

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 $f_s \leq \mu_s F_N$ 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 $g = 10 \text{ m s}^{-2}$). 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, μ_s or μ_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 / μ_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 $g = 10 \text{ m s}^{-2}$).

(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]