AP PHYSICS 1 • EXERCISE SHEET

2.9 Circular Motion

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on **circular motion**.

You must be able to:

- define **uniform circular motion** 匀速圆周运动 as motion in a circle at constant speed
- use the **centripetal acceleration** 向心加速度 $a_c = \dfrac{v^2}{r}$, directed toward the centre
- identify the net force that provides the **centripetal force** 向心力 $F_c = \dfrac{mv^2}{r}$
- relate the **period** 周期, **frequency** 频率, and speed of circular motion

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Centripetal acceleration points inward

Even at constant speed, the **direction** of velocity changes, so there is an acceleration $a_c = \dfrac{v^2}{r}$ toward the centre. A car at 10 m s^{-1} on a 20 m radius bend: $a_c = \dfrac{10^2}{20} = 5.0$ m s^{-2}.

■ The centripetal force is a role, not a new force

Some **real** force (friction, tension, gravity, normal) provides $F_c = \dfrac{mv^2}{r}$. For the car, friction supplies it: $F_c = \dfrac{mv^2}{r}$.

■ Period and frequency

The object covers one circumference per period: $v = \dfrac{2\pi r}{T}$, and frequency $f = \dfrac{1}{T}$.

2 Practice

2.1 A ball moves at 4.0 m s^{-1} in a circle of radius 2.0 m. Find its centripetal acceleration. [2]

2.2 Name the force that keeps a car moving around a flat circular track. [1]

2.3 A 0.50 kg ball moves in a circle with centripetal acceleration 8.0 m s^{-2}. Find the centripetal force. [1]

2.4 An object completes a circle in 0.25 s. Find its frequency. [1]

3 Exam-style questions

3.1 For an object in uniform circular motion, the net force points [1]

- **A** along the velocity
- **B** opposite the velocity
- **C** toward the centre
- **D** away from the centre

3.2 If the speed of an object in a circle doubles (same radius), the centripetal acceleration becomes [1]

- **A** unchanged
- **B** twice as large
- **C** four times as large
- **D** half as large

3.3 A 0.20 kg ball on a string moves in a horizontal circle of radius 0.50 m at 3.0 m s^{-1}.

(a) Find the centripetal acceleration. [2]

(b) Find the tension in the string (the centripetal force). [2]

4 Go further

- work through the **2.9 Circular Motion** lesson on the **Learn** page;
- read the **Force and Translational Dynamics** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 $a_c = \dfrac{v^2}{r} = \dfrac{4.0^2}{2.0} = 8.0 \text{ m s}^{-2}$.

2.2 friction (between the tyres and the road).

2.3 $F_c = ma_c = 0.50 \times 8.0 = 4.0 \text{ N}$.

2.4 $f = \dfrac{1}{T} = \dfrac{1}{0.25} = 4.0 \text{ Hz}$.

3.1 C.

3.2 C —$a_c \propto v^2$.

3.3 (a) $a_c = \dfrac{3.0^2}{0.50} = 18 \text{ m s}^{-2}$. (b) $F_c = ma_c = 0.20 \times 18 = 3.6 \text{ N}$.