

## 5.3 Torque

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

**Total: 12 marks****KEY WORDS** torque 力矩 • lever arm 力臂

### Objective

Build the skills to answer exam questions on **torque**.**You must be able to:**

- define **torque** 力矩 as the tendency of a force to cause rotation about an axis
- calculate a torque with  $\tau = rF \sin \theta$
- identify the **lever arm** 力臂 as the perpendicular distance from the axis to the line of action
- determine the **direction** of a torque (clockwise or counterclockwise)

### 1 Worked examples

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

#### ■ Torque formula

$\tau = rF \sin \theta = F \times (\text{lever arm})$ , measured in N m. The **lever arm** is the perpendicular distance from the axis to the force's line of action.

#### ■ Maximum torque

Torque is greatest when the force is **perpendicular** to  $r$  ( $\theta = 90^\circ$ ) and zero when the force points along  $r$ .

#### ■ Example

A 20 N force at the end of a 0.50 m wrench, perpendicular to it:  $\tau = 20 \times 0.50 = 10 \text{ N m}$ .

### 2 Practice

**2.1** A 30 N force acts perpendicular to a door, 0.80 m from the hinge. Find the torque.<sup>[1]</sup>

**2.2** State the angle between the force and the lever arm that gives the maximum torque.<sup>[1]</sup>

**2.3** A 40 N force acts at  $30^\circ$  to a 0.60 m arm. Find the torque.<sup>[2]</sup>

**2.4** Explain why a longer wrench makes it easier to loosen a tight bolt.<sup>[2]</sup>

### 3 Exam-style questions

**3.1** Torque is greatest when the force is applied<sup>[1]</sup>

|   |   |
|---|---|
| A | B |
| C | D |

A along the arm

B at  $45^\circ$  to the arm

C perpendicular to the arm

D at the axis

**3.2** A 10 N force acts at a perpendicular distance of 0.20 m from an axis. The torque is<sup>[1]</sup>

|   |   |
|---|---|
| A | B |
| C | D |

A 0.02 N m

B 2.0 N m

C 10 N m

D 50 N m

**3.3** A seesaw pivots at its centre. A 300 N child sits 1.5 m from the pivot.

(a) Find the torque this child produces.<sup>[2]</sup>

(b) Find where a 450 N child must sit to balance the seesaw.<sup>[2]</sup>