Forces

Force is the push or pull on an object. All forces are *vector* quantities, meaning they measure both magnitude (size) *and* direction. Forces act in pairs and are measured in Newtons.

Objectives:

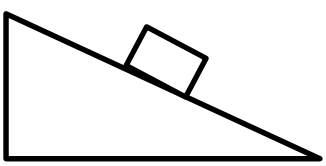
- Understand Newton's 1st Law of Motion and define mass and inertia.
- Draw properly labeled free body diagrams showing all forces acting on an object.
- Understand and apply Newton's 2nd Law of Motion to find unknown forces, accelerations, masses, weights, ect.
- Understand the meaning of Newton's 3rd Law of Motion and can apply it to solve problems.
- Solve problems involving frictional forces.

Force Formulas:

$$a = \frac{F_{net}}{m} \qquad g = \frac{F_g}{m} \qquad F_f = \mu F_N$$

Concepts to Watch Out For:

- The unit for Newtons is $kg{\cdot}m/s^2$ (the force needed to accelerate 1kg at a rate of 1 m/s^2).
- Inertia is another word for mass. Inertia is **not** momentum.
- Equilibrium means that all forces are balanced. The objects may be at rest ***or*** moving at a constant velocity.
- If an object is moving at a constant velocity then frictional force is equal to the applied force.
- When measuring forces at an angle, break up forces into two components.
- Static friction are bodies *not in motion (rest)*
- Kinetic friction are bodies *in motion*
- Static friction is *always greater than* kinetic friction
- Coefficient of friction *does not* have units
- Normal Force is perpendicular to the surface



The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING

PHYSICS

Forces

NOTES:

Part A

Answer all questions in this part.

Directions (1–24): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1 A 2.0-kilogram body is initially traveling at a velocity of 40. meters per second east. If a constant force of 10. newtons due east is applied to the body for 5.0 seconds, the final speed of the body is

(1) 15 m/s
(2) 25 m/s
(3) 65 m/s
(4) 130 m/s

2 A container of rocks with a mass of 65.0 kilograms is brought back from the Moon's surface where the acceleration due to gravity is 1.62 meters per second^2. What is the weight of the container of rocks on Earth's surface?

(1) 638 N
(2) 394 N
(3) 105 N
(4) 65.0 N

3 Which cart has the greatest inertia?

(1) a 1-kilogram cart traveling at a speed of 4 m/s
(2) a 2-kilogram cart traveling at a speed of 3 m/s
(3) a 3-kilogram cart traveling at a speed of 2 m/s
(4) a 4-kilogram cart traveling at a speed of 1 m/s

4 A 3-newton force and a 4-newton force are acting concurrently on a point. Which force could *not* produce equilibrium with these two forces?

(1) 1 N
(2) 7 N
(3) 9 N
(4) 4 N

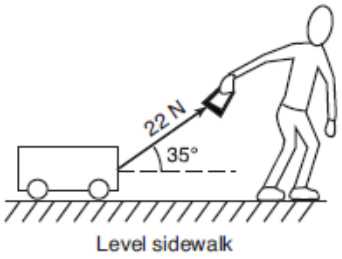
5 A student is standing in an elevator that is accelerating downward. The force that the student exerts on the floor of the elevator must be

(1) less than the weight of the student when at rest
(2) greater than the weight of the student when at rest
(3) less than the force of the floor on the student
(4) greater than the force of the floor on the student

6 A 75-kilogram hockey player is skating across the ice at a speed of 6.0 meters per second. What is the magnitude of the average force required to stop the player in 0.65 second?

(1) 120 N
(2) 290 N
(3) 690 N
(4) 920 N

7 A child pulls a wagon at a constant velocity along a level sidewalk. The child does this by applying a 22-newton force to the wagon handle, which is inclined at 35° to the sidewalk as shown below.



What is the magnitude of the force of friction on the wagon?

(1) 11 N
(2) 13 N
(3) 18 N
(4) 22 N

8 Which object has the greatest inertia?

(1) a 15-kg mass traveling at 5.0 m/s
(2) a 10.-kg mass traveling at 10. m/s
(3) a 10.-kg mass traveling at 5.0 m/s
(4) a 5.0-kg mass traveling at 15 m/s

9 Which situation describes an object that has *no* unbalanced force acting on it?

(1) an apple in free fall
(2) a satellite orbiting Earth
(3) a hockey puck moving at constant velocity across ice
(4) a laboratory cart moving down a frictionless 30.° incline

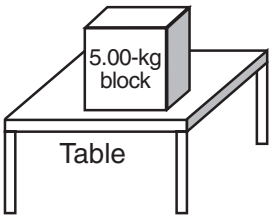
10 A 0.50-kilogram puck sliding on a horizontal shuffleboard court is slowed to rest by a frictional force of 1.2 newtons. What is the coefficient of kinetic friction between the puck and the surface of the shuffleboard court?

(1) 0.24
(2) 0.42
(3) 0.60
(4) 4.1

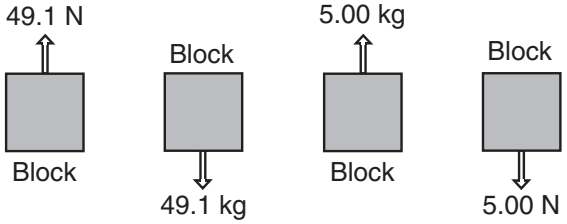
11 A 2.0-kilogram object is falling freely near Earth's surface. What is the magnitude of the gravitational force that Earth exerts on the object?

(1) 20. N
(2) 2.0 N
(3) 0.20 N
(4) 0.0 N

12 The diagram below shows a 5.00-kilogram block at rest on a horizontal, frictionless table.



Which diagram best represents the force exerted on the block by the table?



13 Two 20.-newton forces act concurrently on an object. What angle between these forces will produce a resultant force with the greatest magnitude?

(1) 0°
(2) 45°
(3) 90.°
(4) 180.°

14 Which object has the greatest inertia?

(1) a 0.010-kg bullet traveling at 90. m/s
(2) a 30.-kg child traveling at 10. m/s on her bike
(3) a 490-kg elephant walking with a speed of 1.0 m/s
(4) a 1500-kg car at rest in a parking lot

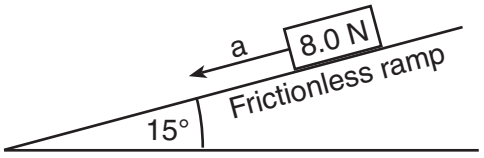
15 An 8.0-newton wooden block slides across a horizontal wooden floor at constant velocity. What is the magnitude of the force of kinetic friction between the block and the floor?

(1) 2.4 N
(2) 3.4 N
(3) 8.0 N
(4) 27 N

16 Which situation represents a person in equilibrium?

(1) a child gaining speed while sliding down a slide
(2) a woman accelerating upward in an elevator
(3) a man standing still on a bathroom scale
(4) a teenager driving around a corner in his car

17 An 8.0-newton block is accelerating down a frictionless ramp inclined at 15° to the horizontal, as shown in the diagram below.



What is the magnitude of the net force causing the block's acceleration?

(1) 0 N
(2) 2.1 N
(3) 7.7 N
(4) 8.0 N

18 A baseball bat exerts a force of magnitude F on a ball. If the mass of the bat is three times the mass of the ball, the magnitude of the force of the ball on the bat is

(1) F
(2) $2F$
(3) $3F$
(4) $F/3$

19 A 750-newton person stands in an elevator that is accelerating downward. The upward force of the elevator floor on the person must be

(1) equal to 0 N
(2) less than 750 N
(3) equal to 750 N
(4) greater than 750 N

20 A 15-kilogram cart is at rest on a horizontal surface. A 5-kilogram box is placed in the cart. Compared to the mass and inertia of the cart, the cart-box system has

(1) more mass and more inertia
(2) more mass and the same inertia
(3) the same mass and more inertia
(4) less mass and more inertia

21 A 160.-kilogram space vehicle is traveling along a straight line at a constant speed of 800. meters per second. The magnitude of the net force on the space vehicle is

(1) 0 N
(2) 1.60×10^2 N
(3) 8.00×10^2 N
(4) 1.28×10^5 N

22 A 1.5-kilogram cart initially moves at 2.0 meters per second. It is brought to rest by a constant net force in 0.30 second. What is the magnitude of the net force?

(1) 0.40 N
(2) 0.90 N
(3) 10. N
(4) 15 N

23 As a 5.0×10^2-newton basketball player jumps from the floor up toward the basket, the magnitude of the force of her feet on the floor is 1.0×10^3 newtons. As she jumps, the magnitude of the force of the floor on her feet is

(1) 5.0×10^2 N
(2) 1.0×10^3 N
(3) 1.5×10^3 N
(4) 5.0×10^5 N

24 A 4.0-kilogram object is accelerated at 3.0 meters per second^2 north by an unbalanced force. The same unbalanced force acting on a 2.0-kilogram object will accelerate this object toward the north at

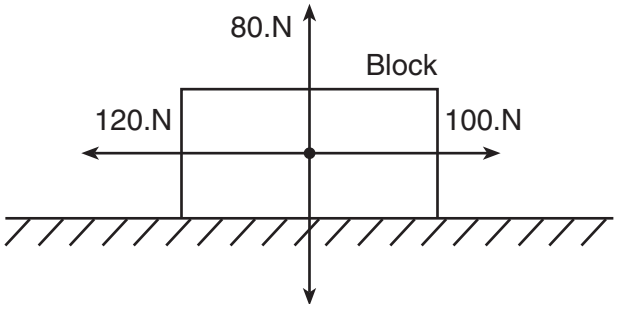
(1) 12 m/s^2
(2) 6.0 m/s^2
(3) 3.0 m/s^2
(4) 1.5 m/s^2

Part B–1

Answer all questions in this part.

Directions (25–30): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/ Physics.* Record your answers on your separate answer sheet.

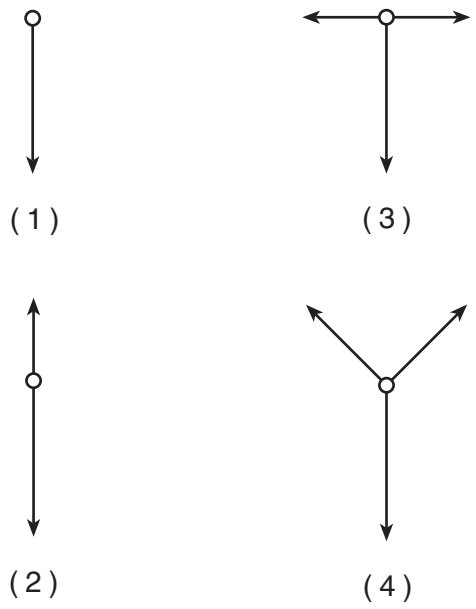
25 Four forces act concurrently on a block on a horizontal surface as shown in the diagram below.



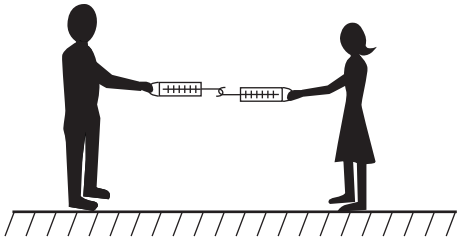
As a result of these forces, the block

(1) moves at constant speed to the right
(2) moves at constant speed to the left
(3) accelerates to the right
(4) accelerates to the left

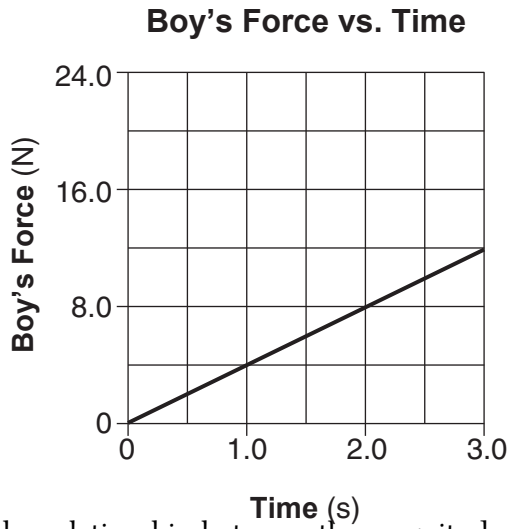
26 An object is in equilibrium. Which force vector diagram could represent the force(s) acting on the object?



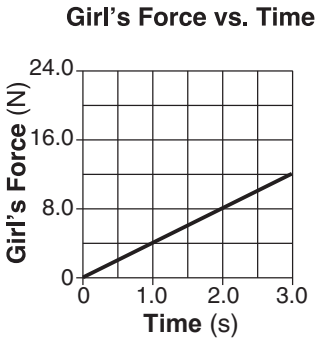
27 A 100.0-kilogram boy and a 50.0-kilogram girl, each holding a spring scale, pull against each other as shown in the diagram below.



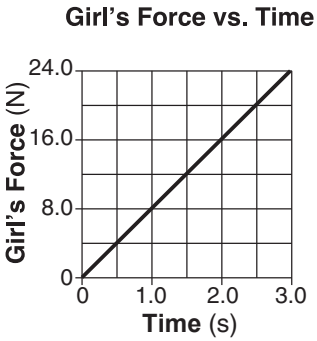
The graph below shows the relationship between the magnitude of the force that the boy applies on his spring scale and time.



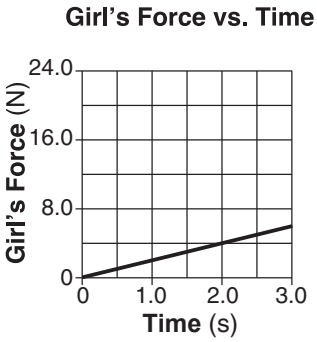
Which graph best represents the relationship between the magnitude of the force that the girl applies on her spring scale and time?



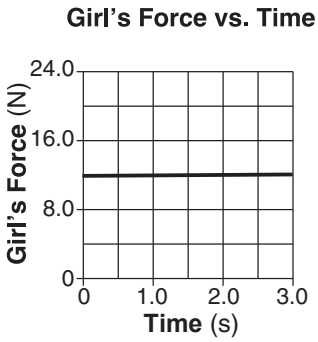
(1)



(2)

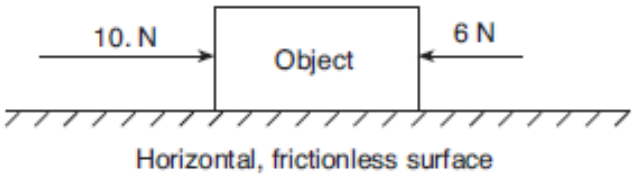


(3)



(4)

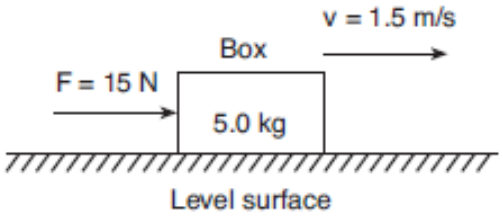
28 Two forces act concurrently on an object on a horizontal, frictionless surface, as shown in the diagram below.



What additional force, when applied to the object, will establish equilibrium?

(1) 16 N toward the right
(2) 16 N toward the left
(3) 4 N toward the right
(4) 4 N toward the left

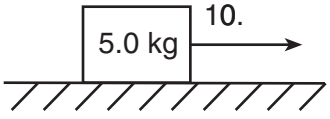
29 As shown in the diagram below, an open box and its contents have a combined mass of 5.0 kilograms. A horizontal force of 15 newtons is required to push the box at a constant speed of 1.5 meters per second across a level surface.



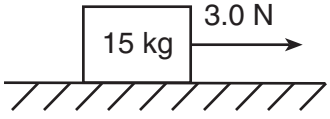
The inertia of the box and its contents increases if there is an increase in the

(1) speed of the box
(2) mass of the contents of the box
(3) magnitude of the horizontal force applied to the box
(4) coefficient of kinetic friction between the box and the level surface

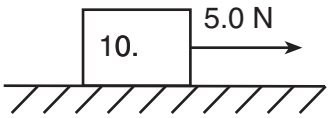
30 A different force is applied to each of four different blocks on a frictionless, horizontal surface. In which diagram does the block have the greatest inertia 2.0 seconds after starting from rest?



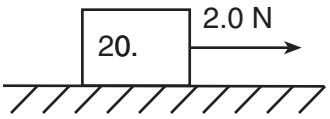
(1)



(3)



(2)



(4)

Part B–2

Answer all questions in this part.

Directions (31-37): Record your answers in the spaces provided in your answer booklet.

31-32 A 0.50-kilogram frog is at rest on the bank surrounding a pond of water. As the frog leaps from the bank, the magnitude of the acceleration of the frog is 3.0 meters per second^2. Calculate the magnitude of the net force exerted on the frog as it leaps. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 18 through 20 on the information below.

A student and the waxed skis he is wearing have a combined weight of 850 newtons. The skier travels down a snow-covered hill and then glides to the east across a snow-covered, horizontal surface.

33 Determine the magnitude of the normal force exerted by the snow on the skis as the skier glides across the horizontal surface. [1]

34-35 Calculate the magnitude of the force of friction acting on the skis as the skier glides across the snow-covered, horizontal surface. [Show all work, including the equation and substitution with units.] [2]

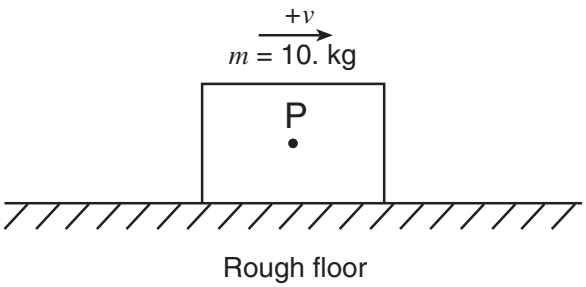
36-37 Calculate the time required for a 6000.-newton net force to stop a 1200.-kilogram car initially traveling at 10. meters per second. [Show all work, including the equation and substitution with units.] [2]

Part C

Answer all questions in this part.

Base your answers to questions 38 through 28 on the information and diagram below.

A 10.-kilogram box, sliding to the right across a rough horizontal floor, accelerates at –2.0 meters per second^2 due to the force of friction.



38-39 Calculate the magnitude of the net force acting on the box. [Show all work, including the equation and substitution with units.] [2]

40-41 On the diagram *in your answer booklet,* draw a vector representing the net force acting on the box. Begin the vector at point *P* and use a scale of 1.0 centimeter = 5.0 newtons. [2]

42-43 Calculate the coefficient of kinetic friction between the box and the floor. [Show all work, including the equation and substitution with units.] [2]

44-45 A 10.-kilogram rubber block is pulled horizontally at constant velocity across a sheet of ice. Calculate the magnitude of the force of friction acting on the block. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 46 through 50 on the information below and on your knowledge of physics.

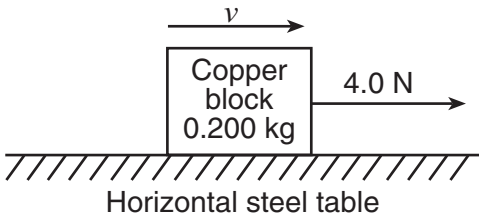
A horizontal 20.-newton force is applied to a 5.0-kilogram box to push it across a rough, horizontal floor at a constant velocity of 3.0 meters per second to the right.

46 Determine the magnitude of the force of friction acting on the box. [1]

47–48 Calculate the weight of the box. [Show all work, including the equation and substitution with units.] [2]

49–50 Calculate the coefficient of kinetic friction between the box and the floor. [Show all work, including the equation and substitution with units] [2]

The diagram below represents a 4.0-newton force applied to a 0.200-kilogram copper block sliding to the right on a horizontal steel table.



51 Determine the weight of the block. [1]

52–53 Calculate the magnitude of the force of friction acting on the moving block. [Show all work, including the equation and substitution with units.] [2]

54 Determine the magnitude of the net force acting on the moving block. [1]

55 Describe what happens to the magnitude of the velocity of the block as the block slides across the table. [1]

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

ANSWER SHEET

Student . . . . . Sex: ☐ Male ☐ Female Grade . . . . . .

Teacher . . . . . School . . . . . .

Record your answers to Part A and Part B–1 on this answer sheet.

Part A

1 . . . . . 13 . . . . . .

2 . . . . . 14 . . . . . .

3 . . . . . 15 . . . . . .

4 . . . . . 16 . . . . . .

5 . . . . . 17 . . . . . .

6 . . . . . 18 . . . . . .

7 . . . . . 19 . . . . . .

8 . . . . . 20 . . . . . .

9 . . . . . 21 . . . . . .

10 . . . . . 22 . . . . . .

11 . . . . . 23 . . . . . .

12 . . . . . 24 . . . . . .

Part A Score

Part B-1

25 . . . . . .

26 . . . . . .

27 . . . . . .

28 . . . . . .

29 . . . . . .

30 . . . . . .

Part B-1 Score

Write your answers to Part B–2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

ANSWER BOOKLET

Student . . . . . Sex: ☐ Male ☐ Female

Teacher . . . . . .

School . . . . . Grade . . . . .

Answer all questions in Part B–2 and Part C. Record your answers in this booklet.

Part	Maximum Score	Student's Score
A	24	
B–1	7	
B–2	5	
C	19	

Total Written Test Score (Maximum Raw Score: 85)

Final Score (From Conversion Chart)

Raters' Initials:

Rater 1 . . . . . **Rater 2** . . . . .

Part B–2

For Raters Only

31-32

31

32

33 _____ **N**

33

34-35

34

35

Part B–2

36-37

For Raters Only

36 ☐

37 ☐

Part C

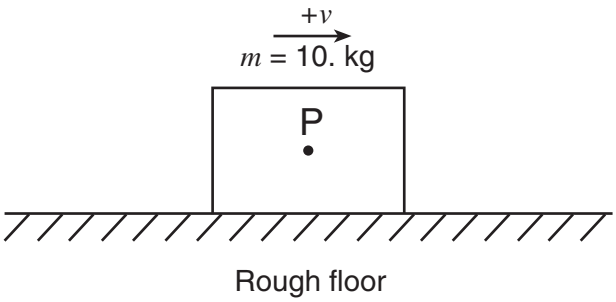
For Raters Only

38-39

38 ☐

39 ☐

40-41



40 ☐

41 ☐

42-43

42 ☐

43 ☐

44-45

44 ☐

45 ☐

Part C

For Raters Only

46 _____ N

47–48

49–50

51 _____ N

52–53

54 _____ N

46

47

48

49

50

51

52

53

54