Mechanics from June 2011
37 credits of 85 possible
or 46 % of test

Name_____

Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, write in your answer booklet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1 Scalar is to vector as
(1) speed is to velocity
(2) displacement is to distance
(3) displacement is to velocity
(4) speed is to distance

2 If a car accelerates uniformly from rest to 15 meters per second over a distance of 100. meters, the magnitude of the car's acceleration is
(1) 0.15 m/s^2
(2) 1.1 m/s^2
(3) 2.3 m/s^2
(4) 6.7 m/s^2

3 An object accelerates uniformly from 3.0 meters per second east to 8.0 meters per second east in 2.0 seconds. What is the magnitude of the acceleration of the object?
(1) 2.5 m/s^2
(2) 5.0 m/s^2
(3) 5.5 m/s^2
(4) 11 m/s^2

4 A rock is dropped from a bridge. What happens to the magnitude of the acceleration and the speed of the rock as it falls? [Neglect friction.]
(1) Both acceleration and speed increase.
(2) Both acceleration and speed remain the same.
(3) Acceleration increases and speed decreases.
(4) Acceleration remains the same and speed increases.

5 A soccer ball kicked on a level field has an initial vertical velocity component of 15.0 meters per second. Assuming the ball lands at the same height from which it was kicked, what is the total time the ball is in the air? [Neglect friction.]
(1) 0.654 s
(2) 1.53 s
(3) 3.06 s
(4) 6.12 s

6 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

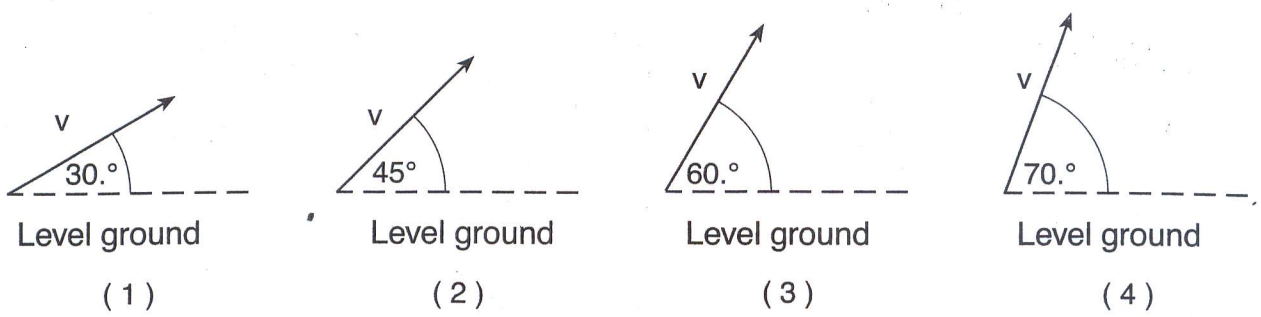
7 The magnitude of the centripetal force acting on an object traveling in a horizontal, circular path will *decrease* if the
(1) radius of the path is increased
(2) mass of the object is increased
(3) direction of motion of the object is reversed
(4) speed of the object is increased

8 The centripetal force acting on the space shuttle as it orbits Earth is equal to the shuttle's
(1) inertia
(2) momentum
(3) velocity
(4) weight

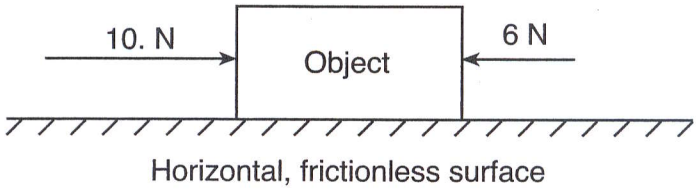
9 As a box is pushed 30. meters across a horizontal floor by a constant horizontal force of 25 newtons, the kinetic energy of the box increases by 300. joules. How much total internal energy is produced during this process?
(1) 150 J
(2) 250 J
(3) 450 J
(4) 750 J

10 What is the power output of an electric motor that lifts a 2.0-kilogram block 15 meters vertically in 6.0 seconds?
(1) 5.0 J
(2) 5.0 W
(3) 49 J
(4) 49 W

11 Four identical projectiles are launched with the same initial speed, v, but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.]



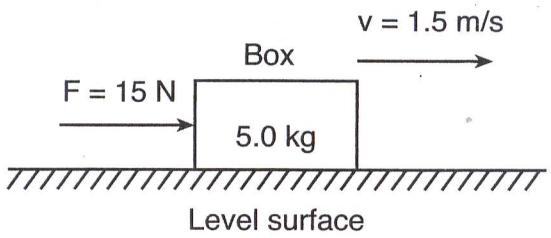
12 Two forces act concurrently on an object on a horizontal, frictionless surface, as shown in the diagram below.



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

13 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

14 Which statement describes the kinetic energy and total mechanical energy of a block as it is pulled at constant speed up an incline?

(1) Kinetic energy decreases and total mechanical energy increases.
(2) Kinetic energy decreases and total mechanical energy remains the same.
(3) Kinetic energy remains the same and total mechanical energy increases.
(4) Kinetic energy remains the same and total mechanical energy remains the same.

Part B–1

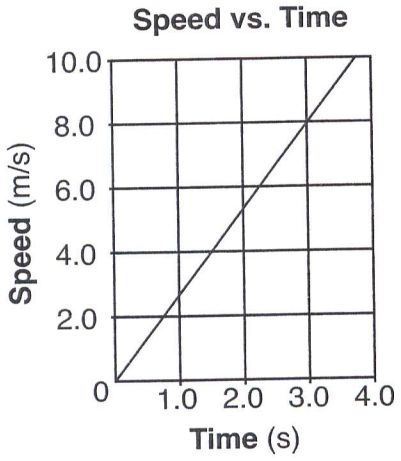
Answer all questions in this part.

Directions (36–50): For *each* statement or question, write in your answer booklet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

36 What is the approximate diameter of an inflated basketball?

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

37 The graph below shows the relationship between the speed and elapsed time for an object falling freely from rest near the surface of a planet.



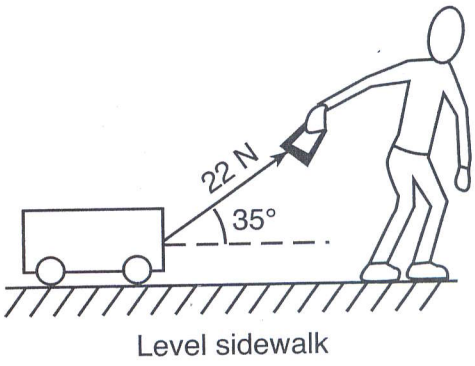
What is the total distance the object falls during the first 3.0 seconds?

(1) 12 m
(2) 24 m
(3) 44 m
(4) 72 m

38 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

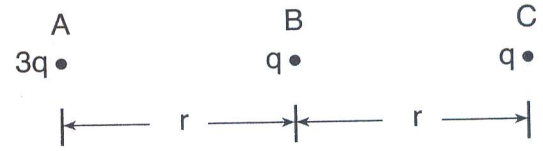
39 A child pulls a wagon at a constant velocity along a level sidewalk. The child does this by applying a 22-newton force to the wagon handle, which is inclined at 35° to the sidewalk as shown below.



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

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

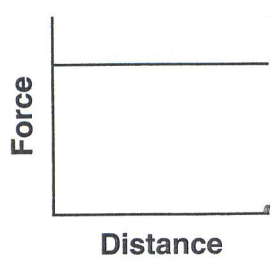
40 The diagram below shows the arrangement of three small spheres, A, B, and C, having charges of $3q$, q, and q, respectively. Spheres A and C are located distance r from sphere B.



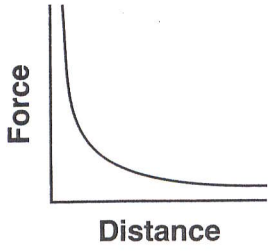
Compared to the magnitude of the electrostatic force exerted by sphere B on sphere C, the magnitude of the electrostatic force exerted by sphere A on sphere C is

(1) the same
(2) twice as great
(3) $\frac{3}{4}$ as great
(4) $\frac{3}{2}$ as great

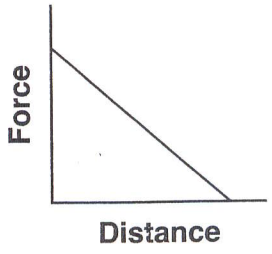
41 A space probe is launched into space from Earth's surface. Which graph represents the relationship between the magnitude of the gravitational force exerted on Earth by the space probe and the distance between the space probe and the center of Earth?



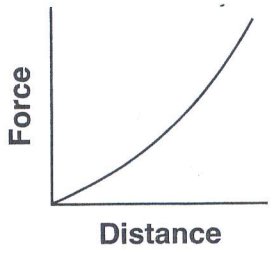
(1)



(2)

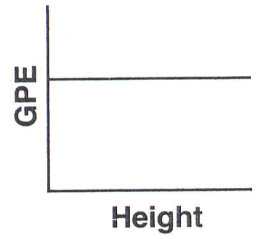


(3)

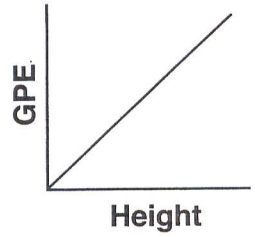


(4)

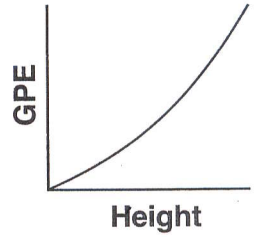
42 Which graph represents the relationship between the gravitational potential energy *(GPE)* of an object near the surface of Earth and its height above the surface of Earth?



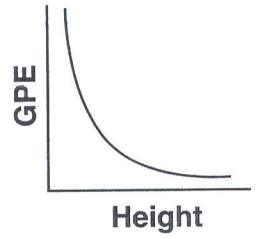
(1)



(2)



(3)



(4)

Part B–2

Answer all questions in this part.

Directions (51–65): Record your answers in the spaces provided in your answer booklet.

51–52 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 53 through 55 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.

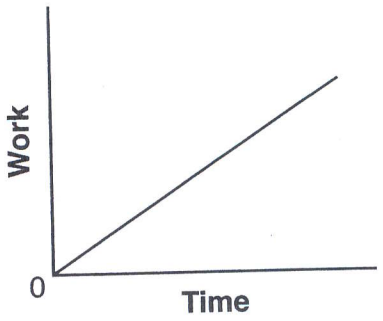
53 Determine the magnitude of the normal force exerted by the snow on the skis as the skier glides across the horizontal surface. [1]

54–55 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]

56–57 Calculate the kinetic energy of a particle with a mass of 3.34×10^{-27} kilogram and a speed of 2.89×10^5 meters per second. [Show all work, including the equation and substitution with units.] [2]

58 A simple circuit consists of a 100.-ohm resistor connected to a battery. A 25-ohm resistor is to be connected in the circuit. Determine the *smallest* equivalent resistance possible when both resistors are connected to the battery. [1]

59 The graph below represents the relationship between the work done by a person and time.



Identify the physical quantity represented by the slope of the graph. [1]

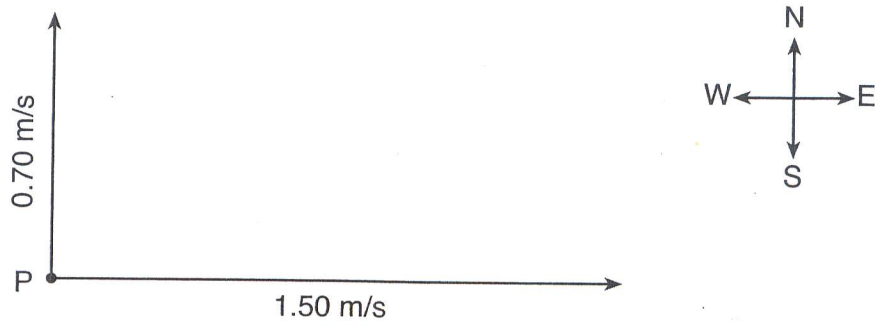
Part C

Answer all questions in this part.

Directions (66–85): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 66 through 69 on the information and diagram below.

A model airplane heads due east at 1.50 meters per second, while the wind blows due north at 0.70 meter per second. The scaled diagram below represents these vector quantities.



66 Using a ruler, determine the scale used in the vector diagram. [1]

67 On the diagram *in your answer booklet*, use a protractor and a ruler to construct a vector to represent the resultant velocity of the airplane. Label the vector *R*. [1]

68 Determine the magnitude of the resultant velocity. [1]

69 Determine the angle between north and the resultant velocity. [1]

Base your answers to questions 70 through 73 on the information below.

A vertically hung spring has a spring constant of 150. newtons per meter. A 2.00-kilogram mass is suspended from the spring and allowed to come to rest.

70–71 Calculate the elongation of the spring produced by the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.] [2]

72–73 Calculate the total elastic potential energy stored in the spring due to the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.] [2]

Answer Sheet

Name _____

1 _____
2 _____
3 _____
4 _____
5 _____

6 _____
7 _____
8 _____
9 _____
10 _____

11 _____
12 _____
13 _____
14 _____

36 _____
37 _____
38 _____
39 _____
40 _____

41 _____
42 _____

51 - 52

53

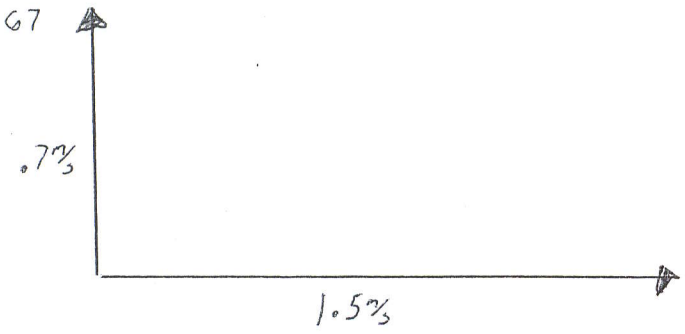
54 - 55

56 - 57

58 ⇒ Slope = _____

66 1 km = _____ m/s

67



68 R = _____ m/s

69 ∡ = _____ °

70 - 71

72 - 73

Answer Sheet

Name KEY

1	1	6	1	11	2	36	2
2	2	7	1	12	4	37	1
3	1	8	4	13	3	38	3
4	4	9	3	14	3	39	3
5	3	10	4			40	4

41	2
42	2

51-52

$F_{Net} = ma$

$F_{Net} = .5kg(3 m/s^2)$

$= 1.5 N$

53

$F_F = \mu F_N$

$= .05(850N)$

54-55

$F_F = 40N$

56-57

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

$= \frac{1}{2}(3.34 \times 10^{-27} kg)(2.89 \times 10^5 m/s)^2$

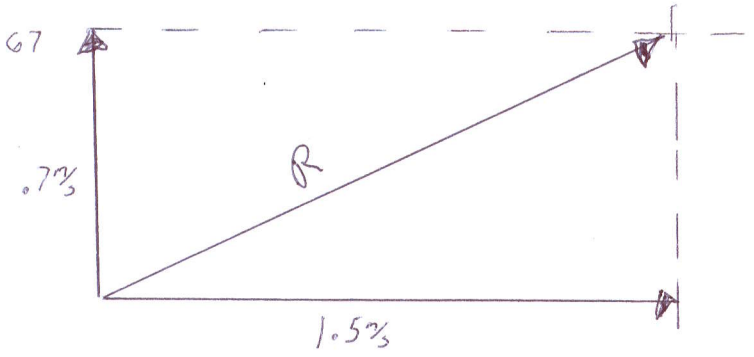
$KE = 1.39 \times 10^{-16}$ Joules

58 Slope = power

66

1 km = 0.2 m/s m/s

67



68 R = 1.7 m/s

69 θ = 65°

70-71

$F = Kx$

$20N = 150 \frac{N}{m}(x)$

$x = .131m$

72-73

$PE = \frac{1}{2}Kx^2$

$= \frac{1}{2}\left(150 \frac{N}{m}\right)(.131m)^2$

$PE = 1.29$ Joules