AP PHYSICS 1 • EXERCISE SHEET

# 2.7 Kinetic and Static Friction

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

**KEY WORDS** kinetic friction 动摩擦 • static friction 静摩擦 • coefficient of friction 摩擦系数 • normal force 法向力 • friction 摩擦力

## Objective

Build the skills to answer exam questions on **kinetic and static friction**.

**You must be able to:**

- distinguish **static friction** 静摩擦 (prevents sliding) from **kinetic friction** 动摩擦 (opposes sliding)
- use $f_s \le \mu_s F_N$ for maximum static friction and $f_k = \mu_k F_N$ for kinetic friction
- explain that friction depends on the **normal force** 法向力 and the **coefficient of friction** 摩擦系数, not on contact area
- analyse the role of friction in motion and equilibrium

## 1 Worked examples

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

### ■ Static friction adjusts itself

Static friction matches the applied force up to a maximum $f_{s,\max} = \mu_s F_N$. Below that, the object stays put; push harder than $f_{s,\max}$ and it starts to slide.

### ■ Kinetic friction is fixed

Once sliding, $f_k = \mu_k F_N$ (usually $\mu_k < \mu_s$). A 10 kg box on a floor, $\mu_k = 0.30$, $g = 10$: $F_N = 100$ N, so $f_k = 0.30 \times 100 = 30$ N.

### ■ Area doesn't matter

Friction depends on $F_N$ and the surfaces, **not** on the contact area — a brick slides with the same friction on its large or small face.



## 2 Practice

**2.1** State the difference between static and kinetic friction. [2]

**2.2** A 5.0 kg block rests on a floor, $\mu_k = 0.40$ (take $g = 10$ m s$^{-2}$). Find the kinetic friction force once it slides. [2]

**2.3** A box needs 18 N to start moving but only 12 N to keep moving. State which coefficient is larger, $\mu_s$ or $\mu_k$. [1]

**2.4** State what happens to the friction force if the same box is turned to rest on a smaller face. [1]

## 3 Exam-style questions

**3.1** The maximum static friction force is given by [1]

- **A** $\mu_s F_N$
- **B** $\mu_k F_N$
- **C** $\mu_s mg \sin\theta$
- **D** $F_N / \mu_s$

**3.2** Doubling the contact area (same weight) changes the kinetic friction force by a factor of [1]

- **A** 0.5
- **B** 1 (no change)
- **C** 2
- **D** 4

**3.3** A 4.0 kg block sits on a level floor, $\mu_s = 0.50$, $\mu_k = 0.30$ (take $g = 10$ m s$^{-2}$).

(a) Find the maximum static friction. [2]

(b) A horizontal push of 15 N is applied. State whether the block moves, and find the friction force acting. [2]



## Solutions

**2.1** Static friction acts on a surface that is **not sliding** and adjusts up to a maximum; kinetic friction acts on a **sliding** surface and has a fixed value $\mu_k F_N$.

**2.2** $F_N = mg = 50$ N; $f_k = 0.40 \times 50 = 20$ N.

**2.3** $\mu_s$ is larger (more force is needed to start it moving).

**2.4** it is unchanged — friction does not depend on contact area.

**3.1** **A**.

**3.2** **B**.

**3.3** (a) $F_N = 40$ N, $f_{s,\max} = 0.50 \times 40 = 20$ N. (b) $15 < 20$ N, so it does not move; static friction $= 15$ N, matching the push.