



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 i) type 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	1810351
2	Title of Examination Paper	Scientific Principles of OME Design
3	Module Code	ACDA 6008
4	Date and Time of Examination	05/05/22
5	Examination Venue	Library 001
6	Seat Number	14/A
7	Number of Answer Books handed in	1 of 1

List the numbers of the questions you have attempted	Office Use
1	3.5
2	2.5
3	0
4	2.5
5	2
6	4
7	2.7
8	16
Total	57.5

1

governs penetration properties of warhead on target.

a

- Penetration properties include the energy coupling at the warhead to the target, $\frac{1}{2}$
- The size, mass, shape and speed of any fragments produced 1
- The armour, if any, of the target, its geometry such as sloping at 65° or its composition and/or use of ERA.

b

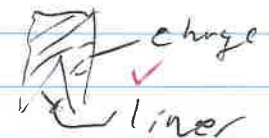
Characteristic of explosive for velocity of fragment

- Charge density, charge velocity of detonation, interaction of detonation front with charge casing, 2
- detrimental effects include case-to-charge ratio being bias to case. i.e. case is too thick for charge to effectively rupture with enough residual energy to impart sufficient velocity to fragments produced.

2

Function of SSG vs Tank, Tank defense, mechs employ warheads that can overcome said features.

- Shaped charge jet functions by focusing energy of explosive into a narrow jet, by using a conical liner inside the warhead which is compressed and extended forward by the detonation of the charge.



Jet functions to penetrate armour through exceeding the armour's material properties. Does not melt through rather pushes the armour aside due to massive, focused pressure.

Tank defense includes sloped armour at 60° or greater ERA, explosive, reactive, armour to disrupt the jet and/or stand off plating to initiate shape charge too far from tank for its effects to be effective.

Q1 =

3-5

Q2 =

2-5

A 155 shell uses bag charges to provide propulsion.

Question No.

3

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


$m = 40 \text{ kg}$ Insid dia 135mm? Compressive stress = 600MPa

3.1 acceleration of shell when pressure = 350MPa

$$a = \frac{F}{m} \quad a = \frac{350 \text{ MPa}}{40 \text{ kg}} \quad a = \frac{350000000 \text{ Pa}}{40 \text{ kg}}$$

$$a = 8750000 \text{ ms}^{-2}$$

3.2 mass forward at the shell

$$m = \frac{F}{a} \quad m = \frac{350 \text{ MPa}}{8750000} \quad m = X$$

4

4.1 isotropic ✓

4.2 charge density, charge material, movement of charge.
if charge is moving through space at a speed then it
become non-isotropic is blast wave shape.

4.3 adding Aluminium

- Increases impulse due to the presence of additional
fuel for use during detonation. Impulse also extended
due to secondary burning of Aluminium product

Examiner Only

Question No.

5

dynamic loading ✓ - Impact of blast wind as it moves
through the target

diffraction ✓ - bending at the blast wave around
a structure resulting in loading
of structure from several angles
and creating zones of higher
pressure, such as corners.

Q5=2

Q3
=0

6

6.1 ballistic life

the life of the propellant ~~is~~ defined by its ability
to produce sufficient performance: i.e. a
percentage of its original pressure output

Q6
=4

6.2 autocatalytic

- autocatalytic decomposition through nitrate esters &
given of.
- quantity of energetic compared to binder/stabilisers
designed to mitigate ~~at~~ nitrate esters.
- presence of moisture, ingress etc. Temp and humidity
exposure ✓

Section B

Q 7 aircraft

- Frag due to altitude ✓
- Small payload due to target closing and weight constraints ✓

a. Attack of air platforms is typically through the use of high fragmenting warheads, with the number and density of the fragment field being of great importance. Some systems such as napier use blast as a damage mechanism although these require impact with target to deliver effect. A fragmenting warhead, such as used in ASRAM, only need to be close to an air platform to deliver effect, therefore they benefit from a greater area of effect and less dispersion.

Fragmentation is desirable for air platform attack as, at altitude, air density is greatly reduced, effectively reducing the medium which blast overpressure ~~effects~~ ~~used~~ uses to cause effect. Conversely the reduced air density has a positive impact on fragmentation as the less dense air provides less ~~drag~~ drag and therefore effective range of fragmentation is increased.

Air platform warheads are typically small in nature, due to the constraints put upon them such as weight ~~to~~ and the need ~~to~~ of the munition to carry sufficient propellant to get the warhead to target. Warhead sizes around 10kgs are typical. preformed fragments otherwise called shrapnel are also used to further allow for reliable ~~to~~ field densities to be achieved. Preformed fragment can more easily be modelled for effect as they have a known shape and ~~mass~~ mass, fragments from case rupture are more random in such areas and so can be determined as less reliable or consistent in fragment field geometry creation.

Sect 3

Q 7 b

Attack of submarines require the target to be penetrated to a degree before structural damage can take place.

The use of either a shaped charge ~~or~~ or EFP frontal warhead with a significant NEM of charge is typical.

The shaped charge or EFP ^{whilst} is used to penetrate the hulls of the submarine ~~before~~ the large charge creates an underwater cavity through its detonation. this bubble attaches to the submarine hull and ~~as~~ effectively implodes once the bubble pressure reaches a low pressure state, allowing the surrounding, higher pressure water, to collapse back. this collapse can cause secondary detonation of unburnt explosive products. It is ~~also~~ followed by the creation of a second bubble as the collapsing water decreases in pressure but increases the gas pressure through compression. this effect may ~~not~~ occur several times.

Shaped charge and/or EFP effectiveness underwater is ~~reduced~~ lessened due to the more dense nature of the water medium.

This increases drag massively when compared to air at sea level. It is noteworthy that the spacing of subs double hull, with the cavity between filled with water to act as ballast also reduces the effectiveness of shaped charge performance.

Munitions such as tiger fish or Mk18 torpedoes employ the above mentioned features with smaller systems such as Stingray only deploying a shaped charge as its size is such ~~that~~ ^{that} underwater blast ~~is~~ has reduced effect.

W/rt - sizes?

Q7a
=14

Q7b
=13

Q7 Total
= 14 + 13
= 27

8

a Composition is of projectile, casing to contain propelling charge, propelling charge and a means of ignition.

4 types of gun propellant, single base, double base, triple base and composite.

Single base = Just Nitrocellulose as energetic, is negatively oxygen balanced and used in shoulder fired gun systems as well as mortar - curving mounting charges

double base = Nitrocellulose and Nitroglycerine (NG) as energetic composition. High heat of flame, faster acting and used in handgun and firing systems due to rapid gas production - is more sensitive to shock, friction etc than single based.

Triple = NC, NG, NX, similar to single base in performance but much less sensitive. used in large guns.

Composite = RDX based, high heat high velocities sensitive.

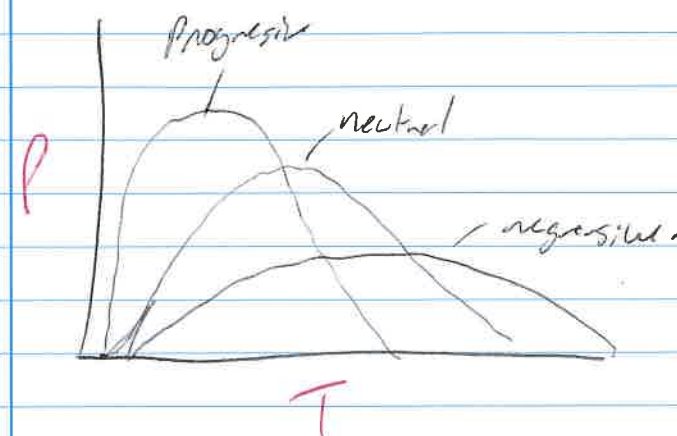
Progressive grain shape = upon burning surface area increases as does gas production.
designs such as multitubular

Neutral = upon burning surface area remains the same with consistent gas production.
designs such as ribbon or flakes used.

Regressive = upon burning, surface area decreases with gas production also decreasing.
designs such as spheres or single stick/tubes.

8a

Progressive, neutral, regressive graph



Q8a

7

Q8a = 7

8 b

- reduced weight of ammunition through the use of caseless
- low flash signature ✓
- consistent pressure output
- insensitive to ignition other than what is needed ✓
- cheap ✓
- non hazardous (toxic, corrosive etc) ✓

Q8b

2

Q8b = 2

8 c

NC is oxygen negative in its properties and as such can be considered to "burn dirty" resulting in fouling and the need to add additives such as surface moderator or lubricants. It is hard to nitrate reliably with a combination of Cl, Bi and Pri nitrate groups typically present at any one point.

NC is made from natural material such as wood pulp, a material that may not be readily accessible by some nations.

This can be addressed by moving away from NC entirely and selecting another energetic material. This will also address oxygen balance as well as the "dirty" burning. However compromise is found as many alternative propellants are comparatively more sensitive and hazardous such as being corrosive.

8c

liquid propellants as a replacement for of NC would allow for features such as being able to ~~tailor~~ tailor the quantity of propellant precisely for each shot. If loaded by mechanical means it would also allow for more combat effectiveness is used in a tank under Topdown, NBC conditions.

liquid propellants ~~however~~ however are highly toxic to humans, hard to store safely and would take up significant space.

Composite propellants using materials such as RDX could also replace NC based propellants. They produce much greater pressures over much less time but as a result burn very hot. this T_i feature reduces barrel life significantly as throat erosion is increased.

RDX based propellants are also considerably more sensitive ~~than~~ to impact and friction when compared to Nitro cellulose.

LOVA, ECCs, CMPC & LTC
are the new developments

Q8
7
8c

7

Q8
TOTAL
7+2+7
=16