**Lesson 3**

**Constant Acceleration Kinematics**
**Applied Mathematics (Mechanics) Year 1**

## 3.1 Vertical Launch Kinematics #1

$$v = u + at \qquad s$$

$$s = vt - \frac{1}{2} a t^2 \qquad u$$

$$s = ut + \frac{1}{2} a t^2 \qquad v$$

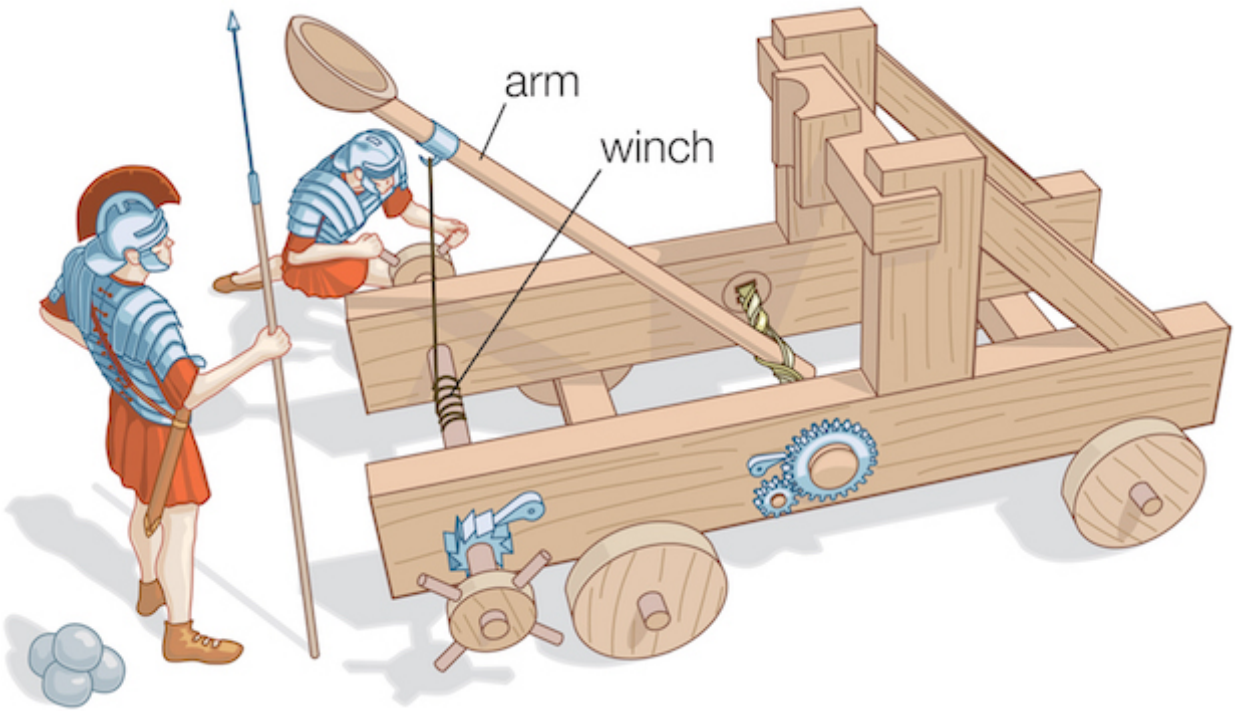
$$s = \left( \frac{v + u}{2} \right) t \qquad a$$

$$v^2 = u^2 + 2as \qquad t$$

The five *suvat* equations **ASSUME CONSTANT ACCELERATION**

Fortunately, there are many situations in the physical world where the acceleration is indeed constant. One useful 'real world' application of the *suvat* equations is in analysing a projectile.

**Discuss :** What is a projectile ?



**3.2 Example**

It is Chloe's birthday.

To help her celebrate her eleven best friends collectively chuck her into the air.

Chloe has a mass of 43 kg and she is launched vertically upwards at 4 $ms^{-1}$

**( i )** How high does she go ?

**( ii )** For how long is she aloft ?

**( iii )** Did Chloe's mass play any part in this question's calculations ?

## 3.4 Exercise

### Question 1


Water is launched by the Jet d'Eau in Geneva at 54 m/s (120 mph). Ignoring air resistance, how high is the water projected ?

**Question 2**

To find the launch speed of a catapult a stone is fired vertically upwards.
12 seconds later it returns to Earth.

**( i )** Calculate the launch speed of the catapult.

**( ii )** What was the greatest height reached by the stone during it's flight ?

**Question 3**

A ball is kicked vertically upwards with speed 21 m/s.
It hits the ground 4.35 seconds later.
Find the height above the ground from which the ball was kicked.

**Question 4**

A stone is dropped from the Clifton Suspension Bridge, near Bristol.
It takes 4.7 seconds to reach the water below.

**( i )** How high is the bridge above the water ?

**( ii )** A second stone is thrown vertically downward with an initial speed of 18 m/s.
How long will this stone take to reach the water ?

**Question 5**

*M1 Examination Question, January 2011, Q2*

A ball is thrown vertically upwards with speed $u$ ms$^{-1}$ from a point $P$ at height $h$ metres above the ground. The ball hits the ground 0.75 s later.

The speed of the ball immediately before it hits the ground is 6.45 ms$^{-1}$

The ball is modelled as a particle.

**( a )** Show that $u = 0.9$

**[ 3 marks ]**

**( b )** Find the height above $P$ to which the ball rises before it starts to fall towards the ground again

**[ 2 marks ]**

**( c )** Find the value of $h$

**[ 3 marks ]**

**Question 6**

A particle is projected vertically upwards from a point $O$.

The greatest height reached by the particle is 62.5 metres above $O$.

**( i )** With what speed was the particle initially projected ?

**( ii )** What was the total time for which the particle was 50 metres or more above $O$ ?