

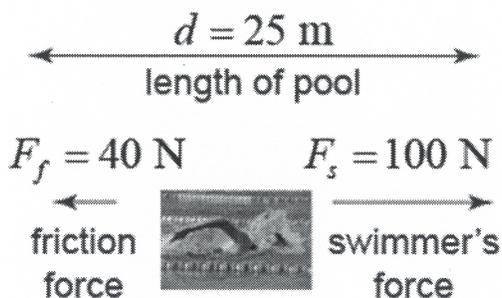
First Name: _____ Last Name: _____

1.06 – Worksheet – Net forces, Acceleration, and friction

PART 1: Net Force and Acceleration

Use the following information to answer Q1:

While searching for potential Physics 20 questions online, Mr. Bayer found this very suspect Free-Body Diagram.



Doubting the validity of these values, Mr. Bayer decided to investigate by calculating the swimmer's final velocity, assuming they were initially stationary on one side of the pool, and swam the entire 25.0m. *Assume the swimmer weighs 80 kg.*

Q1: (Long Answer) What is the calculated final velocity of the swimmer?

$$\begin{aligned} \vec{F}_{\text{net}} &= \vec{F}_s + \vec{F}_f \\ &= 100\text{ N} + (-40\text{ N}) \\ &= 60\text{ N [F]} \end{aligned}$$

$$\vec{a} = \frac{\vec{F}_{\text{net}}}{m} = \frac{60\text{ N [F]}}{80\text{ kg}} = 0.75\text{ m/s}^2 \text{ [forward]}$$

$$\begin{aligned} v_f^2 &= v_i^2 + 2ad \\ &= (0\text{ m/s})^2 + 2(0.75\text{ m/s}^2)(25\text{ m}) \\ &= 0 + 37.5 \end{aligned}$$

$$v_f^2 = 37.5$$

$$v_f = 6.12\text{ m/s [forward]}$$

$$\approx 22\text{ km/h.}$$

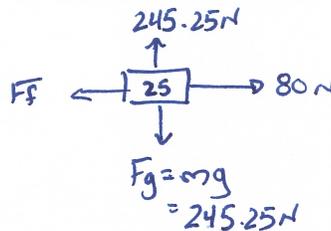
PART 2: Friction in 1-Dimension

Use the following information to answer Q2– Q3:

Material	Coefficient of Static Friction μ_s	Coefficient of Kinetic Friction μ_k
Copper on copper	1.6	1.0
Steel on dry steel	0.41	0.38
Steel on greased steel	0.15	0.09
Q2 → Dry oak on dry oak	0.5	0.3
Rubber tire on dry asphalt	1.2	0.8
Rubber tire on wet asphalt	0.6	0.5
Rubber tire on dry concrete	1.0	0.7
Rubber tire on wet concrete	0.7	0.5
Rubber tire on ice	0.006	0.005
Q3 → Curling stone on ice	0.003	0.002
Teflon™ on Teflon™	0.04	0.04
Waxed hickory skis on dry snow	0.06	0.04
Waxed hickory skis on wet snow	0.20	0.14
Synovial fluid on joint	0.01	0.01

Q2: A 25.0 kg oak block is initially stationary on an oak floor. A small child applies a force of 80N. What is the force of friction acting on the block?

- a. 3.2 N
- b. 73.6 N
- c. 80.0 N**
- d. 122.6 N



$$F_{fs} \leq \mu_s F_N$$

$$\leq (0.5)(245.25N)$$

$$\leq 122.625N$$

$$F_{f_{max}} = 122.625N.$$

Only 80N applied?
Only 80N F_{fs} .

Q3: A 19.0 kg curling stone is resting on ice. How much force is required to overcome static friction?

- a. 5.7×10^{-2} N
- b. 3.7×10^{-1} N
- c. 5.6×10^{-1} N**
- d. 1.9×10^2 N

$$F_{fs} \leq \mu_s F_N$$

$$\leq (0.003)(186.39N)$$

$$\leq 0.55917 N$$

$$\leq 5.5917 \times 10^{-1} N$$

$$F_N = 186.39N$$



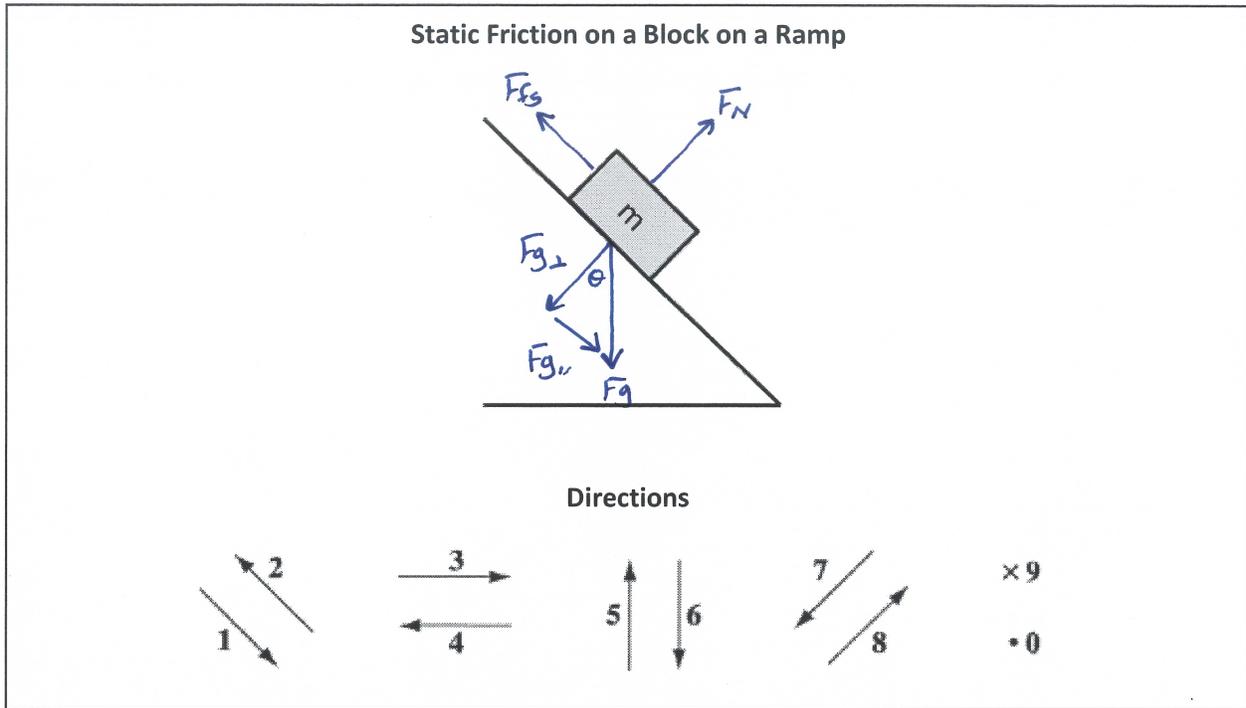
$$F_g = mg$$

$$= (19kg)(9.81m/s^2)$$

$$= 186.39N$$

PART 3: Static Friction in 2-Dimensions

Use the following to answer Q4:



Q4: Use the vector directions above to fill in the blanks below.

Direction: <u>6</u>	<u>8</u>	<u>2</u>
Description: Direction of Force of Gravity	Direction of Normal Force	Direction of Force of Friction

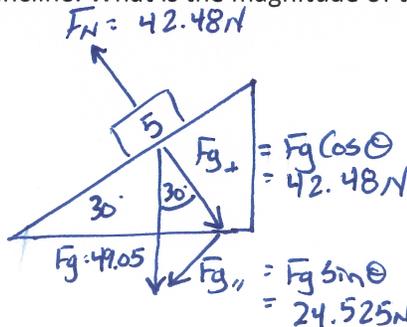
(Record your **three-digit** answer in the Numerical Response boxes below)

6	8	2	
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↑ Leave this one blank.

Q5: A 5.0kg block rests on a 30° incline. What is the magnitude of the Normal Force that the block experiences?

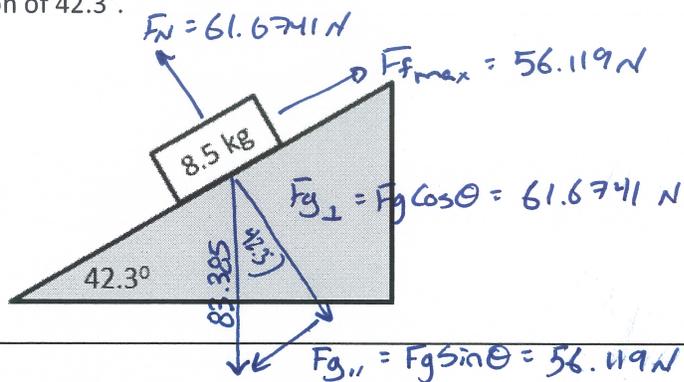
- a. 24.53 N
- b. 28.32 N
- c. 42.48 N
- d. 49.05 N



KEY

Use the following information to answer Q6:

A 8.5 kg block rests on a surface. The surface is inclined until the block *just* starts to slip, which happens at an angle of inclination of 42.3° .



Q6: The coefficient of static friction is $a.bc \times 10^{-d}$, where a , b , c , and d are __, __, __, and __.

(Record your **four-digit** answer in the Numerical Response boxes below)

9	1	0	1
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$$F_{f_s} \leq \mu_s F_N$$

$$F_{f_{s_{\max}}} = \mu_s F_N$$

$$56.119 \text{ N} = \mu_s (61.6741)$$

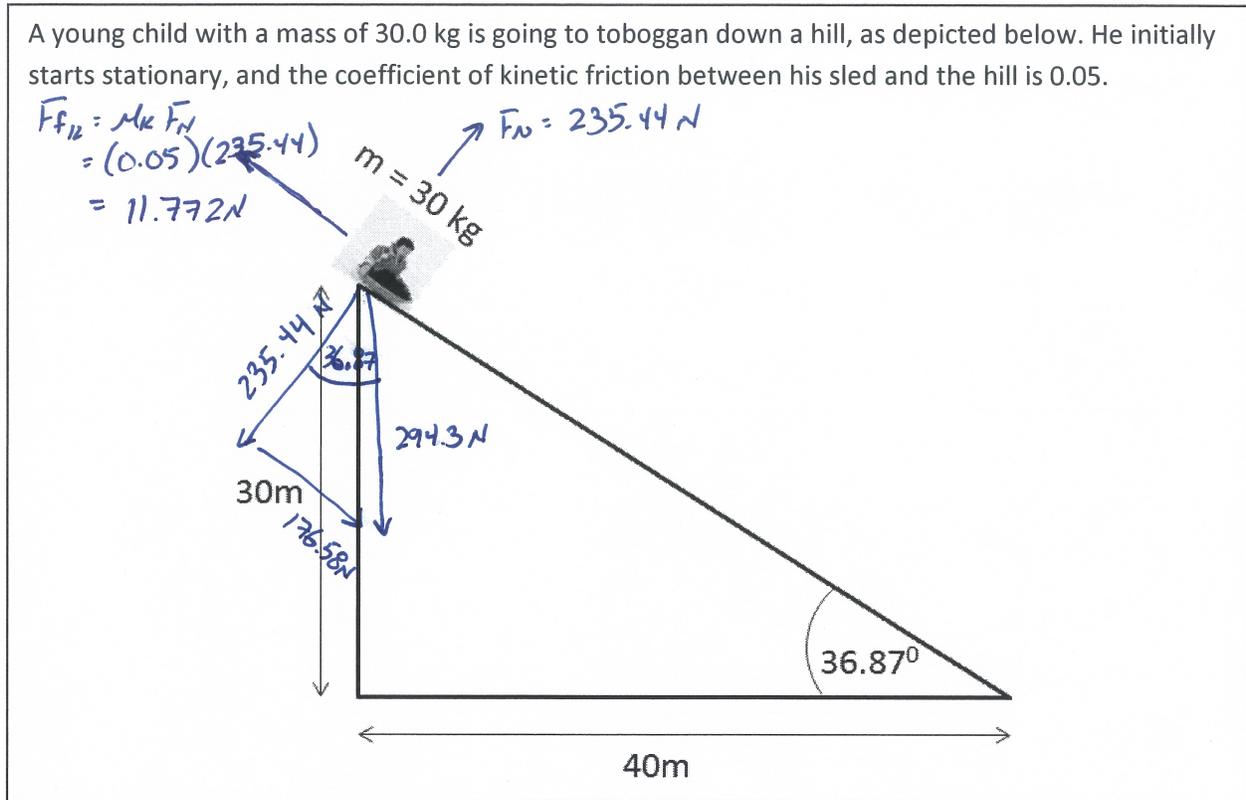
$$\mu_s = 0.9099$$

$$\approx 9.099 \times 10^{-1}$$

$$\approx 9.10 \times 10^{-1}$$

PART 4: Kinetic Friction in 2-Dimensions

Use the following information to answer Q7:



Q7: (Long Answer) What is the acceleration of the child?

Parallel Comp

$$\vec{F}_{\text{net}} = \vec{F}_{g_{\parallel}} + \vec{F}_f$$

$$= 176.58\text{ N} + (-11.772\text{ N})$$

$$= 164.808\text{ N}$$

$$a = \frac{F_{\text{net}}}{m} = \frac{164.808\text{ N}}{30\text{ kg}} = 5.49\text{ m/s}^2 \text{ [forward]}$$

As a side note, child goes 50 m down hill

$$v_f^2 = v_i^2 + 2ad$$

$$= (0\text{ m/s})^2 + 2(5.49\text{ m/s}^2)(50\text{ m})$$

$$= 549$$

$$v_f = 23.43\text{ m/s (or } \approx 84\text{ mph).}$$