Mechanics Review test
June 2010

Name____________________

This test had 41 of 85 possible credits or about 48% of test

1 A baseball player runs 27.4 meters from the batter's box to first base, overruns first base by 3.0 meters, and then returns to first base. Compared to the total distance traveled by the player, the magnitude of the player's total displacement from the batter's box is

(1) 3.0 m shorter
(2) 6.0 m shorter
(3) 3.0 m longer
(4) 6.0 m longer

2 A motorboat, which has a speed of 5.0 meters per second in still water, is headed east as it crosses a river flowing south at 3.3 meters per second. What is the magnitude of the boat's resultant velocity with respect to the starting point?

(1) 3.3 m/s
(2) 5.0 m/s
(3) 6.0 m/s
(4) 8.3 m/s

3 A car traveling on a straight road at 15.0 meters per second accelerates uniformly to a speed of 21.0 meters per second in 12.0 seconds. The total distance traveled by the car in this 12.0-second time interval is

(1) 36.0 m
(2) 180. m
(3) 216 m
(4) 252 m

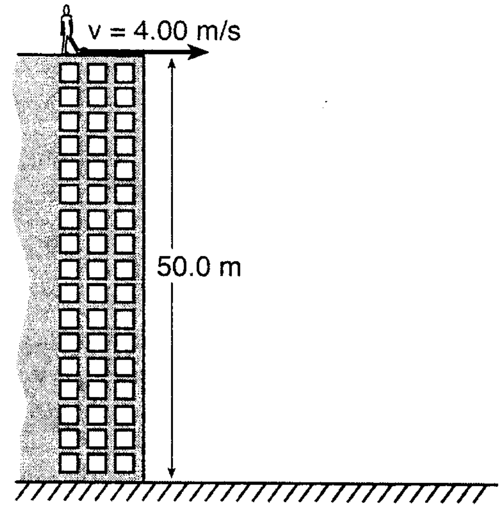
4 A 0.149-kilogram baseball, initially moving at 15 meters per second, is brought to rest in 0.040 second by a baseball glove on a catcher's hand. The magnitude of the average force exerted on the ball by the glove is

(1) 2.2 N
(2) 2.9 N
(3) 17 N
(4) 56 N

5 Which body is in equilibrium?

(1) a satellite moving around Earth in a circular orbit
(2) a cart rolling down a frictionless incline
(3) an apple falling freely toward the surface of Earth
(4) a block sliding at constant velocity across a tabletop

6 As shown in the diagram below, a student standing on the roof of a 50.0-meter-high building kicks a stone at a horizontal speed of 4.00 meters per second.



(Not drawn to scale)

How much time is required for the stone to reach the level ground below? [Neglect friction.]

(1) 3.19 s
(2) 5.10 s
(3) 10.2 s
(4) 12.5 s

7 On the surface of Earth, a spacecraft has a mass of 2.00×10^4 kilograms. What is the mass of the spacecraft at a distance of one Earth radius above Earth's surface?

(1) 5.00×10^3 kg
(2) 2.00×10^4 kg
(3) 4.90×10^4 kg
(4) 1.96×10^5 kg

8 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?

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

9 The data table below lists the mass and speed of four different objects.

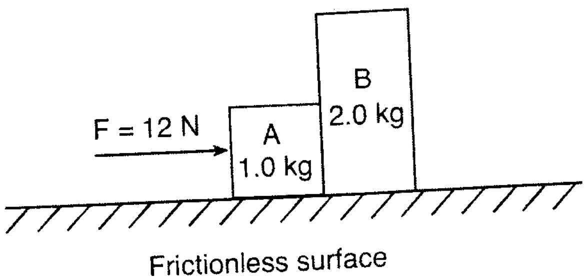
Data Table

Object	Mass (kg)	Speed (m/s)
A	4.0	6.0
B	6.0	5.0
C	8.0	3.0
D	16.0	1.5

Which object has the greatest inertia?

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

10 The diagram below shows a horizontal 12-newton force being applied to two blocks, *A* and *B*, initially at rest on a horizontal, frictionless surface. Block *A* has a mass of 1.0 kilogram and block *B* has a mass of 2.0 kilograms.



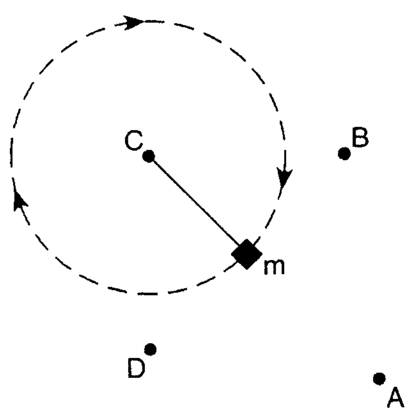
The magnitude of the acceleration of block *B* is

(1) 6.0 m/s^2
(2) 2.0 m/s^2
(3) 3.0 m/s^2
(4) 4.0 m/s^2

11 A ball is thrown vertically upward with an initial velocity of 29.4 meters per second. What is the maximum height reached by the ball? [Neglect friction.]

(1) 14.7 m
(2) 29.4 m
(3) 44.1 m
(4) 88.1 m

12 The diagram below represents a mass, *m*, being swung clockwise at constant speed in a horizontal circle.



At the instant shown, the centripetal force acting on mass *m* is directed toward point

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

13 A 3.1-kilogram gun initially at rest is free to move. When a 0.015-kilogram bullet leaves the gun with a speed of 500. meters per second, what is the speed of the gun?

(1) 0.0 m/s
(2) 2.4 m/s
(3) 7.5 m/s
(4) 500. m/s

14 Four projectiles, *A*, *B*, *C*, and *D*, were launched from, and returned to, level ground. The data table below shows the initial horizontal speed, initial vertical speed, and time of flight for each projectile.

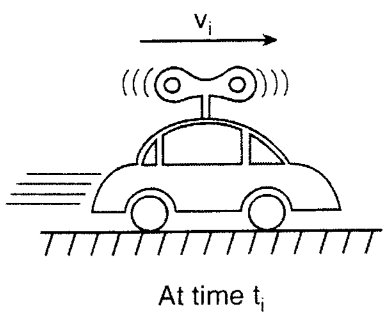
Data Table

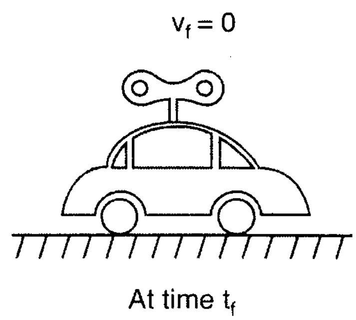
Projectile	Initial Horizontal Speed (m/s)	Initial Vertical Speed (m/s)	Time of Flight (s)
A	40.0	29.4	6.00
B	60.0	19.6	4.00
C	50.0	24.5	5.00
D	80.0	19.6	4.00

Which projectile traveled the greatest horizontal distance? [Neglect friction.]

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

15 A wound spring provides the energy to propel a toy car across a level floor. At time t_i, the car is moving at speed v_i across the floor and the spring is unwinding, as shown below. At time t_f, the spring has fully unwound and the car has coasted to a stop.





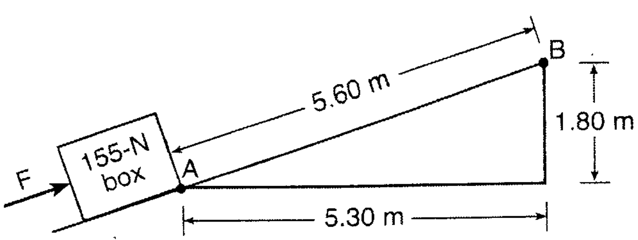
Which statement best describes the transformation of energy that occurs between times t_i and t_f?

(1) Gravitational potential energy at t_i is converted to internal energy at t_f.
(2) Elastic potential energy at t_i is converted to kinetic energy at t_f.
(3) Both elastic potential energy and kinetic energy at t_i are converted to internal energy at t_f.
(4) Both kinetic energy and internal energy at t_i are converted to elastic potential energy at t_f.

16 A 75-kilogram bicyclist coasts down a hill at a constant speed of 12 meters per second. What is the kinetic energy of the bicyclist?

(1) 4.5×10^2 J
(2) 9.0×10^2 J
(3) 5.4×10^3 J
(4) 1.1×10^4 J

17 The diagram below represents a 155-newton box on a ramp. Applied force *F* causes the box to slide from point *A* to point *B*.



What is the total amount of gravitational potential energy gained by the box?

(1) 28.4 J
(2) 279 J
(3) 868 J
(4) 2740 J

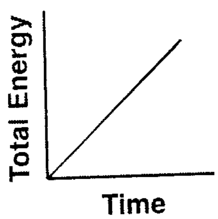
36 The total work done in lifting a typical high school physics textbook a vertical distance of 0.10 meter is approximately

(1) 0.15 J
(2) 1.5 J
(3) 15 J
(4) 150 J

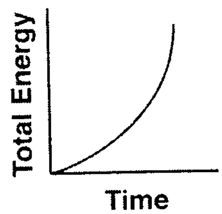
40 A child, starting from rest at the top of a playground slide, reaches a speed of 7.0 meters per second at the bottom of the slide. What is the vertical height of the slide? [Neglect friction.]

(1) 0.71 m
(2) 1.4 m
(3) 2.5 m
(4) 3.5 m

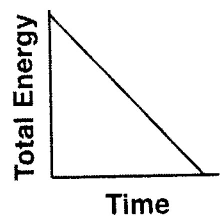
39 A ball is dropped from the top of a cliff. Which graph best represents the relationship between the ball's total energy and elapsed time as the ball falls to the ground? [Neglect friction.]



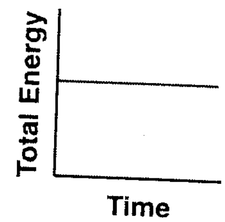
(1)



(2)

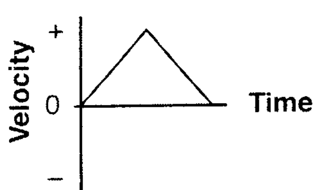


(3)

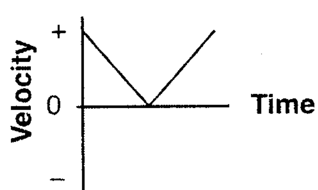


(4)

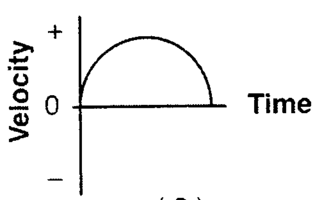
42 A student throws a baseball vertically upward and then catches it. If vertically upward is considered to be the positive direction, which graph best represents the relationship between velocity and time for the baseball? [Neglect friction.]



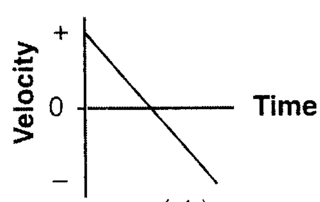
(1)



(3)



(2)



(4)

43 A 5.0-kilogram sphere, starting from rest, falls freely 22 meters in 3.0 seconds near the surface of a planet. Compared to the acceleration due to gravity near Earth's surface, the acceleration due to gravity near the surface of the planet is approximately

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

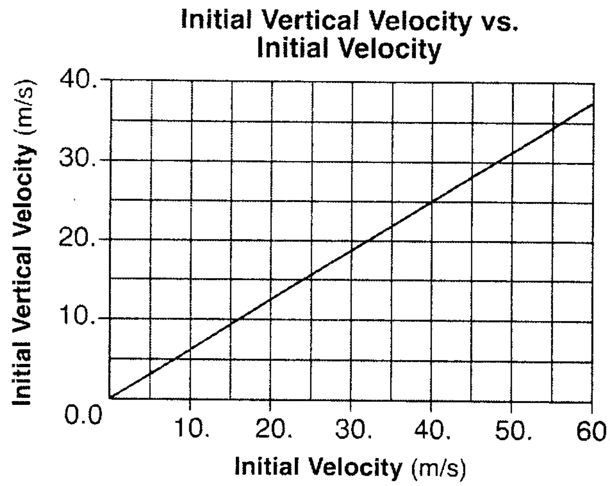
44 A 15.0-kilogram mass is moving at 7.50 meters per second on a horizontal, frictionless surface. What is the total work that must be done on the mass to increase its speed to 11.5 meters per second?

(1) 120. J
(2) 422 J
(3) 570. J
(4) 992 J

Directions (51–60): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 51 through 53 on the information and graph below.

A machine fired several projectiles at the same angle, θ, above the horizontal. Each projectile was fired with a different initial velocity, v_i. The graph below represents the relationship between the magnitude of the initial vertical velocity, v_{iy}, and the magnitude of the corresponding initial velocity, v_i, of these projectiles.



51 Determine the magnitude of the initial vertical velocity of the projectile, v_{iy}, when the magnitude of its initial velocity, v_i, was 40. meters per second. [1]

52 Determine the angle, θ, above the horizontal at which the projectiles were fired. [1]

53 Calculate the magnitude of the initial horizontal velocity of the projectile, v_{ix}, when the magnitude of its initial velocity, v_i, was 40. meters per second. [Show all work, including the equation and substitution with units.] [2]

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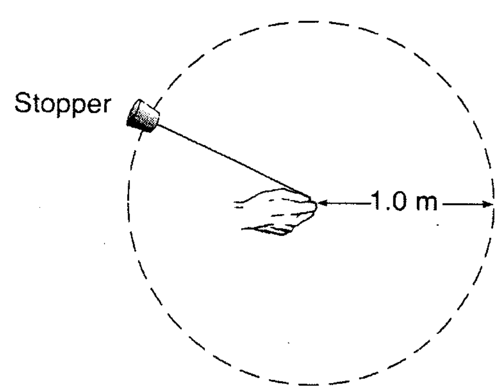
54 A student makes a simple pendulum by attaching a mass to the free end of a 1.50-meter length of string suspended from the ceiling of her physics classroom. She pulls the mass up to her chin and releases it from rest, allowing the pendulum to swing in its curved path. Her classmates are surprised that the mass doesn't reach her chin on the return swing, even though she does not move. Explain why the mass does *not* have enough energy to return to its starting position and hit the girl on the chin. [1]

Base your answers to questions 59 and 60 on the information below.

In an experiment, a 0.028-kilogram rubber stopper is attached to one end of a string. A student whirls the stopper overhead in a horizontal circle with a radius of 1.0 meter. The stopper completes 10. revolutions in 10. seconds.



(Not drawn to scale)

59 Determine the speed of the whirling stopper. [1]

60 Calculate the magnitude of the centripetal force on the whirling stopper. [Show all work, including the equation and substitution with units.] [2]

Part C

Answer all questions in this part.

Directions (61–75): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 61 through 64 on the information below.

In a laboratory investigation, a student applied various downward forces to a vertical spring. The applied forces and the corresponding elongations of the spring from its equilibrium position are recorded in the data table below.

Data Table

Force (N)	Elongation (m)
0	0
0.5	0.010
1.0	0.018
1.5	0.027
2.0	0.035
2.5	0.046

Directions (61–63): Construct a graph on the grid *in your answer booklet*, following the directions below.

61 Mark an appropriate scale on the axis labeled "Force (N)." [1]

62 Plot the data points for force versus elongation. [1]

63 Draw the best-fit line or curve. [1]

64 Using your graph, calculate the spring constant of this spring. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 65 through 68 on the information below.

An ice skater applies a horizontal force to a 20.-kilogram block on frictionless, level ice, causing the block to accelerate uniformly at 1.4 meters per second^2 to the right. After the skater stops pushing the block, it slides onto a region of ice that is covered with a thin layer of sand. The coefficient of kinetic friction between the block and the sand-covered ice is 0.28.

65 Calculate the magnitude of the force applied to the block by the skater. [Show all work, including the equation and substitution with units.] [2]

66 On the diagram *in your answer booklet*, starting at point *A*, draw a vector to represent the force applied to the block by the skater. Begin the vector at point *A* and use a scale of 1.0 centimeter = 5.0 newtons. [1]

67 Determine the magnitude of the normal force acting on the block. [1]

68 Calculate the magnitude of the force of friction acting on the block as it slides over the sand-covered ice. [Show all work, including the equation and substitution with units.] [2]

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1 ______
2 ______
3 ______
4 ______
5 ______
6 ______

7 ______
8 ______
9 ______
10 ______
11 ______
12 ______
13 ______

14 ______
15 ______
16 ______
17 ______
36 ______
39 ______
40 ______
42 ______
43 ______
44 ______

51 - V_{iy} = ______ m/s

52 - θ = ______ °

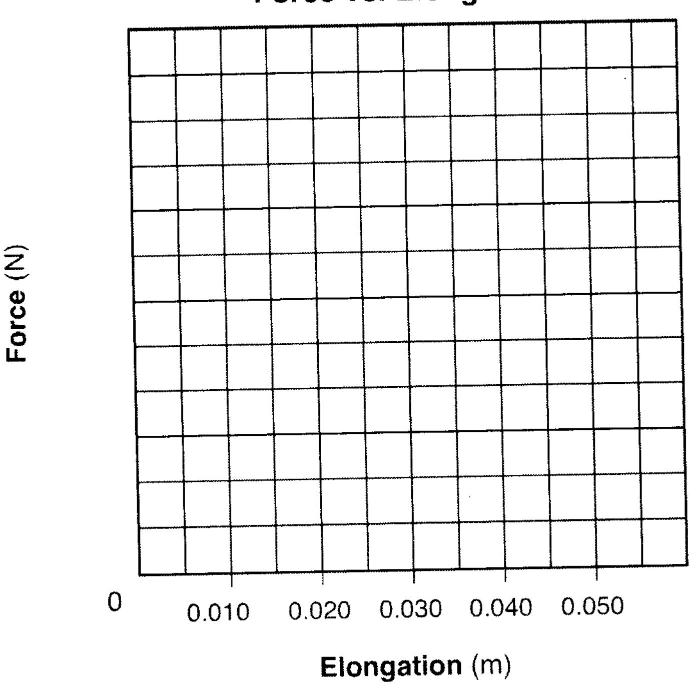
53 -

54

59 - V = ______ m/s

60 -

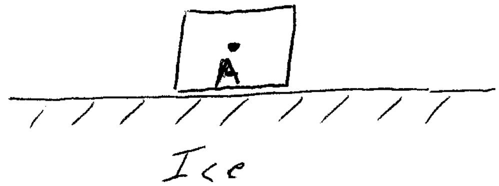
Force vs. Elongation



64

65

66 -



67

68

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1 2
2 3
3 3
4 4
5 4
6 1
7 2
8 1
9 4
10 4
11 3
12 3
13 2
14 4
15 3
16 3
17 2
36 2
39 4
40 3
42 4
43 3
44 3

51 – $V_{iy} = 25$ m/s

52 – $\theta = 39°$

53 – $V_{ix} = V\cos\theta$

$= 40\,\text{m/s}\cos 39°$

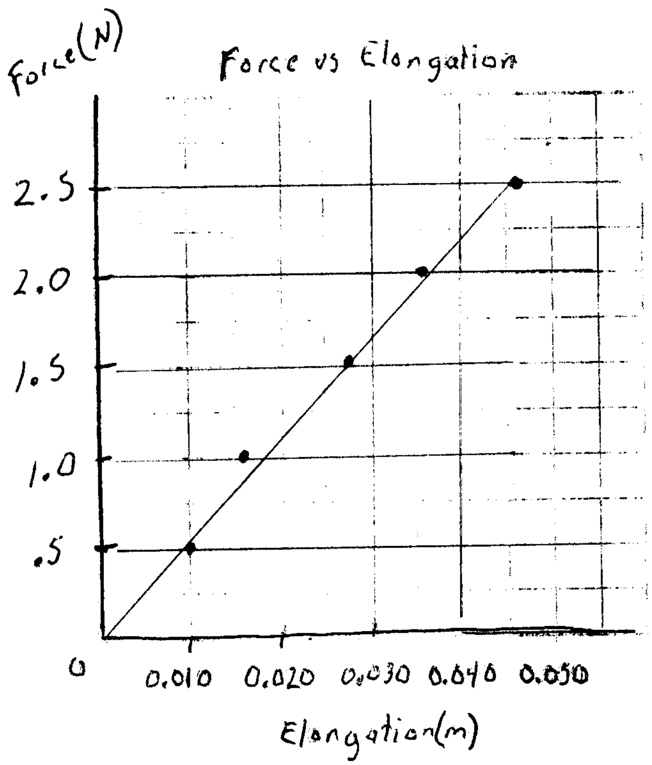
$V_{ix} = 31\,\text{m/s}$

54 – Some energy is lost to friction or heat energy and air resistance

59 – $V = 6.3$ m/s

60 – $F_c = m a_c$ $\quad F_c = m\frac{v^2}{r}$

$F_c = .028\,\text{kg}\frac{(6.3\,\text{m/s})^2}{1\,\text{m}} = 1.1\,\text{N}$



64) $\text{Slope} = \frac{\Delta Y}{\Delta X} = \frac{\Delta F}{\Delta X} = \frac{2.5\,\text{N} - .8\,\text{N}}{.046\,\text{m} - .015\,\text{m}}$

$\approx 55\,\frac{\text{N}}{\text{m}}$

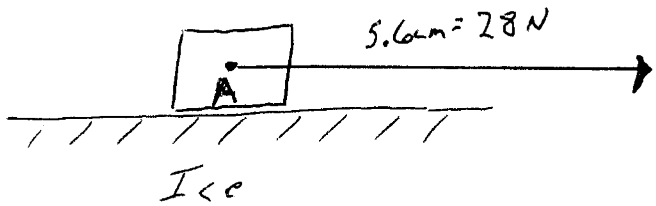
65)

$F_{Net} = ma$

$= 20Kg(1.4 m/s^2)$

$F_{Net} = 28 N$

66 -



67) 200 N

or

196 N

68)

$F_F = \mu F_N$

$= .28(200N)$

$= 56N$