AP PHYSICS C: MECHANICS • EXERCISE SHEET

2.7 Kinetic and Static Friction

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

KEY WORDS kinetic 动摩擦 • static 静摩擦 • normal force 法向力 • friction 摩擦力 • force 力

Objective

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

You must be able to:

- use **kinetic friction** 动摩擦: $f_k = \mu_k N$
- use the **static friction** 静摩擦 limit: $f_s \leq \mu_s N$
- explain that static friction adjusts up to a maximum before slipping
- find the normal force N first, then the friction

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.

■ Kinetic friction

Once sliding, $f_k = \mu_k N$. A 10 kg block on the flat ($N = mg = 100$ N) with $\mu_k = 0.3$ feels

$$f_k = 0.3 \times 100 = 30 \text{ N},$$

opposing its motion.

■ Static friction adjusts

Before sliding, static friction matches the applied force up to a maximum $f_{s,\max} = \mu_s N$. Push with 20 N on a block whose $f_{s,\max} = 40$ N and it does not move – static friction is exactly 20 N.

■ Find the normal force first

On a flat surface $N = mg$; on an incline $N = mg\cos\theta$. Always find N, then multiply by μ.

2 Practice

Now apply the methods above.

2.1 A block with $N = 50$ N slides with $\mu_k = 0.2$. Find the kinetic friction. [2]

2.2 State the direction of the friction force on a sliding block. [1]

2.3 A block has $f_{s,\max} = 30$ N. You push with 25 N and it stays still. State the static friction force. [1]

2.4 A 4 kg block on the flat has $\mu_k = 0.25$ ($g = 10$ m s^{-2}). Find the kinetic friction while it slides. [2]

3 Exam-style questions

3.1 Kinetic friction on a sliding object is given by [1]

- **A** $\mu_k N$
- **B** μ_k / N
- **C** N / μ_k
- **D** $\mu_k m$

3.2 Static friction [1]

- **A** is always at its maximum
- **B** adjusts up to a maximum, then the object slips
- **C** is always larger than kinetic friction while sliding
- **D** points in the direction of motion

3.3 A 6 kg box on the flat has $\mu_s = 0.5$ and $\mu_k = 0.4$ ($g = 10$ m s^{-2}).

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

(b) Find the kinetic friction once it slides. [1]

3.4 A 5 kg block is pushed along the flat by 30 N with $\mu_k = 0.2$ ($g = 10$ m s^{-2}).

(a) Find the kinetic friction. [2]

(b) Find the net force and the acceleration. [2]

Solutions

2.1 $f_k = \mu_k N = 0.2 \times 50 = 10$ N.

2.2 Opposite to the motion.

2.3 25 N (static friction matches the applied force).

2.4 $N = mg = 40$ N; $f_k = 0.25 \times 40 = 10$ N.

3.1 **A** — $f_k = \mu_k N$.

3.2 **B** — static friction adjusts up to a maximum, then slipping begins.

3.3 (a) $N = 60$ N, $f_{s,\max} = 0.5 \times 60 = 30$ N. (b) $f_k = 0.4 \times 60 = 24$ N.

3.4 (a) $N = 50$ N, $f_k = 0.2 \times 50 = 10$ N. (b) $F_{net} = 30 - 10 = 20$ N; $a = 20/5 = 4$ m s^{-2}.