

**A Level Physics A**  
**H556/01** Modelling physics

**Question Set 12**

1 (a)

A tennis ball is struck with a racket. The initial velocity  $v$  of the ball leaving the racket is  $30.0 \text{ ms}^{-1}$  and it makes an angle of  $70^\circ$  to the horizontal as shown in Fig. 16. Air resistance is negligible.

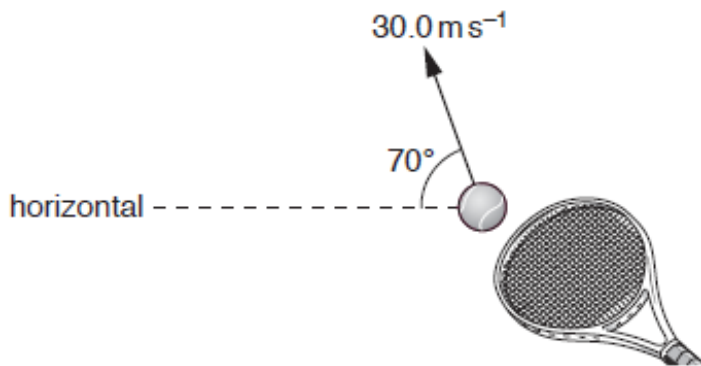


Fig. 16

(i) Calculate the vertical component of the initial velocity of the ball.

$$30 \sin(70) = 28.19 \text{ ms}^{-1} \quad \text{vertical component} = \dots\dots\dots 28.2 \text{ ms}^{-1} \quad [1]$$

(ii) Use your answer in (i) to show that the ball reaches a maximum height  $h$  of about 40 m.

$$v^2 = u^2 + 2as$$

$$0 = 28.19^2 - 2(9.81)s$$

$$s = \frac{28.19^2}{2 \times 9.81} = 40.5$$

$$h = \dots\dots\dots 40.5 \text{ m} \quad [2]$$

(iii) Explain why the kinetic energy of the ball is not zero at maximum height. [1]

It still has horizontal motion.

(iv) The mass  $m$  of the ball is 57.0 g. Calculate the kinetic energy  $E_k$  of the ball when it is at its **maximum** height.

All KE from horizontal velocity

Horizontal velocity =  $30 \cos(70) = 10.26 \text{ ms}^{-1}$

$$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 57 \times 10^{-3} \times 10.26^2$$

$$E_k = \dots\dots\dots 3.0 \text{ J} \quad [2]$$

(b)\* A metal ball is rolled off the edge of a horizontal laboratory bench. The initial horizontal velocity of the ball is  $v$ . The ball travels a horizontal distance  $x$  before it hits the level floor.

Use your knowledge of projectile motion to suggest the relationship between  $v$  and  $x$ . Describe how an experiment can be safely conducted to test this relationship and how the data can be analysed. [6]

Neglecting air resistance, the horizontal velocity  $v$  will remain constant for the whole flight. Therefore, the horizontal distance travelled will be directly proportional to  $v$ :  $x \propto v$ .

To set up an experiment to test this, first use a spring with different compression levels to eject the ball at different  $v$ . Measure  $v$  using a motion sensor. For each value of  $v$ , measure  $x$  using a ruler and a slow-motion video recording. Repeat several times for a set value of  $v$  to find an average.

To test  $x \propto v$ , plot a graph of  $x$  against  $v$ . If correct, should be straight line through origin.

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