



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.**

1	Student Number	1810319
2	Title of Examination Paper	ACDA 6008
3	Module Code	Scientific Principles of OME design
4	Date and Time of Examination	5/5/22 11:00
5	Examination Venue	FF001
6	Seat Number	
7	Number of Answer Books handed in	1082

List the numbers of the questions you have attempted	Office Use
1	2
2	4
3	0
4	4
5	4
6	3
7	25
9	10
Total	52

1

War head velocity
 War head mass
 War head material
 Target material

you want a dense ~~high~~ explosive with a high velocity of detonation to impart as much energy in to the fragments as possible.

Q1
 = 2

Things to consider

Case thickness

Case material

Size, Shape, mass of fragment.

The right amount of lethal fragments at the right velocities

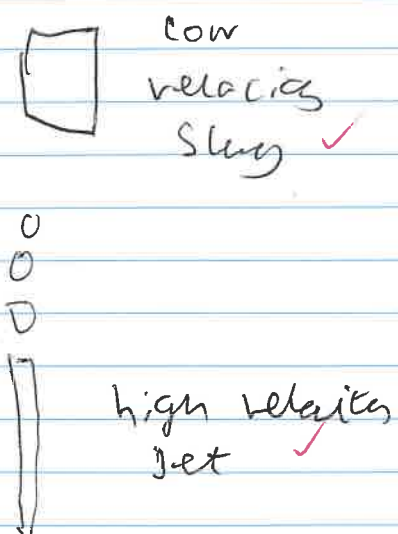
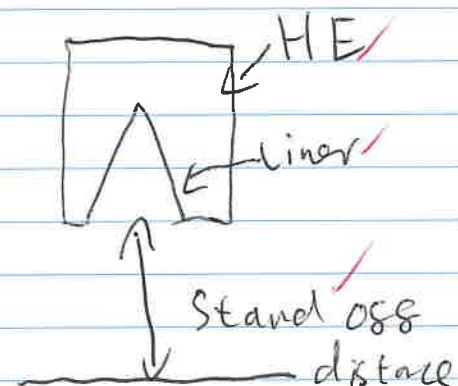
Too many small or not enough big
 won't produce the desired lethal effect.

2

Shaped charge jet works by shooting a liner at the target. The liner is super plastic not liquid hydrodynamic. A jet is formed by the explosive collapsing the liner. The jet is ~~20%~~ 20% of the liner gathered by the slug at 80%. Copper is a common liner used. A stand off distance is required for the jet to fully form usually 3-6 cone diameters.

Tanks can use explosive reactive armour (ERA) or non explosive reactive armour (NERA). This prevents the jet from forming. Grids, mesh and bars can be added to disrupt jet formation.

War heads can use precursor SC to disrupt ERA allowing a second SC to ~~penetrate~~ penetrate the tank.

3
1

$$A = \frac{F}{M}$$

$$\text{acceleration} = \frac{350}{40} = 8.75 \text{ m/s}$$

$$M = \frac{F}{A}$$

$$\text{mass} = \frac{600}{8.75} = 68.57 \text{ kg}$$

Q2
=4Q3
=0

4 The blast wave will propagate out spherically from the charge giving an even spherical shock wave ✓

initiation point ✓
case material
case thickness
~~power~~

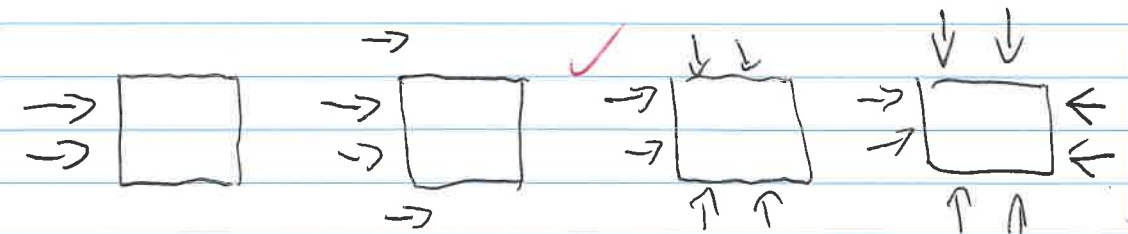
Adding aluminium increases the positive pressure phase. ~~that~~ Fine aluminium powder reacts with the detonation products adding heat to the explosion giving a bigger bubble. ✓

5

Shock wave ✓
this is the initial shock from an explosion

Dynamic loading ✓
This is the detonation products carried by the blast wind. ✓ Affects structures. Carries secondary fragments, bricks, the rocket etc

Diffraction loading ✓
this is where the shock wave travels around a building causing the structure to fail



it lifts the building during positive phase then drops in negative

Q5 =
4

Q4
=4

6 The ballistic life of a gun propellant is the safe life of a propellant before the propellant starts to auto catalytically decompose. The safe shelf life of a munition. Spot checks help track the life of a propellant.

The storage conditions affect the life of a gun propellant. Has it been stored in hot or cold conditions humidity, wet climates.

Additives can affect the life of a gun propellant

Stabilisers

Plasticisers

Surface moderators

Coolants

Decoppering agents

Barrel wear reducers

7

a There are two main types of warhead used against aircraft, Fragmentation and internal blast. External blast is not used as the effect of blast is reduced at altitude.

Fragmentation warheads come in different varieties. There is natural and controlled fragmentation. Natural fragmentation is where the case ruptures naturally upon detonation. This method is not commonly used as the shape, size and mass of fragment are not controlled not guaranteeing any lethal fragments.

There are a number of ways fragments can be controlled. Continuous rod is one way, this uses rods that are welded together at each end. On detonation the rods expand to create a lethal ring that can damage aircraft and cut off wings. Pre formed fragments can be placed between the case and the explosive. These fragments can be ball bearings, cubes, rods. These are specific shapes, sizes and weights to give a lethal effect. The case of the warhead can be used to give controlled fragments. The case can be lined or scored giving the desired fragments.

EXAMPLES?

Internal blast is used inside an aircraft to cause a lethal effect. An internal blast from a ~~semi~~ warhead could kill the pilot and/or damage avionics and the aircraft.

EXAMPLE?

Continuous rod can be 60 feet in diameter

7a Anti aircraft war heads are generally small in size about 1Kg - 5Kg however can be up to 50 Kg for larger systems. The angle at which fragments are disintegrated from the war head can be calculated using Taylors equation.

These missiles are small as they need to be manoeuvrable as they chase the target. They are also generally air ~~car~~ carried which will determine size.

AA - Good Key

1K6 - Bluntish

50kg - Bluntish

7B Blast warheads and Shaped Charge jets (SCJ) are commonly used on submarines. Fragmentation warheads are not used due to the higher density of water over air.

Blast warheads can be delivered by torpedoes or sea mine. The effect of blast underwater is greater than air due to the density of water. When detonated underwater the warhead produces a bubble of gaseous detonation products. This bubble expands and contracts oscillating through ambient water pressure. The bubble can expand and contract up to 10 times as it rises to the surface. If this bubble is oscillating under a submarine this could break the submarine in half.

Another characteristic of underwater blast warheads is the shock wave. This shock wave can travel through the submarine damaging compartments and equipment. The shock wave can also reflect off the sea bed and sea surface damaging the submarine via reflected waves.

Adding aluminium to underwater blast warheads increases the initial phase giving a larger bubble. The aluminium reacts with the detonation products burning slowly.

Blast warheads can be torpedo delivered with a proximity fuse, or mines with a contact or proximity fuse.

Equivalent bare charge can be calculated to give explosive power without case

$$1 + \left(\frac{1 + m_r}{1 + m_c} \right) \times C$$

7B SCT are used to punch a hole in the side of a submarine flooding compartments. The jet needs time to form so a proximity fuze is used to give the jet the optimal distance to form.

As submarines are subjected to immense pressures their hull is thick so a large warhead is required.

Manifolds used to attack submarines are large warheads and weigh 100 kg - 500 kg.

SCT the jet travels 8-12 km/s
the slug travels at 300-1000 m/s

9a Mono and bi propellants are used in rocket motors.

Mono propellants contain one propellant, and no oxidizer. Hydrazine is a common mono propellant. These propellants require a catalyst or pyrotechnic stimulus to start the propellant burning.

Bi propellants use two chemicals to give the desired effect. A fuel and oxidizer are carried in separate tanks and mixed in the combustion chamber. Bi propellants can be hypogolic meaning they combust upon mixing and don't require a starting stimulus. If not hypogolic a pyro can be used to ignite. Hydrogen and oxygen is an example of a bi propellant.

Bi propellants burn smokier with a higher α value.

Q9a =

Q9 =
Total
= 10
(6+1+1+2)

Q 8

Liquid propellants are far more complex than solid propellants. They require combustion chambers, pipe work etc. whereas solid just has an ignition source and a venturi for the propulsion gases to exit.

Solid propellants are safer and easier to transport. They are less likely to leak.

Liquid propellants have higher Δv values giving them more energy meaning they can fly faster than solid propellants.

Solid motors can crack giving an uneven burn or become detached from the case if case bonded.

Solid propellants need careful storage handling and short times. A Teacase may be needed to restrict short times and altitudes to prolong the life of the munition.

Good answers if subject was asked about solid fuel!

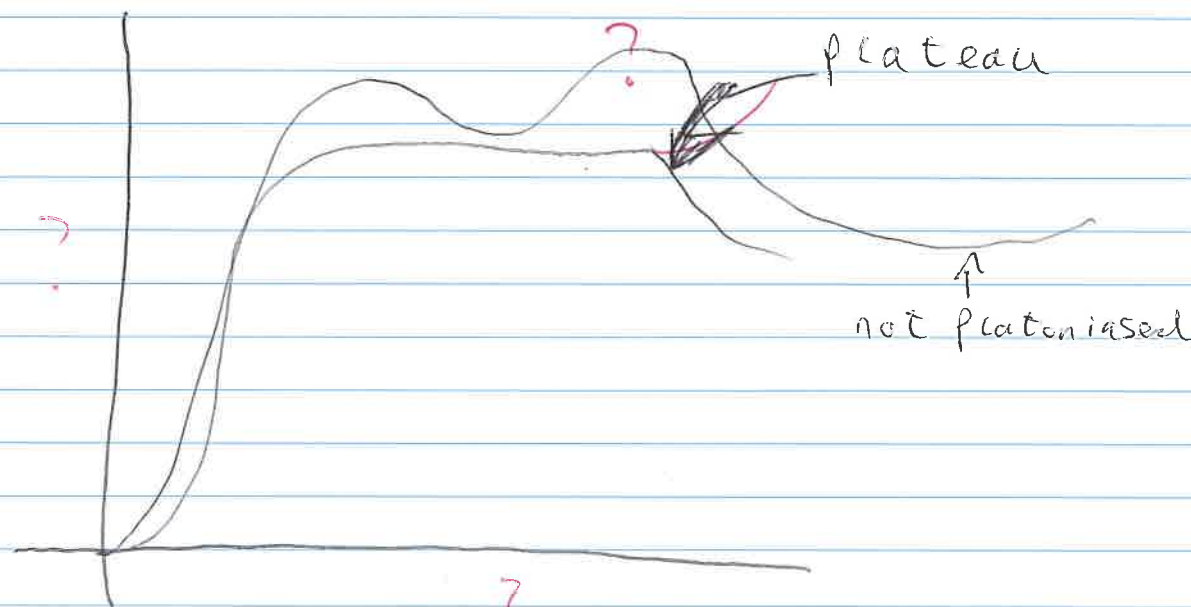
Q 8
= 1

2082

Question No.

Examiner Only

Q1 Platonisation is the flattening of the burning curve giving an even burn. This plateau means there is no variation in velocity.



The main advantage of platonisation is to give the rocket motor a long steady even burn.

This can reduce the overall maximum pressure expelled by the rocket motor.

Author yn unig

Phyl y Cwestiwn

9 d

~~There are two types of comp~~

Rubbery rocket propellants are safer than plastic rocket propellants. They are less likely to crack. They have high α value - specific impulse

~~low~~ high T_{vol} - flame temperature

good glass transition temperature ✓

They can be case bonded ✓

Long shelf life

Safe

expensive

Q9d
=2

Q9=