RLP-PSB · RLP Physical Science B — Forces, Energy and Waves

Unit 2: Gravity, Electricity and Magnetism

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 2.1 — Satellites Over Missouri: Gravity at a Distance

FLUENCY

1. If the distance between two masses doubles, by what factor does the gravitational force change? If it triples?

2. If one of two masses doubles and the distance stays the same, how does the gravitational force change?

3. A student weighs 588 N at Earth's surface. What would the gravitational force on her be at twice Earth's radius from the center? At three times?

4. Write 6,371 km in meters in scientific notation.

5. Calculate the weight (mg) of a 60 kg student on Earth ($g = 9.8\ m/s^2$) and on Mars ($g = 3.71\ m/s^2$).

APPLICATION

6. Use $F = Gm_1m_2/r^2$ to find the gravitational force between two 1,500 kg cars parked with their centers 2.0 m apart ($G = 6.674 \times 10^{-11}$). Why don't parked cars roll toward each other?

7. GPS satellites orbit about 20,200 km above Earth's 6,371 km radius. By what factor is the gravitational force on a satellite smaller there than it would be at the surface?

8. A friend says 'the Moon doesn't fall to Earth because there's no gravity in space.' Correct the claim with the calculation that Earth and the Moon pull on each other with about 2.0×10^{20} N and the idea of an orbit.

CHALLENGE

9. Earth's gravity at the surface is 9.8 m/s^2. The ISS orbits at about 400 km altitude. Using the inverse-square ratio with Earth's radius of 6,371 km, estimate the acceleration due to gravity at the ISS, and explain why astronauts still feel weightless.

REVIEW

10. A 20 kg box is pushed with 20 N to the right against 18 N of friction. Find the net force and the acceleration.

11. A 1500 kg object moving at 20 m/s collides and sticks to a 1000 kg object moving at 4.0 m/s (same line; positive is the first object's direction). Find the total momentum and the velocity just after the collision.

Lesson 2.2 — Electromagnets and Moving Magnets

FLUENCY

1. What happens to a compass needle near a wire when current flows? When the current is reversed?

2. Name three ways to make an electromagnet stronger.

3. A magnet is pushed into a coil connected to a meter, then held still, then pulled out. Describe the three readings.

4. In the clip test, name the independent variable, the dependent variable and two controlled variables.

5. Why does the induction part of the lab use no battery?

APPLICATION

6. Illustrative data: 10 turns lifted 2 clips, 20 turns 5, 30 turns 7, 40 turns 10. The best-fit line is clips = 0.26 × turns − 0.5. Predict the clips for 50 turns and say one reason the real result might be lower.

7. A student reads 0.4 mA when pushing the magnet in slowly and 1.3 mA when pushing it in quickly. Explain the difference.

8. An electromagnet in a scrapyard crane lifts cars and then drops them when the operator switches it off. Explain why a permanent magnet could not do this job as well.

CHALLENGE

9. A student holds a magnet still and moves the coil over it instead. Will a current be induced? Explain what the necessary condition really is.

REVIEW

10. An object starts at 2 m/s and accelerates at 1 m/s^2 for 9 s. How far does it travel?

11. Convert 1250 mL to L.

Lesson 2.3 — Coulomb's Law: Electric Force Versus Gravity

FLUENCY

1. Two charges repel with 0.80 N. What is the force if the distance between them is halved?

2. Two charges attract with 0.60 N. One charge is tripled. What is the new force?

3. Will a positive and a negative charge attract or repel? Two negatives?

4. A balloon rubbed on hair becomes negatively charged. Did it gain or lose electrons?

5. Name one way Coulomb's law and Newton's law of gravitation are alike and one way they differ.

APPLICATION

6. Charges of 2.0 μC and 3.0 μC are 0.30 m apart. Find the force between them ($k = 8.99 \times 10^9$ $\text{N}\cdot\text{m}^2/\text{C}^2$).

7. Two balloons each carry about 50 nC (5.0×10^{-8} C, illustrative) and hang 5.0 cm apart. Estimate the repulsive force and compare it with the weight of a 1 mg scrap of paper.

8. In a hydrogen atom the electric force between the electron and proton is about 8.2×10^{-8} N and the gravitational force about 3.6×10^{-47} N. How many times stronger is the electric force, and what does this imply about what holds matter together?

CHALLENGE

9. If electric forces are so much stronger than gravity, explain why gravity, not electric force, controls the orbits of planets and satellites.

REVIEW

10. A 0.75 kg object moving at 1.2 m/s collides and sticks to a 1.5 kg object at rest (same line; positive is the first object's direction). Find the total momentum and the velocity just after the collision.

11. A 0.20 kg ball's momentum changes by 4.0 kg·m/s in 0.010 s. What is the average force?

Lesson 2.4 — Energy in Fields: Motors and Generators

FLUENCY

1. Find the gravitational potential energy gained when a 2 kg object is lifted 40 m ($g = 9.8\ m/s^2$).

2. Find the gravitational potential energy gained when a 70 kg object is lifted 40 m ($g = 9.8\ m/s^2$).

3. Find the gravitational potential energy gained when a 0.5 kg object is lifted 3 m ($g = 9.8\ m/s^2$).

4. When you pull two attracting magnets apart, is energy stored in the field or released from it?

5. When two like charges are pushed closer together, does the field's stored energy increase or decrease?

6. Write the energy chain for a generator in a wind turbine.

APPLICATION

7. A 0.50 kg book is lifted 0.80 m and then dropped. How much energy is stored in the Earth-book field at the top, and how fast is the book moving just before it lands (ignore air resistance)?

8. A hand-crank flashlight is easy to crank with the bulb disconnected and harder to crank with it connected. Explain using the generator model.

9. Draw (describe) field lines between two north poles facing each other and between a north and a south pole. In which case does pushing the magnets together store energy?

CHALLENGE

10. An electric car's motor can run as a generator while braking. Trace the energy transfers during braking and explain why this extends the car's range.

REVIEW

11. A cyclist moving at 5 m/s brakes with a deceleration of 2 m/s^2. How long does it take to stop, and how far does it travel while stopping?

12. A 1.0 kg cart at 4.0 m/s sticks to a 1.0 kg cart at rest. What is their speed after?

Unit 2 checkpoint

1. The gravitational force between two objects is 100 N. The distance between them is doubled. The force is now
   A. 200 N
   B. 50 N
   C. 25 N
   D. 400 N
2. Which is true of both Newton's law of gravitation and Coulomb's law?
   A. Both forces can repel
   B. Both depend on 1/r²
   C. Both depend only on mass
   D. Both are equally strong
3. True or false: Astronauts in orbit float because gravity is zero there.
4. Two charges attract with 2.0 N. When the distance is halved, the force becomes _____ N.
5. Which observation shows that an electric current produces a magnetic field?
   A. A magnet sticks to a fridge
   B. A compass needle swings when current flows in a nearby wire
   C. A balloon attracts paper
   D. A bulb gets hot
6. A current is induced in a coil when
   A. a magnet rests inside it
   B. the magnetic field through it changes
   C. it is made of copper
   D. it is connected to a battery
7. True or false: Adding more turns to an electromagnet's coil makes it stronger.
8. When you pull apart two magnets that are stuck together, the energy you supply is
   A. destroyed
   B. stored in the magnetic field
   C. turned into mass
   D. stored in your hands

9. In a generator, mechanical work becomes electrical energy because
   A. the induced current's field pushes back against the rotation
   B. the magnet runs down
   C. friction creates charge
   D. the coil is heated
10. Lifting a 3.0 kg box 2.0 m stores _____ J in the gravitational field (g = 9.8 m/s²).
11. True or false: Electric forces hold atoms together, while gravity dominates the motion of planets because large objects are almost neutral.
12. A motor converts
    A. kinetic energy to electrical energy
    B. electrical energy to kinetic energy
    C. thermal energy to electrical energy
    D. light to sound

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