



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	P44284
2	Title of Examination Paper	Munitions
3	Module Code	M6x00444
4	Date and Time of Examination	24/06/17
5	Examination Venue	
6	Seat Number	N/A

7	Number of Answer Books handed in	
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List the numbers of the questions you have attempted	Office Use
1	5
2	4.5
3	6.5
4	8.5
5	7.5
6	9
Total	41

Please complete this section and SEAL before the examination starts.

Surname Clayton Forename(s) Thomas James (Block Capitals)

Complete section, remove strip, fold as indicated and SEAL

Equation lists

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

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

$$\sqrt{2E} = \frac{VOD}{2.97}$$

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

1) a A passive homing method would be like that found on sidewinder, which is a heatseeking missile. This homing type emits no form of radiation and relies on the emission source being produced at the target end. In this case the thermal signature of the engines.

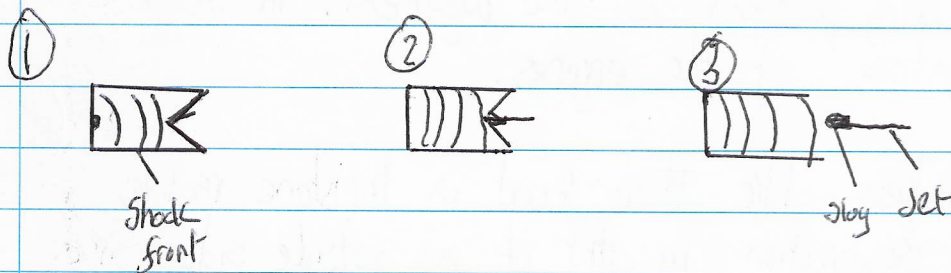
Semi active seekers like those found in brimstone missiles rely on target designation by that of an outside side source. likely examples are a seeker pod located on a tracker plane or soldier spotting at ground level emitting laser light which is detectable by the seeker.

Active seekers like asraam ~~emit~~ using millimetric radar designate and track their own target through radar transmission and reception.

b) Cheaper production costs due to technological advances

c) An inertial tracking system uses an initial pre-programmed position provided by the air frame, when launched accelerometers and gyroscopes monitor the missile position, accuracy is reduced over distance due to sensitivity issues. ~~accelerometers~~ ins systems are often updated via gps to compensate for ins drift.

- 2) a) On detonation of the explosive charge a wave former is often used to focus the primary blast. This shockwave then travels under confinement provided by the casing walls until reaching the conical liner. This liner is then subjected to the shock wave which overcomes its material properties. The liner then ~~the~~ elongates forming a jet. If optimized slug formation will be minimal and greater hydrodynamic penetration will occur



- b)
- stand off distance, ideally 3-7 times cone diameter
 - charge mass - VOID
 - cone angle - jet formation
 - ~~material~~ core material - ductility
 - Explosive type - VOID

- c) Medium density is greater than air disrupting jet formation thereby increasing ideal standoffs distances

3a ~~Set back force~~

~~Eg Centrifugal force~~

~~Deceleration force.~~

Point detonating fuze - Detonate on impact

Stand off fuze - Detonates away from impact - milimetric radar stand off

Delay fuze - Detonates post impact (timer)

(3)

3b High explosive motors can be identified by the markings and coloration used on the casings. One would expect to see dark green background with a yellow stripe with yellow writing describing the munition nature.

(2)

Illumination motors are ~~motors~~ categorised in the same way but with white banding and lettering.

Motors achieve stability using fin stabilisation which ~~forces~~ forces the center of pressure rearward until it is behind the center of gravity.

(1.5)

4 a)

Primary - The Main blast wave made up of high pressure expanding gases. Internal organ damage from overpressure. ✓

Secondary - Fragmentation produced by the munition casing or debris from the resultant blast wave. Impact to injure ✓

Tertiary - Effects from personnel falling/ ~~and~~ loss of balance resulting in additional impact injuries. ✓

2.5

b)

①

○ — Explosive

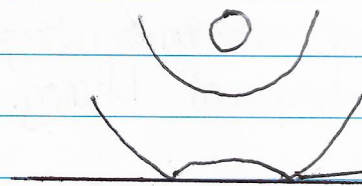
ground

②



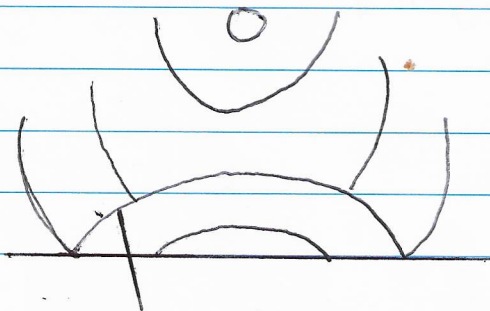
Detonation shock front
forms incident wave

③



Incident
wave impacts
the ground and
is reflected

④



Reflected wave interacts with the incident wave.

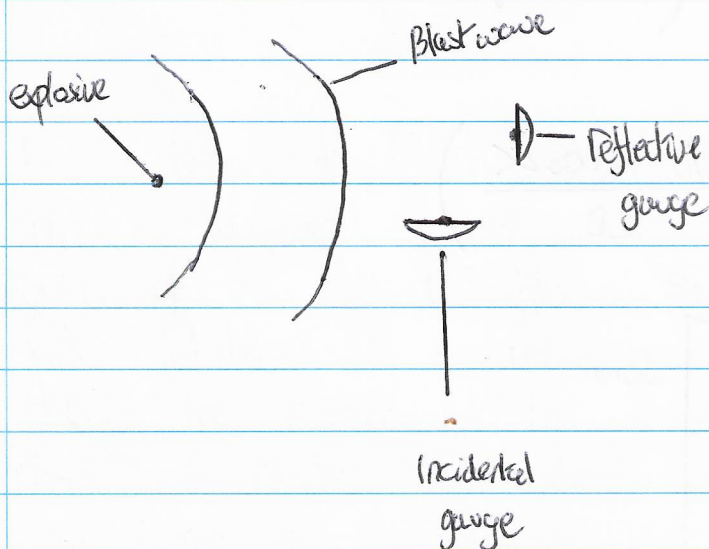
Due to the incident wave traveling through static air its rate of expansion is slowed relative to the reflected wave which is traveling through a medium of reduced ~~density~~ density. On convergence the reflect wave reinforces the incident wave increasing pressure.

3.5

C) Reflected waves occur when the longitudinal face of a blast gauge intersects with the main blast wave. Due to the exposed surface area peak pressure is dramatically increased.

Incident Blast pressures measured in gauges set up incidentally would expect to see reduced peak pressures but a higher specific impulse. surface area is reduced ~~and~~ on contact with the wave front ~~but~~ however if the gauge is exposed for a longer time period increasing impulse

2.5



Gurney

5a

i)

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

$$\sqrt{2E} = \frac{V_{OD}}{2.97} = \frac{8440}{2.97} = 2841.75$$

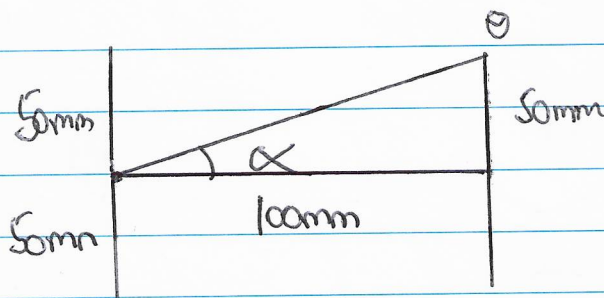
$$V_0 = 2841.75 \times \left(\frac{6}{4.5} + \frac{1}{2} \right)^{-\frac{1}{2}} = \underline{\underline{2098.77 \text{ m/s}}}$$

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

$$V_0 = 3067.34 \times \left(\frac{6}{4.5} + \frac{1}{2} \right)^{-\frac{1}{2}} = \underline{\underline{2265.38 \text{ m/s}}}$$

5b

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



$$\alpha = \tan^{-1} \frac{50}{100} = \underline{\underline{26.57^\circ}}$$

$$\theta = \sin^{-1} \left(\frac{(2098.77) \times \cos 26.57}{2 \times 8440} \right)$$

$$\approx 6.38^\circ$$

$$\underline{\underline{\theta = 6.38^\circ}}$$

$$5c) V_d = \sqrt{V_o^2 + V_m^2}$$

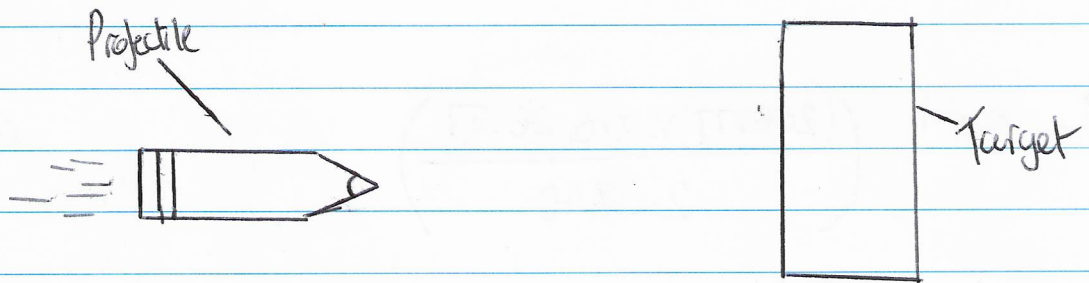
$$V_d = \sqrt{(2098.77)^2 + 420^2} = \underline{\underline{2140.38 \text{ m/s}}}$$

6a The nose pad is designed to deform on impact with the target to ensure an even spread of explosive filling.

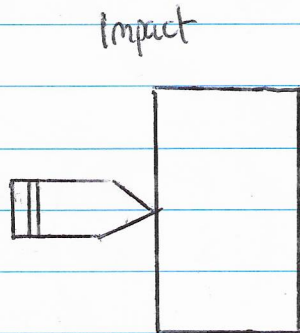
6b When the Hesh round impacts the target the nose cone is deformed and plastic explosive deposited on the surface of the material. After a short initial delay the base fuze detonates. A compressive wave front starts to propagate through the structure of the target material. When this shock front reaches the material edge it cannot transmit into air due to the difference in density. The wave is then reflected becoming a tensile wave front. Due to materials being stronger in compression than tension the target structure fails and scabbing occurs behind the target face.

Illustration next page

①



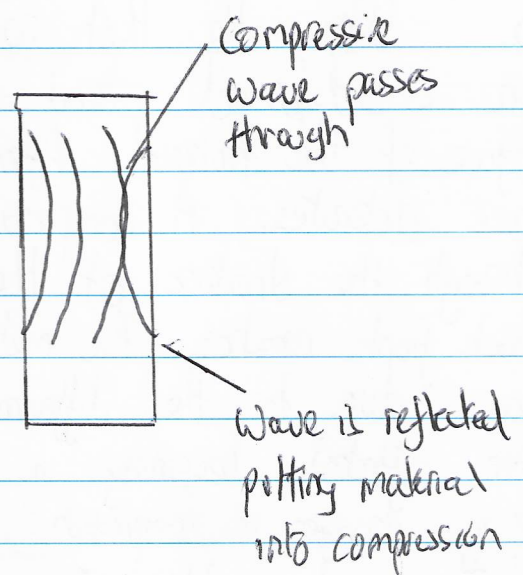
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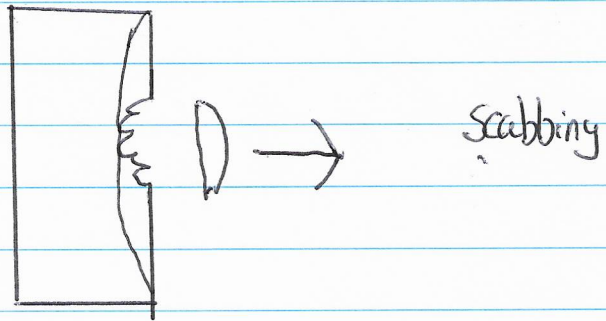
③



④



⑤



Material fails & scabbing occurs.

