Unit 2: Linear Motion and Waves Content Descriptions

Sports science

The study of linear motion and forces has led to major developments in athlete training programs, sporting techniques and equipment development. Biomechanics applies the laws of force and motion to gain greater understanding of athletic performance through direct measurement, computer simulations and mathematical modelling (ACSPH054). In archery the kinetic energy and momentum of an arrow are used to calculate arrow penetration in a target.

Learning Objectives

By the end of this lesson students should understand the relationship between kinetic energy (KE) of an object and momentum.

> **KE = 0.5 • m • v^2** where **m** = mass of object (kg), **v** = speed of object (m/s), **KE = Joules**

In physics, the symbol for the quantity momentum is the lower case p.

> p = m • v where the units for momentum would be mass units times velocity units. The standard metric unit of momentum is the kg•m/s.

> **Note**: 1 foot/second = 0.3048 meter/second

Preparation (10 min) Sign in and get archery equipment

Introduction (20 min) Safety, demonstration of beginner archery technique and outline of lesson.

Lesson

1. Form a **hypothesis** for arrow penetration in a target. What are the **variables** we cannot control?
2. Students will shoot 2 x ends of 6 arrows to determine the most **accurate archer**.
3. Arrow mass will be measured for carbon and aluminium arrows.
4. The accurate archer will use a 20lb, 18lb and 16lb bow to shoot carbon and aluminium arrows. **Arrow speed** will be measured via a **chronometer** and recorded.
5. **Calculations** will be performed for **KE** and **p** for each bow poundage and arrow type combination.
6. **Analysis** for the best and worst combination of bow and arrow for target penetration at 10m.

Bow (lb)	Arrow Type	Arrow mass (kg)	Velocity (fps)	Velocity (m/s) (fps * 0.3048)	KE	p
20	Carbon	.02056				
18	Carbon	.02056				
16	Carbon	.02056				
20	Aluminium	.02677				
18	Aluminium	.02677				
16	Aluminium	.02677				

Bow (lb)	Arrow Type	Arrow mass (kg)	Velocity (fps)	Velocity (m/s) (fps * 0.3048)	KE	p
20	Carbon	0.02056	141.4	43.10	19.10	0.89
18	Carbon	0.02056	135.1	41.18	17.43	0.85
16	Carbon	0.02056	122.6	37.37	14.36	0.77
20	Aluminium	0.02677	126.8	38.65	19.99	1.03
18	Aluminium	0.02677	110.9	33.80	15.29	0.90
16	Aluminium	0.02677	109.3	33.31	14.86	0.89