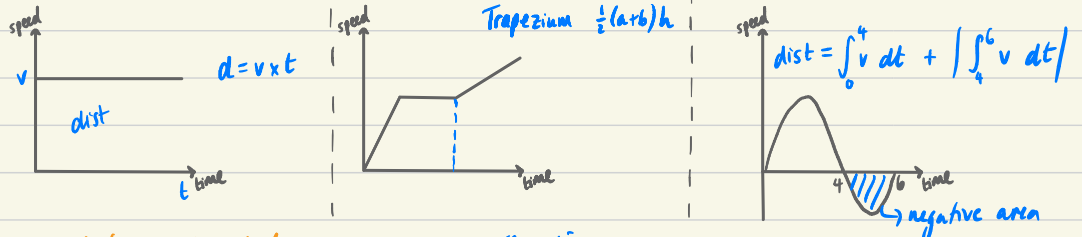
Kinematics - motion

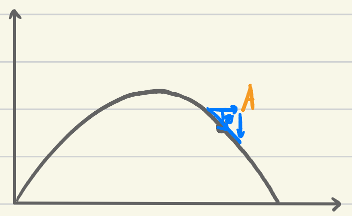
	Constant Speed, $a=0$	Constant Acceleration	Variable Acceleration
Kinematic Equations	dist = speed × time kmph $\xrightarrow[\div 60 \div 60]{\times 1000}$ ms^{-1} ms^{-1} $\xrightarrow[\times 60 \times 60]{\div 1000}$ kmph	F: $v=u+at$ F: $s=ut+\frac{1}{2}at^2$ F: $s=vt-\frac{1}{2}at^2$ F: $v^2=u^2+2as$ F: $s=\frac{1}{2}(u+v)t$	s/x → v → a: $\frac{d}{dt}$ Down Differentiate; $\int dt$ up
Speed-Time Graphs	$d = v \times t$ (dist = area)	Trapezium $\frac{1}{2}(a+b)h$	$dist = \int_0^4 v\, dt + \left\lvert \int_4^6 v\, dt \right\rvert$ → negative area
Vector Motion	$\underline{r} = \underline{r}_0 + \underline{v}t$	$\underline{v}=\underline{u}+\underline{a}t$ $\underline{r}=\underline{r}_0+\underline{u}t+\frac{1}{2}\underline{a}t^2$ $\underline{r}=\underline{r}_0+\underline{v}t-\frac{1}{2}\underline{a}t^2$	$\underline{r}$ → $\underline{v}$ → $\underline{a}$: $\frac{d}{dt}$; $\int dt$



distance travelled = area under the line

acceleration = gradient of the line

Projectiles



Horizontal Motion: $a=0$

Vertical Motion: $a=-g$

connected by t

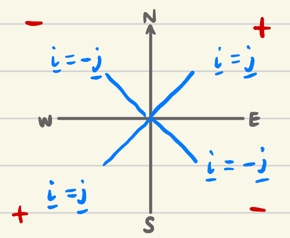
Find the speed and direction of motion at A

Horizontal speed, Vertical speed } Pythagoras for speed, $\tan^{-1}$ for direction

Vector Motion

"moving in the direction $\binom{2}{3}$" $\underline{v} = k\binom{2}{3}$

"is north-east of the origin" $\underline{r} = k\binom{1}{1}$ ↳ i comp = j comp



Modelling Assumptions

smooth pulley: tension on either side of the pulley is equal

light string: tension is equal throughout the string

inextensible string: both particles have same acceleration

particle: ignore air resistance, ignore rotational effects

rod: rigid, so it doesn't bend, it has no thickness

+ obvious ones like smooth, rough, etc.

Forces

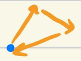
Equilibrium

static/at rest

on the point of slipping/limiting equilibrium

constant speed

} forces are balanced: ← = →, ↑ = ↓

Vector forces  $\underline{F}_1 + \underline{F}_2 + \underline{F}_3 = 0$

Dynamics, F=ma

If none of the above, it is accelerating/decelerating

Resolve using $F=ma$, in the direction of motion.

Vectors, use $\underline{F}=m\underline{a}$ where $\underline{F}$ is the resultant, $\underline{R}$

$\underline{R} = \underline{F}_1 + \underline{F}_2 + \underline{F}_3$

Friction

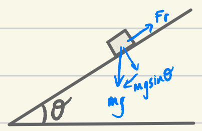
Always opposes the direction of motion/it is about to move in

If static, $F_r \le \mu R$

If limiting equilibrium/dynamic $F_r = \mu R$

$0 \le \mu$ ~~≤1~~ <4 ish

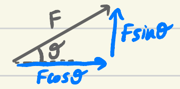
On slopes

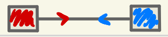


$mg\sin\theta > F_{r\,max}$ it will move down

$mg\sin\theta \le F_{r\,max}$ it will remain at rest

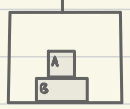
Forces Diagrams - Basic

Resolving 

Tension 

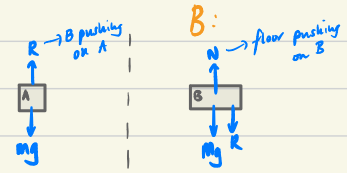
Thrust 

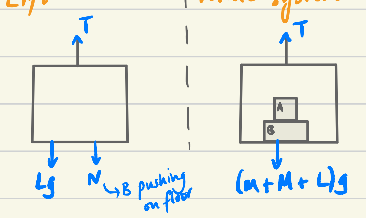
Boxes on boxes/Lifts



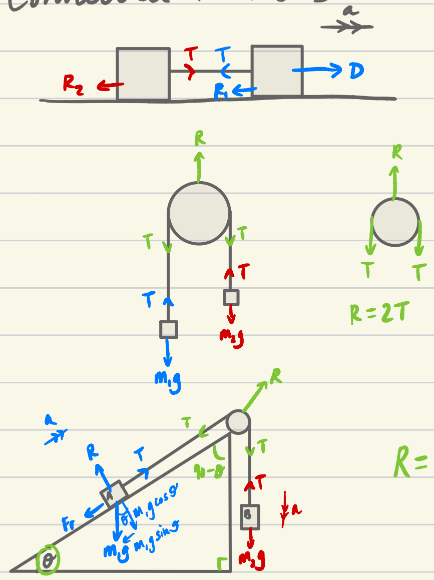
A: m kg

B: M kg Lift: L kg

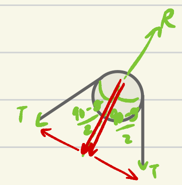




Connected Particles



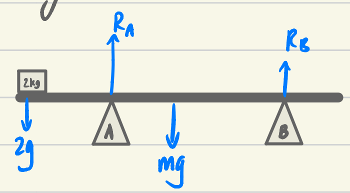
$R = 2T\cos\left(\frac{90-\theta}{2}\right)$



Method

1) $F=ma$ } equation of motion
2) $F=ma$ }
3) Sim. Equations
4) SUVAT find $v \rightarrow u$ after string breaks after particle hits floor.
5) New acceleration, $T=0$
6) More SUVAT, use new a and u will be v from before.

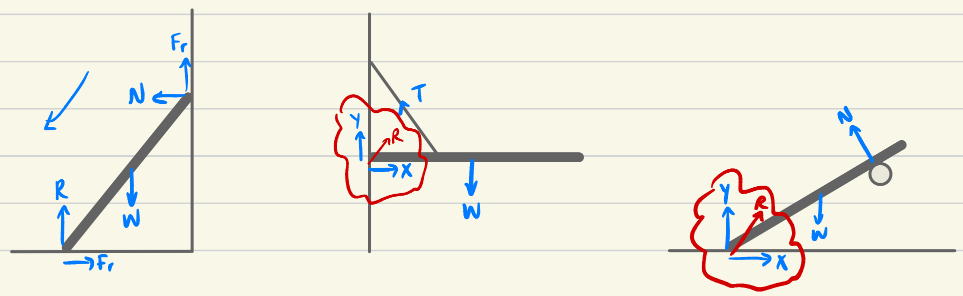
Rigid Bodies



uniform: weight acts at centre

non-uniform: weight doesn't act at centre

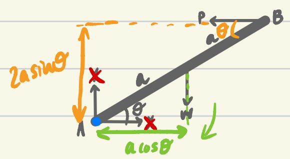
on the point of tilting about A: $R_B = 0$



Moments

moment = force × perp. dist / perp. force × dist

anticlockwise = clockwise (if in equilibrium)



Method:

1) Resolve up/down ↕ $Y = W$

2) Resolve left/right ↔ $X = P$

3) Moments about A

$a\cos\theta \times W = 2a\sin\theta \times P$

BICEN MATHS