AP PHYSICS C: MECHANICS • EXERCISE SHEET

4.1 Linear Momentum

Name: _____ Class: _____ Date: _____ **Total: 15 marks**

Objective

Build the skills to answer exam questions on **linear momentum**.

You must be able to:

- calculate **momentum** 动量: $\vec{p} = m\vec{v}$
- treat momentum as a vector (direction matters)
- find momentum from mass and velocity, or velocity from momentum
- state the unit of momentum (kg m s^{-1})

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

Momentum is mass times velocity

$$\vec{p} = m\vec{v}.$$

A 3 kg ball at 4 m s^{-1} has $p = 3 \times 4 = 12$ kg m s^{-1}.

Momentum is a vector

Its direction is the direction of the velocity. Taking right as positive, a 2 kg ball moving left at 5 m s^{-1} has $p = -10$ kg m s^{-1}.

Comparing momenta

A heavy slow object can have the same momentum as a light fast one: 10 kg at 2 m s^{-1} and 2 kg at 10 m s^{-1} both have $p = 20$ kg m s^{-1}.

2 Practice

Now apply the methods above.

2.1 A 5 kg object moves at 3 m s^{-1}. Find its momentum. [2]

2.2 State the unit of momentum. [1]

2.3 Taking right as positive, find the momentum of a 2 kg ball moving left at 6 m s^{-1}. [2]

2.4 An object has momentum 24 kg m s^{-1} and mass 4 kg. Find its speed. [2]

3 Exam-style questions

3.1 Momentum is calculated as [1]

- **A** $\frac{1}{2}mv^2$
- **B** mv
- **C** ma
- **D** Fd

3.2 Which quantity is a vector? [1]

- **A** mass
- **B** speed
- **C** momentum
- **D** kinetic energy

3.3 A 1200 kg car moves east at 15 m s^{-1}.

(a) Find its momentum. [2]

(b) State the direction of the momentum. [1]

3.4 Object A: 8 kg at 3 m s^{-1}. Object B: 2 kg at 12 m s^{-1}.

(a) Find each momentum. [2]

(b) State which has the greater momentum. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **4.1 Linear Momentum** lesson on the **Learn** page;
- read the **Linear Momentum** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 $p = mv = 5 \times 3 = 15$ kg m s^{-1}.

2.2 kg m s^{-1}.

2.3 $p = 2 \times (-6) = -12$ kg m s^{-1}.

2.4 $v = p/m = 24/4 = 6$ m s^{-1}.

3.1 B —$p = mv$.

3.2 C —momentum is a vector.

3.3 (a) $p = 1200 \times 15 = 1.8 \times 10^4$ kg m s^{-1}. (b) East.

3.4 (a) A: 24 kg m s^{-1}; B: 24 kg m s^{-1}. (b) Equal.