

- 1 The average speed with which a change in electric potential moves through a wire is
  - a. close to the speed of sound.
  - b. a few millimeters per second.
  - c. zero.
  - d. close to the speed of light.
  
- 2 Subway cars sometimes get their power from a “third rail” that is at a potential of about 600V above the potential of the other two rails (which are connected to the ground). If you are unfortunate enough to find yourself on the tracks of such a subway, which of the following situations is the most dangerous.
  - a. both feet on a grounded rail.
  - b. one foot on the third rail and one foot on another rail.
  - c. both feet on the third rail.
  - d. neither foot on a rail.
  
- 3 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
  - a. reduced and virtual.
  - b. enlarged and virtual.
  - c. enlarged and real.
  - d. reduced and real.
  
- 4 A baseball pitcher acquires an unbalanced electrical charge by scuffing his feet in the dirt and transfers  $-0.0001\text{C}$  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 up*. The electrical force on the baseball is
  - a.  $0.1\text{N}$  upward.
  - b.  $1\text{N}$  upward.
  - c.  $0.1\text{N}$  downward.
  - d.  $1\text{N}$  downward.
  
- 5 The speed of light is  $3 \times 10^8\text{m/s}$ . How much energy is released when the mass of a system decreases by one gram ( $10^{-3}\text{kg}$ )?.
  - a.  $9 \times 10^{10}\text{J}$ .
  - b.  $9 \times 10^{16}\text{J}$ .
  - c.  $3 \times 10^5\text{J}$ .
  - d.  $9 \times 10^{13}\text{J}$ .
  
- 6 In relativistic mechanics, the one inertial reference frame that is uniquely defined for describing a moving object is
  - a. the universal rest frame.
  - b. the inertial frame of the observer.
  - c. the frame in which the microwave background is at rest.
  - d. the instantaneous rest frame of the object.

- 7 You are standing in a stream (up to your knees) and see a fish swimming by. If you wish to hit the fish with a spear, you should
- aim directly at where you see it.
  - aim above where you see it.
  - aim below where you see it.
  - aim beside where you see it.
- 8 Light that strikes a mirror at a 30 degree angle of incidence will reflect at an angle to the perpendicular of
- 90 degrees.
  - 30 degrees.
  - 60 degrees.
  - 45 degrees.
- 9 The number of waves that pass a given point in one second is called the
- amplitude.
  - frequency.
  - wave velocity.
  - wavelength.
- 10 (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 that is a full half-circle in the eastern sky. What time is it?
- 6:00 pm.
  - 3:00 pm.
  - 6:00 am.
  - 9:00 am.
- 11 The set of wavelengths present in the light from a given source is that source's
- electronic structure.
  - spectrum.
  - intensity.
  - radiation curve.
- 12 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
- less than 22 years old.
  - either older or younger than 22, there is no way to tell.
  - more than 22 years old.
  - also 22 years old.

- 13 A total eclipse of the moon happens when
- the moon passes into the penumbra of the earth's shadow.
  - the earth passes into the umbra of the moon's shadow.
  - the moon passes into the umbra of the earth's shadow.
  - the earth passes into the penumbra of the moon's shadow.
- 14 When one coulomb of charge passes through a battery, the electrical potential energy of the charge increases by 1.5J. If 4 coulombs of charge pass through the same battery, its electrical potential energy will increase by
- 0.375J.
  - 3.0J.
  - 1.5J.
  - 6.0J.
- 15 A compound microscope can be thought of as
- a camera looking at the image formed by a magnifier.
  - a magnifier looking at a camera image.
  - a magnifier looking at a projector image.
  - one magnifier looking at the image from another.
- 16 Which of the following colors corresponds to the longest wavelength?
- blue.
  - violet.
  - green.
  - red.
- 17 A converging lens
- spreads all light rays apart.
  - spreads parallel light rays apart.
  - brings parallel light rays together.
  - brings all light rays together.
- 18 A pair of electrically charged objects repel each other with a force of 144 Newton when they are a distance of 2m apart. If their charges stay the same, what will be the repulsive force between them when they are 6m apart?
- 48N.
  - 16N.
  - 144N.
  - 9N.

- 19 A near-sighted person, someone who has trouble focusing on distant objects, needs to wear glasses with
- diverging lenses.
  - converging lenses.
  - barrel-shaped lenses.
  - flat lenses.
- 20 Which of the following colors would you expect to be deflected the most by a glass prism?
- yellow.
  - red.
  - blue.
  - green.
- 21 In order for a converging lens to produce an enlarged virtual image, the object should be placed
- at the focal point of the lens.
  - just beyond the focal point of the lens.
  - between the lens and its focal point.
  - far beyond the focal point of the lens.
- 22 Which of the following rays from a point on an object will pass through the farther focus of a converging lens?
- a ray that passes through the nearer focal point of the lens.
  - a ray parallel to the axis.
  - a ray that passes through the center of the lens.
- 23 Which way does the earth's magnetic field point at a position directly over the magnetic equator (somewhere in Brazil, perhaps).
- north.
  - down.
  - south.
  - up.
- 24 If the frequency of a wave increases by a factor of ten and its velocity stays the same, its wavelength will be multiplied by a factor of
- 1.
  - 0.1.
  - 10.
  - 0.01.

- 25 Consider a mirror shaped like a shallow bowl. When light strikes this mirror from the top (into the bowl), the mirror acts like
- a converging lens.
  - a diverging lens.
  - a pinhole camera.
  - a pane of glass.
- 26 If the electric field everywhere near a particular point in space points away from that point, it follows that
- there is a negative charge at that point.
  - there is a dipole at that point.
  - there is no charge at that point.
  - there is a positive charge at that point.
- 27 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 ten days.
  - has gained one millisecond.
  - reads exactly the correct time.
  - has lost one millisecond.
- 28 If one of two charges is increased by a factor of 5 and the distance between the charges is not changed, then the electrical force between the charges is
- unchanged.
  - divided by 5.
  - multiplied by 5.
  - divided by 25.
- 29 If a bar magnet is cut in half, the result will be
- one half with a strong north-seeking pole and a weak south-seeking pole and one half the reverse.
  - cancellation of the magnetic field.
  - two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.
  - one half that is a north-seeking pole and one half that is a south-seeking pole.
- 30 The potential energy of a charge of 3 coulombs in a potential of 50 volts is
- 4J.
  - 50J.
  - 200J.
  - 150J.
  - 6J.

- 31 The MKS unit of electrical current is the
- ampere.
  - ohm.
  - volt.
  - watt.
  - coulomb.
- 32 A negative charge of one micro-coulomb is one meter away from a much larger positive charge and has two joules of potential energy. If the charge moves to two meters away from the positive charge, its potential energy could be
- 3J.
  - 2J.
  - 1J.
- 33 Two particles, each with a rest mass-energy of 1 Mev, collide head-on. Before the collision, each particle is moving at  $\frac{12}{13}$  the speed of light. If the energy of the collision materializes as 1 Mev particles, how many of them could there be after the collision (including the two that we started with)?
- 3.
  - 6.
  - 5.
  - 2.
  - 4.
- 34 The image that is produced by a movie projector is
- real only when it appears on a screen.
  - always a virtual image.
  - always a real image.
  - virtual only when it appears on a screen.
- 35 Calculate (based on the assumptions made in class) the smallest potential difference that could possibly cause death to someone touching bare terminals with clean hands.
- 5000V.
  - 50V.
  - 5V.
  - 24V.
  - 120V.

- 36 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
- a. the water side at a 50 degree angle of incidence.
  - b. the air side at a 45 degree angle of incidence.
  - c. the water side at a 45 degree angle of incidence.
  - d. the air side at a 50 degree angle of incidence.
- 37 If light is incident on a diffuse reflector from a single direction, it will be
- a. completely absorbed.
  - b. reflected into a single direction.
  - c. scattered in all directions.
  - d. reflected without loss.
- 38 All of the following statements are true. Which one states the ray approximation?
- a. For long wavelengths, rays bend around corners.
  - b. Rays spread outward from a source.
  - c. Rays are perpendicular to wavefronts.
  - d. For short wavelengths, rays are straight lines.

## Answer Key: Fall 2007 PHX4C

- 1 Choice d. (close to the speed of light.)
- 2 Choice b. (one foot on the third rail and one foot on another rail.)
- 3 Choice c. (enlarged and real.)
- 4 Choice d. (1N downward.)
- 5 Choice d. ( $9 \times 10^{13}\text{J}$ .)
- 6 Choice d. (the instantaneous rest frame of the object.)
- 7 Choice c. (aim below where you see it.)
- 8 Choice b. (30 degrees.)
- 9 Choice b. (frequency.)
- 10 Choice a. (6:00 pm.)
- 11 Choice b. (spectrum.)
- 12 Choice c. (more than 22 years old.)
- 13 Choice c. (the moon passes into the umbra of the earth's shadow.)
- 14 Choice d. (6.0J.)
- 15 Choice c. (a magnifier looking at a projector image.)
- 16 Choice d. (red.)
- 17 Choice c. (brings parallel light rays together.)
- 18 Choice b. (16N.)
- 19 Choice a. (diverging lenses.)
- 20 Choice c. (blue.)
- 21 Choice c. (between the lens and its focal point.)
- 22 Choice b. (a ray parallel to the axis.)
- 23 Choice a. (north.)
- 24 Choice b. (0.1.)
- 25 Choice a. (a converging lens.)
- 26 Choice d. (there is a positive charge at that point.)
- 27 Choice d. (has lost one millisecond.)
- 28 Choice c. (multiplied by 5.)
- 29 Choice c. (two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.)
- 30 Choice d. (150J.)
- 31 Choice a. (ampere.)
- 32 Choice a. (3J.)
- 33 Choice c. (5.)
- 34 Choice c. (always a real image.)
- 35 Choice b. (50V.)

- 36 Choice a. (the water side at a 50 degree angle of incidence.)
- 37 Choice c. (scattered in all directions.)
- 38 Choice d. (For short wavelengths, rays are straight lines.)

## Solutions

- 1 Module 084 Electric Current: Question 4.1
- 2 Module 083 Definition of Electric Potential: Question 4.1
- 3 Module 107 Optical Instruments: Question 1.3
- 4 Module 080 Definition of an Electric Field: Question 3.1
- 5 Module r42 Relativistic Mechanics: Question 4.1
- 6 Module r42 Relativistic Mechanics: Question 2.2
- 7 Module 102 Interactions at boundaries: Question 3.1
- 8 Module 102 Interactions at boundaries: Question 1.1
- 9 Module 099 Wave Properties: Question 3.1
- 10 Module 103 Dispersion effects: Question 3.2
- 11 Module 100 Wave Properties: Question 4.2
- 12 Module r41 The Twin Paradox: Question 3.2
- 13 Module 104 The Ray Approximation: Question 3.2
- 14 Module 082 Electric Potential Energy: Question 4.1
- 15 Module 107 Optical Instruments: Question 4.2
- 16 Module 100 Wave Properties: Question 1.1
- 17 Module 106 Lenses: Question 1.3
- 18 Module 077 Coulomb's Force Law: Question 1.3
- 19 Module 107 Optical Instruments: Question 3.3
- 20 Module 103 Dispersion effects: Question 1.2
- 21 Module 107 Optical Instruments: Question 2.2
- 22 Module 105 Images: Question 1.4
- 23 Module 092 Magnetic Poles: Question 4.3
- 24 Module 099 Wave Properties: Question 4.2
- 25 Module 106 Lenses: Question 3.1
- 26 Module 080 Definition of an Electric Field: Question 1.2
- 27 Module r41 The Twin Paradox: Question 1.1
- 28 Module 077 Coulomb's Force Law: Question 2.1
- 29 Module 092 Magnetic Poles: Question 3.2
- 30 Module 083 Definition of Electric Potential: Question 2.4
- 31 Module 084 Electric Current: Question 1.3
- 32 Module 082 Electric Potential Energy: Question 2.2
- 33 Module r42 Relativistic Mechanics: Question 3.3
- 34 Module 105 Images: Question 2.2
- 35 Module 086 Electrical Resistance: Question 4.2
- 36 Module 102 Interactions at boundaries: Question 4.3

37 Module 102 Interactions at boundaries: Question 2.2

38 Module 104 The Ray Approximation: Question 2.1