

NEWTON'S LAWS of MOTION & FORCES STUDY GUIDE

Define the Following:

1. elastic collision - OBJECTS PART AFTER COLLISION
2. force - PUSH OR PULL
3. friction - FORCE THAT OPPOSES MOTION.
4. gravity - Force of attraction between 2 masses
5. inelastic collision - Objects stay together after collision
6. momentum - Force of motion that includes mass & velocity
7. motion - Change in position

KEY

Formulas: Write the formulas and give the units for each.

8. Newton's 2nd Law

$$F = ma$$

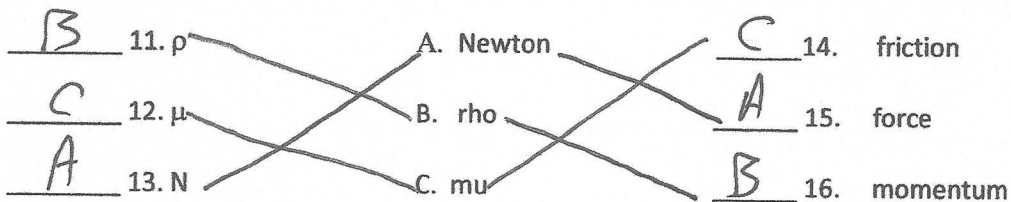
9. Force due to Gravity

$$F = mg$$

10. Momentum

$$p = mv$$

Units & Symbols Matching: Match the symbol to the word. Then match the word to the measurement.



17. State Newton's 3 laws of motion.

#1 An object will stay at rest, and an object will stay in motion until a force acts on it. -law of inertia

#2 $F = mg$

#3 For every action there is an equal but opposite reaction

18. Which tool did we use to measure gravity and forces?

force meter



19. What is the value for the acceleration to Earth due to gravity?

$$g = 9.81 \text{ m/s}^2$$

20. Describe what happens when 2 objects of different masses are dropped from the same height at the same time.

They fall at the same rate and hit the ground together

21. What is required in order to change the motion of an object?

A force

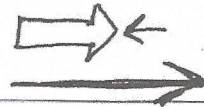
22. What is the difference between balanced and unbalanced forces on an object?

Balanced forces result in NO motion ~~→~~

Unbalanced forces result in motion ~~→~~
in the direction of the larger force

23. When forces are unbalanced, what will be the direction of the motion of the object?

Motion will be in the direction of the larger force



24. How are mass and momentum related?

More mass, more momentum

25. How are velocity and momentum related?

More velocity, more momentum

26. What is the direction of friction?

Friction is in the opposite direction of motion.

27. Describe the coefficient of friction. Why does it have no unit?

$$\mu = \frac{\text{force to slide}}{\text{force of gravity (=weight)}}$$

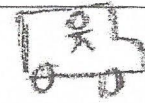
units cancel ~~✗~~

28. How does the weight of an object affect the friction with the surface it's sliding across?

More weight creates more friction

29. A girl is on a bus, what is her frame of reference?

The bus



Her friend is on the side walk, do they have the same frame of reference?

No, her friend's is the sidewalk

30. If a man in a moving car drops his cell phone, why does it look to him like it drops straight down, but to someone outside the car the phone would appear to fall forward?

His frame of reference is the car, same as the phone. To someone outside the car, the phone would appear to fall forward as the car moves.

Practice Problems:

31. A pinecone with a mass of 2.0kg rolls off the edge of a roof and falls by gravity. What is the force from that pinecone when it hits the ground?

G $m = 2.0 \text{ kg}$ $g = 9.81 \text{ m/s}^2$

U $F = ?$

E $F = mg$

S $F = (2.0 \text{ kg})(9.81 \text{ m/s}^2)$

S $F = 19.6 \text{ N}$

33. A cart has a mass of 2 kg. If it is accelerating at 3 m/s/s, with what force will it hit the wall?

G $m = 2 \text{ kg}$ $a = 3 \text{ m/s}^2$

U $F = ?$

E $F = ma$

S $F = (2 \text{ kg})(3 \text{ m/s}^2)$

S $F = 6 \text{ N}$

32. A man has a weight of 73 N on a bathroom scale. What is his mass in kilograms?

G $F = 73 \text{ N}$ $g = 9.81 \text{ m/s}^2$

U $m = ?$ $73 \text{ N} = m(9.81 \text{ m/s}^2)$

E $F = mg \Rightarrow m = \frac{F}{g}$

S $m = \frac{73 \text{ N}}{9.81 \text{ m/s}^2}$

S $m = 7.44 \text{ kg}$

34. A 95 kg boy is riding a 6 kg skateboard on the sidewalk at 6 m/s. What is the boy's momentum?

G $m = 95 \text{ kg} + 6 \text{ kg} = 101 \text{ kg}$

U $v = 6 \text{ m/s}$

U $p = ?$

E $p = mv$

S $p = (101 \text{ kg})(6 \text{ m/s})$

S $p = 606 \text{ kg m/s}$

Momentum

Inelastic collision

35. A 5 kg ball of clay rolls at 10 m/s into a 2 kg ball of clay that was sitting still. Once they are stuck together, at what velocity will they roll together?

G $m_1 = 5 \text{ kg}$ $m_2 = 2 \text{ kg}$
 U $v_1 = 10 \text{ m/s}$ $v_2 = 0 \text{ m/s}$

U $v_F = ?$

E $m_1 v_1 + m_2 v_2 = m_F v_F$

S $\frac{(5 \text{ kg})(10 \text{ m/s}) + (2 \text{ kg})(0 \text{ m/s})}{5 \text{ kg} + 2 \text{ kg}} = v_F$

S $v_F = \frac{50 \text{ kg m/s}}{7 \text{ kg}} = \boxed{7.14 \text{ m/s}}$

Friction

36. 3N of force are applied to drag a 8N box to slide it across the floor. What is the coefficient of friction?

G $F_{\text{slide}} = 3 \text{ N}$ $F_g = 8 \text{ N}$

U $\mu = ?$

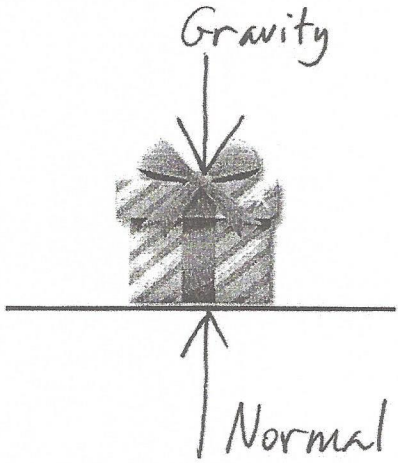
E $\mu = \frac{F_{\text{slide}}}{F_g}$

S $\mu = \frac{3 \text{ N}}{8 \text{ N}}$

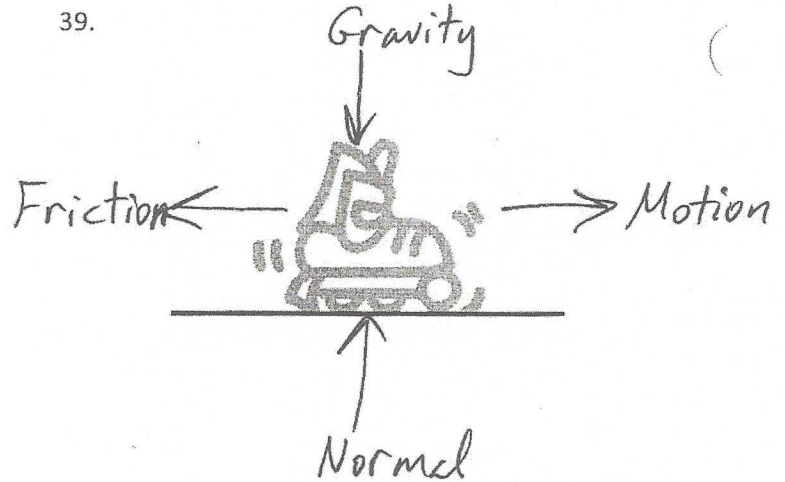
S $\mu = \boxed{0.4}$

Force Diagrams: Draw and label the arrows to show all the forces at work on the objects below.
 (Normal, Gravity, Motion, Friction)

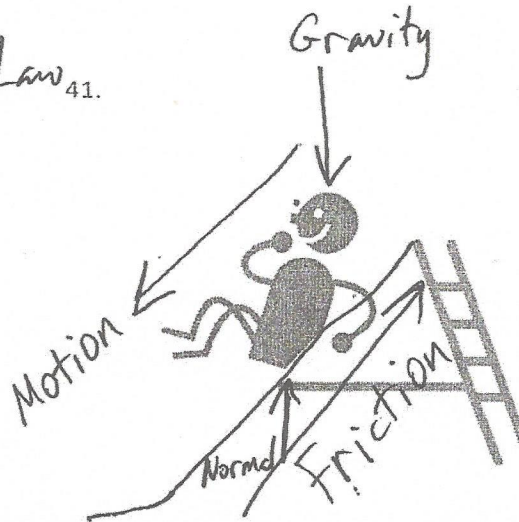
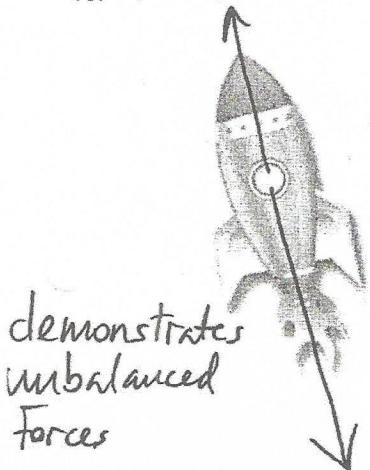
38.



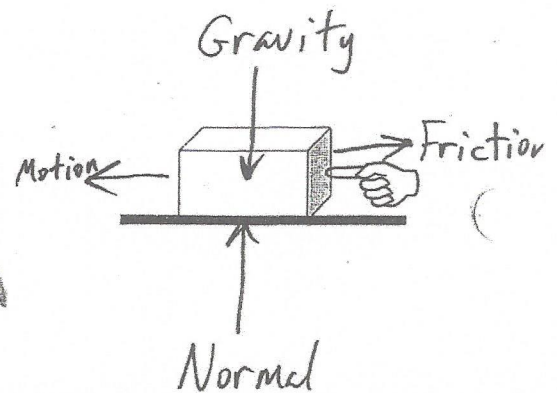
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40. Newton's 3rd Law 41.



42.

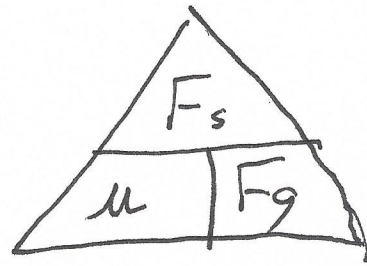


Coefficient of Friction Practice

Coefficient of Friction (μ)

$$\mu = \frac{F_s}{F_g} \quad (\text{no units})$$

μ = force to slide object at constant velocity / perpendicular force of mass x gravity



1. A hockey puck has a coefficient of kinetic friction of $\mu = .16$. If the puck feels a normal force (F) of 10 N, what is the frictional force that acts on the puck?

$$F_s = \mu(F_g)$$

$$F = (.16) 10N = 1.6N$$

2. Suppose a 25 N force is applied to the side of a 12 kg block that is sitting on a table. The block experiences a frictional force against the force that is applied. Hint: You have to figure out force of gravity ($F=mg$) first, then find friction.

$$\mu = \frac{F_s}{F_g}$$

$$F = mg$$

$$(12 \text{ kg}) 9.8 \text{ m/s}^2$$

$$F = 117.7 \text{ N}$$

$$\mu = \frac{25 \text{ N}}{117.7} = .2$$

$$\mu = .2$$

3. A 35 kg box is sitting on a table. I push that box with a force of 25N, what is the coefficient of friction?

$$\mu = \frac{F_s}{F_g}$$

$$F = mg$$

$$35 \text{ kg} (9.8 \text{ m/s}^2)$$

$$343.4 \text{ N}$$

$$\mu = \frac{25 \text{ N}}{343.4 \text{ N}} = .07$$

$$\mu = .07$$

4. An Under Armour shoe has a perpendicular force of 5.5 N, and takes 3.7 N of force to slide. What is the coefficient of friction?

$$\mu = \frac{F_s}{F_g}$$

$$\frac{3.7 \text{ N}}{5.5 \text{ N}} = .67$$

$$\mu = .67$$

5. A 786 kg block of concrete is being pushed by a bulldozer with a force of 721 N, what is the coefficient of friction?

$$F = mg$$

$$786 \text{ kg} (9.8 \text{ m/s}^2)$$

$$F = 7,710.7 \text{ N}$$

$$\mu = \frac{F_s}{F_g} = \frac{721 \text{ N}}{7,710.7 \text{ N}} = .09$$

$$\mu = .09$$