

CIE  
Further Mechanics  
分类真题  
2020-2022 册

A Level Clouds 出品

# 目录

<b>Chapter 1 Projectiles</b>	<b>1</b>
<b>Chapter 2 Equilibrium of a Rigid Body</b>	<b>22</b>
<b>Chapter 3 Circular Motion</b>	<b>45</b>
<b>Chapter 4 Hooke's Law</b>	<b>75</b>
<b>Chapter 5 Linear Motion Under a Variable Force</b>	<b>92</b>
<b>Chapter 6 Momentum</b>	<b>113</b>

# **Chapter**

## **Projectiles**

**Q1: 9231/31/S20**

- 1 A particle  $P$  is projected with speed  $u$  at an angle of  $30^\circ$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The particle reaches its greatest height at time  $T$  after projection.

Find, in terms of  $u$ , the speed of  $P$  at time  $\frac{2}{3}T$  after projection.

[5]

**Q2: 9231/33/S20**

- 6 A particle  $P$  is projected with speed  $u$  at an angle  $\theta$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The direction of motion of  $P$  makes an angle  $\alpha$  above the horizontal when  $P$  first reaches three-quarters of its greatest height.

- (a) Show that  $\tan \alpha = \frac{1}{2} \tan \theta$ .

[6]

- (b) Given that  $\tan \theta = \frac{4}{3}$ , find the horizontal distance travelled by  $P$  when it first reaches three-quarters of its greatest height. Give your answer in terms of  $u$  and  $g$ . [4]

**Q3: 9231/31/W20**

- 5 A particle  $P$  is projected with speed  $u$  at an angle  $\alpha$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of  $P$  from  $O$  at a subsequent time  $t$  are denoted by  $x$  and  $y$  respectively.

- (a) Derive the equation of the trajectory of  $P$  in the form

$$y = x \tan \alpha - \frac{gx^2}{2u^2} \sec^2 \alpha. \quad [3]$$

The point  $Q$  is the highest point on the trajectory of  $P$  in the case where  $\alpha = 45^\circ$ .

- (b) Show that the  $x$ -coordinate of  $Q$  is  $\frac{u^2}{2g}$ . [3]

- (c) Find the other value of  $\alpha$  for which  $P$  would pass through the point  $Q$ . [4]

**Q4: 9231/32/W20**

- 5 A particle  $P$  is projected with speed  $u \text{ m s}^{-1}$  at an angle of  $\theta$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of  $P$  from  $O$  at a subsequent time  $t \text{ s}$  are denoted by  $x \text{ m}$  and  $y \text{ m}$  respectively.

- (a) Starting from the equation of the trajectory given in the List of formulae (MF19), show that

$$y = x \tan \theta - \frac{gx^2}{2u^2}(1 + \tan^2 \theta). \quad [1]$$

When  $\theta = \tan^{-1} 2$ ,  $P$  passes through the point with coordinates  $(10, 16)$ .

- (b) Show that there is no value of  $\theta$  for which  $P$  can pass through the point with coordinates  $(18, 30)$ . [6]

# **Q5: 9231/31/S21**

- 7 A particle  $P$  is projected from a point  $O$  on a horizontal plane and moves freely under gravity. The initial velocity of  $P$  is  $100\text{ m s}^{-1}$  at an angle  $\theta$  above the horizontal, where  $\tan \theta = \frac{4}{3}$ . The two times at which  $P$ 's height above the plane is  $H$  m differ by 10 s.

(a) Find the value of  $H$ .

[5]

- (b) Find the magnitude and direction of the velocity of  $P$  one second before it strikes the plane. [4]

**Q6: 9231/33/S21**

- 7 A particle  $P$  is projected with speed  $u$  at an angle  $\theta$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of  $P$  from  $O$  at a subsequent time  $t$  are denoted by  $x$  and  $y$  respectively.

- (a) Use the equation of the trajectory given in the List of formulae (MF19), together with the condition  $y = 0$ , to establish an expression for the range  $R$  in terms of  $u$ ,  $\theta$  and  $g$ . [2]

A large, faint watermark is printed diagonally across the page. The text "view clouds" is repeated three times in a stylized, rounded font. Each instance of the text is composed of two overlapping layers of gray, creating a sense of depth. The watermark is oriented from the top-left towards the bottom-right, covering approximately one-third of the page area.

- (b) Deduce an expression for the maximum height  $H$ , in terms of  $u$ ,  $\theta$  and  $g$ . [2]

A large, faint watermark is printed across the page. The word "ALIVE" is repeated diagonally from the top-left towards the bottom-right. Each "ALIVE" is composed of four separate letters, all in a bold, sans-serif font.