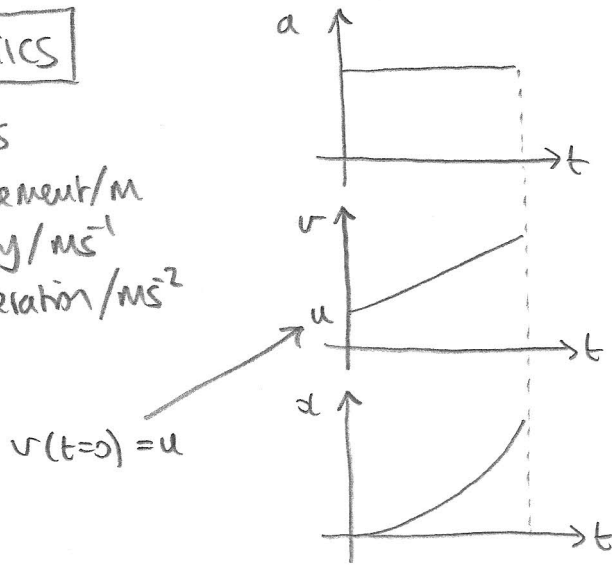


LINEAR MECHANICS: KINEMATICS, FORCE, MOMENTUM, ENERGY

KINEMATICS

- t Time/s
- x Displacement/m
- v Velocity/ ms^{-1}
- a Acceleration/ ms^{-2}



ASSUME **CLASSICAL** i.e. $v \ll c$

Speed of light \uparrow

$a = \frac{dv}{dt}$ $\Rightarrow v = \int a dt$

$v = \frac{dx}{dt}$ $\Rightarrow x = \int v dt$

i.e. gradient of linear (t,v) graph

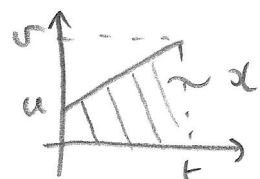
* Special case *

Constant acceleration motion: $a = \text{constant}$

"XUVAT"

$a = \frac{v-u}{t} \Rightarrow v = u + at$

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



$x = \frac{1}{2}(u+v)t$
i.e. area under (t,v) graph

$x = \frac{1}{2}(u + u + at)t$
 $x = ut + \frac{1}{2}at^2$

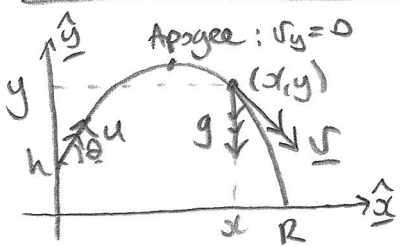
$x = \frac{1}{2}(u+v)(v-u)/a$
 $2ax = uv + v^2 - u^2 - uv$
 $v^2 = u^2 + 2ax$

So displacement of a ball dropped in time t is $x = \frac{1}{2}gt^2$

constant acceleration in x and y direction

PROJECTILE MOTION

No horizontal acceleration i.e. ignore air resistance



$x = ut \cos \theta$
 $v_x = u \cos \theta$
 $a_x = 0$

$y = h + ut \sin \theta - \frac{1}{2}gt^2$
 $v_y = u \sin \theta - gt$
 $a_y = -g$
 $v_y^2 = u^2 \sin^2 \theta - 2gy$

* $t = \frac{x}{u \cos \theta}$

Parabolic trajectory

$\underline{v} = v_x \hat{x} + v_y \hat{y}$

$v^2 = v_x^2 + v_y^2 = u^2(\cos^2 \theta + \sin^2 \theta) - 2gy$
 $\Rightarrow v^2 = u^2 - 2gy$

$\frac{1}{\cos^2 \theta} = 1 + \tan^2 \theta$

\hat{x}, \hat{y} unit vectors
 $|\hat{x}| = |\hat{y}| = 1; \hat{x} \cdot \hat{y} = 0$

* $y = h + \frac{u \sin \theta}{u \cos \theta} x - \frac{1}{2}g \left(\frac{x}{u \cos \theta}\right)^2$
 $y = h + x \tan \theta - \frac{gx^2}{2u^2} (1 + \tan^2 \theta)$

Ball dropped from rest. $\downarrow x \neq g$

