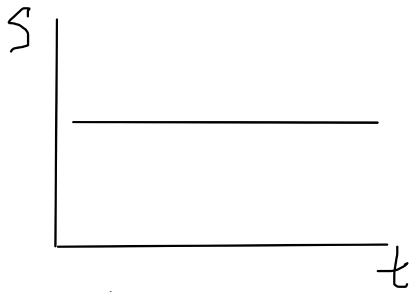
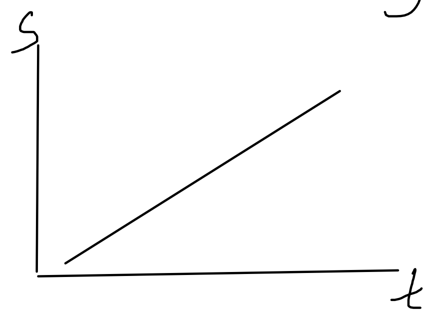
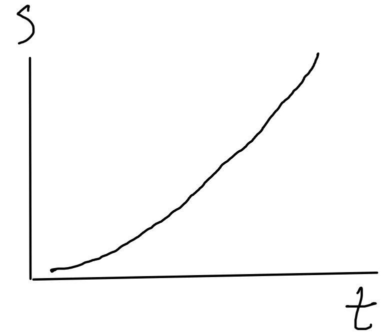
Displacement

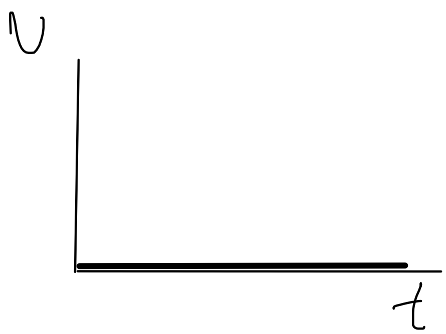
At rest | Constant Velocity | Accelerate

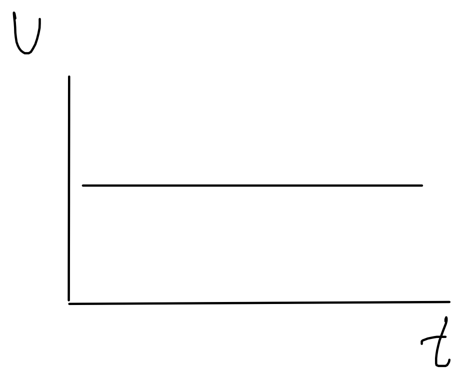


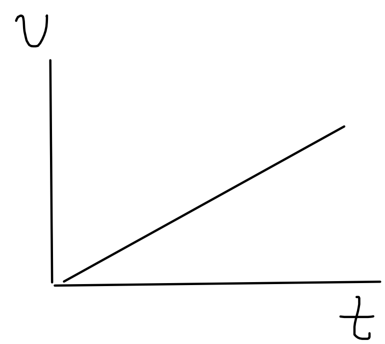




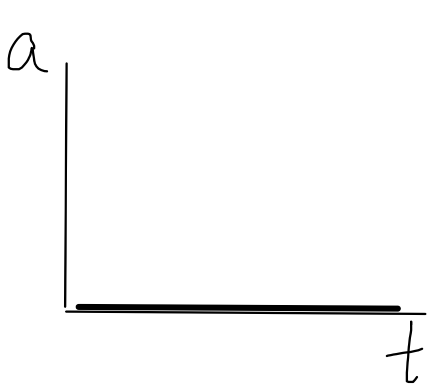
Velocity

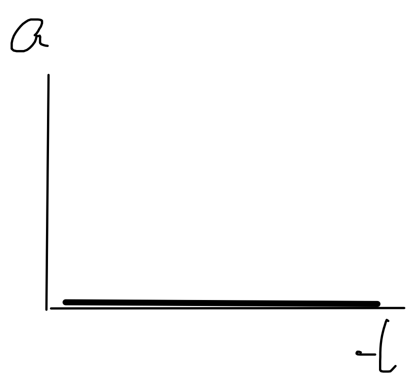


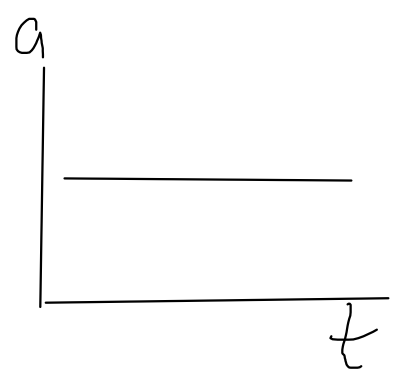




Acceleration



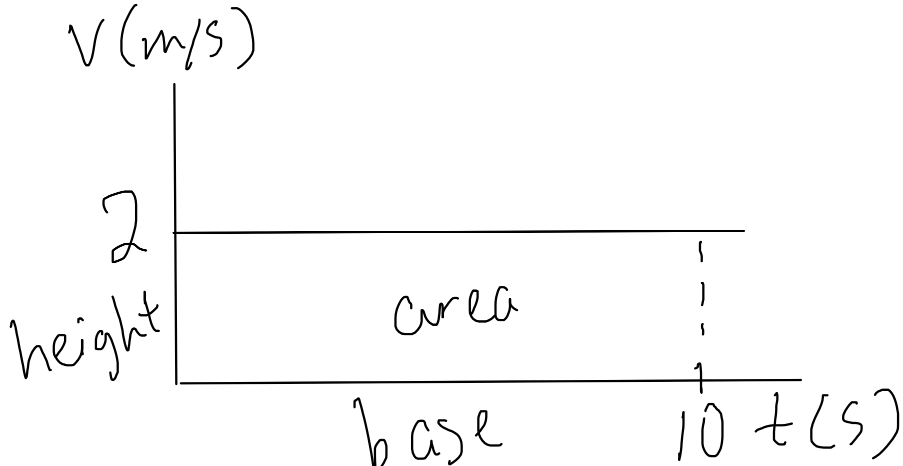




find displacement from the area under a velocity-time graph

Velocity-time graph (displacement) Dr. K.M. Hock

e.g. constant velocity

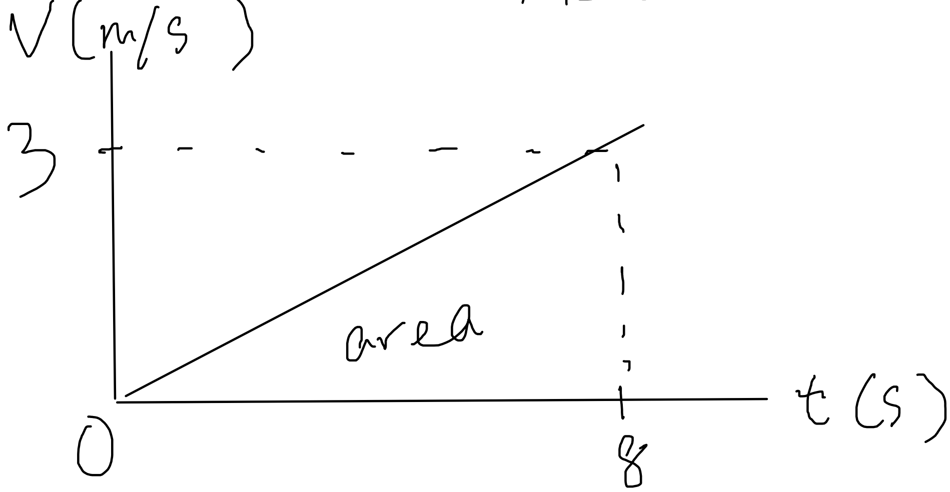


displacement = velocity × time

= 2 × 10

= height × base = area !

e.g. accelerating } extend idea



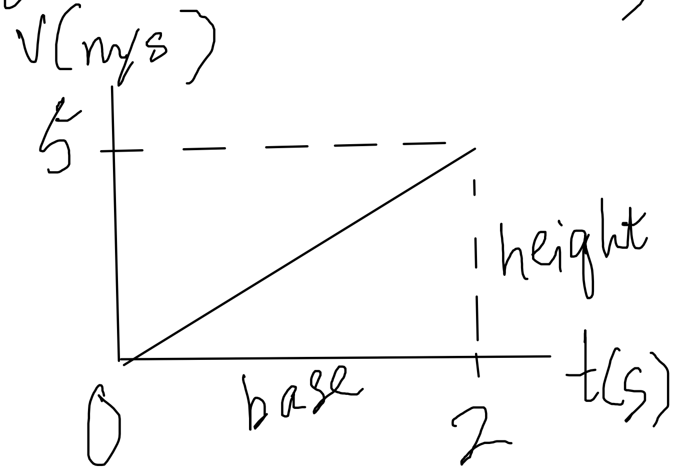
displacement = area

$= \frac{1}{2} \times 8 \times 3 = 12$ m.

use the slope of a velocity-time graph to find the acceleration

Velocity-time graph (acceleration) Dr K M Hock

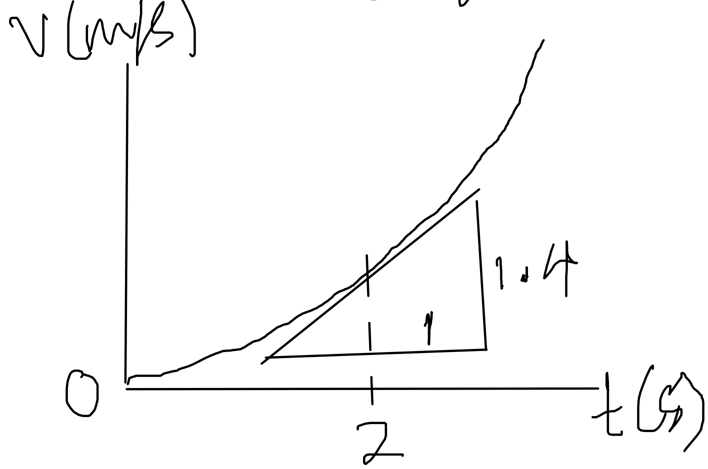
e.g. uniform velocity



$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$\frac{5}{2} \leftarrow = \frac{\text{height}}{\text{base}} = \text{gradient}$$

e.g. Changing velocity



At $t = 2$, instantaneous velocity $= 1.4 \div 2$

= gradient

derive, from the definitions of velocity and acceleration, equations which represent uniformly accelerated motion in a straight line

Acceleration equations

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t time

s displacement

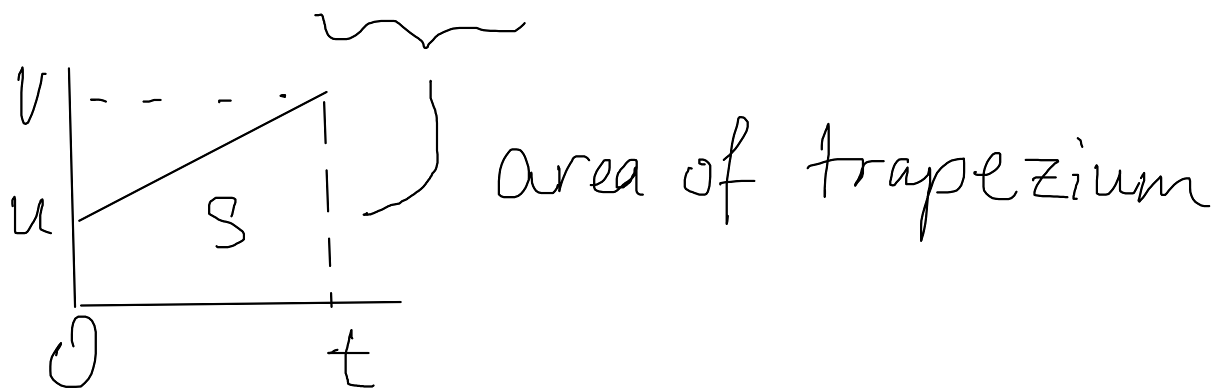
u initial velocity

v final "

a acceleration

1. $a = \frac{v-u}{t}$

2. $s = \frac{u+v}{2} t$



3. $s = ut + \frac{1}{2}at^2$

Eq. 1 → $v = u + at$ → Eq. 2

4. $v^2 = u^2 + 2as$

Eq. 1 → $v - u = at$

Eq. 2 → $u + v = \frac{2s}{t}$

multiply

solve problems using equations which represent uniformly accelerated motion in a straight line, including the motion of bodies falling in a uniform gravitational field without air resistance

Solve Problems

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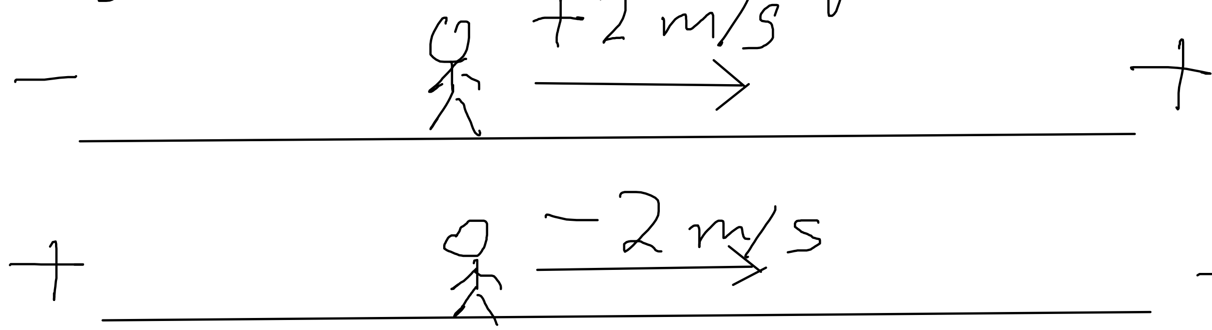
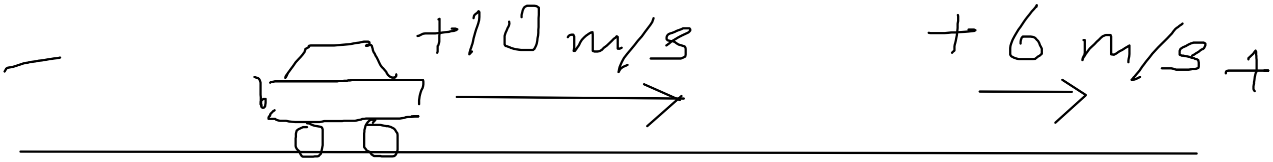
e.g. direction and signs



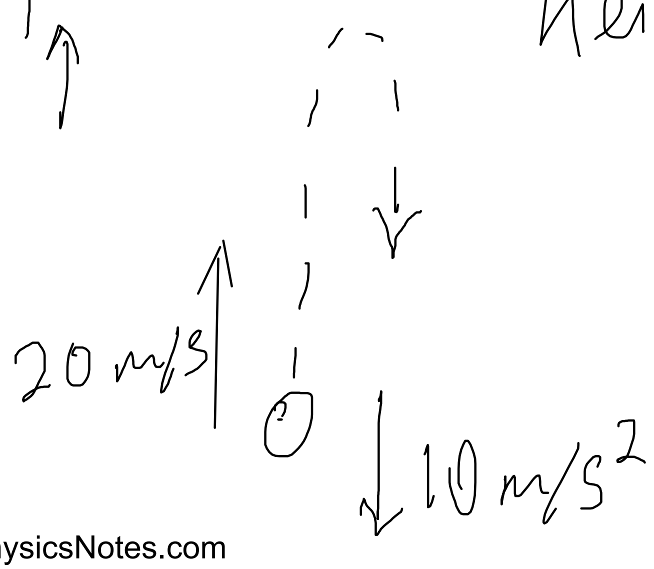
e.g. deceleration



$$a = \frac{6-10}{2} = -2\ m/s^2$$

← direction opposite to velocity.

e.g. free fall



height?

$+20$ m/s $\quad -10$ m/s^2

$$v^2 = u^2 + 2as$$

v → 0 m/s $\quad s$ → height

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describe qualitatively the motion of bodies falling in a uniform gravitational field with air resistance

Air Resistance

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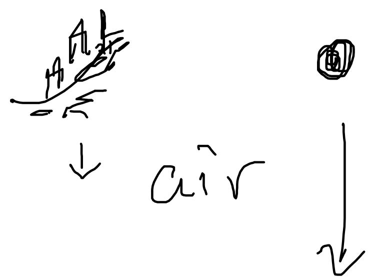
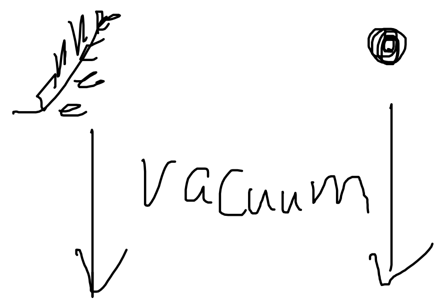
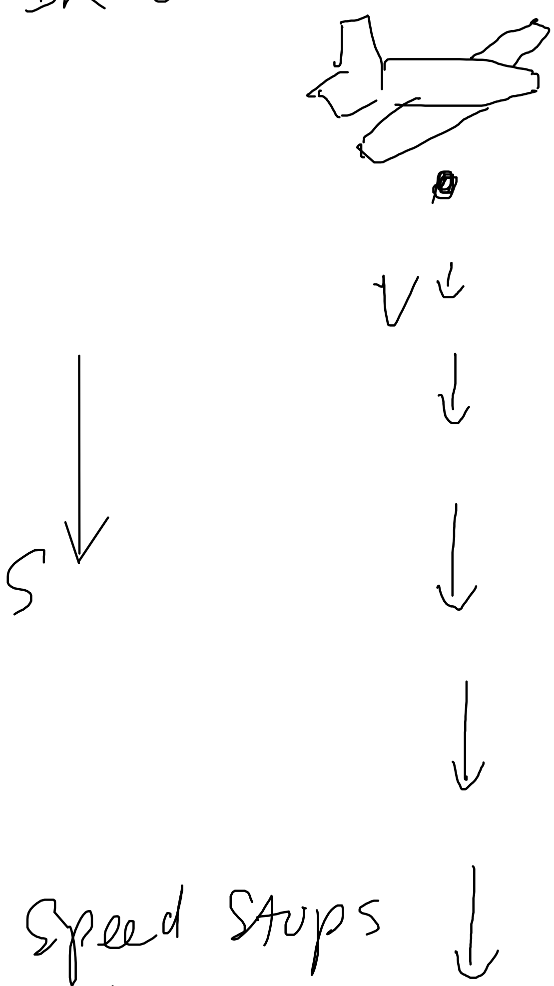
On earth



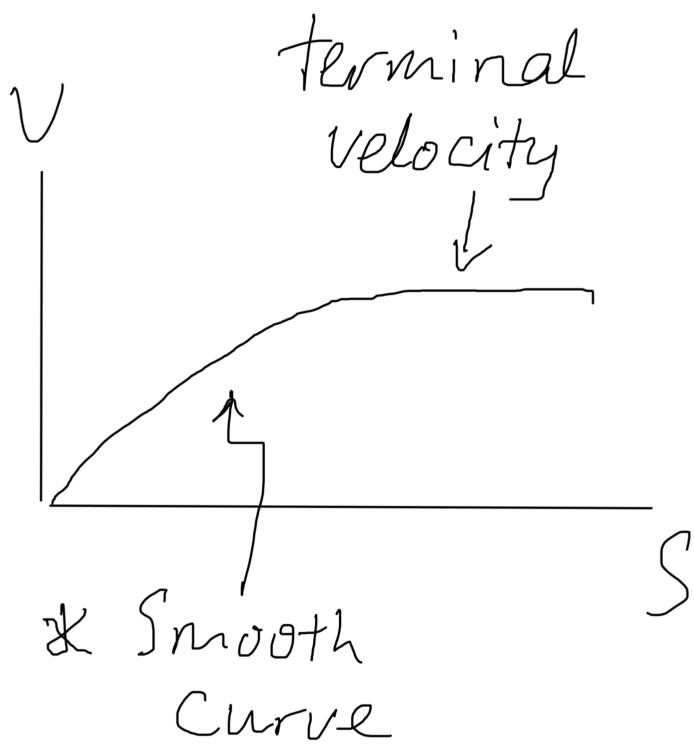
On moon



In air:



Speed stops increasing



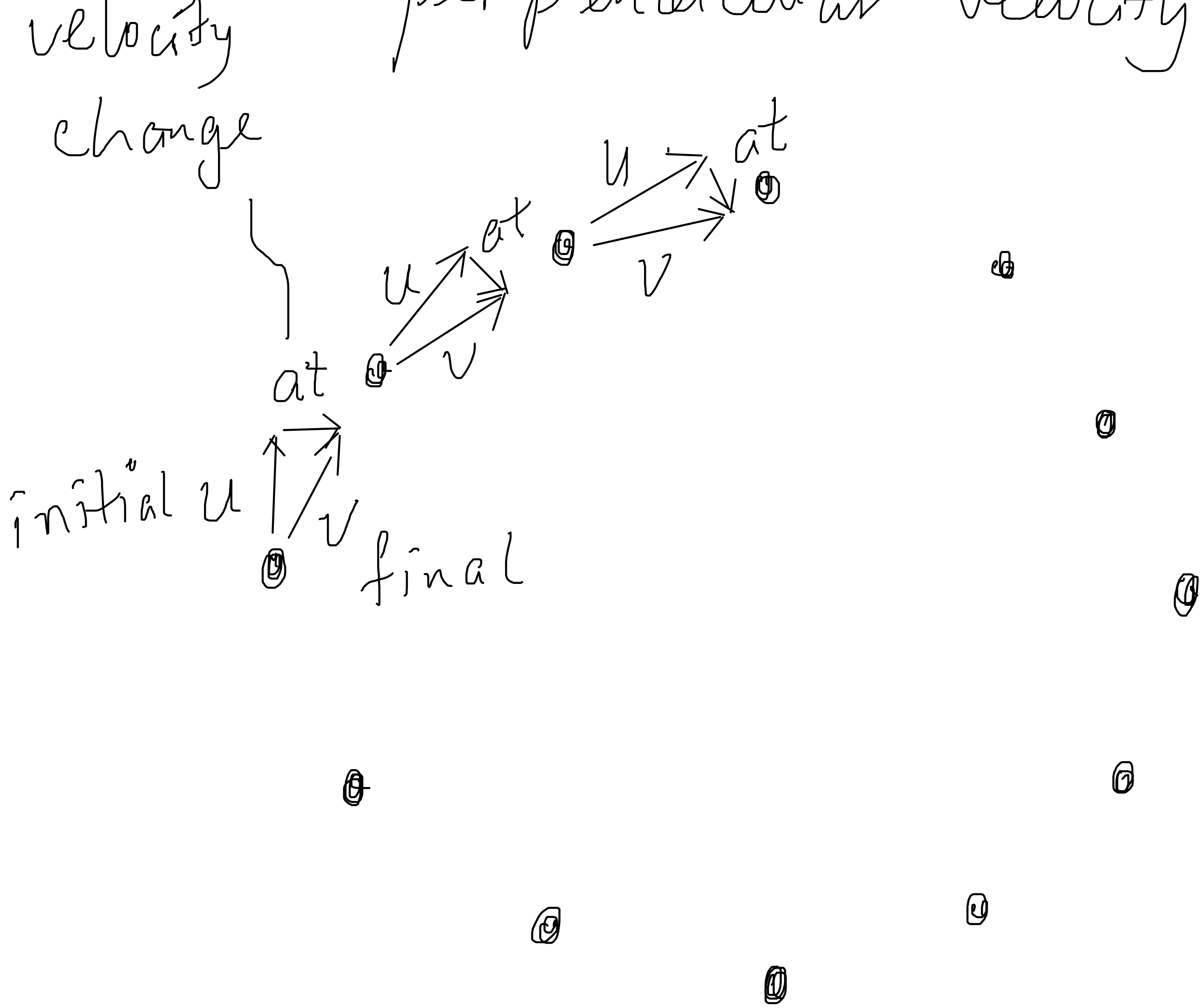
describe and explain motion due to a uniform velocity in one direction and a uniform acceleration in a perpendicular direction.

Perpendicular Acceleration

DrKMHock

↓

perpendicular velocity change



- body goes round in circle -