



Examination Answer Book

24 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 and seal 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	P144278
2	Title of Examination Paper	MUNITIONS
3	Module Code	M6X00944
4	Date and Time of Examination	29/06/17 1100hrs
5	Examination Venue	
6	Seat Number	

7	Number of Answer Books handed in	1
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List the numbers of the questions you have attempted	Office Use
1	9
2	55
3	8
4	8
5	7
6	9
Total	465

Please complete this section and SEAL before the examination starts.

Surname McAuliffe Forename(s) Harry George (Block Capitals)

Complete section, remove strip, fold as indicated and SEAL

Q1) a) passive - Homes in on emissions naturally emanating from the target (i.e. heat, exhaust signature) ✓

Semi-Active - Homes in on a reflected energy signature from the target. ✓
the target is designated or "illuminated" by a 3rd party typically a plane or laser designator team of infantry

Active - the missile transmits and receives information about the environment, using on board logic to Home in on the target. ✓

b) Passive Homing is the cheapest method of Homing functionality. it is a fire and forget weapon that does not require emissions of a homing signal (less visibility of the attack). ✓

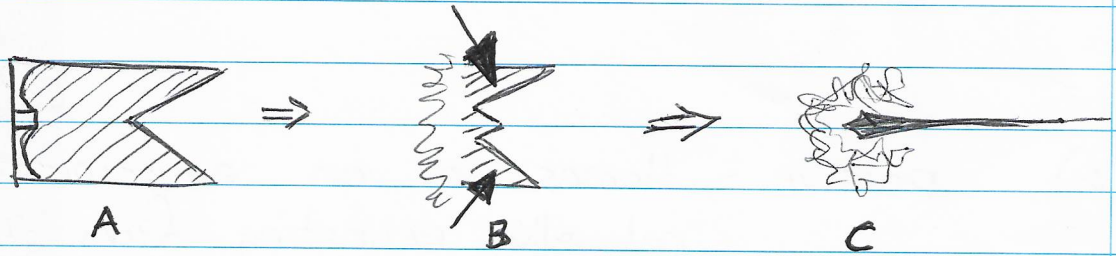
c) Accelerometers, Gyroscopes, GPS ✓

↓
able to determine sideways/up/down movement that ~~may~~ does not shift the gyroscopes off-axis.

↓
determine tilt, roll and dive, adjusting the axes of the gyroscopes

↓
sets the initial missile position in space.

2a)



when a shaped charge initiates, the cylindrical walls of the ^{Apex}minution focus the ~~Detonation~~ Detonation wave to the ~~tip~~ of the shaped charge liner.

this causes deformation of the apex, while detonation wave continue up the minution length. the resulting liner acts ~~as~~ to compress the liner apex ~~the~~ into forming a Hyper-Velocity Jet of material.

this jet is then used to penetrate the target, while the slug is formed by the remaining low velocity liner.

this slug then follows the same path as the Jet, plugging the entry hole.

2b)

- * stand-off from target
- * Velocity of Detonation.
- * Purity of the shaped charge liner material

2c)

~~shaped~~ shaped charge performance is reduced by 1000, due to the density of the medium that the Jet passes through. ✓

3a)

Set-back - the rearward force caused by firing the round from a barrel

Creep - the forward force caused by the deceleration of the round in flight (caused by Drag)

Point Detonating - the impact pushes the firing pin into a stab sensitive Detonator, ~~which~~ flashing through to the main charge

(4)

Delay

↑
- same as PD, except the detonation 'Flash' is diverted to a delay composition before reaching the main charge

proximity

- Radar. initiates an electric detonator when it gets close to a target

timed

- after arming, ~~ex~~ it sets off an electrical Detonator after a specific time has elapsed.

3b)

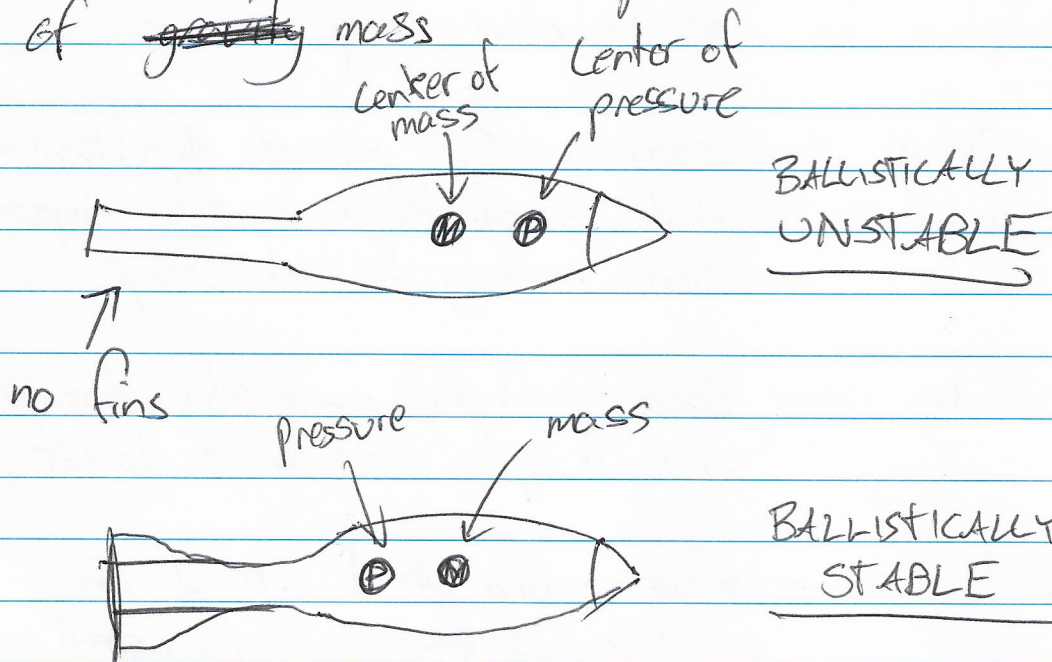
High Explosive - HE mortars have relatively thick shell bodies to produce fragmentation of an appropriate size. they are painted olive drab, with "YELLOW" lettering to denote the HE Fill

PTO

illuminating - use relatively thin walls to keep the round as light as possible. the casing is painted white (for denoting illumination function) with brown writing to denote the low explosive compound within. this compound serves to ignite and eject the illumination composition (phosphorous) and parachute.

(2)

Mortars achieve ballistic stability by using fins to move the center of pressure behind the center of ~~gravity~~ mass



(1)

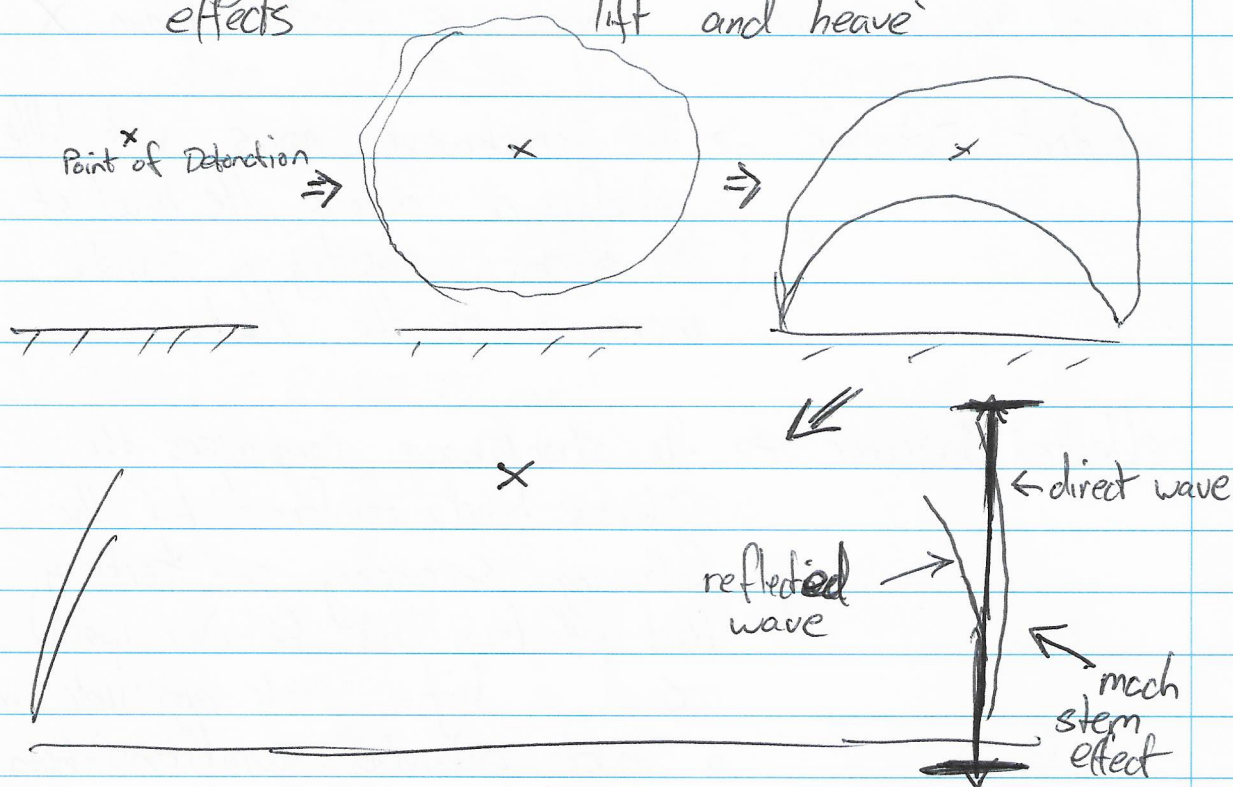
4a)

primary blast → shockwave, shattering effect
(~~an~~ instantaneous rise in pressure)

Secondary blast → Heat, light, fragmentation

tertiary blast → Propulsive force, known as
'lift and heave'

b)

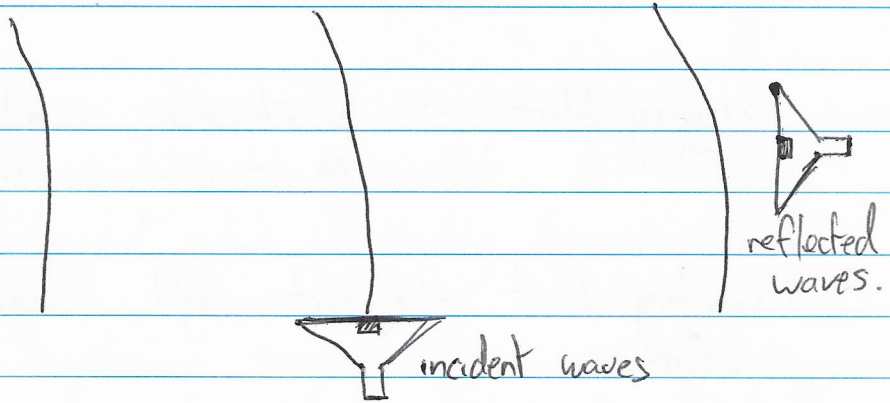


when a high-blast munition detonates in air, the shockwave travels radially away from the source. when the shockwave hits the ground, the shock is reflected. this then overlaps the direct shockwave to cause the moch stern effect.

the overlapping wavefronts interfere with each other to create increased Amplitude and duration of the blast.

4c)

X



in the diagram above, two blast gauges are placed to measure a shockwave emitted from X

incident Detector $\rightarrow$ the shockwave moves with little interference across the head of the detector, providing a realistic measure of the blast.

reflected Detector $\rightarrow$ the shockwave compresses the Detector head, reinforced by the following secondary and tertiary blast effects. this Detector would record a higher peak amplitude and a much extended duration than the incident Detector.

2.5

5a) mass = 6 kg
 Case = 4.5 kg
 $V_{0D(RDX)} = 8440 \text{ ms}^{-1}$
 $V_{0D(HMX)} = 9110 \text{ ms}^{-1}$

$$i) V_0 = \sqrt{2E} \left(\frac{m}{c} + \frac{1}{2} \right)^{-\frac{1}{2}}$$

$$\text{where } \sqrt{2E} = \frac{V_{0D}}{2.97} = \frac{8440}{2.97}$$

1.5

$$V_0 = 2841.75 \left(\frac{6}{4.5} + \frac{1}{2} \right)^{-\frac{1}{2}}$$

$$V_0(RDX) = 2098.77 \text{ ms}^{-1}$$

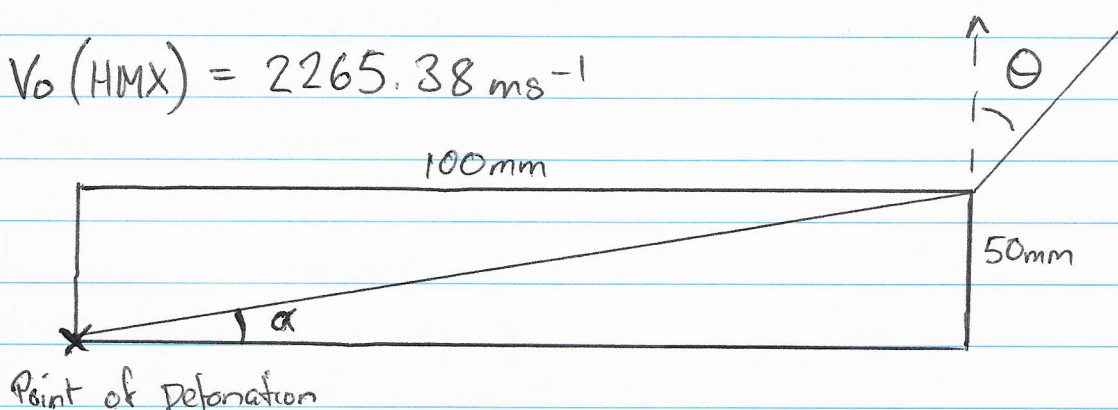
$$ii) \sqrt{2E} = \frac{9110}{2.97} = 3067.34$$

1.5

$$V_0 = 3067.34 \left(\frac{6}{4.5} + \frac{1}{2} \right)^{-\frac{1}{2}}$$

$$V_0(HMX) = 2265.38 \text{ ms}^{-1}$$

5b)



$$\theta = \sin^{-1} \left(\frac{V_0 \cos \alpha}{2 \times V_{0D(RDX)}} \right)$$

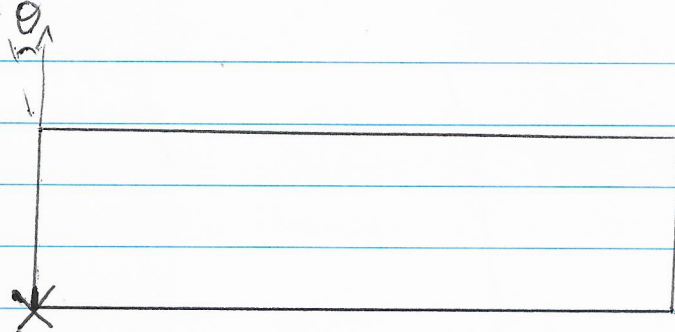
$$\alpha = \tan^{-1} \left(\frac{50}{100} \right) = 26.565^\circ$$

FRONT BEAM
ANGLE



$$\theta = \sin^{-1} \left(\frac{(2098.77) \times \cos(26.565)}{2 \times 8440} \right) = 6.385^\circ$$

3.5



$$\theta = \sin^{-1} \left(\frac{V_0 \cos \alpha}{2 \times 8440} \right) \quad \text{where } \alpha = 90$$

$$\cos(90^\circ) = 0$$

REAR BEAM
ANGLE

$$\text{So: } \theta = 0^\circ$$



$$\begin{aligned} \text{Beam angle} &= 6.385 + 0 \\ &= 6.385^\circ \end{aligned}$$

5c)

$$V_R = \sqrt{V_0^2 + V_m^2}$$

$$V_R = \sqrt{(2098.77^2) + 420^2}$$

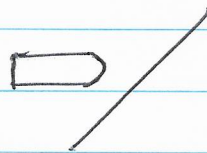
$$V_R = 2140.38 \text{ ms}^{-1}$$

0.5

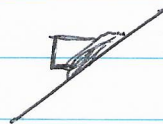
6a) the nose-pad in HESH Ammunition is Designed to spread the explosive composition over the surface of the target. it also dampens the shock to the detonator momentarily.

①

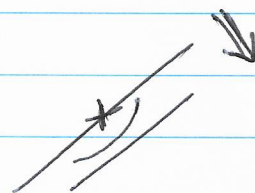
b) HESH Rounds impact a target at approximately $400-500 \text{ ms}^{-1}$,



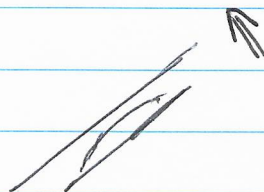
upon impact the 'nose-pad' deforms spreading a layer of high explosive over the armour surface like a 'cowpat'.



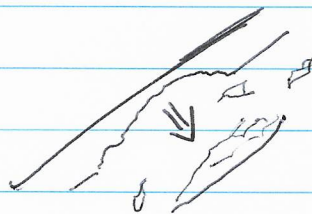
the detonator in the rear of the round initiates the explosive, putting a compressive wave through the material.



the wave meets the material boundary inside the armour, and is reflected as a tensile wave.



the armour undergoes tensile shear failure, causing spalling of a significant enough velocity to cause injury and death.



this works especially well against Rolled Homogenous Armour (RHA) as the manufacturing process creates laminations in the material, further reducing its resistance to tensile failure.

⑧

