

Section A

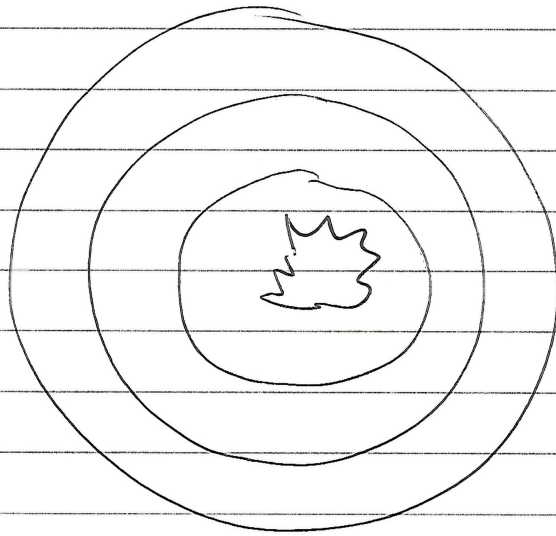
- ① Combustion is a burning reaction between a fuel and oxidant. Generally this will be at low speed. $< 400 \text{ m/s}$
Deflagration is a faster speed burn, generally subsonic, where the combustion heats the next part of the material & ignites it.
Detonation is a ~~supersonic~~ chemically driven supersonic shock wave passing through the material, expelling heat & gas.
Detonates is a high explosion - As the shock wave passes through the material, hot spots create a chemical reaction, that chemical reaction is so fast it pushes the shock wave until a sustained velocity of detonation occurs, the shock wave will then pass through the material at that speed, expelling heat, gas, light.
- ② When a deflagration is taking place, the material is burning fast - as pressure can build up build. If the pressure and heat is not lost, then the speed of the burn can accelerate. If the material is sufficiently energetic the burn front may be accelerated to the speed of sound in that material. If when the speed of sound is reached the burn front becomes a shock front and transitioning from deflagration to detonation has begun.
- ③ Blast is a large quantity of hot gas expanding rapidly, supersonic to begin with, producing a shock followed by the gas.
Fragmentation is using the hot expanding gas to break open a metal can and produce fragments.
For a fixed size case (outer diameter) these effects can be varied. The thickness of the case. A thick case will produce large fragments, but less blast as a lot of energy is used to break open the case. A thin case will produce small fragments at

- A ③ high velocity but will also have the effect of blast as less energy has been used to break the case.
The case can be 'pre cut' this means a thicker case can be used to create ~~frag~~ larger fragments without compromising blast as the pre cut will allow the case to 'fail' easier.
Different explosives will have different effect also. A high brisant material like RDX or HMX will help shatter the case. A Material such as torpex will have less ~~br~~ brisance but will have more blast pressure due to the Aluminium.
- ④ Priming explosives are 'sensitive' materials such as lead Azide. They are primary because they can easily run to detonation with little of the correct stimulus. They tend to have relatively less power + slower 'Velocity of detonation' $\sim 4000 \text{ m/s}$
Secondary explosives tend to be more powerful with a higher VOD, but they cannot self run to detonation. Material like TNT or RDX need a sufficient stimulus or (normally shock) to allow the detonation to begin.
Some detonators may not produce a large enough shock wave to give the secondary explosive sufficient stimulus, therefore an intermediary is used, Tetryl or PBXN 7 will be ignited by the detonator and will transfer enough shock to ignite the secondary output main charge.
- ⑤ Propellant grain sizes differ to add more or less surface area. In general, the larger surface area, the faster the burn rate. Cutting specific holes or shapes allows the designer to control the speed of the burn. ~~A~~ A larger diameter solid grain will have ~~more~~ a slower rise time of internal temperature and the rate of gas production will decrease. With holes in the grain the rate of

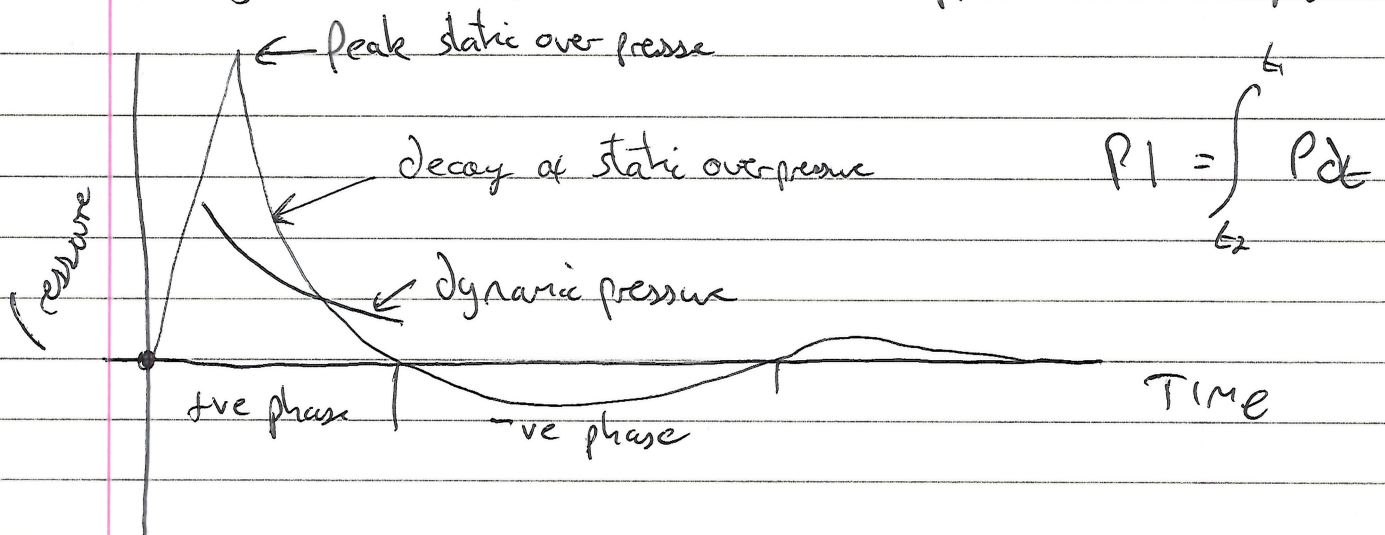
A 5 gas production will decrease at a slower rate.

- ⑥ Aluminium is the fuel in flash powder. The correct size of particle must be chosen for the desired output. Jagged or rough particles will have a greater surface area heating more rapidly allowing faster propagation of reaction. Smooth round shapes will far easier and this can help with manufacture especially with extrudates. Larger particles will not heat as fast and produce a slower burn rate. The smaller part

B ① Blast warhead,



At a height above the ground the explosion will cause a shock wave in air followed by the build up of gases. Through time the shock wave and over pressure will dissipate.



The higher the altitude the lower the effect of the blast will be. As you go higher the air gets less dense, there is less air for the shock to propagate in.

Not taking into account altitude, Hopkinson scaling can be used to calculate peak over pressure as a function of distance.

B ① and mass,

lower to the ground blast will hit the ground and reflect back up into the air.



The reflected shock wave meets with the primary shock wave and as the 2 shocks work together there is a point of almost double the energy. This point is called the mach stem. As a rule of thumb, a mach stem is likely to occur if $H_{\text{blast}} \propto \text{burst (scaled)} < 10 \text{ m/kg}^3$

The design of the warhead should be matched to the target. A light case of Aluminium or thin steel will allow greater blast. This is more effective at lower altitude. ~~For~~ Soft targets will be suited to a warhead that fragments, Hard targets will be more suitable for a blast to run shockwave through the target destroying it or energy inside it