all answers on the scan-tron sheets in the appropriate numbers. ANY 4 groups and do all 10 questions in each group. ($1\frac{1}{2}$ pts each)

Group I MOTION

1. A car travels 20 meters east in 1.0 sec. The displacement of the car at the end of this 1 sec interval is 1) 20 m 2) 20 m/s 3) 20 m east 4) 20 m/s east

2. An astronaut on the moon is holding a baseball and a balloon. The astronaut releases both objects at the same time. What does the astronaut observe? (NOTE: The moon has no atmosphere.) 1) The baseball falls slower than the balloon 2) The baseball falls faster than the balloon 3) The baseball and balloon fall at the same rate. 4) The baseball and balloon remain suspended and do not fall.

3. The approximate mass of a nickel is 1) 0.0005 kg 2) 0.005 kg 3) 0.5 kg 4) 5 kg

4. A rock falls freely from rest near the surface of a planet where the acceleration due to gravity is 4 m/s^2. What is the speed of this rock after it falls 32 meters? 1) 8 m/s 2) 16 m/s 3) 25 m/s 4) 32 m/s

$V_f^2 = V_i^2 + 2ad$

$V_f = \sqrt{(2)(4\frac{m}{s^2})(32}$

$= 16$

Base your answers to questions 5 and 6 on the information below.

A car is traveling at a constant speed of 14 m/s along a straight highway. A tree and a speed limit sign are beside the highway. As it passes the tree, the car starts to accelerate. The car is accelerated uniformly at 2 m/s^2 until it reaches the speed limit sign, 5 sec later.

$V_i = 14\ m/s$

$a = 2\ m/s^2$

$t = 5s$

5. When the car reaches the sign, the car's speed is 1) less than the speed limit 2) greater than the speed limit 3) equal to the speed limit

$V_f = V_i + at$

$V_f = 24\ m/s$

6. What is the distance between the tree and the sign? 1) 10 m 2) 25 m 3) 70 m 4) 95 m

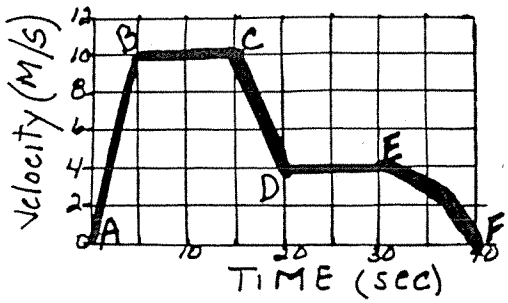
$d = \frac{1}{2}(V_f + V_i)t$

$d = 95m$

or $d = V_i t + \frac{1}{2}at^2$

$= 95m$

Base your answers on questions 7 through 10 on the diagram at right.



7. No unbalanced force is acting on the car during time interval 1) AB 2) BC 3) CD 4) EF

$a = 0$

8. The acceleration of the car during time interval AB is 1) 0 m/s^2 2) 1.0 m/s^2 3) 2.0 m/s^2 4) 2.5 m/s^2

$a = \frac{V_f - V_i}{t} = \frac{10-0}{5} = 2\ m/s^2$

9. During time interval CD, the average velocity of the car is 1) 0 m/s 2) 1.2 m/s 3) 5 m/s 4) 7 m/s

$\bar{V} = \frac{V_f + V_i}{2} = \frac{4+10}{2} = 7\ \frac{m}{s}$

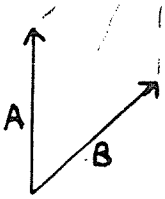
10. The average acceleration during the given time period 0 to 40 sec is 1) 0 m/s^2 2) 0.5 m/s^2 3) 1.0 m/s^2 4) 1.2 m/s^2

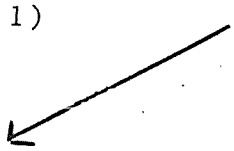
$\bar{a} = \frac{\Delta V}{t}$

Group II Scalar and Vector Quantities

1. A person travels 6 meters north, 4 meters east, and 6 meters south. What is the total displacement? 1) 16 m east 2) 6 m north 3) 6 m south 4) 4 m east

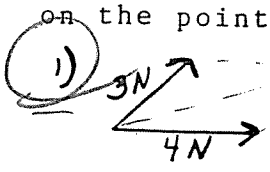
2. Which vector below represents the resultant of the concurrent vectors A and B in the diagram at the right?

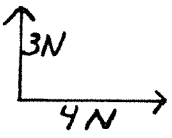


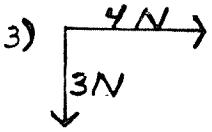
1) 
2) 
3) 
4) 

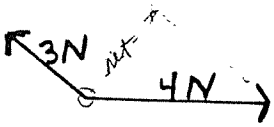
3. Which terms represent scalar quantities? 1) power and force 2) work and displacement 3) time and energy 4) distance and velocity

4. A 3 N force and a 4 N force act concurrently on a point. In which diagram below would the orientation of these forces produce the greatest net force on the point?

1) 

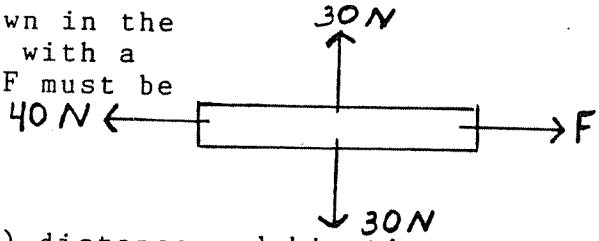
2) 

3) 

4) 

5. A 5 N force directed north and a 5 N force directed west both act on the same point. The resultant of these two forces is approximately 1) 5 N northwest 2) 7 N northwest 3) 5 N southwest 4) 7 N southwest

6. Four forces are acting on an object as shown in the diagram at right. If the object is moving with a constant velocity, the magnitude of force F must be 1) 0 N 2) 20 N 3) 100 N 4) 40 N

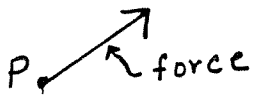


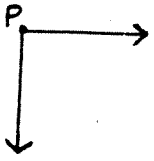
v = const
$\Sigma F_{horiz} = 0$

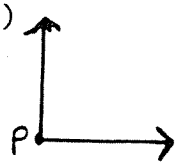
7. Which terms represent vector quantities? 1) distance and kinetic energy 2) displacement and work 3) speed and impulse 4) velocity and momentum

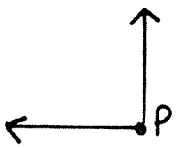
8. A boat heads directly eastward across a river at 12 m/s. If the current in the river is flowing at 5 m/s due south, what is the magnitude of the boat's resultant velocity? 1) 7 m/s 2) 8.5 m/s 3) 13 m/s 4) 17 m/s

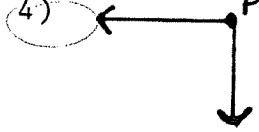
9. The diagram at the right represents a force acting at point P. Which pair of concurrent forces would produce equilibrium when added to the force acting at point P?



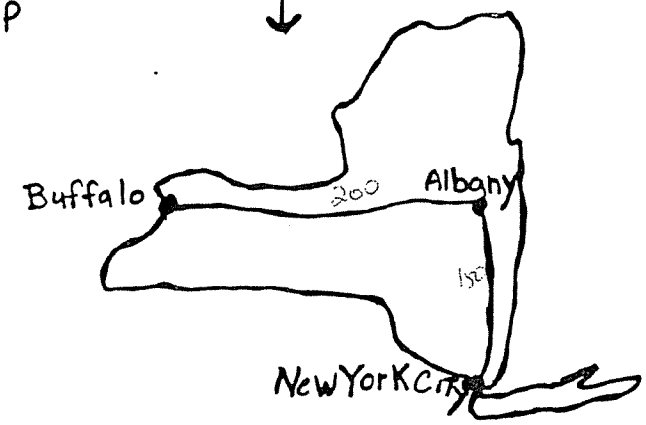
1) 

2) 

3) 

4) 

10. A car is driven from Buffalo to Albany and on to New York City, as shown in the diagram at right. Compared to the magnitude of the car's total displacement, the distance driven is 1) shorter 2) longer 3) the same

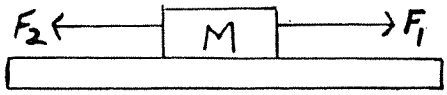


Group III Newton's Three Laws

1. A net force of 5×10^2 N causes an object to accelerate at a rate of $5\ m/s^2$. What is the mass of the object? 1) 1×10^2 kg 2) 2×10^{-1} kg 3) 6×10^2 kg 4) 2.5×10^3 kg

2. Which statement explains why a book resting on a table is in equilibrium? 1) There is a net force acting downward on the book 2) The weight of the book equals the weight of the table. 3) The acceleration due to gravity is $9.8\ m/s^2$ for both the book and the table 4) The weight of the book and the table's upward force on the book are equal in magnitude, but opposite in direction.

3. In the diagram below, box M is on a frictionless table with forces F_1 and F_2 acting as shown.



If the magnitude of F_1 is greater than the magnitude of F_2, than the box is 1) moving with a constant speed in the direction of F_1 2) moving with a constant speed in the direction of F_2 3) accelerating in the direction of F_1 4) accelerating in the direction of F_2

4. An object weighing 20 N at the earth's surface is moved to a location where its weight is 10 N. The acceleration due to gravity at this location would be 1) $2.4\ m/s^2$ 2) $4.9\ m/s^2$ 3) $9.8\ m/s^2$ 4) $19.6\ m/s^2$

5. What force is necessary to give a 2 Kg mass initially at rest an acceleration of $5\ m/s^2$? 1) 0.4 N 2) 2.5 N 3) 10 N 4) 20 N

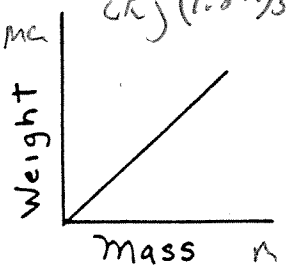
6. Two unequal masses falling freely from the same point above the earth's surface would experience the same 1) acceleration 2) decrease in potential energy 3) increase in kinetic energy 4) increase in momentum

7. A 1.2×10^3 Kg automobile in motion strikes a 1×10^{-4} Kg insect. As a result, the insect is accelerated at a rate of $1 \times 10^2\ m/s^2$. What is the magnitude of the force the insect exerts on the car? 1) 1×10^{-2} N 2) 1.2×10^2 N 3) 1×10^1 N 4) 1.2×10^3 N

8. If the mass of an object were doubled, its weight would be 1) halved 2) doubled 3) quadrupled 4) unchanged

9. A 2 Kg mass is at rest on a horizontal surface. The force exerted by the horizontal surface on the mass is approximately 1) 0 N 2) 2 N 3) 9.8 N 4) 19.6 N

10. The graph at the right shows the relationship between weight and mass for a series of objects. The slope of this graph represents 1) change of position 2) normal force 3) momentum 4) acceleration due to gravity



1. The magnitude of the gravitational force between two objects is 20 N. If the mass of each object were doubled, the magnitude of the gravitational force between the objects would be 1) 5 N 2) 10 N 3) 20 N 4) 80 N

$F = \frac{G m_1 m_2}{d^2} = (2)(2) = 4\times$

2. The mass of a space shuttle is approximately 2 X 10^6 Kg. During lift-off, the net force on the shuttle is 1 X 10^7 N directed upward. What is the speed of the shuttle 10 seconds after lift-off? (Neglect air resistance and the mass change of the shuttle.) 1) 5 X 10^0 m/s 2) 5 X 10^1 m/s 3) 5 X 10^2 m/s 4) 5 X 10^3 m/s

$F = ma \quad a = 5 m/s^2 \quad V_f = V_i + at \quad Ft = m\Delta V$

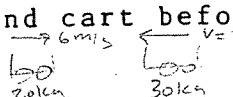
$(1\times10^7 N)(10s) = (2\times10^6 kg)\Delta V$

$\Delta V = 50 m/s$

3. A 2 Kg toy cannon is at rest on a frictionless surface. A remote triggering device causes a 0.005 Kg projectile to be fired from the cannon. Which equation describes this system after the cannon is fired? 1) mass of cannon + mass of projectile = 0 2) speed of cannon + speed of projectile = 0 3) momentum of cannon + momentum of projectile = 0 4) velocity of cannon + velocity of projectile = 0

$0 = m_c v_c + m_p v_p$

4. A 20 Kg cart traveling east with a speed of 6 m/s collides with a 30 Kg cart traveling west. If both carts come to rest after the collision, what was the speed of the westbound cart before collision? 1) 0 m/s 2) 9 m/s 3) 3 m/s 4) 4 m/s



$\Rightarrow$ stop $m_1 v_1 = m_2 v_2$

5. A force of 20 N is exerted on a cart for 10 seconds. How long must a 50 N force act to produce the same impulse? 1) 10 sec 2) 2 sec 3) 5 sec 4) 4 sec

$(20)(10) = (50)t \quad t = 4s$

6. Two rocks weighing 5 N and 10 N, respectively, fall freely from rest near the Earth's surface. After 3 seconds of free-fall, compared to the 5 N rock, the 10 N rock has greater 1) acceleration 2) height 3) momentum 4) speed

7. Two bodies of mass m_1 and m_2, 100 meters apart, attract each other with a gravitational force of 5 N. What will be the force of attraction if the distance between the two masses tripled? 1) 0.56 N 2) 1.10 N 3) 1.25 N 4) 2.50 N

$F = \frac{G m_1 m_2}{d^2} \propto \frac{1}{(3)^2} \times 5N$

8. A 50 Kg woman wearing a seat belt is traveling in a car that is moving with a velocity of 10 m/s. In an emergency, the car is brought to a stop in 0.50 second. What force does the seat belt exert on the woman so that she remains in her seat? 1) 1 X 10^3 N 2) 5 X 10^2 N 3) 5 X 10^1 N 4) 2.5 X 10^1 N

$Ft = m\Delta V$

$= \frac{(50kg)(10 m/s)}{.5} = 1\times10^3 N$

9. When a satellite is a distance d from the center of the Earth, the force due to gravity on the satellite is F. What would be the force due to gravity on the satellite when its distance from the center of the Earth is $\frac{1}{2}$d? 1) F 2) F/4 3) 2F 4) 4F

$F = \frac{G m_1 m_2}{d^2} \propto \frac{1}{(.5)^2} = 4$

10. A 2 N force acts on a mass. If the momentum of the mass changes by 120 Kg•m/s, the force acts for a time of 1) 8 sec 2) 30 sec 3) 60 sec 4) 120 sec

$Ft = m\Delta V$

$t = \frac{120 kg\,m/s}{2N} = 60s$

* momentum
impulse

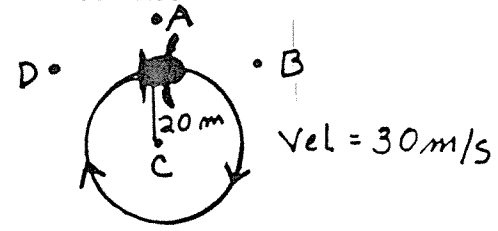
over

42. A motorcycle of mass 100 Kg travels around a flat circular track of radius 10 m. with a constant speed of 20 m/s. What force is required to keep the motorcycle moving in a circular path at this speed? 1) 200 N 2) 400 N 3) 2000 N 4) 4000 N $F = \frac{mv^2}{r} = \frac{(100kg)(20)^2}{10}$

If the distance of a satellite from the center of the earth were increased from 4 earth radii to 5 earth radii, the centripetal force on the satellite would 1) decrease 2) increase 3) remain the same

43. A motorcycle travels around a flat circular track. If the speed of the motorcycle is increased, the force required to keep it in the same circular path 1) decreases 2) increases 3) remains the same

Base your answers to questions 44 through 46 on the diagram at right which shows a 2 Kg model airplane attached to a wire. The airplane is flying clockwise in a horizontal circle of radius 20 meters at 30 m/s.



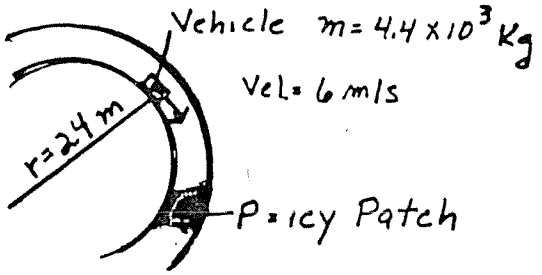
44. The centripetal force acting on the airplane at the position shown is directed toward point 1) A 2) B 3) C 4) D

45. What is the magnitude of the centripetal acceleration of the airplane 1) 0 m/s^2 2) 1.5 m/s^2 3) 45 m/s^2 4) 90 m/s^2 $a = \frac{v^2}{r}$

46. If the wire breaks when the airplane is at the position shown, the airplane will move toward point 1) A 2) B 3) C 4) D

Base your answers to questions 47 and 48 on the diagram at right.

A vehicle travels at a constant speed of m/s around a horizontal circular curve with a radius of 24 m. The mass of the vehicle is 4.4 X 10^3 Kg. An icy patch is located at P on the curve.



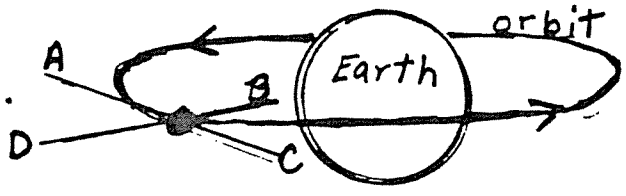
47. What is the magnitude of the force that keeps the vehicle on its circular path? 1) 1.1 X 10^3 N 2) 6.6 X 10^3 N 3) 4.3 X 10^4 N 4) 6.5 X 10^4 N $F = \frac{(4.4 \times 10^3)(6)}{24m}$

On the icy patch of pavement, the frictional force on the vehicle is zero.

Which arrow best represents the direction of the vehicle's velocity when it reaches icy patch P?

1) → 2) ← 3) ↑ 4) ↓

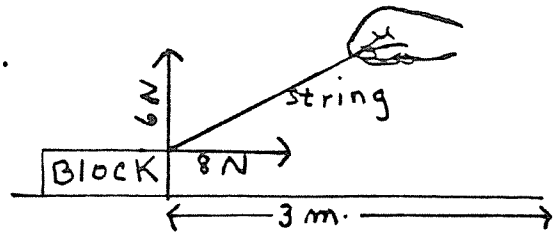
49. A satellite is moving at constant speed in a circular orbit about the Earth, as shown in the diagram at right. The net force acting on the satellite is directed toward point 1) A 2) B 3) C 4) D



50. What is the direction of the ball's acceleration at point X? 1) down 2) up 3) west 4) east

Key

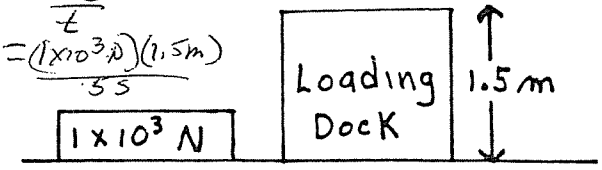
A student pulls a block 3 meters along a horizontal surface at constant velocity. The diagram at right shows the components of the force exerted on the block by the student. How much work is done against friction? 1) 18 J 2) 24 J 3) 30 J 4) 42 J



$W = F \cdot d = (8N)(3m) = 24J$

52. The diagram at right shows a 1×10^3 N crate to be lifted at constant speed from the ground to a loading dock 1.5 m high in 5 sec. What power is required to lift the crate? 1) 1.5×10^3 W 2) 2×10^2 W 3) 3×10^2 W 4) 7.5×10^3 W

$P = \frac{F \cdot d}{t} = \frac{(1 \times 10^3 N)(1.5m)}{5s}$



53. A force of 0.2 N is need to compress a spring a distance of 0.02 m. The potential energy stored in this compresses spring is 1) 8×10^{-5} J 2) 2×10^{-3} J 3) 2×10^{-5} J 4) 4×10^{-5} J

$F = kx$, $k = \frac{F}{x} = \frac{.2N}{.02} =$

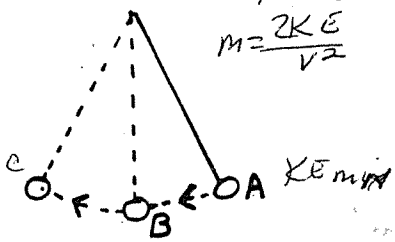
$PE_S = \frac{1}{2}kx^2 = (\frac{1}{2})(10)(.02)^2$

54. An object with a speed of 20 m/s has a kinetic energy of 400 joules. The mass of the object is 1) 1 Kg 2) 2 Kg 3) 0.5 Kg 4) 40 Kg

$KE = \frac{1}{2}mv^2$

$m = \frac{2KE}{v^2}$

55. In the diagram at right, an ideal pendulum released from Point A swings freely through Point B. Compared to the pendulum's kinetic energy at A, its potential energy at B is 1) half as great 2) twice as great 3) the same 4) four times as great



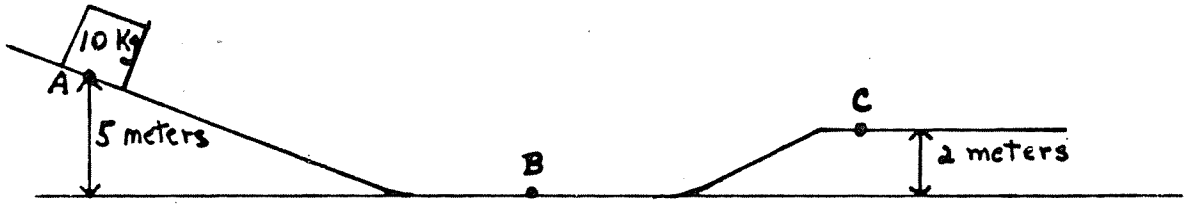
56. A net force of 5 N moves a 2 Kg object a distance of 3 meters in 3 sec. How much work is done on the object? 1) 1 J 2) 10 J 3) 15 J 4) 30 J

$W = F \cdot d$

57. As the time required to do a given quantity of work decreases, the power developed 1) decreases 2) increases 3) remains the same

$P = \frac{W}{t}$

Base your answers to questions 58 through 60 on the diagram below represents a frictionless track. A 10 Kg block starts from rest at point A and slides along the track.



58. As the block moves from point A to point B, the total amount of gravitational potential energy changed to kinetic energy is approximately 1) 5 J 2) 20 J 3) 50 J 4) 500 J

$PE = mgh =$

$PE_{B_{bottom}} = 0$

59. What is the approximate speed of the block at point B? 1) 1 m/s 2) 10 m/s 3) 50 m/s 4) 100 m/s

$500 = \frac{1}{2}mv^2$

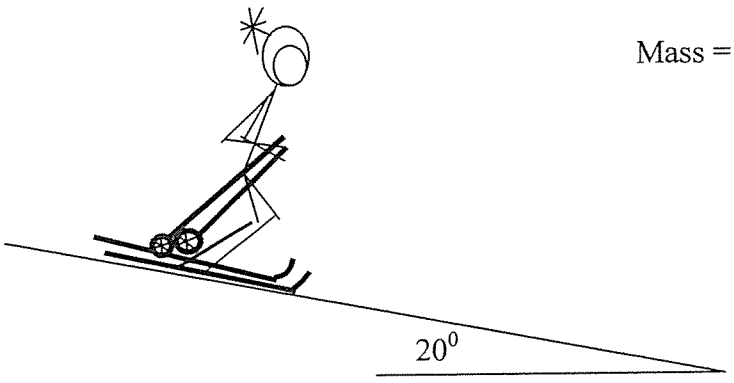
60. What is the approximate potential energy of the block at point C? 1) 20 J 2) 200 J 3) 300 J 4) 500 J

$PE = mgh$

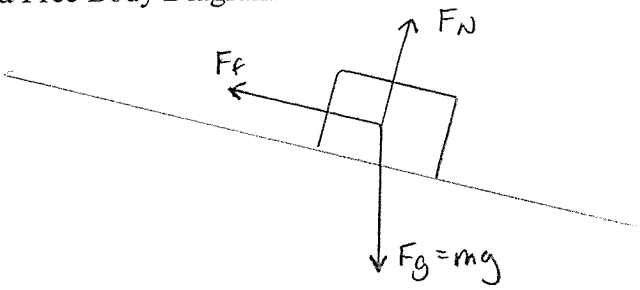
$500J = \overset{PE + KE}{200J} + \frac{1}{2}mv^2$

$300J = (\frac{1}{2})(10)v^2$

$\sqrt{60} = v = 7.7 \text{ m/s}$

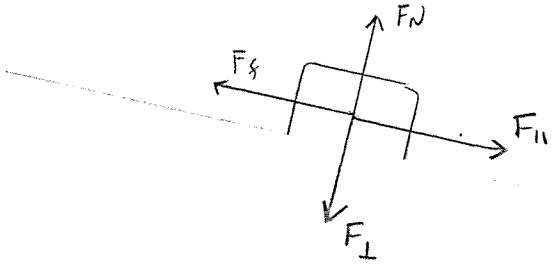


a) Draw a Free Body Diagram



$mg = (60kg)(10 m/s^2)$
$= 600N$

b) Draw a resolved free body diagram



$F_{||} = (\sin 20°)mg$
$F_{||} = (\sin 20°)600N$
$= 205N$

$F_\perp = (\cos 20°)mg$
$= (\cos 20°)600N$
$= 564N = F_N$

c) The coefficient of kinetic friction between the ski and the snow is 0.20. Calculate the acceleration of the skier.

$F_f = \mu F_N$
$= (.20)(564N) = 113N$

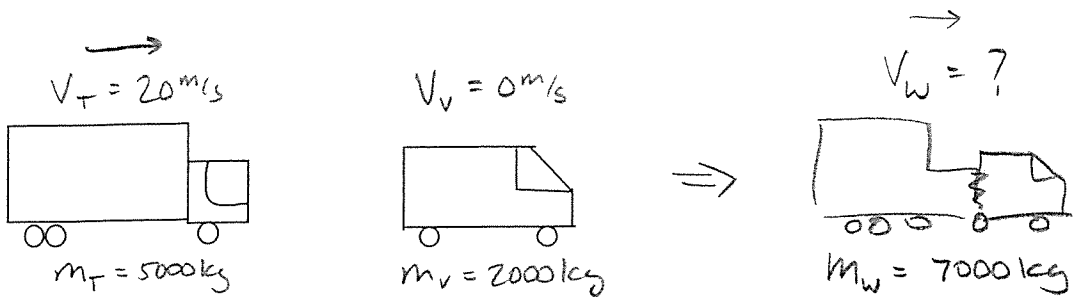
$\Sigma F_{\text{along hill}} = ma$
$F_{||} - F_f = ma$
$205N - 113N = (60kg)a$
$a = \frac{92}{60} = 1.53 m/s^2$

d) What is the speed of the skier at the bottom of the 100 meter hill? (Assume the incline is constant and the skier starts from rest.)

$V_f = ?$
$V_0 = 0 m/s$
$\Delta x = 100m$
$a = 1.53 m/s^2$

$V_f^2 = V_0^2 + 2a\Delta x$
$V_f^2 = 0^2 + (2)(1.53 m/s^2)(100m)$
$V_f = \sqrt{306}$
$V_f = 17.5 m/s$

A 5,000 kg truck traveling at 20.0 m/s strikes a 2,000 kg van initially at rest. The vehicles crumple together and slide together down the road.



a) Complete the before and after picture. Include and label all masses and velocities.

b) Calculate the initial momentum of the truck.

$$p_T = (mv)_T = (5000\,kg)(20^{m/s}) = 1\times10^5\ \frac{kg\,m}{s}$$

c) Calculate the speed of the wreck.

$$(mv)_T + (mv)_V = (m_T + m_V)V_W$$

$$1\times10^5\ \frac{kg\,m}{s} = (5000\,kg)V_W \qquad V_W = 14.3^{m/s}$$

d) Calculate the change of momentum of the truck.

$$\Delta p_T = p_f - p_i = (5000kg)(14.3^{m/s}) - (5000kg)(20^{m/s})$$
$$= -2.85\times10^4\ \frac{kg\,m}{s}$$

e) What is the change of momentum of the van?

$$\Delta p_T = -\Delta p_V = +2.85\times10^4\ \frac{kg\,m}{s}$$

f) Is this an elastic collision? EXPLAIN

No total KE before ≠ total KE after

g) What is the magnitude of the impulse on the truck?

$$J = Ft = m\Delta V = -2.85\times10^4\ \frac{kg\,m}{s}$$

Ignore sign

h) How does the impulse on the van compare to the impulse on the truck?

Same magnitude but opposite direction

i) The wreck slides along crashing into a bunch of safety barrels that bring it to a stop. EXPLAIN how the safety barrels reduce the amount of injuries as compared to stopping against a brick wall..

The barrels increase the time during which the wreck is coming to a stop. A longer time reduces the force to stop the motion. Lower force therefor less injuries.

27pts Total
1 pt Each

Ans. Key
Name /

Regents

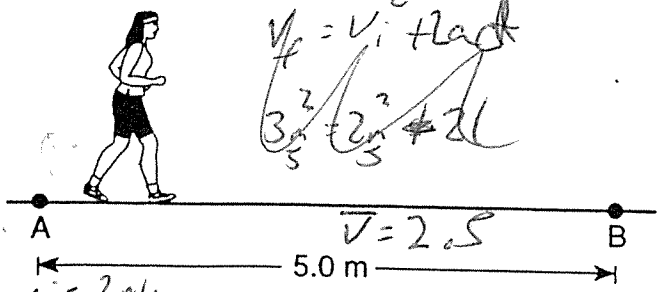
Part I

Answer all 55 questions in this part. [65]

Directions (1–55): For *each* statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer paper in accordance with the directions on the front page of this booklet.

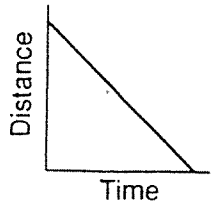
1 The thickness of a dollar bill is closest to
(1) 10^{-4} m
(2) 10^{-2} m
(3) 10^{-1} m
(4) 10^{1} m

2 A jogger accelerates at a constant rate as she travels 5.0 meters along a straight track from point *A* to point *B*, as shown in the diagram below.

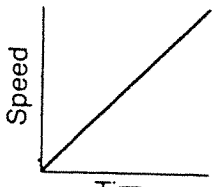


If her speed was 2.0 meters per second at point *A* and will be 3.0 meters per second at point *B*, how long will it take her to go from *A* to *B*?
(1) 1.0 s
(2) 2.0 s
(3) 3.3 s
(4) 4.2 s

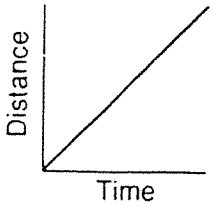
3 Which graph best represents the motion of an object falling from rest near the Earth's surface? [Neglect friction.]



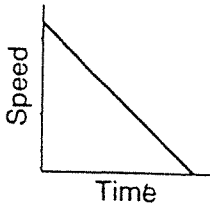
(1)



(3)



(2)

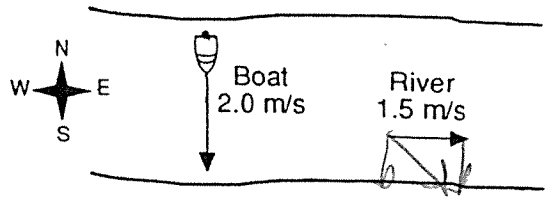


(4)

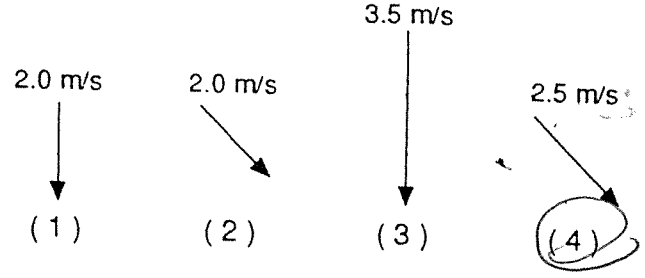
4 An object falls freely from rest near the surface of the Earth. What is the speed of the object when it has fallen 4.9 meters from its rest position?
(1) 4.9 m/s
(2) 9.8 m/s
(3) 24 m/s
(4) 96 m/s

5 Which term represents a vector quantity?
1 work
2 power
3 force
4 distance

6 A river flows due east at 1.5 meters per second. A motorboat leaves the north shore of the river and heads due south at 2.0 meters per second, as shown in the diagram below.



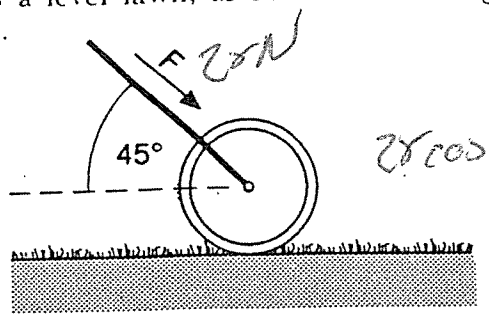
Which vector best represents the resultant velocity of the boat relative to the riverbank?



7 Which combination of concurrent forces could *not* produce equilibrium?
(1) 10. N, 20. N, and 50. N
(2) 20. N, 30. N, and 50. N
(3) 30. N, 40. N, and 50. N
(4) 40. N, 40. N, and 50. N

8 A 60.-kilogram astronaut weighs 96 newtons on the surface of the Moon. The acceleration due to gravity on the Moon is
(1) 0.0 m/s^2
(2) 1.6 m/s^2
(3) 4.9 m/s^2
(4) 9.8 m/s^2

9 The handle of a lawn roller is held at 45° from the horizontal. A force, F, of 28.0 newtons is applied to the handle as the roller is pushed across a level lawn, as shown in the diagram below.



What is the magnitude of the force moving the roller forward?

(1) 7.00 N
(2) 14.0 N
(3) 19.8 N
(4) 39.0 N

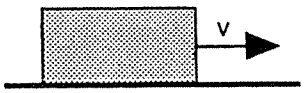
10 A 1.0×10^2-kilogram box rests on the bed of a truck that is accelerating at 2.0 meters per second^2. What is the magnitude of the force of friction on the box as it moves with the truck without slipping?

(1) 1.0×10^3 N
(2) 2.0×10^2 N
(3) 5.0×10^2 N
(4) 0.0 N

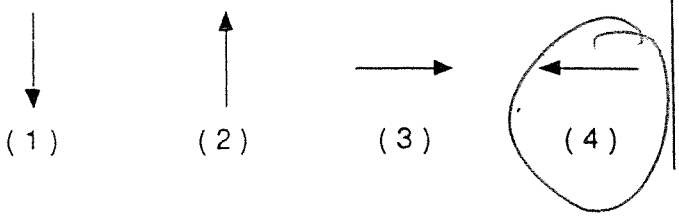
11 A student weighing 500. newtons stands on a spring scale in an elevator. If the scale reads 520. newtons, the elevator must be

1 accelerating upward
2 accelerating downward
3 moving upward at constant speed
4 moving downward at constant speed

12 A box decelerates as it moves to the right along a horizontal surface, as shown in the diagram at the right.



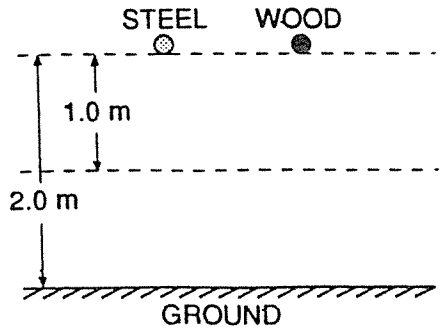
Which vector best represents the force of friction on the box?



13 If a net force of 10. newtons acts on a 6.0-kilogram mass for 8.0 seconds, the total change of momentum of the mass is

(1) 48 kg•m/s
(2) 60. kg•m/s
(3) 80. kg•m/s
(4) 480 kg•m/s

14 In the diagram below, a 0.4-kilogram steel sphere and a 0.1-kilogram wooden sphere are located 2.0 meters above the ground. Both spheres are allowed to fall from rest.



Which statement best describes the spheres after they have fallen 1.0 meter? [Neglect air resistance.]

1 Both spheres have the same speed and momentum.
2 Both spheres have the same speed and the steel sphere has more momentum than the wooden sphere.
3 The steel sphere has greater speed and has less momentum than the wooden sphere.
4 The steel sphere has greater speed than the wooden sphere and both spheres have the same momentum.

15 A constant force of 2.0 newtons is used to push a 3.0-kilogram mass 4.0 meters across the floor. How much work is done on the mass?

(1) 6.0 J
(2) 8.0 J
(3) 12 J
(4) 24 J

16 A 4.0×10^3-watt motor applies a force of 8.0×10^2 newtons to move a boat at constant speed. How far does the boat move in 16 seconds?

(1) 3.2 m
(2) 5.0 m
(3) 32 m
(4) 80. m

Part II

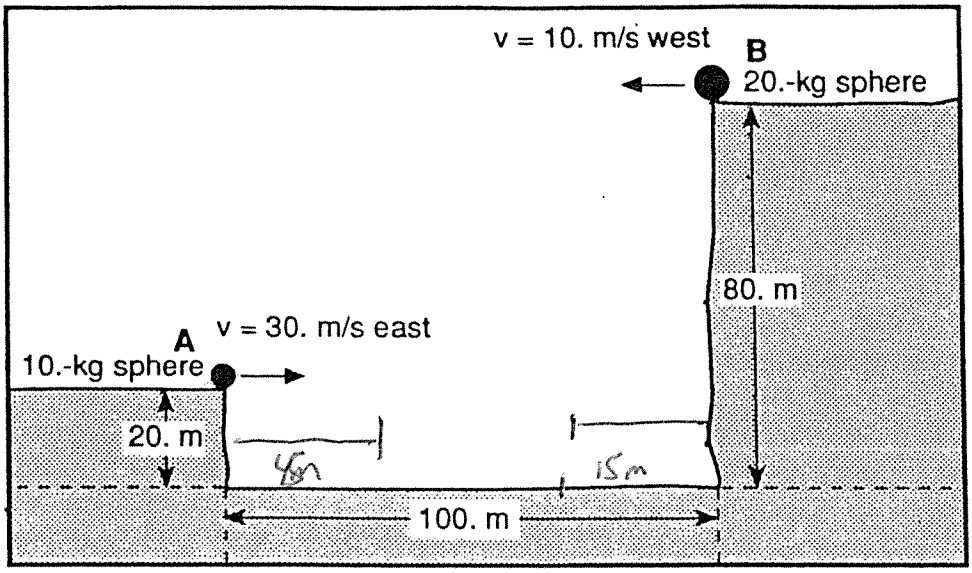
This part consists of six groups, each containing ten questions. Each group tests an optional area of the course. Choose two of these six groups. Be sure that you answer all ten questions in each group chosen. Record the answers to the questions in accordance with the directions on the front page of this booklet. [20]

Group 1 — Motion in a Plane

If you choose this group, be sure to answer questions 56–65.

Base your answers to questions 56 through 58 on the information and diagram below.

In the diagram below, a 10.-kilogram sphere, *A*, is projected horizontally with a velocity of 30. meters per second due east from a height of 20. meters above level ground. At the same instant, a 20.-kilogram sphere, *B*, is projected horizontally with a velocity of 10. meters per second due west from a height of 80. meters above level ground. [Neglect air friction.]



56 Initially, the spheres are separated by a horizontal distance of 100. meters. What is the horizontal separation of the spheres at the end of 1.5 seconds?

(1) 15 m
(2) 30. m
(3) 40. m
(4) 45 m

57 The magnitude of the horizontal acceleration of sphere *A* is

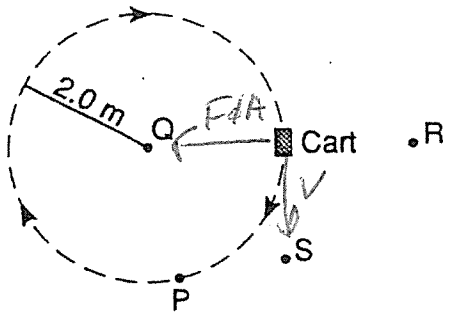
(1) 0.0 m/s^2
(2) 2.0 m/s^2
(3) 9.8 m/s^2
(4) 15 m/s^2

58 Compared to the vertical acceleration of sphere *A*, the vertical acceleration of sphere *B* is

1 the same
2 twice as great
3 one-half as great
4 four times as great

Base your answers to questions 59 through 62 on the information and diagram below.

The diagram shows a 5.0-kilogram cart traveling clockwise in a horizontal circle of radius 2.0 meters at a constant speed of 4.0 meters per second.



59 At the position shown, the velocity of the cart is directed toward point

(1) *P*
(2) *Q*
(3) *R*
(4) *S*

60 At the position shown, the centripetal acceleration of the cart is directed toward point

(1) *P*
(2) *Q*
(3) *R*
(4) *S*

61 If the mass of the cart was doubled, the magnitude of the centripetal acceleration of the cart would be

1 unchanged
2 doubled
3 halved
4 quadrupled

62 What is the magnitude of the centripetal force acting on the cart?

(1) 8.0 N
(2) 20. N
(3) 40. N
(4) 50. N

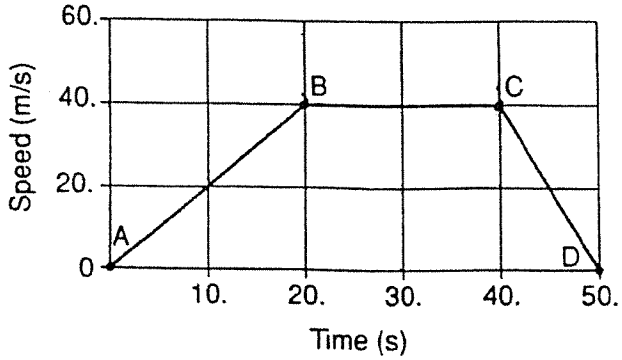
64 A cannon with a muzzle velocity of 500. meters per second fires a cannonball at an angle of 30.° above the horizontal. What is the vertical component of the cannonball's velocity as it leaves the cannon?

(1) 0.0 m/s
(2) 250. m/s
(3) 433 m/s
(4) 500. m/s

Part III

You must answer *all* questions in this part. Record your answers in the spaces provided on the separate answer paper. Pen or pencil may be used. [15]

Base your answers to questions 116 through 118 on the speed–time graph below, which represents the linear motion of a cart.



116 Determine the magnitude of the acceleration of the cart during interval *AB*. [Show all calculations, including the equation and substitution with units.] [2]

117 Calculate the distance traveled by the cart during interval *BC*. [Show all calculations, including the equation and substitution with units.] [2]

118 What is the average speed of the cart during interval *CD*? [1]

Name: Key August 2002 Midterm Review

Date: _____

Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, write on the separate anwser sheet, the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1 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?

(1) 0.0 m/s^2
(2) 0.26 m/s^2
(3) 0.40 m/s^2
(4) 2.5 m/s^2

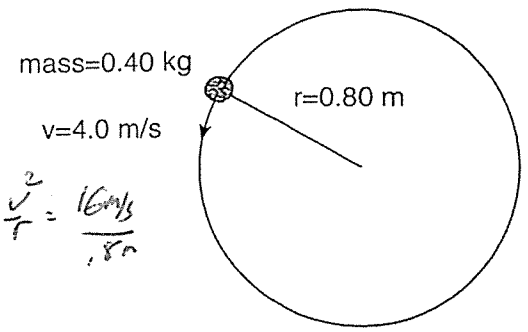
2 The speed of a car is increased uniformly from 20. meters per second to 30. meters per second in 4.0 seconds. The magnitude of the car's average acceleration in this 4.0-second interval is

(1) 0.40 m/s^2
(2) 2.5 m/s^2
(3) 10 m/s^2
(4) 13 m/s^2

3 A roller coaster, traveling with an initial speed of 15 meters per second, decelerates uniformly at −7.0 meters per second^2 to a full stop. Approximately how far does the roller coaster travel during its deceleration?

(1) 1.0 m
(2) 2.0 m
(3) 16 m
(4) 32 m

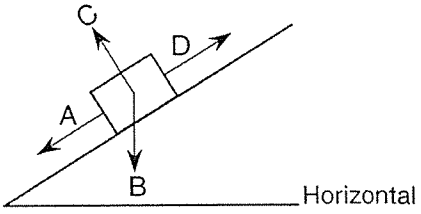
4 The diagram below represents a 0.40-kilogram stone attached to a string. The stone is moving at a constant speed of 4.0 meters per second in a horizontal circle having a radius of 0.80 meter.



The magnitude of the centripetal acceleration of the stone is

(1) 0.0 m/s^2
(2) 2.0 m/s^2
(3) 5.0 m/s^2
(4) 20. m/s^2

5 In the diagram below, a box is at rest on an inclined plane.



Which vector best represents the direction of the normal force acting on the box?

(1) *A*
(2) *B*
(3) *C*
(4) *D*

Note that question 6 has only three choices.

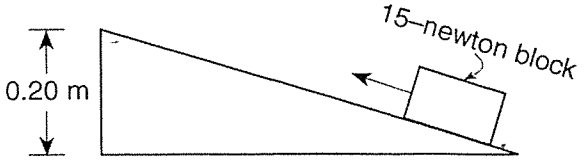
6 If the magnitude of the gravitational force of Earth on the Moon is *F*, the magnitude of the gravitational force of the Moon on Earth is

(1) smaller than *F*
(2) larger than *F*
(3) equal to *F*

7 Which term represents a scalar quantity?

(1) distance
(2) displacement
(3) force
(4) weight

8 A block weighing 15 newtons is pulled to the top of an incline that is 0.20 meter above the ground, as shown below.



If 4.0 joules of work are needed to pull the block the full length of the incline, how much work is done against friction?

(1) 1.0 J
(2) 0.0 J
(3) 3.0 J
(4) 7.0 J

9 A 1.0-kilogram rubber ball traveling east at 4.0 meters per second hits a wall and bounces back toward the west at 2.0 meters per second. Compared to the kinetic energy of the ball before it hits the wall, the kinetic energy of the ball after it bounces off the wall is

(1) one-fourth as great
(2) one-half as great
(3) the same
(4) four times as great

Note that questions 10 and 11 have only three choices.

10 As a spring is stretched, its elastic potential energy

(1) decreases
(2) increases
(3) remains the same

12 A catapult with a spring constant of 1.0×10^4 newtons per meter is required to launch an airplane from the deck of an aircraft carrier. The plane is released when it has been displaced 0.50 meter from its equilibrium position by the catapult. The energy acquired by the airplane from the catapult during takeoff is approximately

(1) 1.3×10^3 J
(2) 2.0×10^4 J
(3) 2.5×10^3 J
(4) 1.0×10^4 J

24 What type of nuclear force holds the protons and neutrons in an atom together?

(1) a strong force that acts over a short range
(2) a strong force that acts over a long range
(3) a weak force that acts over a short range
(4) a weak force that acts over a long range

25 Which is an acceptable unit for impulse?

(1) N•m
(2) J/s
(3) J•s
(4) kg•m/s

26 The centers of two 15.0-kilogram spheres are separated by 3.00 meters. The magnitude of the gravitational force between the two spheres is approximately

(1) 1.11×10^{-10} N
(2) 3.34×10^{-10} N
(3) 1.67×10^{-9} N
(4) 5.00×10^{-9} N

27 During a collision, an 84-kilogram driver of a car moving at 24 meters per second is brought to rest by an inflating air bag in 1.2 seconds. The magnitude of the force exerted on the driver by the air bag is approximately

(1) 7.0×10^1 N
(2) 8.2×10^2 N
(3) 1.7×10^3 N
(4) 2.0×10^3 N

28 An apple weighing 1 newton on the surface of Earth has a mass of approximately

(1) 1×10^{-1} kg
(2) 1×10^0 kg
(3) 1×10^1 kg
(4) 1×10^2 kg

29 In raising an object vertically at a constant speed of 2.0 meters per second, 10. watts of power is developed. The weight of the object is

(1) 5.0 N
(2) 20. N
(3) 40. N
(4) 50. N

31 In which situation is the net force on the object equal to zero?

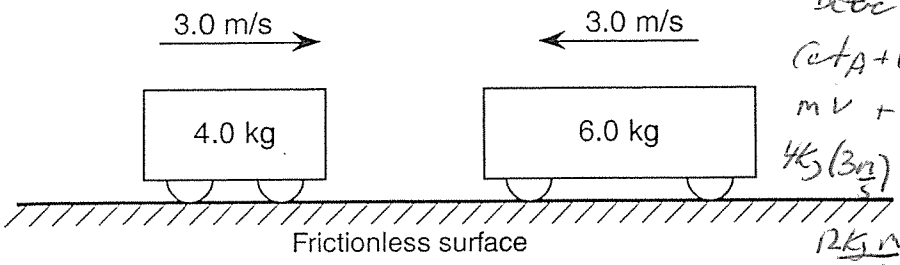
(1) a satellite moving at constant speed around Earth in a circular orbit
(2) an automobile braking to a stop
(3) a bicycle moving at constant speed on a straight, level road
(4) a pitched baseball being hit by a bat

Part B–1

Answer all questions in this part.

Directions (36–47): 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.

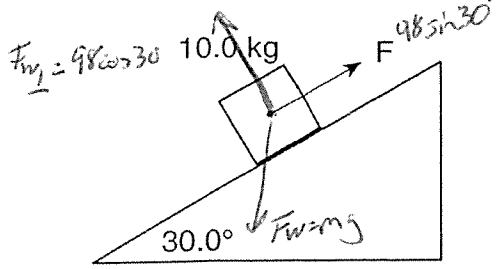
36 The diagram below shows a 4.0-kilogram cart moving to the right and a 6.0-kilogram cart moving to the left on a horizontal frictionless surface.



When the two carts collide they lock together. The magnitude of the total momentum of the two-cart system after the collision is

(1) 0.0 kg•m/s
(2) 6.0 kg•m/s
(3) 15 kg•m/s
(4) 30. kg•m/s

37 The diagram below shows a 10.0-kilogram mass held at rest on a frictionless 30.0° incline by force F.



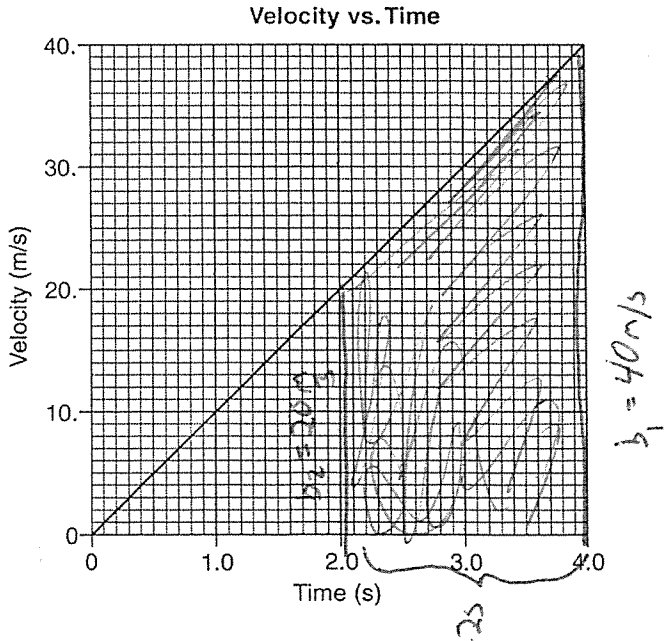
What is the approximate magnitude of force F?

(1) 9.81 N
(2) 49.1 N
(3) 85.0 N
(4) 98.1 N

38 An archer uses a bow to fire two similar arrows with the same string force. One arrow is fired at an angle of 60.° with the horizontal, and the other is fired at an angle of 45° with the horizontal. Compared to the arrow fired at 60.°, the arrow fired at 45° has a

(1) longer flight time and longer horizontal range
(2) longer flight time and shorter horizontal range
(3) shorter flight time and longer horizontal range
(4) shorter flight time and shorter horizontal range

39 The graph below shows the velocity of a race car moving along a straight line as a function of time.

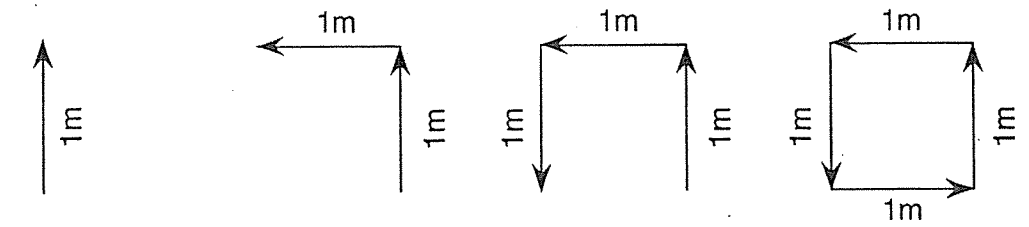


What is the magnitude of the displacement of the car from t = 2.0 seconds to t = 4.0 seconds?

(1) 20. m
(2) 40. m
(3) 60. m
(4) 80. m

hypotenuse = Biggest Side

40 Which vector diagram represents the greatest magnitude of displacement for an object?



(1) (2) (3) (4)

---

6 minutes = 360s

43 What is the total electrical energy used by a 1500-watt hair dryer operating for 6.0 minutes?

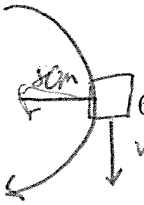
(1) 4.2 J
(2) 250 J
(3) 9.0×10^3 J
(4) 5.4×10^5 J

$P = \frac{W}{t}$ $1500\,W = \frac{W}{360\,s}$ 540,000 J

Base your answers to questions 64 and 65 on the information given below.

Friction provides the centripetal force that allows a car to round a circular curve.

64 Find the minimum coefficient of friction needed between the tires and the road to allow a 1600-kilogram car to round a curve of radius 80. meters at a speed of 20. meters per second. [Show all work, including formulas and substitutions with units.] [4]



65 If the mass of the car were increased, how would that affect the maximum speed at which it could round the curve? [1]

64. $F_c = \frac{mv^2}{r} = \frac{1600\,kg\,(20\,\frac{m}{s})^2}{80\,m} = 8000\,N$

$F_f = F_c$ $F_N = mg$

$= (1600\,kg)(9.8\,\frac{m}{s^2})$

$F_f = \mu F_N$ $= 16{,}000\,N$

$8000\,N = \mu\, 16{,}000\,N$

$\mu = .5$

65. No affect

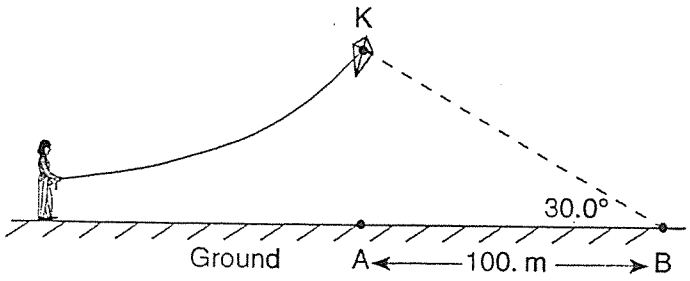
$v = \frac{d}{t} = \frac{2\pi r}{t}$

$F_c = F_f$

$\frac{mv^2}{r} = \mu mg$

Base your answers to questions 61 through 63 on the information and diagram below.

A child is flying a kite, *K*. A student at point *B*, located 100. meters away from point *A* (directly underneath the kite), measures the angle of elevation of the kite from the ground as 30.°.



61 *In your answer booklet,* use a metric ruler and protractor to draw a triangle representing the positions of the kite, *K*, and point *A* relative to point *B* that is given. Label points *A* and *K*. Use a scale of 1.0 centimeter = 10. meters. [2]

11.3 × 10 = 113 m

62 Use a metric ruler and your scale diagram to determine the height, *AK*, of the kite. [1]

57 m

63 A small lead sphere is dropped from the kite. Calculate the amount of time required for the sphere to fall to the ground. [Show all calculations, including the equation and substitution with units. Neglect air resistance.] [2]

Part C

61

Scale
1.0 cm = 10.m

Ground B

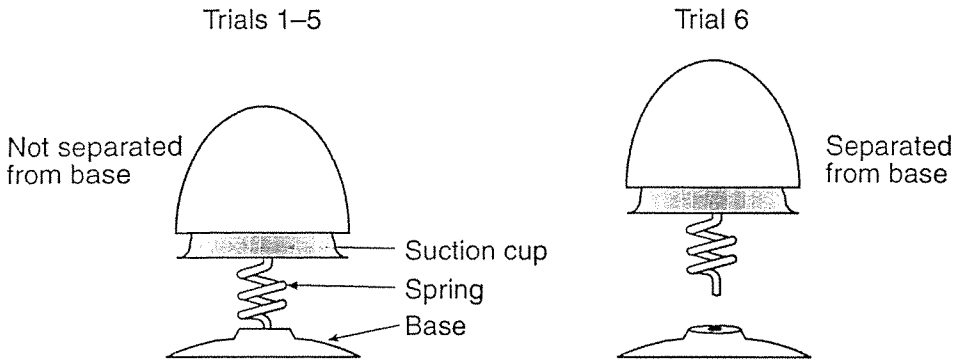
62 5.7 × 10 = 57 m

63. $d = v_i^0 t + \frac{1}{2}at^2$, $\sqrt{11.63} = \sqrt{t^2}$

$57\text{m} = \frac{1}{2}\left(9.8\frac{\text{m}}{\text{s}^2}\right)t^2$ $t = 3.4\text{s}$

Base your answers to questions 66 and 67 on the information below and on your knowledge of physics.

Using a spring toy like the one shown in the diagram, a physics teacher pushes on the toy, compressing the spring, causing the suction cup to stick to the base of the toy.



When the teacher removes her hand, the toy pops straight up and just brushes against the ceiling. She does this demonstration five times, always with the same result.

When the teacher repeats the demonstration for the sixth time the toy crashes against the ceiling with considerable force. The students notice that in this trial, the spring and toy separated from the base at the moment the spring released.

The teacher puts the toy back together, repeats the demonstration and the toy once again just brushes against the ceiling.

66 Describe the conversions that take place between pairs of the three forms of mechanical energy, beginning with the work done by the teacher on the toy and ending with the form(s) of energy possessed by the toy as it hits the ceiling. [Neglect friction.] [3]

67 Explain, in terms of mass and energy, why the spring toy hits the ceiling in the sixth trial and not in the other trials. [2]

66. $W = \Delta E$ Work → PEs
PEs → KE
KE → PE
+1 Credit each conv.

67. Some Energy, less mass
+1 +1
1 pt each part

Name: _____

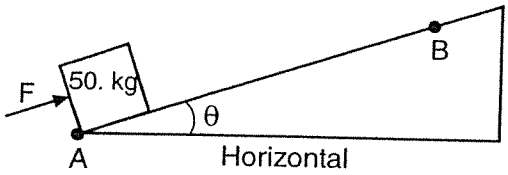
Physics: December Packet

Date: _____

Period: ____

Directions: Answer all questions and show all work. For problems 22-36, please write the equation, plug in with units, and leave the answer with units where possible.

1 The diagram below shows a 50.-kilogram crate on a frictionless plane at angle θ to the horizontal. The crate is pushed at constant speed up the incline from point *A* to point *B* by force *F*.



If angle θ were increased, what would be the effect on the magnitude of force *F* and the total work *W* done on the crate as it is moved from *A* to *B*?

(1) *W* would remain the same and the magnitude of *F* would decrease.
(2) *W* would remain the same and the magnitude of *F* would increase.
(3) *W* would increase and the magnitude of *F* would decrease.
(4) *W* would increase and the magnitude of *F* would increase.

2 A vector makes an angle, θ, with the horizontal. The horizontal and vertical components of the vector will be equal in magnitude if angle θ is

(1) 30°
(2) 45°
(3) 60°
(4) 90°

3 A car initially traveling at a speed of 16 meters per second accelerates uniformly to a speed of 20. meters per second over a distance of 36 meters. What is the magnitude of the car's acceleration?

(1) 0.11 m/s²
(2) 2.0 m/s²
(3) 0.22 m/s²
(4) 9.0 m/s²

4 A ball is thrown at an angle of 38° to the horizontal. What happens to the magnitude of the ball's vertical acceleration during the total time interval that the ball is in the air?

(1) It decreases, then increases.
(2) It decreases, then remains the same.
(3) It increases, then decreases.
(4) It remains the same.

5 A man standing on a scale in an elevator notices that the scale reads 30 newtons greater than his normal weight. Which type of movement of the elevator could cause this greater-than-normal reading?

(1) accelerating upward
(2) accelerating downward
(3) moving upward at constant speed
(4) moving downward at constant speed

Base your answers to questions 6 and 7 on the information below.

Projectile *A* is launched horizontally at a speed of 20. meters per second from the top of a cliff and strikes a level surface below, 3.0 seconds later. Projectile *B* is launched horizontally from the same location at a speed of 30. meters per second.

6 The time it takes projectile *B* to reach the level surface is

(1) 4.5 s
(2) 2.0 s
(3) 3.0 s
(4) 10. s

7 Approximately how high is the cliff?

(1) 29 m
(2) 44 m
(3) 60. m
(4) 104 m

8 A 60-kilogram skydiver is falling at a constant speed near the surface of Earth. The magnitude of the force of air friction acting on the skydiver is approximately

(1) 0 N
(2) 6 N
(3) 60 N
(4) 600 N

9 An astronaut weighs 8.00×10^2 newtons on the surface of Earth. What is the weight of the astronaut 6.37×10^6 meters above the surface of Earth?

(1) 0.00 N
(2) 2.00×10^2 N
(3) 1.60×10^3 N
(4) 3.20×10^3 N

10 Which person has the greatest inertia?

(1) a 110-kg wrestler resting on a mat
(2) a 90-kg man walking at 2 m/s
(3) a 70-kg long-distance runner traveling at 5 m/s
(4) a 50-kg girl sprinting at 10 m/s

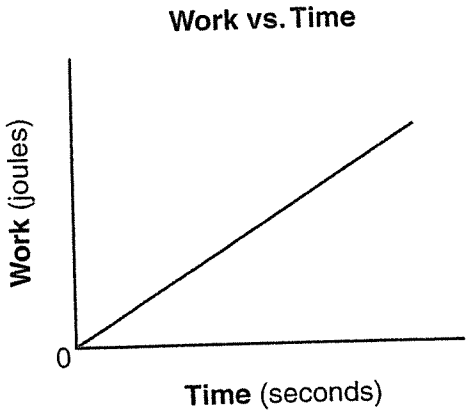
11 When a 12-newton horizontal force is applied to a box on a horizontal tabletop, the box remains at rest. The force of static friction acting on the box is

(1) 0 N
(2) between 0 N and 12 N
(3) 12 N
(4) greater than 12 N

12 A 1.5-kilogram lab cart is accelerated uniformly from rest to a speed of 2.0 meters per second in 0.50 second. What is the magnitude of the force producing this acceleration?

(1) 0.70 N
(2) 1.5 N
(3) 3.0 N
(4) 6.0 N

14 The graph below shows the relationship between the work done by a student and the time of ascent as the student runs up a flight of stairs.



The slope of the graph would have units of

(1) joules
(2) seconds
(3) watts
(4) newtons

Note that question 15 has only three choices.

15 As a ball falls freely (without friction) toward the ground, its total mechanical energy

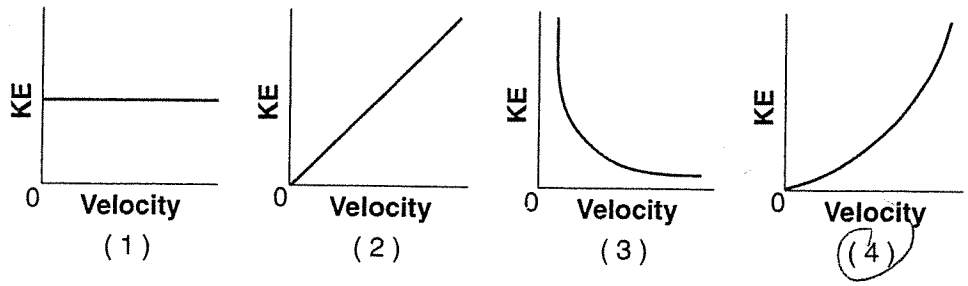
(1) decreases
(2) increases
(3) remains the same

16 A 0.50-kilogram ball is thrown vertically upward with an initial kinetic energy of 25 joules. Approximately how high will the ball rise? [Neglect air resistance.]

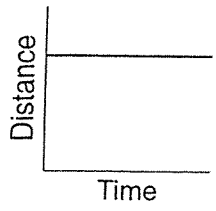
(1) 2.6 m
(2) 5.1 m
(3) 13 m
(4) 25 m

KE=PE

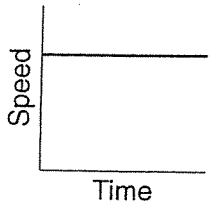
13 Which graph best represents the relationship between the kinetic energy, *KE*, and the velocity of an object accelerating in a straight line?



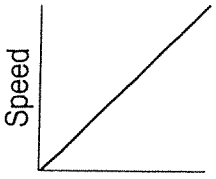
17 Which graph best represents the motion of an object that is *not* in equilibrium as it travels along a straight line?



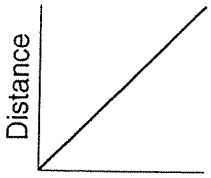
(1)



(3)

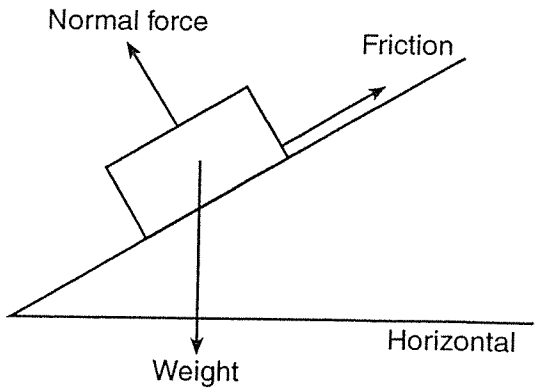


(2)



(4)

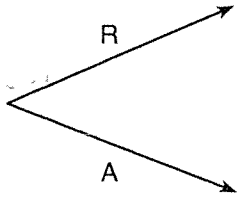
18 Three forces act on a box on an inclined plane as shown in the diagram below. [Vectors are not drawn to scale.]



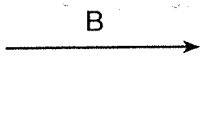
If the box is at rest, the net force acting on it is equal to

(1) the weight
(2) the normal force
(3) friction
(4) zero

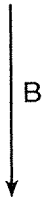
19 Forces A and B have a resultant R. Force A and resultant R are represented in the diagram below.



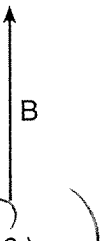
Which vector best represents force B?



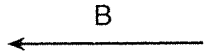
(1)



(3)



(2)



(4)

20 What is the average power developed by a motor as it lifts a 400.-kilogram mass at constant speed through a vertical distance of 10.0 meters in 8.0 seconds?

(1) 320 W
(2) 500 W
(3) 4,900 W
(4) 32,000 W

$P = \frac{Fd}{t}$ $\frac{4000N(10m)}{8}$

21 What is the approximate width of a person's little finger?

(1) 1 m
(2) 0.1 m
(3) 0.01 m
(4) 0.001 m

1cm

Base your answers to questions 22 and 23 on the information below.

A hiker walks 5.00 kilometers due north and then 7.00 kilometers due east.

22 What is the magnitude of her resultant displacement? [1]

8.6 m

23 What total distance has she traveled? [1]

12M

Base your answers to questions 24 through 26 on the information below.

A 50.-kilogram child running at 6.0 meters per second jumps onto a stationary 10.-kilogram sled. The sled is on a level frictionless surface.

24 Calculate the speed of the sled with the child after she jumps onto the sled. [Show all work, including the equation and substitution with units.] [2]

25 Calculate the kinetic energy of the sled with the child after she jumps onto the sled. [Show all work, including the equation and substitution with units.] [2]

26 After a short time, the moving sled with the child aboard reaches a rough level surface that exerts a constant frictional force of 54 newtons on the sled. How much work must be done by friction to bring the sled with the child to a stop? [1]

$w = F \cdot d$

Answer Here

24) $mv_{child} + mv_{sled} = mv_{combo}$

$50kg(6\frac{m}{s}) + 10kg(0\frac{m}{s}) = 60kg\ v$

$\frac{300}{60} = \frac{60v}{60}$

$5\frac{m}{s} = v$

25) $KE = \frac{1}{2}mv^2$

$\frac{1}{2}(60kg)(5\frac{m}{s})^2$

750J

26)

750J

Answer Here

Base your answers to questions 27 through 30 on the information and data table below.

In an experiment, a student measured the length and period of a simple pendulum. The data table lists the length (ℓ) of the pendulum in meters and the square of the period (T^2) of the pendulum in seconds^2.

Length (ℓ) (meters)	Square of Period (T^2) (seconds^2)
0.100	0.410
0.300	1.18
0.500	1.91
0.700	2.87
0.900	3.60

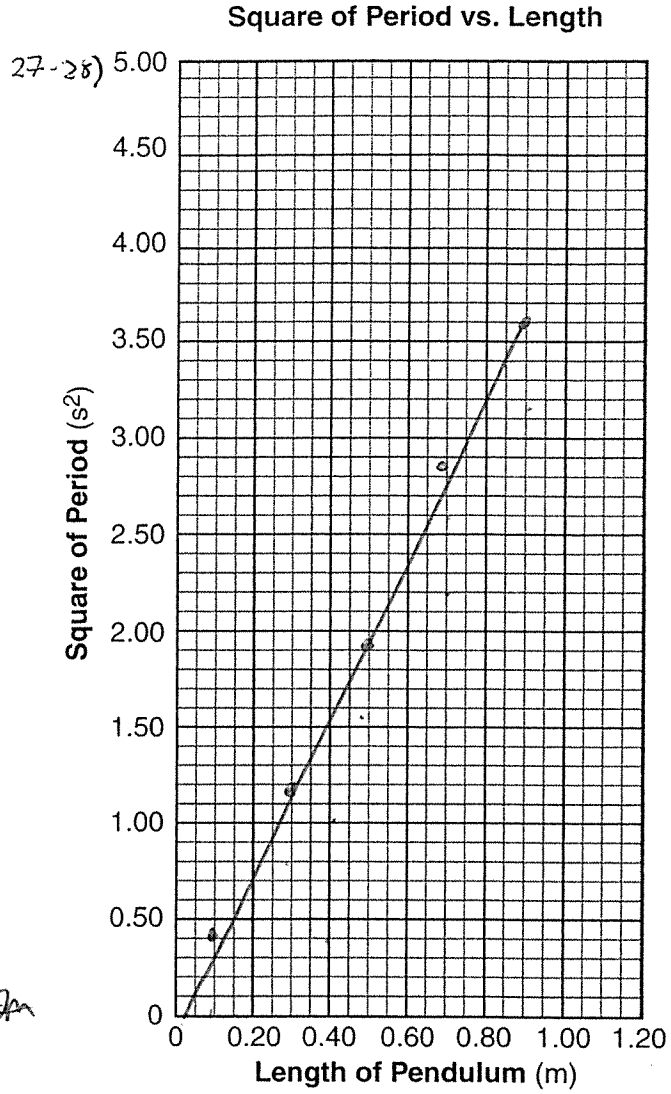
Directions (58–59): Using the information in the data table, construct a graph on the grid *provided in your answer booklet*, following the directions below.

27 Plot the data points for the square of period versus length. [1]

28 Draw the best-fit straight line. [1]

29 Using your graph, determine the time in seconds it would take this pendulum to make one complete swing if it were 0.200 meter long. [1]

30 The period of a pendulum is related to its length by the formula: $T^2 = \left(\frac{4\pi^2}{g}\right) \cdot \ell$ where g represents the acceleration due to gravity. Explain how the graph you have drawn could be used to calculate the value of g. [You do *not* need to perform any actual calculations.] [1]



$\sqrt{.73} =$

29) .89 s ± .1

30)