Section B

Answer **one** question from this Section in the spaces provided.

8 Fig. 8.1 shows an M777 howitzer secured to the ground firing a projectile at an angle of 50° to the horizontal. The projectile exits the muzzle at a speed of 800 m s^{-1}.

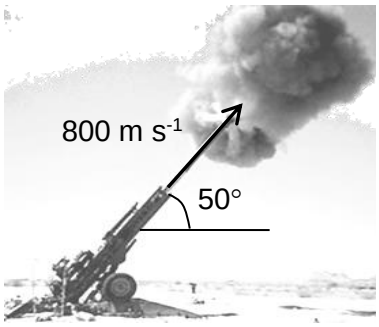


Fig. 8.1

(a) **(i)** Calculate the vertical component of the projectile's initial velocity.

vertical component = …… m s^{-1} [1]

(ii) Neglecting air resistance and the height of the howitzer, determine the horizontal range of this projectile.

range = …… km [3]

(iii) It can be proven that launching the projectile at 40° will achieve the same horizontal range. Suggest one advantage of launching the projectile at this smaller angle.

……

…….. [1]

(b) The howitzer is set up to destroy an enemy tank by aiming its projectile to land at the expected position of the moving tank.

The enemy tank, initially stationary, is 3.0 km away from the landing point of the howitzer's projectile as shown in Fig. 8.2.

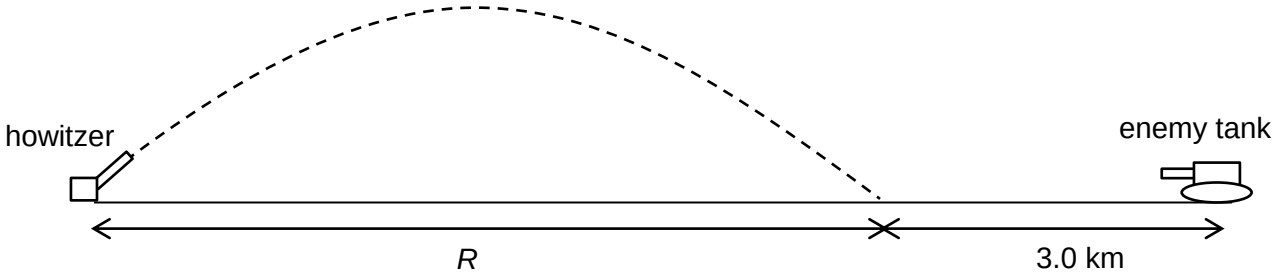


Fig. 8.2

The tank has a maximum speed of 60 km h^{-1} and a maximum acceleration of 1.0 m s^{-2}.

(i) Calculate the minimum time required for the tank to reach the landing point of the howitzer's projectile.

time = …… s [4]

(ii) Determine the time the howitzer should start firing after the tank starts moving so that the projectile will hit the tank.

time = …… s [1]

(c) In reality, the projectile experiences a large magnitude of air resistance.

(i) In Fig. 8.3(a) and 8.3(b), draw and label the forces acting on the projectile as it is moving up and as it is moving down. [2]

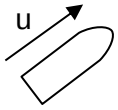
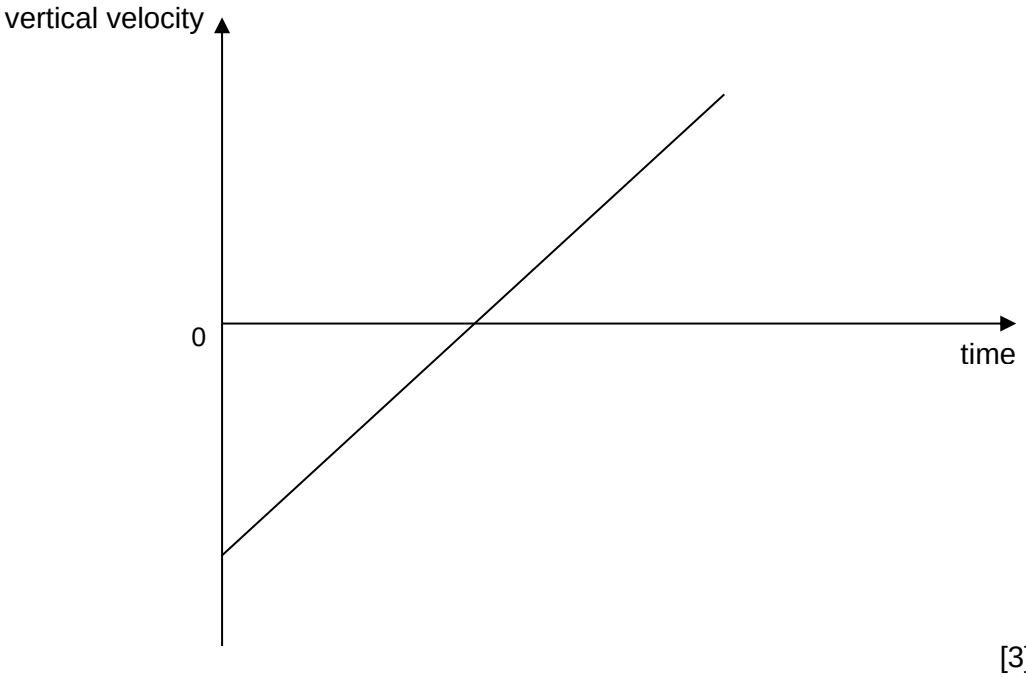


Fig. 8.3(a) Projectile moving up

Fig. 8.3(b) Projectile moving down

(ii) Fig 8.4 shows the variation with time of the vertical velocity of the projectile when the air resistance is negligible from the time it is fired to when it reaches the ground.

On Fig. 8.4, draw a line to show the variation with time of the vertical velocity of the projectile when air resistance is not negligible.



[3]

Fig. 8.4

(iii) Label a point **P** on your line when the projectile's vertical acceleration is equal to the acceleration of free fall. [1]

(d) **(i)** State the *principle of conservation of linear momentum.*

……

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…….... [2]

(ii) If the howitzer and the projectile are considered as a system, explain whether the principle of conservation of momentum could be applied to this system during the firing process.

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…….... [2]