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 m s^{-1} and it makes an angle of 70° to the horizontal as shown in Fig. 16.
Air resistance is negligible.

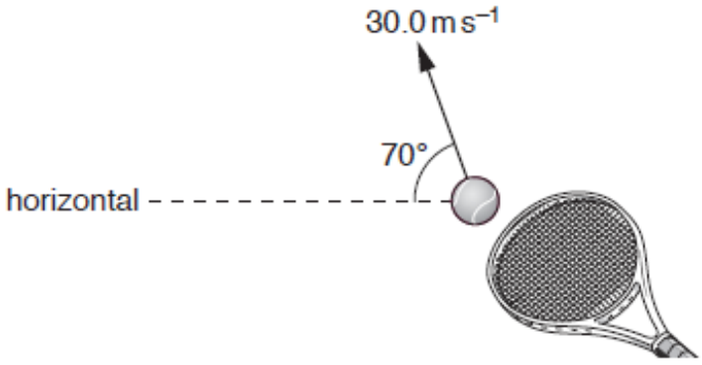

Fig. 16

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

$30 \sin(70) = 28.19 \text{ ms}^{-1}$

vertical component = 28.2 m s^{-1} **[1]**

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

$s = ?$, $u = 28.19$, $v = 0$, $a = -9.81$, $t = ?$

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

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

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

h = 40.5 m **[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 = $30\cos(70) = 10.26 \text{ ms}^{-1}$

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

$= 3.000$ J

E_k = 3.0 J **[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.

Total Marks for Question Set 12: 12