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

Unit 5: Missouri Physical Science Supplement

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

Name _____ Period _____

Lesson 5.1 — The Sun and the Universe: Fusion, Redshift and the Big Bang

FLUENCY

1. What is the net nuclear reaction that powers the Sun's core?

2. Name, in order, the regions energy passes through from the Sun's core to space.

3. A spectral line from a galaxy arrives at a longer wavelength than it was emitted. Is the galaxy approaching or moving away?

APPLICATION

4. Using NIST masses, 4 × 1.00783 u = 4.03130 u of hydrogen becomes 4.00260 u of helium. What percentage of the mass becomes energy?

5. The Sun converts 4.26×10^9 kg of mass into energy each second. Use $E = mc^2$ with $c = 3.00 \times 10^8$ m/s to find the power, and compare with NASA's luminosity of 3.828×10^{26} W.

6. M87 in the Virgo Cluster has $z = 0.004283$. Find its recession speed ($c = 299{,}792$ km/s) and the wavelength at which its 656.28 nm hydrogen-alpha line arrives.

CHALLENGE

7. The Sun will spend about 10 billion years on the main sequence, losing 4.26×10^9 kg each second (1 year = 3.156×10^7 s). What fraction of its 1.9884×10^{30} kg mass is that, and what does the answer say about why its main-sequence life ends?

8. Andromeda is approaching us at about 297 km/s, yet NGC 4874 in the Coma Cluster, about 300 million light-years away, recedes at about 7,167 km/s. Explain how both facts fit an expanding universe.

REVIEW

9. (Unit 4) Which kind of electromagnetic radiation has the longest wavelength: microwaves, visible light or X-rays?

10. (Physical Science A) In a nuclear reaction, what quantity is conserved besides charge and the total number of nucleons?

Lesson 5.2 — Predicting Orbits with Kepler's Laws

FLUENCY

1. State Kepler's first law.

2. According to Kepler's second law, where in its orbit does a planet move fastest?

3. Write Kepler's third law for planets with T in years and a in AU.

APPLICATION

4. NASA lists Jupiter at 778.5 million km. Convert to AU (1 AU = 149.6 million km) and predict its period.

5. A body orbits the Sun with a period of 8 years. What is its average distance?

6. Use the Moon as a ruler (a = 384,400 km, T = 655.7 h) to predict the period of the space station at r = 6,771 km from Earth's center.

CHALLENGE

7. A GOES satellite must orbit once per sidereal day, 23.93 hours. Using the Moon ruler, how far from Earth's center must it be? Compare with 42,164 km.

8. Earth's speed is 30.29 km/s at 147.095 million km and 29.29 km/s at 152.100 million km. Show that these fit Kepler's second law, and explain the result with Newton's gravity.

REVIEW

9. (Unit 2) If the distance between two objects triples, by what factor does the gravitational force change?

10. (Unit 2) Why does a satellite in orbit not fall to Earth?

Lesson 5.3 — Earth's Engine and Energy Budget

FLUENCY

1. List Earth's layers from the center outward and say which is liquid.

2. What is Earth's albedo, and what does it measure?

3. Name the three Milankovitch cycles and their approximate periods.

APPLICATION

4. NASA lists the core's radius as 3,485 km and Earth's as 6,371 km. What fraction of Earth's volume is core?

5. The Mid-Atlantic Ridge opens about 2.5 cm a year. How far apart do the two sides move in 1 million years, in km?

6. Use $T = [S(1 - A) \div (4\sigma)]^{1/4}$ with $S = 1{,}361\ W/m^2$, $A = 0.28$ and $\sigma = 5.67 \times 10^{-8}\ W/(m^2 \cdot K^4)$. What happens compared with 255.1 K at $A = 0.294$?

CHALLENGE

7. The New Madrid region is in the middle of the North American plate, far from any plate boundary. Use the convection model to explain how large earthquakes can still happen there.

8. St. Louis averaged 55.7 °F in the 1960s and 59.2 °F in 2016-2025. A 0.1% brighter Sun warms the energy-budget model only about 0.06 K (0.1 °F). Is a change in solar output a likely explanation for the St. Louis change? Give a better candidate and one caution.

REVIEW

9. (Unit 3) In which direction does thermal energy flow on its own?

10. (Unit 4) What kind of electromagnetic radiation does Earth mainly give off to space?