Activity 6: Interaction Between a Magnet and an Electric Current

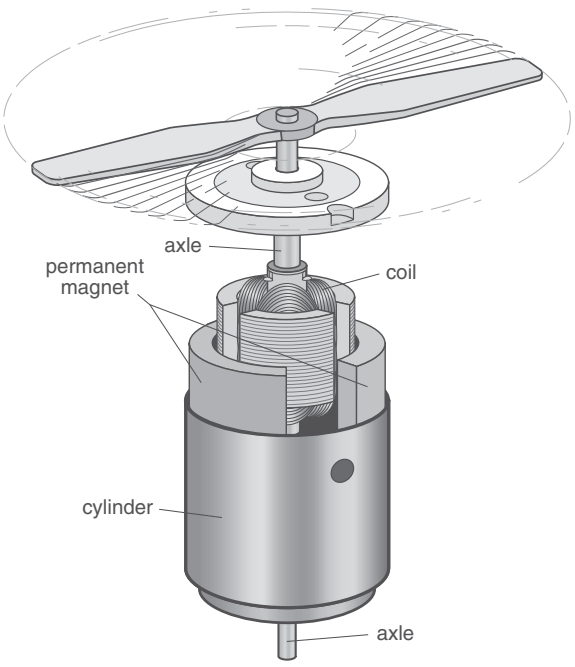
Name Date Class

Part 1

Motors in Everyday Life

Motors operate in nearly every electrical device that has a part that spins or rotates. This spinning is a direct consequence of the electric charges flowing through the device. In every motor, the coils are connected to an axle that rotates as a result of the electromagnetic interaction between the current-carrying coils and the permanent magnets.

In many cases, the effect of the motor on the operation of the electrical device is obvious. For example, the blades of a fan are connected to the spinning axle, so that when the axle rotates, the fan spins with it. To increase the speed of the fan, you must increase the electric current in the coils of wire. This increases the speed at which the axle rotates and makes the fan spin faster.



Fans are among the most common of motor-driven electrical devices. Fans include not only stand-alone fans (like those you put in your room to keep cool during summer), but also those used to cool automobile engines, to draw air into hair dryers, and to cool computers. Fans are also used in microwave ovens and "convection ovens" that circulate heated air around the cooking food.

1. For the electromagnetic interaction in a spinning fan motor like the one shown, what are the interacting objects?

2. In your own words, explain why the axle in the motor on the previous page spins rapidly.

3. What happens when an electric current is passed through coils of wire wrapped around a compass?

4. For an ammeter, what is the relationship (in a complete sentence) between the amount of electric current in the coil and the number of degrees the needle of the ammeter rotates?

5. In a motor, an interaction occurs between the permanent magnet and

a) the fan blades.
b) the axle.
c) the current in the coils of wire.
d) itself (the permanent magnet).

6. This type of interaction is a(n)

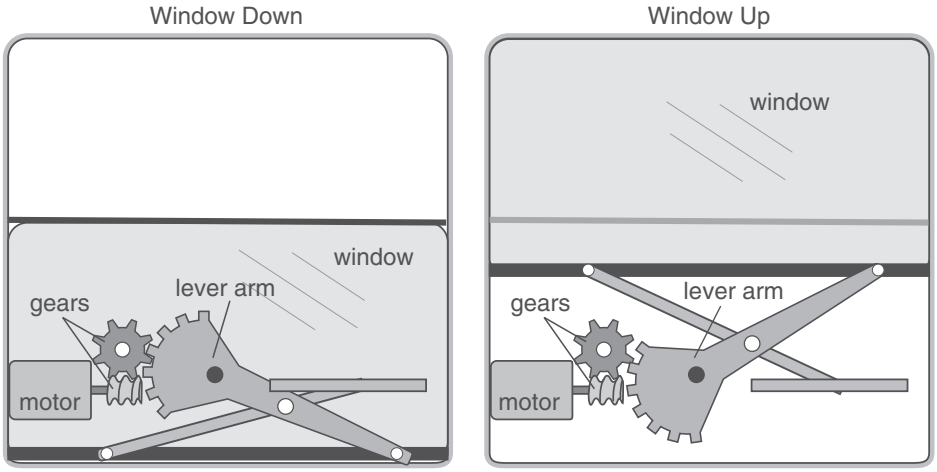
a) electric circuit interaction.
b) electric charge interaction.
c) electromagnetic interaction.
d) mechanical interaction.

Part 2

Other Devices Using Motors

Several devices use the same principle as fans. A part of the device rotates or spins because it is connected to the spinning axle. Increasing the speed at which the axle spins increases the spin speed of this part of the device. For example, several entertainment devices contain motors. These devices have spinning heads driven by motors. These include the spinning heads of cassette tape players and VCRs, the disc drives of CD and DVD players, and the turntables on record players (phonographs). Computers also contain motors that spin both hard drives and portable discs, like CDs.

Electric motors have replaced many things people used to do by hand. For example, the first phonographs worked by having someone crank up the phonograph like a wind-up toy or a grandfather clock. That would make the turntable spin as the spring inside the phonograph slowly unwound. In a similar way, a person riding in a car without electric windows needs to turn a crank handle in circles to open a window. Electric windows have a motor that replaces the crank handle. In both cases, the axle turned by the person or the motor is connected to gears that are in turn connected to a lever arm. The lever arm either raises or lowers the window depending upon the direction in which the gear turns.



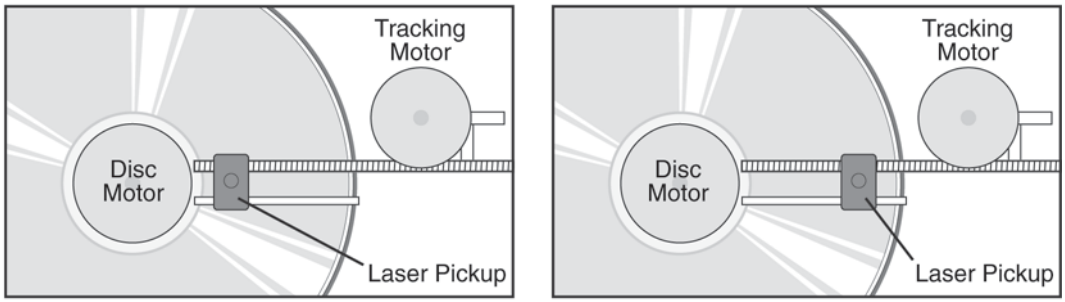
Motors for other electrical devices cause objects to move in different ways through an assembly of gears and other parts connected to a spinning axle. For example:

- A motor in a garage door opener either raises or lowers garage doors.
- A motor in automobile windshield wipers causes the wipers to sweep alternately left and right.
- Motors in electric toothbrushes cause the toothbrush bristles to move both back-and-forth and in a circular motion.
- A motor and a set of gears in an electric (non-digital) clock cause the second hand, minute hand, and hour hand to all move at different speeds.
- Motors in clothes washers cause the tubs containing the clothes to both rock back and forth and to spin.

Motors are a particularly important feature of CD players. In addition to the motor in the disc drive, a motor controls the motion of the tracking laser and its pickup unit. The tracking laser shines on the mirrored disc surface. If the laser light bounces off the mirrored disc surface, it is picked up as a digital signal of 0. If a tiny pit is present on the disc, the light is not reflected back to the pickup and a signal of 1 is sensed. Millions of these 0 and 1 digital signals are interpreted as sound pitch and amplitude in time, thereby reproducing the recorded music.

The motor controlling the assembly with both the laser and the pickup works like the motor controlling an automatic window in a car. Like a car window that can go up or down, the laser/pickup assembly can move either in or out, depending upon which way the tracking motor axle spins. Normally, the CD is read from the inside of the disc going out. A computer controls the rate at which the disc motor spins the disc. So the laser pickup reads the data on the disc at the same rate on its outer edge as it does on the disc's inner edge. That requires the disc to spin faster when the laser/pickup assembly is near the inner edge of the disc than when it is close to the outside edge, as shown below (RPM = revolutions per minute).

Reading the Compact Disc



Motors are a common feature of electrical devices that we use every day. Beyond those devices mentioned, you can find motors in vacuum cleaners, garbage disposals, electric tools, electric razors, and many toys. Through the usage of motors, the electromagnetic interaction has become an important component of our advanced technological world.

Answer these questions, based upon the reading above.

1. If you increase the speed of a fan, what changes in the fan's motor?

a) The number of wire loops in the coils connected to the motor axle increases.

b) The length of the axle increases.

c) The strength of the permanent magnet increases.

d) The amount of electric current increases.

2. Where would you *not* expect to find a motor-driven fan?

a) automobile engine

b) personal CD player

c) hair dryer

d) computer

3. Which device commonly used for entertainment contains motors?

a) DVD player

b) video cassette recorder (VCR)

c) phonograph (record player)

d) all of the above

4. What does the motor used with electric car windows replace?

a) a disc drive

b) a crank handle operated by a human hand

c) an engine

d) none of the above

5. How many motors does it take to move the second hand, minute hand, and hour hand of an electric clock?

a) zero

b) one

c) two

d) three

6. How many motors does a CD player have and how are they used?

a) one motor that spins the disc

b) one motor that moves the tracking laser/pickup assembly

c) one motor that spins the disc and one motor that moves the tracking laser/pickup assembly

d) two motors that spin the disc

7. How does the speed at which a CD spins change as the tracking laser moves from the inside edge of the disc to its outside edge?

a) The spin speed decreases.

b) The spin speed stays the same.

c) The spin speed increases.

d) The change in the spin speed depends upon how the CD was burned.

8. What is common to all electric devices that have motors?

a) They all have fans.

b) They all have parts that move in and out.

c) They all have parts that move and the types of motions vary.

d) They all have parts that move back and forth.