

Friction, slopes, pulleys and springs

AP Physics 1 (algebra-based) · Test answers (mark scheme)

The answers show the expected method and marks. Award follow-through marks when a correct method is applied to a wrong earlier value.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 2

Question 1 Kinetic friction (1 mark)

$f_k = \mu_k N$, where f_k is the kinetic friction force (N), μ_k the coefficient of kinetic friction (no unit) and N the normal force (N).

Marking: 1 mark for the equation and symbols.

Question 2 Box on a floor (3 marks)

a. $N = 8.0 \times 9.81 = 78.5 \text{ N}$; $f_{s,\max} = 0.60 \times 78.5 = \mathbf{47 \text{ N}}$.

b. 40 N is below 47 N, so the box does not move and the friction force equals the push: **40 N**.

Marking: (a) 1 for N , 1 for the product; (b) 1.

Question 3 Sliding on a slope (3 marks)

$a = g (\sin \theta - \mu_k \cos \theta) = 9.81 \times (0.342 - 0.10 \times 0.940) = 9.81 \times 0.248 = \mathbf{2.4 \text{ m/s}^2}$ down the slope.

Marking: 1 for $N = mg \cos \theta$, 1 for the net force equation, 1 for the value.

Question 4 Atwood machine (4 marks)

a. $a = (5.0 - 3.0) \times 9.81 \div 8.0 = \mathbf{2.5 \text{ m/s}^2}$.

b. For the 3.0 kg mass $T = 3.0 \times (9.81 + 2.45) = \mathbf{37 \text{ N}}$.

Marking: (a) 1 for the system equation, 1 for the value; (b) 1 for the equation on one mass, 1 for the value.

Question 5 Spring (3 marks)

a. $F = kx = 120 \times 0.080 = \mathbf{9.6 \text{ N}}$.

b. $mg = 9.6$, so $m = 9.6 \div 9.81 = \mathbf{0.98 \text{ kg}}$.

Marking: (a) 1; (b) 1 for $mg = kx$, 1 for the value.

Question 6 Why μ is not constant (2 marks)

The maximum static friction is larger than the kinetic friction (μ_s is larger than μ_k). A push must exceed $\mu_s N$ to start the motion, but once sliding only $\mu_k N$ has to be balanced to keep a constant speed.

Marking: 1 for the larger static value, 1 for the link to starting and sliding.

Question 7 Stopping on the road (3 marks)

$$a = \mu_k g = 0.70 \times 9.81 = 6.87 \text{ m/s}^2; d = v^2 \div 2a = 400 \div 13.7 = \mathbf{29 \text{ m}}.$$

Marking: 1 for $f = \mu mg$, 1 for a , 1 for d .

Question 8 Sled pulled at an angle (1 mark)

The rope's upward component reduces the normal force, $N = mg - F \sin \theta$, so $f = \mu N$ is smaller.

Marking: 1 mark for the reduced normal force.