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(see note 2 below)

Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

SURNAME: Malcolm

FORENAME(S): Luke William

1	Student Number	2030773
2	Title of Examination Paper	24 Principles of OME
3	Module Code	ACDA 4019
4	Date and Time of Examination	10th May 2023 0900
5	Examination Venue	IQ310
6	Seat Number	006
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	8
2	10
3	8
4	7
5	6
6	7
7	8
8	9
9	9
10	8
Total	80

1.

Explosion - rapid decomposition of a chemical system, evolving heat and gas.

(2)

Burning - surface effect relying on convection. Surface of burning material regresses inward, gases travel in the opposite direction. Relies on atmospheric oxygen. Typically less than 100m/s, Power $\sim 100\text{W/kg}$

(2)

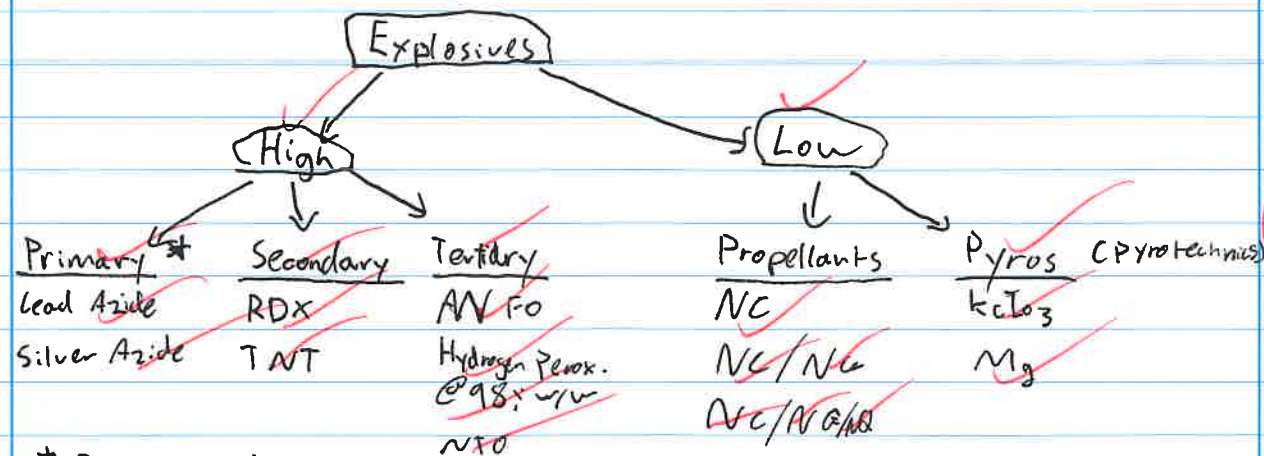
Deflagration - in effect, a very fast burn. Relies on oxygen within the material. Velocities of hundreds of meters/sec. Similar power output to regular burn.

(1)

Detonation - rapid decomposition with a shock front travelling faster than the speed of sound in that material. Very high power outputs (1000W/kg). Oxygen from within material.

(3)

2.



* Primaries have two sub categories
Can burn deflagrate (mercury fulminate)
or detonate (Azides)

Explosive - Chemical substance capable of causing an explosion

High explosive - undergoes detonation

Low explosive - undergoes deflagration

Primary HE - requires a very small stimulus to detonate.

Figure of Insensitiveness (FoI) less than 50.

Secondary HE - Requires a large stimulus to initiate.

Tertiary HE - Extremely insensitive, requires a very large stimulus to detonate.

Propellant - mainly used to generate large amounts of gas in a reliable and controlled manner. Consistent!

Pyrotechnic - Used to generate heat, light, sound, or smoke.

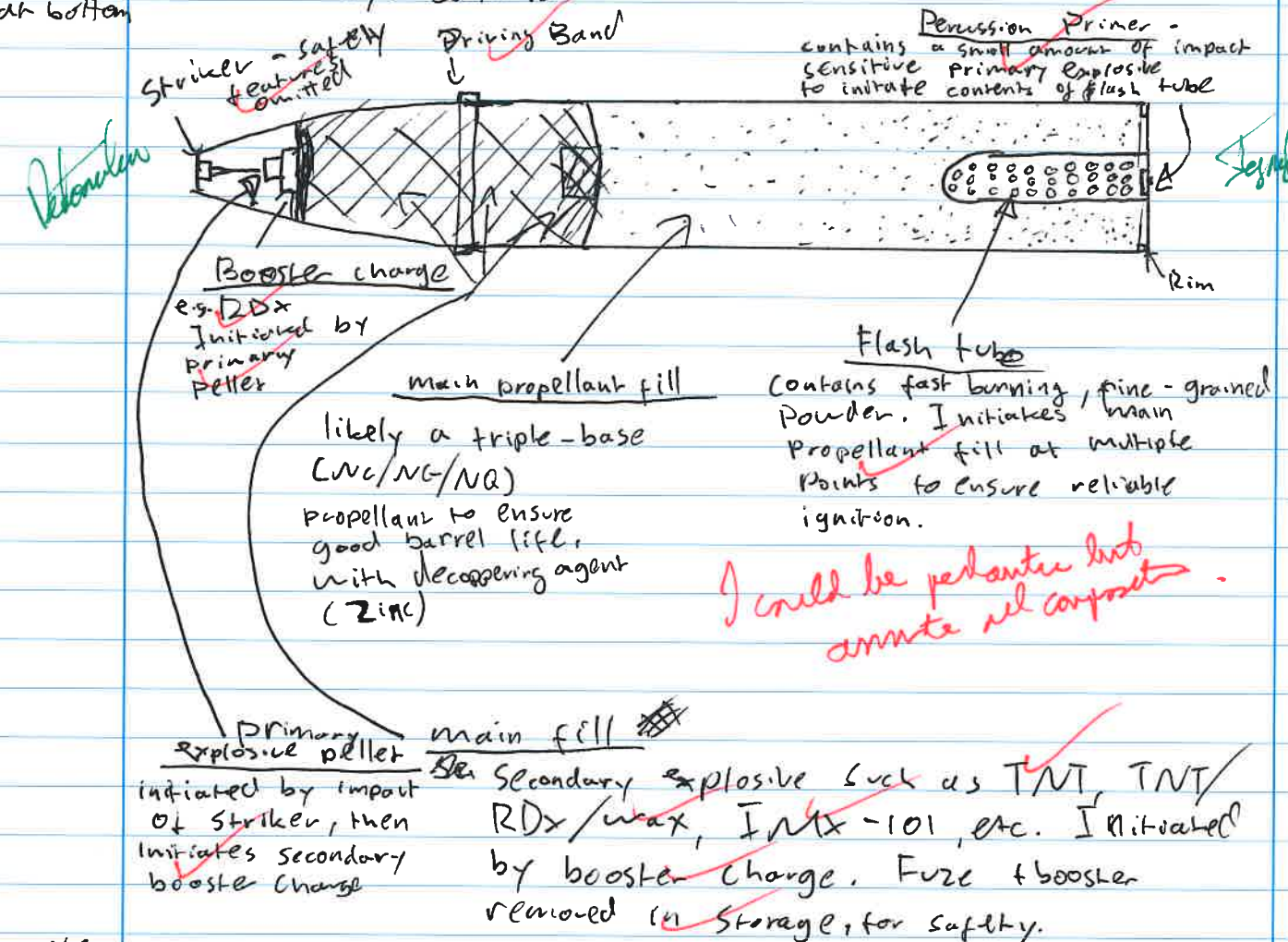
Det and ANFO - AN/FO is a tertiary explosive, which requires a very large stimulus ^{to detonate} far in excess of that which a small commercial detonator, filled with a small Qty. of primary explosive, can deliver. A booster charge containing a secondary explosive, should have been placed between the det and the AN/FO.

3. Critical Diameter - the charge diameter below which a detonation will not be reliably sustained

Critical Density - the density to which an explosive must be pressed to ensure reliable detonation.

(Do not press to the point of dead pressing though, more is not always better!)

Next Q at bottom

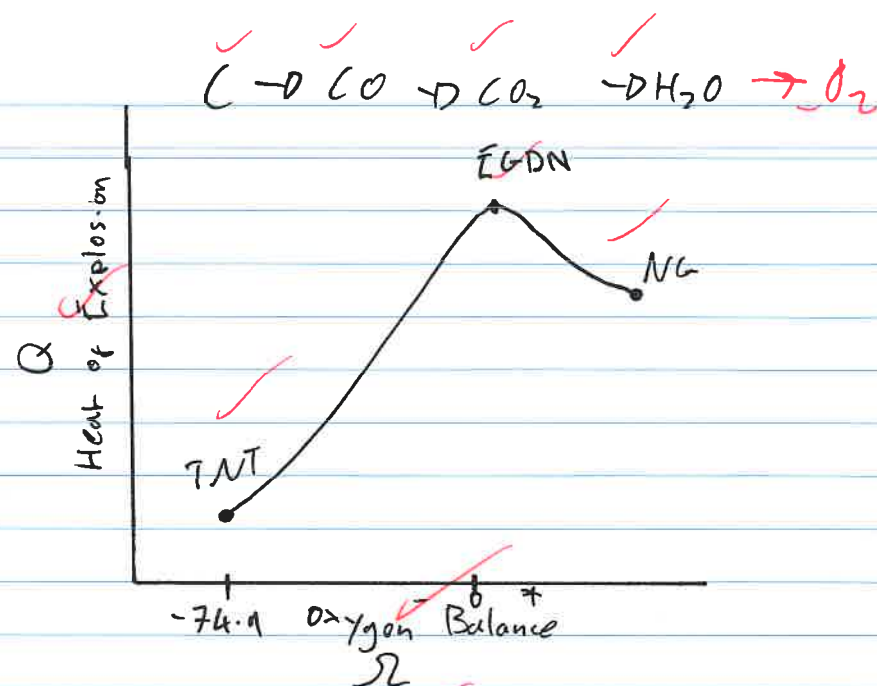


* 2

Critical Diameter and Density in design -

Knowing the critical diameter/density, and ensuring you are comfortably above both, ensures a significantly more reliable munition in all circumstances.

4.



EGDW - ~~Zero~~ Zero $\checkmark$
 TNT - -74.9 almost $\checkmark$

TNT Plume black - Presence of carbon particles, not a complete burn due to extreme negative oxygen balance

EGDW Products of det. - Zero $\checkmark$ α . balance would result in H_2O being produced and CO_2 $\checkmark$

Aluminised - The heat of formation of aluminium oxide (Al_2O_3) is very, very high. This significantly increases the heat of explosion (Q) and therefore gas volume V .

This is a learning point for all.

5.

Hot Spots - Hot Spots occur when the voids between molecules are compressed - this occurs through a mechanism known as Adiabatic Heating. If the pressing density of an explosive is too high, these voids may not be present in sufficient quantity to ensure detonation, this is known as "dead pressing". Hot Spots close together tend to link up, those far apart are quenched. When the energy in a hot spot ~~exceeds~~ ⁵⁴ exceeds the activation energy of an explosive, a detonation proceeds. There can also be a reasonable degree of friction/electrical discharge within these hot spots, further adding to the energy within.

6.

Single Base Prop. - Nitrocellulose (NC), typically used in "regular" small arms ammunition.

Double Base Prop. - Nitrocellulose (NC) and Nitroglycerin (NG). Used in high-performance small arms ammo, ~~and~~ ^{and} medium calibre.

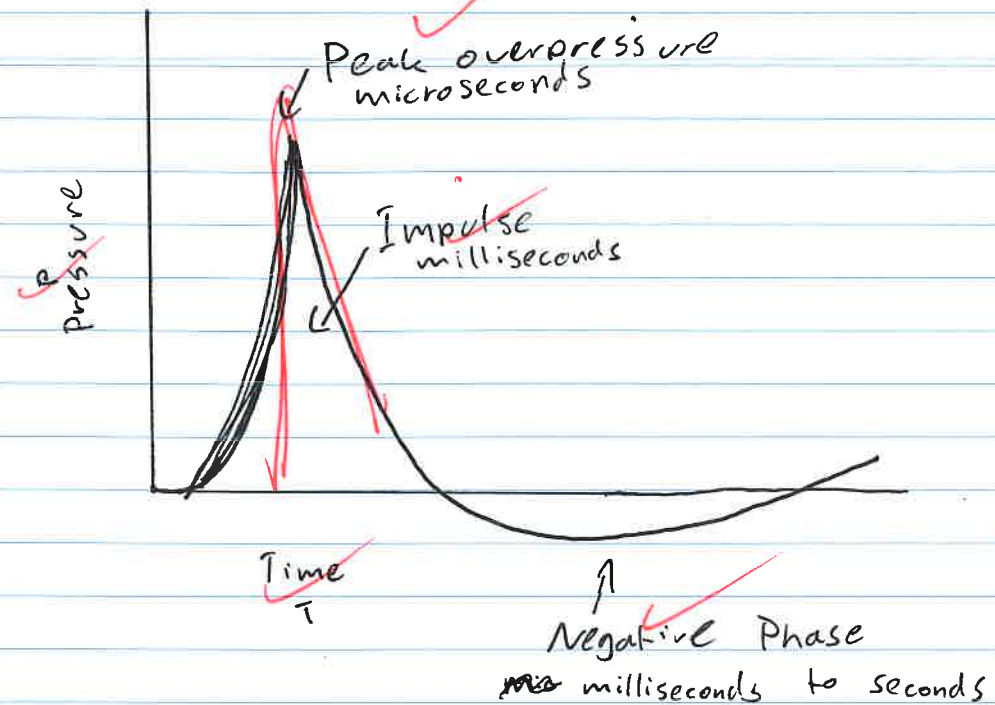
Triple Base Prop. - Nitrocellulose (NC), Nitroglycerin (NG) and Nitroguanidine (NQ). Typically used in tanks, artillery, and other "big gun" applications - where barrel life is a major concern.

Force constant for tank gun - Take an example of a single base tank gun propellant. Add NG to turn it into a double base. *I'm looking for HEN. → RDX*

NQ could be added to a double base tank gun propellant, in combination with modifying the grain structure and adding a surface moderant or deterrent coating - this would allow a ^{higher force constant} faster burn rate over time while keeping flame front temps and shot start pressures down, which is good for barrel ~~lifetime~~ life, and reducing (or at least keeping to a min) the forces on the recuperator and obturator pad. NQ produces nitrogen as it burns, which helps moderate flame front temps.

An increase in force constant will almost unavoidably shorten the life of the gun barrel. ~~But~~ this has implications on training (nobody wants to frequently burn out barrels and pay for replacements) and ^{stresses} supply chains during conflict, potentially leading to a less effective, worse-trained fighting force despite the ballistically superior gun. More investment in simulators and appropriate ballistically matched training ammunition could mitigate this, to some extent.

7.



Warhead types: ^{prox. (EFP)} contact fuze (copper cone)

Armour defeat - Shaped charge, tandem shaped charge, long rod

Personnel in Open - Pure blast, frag (airburst), thermobaric (enhanced blast)

Fast jet at low alt. - Frag, (Proximity fuze)

Damage Mechanisms:

Armour - Penetration (Hydrodynamic or sub.), Spalling, *YES!!*

Personnel - Traumatic injuries through blast or KE projectiles/frag.

Fast jets - Designed to be light and manoeuvrable, minimal armour.

Fragments penetrate thin aircraft skin and damage complex flight control / other mechanisms inside, leading to an uncontrollable aircraft or one on fire. Sufficient blast will remove parts of aircraft (wings, rudders, ceilings, tail, elevator, etc). Fuel tanks very vulnerable to attack. Certain damage may lead to aircraft experiencing uncontrollable high-G events which could further injure the pilot, or render ejection difficult.

*- Internal/External blast
- Internal problematics.*

8. Primary Injury - caused directly by blast overpressure e.g. barotrauma, TBI, etc.

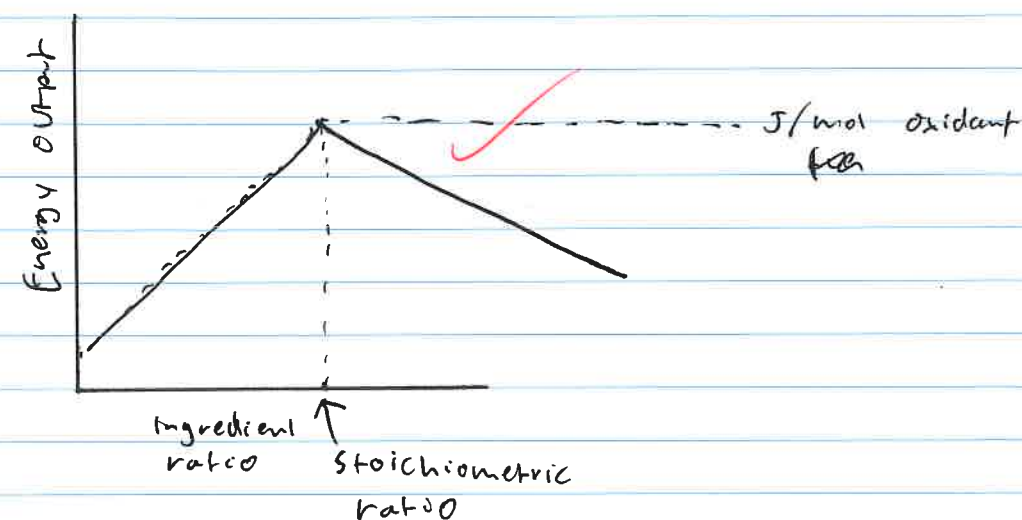
Secondary Injury - caused by fragmentation, e.g. penetrating trauma, other penetrating injuries

Tertiary Injury - caused by blast wind, e.g. fracture from thrown into wall

Quaternary Injury - caused by any other factor including complications of the above (dust inhalation/absorption, complications to existing conditions, etc.).

Matching KE to tgt. - While some degree of overmatch is desirable to ensure reliable prosecution of the target under a variety of circumstances, going too far results in an impractical, expensive, and unsustainable weapon solution - you would not use a KE long rod penetrator on an individual wearing body armor when a burst of machine gun fire from the ^{co-ax} gun would deal with it. You would not fire an individual weapon at an armored vehicle and expect it to penetrate. The matching of the munition to the target in an appropriate manner results in effective outcomes at an effective price, at an effective (and sustainable) rate of use for a given munition type.

9. Stoichiometric mixture - a ratio of fuel and oxidiser that results in a complete burn of both with no excess left over.



Energy output J/mol oxidant - Plateaus after the stoichiometric ratio is reached, as all fuel is being burnt with an excess of oxidiser.

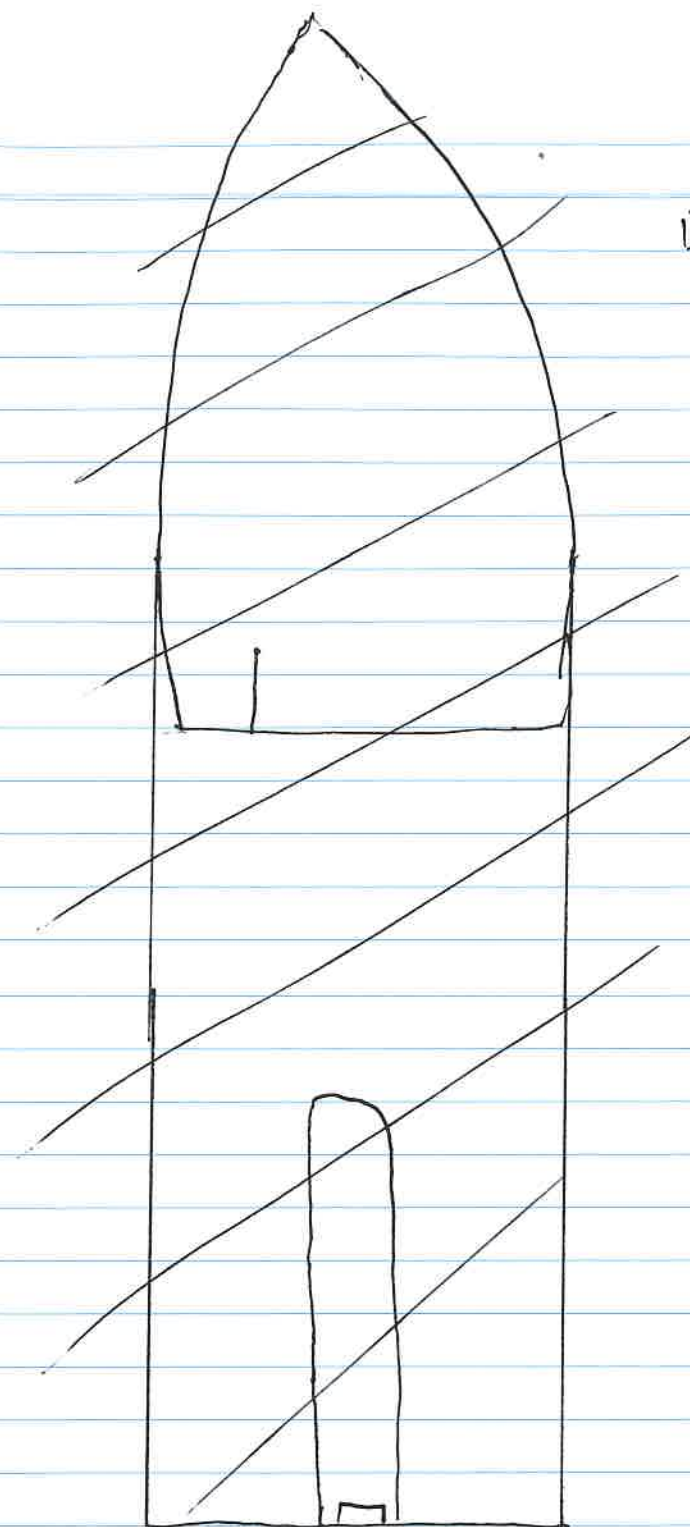
Go: not SG:- Atmospheric oxygen will also be consumed in the reaction, so you can add a little more fuel in the munition.

10. Smoke comp. - composed of a fuel, oxidiser, and dyestuff. Temp of combustion should ideally not burn the dye, and instead allow it to sublime & be released w/ smoke

Reaction Chemistry - the second of the two mixtures should be selected.

- The volume of gaseous reaction products (amount of smoke) is larger
- The mixture is richer, which generates more smoke (at least when you're tuning a carburetor!), and is cooler
- The heat of combustion is lower, meaning the dye is less likely to burn (and the burn risk to those handling/using the munition is also lower)

CO vs CO₂! ΔH of CO & therefore cooler



Do
not
mark!

Rubbish
Drawing

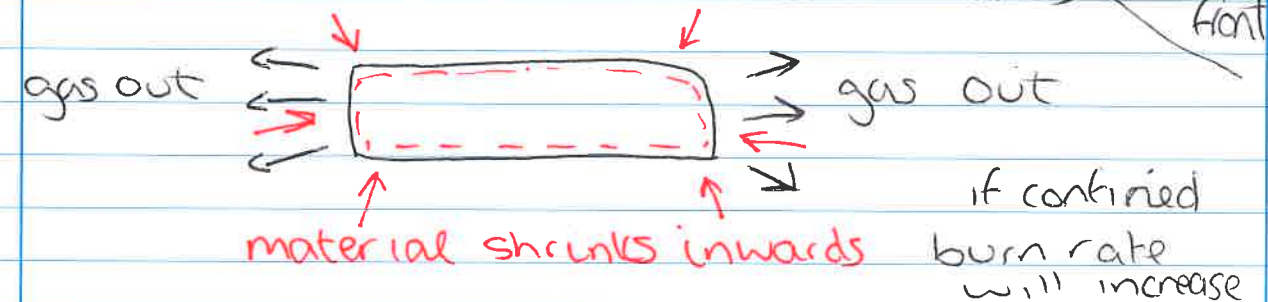
- 1 Explosion is a rapid decomposition of a chemical system with the evolution of gas + heat (and pressure) ✓

(2)

Burning - slow burn burn rate 100 W cm^3 ✓

- on surface of material
- gas moves outwards away from
- material shrinks inwards (Flame front)

(2)



Deflagration 100 W cm^3 - burn rate

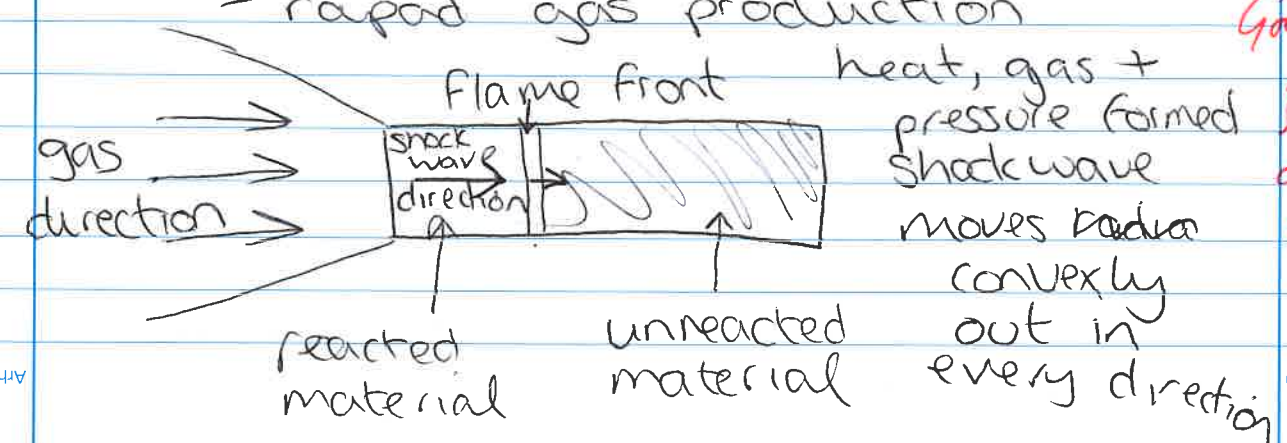
- faster burning - subsonic
- on the surface of the material
- gas moves outwards in the opposite direction to the flame front
- material shrinks inwards
- burn rate increases with confinement

(1)

Detonation 1000 W cm^2 - burn rate

- supersonic ✓ - speed of sound in that material
- occurs throughout/within the material
- gas moves in the same direction as the flame front - shockwave formation
- rapid gas production

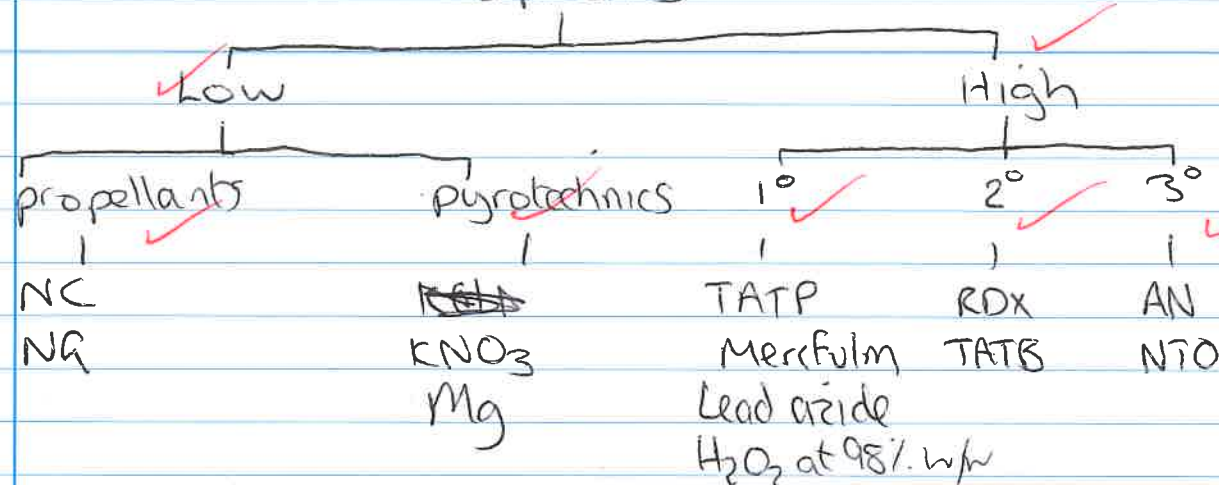
(4)



Good explanation to all but deflagration. However, this is 24.

1° = primaries
2° = secondaries
3° = tertiaries

Explosives



propellants

- propell
- rapid gas production

pyros

- light
- heat
- colour
- gas
- flame

Used to produce a variety of visual effects. Some may be non-visible such as IR.

1°

- Use to initiate less sensitive explosives
- Easy to initiate, less power than a 2°/3°
- Sensitive, used in small quantities

2°

More power + less sensitive - used as main fills, blasting. Needs a shock to detonate. Used in larger quantities than 1°. Bigger boom.

3°

Even less sensitive than 2°, needs a booster and a 1° to detonate. Main fills. More power than a 1° or 2°, used in larger quantities than 1°.

AN is a tertiary (3°) explosive and is very stable / insensitive to stimuli. The commercial detonator would not have

had enough energy to overcome the activation energy for the AN and Fuel oil mix to detonation. The generated stimulus (shock wave) would not have propagated through the explosive.

More power needed from the detonator.

3 Critical diameter

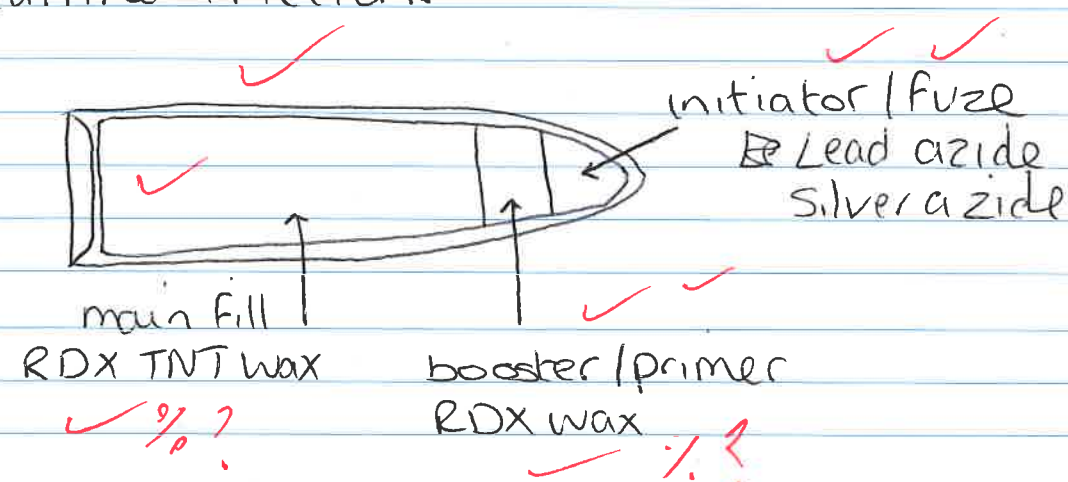
- the diameter required at which a shock wave will continue to propagate through the entire explosive. Below this the shock wave peters out.

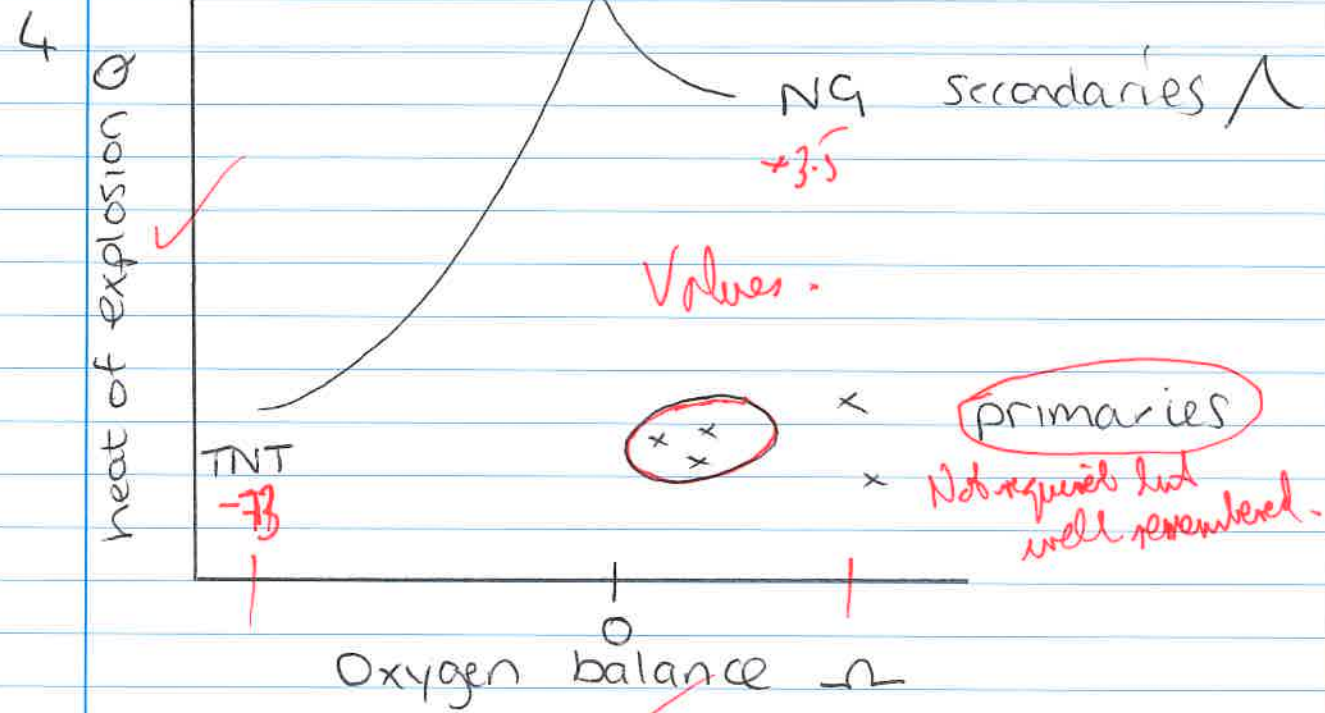
(The investigators are talking)

Critical density

- the density required to allow hotspot formation + adiabatic heating. Too dense and dead pressing occurs. Not dense enough and hotspots can't interact, crystals can't interact - no friction, no heating, no transmission of heat through material. The density below which detonation cannot propagate.

They are important because if they are not designed correctly the shock wave can't be maintained, hot spots can't form, in 1° explosives it could prevent inter-crystalline friction.





TNT is very oxygen deficient = -73.9%. This results in a lot of carbon being formed during detonation reaction resulting in a dark carbon rich gas flame.

EGDN will produce H_2O and CO_2 during detonation. The O_2 balance for EGDN is 0%, meaning there will be no O_2 produced. This is shown at the top of the graph.

Adding aluminium to an explosive will produce Al_2O_3 . The heat of explosion Q will decrease and the gas volume V, will increase. This is very useful in under water explosions - it helps produce bigger shockwaves.

Almost but other way around

5

Hot spots

Factors affecting hot spot progression

- dead pressing - can't interact with each other
- large gaps in molecular structure
- no intra-crystalline friction

A hot spot is an area in an explosive composition which has been compressed and the gas in this area is heated by the compression, causing it to heat.

This is known as adiabatic heating. If this heats ~~the~~ above the activation energy, a shock wave will start to form. If the (critical) density is sufficient in the material and hot spots can interact. The shock wave can't be transmitted through the material. If the hot spots can't interact, heat/energy the wave cannot propagate through the material.

- If the hot spots interact, the reaction will progress towards detonation. If not the material may only deflagrate.

6

Single NC - used in blasting ~~this is a propellant~~
 Double NC + NC - used in propellants
 Triple NC + NC + NC - used in propellants
 You did not mention the ordnance.

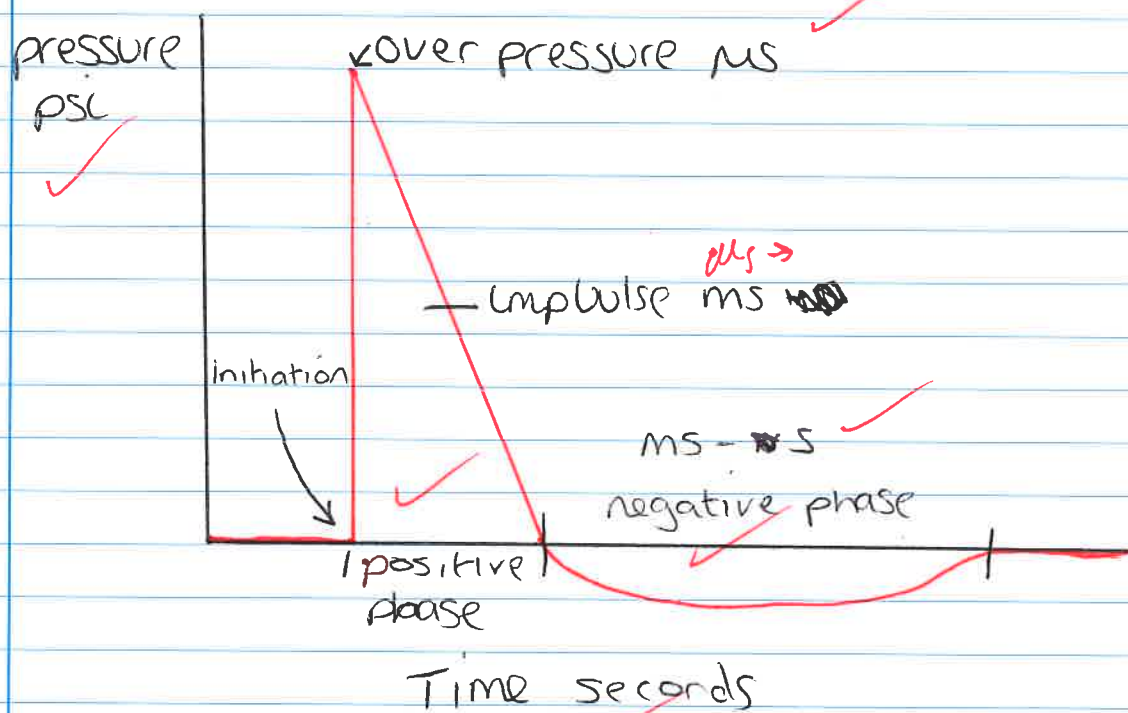
You would add RDX or NQ as a ~~intermediate~~ to increase energy.
 Increasing the force constant would increase the pressure in the barrel. This could limit/shorten the life span of the barrel. To moderate the flame temperature, a coolant

could be used, such as carbamite. This would

Adding NQ to a single or double base propellant increases the amount of gas produced during the reaction but reduces the overall heat of the reaction

- this would increase the force constant.

Increasing the force constant could also increase the heat in the barrel above that initially intended. This could increase the deposits in the barrel and ammunition could get stuck. To help prevent this a decocking agent such as kerosene may be used. Increasing force constant may reduce safety.



armour - HESH

personnel - ~~blast~~ internal HE - internal
- ~~blast~~ internal small - external
arms
ammunition

fast moving jet - long rod (I can't remember)
at low alt. ~~Exp disperse rod, blast/fog~~ Sorry!

HESH - for armour - hits target, squashes sticks to target, energy transferred inside + causes chaos - fragmentation at high velocity in a contained space. - kinetic energy ~~Spalling + debris~~

HE - internal - hits target and explodes explodes with a huge energy release causing damage and destruction to buildings + structures. This may collapse, send debris flying, create a blast over pressure + a blast wind - kinetic energy and heat energy. (may cause things to burn)

Small arms ammunition - uses kinetic energy to defeat personnel - ~~energy~~

Long Rod - ICE / blast - hits target, penetrates target, detonates, destroys target

8 Primary injuries caused by blast over pressure. Causes TBI, burst ear drum, blast lung, barotrauma, traumatic amputations at ends of bones.

Secondary injuries caused by fragmentation + shrapnel. Shrapnel wounds - all wounds considered contaminated. Internal damage which can't be seen

Tertiary injuries - blast wind. People thrown into things or things thrown into them. Causes fractures, breaks in bones, concussion, internal bleeding

Quaternary injuries - anything else not covered by the above. Heat + radiation

Injuries. Complications from other injuries.

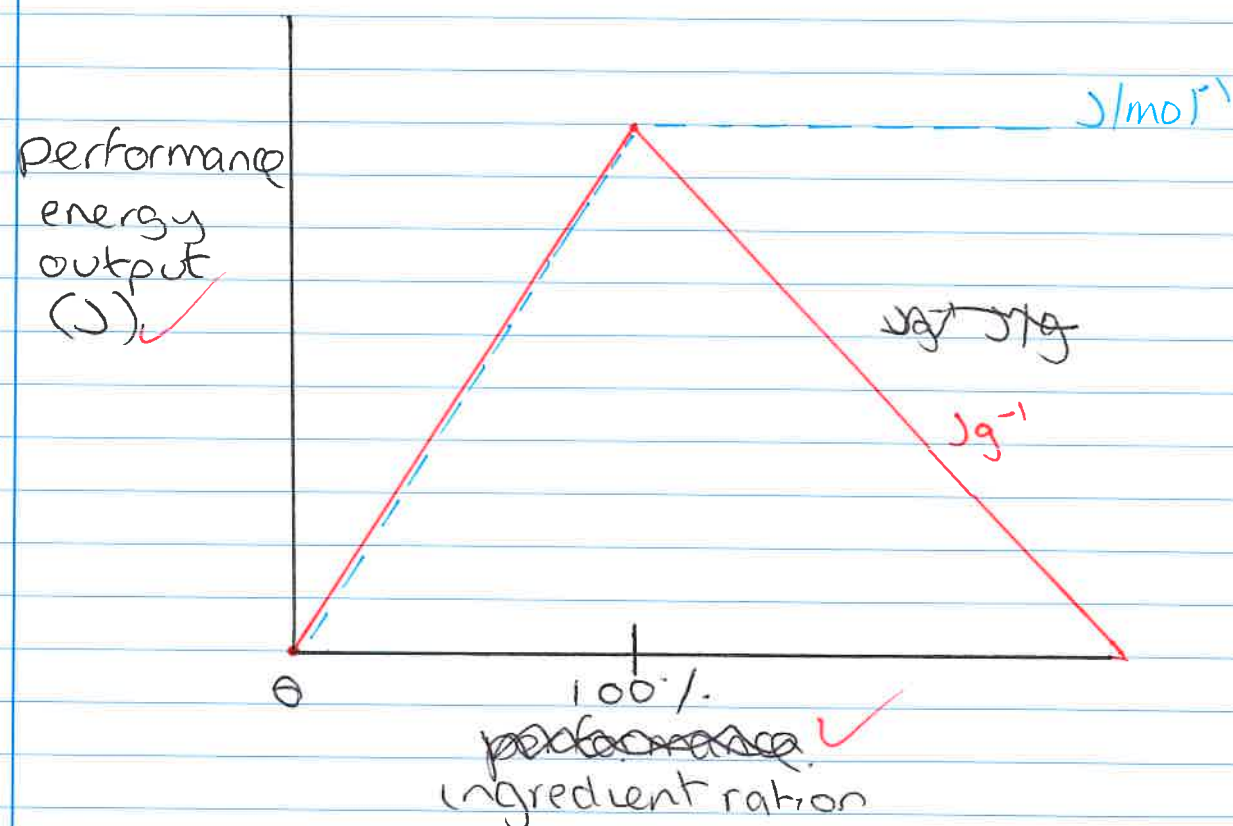
Yes, but I'm looking for percentage/performance.

If the KE is not matched to the target, it may not have enough ~~enough~~ energy to reach its target or perform its function once there.

No point using a .22 round to try and defeat a tank, especially if that tank is 1km away.

9

Stoichiometric mixture - one in which the fuel and ^(reactants) oxidisers will be completely used up in the reaction. A perfect ratio of reactants!



Performance increases until the reactants have been completely used up and then performance (100%).

drops off the other side (Jg^{-1} of mixture)

Energy output will increase up to 100% / per mole and then plateau when normalised for moles. --- For each mole used, performance is constant:

Illuminating Flare uses atmospheric oxygen as well as any in the composition. Metal fragments are released which then burn in atmospheric oxygen. This means the flare functions away from where it was fired - increasing safety and illuminating the target.

10 Smoke composition contains fuel, oxidiser and a dye. 3 parts.

The composition doesn't want to burn too hot as this could damage the dye.

Gas is produced as the reaction progresses releasing coloured dye too. Gas causes an increase in pressure, forcing dye to be released - reaction time allows flare to travel to target. The fuel rich option is most acceptable.

More gas is produced at a lower temperature making it safer + easier to handle.

For every ~~26.7~~ $26.7 dm^3$ of gas is produced in that reaction. Heat of combustion is ~~low~~ lower.



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(see note 2 below)

Examination Answer Books

12 Pages

SURNAME: Nichols

FORENAME(S): Alexander McDonald

2114693

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1	Student Number	2114693
2	Title of Examination Paper	Principles of OME
3	Module Code	ACDA4014
4	Date and Time of Examination	10/05/23 9AM
5	Examination Venue	1Q 310
6	Seat Number	009
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	6
2	6
3	8
4	7
5	5
6	4
7	8
8	9
9	7
10	4
Total	62

Q1

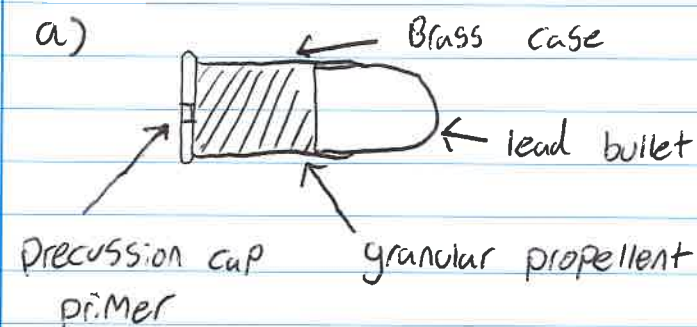
Explosion is a reaction causing heat and the rapid release of gas.

(1)

Burning is a slow decomposition of a flammable material, deflagration is the rapid burn of a substance. Detonation is the burn of an energetic material that exceeds the speed of sound in a material.

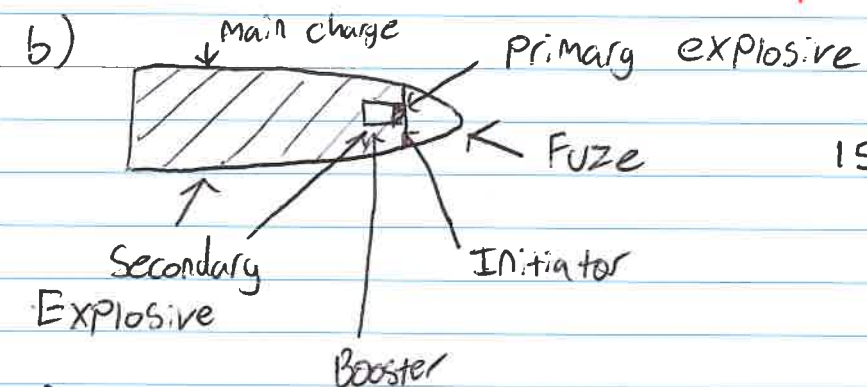
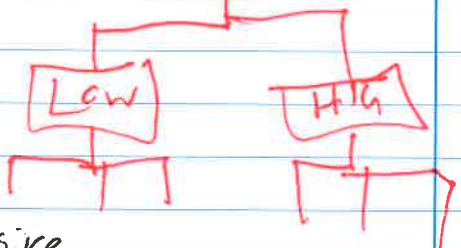
(3)

Q2



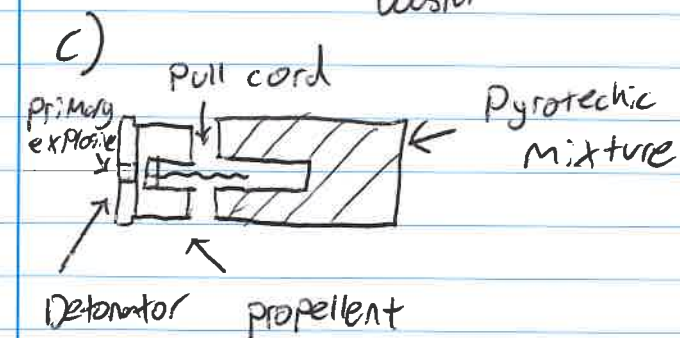
9mm bullet?

EXP



155mm HE shell

?



MTV Flare

?

Q2

- a) Propellant such as gun powder is a form of low explosive that is flammable and deflagrates. Examples include Nitrocellulose and Nitroglycerine.
- b) Secondary explosives are a form of high explosive that have a figure of sensitivity over 50. These explosives detonate and are less sensitive than primary. Examples include TNT and HMX.
- c) Primary explosives are a form of high explosive that are very sensitive. These are commonly used in detonators as they are sensitive to impact and electrical current. These explosives detonate but are less powerful than secondary. Examples include lead azide and lead styphnate.

ANFO requires a significant shock to detonate. Because of this a booster is required consisting of secondary explosive. Commercial detonators to not have a booster and are therefore not powerful enough to initiate an ANFO detonation.

(2)

Q3)

critical diameter is the minimum diameter that a detonation can become a self sustaining reaction.

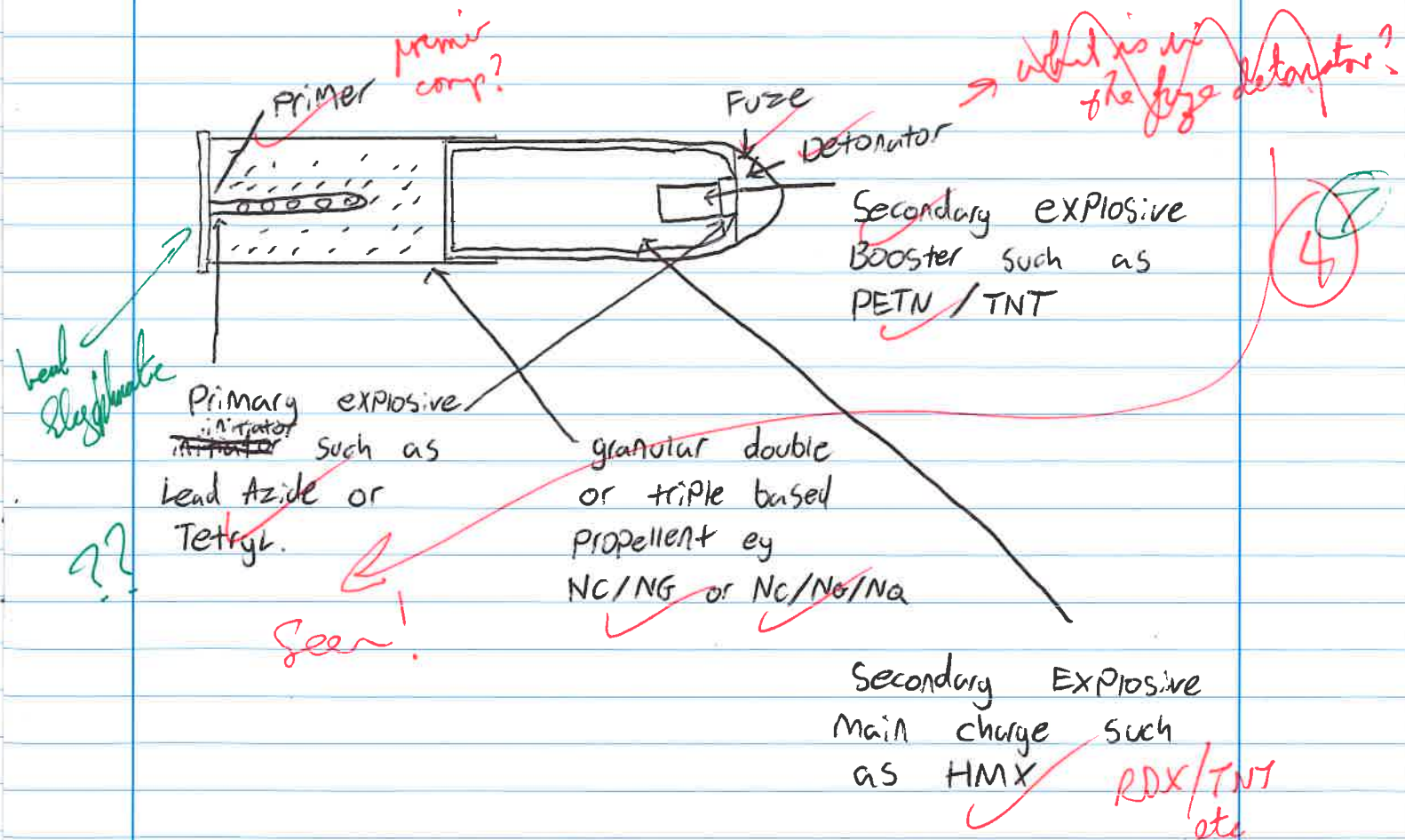
(2)

Critical ^{Density} ~~mass~~ is the minimum density of an explosive to support a continuous detonation

(2)

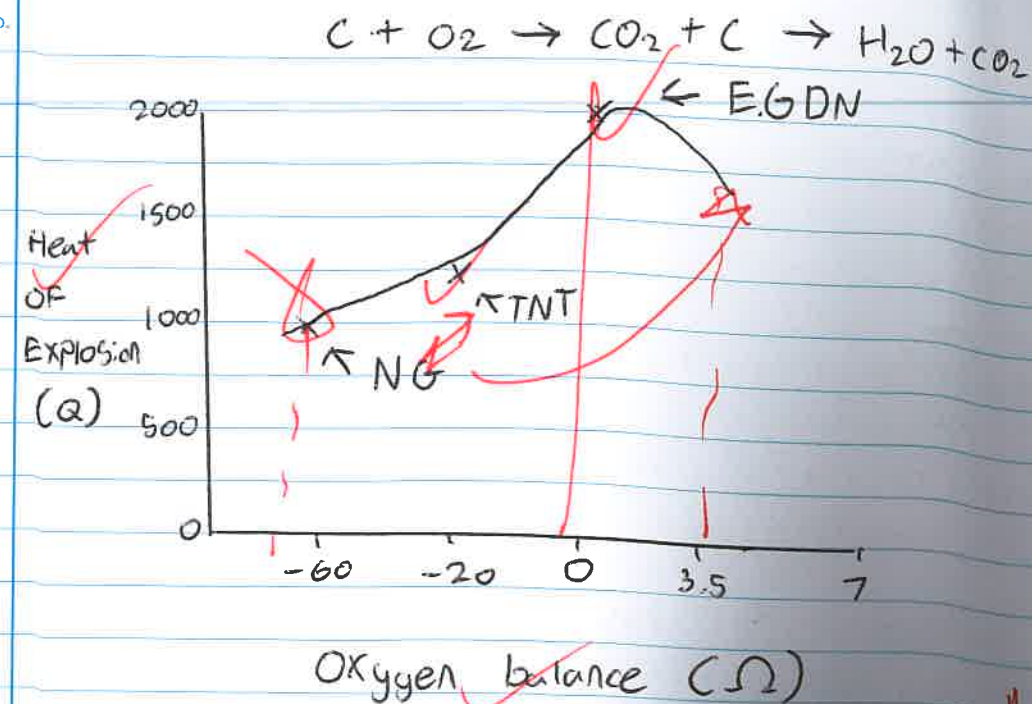
If critical diameter and density is not achieved in a munition it will not function correctly. This could mean no detonation or only a partial detonation occurs. This will result in an ineffective munition with the desired effect not being delivered.

155mm LIS HE Round.



(4)

Q4)



TNT has a large negative oxygen balance so a large part of the left over products is carbon. This forms black soot.

E.GDN is completely balanced so the products of detonation would be no carbon left and carbon dioxide formed. $+H_2O$

Aluminium would create Aluminium oxide. This would cause less gaseous products to be produced. This would also greatly increase the heat of the explosion.

Q5)

A 'Hot Spot' in an explosive is an impurity on the molecular microscopic level. Hot Spots Allow for an ~~expto~~ Detonation and Deflagration to continue in an explosive. This is because these impurities when shocked by the pressure wave created in an explosion form bubbles. When these bubbles collapse they cause the material surrounding them to be shocked. No detonation or deflagration. Another way 'Hot Spots' to this is through the friction between crystals in the explosive which has the same effect. These are important as they aid in maintaining the detonation/deflagration and allow it to be simultaneous in a material. If the ~~an~~ explosive is mixed and pressed too much this results in 'Dead pressing'. This is when an explosive is compressed too much that no 'Hot Spots' form. This has the effect of inhibiting or completely preventing detonation.

①

①

②

③

⑤

Q6)

Single based propellents consist of Nitrocellulose and are used in small crms Ammunition. And such as 4mm and 5.56mm rounds.

Double based propellents are used large calibre ammunition such as 105 and 155mm Artillery rounds. This type of propellant is more powerful and increases range. NC/NG

Triple based propellents are used in High performance guns such as a 120mm gun firing APFSDS rounds. This propellant is more powerful than single and double allowing for greater velocity to defeat armour. This is made of NC/NG/AN. Because of its power this propellant reduces the life of a barrel. No this in DB.

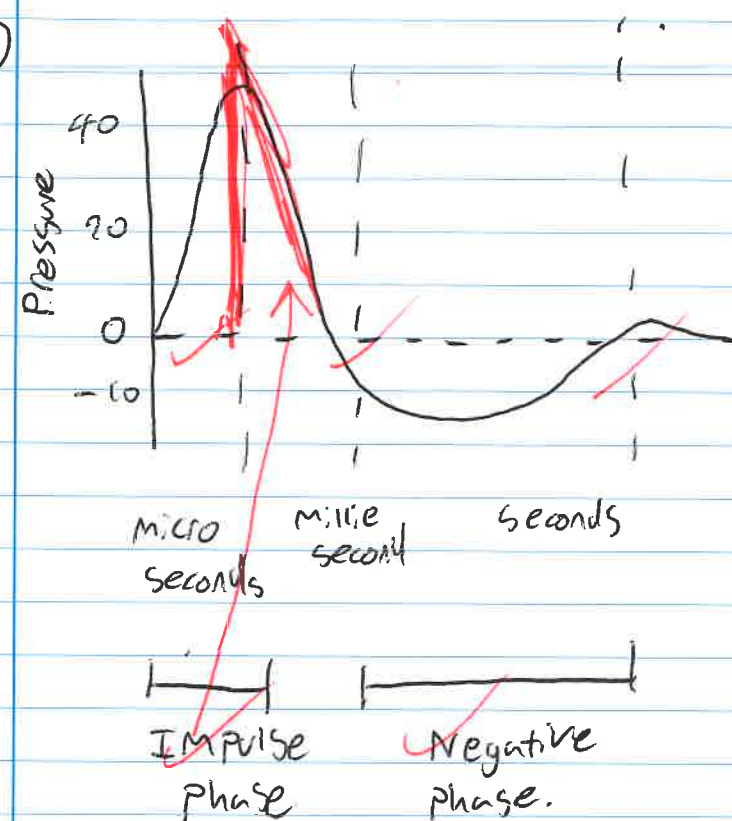
High explosives such as TNT or HMX can be added in small quantities to increase performance. This further limits the life of a tank gun's barrel due to the very high pressures. Because of this incremental charges can be used to reduce the wear. Moderating agents such as columbite can be added to reduce the heat, moderate the surface, and act as a plunger. Tin can also be added as a de-coppering agent to preserve the barrel.

temp too

RDX?

2

Q7)



a) A Shaped charge with a angle of 45 degrees can be used to defeat armour. A HESH round can also be used.

b) High explosive Artillery rounds with a proximity or impact fuze.

c) Heat Seeking missile with a High explosive and proximity fuze.

d) To defeat Armour the kinetic impact of either Spalling, copper jet, or long rod is the principle mechanism for defeat. This is because High speed Fragments will destroy the inside of a tank, overpressure can and heat have secondary impacts

(Next Page)

Q7) B) For Infantry the Primary Mechanism is Shrapnel caused by the explosion of the warhead casing. Over pressure is the secondary mechanism.

C) Blast is the primary mechanism for damage causing damage to the Airframe with Shrapnel from the casing also being used.

Q8)

Primary - Over pressure from the blast compressing air in body, collapsed lung and abdomen. Loss of limbs.

Secondary - Shrapnel caused by the blast causing perforation of body and bleeding.

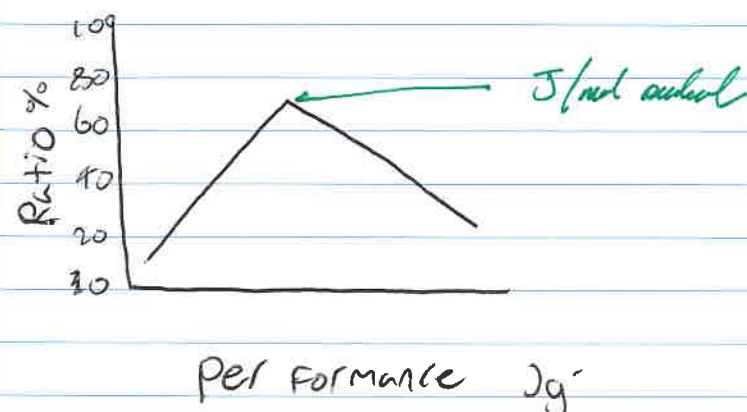
Tertiary - blast winds causing collapse of structure of person to be thrown to ground.

Quaternary - Any other injuries caused from the blast such as burns due to objects catching fire.

If the kinetic energy does not match the target it can lead to undesirable effects. For example too little will cause non-penetration of armour and not the desired effect. This is also the case for too much kinetic energy not delivering the desired effect. An example of this is firing a high velocity rifle round at a small target with the bullet passing clean through not transferring the kinetic energy.

Q9

A stoichiometric mixture is a mixture of oxidiser and fuel. When balanced this mixture will use up all of the reactants in the explosion.



Energy output increases as oxidiser approaches balance and then decreases.

Peak performance is at 60%. Because when used in an oxygen rich environment 4% of the magnesium reacts to form magnesium oxide.

Fuel and oxidiser?

Q10)

Coloured smoke consists of a ^{igniter} and primary explosive to ignite a heating composition. This then ignites the base & digestor producing a coloured smoke. This will be contained in a casing and may feature a delay charge.

For smoke production the second mixture is more desirable. This is because there is a higher fuel content mixture allowing for less heat to be produced. This also means more gaseous products are produced in the reaction increasing the desired effect.



Complete, fold and seal
(see note 2 below)

SURNAME:

Gallagher

FORENAME(S):

John

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1	Student Number	2114620
2	Title of Examination Paper	Principles of OME
3	Module Code	ACDA 4019
4	Date and Time of Examination	9:00am 10/05/23.
5	Examination Venue	1Q UWRSB Rm 310
6	Seat Number	010
7	Number of Answer Books handed in	1

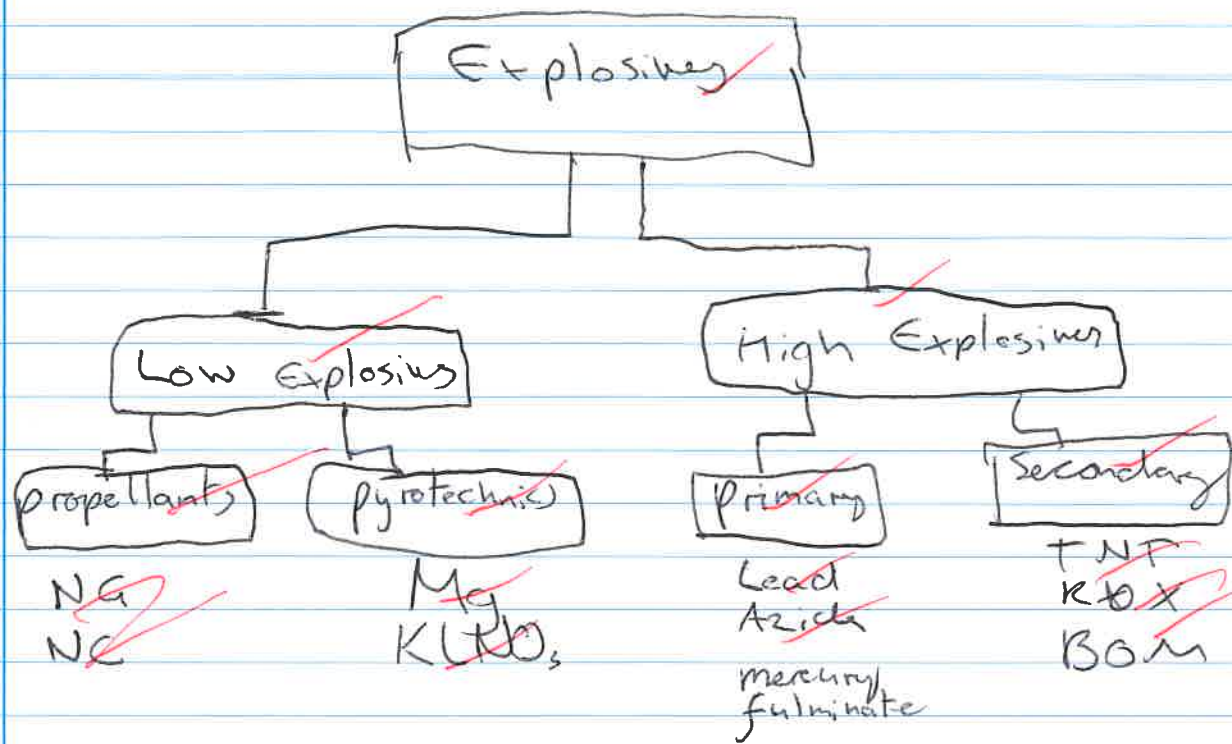
List the numbers of the questions you have attempted	Office Use
1	7
2	5
3	6
4	5
5	3
6	4
7	6
8	7
9	17
10	9
Total	59

1. An explosion is the fast decomposition of a chemical system with the evolution of heat and gas.

For speed of 500 m/s for deflagration with 9000 for detonation.

- Burning is considered a slow process when ignited with deflagration happening at subsonic speed and detonation at supersonic.
- Burning occurs within all explosives while deflagration will only lead to detonation with certain explosives under the correct environment.
- Burning occurs on the surface of the mixture such as burning wood. While deflagration applies an exothermic reaction, which relies on convection through the material as long as it maintains a front shock wave will reach the required energy for detonation.
- Unlike burning, the deflagration of a material high relies on the density and thickness.
- Burning maintains high levels of pressure before it will detonate (can be methodology) and reaches the speed of sound within the material before it detonates.

2



Ammonium nitrate is a tertiary explosive this would require a large amount of energy for this of "insensitive" explosive to initiate. The would require a booster (secondary explosive) such as RDX or TNT to create a shock wave in which will initiate the ammonium nitrate explosive. ∴ a commercial detonator does not supply a sufficient shock wave, it will fail.

But where is your explanation to 2b)?

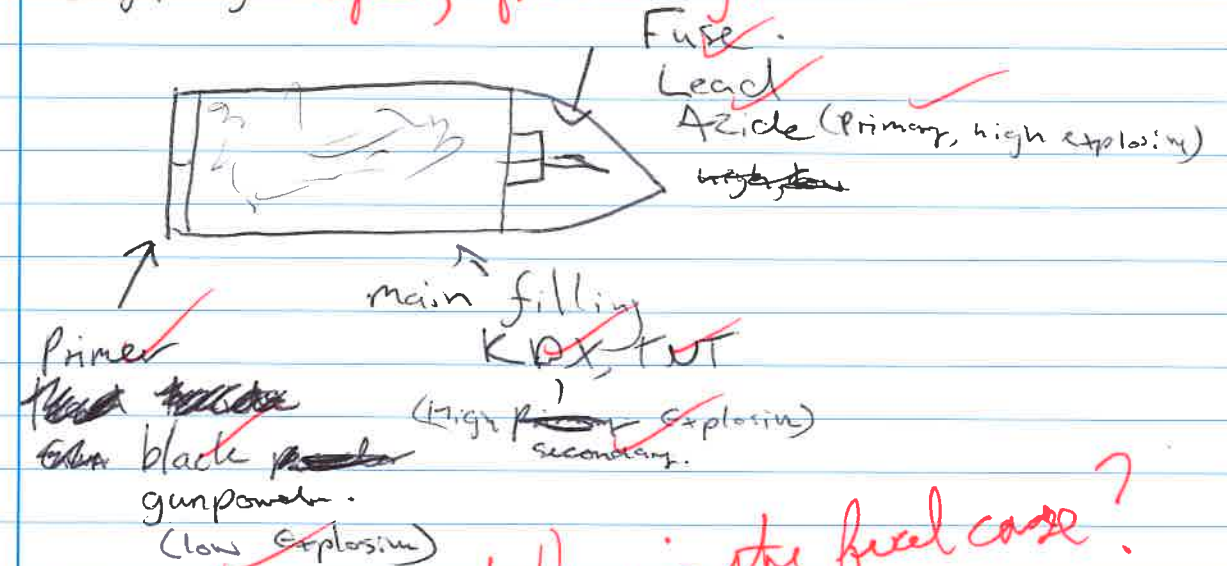
3

"Critical density" - This is the density of your explosive required to produce enough energy for a mixture the successfully detonate. To dense will cause failures such as dead dead pressing, too little in density will cause the material to fail in performance.

"Critical diameter" - The required diameter of your mixture required to successfully detonate it's explosion train.

A mixture that is too dense will cause 'dead pressing' or too little density will cause there not to be enough energy. terminology?

Diameter Critical diameter has to be correct so the mixture can apply enough energy and avoid to reaction not producing anything. Again, your working.



Where is the fuel case?

6

Single Base - NC
lowest β (heat transfer) usually used in (SAA)

Double Base - NC, NG
highest β and is commonly used in SAA, SAG'S.

Triple Base - NC, NG, NQ

Common uses in tanks and supplies a greater heat transfer to compared to NC. *Link between SB + DB is reduces flow etc cool.*

RDX?

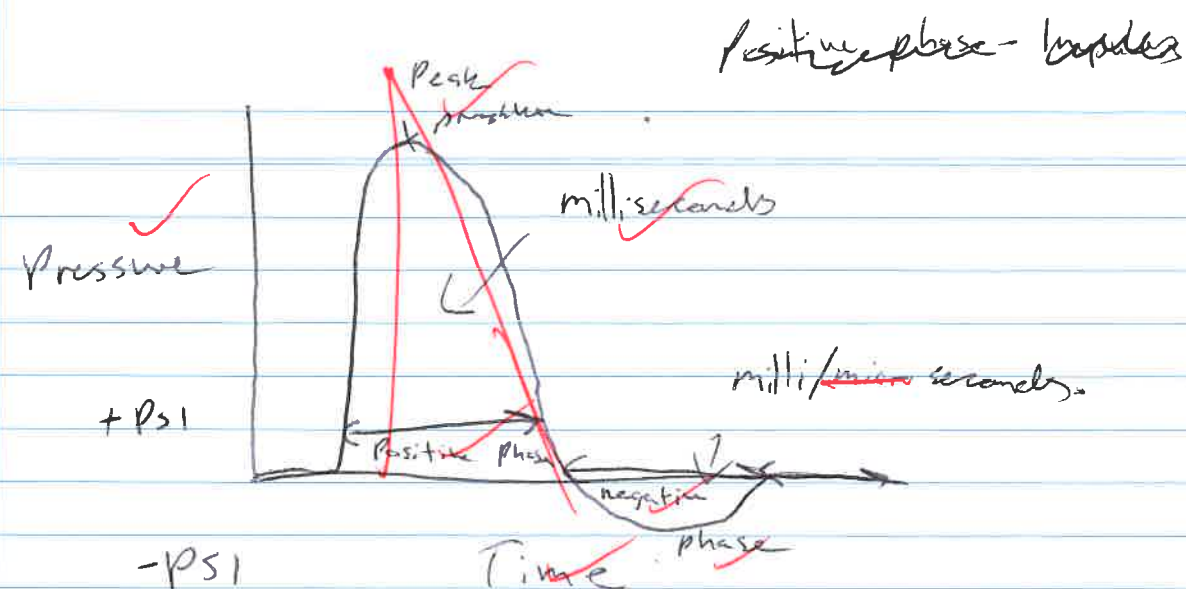
- Carbonite could be added. This is inert to NC, NG and can be used to react with the oxygen present and increase energy dissipated.

- For constant increase would cause high level of heat through the barrel which could cause early detonation or misfire. *Barrel wears with high F + T.*

- In adding NQ, this will increase the gas content but will reduce the temperature in the NC, NG mixtures. *Why? N₂*

7

(3)



(2)

Positive phase - Impulse in positive direction

Tree blowing away

negative phase - energy reflects back but less for less

Tree pulls back from impulse

a) MESH, SHAPED CHARGE

b) Bullet,

c) TANDEM WARHEAD *Blind? External Internal. blind blind*

(2)

a) ~~STRENGTH~~ *Pierce armour through acceleration produced by the explosive mechanism*
b) The kinetic energy of the bullet will be enough to penetrate the body and damage personnel.

c) ~~Internal / External~~ *The impulse of the warhead will be enough to crush the structure.*

8. Primary injury - Blast (Impulse)
 - Blast lung, TBSI etc
 any pocket of air in the body will be damaged.

Secondary - Fragmentation, debris.
 - Skull fracture, skin piercing.
 Small shrapnel moving at high velocities causing death.

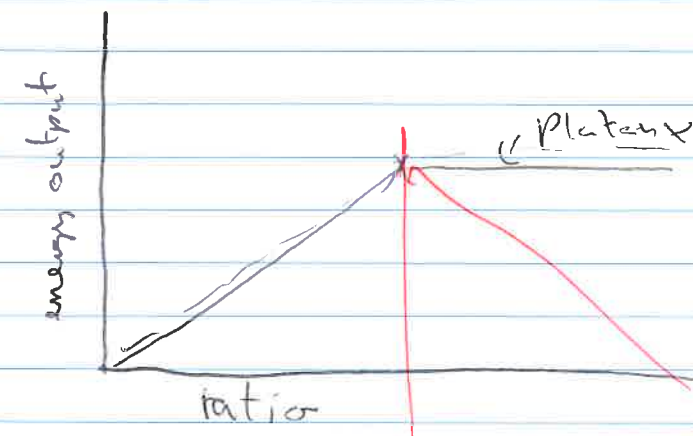
Tertiary - Blast, Wind
 - Brain Trauma, Concussion, bone breaks.

Quaternary damage - Heat, radiation.
 - Burns, illness, poisoning.

All of the above could all and most likely would result in serious injury or death depending on the Time, distance and shielding methodology.

- To ensure the intended target is being met and no civilians are damaged.
 Yes 'ish'.

9. A stoichiometric mixture, is a fuel / oxidiser ratio that will result in the reactants cause both components to be exhausted, (used up).



9d
is at
the end.

The energy will steadily rise until it meets the stoichiometric ratio within the mixture and begin to plateau.

60%? No answer - it is overleaf @

10. A typical coloured smoke composition includes:

• A fuel • An oxidiser • A dye.

The smoke composition will be produced at a low temperature to avoid any damage to the dye.
 The body will be wrapped in Aluminium foil to obtain some of the pressure and cause for easy ignition.

The second scheme can be said to be the most acceptable in terms of smoke production.
 - It has a far higher fuel content. In consideration of the number of moles (24 dm³) and % shown. The mixture also produces gaseous products at a far lower temperature.

Heat → As heat increases, gases decrease, therefore the more fuel rich and lower temperature compared 2 would be more suitable for smoke = production.

9

continued.

Despite an illuminating flame stoichiometric mixture calling for 56% magnesium, the mixture will also react with oxygen within the environment therefore increasing it's % to the 60% as described.



Complete, fold and seal
(see note 2 below)

Examination Answer Books

12 Pages

SURNAME: MCCINLAY

FORENAME(S): MARTYN

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3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
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1	Student Number	2113330
2	Title of Examination Paper	Principles of art
3	Module Code	ACDA 4019
4	Date and Time of Examination	10/5/23 0900
5	Examination Venue	UWTSO
6	Seat Number	011
7	Number of Answer Books handed in	1

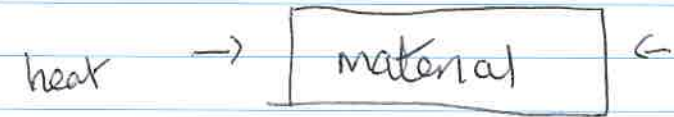
List the numbers of the questions you have attempted	Office Use
1	3
2	6
3	7
4	3 2 → 4
5	2
6	3
7	4
8	7
9	2
10	2
Total	~~13~~ 41

With moderator on q's 4 and 5

① Explosion is an exothermic oxidation reaction ~~that~~ (from chemicals) that cause the explosion which can produce a blast wave, heat and or smoke.

①

Burning - burning can be done in layers when heat/flame is applied



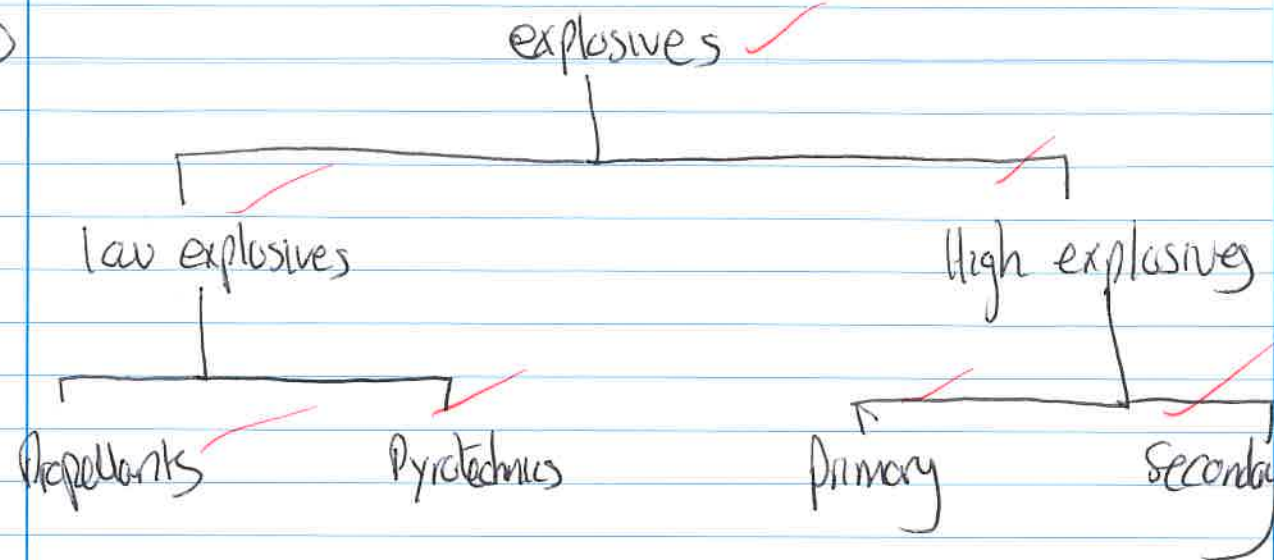
each layer burns & recedes until nothing is left

deflagration → - occurs in low explosives
 such as propellants & pyros.
 - subsonic speed. | via heat

②

detonation - occurs from a stimulus (small for primary & larger for secondary explosives)
 - supersonic speed. You can shock to detonate or burn to detonate.

②



Propellants - used with shell cartridges to help propel the shell out of the barrel & give KE.

- NC
- NG

Pyrotechnics - used to create smoke (colorful) & light.

- mg
- ~~KClO₄~~

Primary explosives - small stimulus required to detonate - normally small amount required to help ~~boost~~ secondary explosives.

- lead azide
- Mercury fulminate

Secondary explosive - very insensitive which require a boost from a primary to get them going. will cause a lot of damage if detonated. (easier to store & process/manufacture)

- TNT
- RDX

The explosive within the commercial detonator

②

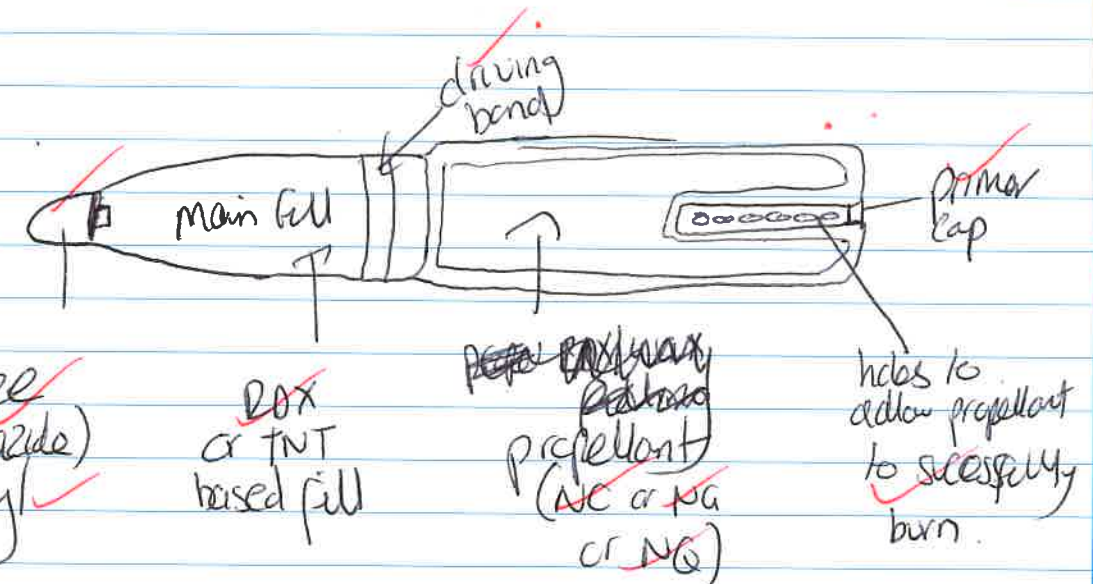
may not have had the correct amount of primary explosives required to shock the ammonium nitrate & fuel oil therefore the activation energy hasn't succeeded and no detonation occurred.

③

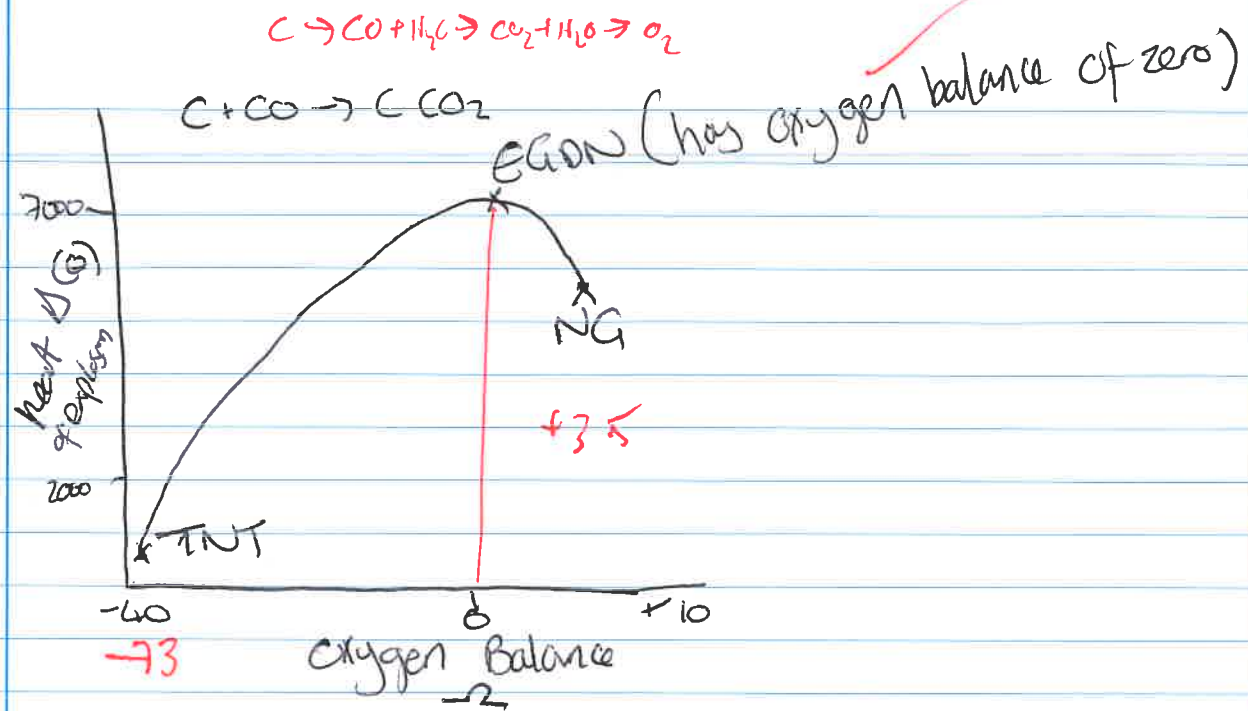
Critical diameter is when the explosive material reaches a certain size to successfully allow detonation to occur. If not met the detonation will not take place.

Critical density is the density of the explosive material and this ensures if the density is correct for the explosive that it will correctly detonate. So, the minimum density required?

They are both critical as they both have to be right to get the detonation required from the explosive substance.



(4)



TNT colour is so dark due to the amount of Carbon the explosion gives off. *Why?*

Products of detonation to find in EGON -
Carbon
CO₂ ✓

Adding aluminium to an explosive -

*There was very little here to draw any marks from.
Poor use of scientific descriptors throughout -*

Examiner Only

Question No.

(5)

Hot spot

Factors stopping a hot spot progressing towards detonation

- activation energy not overcome ✓ *Yes*
- insufficient heat or shock ✓ *Yes*
- damage to the explosive material ✓ *Yes*
- incorrect amount of the explosive compound.

the importance in a hot spot is to allow to process of deflagration or detonation to occur. For TNT its crystal like and when a hot spot occurs (say due to rubbing of crystals or cracks) the energy used creates a hot spot to further set off the remaining explosives.

Once activation energy is exceeded the explosive will go off. *detonate you mean?*

* Incorrect mixture of chemicals (imbalanced)

These are all good ^{statements} explanations of facts but what about the explanation?

Examiner Only

- ⑥ Single based - NC
 double based - NC + NC
 triple based - NC + NC + NC

Attention!

Double is more effective than single but not as effective as triple based. X

Used for
 single -
 double -
 triple -

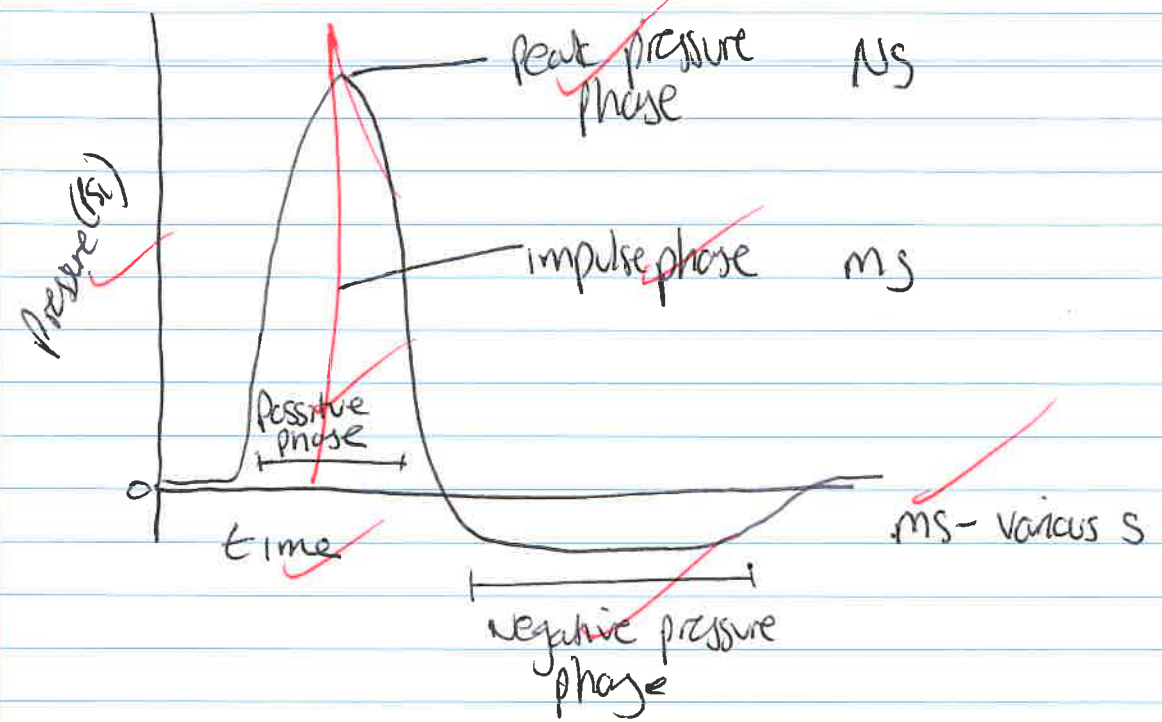
RDX / nitramine

Add in a decapper agent to the munition so it will help remove deposited copper from within the barrel and allow the next round of munition to be fired correctly.

Flame temp can be controlled from adding in a coolant agent within the munition to stop it overheating or taking the correct amount of time in between use to allow the barrel to cool.

②

⑦



②

Armour Bullet

Armour → long rod penetrator to destroy the armour (HEAT Round) High explosive squash head

Personnel → Bullet fired from a gun

Moving Jet → heat seeking missile? Yes! But what warhead?

①

Bullet fired from gun uses kinetic energy to enter the body and destroy the target.

①

Armour long rod penetrator used to pierce into armour & create a vacuum of pressure within a small space and then explode to destroy the armour & potential casualties (say within a tank)

⑥

Fast moving jet -

⑧ 4 types of blast injuries

Primary - caused by blast ~~explosion~~
- barotrauma

Secondary - caused by fragmentation (either from weapon or structures etc)

- amputations
- cuts

Tertiary - caused by the blast wave
- thrown into structure causing head & limb injuries.

Quaternary - ~~caused~~ caused as an indirect injury from the blast, radiation or heat

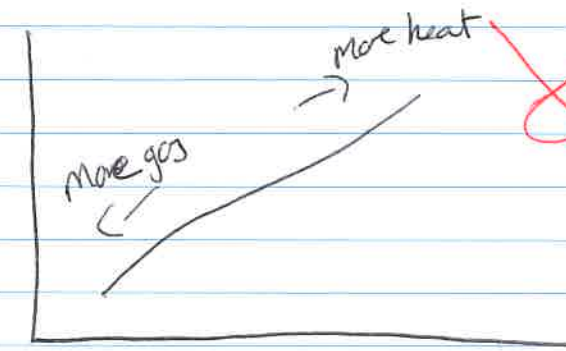
- radiation poisoning
- death further on life from injury.

It is necessary to match the kinetic energy of a weapon system to the target to ensure it will hit the target successfully and not fall short or over stray. In a tank round the propellant required will be measured to ensure the round will hit its target.

⑨ Stoichiometric mixture is the ratio of chemicals required to give the intended reaction to make sure it is successful.

products → reactants

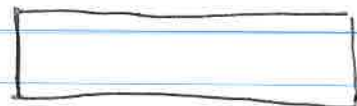
Graph?



Energy output changes & increases as Jmol^{-1} of oxidant is available as this provides more energy.

Peak performance occurs at 60% magnesium instead of 56% as the mag increases in O_2 when heated. therefore less is required within the critical mix. *What is happening?*

(10)



Mixture 2 is more suitable as it has a higher fuel content mix (42.5%) but the heat of combustion is lower (2.63 MJ kg^{-1}) & there is a higher gaseous reaction of the products ($0.632 \text{ m}^3 \text{ kg}^{-1}$)



Complete, fold and seal
(see note 2 below)

SURNAME: Mallon

FORENAME(S): Finn

Examination Answer Books

12 Pages

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1	Student Number	2031021 ~~10110~~
2	Title of Examination Paper	~~ACDA4019~~ Principles of OME
3	Module Code	ACDA4019
4	Date and Time of Examination	10/05/23 09:00-11:00
5	Examination Venue	IQ310
6	Seat Number	024
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	3
3	3
6	2
7	3
8	5
2	4
3	
4	1
6	
9	1
10	0
Total	22

Significant
lack of
understanding.

1

An Explosion is the decomposition of a chemical system, with regards to pressure and heat. *rapid*
to produce gas and heat

①

Burning

Burning occurs on the surface allowing the gases to escape into the atmosphere. Deflagration will burn just the same however, the gases won't be able to escape and the pressure will build, (this is when the chemical mixture contains its own oxygen). Detonation is the same as deflagration until the pressure builds up, as none of the gases can escape. Once the pressure builds to a big enough size it will detonate.

This is not a LT explanation. Velocity of sound in material etc.

②

3

Critical Diameter and Critical Density are important in munition design as they can affect the results of detonation a lot. The critical diameter is important because, having a larger diameter will give more room for when the pressure increases in the munition. Critical Density is also important as this affects the weight, which means a larger density = a bigger detonation. *There is some truth to the above but - - -*

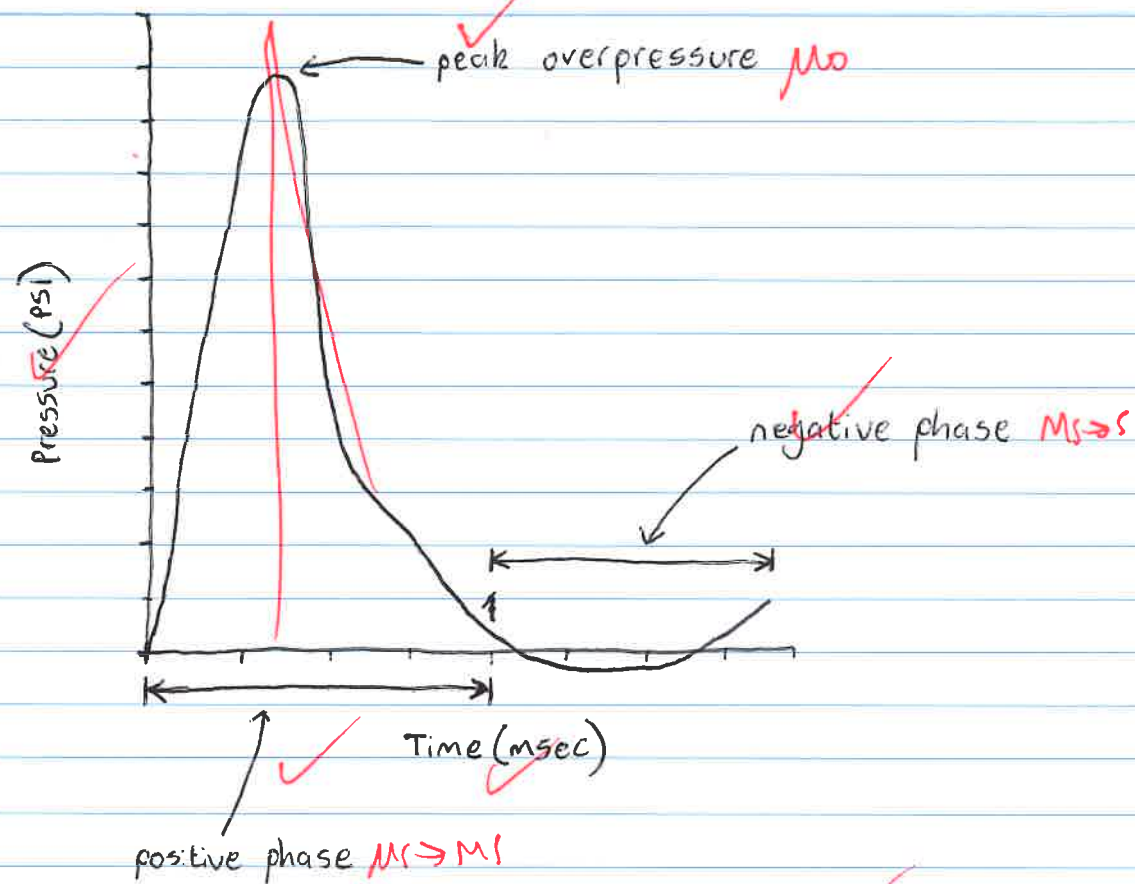
②

6

Single base propellant contains only Nitrocellulose, a double base propellant contains Nitrocellulose + Nitroglycerine and a triple base propellant contains Nitrocellulose + Nitroglycerine + Nitroguanidine. These would be used in Low Explosive types. *Systems?*

②

87



7

- a) armour: this could be a HESH round that will create a scab as it hits the piece of armour, which will lead to the scab bouncing around inside of the piece of armour.
- b) Personnel on the ground *with what*
- c) a fast moving jet at low altitude: Guided missile, this will lock onto the target and will create great damage. APFSDS round that will stay straight as it is fin stabilised and will penetrate into the side of the jet creating an air gap.

Think about the engagement scenarios here and the weapons you would use.

8

Primary injury, this is blast that could cause various different injuries. Blunt trauma.

secondary injury, this is shrapnel that may break away from the munition and cause penetration to the body of an individual and could most definitely cause death.

Tertiary injury, this is the effects from blast, that such as, making the individual fly in the air and come into contact with something else such as a wall or something else along these lines.

Quaternary injury, this is something that is caused by the occurrence of a detonation that isn't direct and less traceable of the cause. This may be something like radiation poisoning or other diseases. Just any other vector that isn't caused with an obvious cause such as a Primary or Secondary injury.

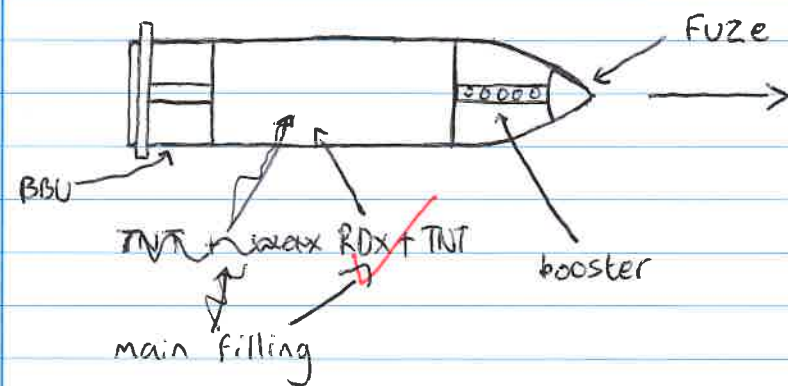
8

It is important to match the kinetic energy of a weapon system to the target because this will make the interaction of the munition and the target more accurate. If it is a moving target it is important to match the kinetic energy of the weapon system to the target as it allows them to interact at a designated point and will give a better chance of making contact.

Again, think of the language you are using.

2 Common types of explosives in everyday use.

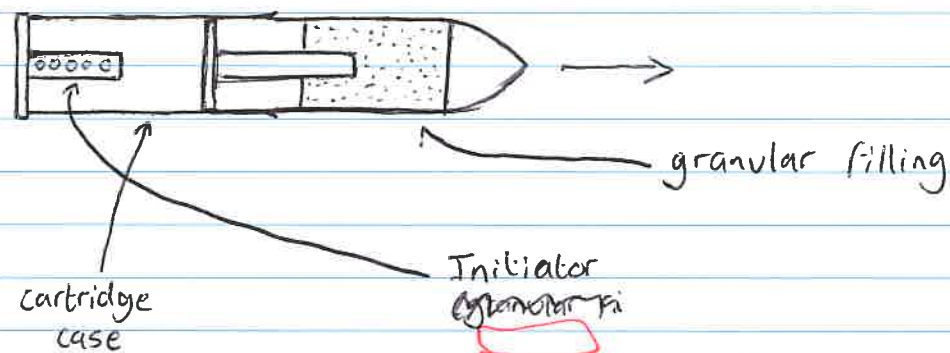
155 mm Illum



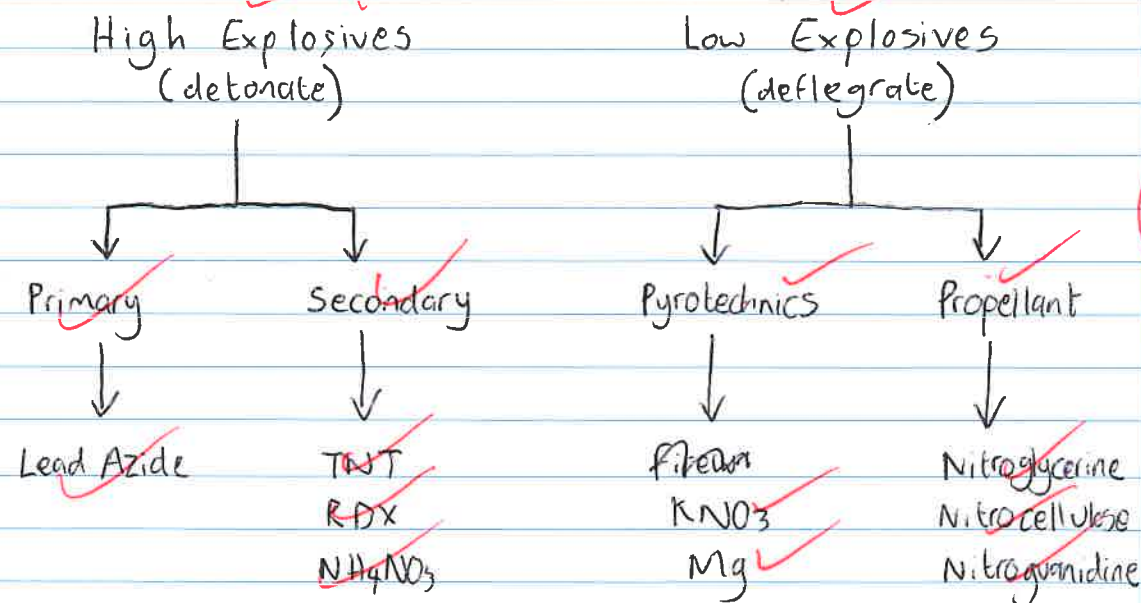
This was a long way to answer parts of this question.

(1)

4.5" MK8



2

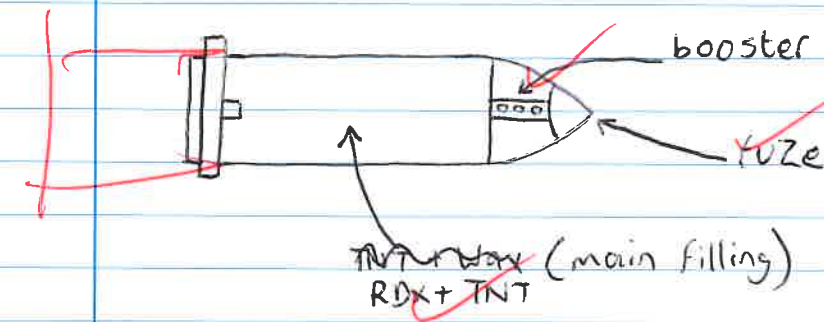


(3)

Q3

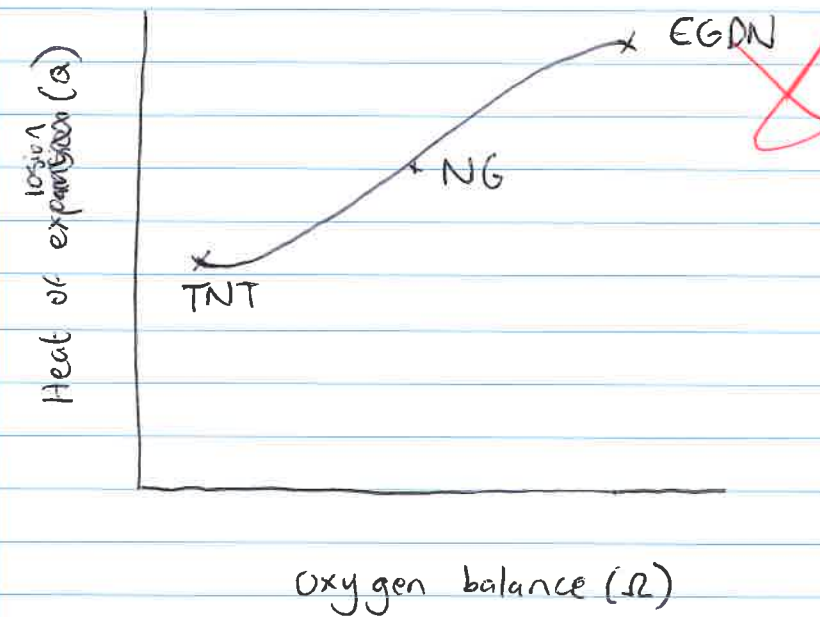
Fixed Case artillery fuze:

— where is the propellant etc? The ignition chain.



(1)

4



4

A TNT explosion is so dark because of the carbon content with the mixture.

(1)

6

An increase in force constant would damage the barrel and cause it to crack. This is due to overpressuring the barrel and can be done easily if the incorrect charge weight is chosen.

We are looking at adding RDX, which increases F , Q and T_0 . Then the addition used to cool.

9

A stoichiometric mixture is where the all parts a value where the peak performance of the mixture should occur.

(1)

10

$$\text{Mixture 1} - 4.43 \times 0.269 = 1.192 \text{ MJ kg}^{-1}$$

$$1.192 \times 0.401 = \underline{0.478 \text{ m}^3 \text{ kg}^{-1}}$$

$$\text{Mixture 2} - 2.63 \times 0.43 = 1.133 \text{ MJ kg}^{-1}$$

$$1.133 \times 0.652 = \underline{0.703 \text{ m}^3 \text{ kg}^{-1}}$$

Mixture 1 is the most acceptable as it produces less smoke per volume.

1

1