Test Review № 4

Newton's Third Law. According to Newton's Third Law, forces always act in equal but opposite pairs. For every action force, there is an equal but opposite reaction force. When you push on a wall, the wall pushes back on you. The action force and the reaction force are on two different objects. As a result, action and reaction forces don't cancel each other..

Action-reaction forces are a bit confusing when it comes to gravity. Gravity pulls down on you, but gravity is a mutual force of attraction. You are also pulling up on the earth. These forces make up one unbalanced action-reaction force pair. When you stand on a surface, your weight presses down, and the surface presses up. This makes up another unbalanced action-reaction force pair. Out of these four forces, there are some balanced forces. Gravity and the surface you are standing on are both exerting forces that are acting on *you*. These forces *are* balanced. As a result, you are not moving. But if you press down with a force greater than your weight, the reaction force is enough to overcome gravity. This is what happens when you jump.

Jet Propulsion. If you blow up a balloon and let it go without tying it, the balloon flies away. The shrinking balloon forces air out the opening. But when the balloon pushes on the air, the air pushes back causing the balloon to move. A jet and a rocket ship move in much the same way. When the fuel in a jet engine or a rocket ship burns, hot gases are released that expand and press against the walls of the chamber. According to Newton's Third Law, the chamber pushes back against the fuel. If there is an opening at one end of the chamber, the expanding gases move out. In order for the molecules to move out of the chamber there must be a net (unbalanced) force. In response, there is a net reaction force at the other end of the chamber. This causes the jet or the rocket ship to move in the opposite direction of the escaping, hot gas molecules.

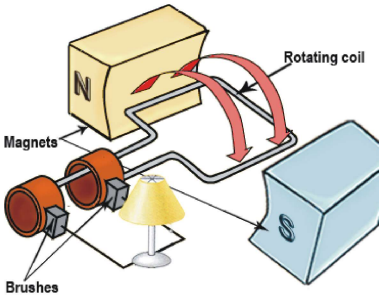
Weightlessness. When you step on a scale, gravity presses you down on the scale with a force equal to your weight. According to Newton's third law, the scale presses back. Suppose the floor beneath the scale suddenly gives way and you are falling together with the scale. Gravity is moving you and the scale together. The scale is not pushing up on you. According to Newton's third law, you are not pushing down on the scale. The scale measures your weight to be zero. You feel weightless because nothing is pushing up on you. Weightlessness in orbit is pretty much the same phenomenon. An object in orbit is falling towards the earth, but it is also moving away from the earth (at a right angle). All the objects in a space craft in orbit are also falling. As a result, they feel weightless. Keep in mind, however, that weight is the downward force due to gravity. Anything that is orbiting the earth is being pulled down by gravity, or it would take off into space instead of orbiting. As a result, technically, it still has weight regardless of how it feels.

The Nature of Energy. Energy is the ability to cause change or do work. Change occurs or work is done when energy is transferred from one object to another. There are two major categories of energy: Kinetic energy and potential energy. Kinetic energy is the energy an object has due to its motion. The faster an object moves the more kinetic energy it has, and the more mass a moving object has, the more kinetic energy it has. Potential energy is stored energy or energy of position. The higher an object is from earth the more potential energy it has due to its position. Kinetic and potential energy come in different forms. Some examples are: (1) Thermal energy (heat), the kinetic energy of moving molecules; (2) Chemical energy, energy stored in chemical bonds; (3) Light energy (radiant energy), the kinetic energy of moving photons; (4) Electrical energy, the kinetic energy of moving electrons; and (5) Nuclear energy, the energy stored in the nucleus of an atom.

Conservation of Energy. Energy can change from one form to another or from one type to another. When it does, energy is conserved. The Law of Conservation of Energy says energy is never created or destroyed. It doesn't always seem that this is true. When a ball is tossed in the air it slows down until its speed reaches zero. This means the kinetic energy decreases to zero. But the speed reaches zero at the highest point where the potential energy is greatest. Energy is not being lost. It is just changing from kinetic energy to potential energy. The gravitational potential energy is the product of the mass, the acceleration of gravity, and the height ($\boldsymbol{PE = mgh}$). The kinetic energy is one half the product of the mass and the velocity squared ($\boldsymbol{KE = \frac{1}{2}mv^2}$). At the highest point, when the speed of a tossed ball is zero and the kinetic energy is zero, the potential energy is equal to the kinetic energy at the lowest point when the speed of the ball is maximum and the potential energy is zero. The total energy of the ball (sum of potential and kinetic) is always the same, because energy is conserved. A bouncing ball will keep bouncing lower and lower until it eventually stops. Even then, energy is conserved. Each time the ball hits the ground, some energy is absorbed by the ground. The ball doesn't have it, but the surroundings do. The total energy is still the same.

Energy Transformations. Energy changes form. This is called an energy transformation. Chemical energy is transformed when fuels and food are used for energy. Food energy is used to move muscles, while fuels are used to move cars and other machines. When fuels and food are used, they also release heat. Appliances are devices that transform electrical energy. An electric light transforms electricity to light, a toaster transforms electricity to heat, and a radio transforms electricity and radio waves to sound. Thermal energy is transformed when hot metals glow giving off light or when hot water produces steam that can run a steam engine. Thermal energy is also produced by energy transformations as when burning fuels (chemical energy) or an electric stove gives off heat. Thermal energy always flows from higher temperature to lower temperature.

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

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

1. Which law of physics that explains how balloons, jets, and rocket ships fly? (1) Newton's first law, (2) Newton's second law, (3) Newton's third law, (4) Newton's fourth law.

2. An astronaut in a satellite orbiting the earth feels weightless because (1) the astronaut doesn't weigh anything, (2) there is no gravity in space, (3) the astronaut is falling at the same rate as the satellite, (4) the satellite has no gravity.

3. Objects that are able to fall have what type of energy? (1) kinetic (2) radiant (3) potential (4) electrical

4. What is the potential energy of a 10.0 kg object suspended at a height of 5.0 m? (1) 50.0 J (2) 490.0 J (3) 19.6 J (4) 4.9 J

5. What is the kinetic energy of a 5.0 kg object moving at 3.0 $^{m}/_{s}$? (1) 15 J (2) 0.6 J (3) 1.67 J (4) 22.5 J

6. Which form of energy does light have? (1) electrical (2) nuclear (3) potential (4) radiant

7. Muscles perform what type of energy transformation? (1) kinetic to potential (2) kinetic to electrical (3) thermal to radiant (4) chemical to kinetic

8. The form of energy that food contains is which of the following? (1) chemical (2) kinetic (3) radiant (4) electrical

9. 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

10. The kinetic energy of a moving object increases if which of the following occurs? (1) Its mass decreases. (2) Its speed increases. (3) Its height above the ground increases. (4) Its temperature increases.

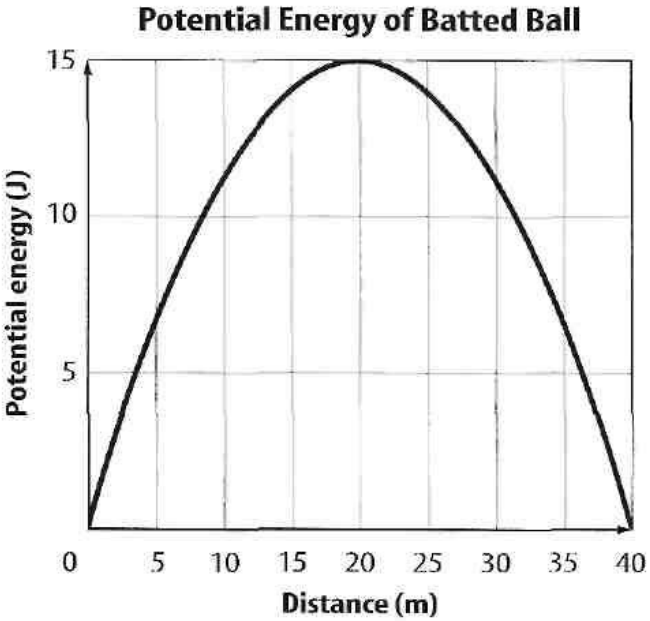
11. A softball player hits a fly ball. Which of the following describes the energy conversion that occurs as it falls from its highest point? (1) kinetic to potential (2) potential to kinetic (3) thermal to potential (4) thermal to kinetic

12. When chemical energy is converted into thermal energy, which of the following must be true? (1) The total amount of thermal energy plus chemical energy changes. (2) Only the amount of chemical energy changes. (3) Only the amount of thermal energy changes. (4) The total amount of thermal energy plus chemical energy doesn't change.

13. When you drop a tennis ball, it hits the floor and bounces back up, but it does not reach the same height as when it was first released. In fact, each successive upward bounce is smaller than the one previous. Which of the following observations would explain how the law of conservation of energy is still obeyed in this case. (1) The tennis ball is compressed each time it hits the ground. (2) The mass of the tennis ball is constant. (3) The tennis ball feels slightly warmer after it finishes bouncing. (4) The speed of the tennis ball is greatest just as it hits the ground.

14. You push a box east with a force of 23 N. The box (1) pushes you east with a force of 23 N, (2) pushes you west with a force of 23 N. (3) moves east without pushing you in any direction. (4) pushes you with an unknown force.

Use the graph below to answer questions 15-17.



15. The graph shows how the potential energy of a batted ball depends on distance from the batter. At what distances is the kinetic energy of the ball the greatest?

16. At what distance from the batter is the height of the ball the greatest?

17. How much less is the kinetic energy of the ball at a distance of 20 m from the batter than at a distance of 0 m?

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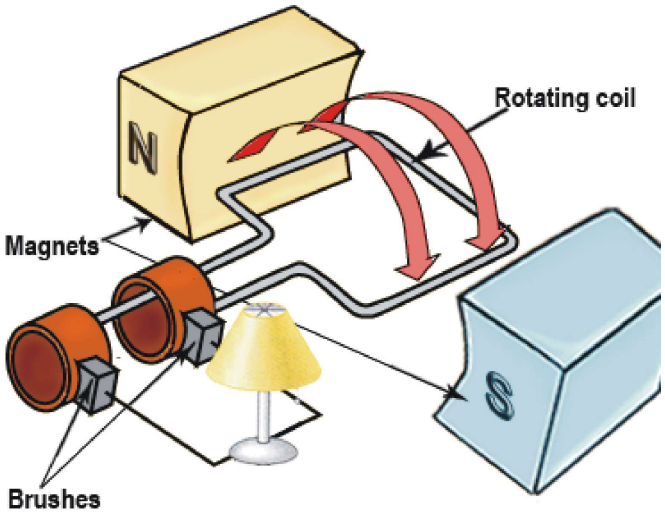
18. Why is it impossible to build a machine that produces more energy than it uses?

19. You toss a ball upward and then catch it on the way down. The height of the ball above the ground when it leaves your hand on the way up and when you catch it is the same. Compare the ball's kinetic energy when it leaves your hand and just before you catch it.

20. A basket ball is dropped from a height of 2 m and another identical basketball is dropped from a height of 4 m. Which ball has more kinetic energy just before it hits the ground?

Answer questions 21-22 by referring to the diagram of the generator below.



A generator

21. 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

22. 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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23. How much potential energy does a baseball with a mass of 0.145 kg have when it is 5.00 m above the ground?

Answers

1. 3	**8.** 1	**15.** 0 m or 40 m	**21.** 4
2. 3	**9.** 3	**16.** 20 m	**22.** 2
3. 3	**10.** 2	**17.** 15 J	**23.** 7.11 J
4. 2	**11.** 2	**18.** It violates conservation of energy.	
5. 4	**12.** 4	**19.** The kinetic energy is the same.	
6. 4	**13.** 3	**20.** The one dropped from 4 m	
7. 4	**14.** 2		