Higher Projectile Motion Questions

1. a) Name the **two components** of motion in **projectiles**.

b) What is the **acceleration** on **Earth** for each of these two components.

2. A pencil case is **dropped vertically** from a height at **rest** and hits the ground **0.5 seconds** later.

a) What **vertical velocity** did the pencil case hit the ground with?

b) What **horizontal velocity** did the pencil case hit the ground with?

3. A stone is **projected vertically upwards** with a velocity of **$12ms^{-1}$**. Calculate or find:

a) **How long** it took the stone to reach its **maximum height**.

b) **Maximum height reached** by the stone.

4. A balloon is climbing **vertically upwards** with a **constant velocity of $4.2ms^{-1}$**.

A **sandbag is dropped** from the balloon and **hits** the **ground 3.6 seconds** later.

Calculate or find:

a) **Velocity** of the sandbag as it hits the ground.

b) **Height** of the sandbag at the instant that it is dropped.

5. A slate is **projected horizontally** from a building roof, which is **6.5m above the ground**.

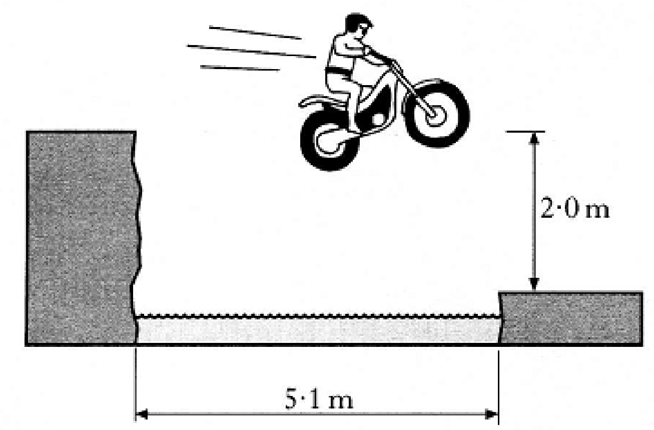
It hits the ground after travelling a horizontal displacement **4.2m** from where it was projected.

Calculate or find:

a) **The time** that the slate is in flight.

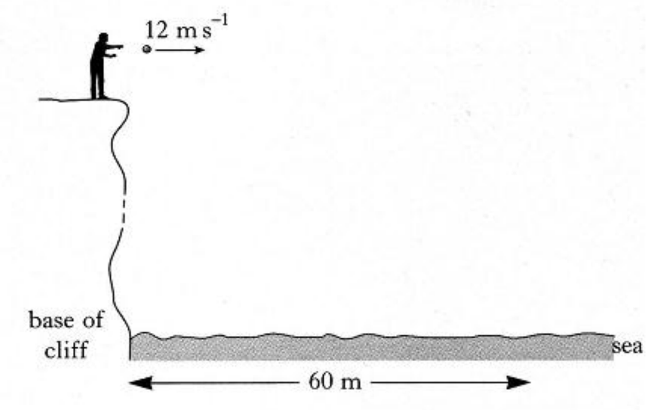
b) The **horizontal velocity** that the slate is projected with.

6. A stunt motorcyclist attempts to jump a river which is **5.1m wide**. The bank from which he will take-off is **2m higher** than the bank on which he will land, as shown below.



Calculate the minimum horizontal speed he must achieve before take-off to avoid landing in the river.

7. A stone is **thrown horizontally** with a **speed of 12ms^{-1}** over the edge of a vertical cliff. It hits the sea at a **horizontal distance of 60m** out from the base of the cliff.



Calculate the height from which the stone was projected above the level of the sea.

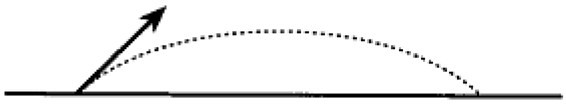
8. A **helicopter** is **descending** vertically at a constant speed of **3ms^{-1}**.

A **sandbag** is **released** from the helicopter and hits the **ground 5 seconds** later.

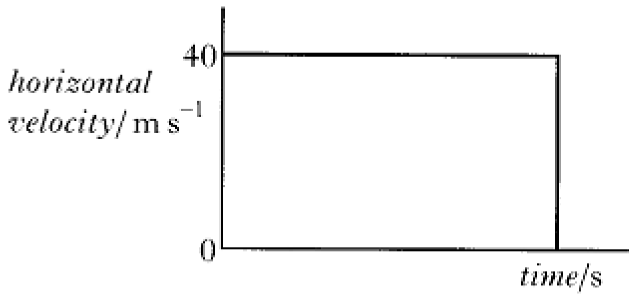
Calculate the height of the helicopter above the ground at the time the sandbag was released.

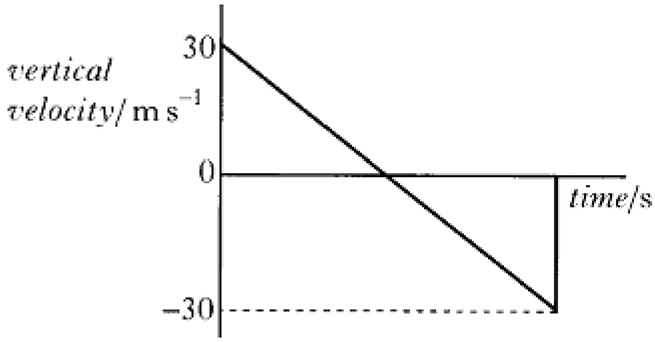
9. A golfer strikes a golf ball which then moves off at an **angle to the ground**.

The ball follows the **path shown below**.



The graphs below show how the **horizontal and vertical components of the velocity** of the ball vary with time.





Calculate the resultant velocity of the ball as it hits the ground. **(Vectors M + D's !!!)**

10. A ball is **projected horizontally** from a cliff with a **velocity of 15ms^{-1}**.

If it takes **3.6 seconds** to reach the **ground**, then calculate or find:

a) **Horizontal velocity** of the ball just before it hits the ground.

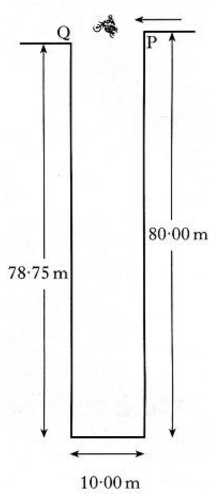
b) **Vertical velocity** of the ball just before it hits the ground.

c) **Height of the cliff** above the ground.

d) **Horizontal range** of the ball.

11. A motorcycle stunt involves crossing a ravine from **P to Q**.

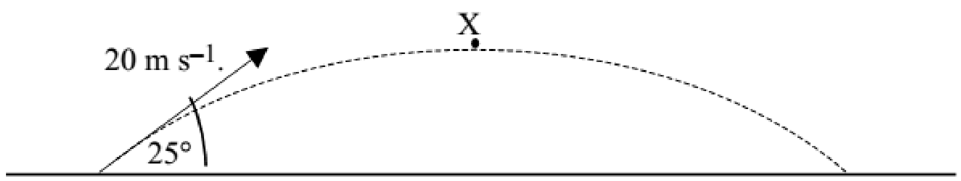
The motorcycle is **travelling horizontally** when it leaves point P as shown below.



Calculate the time taken for the motorcyclist to cross from **P to Q**.

12. A projectile is fired with a velocity of **20ms^{-1}** at an angle of **25° above** the **horizontal**.

Any air resistance can be ignored.

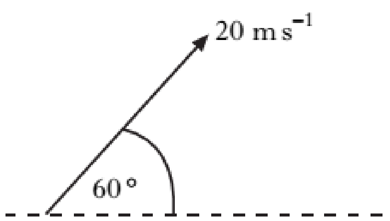


a) Calculate or find:
   i) The **initial vertical component** of the projectiles velocity.
   ii) The **initial horizontal component** of the projectiles velocity.

b) The **maximum height reached** by the projectile at point X.

c) The **horizontal range** achieved by the projectile on hitting the ground.

13. A javelin is thrown at **60°** to the horizontal with a speed of **20ms^{-1}**.



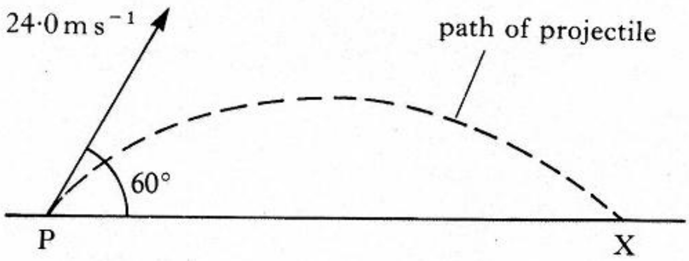
The javelin is in **flight** for **3.5 seconds** and air resistance is considered negligible.

Calculate the horizontal distance travelled by the javelin.

14.

During a visit to the Moon, an astronaut fires a small experimental projectile across a level surface. The projectile is launched, from point P, at a speed of $24{\cdot}0\,m\,s^{-1}$ and at an angle of 60° to the horizontal.

The projectile lands 26·0 s later at point X.

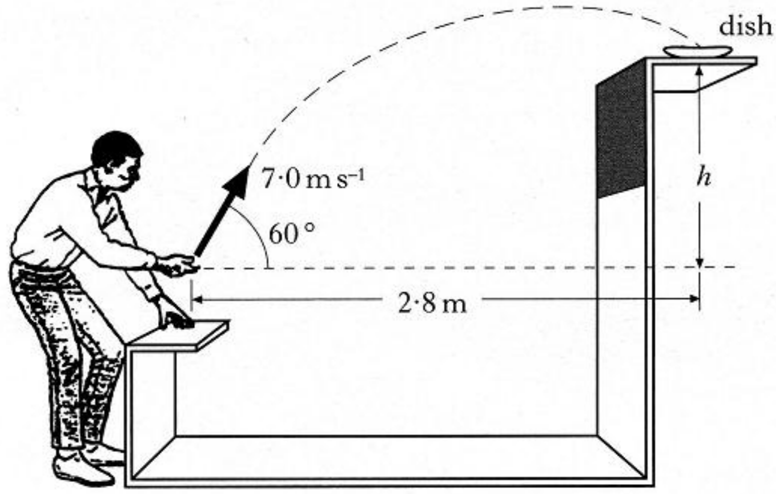


(*a*) Calculate the horizontal speed of the projectile at point P.

(*b*) Calculate the horizontal distance from P to X.

15.

At a funfair, a prize is awarded if a coin is tossed into a small dish. The dish is mounted on a shelf above the ground as shown.



A contestant projects the coin with a speed of $7{\cdot}0\,m\,s^{-1}$ at an angle of 60 ° to the horizontal. When the coin leaves his hand, the **horizontal distance** between the coin and the dish is 2·8 m. The coin lands in the dish.

The effect of air friction on the coin may be neglected.

(*a*) Calculate:

(i) the horizontal component of the initial velocity of the coin;

(ii) the vertical component of the initial velocity of the coin.

(*b*) Show that the time taken for the coin to reach the dish is 0·8 s.

(*c*) What is the height, *h*, of the shelf above the point where the coin leaves the contestant's hand?

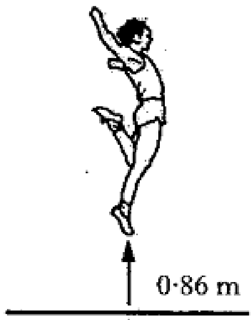
(*d*) How does the value of the kinetic energy of the coin when it enters the dish compare with the kinetic energy of the coin just as it leaves the contestant's hand?

Justify your answer.

16.

(*a*) A long jumper devises a method for estimating the horizontal component of his velocity during a jump.

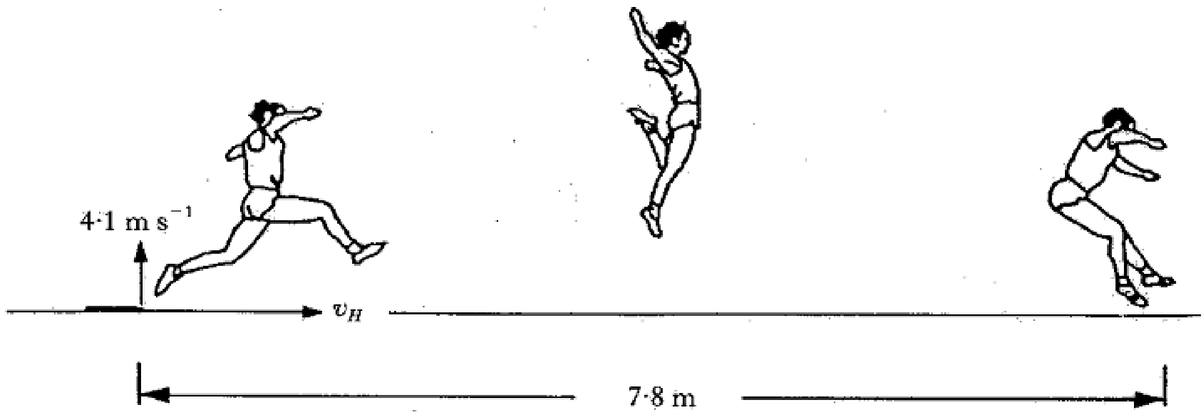
His method involves first finding out how high he can jump **vertically**.



He finds that the maximum height he can jump is 0·86 m.

(i) Show that his initial vertical velocity is 4·1 m s^{-1}.

He now assumes that when he is long jumping, the initial vertical component of his velocity at take-off is 4·1 m s^{-1}.



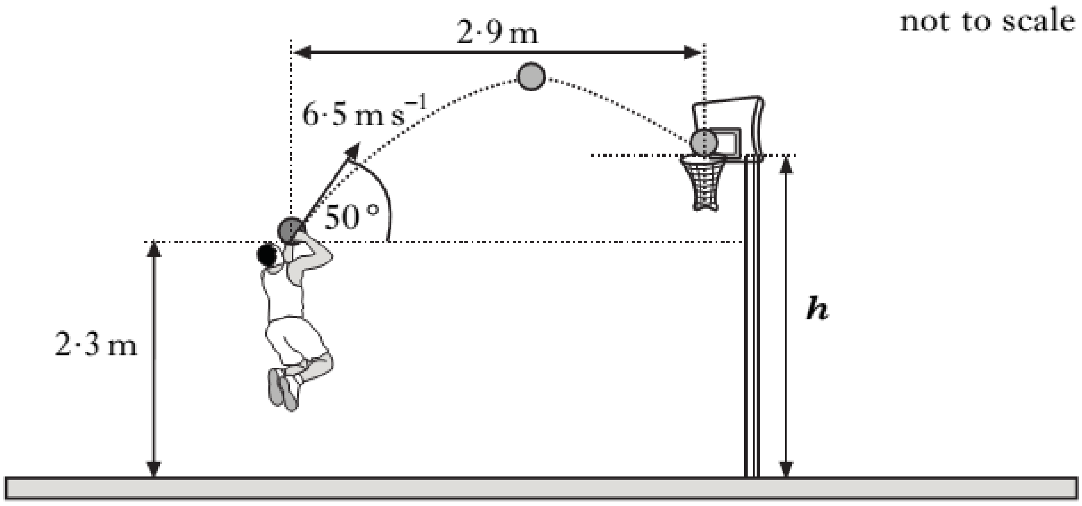
The length of his long jump is 7·8 m.

(ii) Calculate the value that he should obtain for the horizontal component of his velocity, v_H.

(*b*) His coach tells him that, during the 7·8 m jump, his maximum height above the ground was less than 0·86 m. Ignoring air resistance, state whether his actual horizontal component of velocity was greater or less than the value calculated in part (*a*) (ii). You must justify your answer.

17.

A basketball player throws a ball with an initial velocity of $6 \cdot 5\ m\,s^{-1}$ at an angle of $50°$ to the horizontal. The ball is $2 \cdot 3\ m$ above the ground when released.



The ball travels a horizontal distance of $2 \cdot 9\ m$ to reach the top of the basket.

The effects of air resistance can be ignored.

(*a*) Calculate:

(i) the horizontal component of the initial velocity of the ball;

(ii) the vertical component of the initial velocity of the ball.

(*b*) Show that the time taken for the ball to reach the basket is $0 \cdot 69\ s$.

(*c*) Calculate the height ***h*** of the top of the basket.

(*d*) A student observing the player makes the following statement.

"*The player should throw the ball with a higher speed at the same angle. The ball would then land in the basket as before but it would take a shorter time to travel the 2·9 metres.*"

Explain why the student's statement is incorrect.

18. A basketball is projected at **40° from the horizontal** with a velocity of **7.5ms^{-1}**.

Calculate or find:

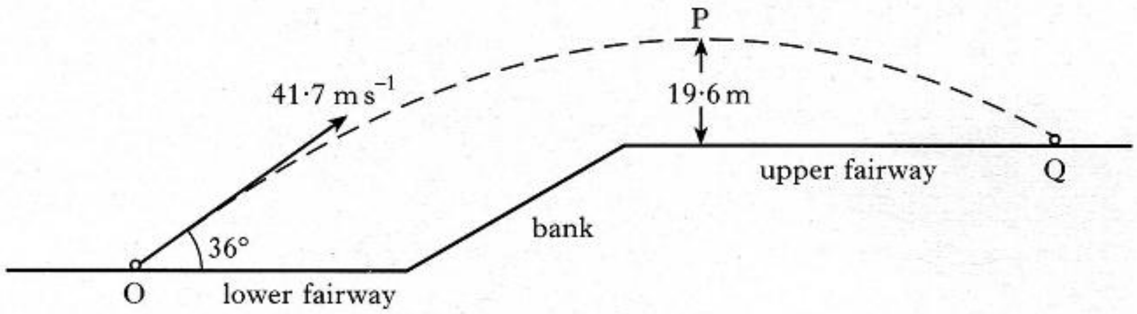
a) **Initial horizontal and vertical components of velocity** of the basketball.

b) **Horizontal and vertical components of velocity** of the basketball after **1.6 seconds**.

c) **Resultant velocity** of the basketball **after 1.6 seconds**.

19.

The fairway on a golf course is in two horizontal parts separated by a steep bank as shown below.



A golf ball at point O is given an initial velocity of $41 \cdot 7\ m\,s^{-1}$ at 36° to the horizontal.

The ball reaches a maximum vertical height at point P above the upper fairway. Point P is 19·6 m above the upper fairway as shown. The ball hits the ground at point Q.

The effect of air friction on the ball may be neglected.

(*a*) Calculate:

(i) the horizontal component of the initial velocity of the ball;

(ii) the vertical component of the initial velocity of the ball.

(*b*) Show that the time taken for the ball to travel from point O to point Q is 4·5 s.

(*c*) Calculate the horizontal distance travelled by the ball.

20. A tennis player strikes a ball with his racket **just as the ball reaches the ground**.

The ball leaves the racket with a **speed of $6.0ms^{-1}$ at 50° to the ground**.

a) i) Calculate the **initial vertical component of velocity** of the ball.

ii) Calculate the **initial horizontal component of velocity** of the ball.

When the player hits the shot they are 2.0m from the base of the net, which is 0.90m high.

(It would be useful to draw a sketch here labelled with the information given!!!)

b) i) **Calculate the time taken** for the ball to travel the **2.0m** to the net after leaving the racket.

ii) The net is **0.90m high** in the centre of the court.

Show by calculation whether the ball will go over the net.