

- 1 Two twins in twin spaceships separate at 99% of the speed of light. When they separate, they are each 20 years old. They have agreed that one of them will turn around after one year of travel and fly back to rejoin the other. If the one who turns around is 22 years old when they get back together, the other twin will be
 - a. less than 22 years old.
 - b. either older or younger than 22, there is no way to tell.
 - c. more than 22 years old.
 - d. also 22 years old.

- 2 When one coulomb of charge passes through a battery, the electrical potential energy of the charge increases by 1.5J. If 2 coulombs of charge pass through the same battery, its electrical potential energy will increase by
 - a. 1.5J.
 - b. 3.0J.
 - c. 6.0J.
 - d. 0.375J.

- 3 If one of two charges is increased by a factor of 6 and the distance between the charges is not changed, then the electrical force between the charges is
 - a. multiplied by 6.
 - b. unchanged.
 - c. divided by 36.
 - d. divided by 6.

- 4 If light is incident on a diffuse reflector from a single direction, it will be
 - a. reflected into a single direction.
 - b. reflected without loss.
 - c. scattered in all directions.
 - d. completely absorbed.

- 5 The set of wavelengths present in the light from a given source is that source's
 - a. radiation curve.
 - b. spectrum.
 - c. electronic structure.
 - d. intensity.

- 6 Which of the following rays from a point on an object will become parallel to the axis after traveling through a converging lens?
 - a. a ray that passes through the center of the lens.
 - b. a ray parallel to the axis.
 - c. a ray that passes through the farther focal point of the lens.
 - d. a ray that passes through the nearer focal point of the lens.

- 7 Near a positive charge, the electric field points
- directly away from the charge.
 - upward.
 - in circles around the charge.
 - directly toward the charge.
- 8 A pair of electrically charged objects repel each other with a force of 1 Newton when they are a distance of 3m apart. If their charges stay the same, what will be the repulsive force between them when they are 1m apart?
- 1N.
 - 9N.
 - 3N.
 - 4N.
- 9 A total eclipse of the sun happens when and where
- the penumbra of the earth's shadow touches the moon.
 - the umbra of the moon's shadow touches the earth.
 - the penumbra of the moon's shadow touches the earth.
 - the umbra of the earth's shadow touches the moon.
- 10 A near-sighted person, someone who has trouble focusing on distant objects, needs to wear glasses with
- flat lenses.
 - diverging lenses.
 - barrel-shaped lenses.
 - converging lenses.
- 11 If 100 coulombs of charge flows through a wire in 10 seconds, the current in the wire is
- 0.01A.
 - 100A.
 - 10A.
 - 0.1A.
- 12 Calculate (based on the assumptions made in class) how much of a shock a person with clean hands can get from a 12 volt automobile battery.
- Death.
 - A painful shock.
 - Not even a tingle.
 - A tingle but no pain.

- 13 A baseball pitcher acquires an unbalanced electrical charge by scuffing his feet in the dirt and transfers -0.0001C to a baseball as he throws it toward home plate. A thunderstorm is brewing and there is a vertical electric field of $10,000\text{N/C}$ pointing straight down. The electrical force on the baseball is
- 1N downward.
 - 0.1N downward.
 - 0.1N upward.
 - 1N upward.
- 14 If light hits the surface of a pond, coming from air, at an angle of incidence of 45° it will travel into the pond (through the water) at an angle of
- 90° from the vertical.
 - 54° from the vertical.
 - 45° from the vertical.
 - 32° from the vertical.
- 15 Two identical clocks, one on the ground and the other in an earth satellite are set to the same time as the satellite passes overhead. A year later, the clocks are read again. According to the earth clock, the satellite clock
(Hint: Don't calculate anything. Only one answer is consistent with physical laws.)
- has gained one millisecond.
 - has lost one millisecond.
 - has gained ten days.
 - reads exactly the correct time.
- 16 The critical angle for a water-air surface is 48 degrees. In which of the following situations will light be 100% reflected?
Light coming from
- the water side at a 50 degree angle of incidence.
 - the air side at a 45 degree angle of incidence.
 - the air side at a 50 degree angle of incidence.
 - the water side at a 45 degree angle of incidence.
- 17 Suppose that the focal point of a converging lens is 4cm from the lens. If an object is placed 4.1cm from the lens, then its image will be
- enlarged and virtual.
 - reduced and virtual.
 - enlarged and real.
 - reduced and real.
- 18 If the wavelength of a wave increases by a factor of ten and its velocity stays the same, its frequency will be multiplied by a factor of
- 0.1.
 - 1.
 - 0.01.
 - 10.

- 19 A compound microscope can be thought of as
- one magnifier looking at the image from another.
 - a magnifier looking at a camera image.
 - a camera looking at the image formed by a magnifier.
 - a magnifier looking at a projector image.
- 20 The potential energy of a charge of 3 micro-coulombs in a potential of 1 million volts is
- 6J.
 - 3J.
 - 1J.
 - 2J.
- 21 A lens that is thick in the middle and thin around the edges
- brings all light rays together.
 - spreads all light rays apart.
 - spreads parallel light rays apart.
 - brings parallel light rays together.
- 22 A positive charge of one micro-coulomb is one meter away from a much larger positive charge and has one joule of potential energy. If the charge moves closer, to one half meter away from the positive charge, its potential energy could be
- 0.5J.
 - 2J.
 - 1J.
- 23 In a magnifier, the object is placed
- just beyond the focal point of the lens.
 - at the focal point of the lens.
 - far beyond the focal point of the lens.
 - between the lens and its focal point.
- 24 Which of the following colors would you expect to be deflected the most by a glass prism?
- yellow.
 - red.
 - green.
 - blue.
- 25 Which of the following types of radiation has the longest wavelength?
- gamma rays.
 - violet light.
 - X-rays.
 - ultraviolet light.

- 26 The ray approximation applies to light in the limit of
- long wavelength.
 - high intensity.
 - low intensity.
 - short wavelength.
- 27 If a bar magnet is cut in half, the result will be
- one half that is a north-seeking pole and one half that is a south-seeking pole.
 - cancellation of the magnetic field.
 - one half with a strong north-seeking pole and a weak south-seeking pole and one half the reverse.
 - two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.
- 28 Suppose that a projectile launcher obtains its energy by converting mass into energy. Assuming that the launcher is 100% efficient, how much mass must it convert in order to launch a one kilogram projectile at $12/13$ the speed of light?
- $(2/3)$ kg.
 - $(1/4)$ kg.
 - $(8/5)$ kg.
 - $(1/12)$ kg.
 - $(13/5)$ kg.
- 29 As you stand there under the TV cameras in your rubber-soled shoes, the evil game-show host tells you that all you must do to win a million dollars is to grasp two electrified handles. There are four handles labeled according to their potentials: 0V, 300V, 400V, 450V. Assuming that the labels are correct, which of the following pairs would give you the best chance of surviving to collect the money?
- 400V and 450V.
 - 0V and 400V.
 - 300V and 450V.
 - 300V and 400V.
 - 0V and 300V.
- 30 In relativistic mechanics, the one inertial reference frame that is uniquely defined for describing a moving object is
- the universal rest frame.
 - the frame in which the microwave background is at rest.
 - the inertial frame of the observer.
 - the instantaneous rest frame of the object.
- 31 Which of these mirrors will bring parallel rays to an approximate focal point?
- a mirror shaped like part of the inside surface of a cylinder.
 - a mirror shaped like part of the outside surface of a cylinder.
 - a mirror shaped like part of the inside surface of a sphere.
 - a mirror shaped like part of the outside surface of a sphere.
 - a flat mirror.

- 32 Light that strikes a mirror at a 30 degree angle of incidence will reflect at an angle to the perpendicular of
- 90 degrees.
 - 60 degrees.
 - 30 degrees.
 - 45 degrees.
- 33 The speed of light is 3×10^8 m/s. Suppose that a nuclear reaction converts 1% of the original reaction mass into energy. Suppose that one microgram (10^{-9} kg) of reaction mass undergoes the reaction. How much energy is released?
- 9×10^5 J.
 - 9×10^7 J.
 - 9×10^{16} J.
 - 3×10^{-3} J.
 - 3×10^{-1} J.
- 34 A few millimeters per second is
- the instantaneous speed of individual electrons in a wire.
 - the typical speed with which a change in electric potential moves through a wire.
 - the typical average speed of electrons in a current-carrying wire.
 - a speed that has nothing to do with electricity.
- 35 Which way does the earth's magnetic field point at a position directly over the magnetic south pole (somewhere in Antarctica).
- south.
 - north.
 - down.
 - up.
- 36 The wavelength of a wave is
- the distance from its beginning to its end.
 - the rate at which waves pass a fixed position.
 - the distance from one wavefront to the next.
 - the velocity of a wavefront.
 - the reciprocal of its rate of spread.

37 (Astronomical note: In this part of the world, the sun rises in the east, moves across the southern sky, and sets in the west.)

It has just stopped raining and you see a rainbow. Which of the following situations is impossible?

You see the rainbow in the

- a. north.
- b. west.
- c. east.
- d. south.

38 For the image of an object to be real, the light from each point of the object must

- a. appear to come from the image point.
- b. travel only in straight lines.
- c. actually reach the image point.
- d. stop at the image point.

Answer Key: Fall 2007 PHX4M

- 1 Choice c. (more than 22 years old.)
- 2 Choice b. (3.0J.)
- 3 Choice a. (multiplied by 6.)
- 4 Choice c. (scattered in all directions.)
- 5 Choice b. (spectrum.)
- 6 Choice d. (a ray that passes through the nearer focal point of the lens.)
- 7 Choice a. (directly away from the charge.)
- 8 Choice b. (9N.)
- 9 Choice b. (the umbra of the moon's shadow touches the earth.)
- 10 Choice b. (diverging lenses.)
- 11 Choice c. (10A.)
- 12 Choice b. (A painful shock.)
- 13 Choice d. (1N upward.)
- 14 Choice d. (32° from the vertical.)
- 15 Choice b. (has lost one millisecond.)
- 16 Choice a. (the water side at a 50 degree angle of incidence.)
- 17 Choice c. (enlarged and real.)
- 18 Choice a. (0.1.)
- 19 Choice d. (a magnifier looking at a projector image.)
- 20 Choice b. (3J.)
- 21 Choice d. (brings parallel light rays together.)
- 22 Choice b. (2J.)
- 23 Choice d. (between the lens and its focal point.)
- 24 Choice d. (blue.)
- 25 Choice b. (violet light.)
- 26 Choice d. (short wavelength.)
- 27 Choice d. (two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.)
- 28 Choice c. ($(8/5)\text{kg}$.)
- 29 Choice a. (400V and 450V.)
- 30 Choice d. (the instantaneous rest frame of the object.)
- 31 Choice c. (a mirror shaped like part of the inside surface of a sphere.)
- 32 Choice c. (30 degrees.)
- 33 Choice a. ($9 \times 10^5\text{J}$.)
- 34 Choice c. (the typical average speed of electrons in a current-carrying wire.)
- 35 Choice d. (up.)

36 Choice c. (the distance from one wavefront to the next.)

37 Choice d. (south.)

38 Choice c. (actually reach the image point.)

Solutions

- 1 Module r41 The Twin Paradox: Question 3.2
- 2 Module 082 Electric Potential Energy: Question 4.2
- 3 Module 077 Coulomb's Force Law: Question 2.2
- 4 Module 102 Interactions at boundaries: Question 2.2
- 5 Module 100 Wave Properties: Question 4.2
- 6 Module 105 Images: Question 1.3
- 7 Module 080 Definition of an Electric Field: Question 1.1
- 8 Module 077 Coulomb's Force Law: Question 1.1
- 9 Module 104 The Ray Approximation: Question 3.3
- 10 Module 107 Optical Instruments: Question 3.3
- 11 Module 084 Electric Current: Question 1.2
- 12 Module 086 Electrical Resistance: Question 4.1
- 13 Module 080 Definition of an Electric Field: Question 3.3
- 14 Module 102 Interactions at boundaries: Question 3.2
- 15 Module r41 The Twin Paradox: Question 1.1
- 16 Module 102 Interactions at boundaries: Question 4.3
- 17 Module 107 Optical Instruments: Question 1.3
- 18 Module 099 Wave Properties: Question 4.1
- 19 Module 107 Optical Instruments: Question 4.2
- 20 Module 083 Definition of Electric Potential: Question 2.2
- 21 Module 106 Lenses: Question 1.1
- 22 Module 082 Electric Potential Energy: Question 1.1
- 23 Module 107 Optical Instruments: Question 2.1
- 24 Module 103 Dispersion effects: Question 1.2
- 25 Module 100 Wave Properties: Question 3.2
- 26 Module 104 The Ray Approximation: Question 2.2
- 27 Module 092 Magnetic Poles: Question 3.2
- 28 Module r42 Relativistic Mechanics: Question 3.4
- 29 Module 083 Definition of Electric Potential: Question 4.2
- 30 Module r42 Relativistic Mechanics: Question 2.2
- 31 Module 106 Lenses: Question 3.3
- 32 Module 102 Interactions at boundaries: Question 1.1
- 33 Module r42 Relativistic Mechanics: Question 4.3
- 34 Module 084 Electric Current: Question 3.2
- 35 Module 092 Magnetic Poles: Question 4.2
- 36 Module 099 Wave Properties: Question 2.2

37 Module 103 Dispersion effects: Question 3.3

38 Module 105 Images: Question 2.1