PROJECTILE QUESTIONS

1.

(a) What is a projectile?

(b) What is special about its motion?

(c) A projectile is fired horizontally at 100 ms^{-1}.

(i) How long will it take it to travel a horizontal distance of 50m?

(ii) What will be its vertical velocity when it hits the ground?

(iii) What will be its average vertical speed?

(iv) How far will it fall in the 50m?

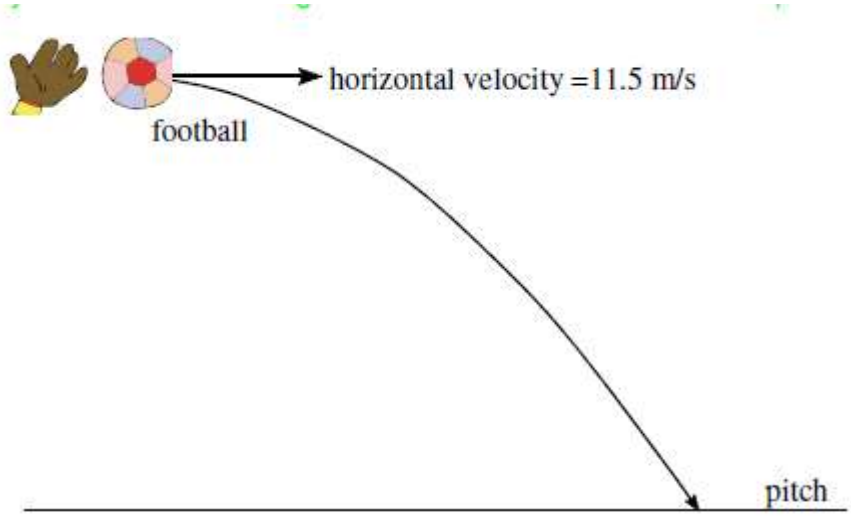
2. A ball rolls along a flat roof at 2 ms^{-1} and rolls off the edge.

(a) If it takes 1.5s to fall to the ground what is the speed on landing?

(b) How high is the roof?

(c) How far away from the base of the building will it land?

3. Jordan the goalkeeper punches a football which has been kicked across his goal mouth. The football leaves his glove with a horizontal velocity of 11.5 m/s to the right and takes 0.80s to land on the pitch.



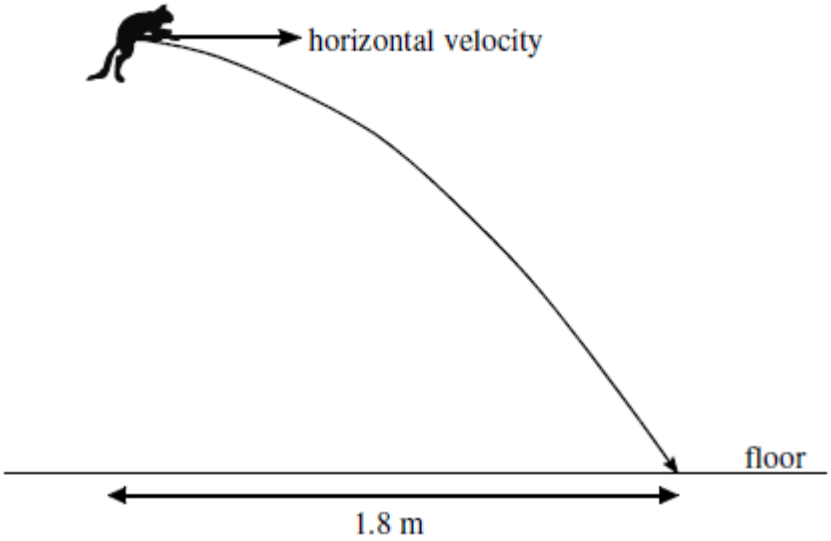
(a) Describe the **horizontal velocity** of the football from the instant it is punched to the instant it lands.

(b) Show, by calculation involving horizontal motion, that the **horizontal displacement** travelled by the football during the 0.8 s is 9.2 m to the right.

(c) At the instant the football leaves Jordan's hand, the downward vertical velocity of the football is 0 m/s. Calculate the **downward vertical velocity** of the football as it lands.

(d) From what height was the ball pitched?

4. The Physics Department's pet cat jumps horizontally to the right from a window ledge. The cat lands on the floor 0.36 s later. Its horizontal displacement is 1.8 m to the right.



(a) During the jump, does the **horizontal velocity** of the cat increase, decrease or remain constant?

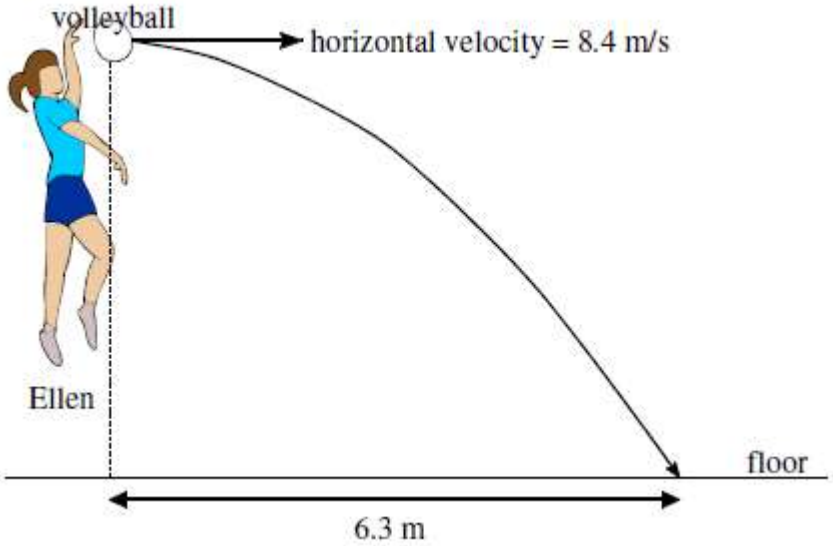
(b) Show, by calculation involving horizontal motion, that the **horizontal velocity** of the cat just before landing is 5 m/s to the right.

(c) What was the height of the window ledge?

(d) At the instant the cat jumps from the window ledge, its downward vertical velocity is 0 m/s. Calculate the **downward vertical velocity** of the cat as it lands.

5. Ellen's hand hits a volleyball from a point directly above the central net.

The volleyball leaves Ellen's hand with a horizontal velocity of 8.4 m/s to the right.



On leaving her hand, the volleyball follows a curved path, hitting the floor when its horizontal displacement is 6.3 m to the right.

(a) Show, by calculation involving horizontal motion, that the **time** taken for the volleyball to travel from Ellen's hand to the floor is 0.75 s.

(b) At the instant the volleyball leaves Ellen's hand, the downward vertical velocity of the volleyball is 0 m/s. Calculate the **downward vertical velocity** of the volleyball as it reaches the floor.

(c) From what vertical height was the volleyball punched?

6. A rocket is fired horizontally from a cliff top at 40 m/s to the right. The rocket hits the sea below after 4 s.

(a) What will be the rocket's **horizontal component of velocity** just before it hits the sea?

(b) What will be the rocket's **range** (**horizontal displacement**)?

(c) What will be the rocket's **vertical component of velocity** just before it hits the sea?

(d) Sketch the **velocity-time graph** for the rocket's **vertical motion**.

(e) Use the graph to determine the rocket's **vertical displacement** (the **height of the cliff**).

7. Fred kicks a football off a cliff with a horizontal velocity of 5 m/s to the right. The football lands on ground below the cliff 2.5 s later.

(a) What will be the ball's **horizontal component of velocity** just before it hits the ground?

(b) What will be the ball's **range** (**horizontal displacement**)?

(c) What will be the ball's **vertical component of velocity** just before it hits the ground?

(d) Sketch the **velocity-time graph** for the ball's **vertical motion**.

(e) Use the graph to determine the ball's **vertical displacement** (the **height of the cliff**).

8. Barney pushes a coin off a staircase. The coin's initial horizontal velocity is 0.5 m/s to the right. It hits the floor after 1.2 s.

(a) What will be the coin's **horizontal component of velocity** just before it hits the floor?

(b) What will be the coin's **range** (**horizontal displacement**)?

(c) What will be the coin's **vertical component of velocity** just before it hits the floor?

(d) Sketch the **velocity-time graph** for the coin's **vertical motion**.

(e) Use the graph to determine the coin's **vertical displacement** (the **height of the staircase**).

9. Wilma throws a dart horizontally at 8 m/s to the right.

The dart hits the floor after 0.6 s.

(a) What will be the dart's **horizontal component of velocity** just before it hits the floor?

(b) What will be the dart's **range** (**horizontal displacement**)?

(c) What will be the dart's **vertical component of velocity** just before it hits the floor?

(d) Sketch the **velocity-time graph** for the dart's **vertical motion**.

(e) Use the graph to determine the dart's **vertical displacement** (the **height it was thrown from**).

10. Betty fires an arrow horizontally at 25 m/s to the right. The arrow hits the ground after 0.4s

(a) What will be the arrow's **horizontal component of velocity** just before it hits the ground?

(b) What will be the arrow's **range** (**horizontal displacement**)?

(c) What will be the arrow's **vertical component of velocity** just before it hits the ground?

(d) Sketch the **velocity-time graph** for the arrow's **vertical motion**.

(e) Use the graph to determine the arrow's **vertical displacement** (the **height it was fired from**).

11. A stone thrown horizontally from a cliff lands 24 m out from the cliff after 3 s. Find:

a) the horizontal speed of the stone.

b) the vertical speed at impact.

c) the resultant velocity on impact.

12. A ball is thrown horizontally from a high window at 6 ms^{-1} and reaches the ground after 2s. Calculate:

a) the horizontal distance travelled

b) the vertical speed at impact.

13. An aircraft flying horizontally at 150 ms^{-1}, drops a bomb which hits the target after 8s.

Find:

a) the distance travelled horizontally by the bomb

b) the vertical speed of the bomb at impact

c) the distance travelled horizontally by the aircraft as the bomb fell

d) the position of the aircraft relative to the bomb at impact.

14. A ball is projected horizontally at 15 ms^{-1} from the top of a vertical cliff. It reaches the ground 5 s later. For the period between projection until it hits the ground, draw graphs with numerical values on the scales of the ball's

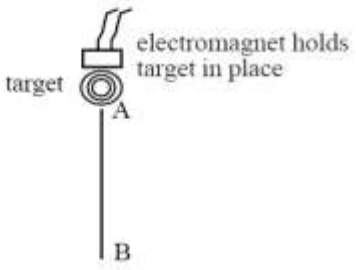
a) horizontal velocity against time

b) vertical velocity against time

c) From the graphs calculate the horizontal and vertical distances travelled.

15. In the experimental set-up shown below, the arrow is lined up towards the target.

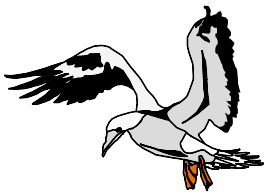
As it is fired, the arrow breaks the circuit supplying the electromagnet, and the target falls downwards from A to B.



a) Explain why the arrow will hit the target.

b) Suggest one set of circumstances when the arrow would fail to hit the target (you must assume it is always lined up correctly).

16. An osprey flying horizontally at a speed of 15 ms^{-1} drops the fish it is carrying in to the lake. The fish hits the water 2seconds later.

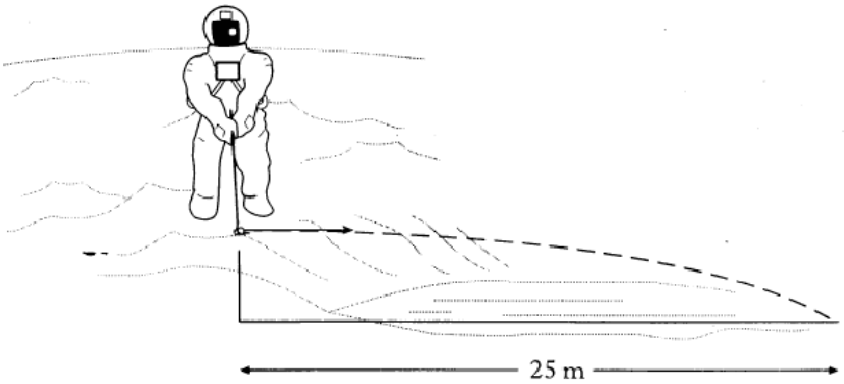


a) Sketch the path the fish took.

b) At what height was the osprey flying when it dropped the fish?

c) Assuming the osprey does not change its speed or direction, where is it in relation to the fish when it hits the water?

17. (a) In 1971, a lunar module carrying two astronauts landed on the Moons surface. The gravitational field strength on the Moon is different from that on Earth.



(i) What is meant by "gravitational field strength"? (1)

(ii) The gravitational field strength at the surface of the Moon is 1.6 N/kg.
What is the value of the acceleration due to gravity at the surface of the Moon? (1)

(b) One of the astronauts played golf on the moon. The golf ball was struck horizontally from the edge of a steep crater. It landed 2 seconds later, 25 m away as shown in the diagram below.

(ii) Calculate the vertical speed of the ball on landing. (2)

iii) How would the horizontal distance travelled by a ball projected with the same horizontal speed from the same height on Earth compare with that on the Moon? Explain your answer. (3)

18. Martin kicks a football into the air at an angle of 30° to the ground. The ball hits the ground after 2 seconds.

a) At what time did the ball reach its greatest height?

b) What was the vertical component of the speed of the ball as it left Martin's foot?

c) At what angle did it hit the ground?

d) Sketch the path of the ball if it had a large air resistance.