Name _____ Class _____ Date _____

Exercises

9.1 Work (pages 145–146)

1. Circle the letter next to the correct mathematical equation for work.
   a. work = force ÷ distance b. work = distance ÷ force
   (c.) work = force × distance d. work = force × distance^2
2. You can use the equation in Question 1 to calculate work when the force is constant and the motion takes place in a straight line in the direction of the force.
3. You do work if you lift a book one meter above the ground. How does the amount of work change in each of the following cases?
   a. You lift the book twice as high. You do twice as much work.
   b. You lift two identical books one meter above the ground. You do twice as much work.
4. Complete the table by naming the two general categories of work and giving an example of each.

Category of Work	Example
work done against another force	Possible answer: When an archer stretches her bow, she is doing work against the elastic forces of the bow.
work done to change the speed of an object	Possible answer: An engine does work increasing or decreasing the speed of a car.

5. The unit of work is the joule.
6. Suppose that you apply a 50-N horizontal force to a 25-kg box, pushing the box 6 meters across the floor. How much work do you do on the box? 300 J

9.2 Power (pages 146–147)

7. Power is the rate at which work is done.
8. Power equals work done divided by time interval.
9. The unit of power is the watt.
10. One megawatt (MW) equals one million watts.
11. In the United States, we customarily rate engines in units of horsepower, which is equivalent to 0.75 kilowatt.

9.3 Mechanical Energy (page 147)

12. Define energy.
    the property of an object or system that enables it to do work
13. What is the SI unit of energy? joule

14. Mechanical energy is the energy due to the position or movement of something.

15. What are the two forms of mechanical energy?

a. kinetic energy

b. potential energy

9.4 Potential Energy (pages 148–149)

16. On each line, write *elastic*, *chemical*, or *gravitational* to identify the type of potential energy described.

chemical a. fossil fuels

elastic b. a compressed spring

gravitational c. water in a reservoir

elastic d. a stretched rubber band

chemical e. food

elastic f. a bow drawn back

chemical g. electric batteries

17. The amount of gravitational potential energy possessed by an elevated object is equal to the work done against gravity in lifting it.

18. What are two ways to calculate gravitational potential energy?

a. weight × height

b. mass × acceleration due to gravity (g) × height

19. Explain what the height is when you calculate an object's gravitational potential energy.

The height is the distance above some chosen reference level, such as the ground or the floor of a building.

20. How do hydroelectric power stations make use of gravitational potential energy?

Water from an upper reservoir flows through a long tunnel to an electric generator. Here, gravitational potential energy of the water is converted to electrical energy.

9.5 Kinetic Energy (page 150)

21. Kinetic energy is energy of motion.

22. Circle the letter for the equation you can use to find the kinetic energy of an object.

a. $KE = 2mv$ b. $KE = \frac{1}{2}mv$

c. $KE = 2mv^2$ (d.) $KE = \frac{1}{2}mv^2$

23. Kinetic energy equals the net force on an object multiplied by the distance the object moves.

24. Is the following sentence true or false? If the speed of an object doubles, the kinetic energy of the object also doubles. false

9.6 Work-Energy Theorem (pages 151–152)

25. Express the work-energy theorem.
Whenever work is done, energy changes.

26. Explain this equation: Work = ΔKE.
Work equals change in kinetic energy.

27. Is the following sentence true or false? If you push against a heavy refrigerator, and it doesn't slide, then you are not doing work on the refrigerator.
true

28. Suppose you push against a box so that it moves across a horizontal surface. Explain how to determine the change in kinetic energy in each of the following cases.

a. The surface has no friction. ΔKE equals your push times the distance of your push.

b. The surface has some friction. ΔKE equals the net force, which is your push minus the frictional force, multiplied by the distance of your push.

c. The box moves at a constant speed across a surface that has some friction.
The net force and net work are zero, and the kinetic energy doesn't change.

29. Is the following sentence true or false? The maximum friction that the brakes of a car can supply is nearly the same whether the car moves slowly or quickly.
true

Match each form of hidden kinetic energy with its description.

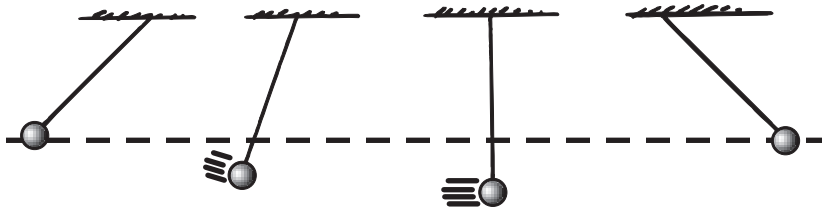
	Form of Kinetic Energy	Description
c	**30.** heat	a. consists of molecules vibrating in rhythmic patterns
a	**31.** sound	b. produced by electrons in motion
b	**32.** electricity	c. results from random molecular motion

9.7 Conservation of Energy (pages 153–154)

33. The energy an arrow delivers to a target is slightly less than the energy it had when it was flying toward the target. What happened to the lost energy?
It was transformed into heat that warmed the arrow and target.

34. Express the law of conservation of energy.
Energy cannot be created or destroyed. It can be transformed from one form into another, but the total amount of energy never changes.

35. The wound spring of a toy car has 10 J of potential energy. Only 8 J of this energy changes to kinetic energy as the car moves. What happens to the remaining 2 J of energy?
It changes to heat in the machinery due to friction.



36. The figure above shows the energy of a swinging pendulum bob at different points along its path.

a. If you ignore friction, how does the energy of the bob at the highest points of its path compare to the energy at the lowest point of its path?

The energy is all potential energy at the highest points and all kinetic energy when the bob is at the lowest point.

b. How does friction affect the pendulum?

Friction gradually changes the energy to heat, and the pendulum eventually stops.

37. The sun shines because some of its nuclear energy is transformed into radiant energy.

38. In nuclear reactors, nuclear energy is transformed into heat.

39. Suppose a person in distress leaps from a burning building onto a firefighter's trampoline near the ground.

a. Describe the change in potential energy, kinetic energy, and total energy as the person falls.

The potential energy changes to kinetic energy. The total energy doesn't change.

b. Suppose the person has 10,000 J of potential energy just before jumping. What are the person's potential energy and kinetic energy upon reaching the trampoline?

The potential energy is zero. The kinetic energy is 10,000 J.

9.8 Machines (pages 155–157)

40. A machine is a device used to multiply forces or change the direction of forces.

41. Circle each letter that describes something a machine can do.

a. puts out more energy than is put into it

(b.) transfers energy from one place to another

(c.) transforms energy from one form to another

d. destroys or creates energy

42. Describe a lever.

a simple machine made of a bar that turns about a fixed point

43. Complete the following mathematical equation for a lever.

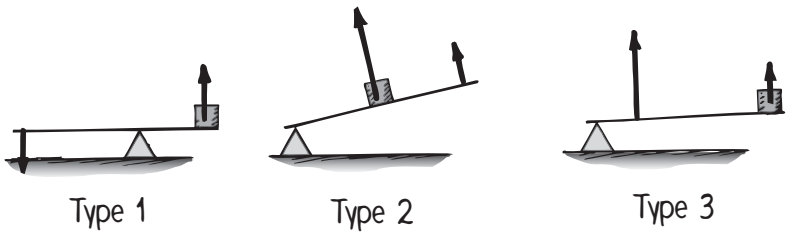
$$(\text{force} \times \text{distance})_{\text{input}} = (\text{force} \times \text{distance})_{\text{output}}$$

44. The pivot point of a lever is called a fulcrum.

45. What are two ways to calculate the mechanical advantage of a machine?

a. Determine the ratio of output force to input force.

b. Determine the ratio of input distance to output distance.



46. The figures above show three types of levers. Give an example of each type.

a. Type 1: Possible answer: a playground seesaw

b. Type 2: Possible answer: a jack used to raise a car

c. Type 3: Possible answer: human arm

47. Describe a pulley.

a type of lever that can be used to change the direction of a force

48. Complete the table about pulleys.

Type of Pulley	Changes direction of the input force?	Multiplies the input force?	Mechanical Advantage
Single pulley with fixed axis	yes	no	1
Single pulley with movable axis	no	yes	2
System of pulleys	possibly	yes	equal to the number of strands of supporting rope

9.9 Efficiency (pages 158–160)

49. Is the following sentence true or false? No real machine can be 100% efficient.

true

50. When a simple lever rocks about its fulcrum, or a pulley turns about its axis, a small fraction of input energy is converted into thermal energy.

51. What are two ratios used to relate the efficiency of a machine to energy and work?

a. Efficiency equals the ratio of useful energy output to total energy input.

b. Efficiency equals the ratio of useful work output to total work input.

52. Suppose you put in 100 J of work on a lever and get out 93 J of work.

a. What is the efficiency of the lever? 93%

b. How much of the work input is lost as heat? 7% or 7J

53. Is the following sentence true or false? The lower the efficiency of a machine, the greater the amount of energy wasted as heat. true

54. Which requires less force: sliding a load up an incline or lifting the load vertically?
sliding the load up the incline

55. The length of an incline is 8 m. The height of the elevated end is 2 m. Circle the letter of the inclined plane's theoretical mechanical advantage.

a. 2 (b.) 4

c. 8 d. 16

56. If the friction of an object against an inclined plane increases, the actual mechanical advantage decreases and the efficiency decreases.

57. What ratio can you use to relate the efficiency of a machine to its mechanical advantage?
Efficiency equals the ratio of actual mechanical advantage to theoretical mechanical advantage.

58. The efficiency of a machine is always less than 1.

59. How can you convert efficiency to percent?
Express it as a decimal value and multiply by 100%.

60. Is the following sentence true or false? An automobile engine is a complex machine that transforms mechanical energy into chemical energy.
false

9.10 Energy for Life (page 160)

61. Most living organisms on this planet feed on various hydrocarbon compounds that release energy when they react with oxygen.

62. Is the following sentence true or false? The amount of energy stored in gasoline is greater than the amount of energy in the products of its combustion.
true

63. Is the following sentence true or false? There is less energy stored in the molecules of food than there is in the reaction products after the food is metabolized.
false

64. How does the metabolism of food in the body compare to the burning of fossil fuels in mechanical engines? How are the processes different?
In both cases, the reaction is self-sustaining once it starts. Also, the same principle of combustion occurs in both cases, but the reaction rate of metabolism is much slower and energy is released only as it is needed by the body.

65. What makes life possible on Earth?
Green plants and some other organisms are able to use the energy of sunlight to make their own food. This energy is passed to other organisms when they eat the plants or eat animals that have eaten plants.

9.11 Sources of Energy (pages 161–162)

66. The sun is the source of practically all our energy on Earth.

67. Sunlight is directly transformed into electricity by photovoltaic cells or flexible solar shingles.

68. Sequence the steps by which sunlight can be used indirectly to generate electricity.

a. Sunlight evaporates water.

b. The water later falls as rain.

c. Rainwater flows into rivers.

d. The river water flows into modern generator turbines.

69. Wind can be considered a type of solar power because wind is caused by unequal warming of Earth's surface.

70. Circle the letter of each correct statement about wind energy.

a. Wind is a steady form of energy.

b. Wind power can provide all of our energy needs.

(c.) Wind can make a substantial contribution to the energy we use.

(d.) Wind energy is practical when the energy is stored for future use.

71. Is the following sentence true or false? Hydrogen is a source of energy.
false

72. In a fuel cell, hydrogen and oxygen gas are compressed at electrodes to produce water and electric current.

73. Earth's interior is kept hot by radioactivity.

74. Geothermal energy is held in underground reservoirs of hot water.