Projectiles and Satellites Questions – NAT 5

1) An astronaut drops a steel ball bearing on to the surface of the Moon from rest. The Moon has a gravitational field strength of **1.6Nkg^{-1}**.

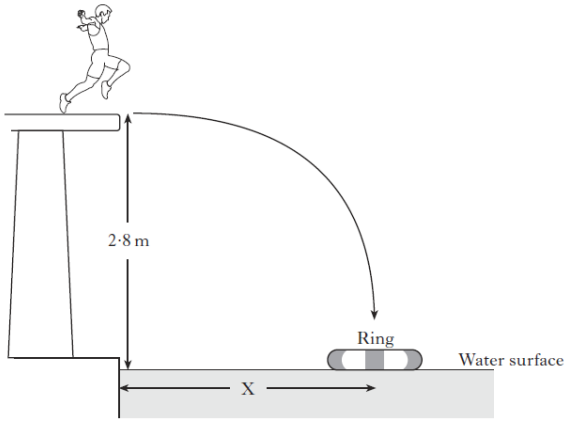
It takes 1.4s for the ball bearing to hit the surface of the Moon.

a) **Calculate the vertical speed** of the ball bearing just before it hits the Moon's surface.

b) If the astronaut throws the ball bearing horizontally from the same height, then how long does it take the ball bearing to fall on to the Moon's surface? **Explain your answer**.

2) In a TV game show, contestants are challenged to run off a horizontal platform, and land in a rubber ring that is floating in a swimming pool.

The platform is 2.8m above the water surface.



a) A contestant has a mass of 60kg.

He runs off a platform with a horizontal velocity of 3ms^{-1} and takes 0.85s to reach the water surface in the centre of the ring.

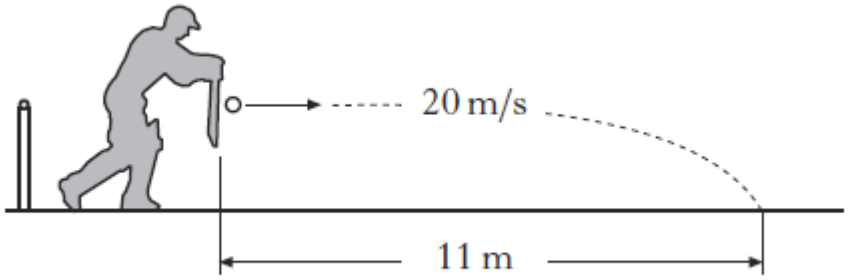
i) Calculate the **horizontal distance X** from the poolside to the centre of a ring.

ii) Calculate the **vertical velocity** of the contestant as he reaches the water surface.

b) Another contestant has a mass of 70kg.

Will he need to run faster, slower or with the same horizontal velocity as the first contestant to land in the ring? **Explain your answer.**

3) A cricketer strikes a ball. The ball leaves his bat at $20ms^{-1}$ and it hits the ground at a point 11m from where it was struck.



a) **Calculate the time** of flight of the ball.

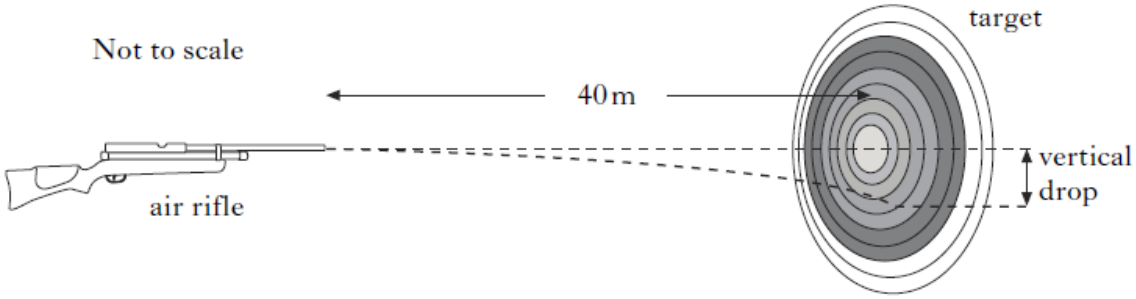
b) Calculate the vertical speed of the ball as it hits the ground.

c) **Sketch a graph** of the vertical speed against time of the ball putting numerical values on both axes.

d) Calculate the **vertical distance** travelled by the ball during its flight.

e) **Explain** why the ball will not travel 11m in this shot in practice.

4) At a firing range a pellet is fired horizontally at a target 40m away.



If the pellet takes 0.25s to reach the target, then calculate or find:

a) i) **Horizontal velocity** that the pellet leaves the gun with.

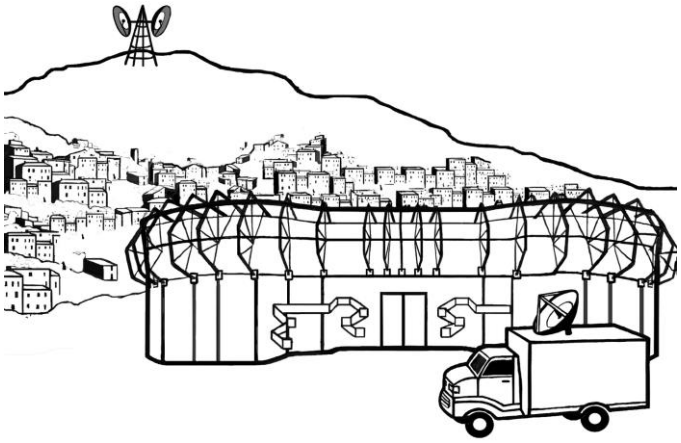
ii) **Horizontal velocity** that the pellet hits the target with.

b) The **vertical velocity** that the pellet hits the target with.

c) The **vertical drop** shown in the diagram.

5) A football match is being broadcast live from Dundee. Signals from the football stadium are transmitted to a television studio in Glasgow via a relay station on top of a nearby hill.

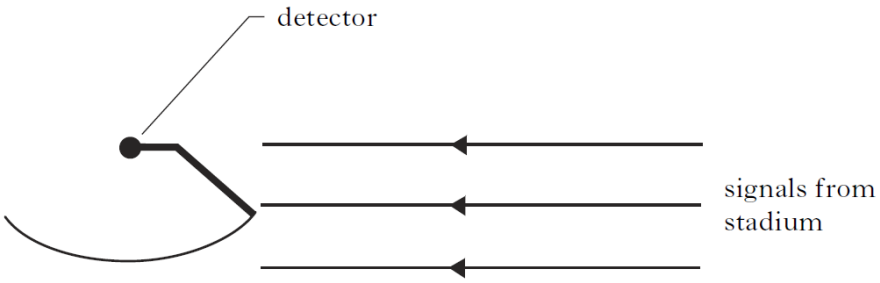
At the relay station a curved reflector is placed behind a detector of the television signals.



a) i) **State the purpose** of the curved reflector.

ii) **Complete the diagram** below to show the effect of the curved reflector on the signal at the relay station.

b) During the match, strong winds cause the reflector to move to a new position as shown.



State the effect that this has on the signal received at the detector.

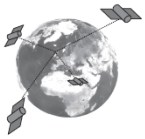
6) A live debate in the Houses of Parliament is transmitted from London to Washington via a satellite.

The satellite is in a geostationary orbit and the signals are transmitted by microwaves.

The frequency of the microwaves being used is 12GHz.

Calculate the wavelength of the microwaves.

7) A satellite navigation system receives radio signals transmitted by satellites in orbit around the Earth.



The satellite navigation system finds its location by calculating the distance the transmitted signals travel.

a) In addition to the speed of the signals, **what other quantity** must be known to calculate the distance?

b) i) **What do** radio waves transfer?

ii) What speed do the radio waves travel at and how does this compare to the speed of sound?

iii) What does the **period** of a satellite **depend on**?

c) A curved reflector is often used to make the signals received from a satellite stronger.

Complete the diagram below to show the effect of the curved reflector on the transmitted signals.

8) Two next door neighbours are watching a live football match on television.

Signals are sent at the same time to a geostationary satellite and to an optical fibre system.

House A receives the signal using a **satellite dish** while **house B** uses an **optical fibre cable**.

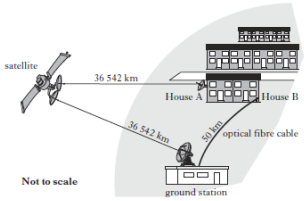
a) **State** what is meant by a geostationary satellite.

b) **What is** an optical fibre?

c) **Complete the table below** by entering the speed of each signal.

Signal	*Transmission speed in* m/s
Satellite	
Optical fibre	

d) The distance travelled by each signal is shown on the diagram below.



One neighbour hears cheering from the house next door before seeing a goal scored.

Calculate the time delay between hearing the cheer and seeing the goal scored.

9) A satellite sends microwaves to a ground station on Earth.

a) The microwaves have a wavelength of **60mm**.

   i) **Calculate the frequency** of the waves.

   ii) **Determine the period** of the waves.

b) The satellite sends radio waves along with the microwaves to the ground station.

   Will the radio waves be received by the ground station **before**, **after** or at the **same time** as the microwaves?

c) When the microwaves reach the ground station they are received by a curved reflector.

   Explain using a diagram why a curved reflector is used.