



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	1810346
2	Title of Examination Paper	Scientific principles of OME Design
3	Module Code	ACDA6008
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	1

List the numbers of the questions you have attempted	Office Use
1	2
2	2.5
3	0
4	4
5	3
6	2
7	23
8	20.5
9	
Total	57%

Q2

2. A shaped charge forms a jet of super plastic material with a tip speed of 8-12 km/s. The jet is powerful enough to defeat thick armour until the angle reaches roughly 60-65°. The tank can ~~stop~~ defend itself with sloping armour, reactive armour. The reactive armour disrupts the jet to stop perforation. The warhead design could incorporate a wave shaper to increase perforation distance, as well as a double ~~washed~~ warhead, allowing the first to disrupt the defence mechanism and the second to ~~perforate~~ ^{penetrate} the tank.

Q2
= 2.5

3.

$$a = \frac{F}{m}$$

$$a = \frac{350 \times 10^6}{40}$$

$$a = 8.75 \times 10^6 \text{ m/s}^2$$

Q3
= 0

$$34.84 \text{ kg}$$

4. The blast wave will be omnidirectional
Initiation point, core geometry, target area

Q4
= 4

The aluminium continues to react after the initial shock wave has passed. It increases the overall energy of the explosion, thus increasing the bubble rupture effect

5. Blast, dynamic loading, diffraction loading

blast produces the initial shockwave to defeat the structure

dynamic ~~loads~~ loading - fatigue of the structure

diffraction loading - effect of fragments caused by the blast wind (~~and~~ indirect damage)

6. Ballistic life is the period the munition will perform within its design parameters safely

Storage conditions
explosive type
Stabiliser content

Q5
=3

Q6
=2

7a. Aircraft can be defeated using blast or fragmentation primarily. Blast is ~~only~~ only very effective internally, if it was external then the omnidirectionality will result in wasted energy.

The shockwave from a blast warhead internally is all useful energy as it is in an enclosed space. In comparison to a frag warhead, blast can be much smaller to defeat the target. One reason for this is the casing. Fragmentation warheads require a much stronger ~~case~~ case to produce the fragments so they need more energy to disrupt the case. Therefore an overall benefit of blast over frag is that the launch platform can carry more blast warheads than frag warheads, thus giving the opportunity to defeat more targets. Frag warheads can defeat ~~single~~ aircraft through perforation. The designer should consider frag density to ensure an appropriate level of ordnance is covered to maximise the hit potential. Controlled fragments are used in missiles such as sidewinders, wing dices or the continuous rod mechanism. Continuous rod acts like a pair of scissors as it is released into the path of the aircraft in an attempt to slice vulnerable parts such as the wings. Initiation point can affect frag direction as well as charge/case geometry. In comparison with blast, frag is a much more complicated complex warhead with many variables contributing to its final effect. Blast is much simpler and cheaper to achieve but as it must contact the aircraft, the ~~single~~ aircraft may have

Q7a
=12

more def. defence mechanism available or opposed to frag which only needs to get close.

a) New's / Sizes

b) examples

c) He^+ - strombreech

7b. Submarines are generally targeted by blast or shaped charge warheads. Blast creates the bubble impulse effect aimed to flex the submarine from underneath. As the gas bubble oscillates, ^{scuba} trying to reach the surface, it forces the submarine to bend multiple times and should cause fatigue in the material. The effect can be improved by ~~aluminizing~~ the explosive, this can increase the overall energy of the explosion by continuing to react after the initial shockwave has passed. The ~~upblast~~ torpedo is a blast warhead, this uses a ~~very~~ very large warhead to defeat its target. The simplicity of the blast warhead against shaped charge reduces the cost, allowing a larger warhead to be produced at possibly the same cost as a smaller shaped charge. The shaped charge warhead works on the same principle as a hard penetrator SC, utilizing the high tip speed of the shaped charge jet to pierce the hull of the submarine, essentially making it flood and sink. Submarines can defend better against SC warheads as they could have a double skinned hull filled with water to stop the jet piercing all the way through. If a jet does pierce through, the submarine could remain buoyant by sealing off that area. A SC warhead may have to

Q7b

$$= 11$$

Q7

TOTAL

$$-12+1$$

-23

be used in multiple areas to appropriately flood the submarine when an one large blast warhead could break the sub in half, leaving it no possibility of surfacing. The SC warhead has the advantage of possibly hitting essential systems like life support, propulsion or the magazine, though they are likely well protected.

9a. A liquid monopropellant burns in the absence of oxygen, ~~it is forced over~~ it uses a catalyst to assist its function. Bipropellant use ~~of~~ oxygen to produce a much higher specific impulse. A common monopropellant is Hydrazine and a common bipropellant would be liquid methane and liquid oxygen as used in SpaceX Raptor engines. monopropellants have a relatively low F value so are generally used in directional thrusters, bipropellants are much stronger so are used in satellite launch vehicles and in the new age of commercial space ~~to~~ travel.

Q9a
= 8

Q6. Advantages:

Liquid propellants have much greater control, the burn rate can be controlled, determining the speed of the rocket. It can also be stopped if there was an issue. Liquid propellant is also easier to manufacture. They are also less susceptible to ignition from external attack.

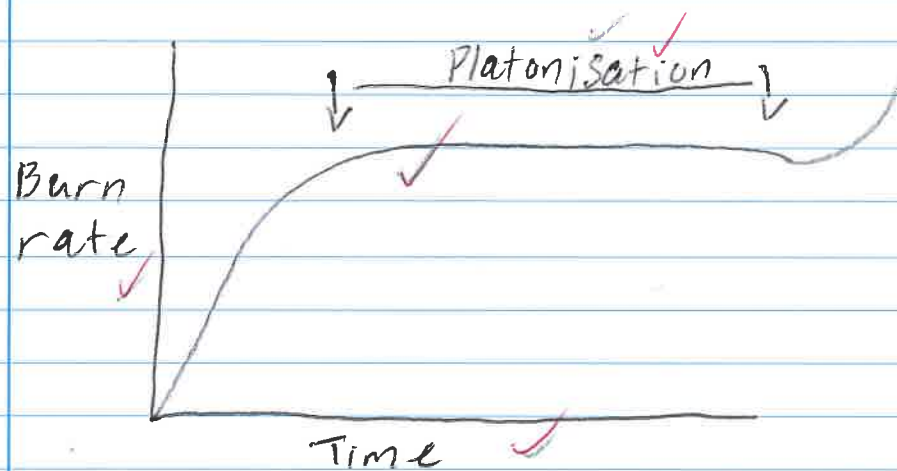
$$Q_4 a = 6$$

Disadvantages:-

It requires a very complex delivery system e.g. pumps, piping, nozzles etc... meaning it is not

very useful for small delivery systems, they would be useless on small gun platforms like a pintle. They also require complex pressurised storage vessels, while that isn't a huge problem for space rockets, for munition it will greatly increase the size and cost of the ~~weapon~~ rocket.

9c. Platonising a rocket mean stabilising the burn rate as shown by the graph below.



Platonisation gives more control over the rocket, ensuring the propellant isn't used up too quickly or too slowly. However it decreases the total energy of the system. It also causes the burning to be smoky.

9d. advantages:
easier to store (less sensitive) ✓
longer shelf life ✓

disadvantages:-
decreased performance
more difficult to manufacture ✓
cost ✓

increase smoke production when burning -
could give away position ✓

Q9c
=4

1. Penetration of ^{generic} a warhead specifically are determined by core material. The type of warhead can determine how it penetrates a target e.g.

Blunt = core design

Shaped charge = Explosive med, core diameter, stand off, core material

Fragmenting = Explosive med, core design, can be estimated using energy theory.

KE = warhead velocity, rod material.

All penetration is limited by the target and the energy coupling should be considered

Overall specific energy can determine speed of fragments. A higher energy explosive will have more energy to put behind the fragments after it has disrupted the core. Initiation point may be detrimental if not coupled with angle of attack on the fuser

Q1
=2

Q9d
=2.5

Q9
Total
8.6 + 4
= 12.6

may work against each other. additives in
the explosive ^{could} ~~will~~ also be detrimental,
stabilisers, plasticisers, coolants and others
may decrease overall performance as they are
needed to improve other characteristics?