

Quiz.

1. A strong gravitational field
 - a) slows a clock.
 - b) speeds up a clock.
 - c) does not affect a clock.

2. Compared to Newton's theory of gravitation, Einstein's theory
 - a) is an exception to the correspondence principle.
 - b) obeys the correspondence principle.
 - c) neither of these.

3. Compared to a watch at the Earth's poles, a watch at the Earth's equator should run
 - a) a tiny bit slower.
 - b) a tiny bit faster.
 - c) at the same speed.

4. The quantity that undergoes a red shift is
 - a) wave frequency.
 - b) wavelength.
 - c) both of these
 - d) neither of these

5. The orbit of Mercury precesses because
 - a) Mercury moves in the gravitational field of the other planets.
 - b) Mercury travels faster than any other planet.
 - c) Mercury is closest to the sun.
 - d) the sun's gravitational field varies along Mercury's orbit.
 - e) none of these

6. According to the principle of equivalence
 - a) mass and energy are two forms of the same thing.
 - b) space and time are two forms of the same thing.
 - c) electricity and magnetism are two forms of the same thing.
 - d) observations made in an accelerating reference frame are indistinguishable from those made in a gravitational field.
 - e) all of these

7. If the orbit of Mercury were perfectly circular, its rate of precession would be
 - a) larger.
 - b) smaller.
 - c) the same.
 - d) zero.

8. If the elliptical orbit of Mercury were more eccentric, its precession rate would be
 - a) larger.
 - b) smaller.
 - c) the same.
 - d) nonexistent.

9. The two-dimensional surface of the Earth is
 - a) positively curved.
 - b) negatively curved.
 - c) both of these
 - d) none of these

Answer Key.

1. a)

As the principle of equivalence states: any effect of acceleration can be duplicated by gravity.

2. b)

General relativity agrees with classical Newtonian mechanics for slow speeds and short distances.

3. b)

The equator has relative motion with respect to the center of the Earth, but the poles do not. The clock at the equator would experience a centrifugal force, whereas a clock at either of the poles would not.

4. c)

We frequently refer to the wavelength of waves being redshifted, but frequency is inversely proportional to wavelength and shifts by the same amount.

5. d)

While more than one of the answer choices are true statements by themselves, only this answer explains the *precession* of Mercury.

6. d)

The first two answer choices are consequences of Einstein's special theory of relativity, and the third answer choice comes from Maxwell's laws. Only this answer correctly states the equivalence principle of Einstein's general theory of relativity.

7. d)

The difference in gravitational field at different distances from the Sun accounts for Mercury's current advancement of perihelion or precession, so Mercury were equidistant from the Sun at every point in its orbit it would not experience this difference.

8. a)

The greater difference in gravitational field for a more elliptical orbit would cause Mercury to precess even more than it already does.

9. a)

The surface of a sphere is positively curved.