

Lesson 5

A-Level Applied Mathematics : Mechanics : Year 2

Projectiles (Kinematics III)

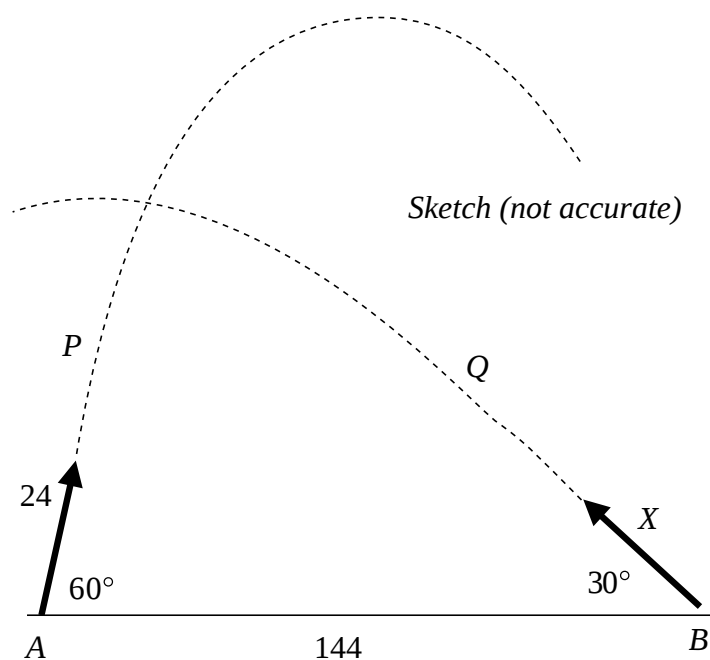
5.1 Twin Projectile Interceptions

Example

The points A and B lie 144 metres apart on horizontal ground. At time $t = 0$ two small balls, P and Q , are projected in the vertical plane containing AB .

Ball P is projected from A with speed 24 m s^{-1} at 60° to AB as shown.

Ball Q is projected from B with speed $X \text{ m s}^{-1}$ at angle 30° to BA as shown.



The two balls collide when $t = 3$ seconds.

- (i) At what height above the ground did the collision take place ?

[6 marks]

- (ii) Was Q gaining or losing height when the collision occurred ?
Justify your answer.

[3 marks]

5.2 Exercise

*Any solution based entirely on graphical
or numerical methods is not acceptable*

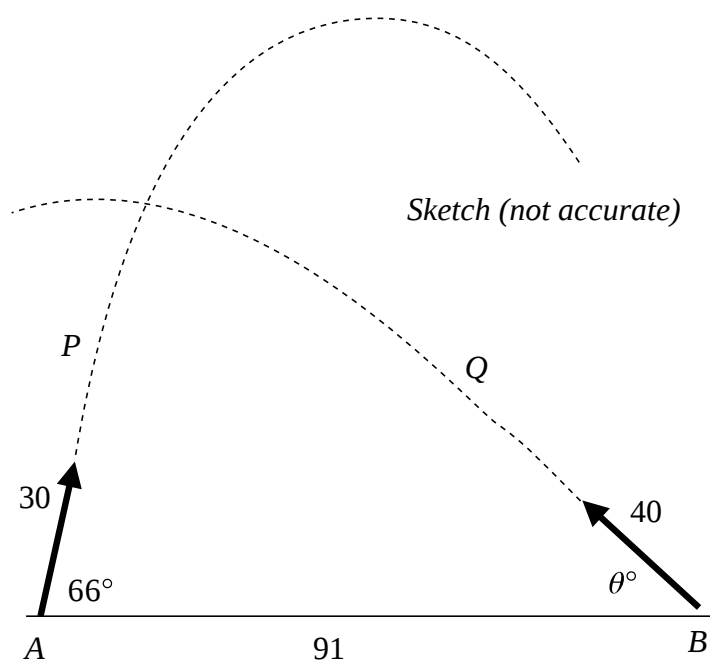
Marks Available : 28

Question 1

The points A and B lie 91 metres apart on horizontal ground. At time $t = 0$ two small balls, P & Q , are projected in the vertical plane containing AB .

Ball P is projected from A with speed 30 m s^{-1} at angle 66° to AB as shown.

Ball Q is projected from B with speed 40 m s^{-1} at angle θ° to BA as shown.



The two balls collide whilst in flight.

(i) With what angle θ was ball B launched ?

[5 marks]

(ii) How many seconds after launch did the collision take place ?

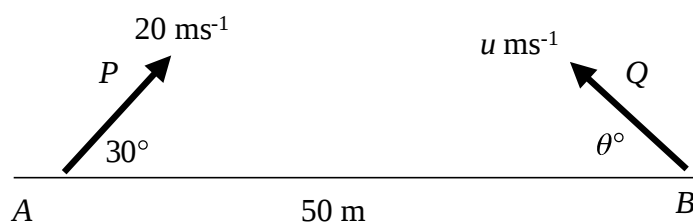
[2 marks]

(iii) How high above the ground did the collision take place ?

[3 marks]

Question 2

A-Level Examination question from June 2019, Q5



The points A and B lie 50 metres apart on horizontal ground. At time $t = 0$ two small balls, P and Q , are projected in the vertical plane containing AB .

Ball P is projected from A with speed 20 m s^{-1} at angle 30° to AB as shown.

Ball Q is projected from B with speed $u \text{ m s}^{-1}$ at angle θ° to BA as shown.

At time $t = 2$ seconds, P and Q collide.

Until they collide, the balls are modelled as particles moving freely under gravity.

(a) Find the velocity of P at the instant before it collides with Q .

[6 marks]

- (b)** Find
- (i)** the size of angle θ

- (ii)** the value of u

[6 marks]

- (c)** State one limitation of the model, other than air resistance, that could affect the accuracy of your answers.

[1 mark]

Question 3



Ginny Weasley, a Chaser in the Gryffindor Quidditch team, attempts to score when at a horizontal distance of 21 metres from the goal and 12 vertical metres below it. She projects the Quaffle with a speed of 30 m s^{-1} at an angle of θ to the horizontal. Given that Ginny scores, determine the two possible angles with which she may have projected the Quaffle.

You may use the equation for a projectile's flight path which is,

$$y = x \tan \theta - \frac{g x^2}{2 u^2} (1 + \tan^2 \theta) \quad \text{where } g = 9.8 \text{ m s}^{-2}$$

[5 marks]

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Teachers may obtain detailed worked solutions to the exercises by email from MHHShrewsbury@Gmail.com