ENERGY REVIEW

Practice Questions for the New York Regents Exam

Directions Name:

Review the Test-Taking Strategies section of this book. Then answer the following questions. Read each question carefully and answer with a correct choice or response.

Part A

1 Which variable expression is correctly paired with its corresponding unit?

(1) $\frac{\text{mass} \cdot \text{distance}}{\text{time}}$ and watt

(2) $\frac{\text{mass} \cdot \text{distance}^2}{\text{time}}$ and watt

(3) $\frac{\text{mass} \cdot \text{distance}^2}{\text{time}^2}$ and joule

(4) $\frac{\text{mass} \cdot \text{distance}}{\text{time}^3}$ and joule

2 What is an essential characteristic of an object in equilibrium?

(1) zero velocity
(2) zero acceleration
(3) zero potential energy
(4) zero kinetic energy

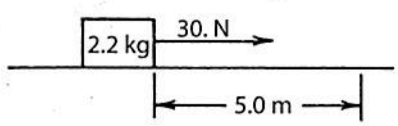
3 A net force with a magnitude of 5.0 newtons moves a 2.0-kilogram object a distance of 3.0 meters in 3.0 seconds. What is the total work done on the object?

(1) 1.0 J (3) 15 J
(2) 10. J (4) 30. J

4 A force is applied to a block causing it to accelerate along a horizontal, frictionless surface. The energy gained by the block is equal to the

(1) work done on the block
(2) power applied to the block
(3) impulse applied to the block
(4) momentum given to the block

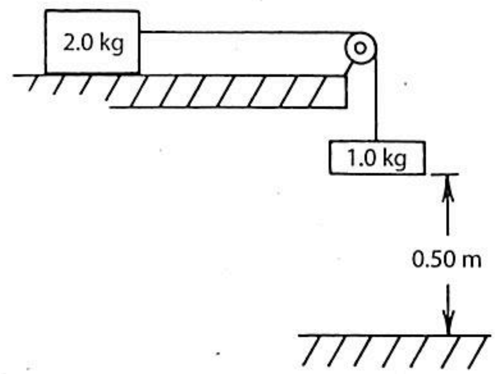
5 A 2.2-kilogram mass is pulled by a horizontal 30.-newton force to the right through a distance of 5.0 meters as shown in the diagram below.



What is the total amount of work done on the mass?

(1) 11 J (3) 150 J
(2) 66 J (4) 330 J

6 In the diagram below, a 1.0-kilogram mass falls a vertical distance of 0.50 meter, causing a 2.0-kilogram mass to slide the same distance along a tabletop.



What is the total work done by the falling mass?

(1) 1.5 J (3) 9.8 J
(2) 4.9 J (4) 15 J

7 A horizontal force with a magnitude of 40. newtons is used to push a block along a level table at a constant speed of 2.0 meters per second. How much work is done on the block in 6.0 seconds?

(1) 80. J (3) 240 J
(2) 120 J (4) 480 J

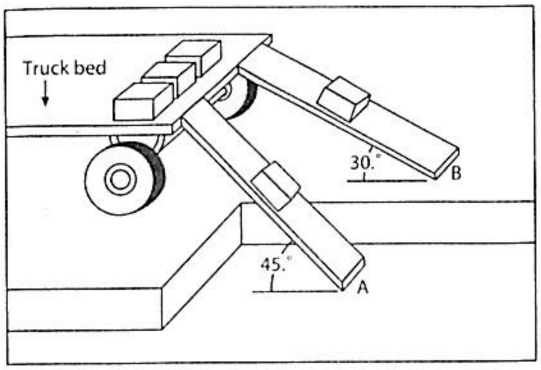
8 A force with a magnitude of 100. newtons is used to push a trunk to the top of an incline 3.0 meters long. Then a force with a magnitude of 50. newtons is used to push the trunk for 10. meters along a horizontal platform. What is the total work done on the trunk?

(1) 8.0×10^2 J
(2) 5.0×10^2 J
(3) 3.0×10^2 J
(4) 9.0×10^2 J

9 The amount of work done against friction to slide a box in a straight line across a uniform, horizontal floor depends most on the

(1) time taken to move the box
(2) distance the box is moved
(3) speed of the box
(4) direction of the box's motion

10 The diagram below shows two identical wooden planks, A and B, at different incline angles. The planks are used to slide concrete blocks from the bed of a truck.



Compared to the amount of work done against friction by a block sliding down plank A, the work done against friction by a block sliding down plank B is

(1) less
(2) more
(3) the same

11 A 95-kilogram student climbs 4.0 meters up a rope in 3.0 seconds. What is the power output of the student?

(1) 1.3×10^2 W
(2) 3.8×10^2 W
(3) 1.2×10^3 W
(4) 3.7×10^3 W

12 What is the minimum power required for a conveyor to raise an 8.0-newton box 4.0 meters vertically in 8.0 seconds?

(1) 260 W
(2) 64 W
(3) 32 W
(4) 4.0 W

13 A weightlifter lifts a 200-kilogram mass a vertical distance of 0.5 meter in 0.1 second. What is the lifter's power output?

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

14 A 4.0×10^3-watt motor applies an 8.0×10^2-newton force 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

15 A boat weighing 9.0×10^2 newtons requires a horizontal force of 6.0×10^2 newtons to move it across the water at 1.5×10^1 meters per second. The boat's engine must provide energy at the rate of

(1) 2.5×10^{-2} J
(2) 4.0×10^{1} W
(3) 7.5×10^{3} J
(4) 9.0×10^{3} W

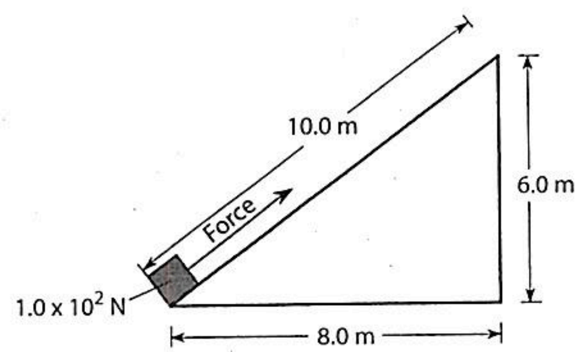
16 As a ball falls freely toward the ground, what happens to the ball's speed and gravitational potential energy with respect to the ground?

(1) Both speed and gravitational potential energy decrease.
(2) Speed decreases and gravitational potential energy increases.
(3) Speed increases and gravitational potential energy decreases.
(4) Both speed and gravitational potential energy increase.

17 An object of mass m is lifted a vertical distance h above the surface of Earth at constant speed v in time t. The total gravitational potential energy with respect to Earth's surface gained by the object is equal to the

(1) average force applied to the object
(2) total weight of the object
(3) total work done on the object
(4) total momentum gained by the object

18 A box weighing 1.0×10^2 newtons is dragged to the top of an incline, as shown in the diagram below.



With respect to the bottom of the incline, the gravitational potential energy of the box at the top of the incline is

(1) 1.0×10^2 J
(2) 6.0×10^2 J
(3) 8.0×10^2 J
(4) 1.0×10^3 J

19 What is the spring constant of a spring of negligible mass that gains 6.0 joules of elastic potential energy as a result of being compressed 0.40 meter?

(1) 2.4 N/m
(2) 15 N/m
(3) 38 N/m
(4) 75 N/m

20 Spring A has a spring constant of 140 newtons per meter and spring B has a spring constant of 280 newtons per meter. Both springs are stretched the same distance. Compared to the elastic potential energy stored in spring A, the elastic potential energy stored in spring B is
(1) the same
(2) twice as great
(3) half as great
(4) four times as great

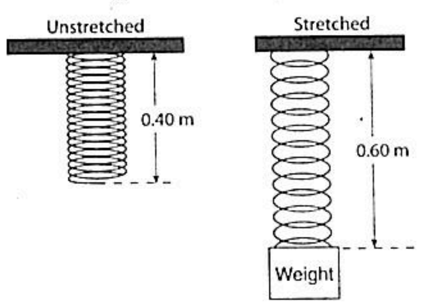
21 A vertical spring 0.100 meter long is elongated to a length of 0.119 meter when a 1.00-kilogram mass is attached to the bottom of the spring. The spring constant of this spring is
(1) 9.8 N/m
(2) 82 N/m
(3) 98 N/m
(4) 520 N/m

22 A force with a magnitude of 10. newtons is required to hold a stretched spring 0.20 meter from its rest position. What is the elastic potential energy stored in the stretched spring?
(1) 1.0 J (2) 2.0 J (3) 5.0 J (4) 50. J

23 When a mass is placed on a spring with a spring constant of 15 newtons per meter, the spring is compressed 0.25 meter. How much elastic potential energy is stored in the spring?
(1) 0.47 J (2) 0.94 J (3) 1.9 J (4) 3.8 J

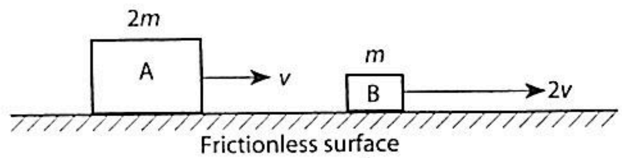
24 A vertically hung spring stretches 0.075 meter when a 5.0-newton block is attached to the spring. What is the spring constant for this spring? [Assume the spring-block system is at rest.]
(1) 38 N/m
(2) 67 N/m
(3) 130 N/m
(4) 650 N/m

25 The unstretched spring in the diagram below has a length of 0.40 meter and a spring constant k. A weight is hung from the spring causing it to stretch to a length of 0.60 meter.



How many joules of elastic potential energy are stored in this stretched spring?
(1) $0.020 \times k$
(2) $0.080 \times k$
(3) $0.18 \times k$
(4) $2.0 \times k$

26 The diagram below shows block A having mass $2m$ and speed v, and block B having mass m and speed $2v$.



Compared to the kinetic energy of block A, the kinetic energy of block B is
(1) the same
(2) twice as great
(3) one-fourth as great
(4) four times as great

27 An object with a speed of 20. meters per second has a kinetic energy of 400. joules. The mass of the object is
(1) 1.0 kg (2) 2.0 kg (3) 0.50 kg (4) 40. kg

28 A total of 10.0 joules of work is done in accelerating a 20.-newton object from rest across a horizontal frictionless table. What is the total kinetic energy gained by the object?
(1) 0.0 J (2) 2.0 J (3) 10. J (4) 200 J

29 A baseball bat strikes a ball with a force with a magnitude of 2.0×10^4 newtons. If the bat stays in contact with the ball for a distance of 5.0×10^{-3} meter, what kinetic energy will the ball acquire from the bat?
(1) 1.0×10^2 J
(2) 2.0×10^2 J
(3) 2.5×10^1 J
(4) 4.0×10^2 J

30 An object 8 meters above the ground has Z joules of gravitational potential energy with respect to the ground. If the object falls freely, how many joules of kinetic energy will it have gained when it is 4 meters above the ground?
(1) Z (2) 2Z (3) $\frac{Z}{2}$ (4) 0

31 A girl rides an escalator that moves her upward at constant speed. As the girl rises, how do her kinetic energy and gravitational potential energy with respect to the bottom of the escalator change?
(1) Kinetic energy decreases and potential energy decreases.
(2) Kinetic energy decreases and potential energy increases.
(3) Kinetic energy remains the same and potential energy decreases.
(4) Kinetic energy remains the same and potential energy increases.

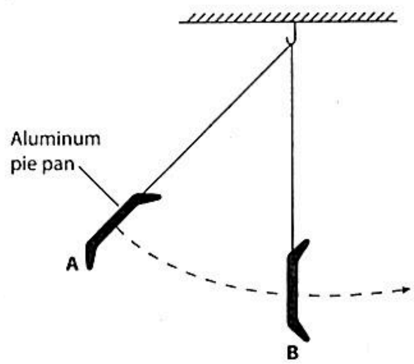
32 A 0.10-kilogram ball dropped vertically from a height of 1.00 meter above the floor bounces back to a height of 0.80 meter. The mechanical energy "lost" by the ball as it bounces is

(1) 0.020 J (3) 0.78 J
(2) 0.20 J (4) 0.98 J

33 A stone is dropped in air from a height of 50 meters above the ground. As the stone falls, what happens to the stone's kinetic energy and internal energy?

(1) Kinetic energy decreases and internal energy decreases.
(2) Kinetic energy decreases and internal energy increases.
(3) Kinetic energy increases and internal energy decreases.
(4) Kinetic energy increases and internal energy increases.

34 An aluminum pie pan is attached to a string and suspended from a hook, as shown in the diagram below. The pan is released from position *A* and swings through the air to position *B*.



What is the relationship between the kinetic energy at position *B*, KE_B, and the gravitational potential energy at position *A*, PE_A with respect to *B*?

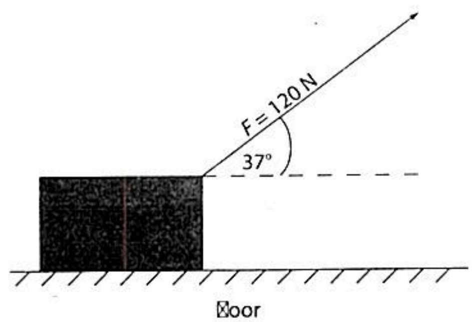
(1) KE_B is equal to PE_A minus work done against friction.
(2) KE_B is equal to the PE_A plus work done against friction.
(3) KE_B is equal to PE_A.
(4) KE_B is equal to $2PE_A$.

35 The bottom of a heavy block is covered with sandpaper. The block is repeatedly slid 1.0 meter at constant speed across a uniform, horizontal wooden plank by the application of a constant horizontal force. As the coefficient of friction between the sandpaper and the plank decreases, the amount of work done in sliding the block 1.0 meter along the plank at constant speed

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

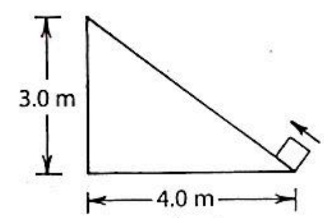
Part B

36 In the diagram below, a box is pulled at constant speed across the floor by the application of a constant force with a magnitude of 120 newtons acting at an angle of 37° to the horizontal.



Calculate the total work done in pulling the box 10. meters across the floor. [2]

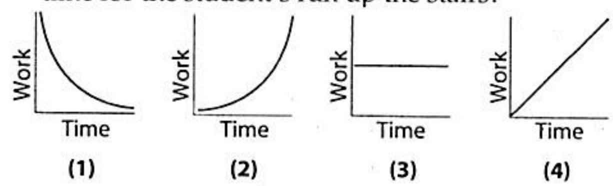
37 A 20.-newton block is at rest at the bottom of a frictionless incline, as shown in the diagram below.



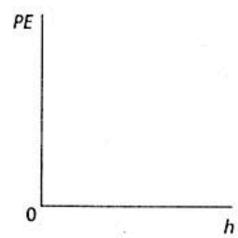
Calculate the work that must be done against gravity to move the block to the top of the incline. [2]

38 A student applies a constant horizontal force having a magnitude of 20. newtons to move a crate at a constant speed of 4.0 meters per second across a rough floor. Calculate the total work done by the student on the 80.-kilogram crate in 6.0 seconds. [3]

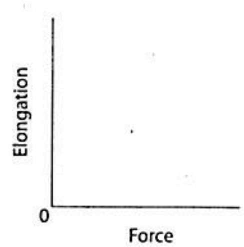
39 A student running up a flight of stairs increases her speed at a constant rate. Which graph best represents the relationship between work and time for the student's run up the stairs?



40 On the axes below, sketch a line to represent the relationship between gravitational potential energy *PE* with respect to the ground and height *h* above the ground for an object near the surface of Earth. [1]

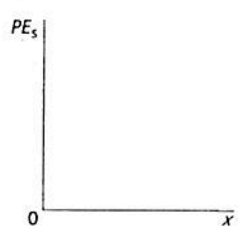


41 On the axes below, sketch a line to represent the relationship between the elongation of an ideal spring and the applied force. [1]

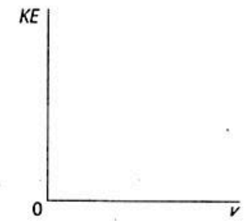


42 A graph represents the relationship between the weight attached to a suspended spring and the resulting total length of the spring. What does the horizontal intercept of the graph represent? [1]

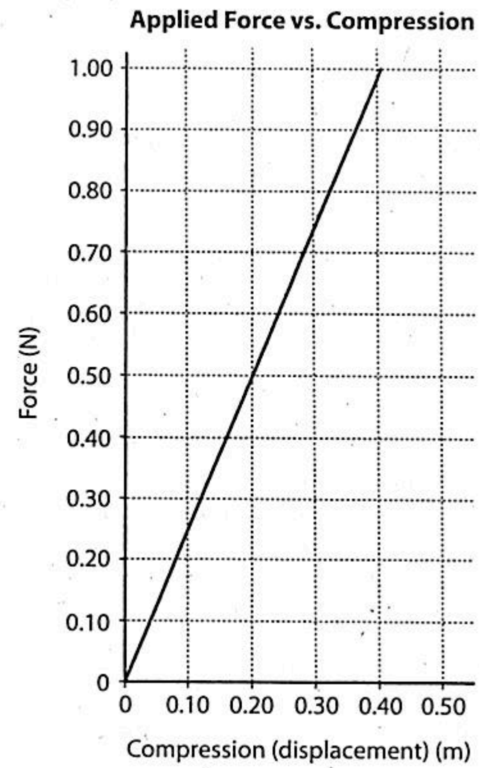
43 On the axes below, sketch a line to represent the relationship between the elastic potential energy stored in a spring PE_s and the change in the length of the spring from its equilibrium position x. [1]



44 On the axes below, sketch a line to represent the relationship between the kinetic energy *KE* of a moving object and its speed v. [1]



Base your answers to questions 45 through 47 on the graph below, which shows the relationship between the force applied to an ideal spring and the compression of the spring.

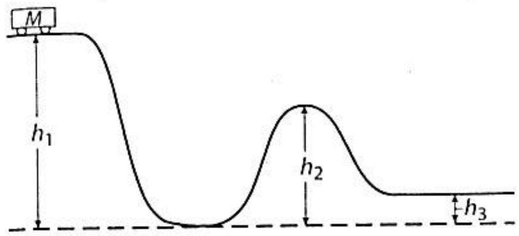


45 Calculate the spring constant for the spring. [2]

46 Calculate the elastic potential energy stored in the spring when it is compressed 0.20 meter. [2]

47 Determine the total work done in compressing the spring 0.20 meter. [1]

48 A cart of mass M on a frictionless track starts from rest at the top of a hill having height h_1, as shown in the diagram below.



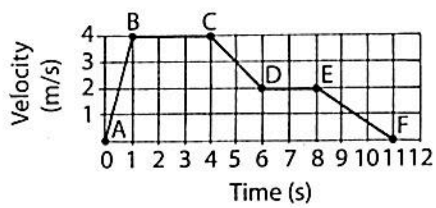
What is the kinetic energy of the cart when it reaches the top of the next hill h_2?

(1) Mgh_1
(2) $Mg(h_1 - h_2)$
(3) $Mg(h_2 - h_3)$
(4) 0

Base your answers to questions 49 through 53 on the information and graph below.

A 2.0-kilogram object moves along a horizontal frictionless surface. The graph shows the relationship between the object's velocity and elapsed time.

Velocity vs. Time



49 Calculate the distance the object moves during interval *EF*. [2]

50 What is the net force on the object during the interval *DE*? [1]

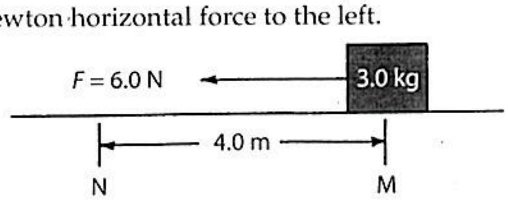
51 Calculate the magnitude of the momentum of the object during interval *BC*. [2]

52 Calculate the kinetic energy of the object during interval *BC*. [2]

53 Identify an interval during which work is *not* being done on the object. [1]

Base your answers to questions 54 through 58 on the information and diagram below.

A 3.0-kilogram mass is being moved at constant speed across a horizontal surface by a constant 6.0-newton horizontal force to the left.



54 What is the change in kinetic energy of the mass as it is moved from point M to point N? [1]

55 Calculate the total work done in 2.0 seconds if energy is supplied at a rate of 10.0 watts. [2]

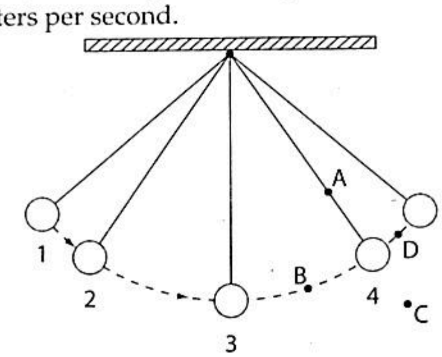
56 What is the magnitude of the force of friction acting on the mass? [1]

57 Calculate the magnitude of the acceleration that would be produced by the 6.0-newton force if the surface the mass slides on was frictionless. [2]

58 Calculate the gravitational potential energy of the 3.0-kilogram mass with respect to the horizontal surface if the mass was raised to a height of 4.0 meters. [2]

Base your answers to questions 59 through 63 on the information and diagram below.

A simple pendulum with a 2.00-kilogram bob and a length of 10.0 meters is released from rest at position 1 and swings without friction through position 4. At position 3, its lowest point, the speed of the bob is 6.00 meters per second.



59 At which point does the bob have its maximum kinetic energy? [1]

60 Calculate the gravitational potential energy of the bob at position 1 with respect to position 3. [2]

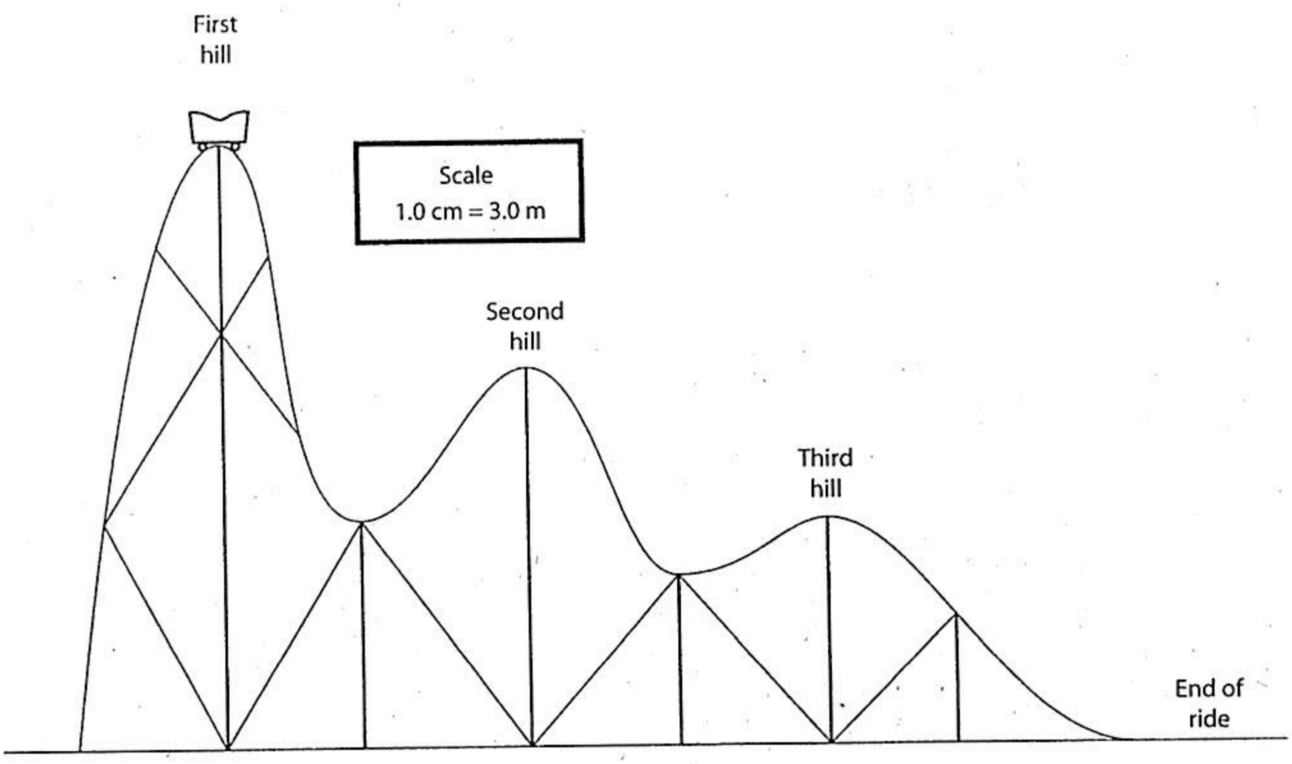
61 At position 4, toward which point, *A*, *B*, *C*, or *D*, is the centripetal force directed? [1]

62 Calculate the magnitude of the centripetal acceleration of the bob at position 3. [2]

63 Compare the sum of the kinetic and potential energies of the bob at position 1 (with respect to position 3) to the sum of the kinetic and potential energies of the bob at position 2 (again, with respect to position 3). [1]

Base your answers to questions 64 through 66 on the information and diagram below, which is drawn to a scale of 1.0 centimeter = 3.0 meters.

A 650-kilogram roller coaster car starts from rest at the top of the first hill of its track and glides freely. [Neglect friction.]



64 Using a metric ruler and the scale 1.0 cm = 3.0 m, determine the height of the first hill. [1]

65 Calculate the gravitational potential energy of the car at the top of the first hill with respect to the end of the ride. [2]

66 Compare the kinetic energy of the car at the top of the second hill to its kinetic energy at the top of the third hill. [1]

Base your answers to questions 67 through 70 on the information below.

A 6.00-kilogram concrete block is dropped from the top of a tall building. The block falls a distance of 55.0 meters and has a speed of 30.0 meters per second when it hits the ground.

67 Calculate the gravitational potential energy of the block with respect to the ground at the instant it is released. [2]

68 Calculate the kinetic energy of the block at the point of impact. [2]

69 Determine the total amount of mechanical energy "lost" by the block as it falls. [1]

70 Explain what happens to the mechanical energy that is "lost" by the block. [1]

Base your answers to questions 71 through 74 on the information and data table below.

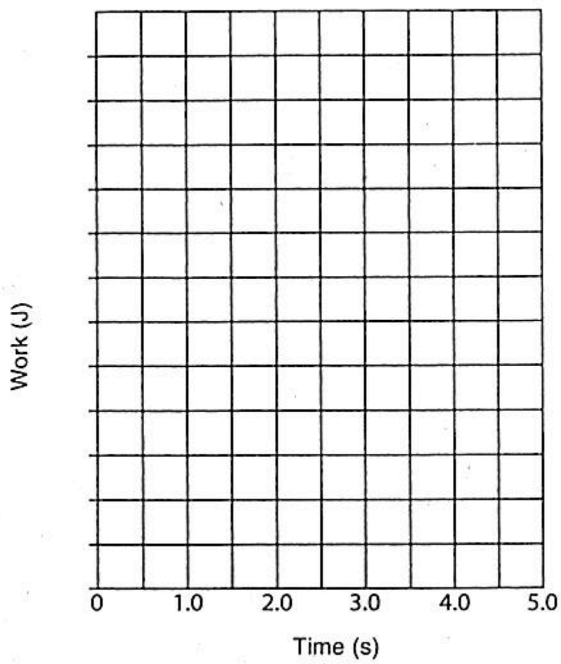
A student performs a laboratory activity in which a constant 15-newton force acts on a 2.0-kilogram mass. The work done over time is summarized in the data table.

Time (s)	Work (J)
0	0
1.0	32
2.0	59
3.0	89
4.0	120.

71 Using information in the data table, construct a graph on the grid provided following the directions below:

- Mark an appropriate scale on the axis labeled "Work (J)." [1]
- Plot the data points. [1]
- Draw the best-fit line. [1]

Work vs. Time



72 Calculate the slope of the line of best fit. [2]

73 What is the physical significance of the slope of the graph? [1]

74 Based on your graph, how much time did it take to do 75 joules of work? [1]

Base your answers to questions 75 through 77 on your knowledge of physics.

75 Explain why it requires more work to stop a ferry boat than a canoe if both are originally traveling with the same velocity. [1]

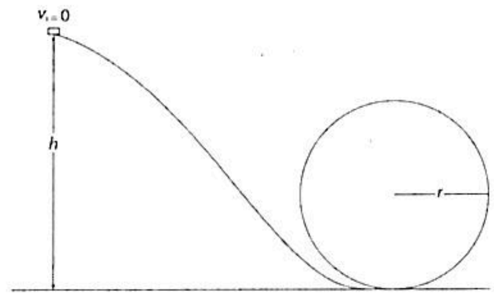
76 A 2.0-kilogram ball is used as the bob of a pendulum suspended from the ceiling of a classroom. The bob is drawn from its equilibrium position and released from the tip of a student's nose. Explain why, if the student does not move, there is no danger of the student being struck on the return swing. [1]

77 A 700.-newton physics teacher runs at constant speed up a flight of stairs rising 6.0 meters in 7.0 seconds. Explain why the teacher can claim he is more powerful than five 100-watt incandescent light bulbs. [1]

Part C

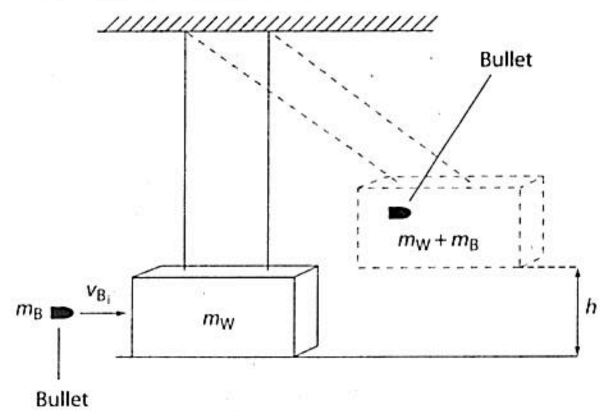
78 Determine the relationship between joules and 1.00 kilowatt · hour. [1]

79 The diagram below shows a small mass sliding along a frictionless track having a loop of radius r.



Using your knowledge of energy and circular motion, prove that if the object is to remain on the track at the top of the loop, the minimum height h from which the object must be released from rest is $\frac{5r}{2}$. [4]

80 A ballistic pendulum is a device consisting of a large block of wood having mass m_W suspended from two light-weight wires. The device is used to measure the initial speed v_{B_i} of a bullet having mass m_B. The bullet is shot into the wood and stopped. The block with embedded bullet has speed v_f immediately after the collision. As the diagram below shows, the bullet-block system swings through some vertical distance h, as mechanical energy is conserved.



Derive an expression for the vertical distance h in terms of m_w, m_B, v_B, and g. [3]

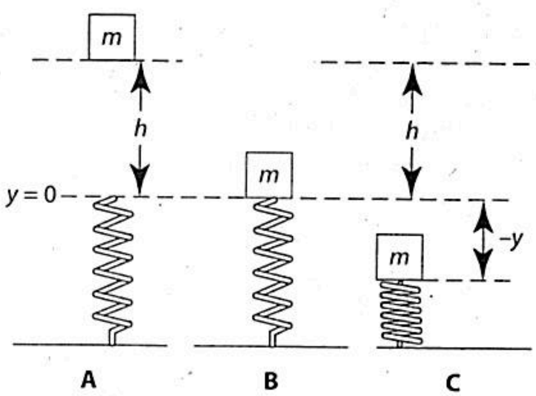
81 When a mass m, hanging from a spring with spring constant k, is set into up-and-down simple harmonic motion, it has a period of vibration T, which is given by the equation $T = 2\pi\sqrt{\frac{m}{k}}$. The amount of elastic potential energy PE_s stored in this spring at any given instant is dependent on its spring constant k and its elongation x. Derive an expression for the potential energy stored in the spring, PE_s, in terms of m, T, and x. [2]

82 A spring in a toy car is compressed a distance, x. When released, the spring returns to its original length, transferring its energy to the car. Consequently, the car having mass m moves with speed v. Derive the spring constant, k, of the car's spring in terms of m, x, and v. [Assume an ideal mechanical system with no loss of energy.] [2]

83 A cart with mass m possesses kinetic energy KE. Write an expression to represent the magnitude of the momentum p of the cart in terms of m and KE. [1]

Base your answers to questions 84 through 87 on the information and diagrams below.

A block of mass m falls from rest a vertical distance h before striking a spring and compressing it a distance $-y$. The spring has spring constant k. At the point where the block first makes contact with the uncompressed spring, the block has speed v and distance is assumed to be zero. [Assume an ideal system.]



84 Write an equation that represents the gravitational potential energy of the block-spring system, as illustrated in A. [1]

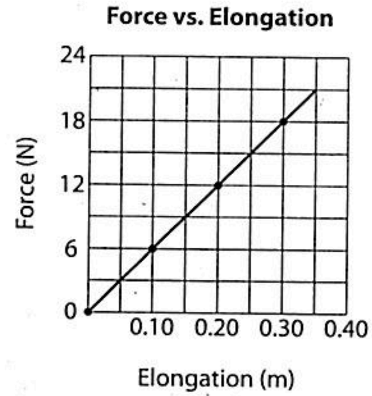
85 Derive an expression for the speed v of the block in terms of h at the instant it makes contact with the uncompressed spring. [1]

86 When the block comes to rest, the spring is compressed a distance $-y$. Write an equation that represents the conservation of energy of the block-spring system in B and C in terms of the variables stated in the problem or other conventional terms. [2]

87 Derive an expression for the spring constant k in terms of g, v, m, and y. [1]

Base your answers to questions 88 and 89 on the following information.

A student performed an experiment in which the force applied to a spring was varied and the resulting elongation measured. The data was graphed, as shown, and the spring constant of the spring was determined to be 60. newtons per meter.



The equivalent spring constant for multiple springs connected in parallel is given by the following equation:

$$k_{\text{eq parallel}} = k_1 + k_2 + k_3 + \ \ldots$$

For multiple springs connected in series the equivalent spring constant is given by the equation:

$$\frac{1}{k_{\text{eq series}}} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \ \ldots$$

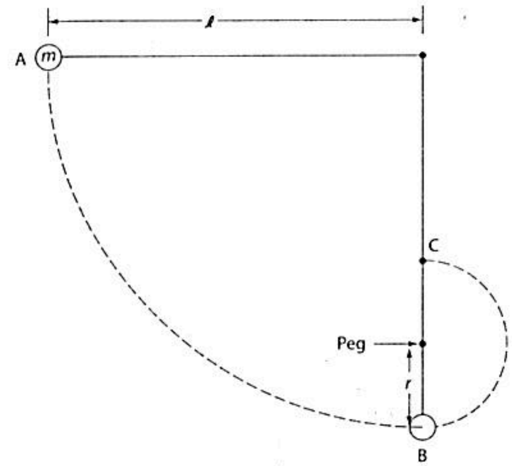
In these equations, k_1, k_2, and k_3 are the spring constants of the individual springs.

88 On a grid, draw a line to represent two identical springs with a spring constant of 60. newtons per meter connected in series. Label the line $k_{\text{eq series}}$. [1]

89 On the grid draw a line to represent the same two springs connected in parallel. Label the line $k_{\text{eq parallel}}$. [1]

Base your answers to questions 90 through 92 on the following information and diagram.

A simple pendulum of length ℓ has a bob of mass m. The bob is released from rest at point A and swings to point B directly below the pivot point. At B the cord comes in contact with a peg located a distance r above the center of the bob. This causes the bob to travel in a circular path to point C, as shown. [Neglect friction. Assume a gravitational potential energy of zero at point B.]



90 Derive an expression for the speed v_B of the bob at point B in terms of ℓ and g. [2]

91 Write an expression for the gravitational potential energy of the bob at point C. [1]

92 Derive an expression for the speed v_C of the bob at point C in terms of ℓ, r, and g. [2]

Base your answers to questions 93 through 96 on the information below.

The driver of a car made an emergency stop on a straight horizontal road. The wheels locked and the car skidded to a stop. The marks made by the rubber tires on the dry asphalt are 16 meters long, and the car's mass is 1200 kilograms.

93 Determine the weight of the car. [1]

94 Calculate the magnitude of the frictional force the road applied to the car in stopping it. [2]

95 Calculate the work done by the frictional force in stopping the car. [2]

96 Assuming that energy is conserved, calculate the speed of the car before the brakes were applied. [2]

Base your answers to questions 97 through 99 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.

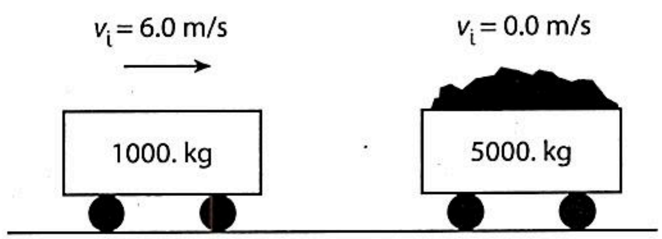
97 Calculate the speed of the sled with the child after she jumps onto the sled. [2]

98 Calculate the kinetic energy of the sled with the child after she jumps onto the sled. [2]

99 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]

Base your answers to questions 100 through 102 on the information and diagram below.

A 1000.-kilogram empty cart moving with a speed of 6.0 meters per second is about to collide with a stationary loaded cart having a total mass of 5000. kilograms, as shown. After the collision, the carts lock and move together. [Assume friction is negligible.]



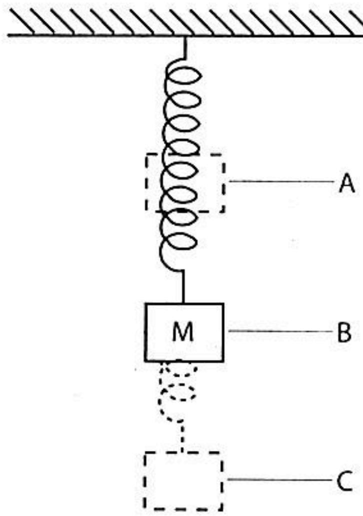
100 Calculate the speed of the combined carts after the collision. [2]

101 Calculate the kinetic energy of the combined carts after the collision. [2]

102 How does the kinetic energy of the combined carts after the collision compare to the kinetic energy of the carts before the collision? [1]

Base your answers to questions 103 through 105 on the information and diagram below.

A mass, *M*, is hung from a spring and reaches equilibrium at position *B*. The mass is then raised to position *A* and released. The mass oscillates between positions *A* and *C*. [Neglect friction.]



103 At which position, *A*, *B*, or *C*, is mass *M* located when the kinetic energy of the system is at a maximum? Explain your choice. [1]

104 At which position, *A*, *B*, or *C*, is mass *M* located when the gravitational potential energy of the system is at a maximum? Explain your choice. [1]

105 At which position, *A*, *B*, or *C*, is mass *M* located when the elastic potential energy of the system is at a maximum? Explain your choice. [1]

Base your answers to questions 106 through 109 on the following information and data table.

The spring in a dart launcher has a spring constant of 140 newtons per meter. The launcher has six power settings, 0 through 5, with each successive setting having a spring compression 0.020 meter beyond the previous setting. During testing, the launcher is aligned to the vertical, the spring is compressed, and a dart is fired upward. The maximum vertical displacement of the dart in each test trial is measured. The results of the testing are shown in the table.

Data Table

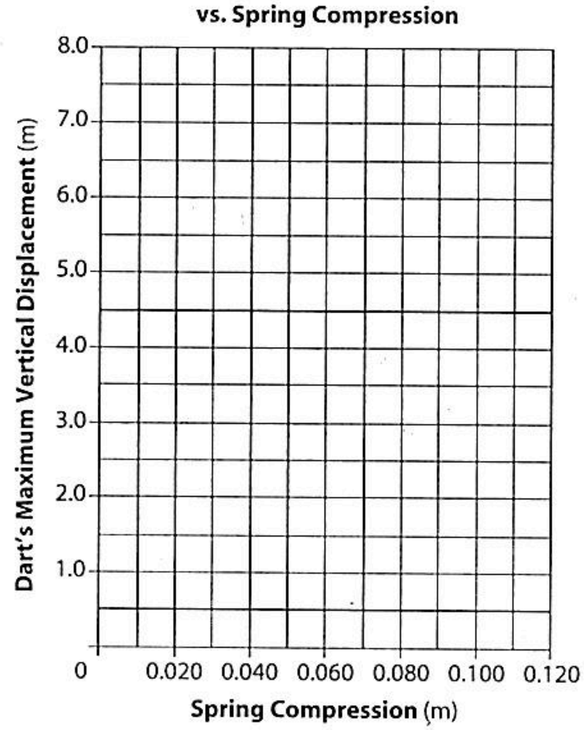
Power Setting	Spring Compression (m)	Dart's Maximum Vertical Displacement (m)
0	0.000	0.00
1	0.020	0.29
2	0.040	1.14
3	0.060	2.57
4	0.080	4.57
5	0.100	7.10

Using the information in the data table, construct a graph on the grid provided following the directions below.

106 Plot the data points for the dart's maximum vertical displacement versus spring compression. [1]

107 Draw the line or curve of best fit. [1]

Dart's Maximum Vertical Displacement vs. Spring Compression



108 Using information from your graph, calculate the energy provided by the compressed spring that causes the dart to achieve a maximum vertical displacement of 3.50 meters. [2]

109 Determine the magnitude of the force, in newtons, needed to compress the spring 0.040 meter. [1]