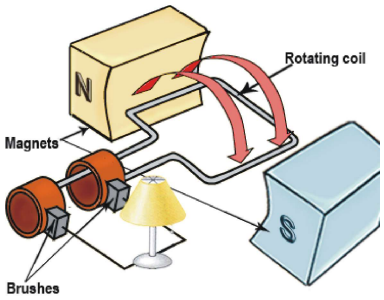
Test Review № 5

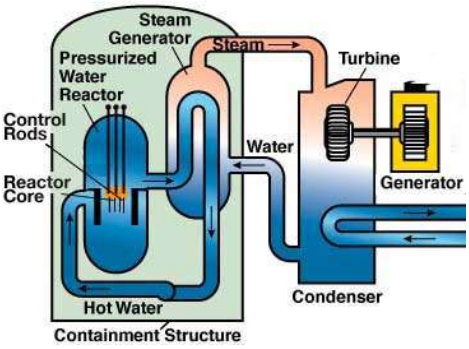
Power Plant. Electricity is the energy of moving electrons. It is generated in a power plant. Power plants generate electricity by energy transformations. Energy is used to turn a generator. This is usually accomplished by burning fuels. Burning fuels heat water to produce steam. The steam pushes on the fan blades of a turbine causing it to spin. The spinning turbine spins a generator, a device that transforms kinetic energy into electrical energy. A generator transforms kinetic energy into alternating voltage by rotating a coil between magnets or by rotating magnets within a stationary coil. The magnets pull on the electrons in the wire causing them to move.



A generator

Energy Sources on Earth. Besides gravitational energy, there are two main sources of energy on Earth: the sun (solar energy), and radioactivity. Radioactivity heats the Earth's core. This heat is seen in volcanos, geysers, and hot springs. It can be tapped for use. This is called geothermal energy. By far, however, most energy used on earth comes from fossil fuels, a form of captured solar energy. There are three main types of fossil fuels: Coal; oil; and natural gas. Fossil fuels come from the remains of ancient plants. Solar energy is captured by plants during photosynthesis. Plants store the energy as oils and carbohydrates. Plant oils and carbohydrates slowly turn to fossil fuels under the influence of heat and pressure over long periods of time. Fossil fuels are considered a nonrenewable resource because they are used much faster than they are made. In addition, burning fossil fuels causes pollution and global warming.

Nuclear Energy. Unstable nuclei of some elements such as U–235, Pu-239, or Th-232 can split into smaller nuclei. When an unstable nucleus splits it is called fission. During fission, neutrons released by fissile (able to undergo fission) nuclei bang into other fissile nuclei and cause them to undergo fission. When a large mass of fissile material is available, it can fuel a nuclear reactor or make a nuclear bomb.



A nuclear reactor is a device that converts nuclear energy into heat energy. The main components are the fuel, a moderator, coolant, control rods, and shielding. The fuel is usually U-235, a fissile isotope of uranium. A moderator is a substance that slows neutrons down without absorbing them in order to increase the chance of collision between the neutrons and the U-235 nuclei. Coolant keeps the system from overheating. Serious overheating could cause a meltdown. Control rods are rods made of boron or cadmium steel. They absorb neutrons, controlling the rate of fission. If the number of neutrons absorbed is greater than the number of neutrons released, fission stops. Shielding provides protection from radiation damage. The core which contains the fuel is surrounded by a steel vessel 20 cm thick. The rest of the reactor is surrounded by high density concrete. A meltdown could breech the shielding and release radioactive material into the environment.

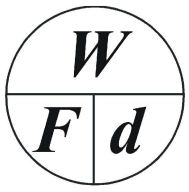
There are pros and cons to nuclear energy. Nuclear energy produces no air pollution, but it produces wastes that are radioactive. Radioactive wastes need to be stored underground in special containers, since no safe way of disposing of them has yet been found.

Alternative Energy. Alternative energy sources are sources of energy based on research to reduce the negative impact on the environment. Alternative energy sources include: Hydroelectricity; Solar energy; Geothermal energy; Tidal energy; and Wind. *Hydroelectricity* produces electricity from the energy in moving water. Water turns a turbine which turns a generator to produce the electricity. It is a renewable resource because it is replenished continuously. It is pollution free, but it disrupts the lives of aquatic organisms, primarily because it depends on dams. *Solar energy* is an inexhaustible resource. Solar collectors which consist of black panels act as a thermal collector by absorbing sunlight and heating water that is sent through pipes for heat, washing, and bathing. Some solar panels have photovoltaic cells that transform radiant energy directly into electricity. Unfortunately, solar energy doesn't work at night without some sort of storage device, and it is unreliable on cloudy days. Solar technology is expensive, and requires a lot of land to generate appreciable power. Production, transportation, and installation of solar panels are *not* pollution free activities. *Geothermal energy* comes from the interior of the earth. The interior of the earth is hot due to radioactivity. The heat can melt rock forming magma. Magma comes close enough to the surface in some places to heat water that seeps through cracks and form steam. Hot water and steam that becomes trapped in cracks and pockets is called a *geothermal reservoir*. Geothermal powerplants are in places where geothermal reservoirs are only several kilometers deep, and wells can be drilled to tap them. Geothermal energy can also be used for heat pumps. Heat pumps stay at a constant temperature, and can be used for either heating or cooling. The temperature several meters below ground is a constant 10°C to 20°C due to geothermal energy. A heat pump contains a water filled loop that passes through a region of the ground where the temperature is nearly constant. Water is pumped through the loop to the region of constant temperature where it either gains or loses heat underground depending on its temperature. Then the water is pumped back up where it is either used for heating or cooling. Geothermal energy is only practical in areas that have geothermal reservoirs, and they can run out of steam. Drilling for geothermal energy at setting up a power plant is very expensive, and harmful gasses may escape through the holes that are drilled. *Tidal energy* can be tapped in places where the difference in the level of the high tide and low tide is large. High tide and low tide occur about twice each day. The tide can be used to generate electricity. As the water comes in, it moves through a turbine. The incoming water is trapped behind a dam. When the tide goes out, the water is released through the turbine. The turbine spins a generator to make electricity. Tidal technology has relatively high costs, and limited availability. *Wind* is an inexhaustible supply of energy. The propellor of a windmill is connected to a generator so it produces electricity. The advantages of wind power are that it is inexhaustible and nonpolluting. Unfortunately, it requires large tracts of flat land, it is noisy, and it may accidentally kill birds.

Work. To do actual work on something, you have to make it move. The further you move it, the more work you do. The heavier it is, the more work you do moving it. The amount of work done is the product of the applied force and the distance through which the applied force operates.

$$W = F \times d$$

- W = work (J)
- F = force (N)
- d = distance (m)



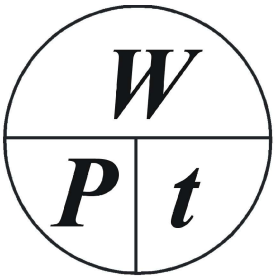
Sample Problem

How much work is done lifting a 30 N object a distance of 1.5 m?

W = F × d
W = (30 N)(1.5 m)
W = 45 N•m = 45 J

Power. Power is the rate at which work is done, or the amount of work per unit of time. The more power something has, the faster it accomplishes work. Power is expressed in watts. (1 watt = 1 $^{J}/_{s}$)

$$Power = \frac{Work}{time} \qquad P = \frac{W}{t}$$



Machines. *A* **machine** *is a device that changes the direction or magnitude and distance through which a force operates*. Sometimes a machine seems to magnify the applied force enabling you to move very heavy things. The apparent change of the applied force is the **mechanical advantage**.

The applied force to a machine is called the **input force**. The resulting force from the machine is called the output force. The **mechanical advantage** is the ratio of the output force to the input force. If the mechanical advantage of a machine is greater than "1," the machine makes work easier.

Sample Problems

How much power is needed to accomplish 250 J of work in 12.5 s?

$$P = \frac{W}{t};\ P = \frac{250J}{12.5s} = 20watts$$

How much energy does a 60 watt bulb use in 1 minute (60 s)?

$$P = \frac{W}{t};\ 60watts = \frac{W}{60s};\ W = (60watts)(60s) = 3600J$$

How high can a 500 N box be lifted in 25 s with 400 watts of power?

Step 1: Calculate work done

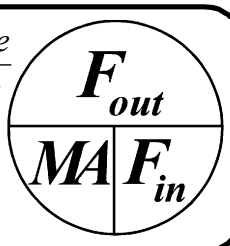
$$P = \frac{W}{t};\ 400watts = \frac{W}{25s};\ W = 10{,}000J$$

Step 2: Calculate the distance

$$W = F \times d;\ 10{,}000J = (500N)(d)$$

$$d = \frac{10{,}000J}{500N};\ d = 20m$$

$$mechanical\ advantage = \frac{output\ force}{input\ force} \qquad MA = \frac{F_{out}}{F_{in}}$$



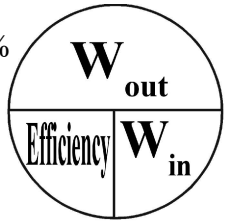
Sample Problem

How much weight can be lifted with a force of 110 N by a machine with a mechanical advantage of 6?

$$MA = \frac{F_{out}}{F_{in}};\ 6 = \frac{F_{out}}{110N};\ F_{out} = (6)(110N) = 660N$$

Efficiency. According to the law of conservation of energy, you can never get more out of a machine than you put into it. But you can certainly waste energy overcoming friction. Friction reduces the work output, making it less than the work input. The efficiency is the ratio of the work output to the work input.

$$efficiency = \frac{work\ output}{work\ input} \times 100\% \qquad eff = \frac{W_{out}}{W_{in}} \times 100\%$$



(*NOTE*: Express efficiency as a decimal to calculate W_{out} or W_{in}.)

Sample Problem

A machine has an efficiency of 65 percent. How much work was done to accomplish 143 J of work?

$$eff = \frac{W_{out}}{W_{in}};\ 0.65 = \frac{143J}{W_{in}};\ W_{in} = \frac{143J}{0.65} = 220J$$

Answer the questions below by circling the number of the correct response

1. Photovoltaics perform what type of energy transformation? (1) thermal to radiant (2) kinetic to electrical (3) radiant to electrical (4) electrical to thermal

2. Solar energy, wind, and geothermal are what type of energy resource? (1) inexhaustible (2) inexpensive (3) nonrenewable (4) chemical

3. Which of the following is a nonrenewable source of energy? (1) hydroelectricity (2) nuclear (3) wind (4) solar

4. A generator is NOT required to generate electrical energy when which of the following energy sources is used? (1) solar (2) wind (3) hydroelectric (4) nuclear

5. Which of the following are fossil fuels? (1) gas (2) coal (3) oil (4) all of these

6. Almost all of the energy that is used on Earth's surface comes from which of the following energy sources? (1) radioactivity (2) the Sun (3) chemicals (4) wind

7. A certain type of power plant is designed to provide energy for 10,000 homes. How many of these power plants would be needed to provide energy for 300,000 homes? (1) 10 (2) 20 (3) 30 (4) 40

Use the table below to answer questions 8 and 9.

Energy Source	Percent of Energy Used
Coal	23%
Oil	39%
Natural gas	23%
Nuclear	8%
Hydroelectric	4%
Other	3%

8. According to the data in the table above, what percentage of the energy used in the United States comes from fossil fuels? (1) 15 % (2) 23 % (3) 39 % (4) 85 %

9. How many times greater is the amount of energy that comes from fossil fuels than the amount of energy from all other energy sources? (1) 5.67 times (2) 2 times (3) 7.67 times (4) 28.33 times

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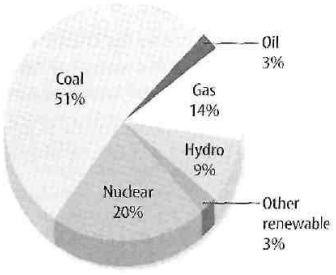
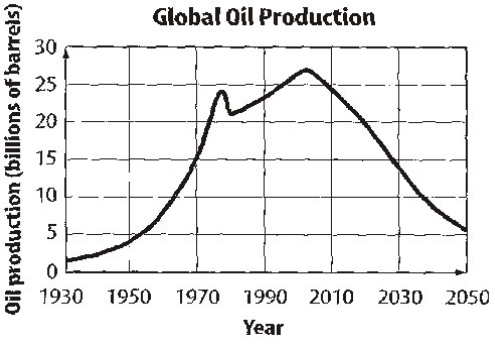
10. Which of the following energy sources is being used faster than it can be replaced? (1) tidal (2) wind (3) fossil fuels (4) hydroelectric

11. The circle graph to the right shows the sources of electrical energy in the United States. In 2002, the total amount of electrical energy produced in the United States was 38.2 quadrillion BTUs. How much electrical energy was produced by nuclear power plants? (1) 3.0 quadrillion BTUs (2) 3.8 quadrillion BTUs (3) 7.6 quadrillion BTUs (4) 35.1 quadrillion BTUs



12. A softball player hits a fly ball. Which of the following describes the energy conversion that occurs as it falls from its highest point? (1) kinetic to potential (2) potential to kinetic (3) thermal to potential (4) thermal to kinetic

Use the graph below to answer questions13-15 .

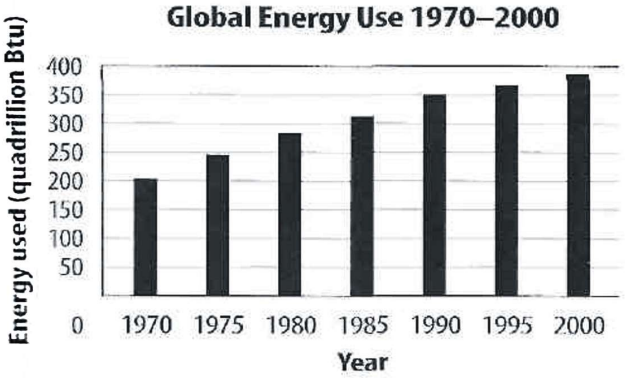


13. According to the graph above, in which year will global oil production be at a maximum? (1) 1974 (2) 2002 (3) 2010 (4) 2050

14. Approximately how many times greater was oil production in 1970 than oil production in 1950? (1) 2 times (2) 10 times (3) 6 times (4) 4 times

15. In which year will the production of oil be equal to the oil production in 1970? (1) 2010 (2) 2015 (3) 2022 (4) 2028

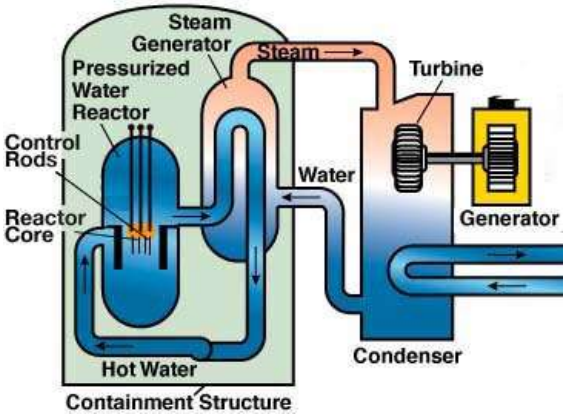
Use the graph below to answer questions 16 and 17



16. According to the graph above, by about how many times did the global use of energy increase from 1970 to 2000? (1) 1.5 times, (2) almost 2 times, (3) 3 times, (4) there was no change.

17. Over which five-year time period was the increase in global energy use the largest? (1) 1970–1975 (2) 1975–1980 (3) 1980–1985 (4) 1995–2000

Answer questions 18-21 by referring to the diagram of the nuclear power plant below.



18. What is the fuel in the reactor core? (1) oil (2) steam (3) hot water (4) U-235

19. The control rods control the rate of the reaction by (1) absorbing neutrons, (2) cooling the water, (3) reducing the pressure, (4) slowing the turbine.

20. What turns the turbine? (1) uranium (2) steam (3) the generator (4) the control rods.

21. What is the purpose of the nuclear power plant pictured above? (1) It produces nuclear wastes. (2) It produces steam. (3) It produces electricity. (4) It produces heat.

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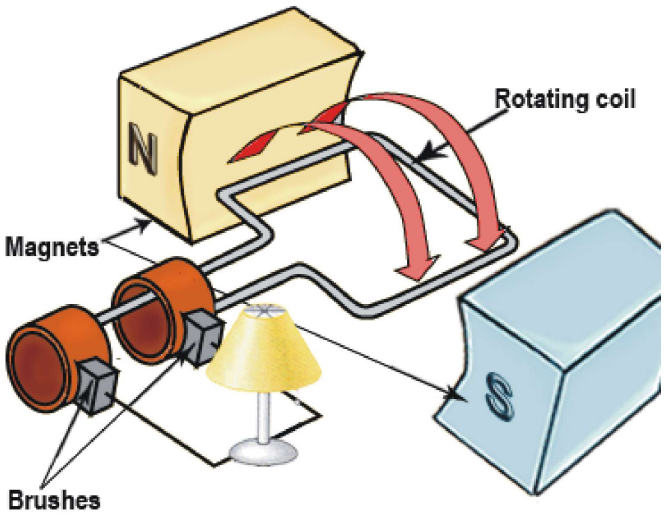
22. What is the major drawback of nuclear energy? (1) It produces air pollution. (2) It causes global warming. (3) It is disrupts the lives of aquatic organisms. (4) It produces nuclear wastes.

23. What is the major drawback to hydroelectric power? (1) It disrupts the lives of aquatic organisms. (2) It causes global warming. (3) It is nonrenewable. (4) It produces air pollution.

24. Which alternative energy source only works during the daylight? (1) geothermal energy (2) solar power (3) wind power (4) tidal energy.

25. Which alternative energy source often kills birds? (1) geothermal energy (2) solar power (3) wind power (4) tidal energy.

Answer questions 26-27 by referring to the diagram of the generator below.



A generator

26. What do the magnets of the generator do? (1) generate heat (2) cause the generator to turn (3) turn the turbine (4) move electrons in the coil

27. What kind of energy transformation is done by a generator? (1) Heat is transformed into mechanical energy. (2) Mechanical energy is transformed into electrical energy. (3) Electrical energy is transformed into mechanical energy. (4) Mechanical energy is transformed into potential energy.

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28. Which of the following is sufficient for work to be done? (1) Force is exerted. (2) Object is held. (3) Force moves an object. (4) Machine is used.

29. How much work is done when a force of 30 N moves an object a distance of 3 m? (1) 3 J (2) 10 J (3) 30 J (4) 90 J

30. How much power is used when 600 J of work are done in 10 s? (1) 6 W (2) 60 W (3) 600 W (4) 610 W

31. Mechanical advantage can be calculated by which of the following expressions? (1) input force/output force (2) output force/input force (3) input work/output work (4) output work/input work

32. What is the mechanical advantage of a machine that changes only the direction of the input force? (1) less than 1 (2) zero (3) 1 (4) greater than 1

33. Explain why the output work for any machine can't be greater than the input work. (1) It would violate conservation of energy. (2) The efficiency would be less than 100 percent. (3) The input force would be too large. (4) The mechanical advantage would be greater than 1

34. On the Moon, the force of gravity is less than on Earth. How would this affect the mechanical advantage of a machine and the input force compared to Earth? (1) Both the input force and the mechanical advantage would be the same. (2) The input force would be less, but the mechanical advantage would be the same. (3) The input force would be less, because the mechanical advantage would be greater. (4) Both the input force and the mechanical advantage would be greater.

35. How much input force is required to lift an 11,000-N beam using a machine with a mechanical advantage of 20? (1) 550 N (2) 220,000 N (3) 11,020 N (4) 10,980 N

36. The input work done on a pulley system is 450 J. What is the efficiency of the pulley system if the output work is 375 J? (1) 120 % (2) 83.3 % (3) 75 % (4) 16.9 %

37. The work done by a boy pulling a snow sled up a hill is 425 J. What is the power expended by the boy if he pulls on the sled for 10.5 s? (1) 24.7 W (2) 40.5 W (3) 247 W (4) 4460 W

38. Which of the following causes the efficiency of a machine to be less than 100%? (1) work (2) power (3) mechanical advantage (4) friction

39. You push a shopping cart with a force of 12 N for a distance of 1.5 m. You stop pushing the cart, but it continues to roll for 1.1 m. How much work did you do? (1) 8.0 J (2) 13 J (3) 18 J (4) 31 J

40. You push a 5-kg box across the floor with a force of 25 N. How far do you have to push the box to do 63 J of work? (1) 0.40 m (2) 1.6 m (3) 2.5 m (4) 13 m

41. How much energy is used by a 75-W lightbulb in 15 s? (1) 5 J (2) 90 J (3) 60 J (4) 1125 J

42. Calculate the amount of work you do pushing a refrigerator 3 m with a force of 50 N (1) 53 J (2) 17 J (3) 150 J (4) 47 J

43. Calculate the amount of work you do when you lift a box weighing 25 N to a height of 2 m. (1) 12.5 J (2) 50 J (3) 27 J (4) 23 J

44. Sal has a weight of 500 N. How many joules of work has Sal done against gravity when he reaches 4 m high on a rock-climbing wall? (1) 2,000 J (2) 125 J (3) 504 J (4) 0.008 J

45. You do 200 J of work against gravity when lifting your backpack up a flight of stairs that is 4 m tall. What is the weight of your backpack in Newtons? (1) 0.02 N (2) 50 N (3) 800 N (4) 204 N

46. A lever has an input force of 5 N and an output force of 15 N. What is the mechanical advantage of the lever? (1) 1 (2) 2 (3) 3 (4) 0.33

47. A simple machine has a mechanical advantage of 5. If the output force is 10 N, what is the input force? (1) 0.5 N (2) 2 N (3) 50 N (4) 15 N

48. You use a rope and pulley system with a mechanical advantage of 5. How big an output load can you lift with an input force of 200 N? (1) 0.25 N (2) 40 N (3) 1,000 N (4) 195 N

49. A 60-W light bulb uses 60 J of electrical energy every second. However, only 6 J of electrical energy is converted into light energy each second. What is the efficiency of the light bulb? Give your answer as a percentage. (1) 1 % (2) 100 % (3) 10 % (4) 66 %

50. The work output is 300 J for a machine that is 50% efficient. What is the work input? (1) 600 J (2) 150 J (3) 250 J (4) 350 J

51. A machine is 75% efficient. If 200 J of work are put into the machine, how much work output does it produce? (1) 150 J (2) 267 J (3) 275 J (4) 125 J

52. Work is done in all of the following situations *except* (1) a crane lifts a heavy crate. (2) a person carries groceries up a set of stairs. (3) a person pushes on a car which does not budge. (4) two people push on a car which moves 1 m.

53. You push on a piano with a force of 50 N and move it 2 m. How much work have you done? (1) 2 J (2) 25 J (3) 50 J (4) 100 J

54. Sonya performs 980 J of work against gravity while lifting a 98 N barbell. How high does she lift the barbell? (1) 1 m (2) 10 m (3) 20 m (4) 50 m

55. Alex weighs twice as much as Bob. Bob weighs twice as much as Carlos. They each climb a flight of stairs in the same amount of time. Who has more power? (1) Alex (2) Bob (3) Carlos (4) they all have the same power

56. You can increase a machine's efficiency by decreasing the (1) power. (2) friction. (3) gravity. (4) energy.

57. You build a machine which is 80% efficient. How many joules of work are put into the machine to produce 400 J of output work? (1) 500 J (2) 320 J (3) 0.2 J (4) 480 J

58. An elevator carries a 490 N person up 10 m. The elevator does 7,000 J of input work. What is the efficiency of the elevator? (1) 50% (2) 70% (3) 90% (4) 100%

59. How much work is done lifting a 25 N box and placing on a 1.5 m high shelf? (1) 16.67 J (2) 26.5 J (3) 37.5 J (4) 23.5 J

60. If 60 J of work are required to slide a box a distance of 5 m, what is the force of friction? (1) 55 N (2) 12 N (3) 0.083 J (4) 300 J

61. How high does a 1.42 N baseball go if 21.32 J of work are done tossing it in the air? (1) 30 m (2) 22.7 m (3) 19.9 m (4) 15 m

62. How much work is done attempting to slide a crate to a doorway 3 m away with a force of 50 N if static friction is 86 N? (1) 0 J (2) 150 J (3) 258 J (4) 29 J

63. A 15 watt compact fluorescent (CFL) bulb is as bright as a standard 60 watt bulb. How much energy is saved every minute by using the CFL bulb? (1) 45 J (2) 0.75 J (3) 75 J (4) 2700 J

64. How long does it take to do 15,000 J of work with 250 watts of power? (1) 0.016 s (2) 60 s (3) 14,750 J (4) 250 J

65. What is the weight of a box that can be lifted 15 m in 25 s with 200 watts of power? (1) 333 N (2) 120 N (3) 18.75 N (4) 0.53 N

66. How high can a 750 N box be lifted in 15 s with 500 watts of power? (1) 22.5 m (2) 0.10 m (3) 25,000 m (4) 10 m

67. What is the mechanical advantage of a machine that can lift 1,400 N with a force of 175 N? (1) 0.125 (2) 1,225 (3) 3 (4) 8

68. What is the maximum weight that can be lifted with a force of 75 N by a machine with a mechanical advantage of 3? (1) 225 N (2) 25 N (3) 78 N (4) 72 N

69. How much effort is needed to lift a 1,500 N crate using a machine with a mechanical advantage of 12? (1) 1488 N (2) 18,000 N (3) 125 N (4) 180 N

70. How efficient is a machine with a work output of 85 J and a work input of 255 J? (1) 85 % (2) 33.3 % (3) 170 % (4) 46.75 %

71. A machine has an efficiency of 25 percent. How much work was done to accomplish 150 J of work? (1) 37.5 J (2) 600 J (3) 3750 J (4) 125 J

72. How much useful work was done if a machine with 75 percent efficiency required an input of 800 J? (1) 600 J (2)1067 J (3) 875 J (4) 725 J

73. The input work done on a pulley system is 450 J. What is the efficiency of the pulley system if the output work is 375 J? (1) 120 % (2) 83.3 % (3) 75 % (4) 16.9 %

74. A lever has an input force of 5 N and an output force of 15 N. What is the mechanical advantage of the lever? (1) 1 (2) 2 (3) 3 (4) 0.33

75. A simple machine has a mechanical advantage of 5. If the output force is 10 N, what is the input force? (1) 0.5 N (2) 2 N (3) 50 N (4) 15 N

76. You use a rope and pulley system with a mechanical advantage of 5. How big an output load can you lift with an input force of 200 N? (1) 0.25 N (2) 40 N (3) 1,000 N (4) 195 N

Answers

1. 3	17. 1	33. 1	49. 3	65. 1
2. 1	18. 4	34. 2	50. 1	66. 4
3. 2	19. 1	35. 1	51. 1	67. 4
4. 1	20. 2	36. 2	52. 3	68. 1
5. 4	21. 3	37. 2	53. 4	69. 3
6. 2	22. 4	38. 4	54. 2	70. 2
7. 3	23. 1	39. 3	55. 1	71. 2
8. 4	24. 2	40. 3	56. 2	72. 1
9. 1	25. 3	41. 4	57. 1	73. 2
10. 3	26. 4	42. 3	58. 2	74. 3
11. 3	27. 2	43. 2	59. 3	75. 2
12. 2	28. 3	44. 1	60. 2	76. 3
13. 2	29. 4	45. 2	61. 4	
14. 4	30. 2	46. 3	62. 1	
15. 4	31. 2	47. 2	63. 4	
16. 2	32. 3	48. 3	64. 2	