

TAP 207- 6: Challenges in target archery

Here you can work on predicting the positions of objects that are accelerated. One archery competition requires archers to fire a total of 90 arrows for a maximum possible score of 900. The targets are 1.22 m in diameter at 60, 50 and 40 metres distance. You can model the motion of the arrow to find out what problems the archer faces.

The arrow leaves the bow at 60 m s^{-1} and travels at almost this speed horizontally for the whole of its flight.

The arrow, of course, falls because of the acceleration due to gravity. You can find its position at any moment by working out how far it has moved horizontally and how far it has fallen vertically.

1. The archer shoots the arrow horizontally at the 40 m target. How far does it drop over this range?
2. How would the archer make allowance for this fall? Think carefully before committing yourself.
3. Now try to calculate the fall at 50 m and 60 m.
4. 50 years ago the release speed of an arrow was about 30 m s^{-1} . What effect would this have on the vertical distance the arrow fell? Calculate the drop for a range of 60 m to check your answer.
5. We have ignored the effect of air resistance in these calculations. How could you take account of it? You can explore it most easily by making a computer model of the motion.

Practical advice

An example where vectors and simple kinematics give insight into a phenomenon.

Social and human context

Accurate archery was important in many spheres – often not in warfare.

Answers and worked solutions

1. Time of flight

$$= \frac{40 \text{ m}}{60 \text{ m s}^{-1}} = 0.67 \text{ s}$$

Vertical drop

$$h = \frac{1}{2}gt^2 = \frac{1}{2} \times 9.81 \text{ m s}^{-2} \times \left(\frac{2}{3} \text{ s}\right)^2 = 2.2 \text{ m}$$

2. Aim above the target.

3. Similar calculations

$$h_{50} = \frac{1}{2} \times 9.81 \text{ m s}^{-2} \times \left(\frac{5}{6} \text{ s}\right)^2 = 3.4 \text{ m}$$

$$h_{60} = \frac{1}{2} \times 9.81 \text{ m s}^{-2} \times (1 \text{ s})^2 = 4.9 \text{ m}$$

4. Twice the trip time so four times fall, at 60 m now drops 20 m.

External references

This activity is taken from Advancing Physics Chapter 9, 110s