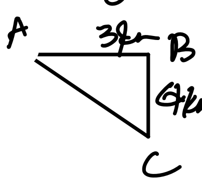
Kinematics

Distance → the length of path of movement is called distance. It is a scalar quantity. unit → metre

Displacement → the distance moved in a particular direction. This is the shortest path length between two points. vector quantity.

eg. A person moves from A to B to C



distance = 7km   displacement = 5km

speed = rate of change of distance

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

scalar quantity   unit → ms^{-1}

velocity = Rate of change of displacement

$$velocity = \frac{displacement}{time}$$

vector quantity   unit → ms^{-1}

Acceleration: rate of change of velocity.

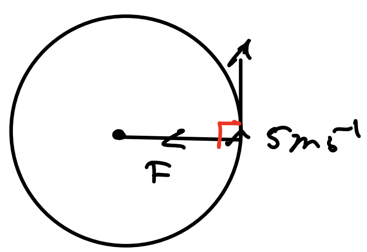
$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$a = \frac{v-u}{t} \qquad ms^{-2}$$

$$\text{Uniform acceleration} = \frac{\text{same change of velocity}}{\text{same time}}$$

eg

let an object is moving in a circular path with constant speed of 5 m/s.



Relative Velocity

Sometimes it is necessary to consider the velocity of an object relative to second moving object. This is called relative velocity.

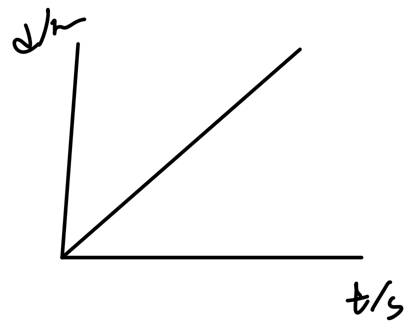
The relative velocity of an object A as seen from object B.

$V_{AB} = \vec{V}_A - \vec{V}_B$

which follows vector sum.

$V_{AB} = 5 - (-2)$
$= 7$

Displacement-time graph

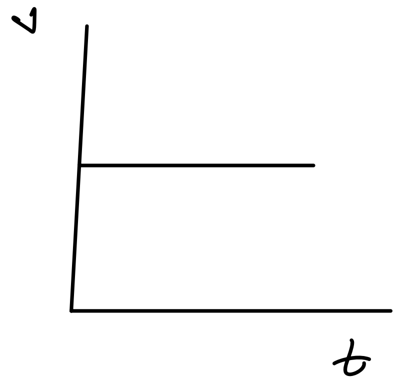


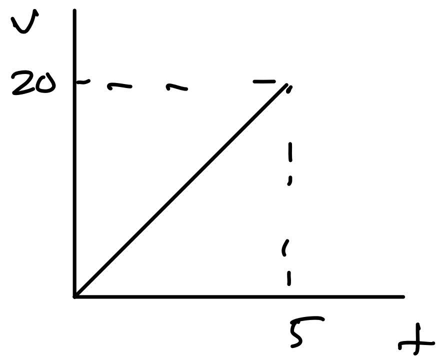
gradient of d-t graph = velocity

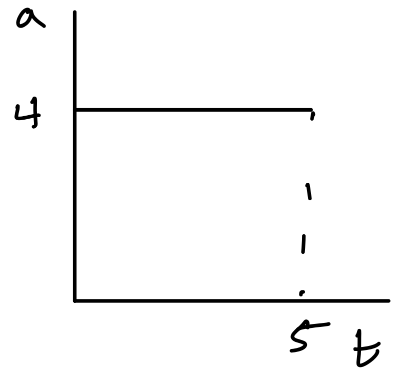
Constant Velocity

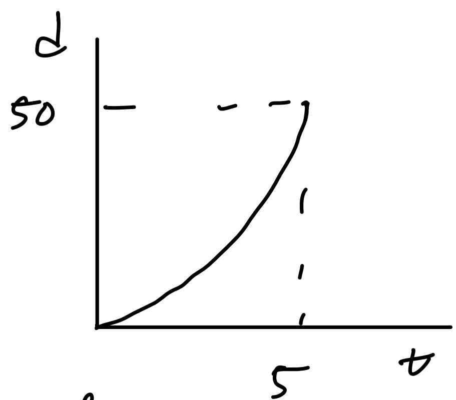
* Gradient of v-t graph = acceleration

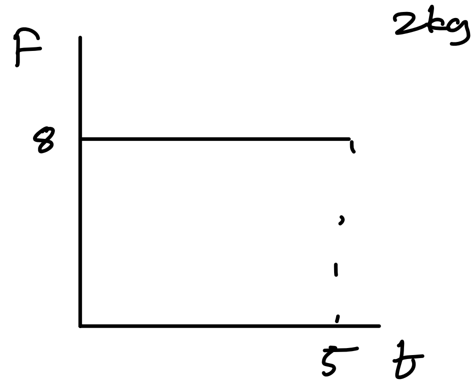
* Area under v-t graph = displacement

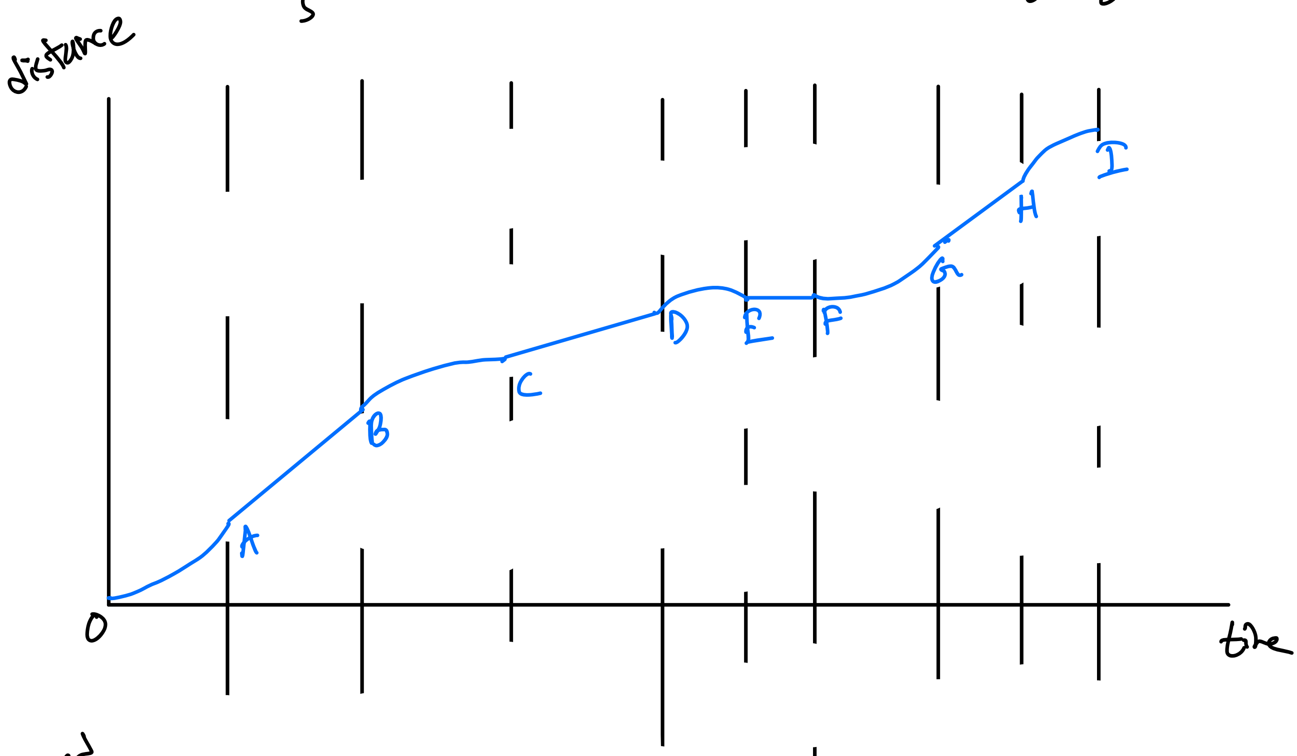


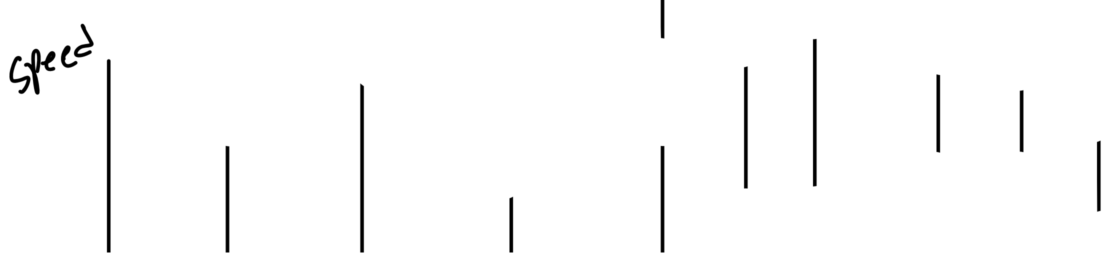

v
20
5
t

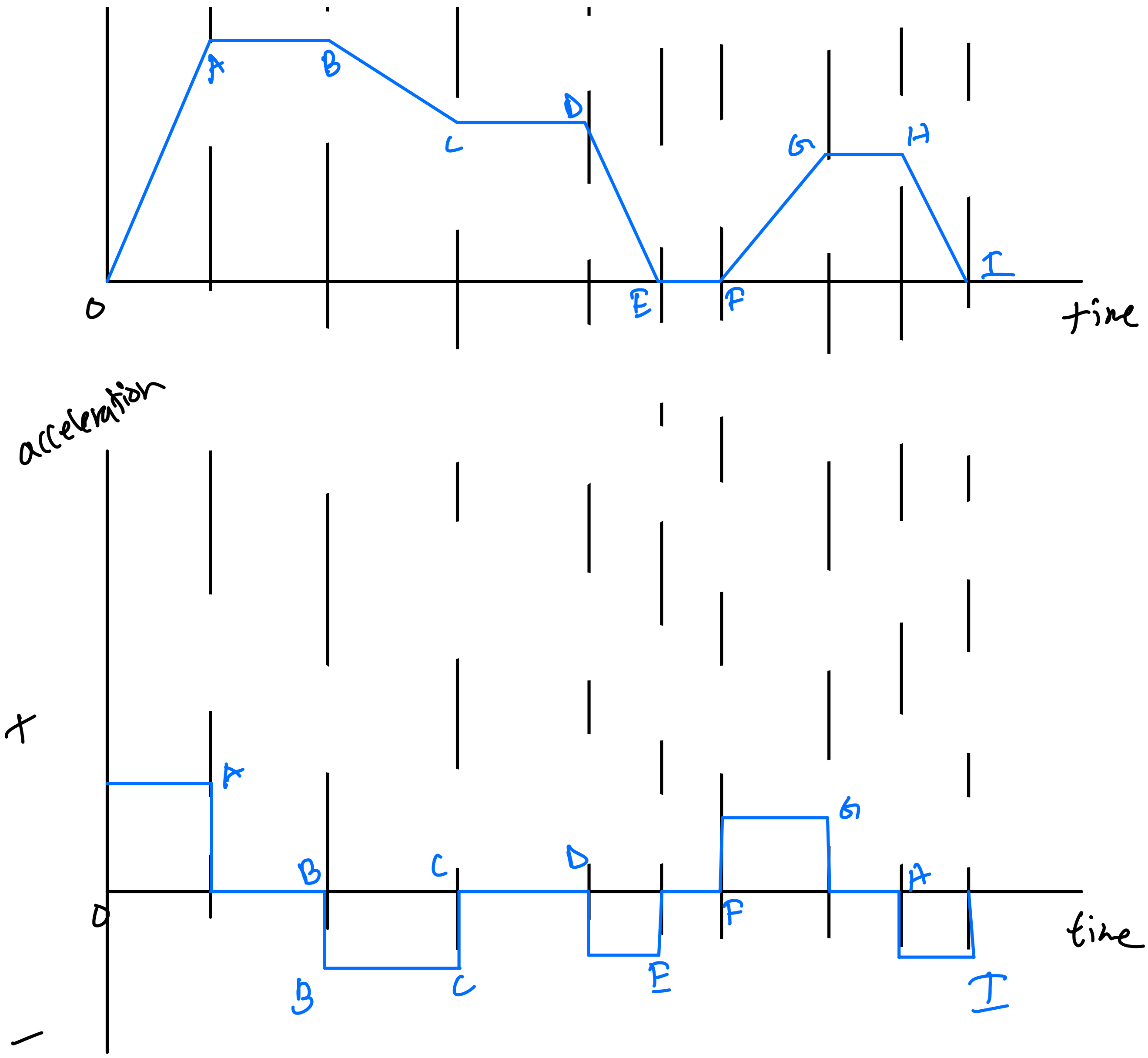

a
4
5
t


d
50
5
t


2kg
F
8
5
t

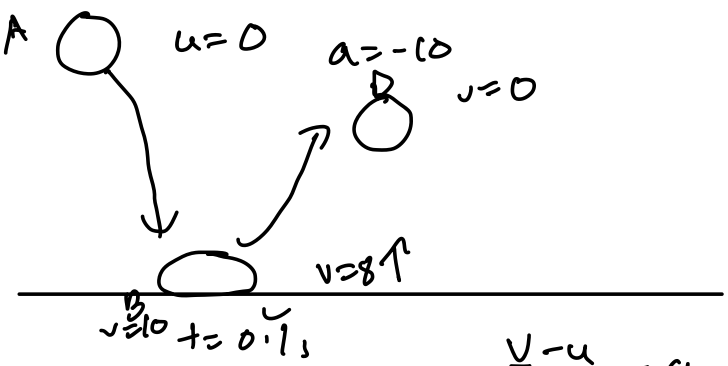

distance
A
B
C
D
E
F
G
H
I
0
time


speed



A
B
C
D
E
F
G
H
I
0
time
acceleration
+
A
B
C
D
F
G
H
0
time
B
C
E
I
–

* Motion of a bouncing ball



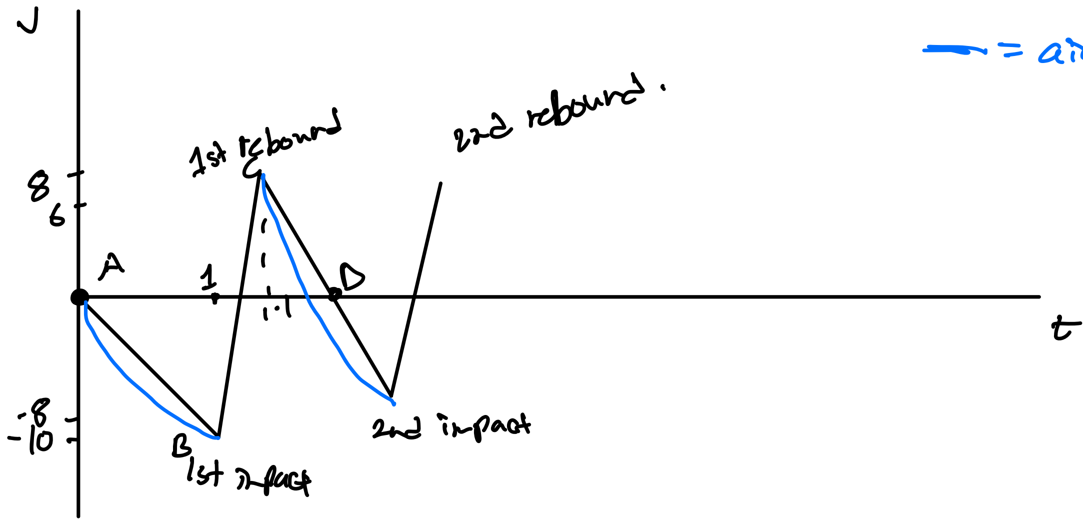
$$\frac{v-u}{t} = a$$

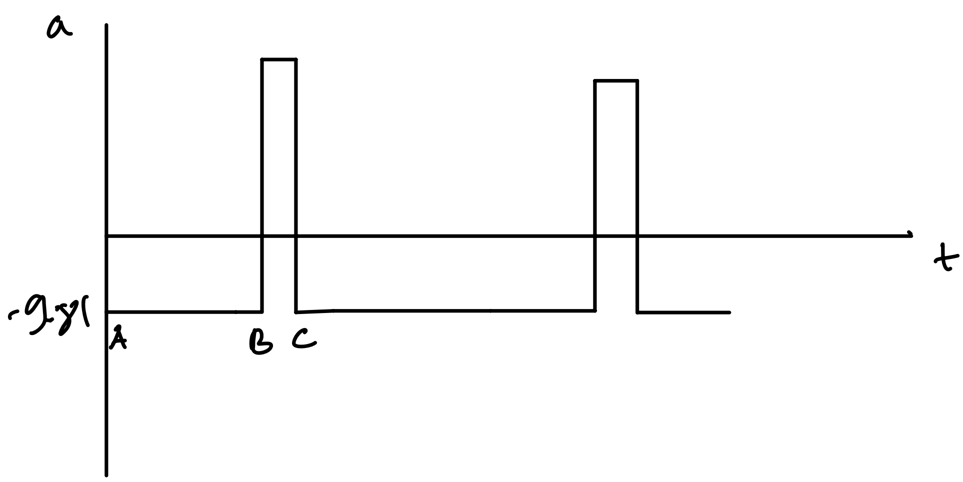
$$a = \frac{v-u}{t}$$

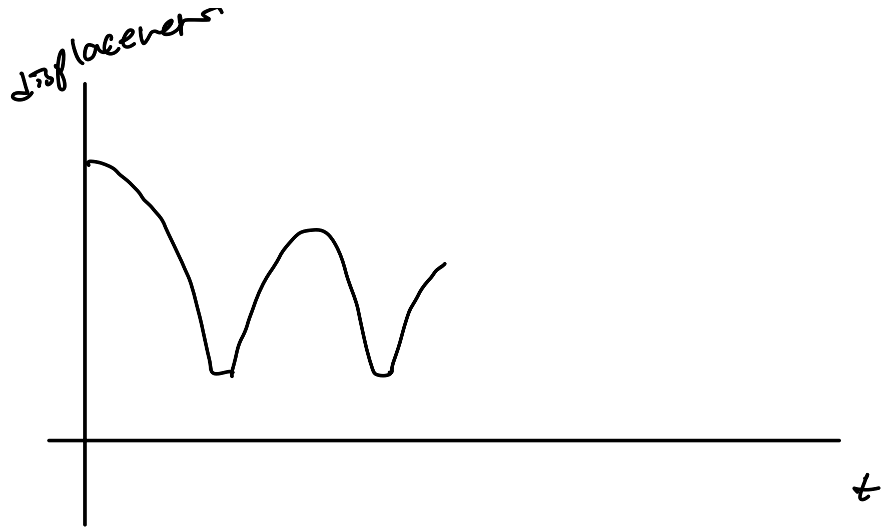
$$\Rightarrow \frac{8 - -(10)}{0.1}$$

$$\Rightarrow 160\ ms^{-2}$$

— = air resistance

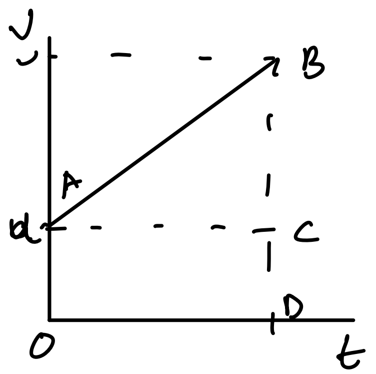






*ticker tape

Equation of motion



area = OACD + ABC

$s = ut + \frac{1}{2}(v-u)t$

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

$v - u = at$

$s = ut + \frac{1}{2}at^2$ (ii)

Average speed : $\frac{u+v}{2}$

$s = \left(\frac{u+v}{2}\right)t$

$v = u + at$

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

$\Rightarrow \left(\frac{u+v}{2}\right)\left(\frac{v-u}{a}\right)$

$\Rightarrow s = \frac{v^2 - u^2}{2a}$

$v^2 = u^2 + 2as$ (iii)

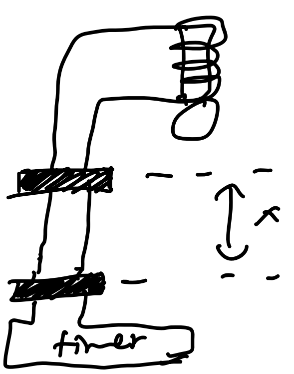
Expt → To find acceleration of free fall (g)

For falling object $s = ut + \frac{1}{2}at^2$

$x = 0 + \frac{1}{2}gt^2$

$g = \frac{2x}{t^2}$

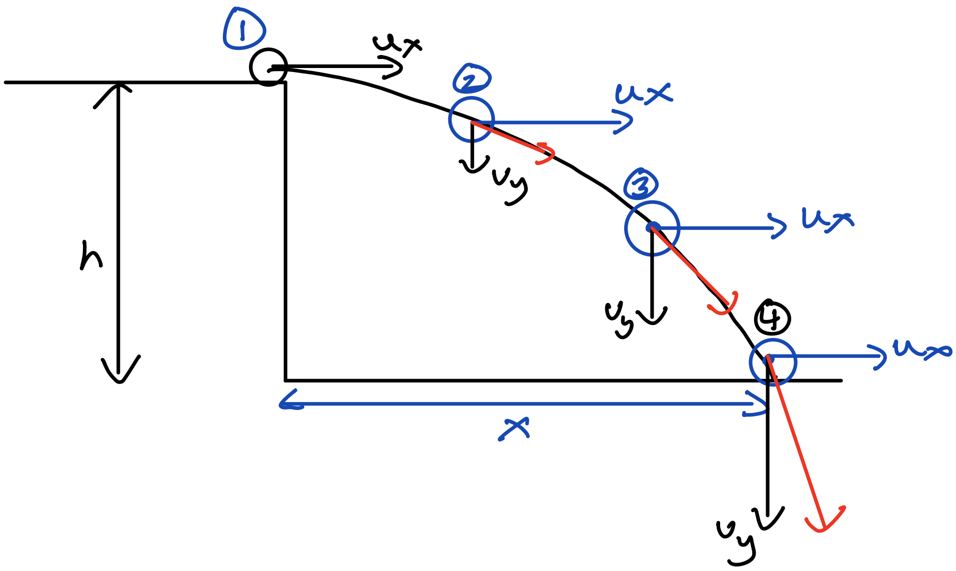
A steel sphere is released from an electromagnet and falls under gravity. As it falls, it passes through light gates which switch an electronic timer on and off. Find x and t, we can get g.



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

Projectile

$v_y^2 = 2gh$



Vertical motion

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

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

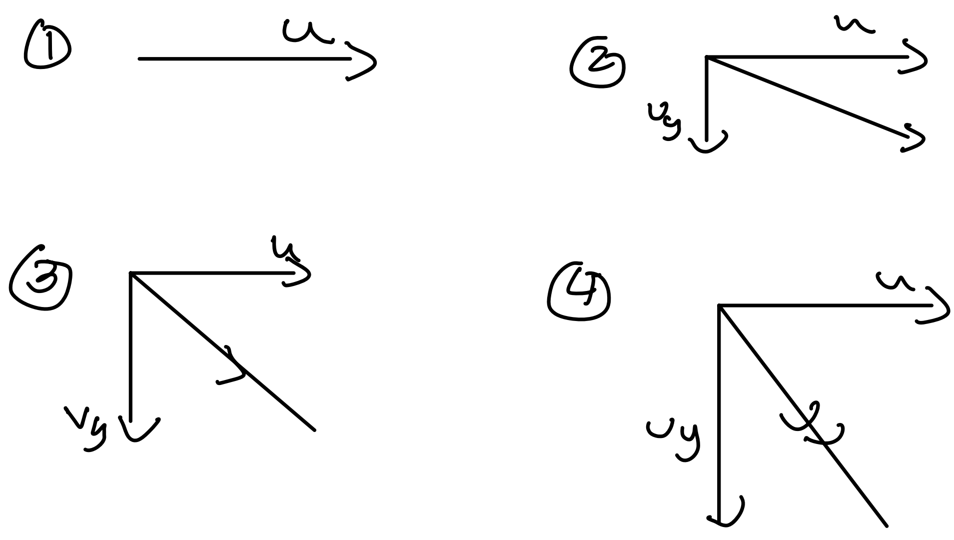
$v = u + gt$

$v_y = gt$

horizontal motion

$u_x = \frac{x}{t}$

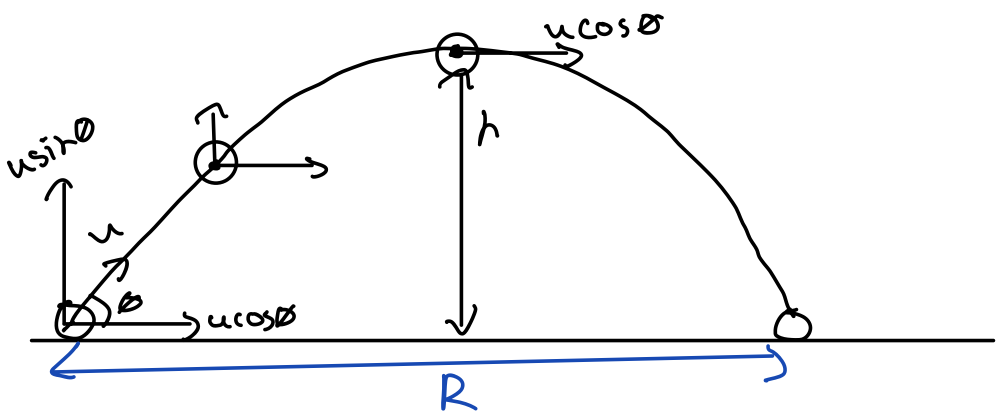
air resistance zero



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

$$v_y^2 = 2gh$$

** Angular Projectile



<table><tr><td>

vertical motion

$v = u + at$

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horizontal motion

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

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$0 = u\sin\theta - gt$

$t = \frac{u\sin\theta}{g}$

$u\cos\theta = \frac{R}{2t}$

$R = u\cos\theta \times 2t$

$R = u\cos\theta \times \frac{2u\sin\theta}{g}$

$R = \frac{2u^2\cos\theta\sin\theta}{g}$

$R = \frac{u^2\sin 2\theta}{g}$

* At $45° = \theta$ projectile travels furthest.