Skill 20: Newton's Laws
Inertia, momentum, impulse etc

18. 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

cart 15kg cart+box 20kg

A) more mass and more inertia
B) more mass and the same inertia
C) the same mass and more inertia
D) less mass and more inertia

19. Which object has the greatest inertia?

mass

A) a 0.010-kg bullet traveling at 90. m/s
B) a 30.-kg child traveling at 10. m/s on her bike
C) a 490-kg elephant walking with a speed of 1.0 m/s
D) a 1500-kg car at rest in a parking lot

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

no acceleration
no change in speed

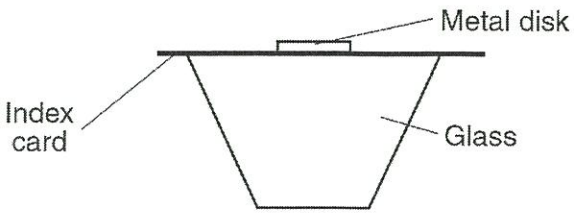
A) an apple in free fall
B) a satellite orbiting Earth
C) a hockey puck moving at constant velocity across ice
D) a laboratory cart moving down a frictionless 30.° incline

21. Cart *A* has a mass of 2 kilograms and a speed of 3 meters per second. Cart *B* has a mass of 3 kilograms and a speed of 2 meters per second. Compared to the inertia and magnitude of momentum of cart *A*, cart *B* has

	A	B
m	2kg	3kg (inertia)
v	3m/s	2m/s
p	6kgm/s	6kgm/s

A) the same inertia and a smaller magnitude of momentum
B) the same inertia and the same magnitude of momentum
C) greater inertia and a smaller magnitude of momentum
D) greater inertia and the same magnitude of momentum

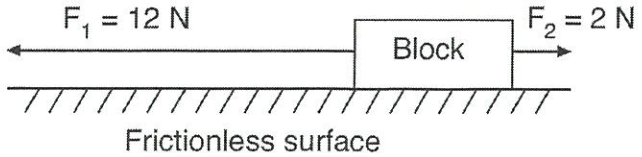
22. Base your answer to the following question on the diagram below, which shows a 1.0-newton metal disk resting on an index card that is balanced on top of a glass.



When the index card is quickly pulled away from the glass in a horizontal direction, the disk falls straight down into the glass. This action is a result of the disk's

A) inertia B) charge C) shape D) temperature

23. Two forces, F_1 and F_2, are applied to a block on a frictionless, horizontal surface as shown below.



$F_{net} = -12N + 2N = -10N$

$a = 2 m/s^2$

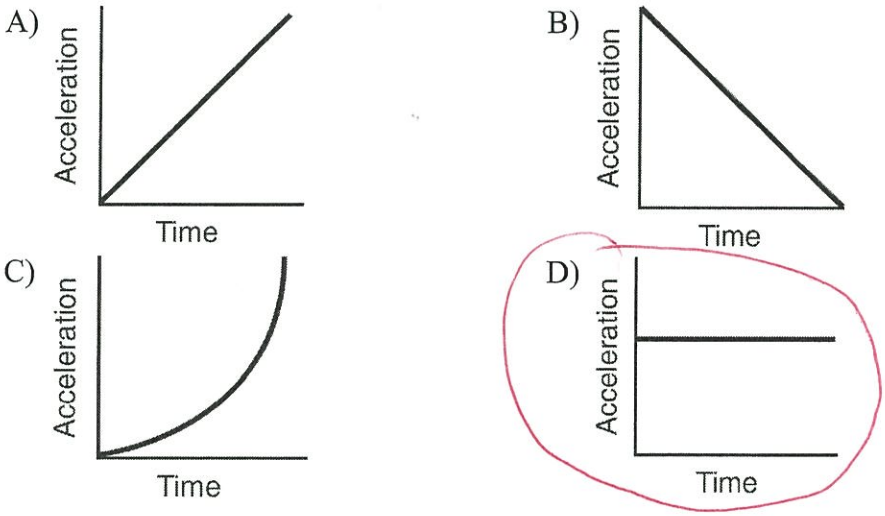
$m = \frac{F_{net}}{a} = \frac{-10N}{-2 m/s^2} = 5kg$

If the magnitude of the block's acceleration is 2.0 meters per second^2, what is the mass of the block?

A) 1 kg B) 5 kg C) 6 kg D) 7 kg

24. A constant unbalanced force is applied to an object for a period of time. Which graph best represents the acceleration of the object as a function of elapsed time?

F_{net}



F_{net} constant
a constant

25. A net force of 25 Newtons is applied horizontally to a 10.-kilogram block resting on a table. What is the magnitude of the acceleration of the block?

A) 0.0 m/s^2 B) 0.26 m/s^2 C) 0.40 m/s^2 D) 2.5 m/s^2

$F_{net} = 25N$
$m = 10kg$
$a = ?$

$a = \frac{F_{net}}{m}$

$a = \frac{25N}{10kg} = 2.5 m/s^2$

26. Which mass would have the greatest acceleration if the same unbalanced force was applied to each?

A) 1 kg B) 2 kg C) 3 kg D) 4 kg

$a = \frac{F_{net}}{m}$ Small m big a

27. An unbalanced force is applied to a mass, producing an acceleration. If the same unbalanced force is applied to a mass one-half as large, the resulting acceleration will be

A) the same B) twice as great
C) one-half as great D) four times as great

a (y)	m (x)
×2	÷2

$a = \frac{F_{net}}{m}$

28. A cart is uniformly accelerating from rest. The net force acting on the cart is

constant

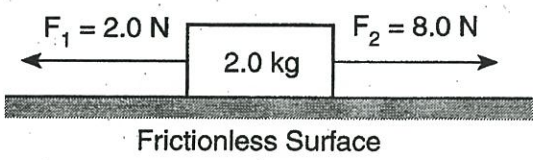
A) decreasing B) zero C) constant D) increasing

29. What force is needed to give an electron an acceleration of 1.00×10^{10} m/s^2?

A) 9.11×10^{-41} N B) 9.11×10^{-31} N
C) 9.11×10^{-21} N D) 1.10×10^{43} N

F_{net}=?
$a = 1 \times 10^{10}$ m/s^2
m = from reference table
$= 9.11 \times 10^{-31}$ kg
$F_{net} = ma = (9.11 \times 10^{-31}\text{ kg})(1 \times 10^{10}\text{ m/s}^2)$

30. Two forces are applied to a 2.0-kilogram block on a frictionless horizontal surface, as shown in the diagram below.



$F_{net} = 8N + -2N = 6N$
$m = 2$ kg
$a = \frac{F_{net}}{m} = \frac{6N}{2kg} = 3$ m/s^2

The acceleration of the block is

A) 5.0 m/s^2 to the right B) 5.0 m/s^2 to the left
C) 3.0 m/s^2 to the right D) 3.0 m/s^2 to the left

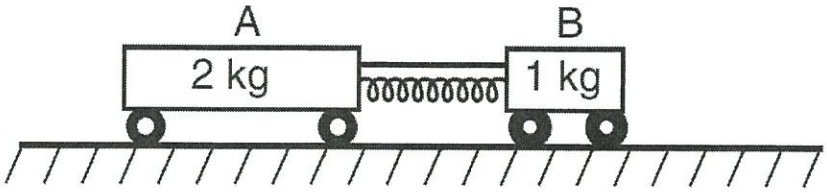
31. An object with a mass of 0.5 kilogram starts from rest and achieves a maximum speed of 20 meters per second in 0.01 second. What average unbalanced force accelerates this object?

A) 1,000 N B) 10 N C) 0.1 N D) 0.001 N

$m = .5$kg, $v_i = 0$, $v_f = 20$ m/s, $t = .01$ s $\Rightarrow a = \frac{\Delta v}{t} = 2000$ m/s^2

$F_{net} = ma$

32. The diagram below shows a compressed spring between two carts initially at rest on a horizontal, frictionless surface. Cart *A* has a mass of 2 kilograms and cart *B* has a mass of 1 kilogram. A string holds the carts together



Newton's 3rd Law

The string is cut and the carts move apart. Compared to the magnitude of the force the spring exerts on cart *A*, the magnitude of the force the spring exerts on cart *B* is

A) the same B) half as great
C) twice as great D) four times as great

Skill 20: Newton's Laws

33. A student pulls a 60.-newton sled with a force having a magnitude of 20. newtons. What is the magnitude of the force that the sled exerts on the student?

A) 20. N B) 40. N C) 60. N D) 80. N

34. A carpenter hits a nail with a hammer. Compared to the magnitude of the force the hammer exerts on the nail, the magnitude of the force the nail exerts on the hammer during contact is

A) less B) greater C) the same

35. Earth's mass is approximately 81 times the mass of the Moon. If Earth exerts a gravitational force of magnitude F on the Moon, the magnitude of the gravitational force of the Moon on Earth is

A) F B) $\frac{F}{81}$ C) $9F$ D) $81F$

36. What is the speed of a 1.5×10^3-kilogram car that has a momentum of 3.0×10^5 kilogram • meters per second east?

A) 5.0×10^{-3} m/s B) 2.0×10^2 m/s
C) 4.5×10^{8} m/s D) 2.0×10^7 m/s

37. A 5.00-kilogram block slides along a horizontal, frictionless surface at 10.0 meters per second for 4.00 seconds. The magnitude of the block's momentum is

A) 200. kg•m/s B) 50.0 kg•m/s C) 20.0 kg•m/s D) 12.5 kg•m/s

38. What is the momentum of a 1,200-kilogram car traveling at 15 meters per second due east?

A) 1.8×10^4 kg•m/s due east B) 1.8×10^4 kg•m/s due west
C) 80. kg•m/s due east D) 80. kg•m/s due west

39. Which is a unit of momentum?

A) N-m/s^2 B) kg-m/s^2 C) N-m/s D) kg-m/s

40. Which of the following objects has the greatest momentum?

A) a 1-kg object moving at 200 m/sec B) a 10-kg object moving at 30 m/sec
C) a 20-kg object moving at 20 m/sec D) a 100-kg object moving at 2 m/sec

41. If the direction of the momentum of an object is west, the direction of the velocity of the object is

A) north B) south C) east D) west

$p = m v$ (p: scalar, v: vector)

42. The product of an object's mass and velocity is equal to

A) force B) weight
C) kinetic energy D) momentum

$m v = p$

43. What is the momentum of a 30-kilogram cart moving with a speed of 10 meters per second?

$p = ?$ m v

A) 20 kg-m/sec B) 40 kg-m/sec C) 3 kg-m/sec D) 300 kg-m/sec

44. A force of 6.0 newtons changes the momentum of a moving object by 1.5 kilogram•meters per second. How long did the force act on the mass?

$F = 6N$
$\Delta p = 1.5 kg\,m/s$

A) 1.0 s B) 4.0 s C) 0.25 s D) 0.50 s

$F_{net} = \frac{\Delta p}{t}$
$t = \frac{\Delta p}{F_{net}}$

Which quantity is vector?

45. Which quantity has both a magnitude and a direction?

A) inertia B) impulse C) speed D) time

46. Which situation will produce the greatest change of momentum for a 1.0-kilogram cart?

$\Delta p = J = F_{net} t$

A) accelerating it from rest to 3.0 m/s $m\Delta v = 3 kg\,m/s$
B) accelerating it from 2.0 m/s to 4.0 m/s $(1kg)(\Delta 2 m/s) = 2 kg\,m/s$
C) applying a net force of 5.0 N for 2.0 s $F \cdot t = J = \Delta p = 10 Ns$
D) applying a net force of 10.0 N for 0.5 s $F \cdot t = J = 5 Ns$

47. In an automobile collision, a 44-kilogram passenger moving at 15 meters per second is brought to rest by an air bag during a 0.10-second time interval. What is the magnitude of the average force exerted on the passenger during this time?

$m = 44 kg$
$v_i = 15 m/s$ $\Delta v = -15 m/s$
$v_f = 0$
$t = .15$
$F = ?$

A) 440 N B) 660 N C) 4400 N D) 6600 N

$F \cdot t = m \Delta v$ $F = \frac{m \Delta v}{t} = \frac{(44kg)(15 m/s)}{.15}$

48. A 0.025-kilogram bullet is fired from a rifle by an unbalanced force of 200 Newtons. If the force acts on the bullet for 0.1 second, what is the maximum speed attained by the bullet?

$m = .025 kg$
$F = 200N$
$t = .1s$
$\Delta v = ?$

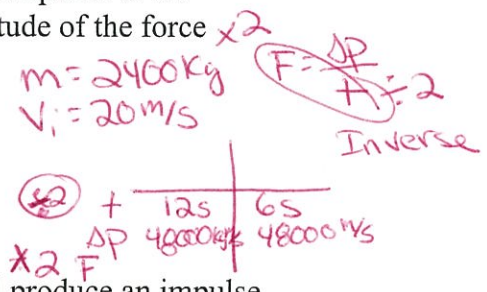
A) 5 m/s B) 20 m/s C) 400 m/s D) 800 m/s

$F \cdot t = m \Delta v$
$\Delta v = \frac{F t}{m} = \frac{(200N)(.1s)}{.025 kg} = 800 m/s$

Skill 20: Newton's Laws

49. A 2,400-kilogram car is traveling at a speed of 20. meters per second. Compared to the magnitude of the force required to stop the car in 12 seconds, the magnitude of the force required to stop the car in 6.0 seconds is

A) half as great
B) twice as great
C) the same
D) four times as great



50. A net force of 12 Newtons acting north on an object for 4.0 seconds will produce an impulse of

A) 48 kg-m/sec north
B) 48 kg-m/sec south
C) 3.0 kg-m/sec north
D) 3.0 kg-m/sec south

J = F·t