1. The electrostatic forces that act between atoms are usually small compared to the gravitational forces that act between atoms.

(a) True.
(b) False.

2. When you desire more power from Toledo Edison, you do so by <u>lowering</u> the effective resistance of your home electrical circuits.

(a) True.
(b) False.

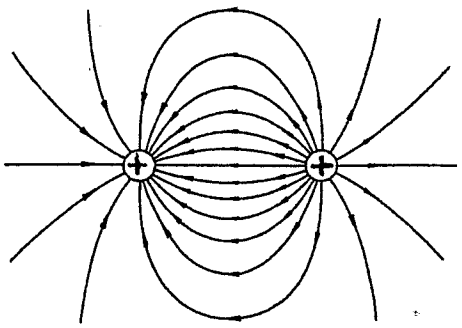
$$P = \frac{V^2}{R}$$

3. An inexperienced repairman receives an electric shock when he reaches inside an unplugged TV set and touches an electronic component. Indicate the type of electronic component that was most likely touched.

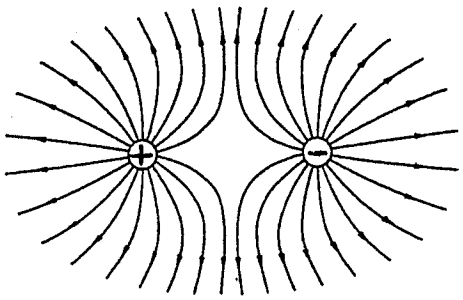
(a) A resistor
(b) A capacitor
(c) An inductor
(d) A transistor
(e) A rheostat

4. Only one of the pictures below conforms to the standard rules for depicting the electric field near charges in terms of "lines of force." Designate the letter that accompanies the valid depiction.

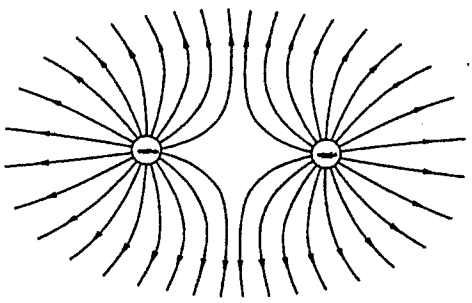
(a)



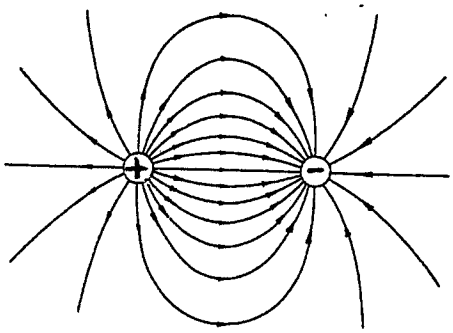
(b)



(c)



(d)



5. A voltage produces a current of approximately one ampere, flowing through a small copper wire in an electrical circuit. This current is caused by the movement of conduction electrons accelerated by the electric field in the wire. The drift velocity of these conduction electrons is

(a) less than one atomic diameter per second
(b) approximately 1/10 millimeter per second
(c) approximately 100 meters per second
(d) approximately 1% the speed of light
(e) faster than the speed of light

6. The charge distribution to the right is called a "dipole" and requires **four** coordinates to specify the positions of its charges (x, y, z-d/2, z+d/2). Comparing to the known behavior of a sheet charge, a line charge, and a point charge, the electric field of a single dipole should decrease with distance in proportion to

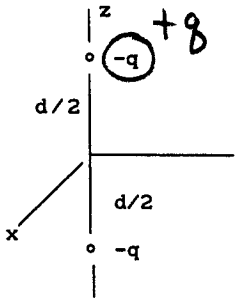


Diagram Misprint - Question Dropped.

(a) $1/r$
(b) $1/r^2$
(c) $1/r^3$
(d) $1/r^4$
(e) $1/r^5$

$$E = \frac{kq}{(r-d/2)^2} - \frac{kq}{(r+d/2)^2} = kq\left[\frac{(r^2+rd+d^2/4)-(r^2-rd+d^2/4)}{(r^2-d^2/4)^2}\right]$$

$$= kqd\,\frac{r}{(r^2-d^2/4)^2} \approx \frac{kqd}{r^3}$$

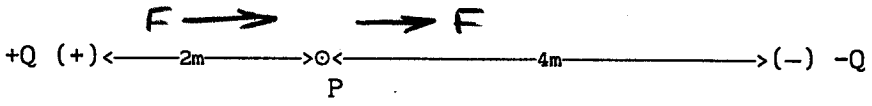
(small)

7. Two charges attract each other with a force of 4 newtons when they are 12 meters apart. If the same two charges are separated by 6 meters the force between them is

(a) 16 Newtons
(b) 8 Newtons
(c) 4 Newtons
(d) 2 Newtons
(e) 1 Newton

$$F = \frac{kqQ}{r^2}$$

The next two questions (8 and 9) both refer to the diagram shown below. Two charges of equal magnitude but opposite sign are 6 meters apart. A point P is 2 meters from the positive charge.



8. The magnitude of the electric field E at the point P in the above diagram is

(a) zero
(b) kQ/4
(c) kQ/16
(d) 5kQ/16
(e) 3kQ/16

$$E = \frac{KQ}{2^2} + \frac{KQ}{4^2} = KQ\left(\underbrace{\frac{1}{4} + \frac{1}{16}}_{5/16}\right)$$

9. The electric potential V at the point P in the above diagram is

(a) kQ/2
(b) kQ/4
(c) 3kQ/4
(d) kQ/6
(e) zero

$$V = \frac{K(+Q)}{2} + \frac{K(-Q)}{4} = KQ\left(\underbrace{\frac{1}{2} - \frac{1}{4}}_{1/4}\right)$$

---

10. Two resistance wires are similar, except that one has a shorter characteristic time between the collisions of the conduction electrons with the atoms of the material. The wire with the <u>shorter</u> average electron flight time will have

(a) a higher resistance.
(b) a lower resistance.
(c) the same resistance as the other wire.

11. Doubling the current in a circuit with a constant resistance has the effect of changing the power dissipated by what factor?

(a) 0.5
(b) 0.25
(c) 2.0
(d) 4.0

$V = IR$; $P = IV$; $P = \underbrace{I^2}_{2^2=4} R$

12. If electricity costs 6 cents per kilowatt hour and your TV uses 3000 Watts, how much does it cost to watch a 2 hour movie on TV?

(a) 12 cents
(b) 18 cents
(c) 24 cents
(d) 36 cents
(e) 72 cents

$$(3\,Kw)(2h)\,\frac{6¢}{Kwh} = 36¢$$

13. Increasing the voltage across the plates of a capacitor will produce what effect on the capacitor?

$Q = CV$

(a) Increase the charge on the plates.
(b) Decrease the charge on the plates.
(c) Increase the capacitance of the device.
(d) Decrease the capacitance of the device.

14. When designed for use in a standard 110 volt outlet, which light bulb will have the smallest electrical resistance?

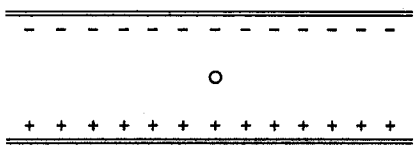
$P = \frac{V^2}{R}$

(a) a 60 watt bulb
(b) a 100 watt bulb
(c) a 150 watt bulb

15. Regardless of how many appliances you plug into the circuits in your home, Toledo Edison endeavors to provide you with the same constant

(a) outage
(b) wattage
(c) ohmage
(d) amperage
(e) voltage

16. In the figure below, a charged 1 gm pellet is suspended motionless between two charged horizontal plates in a laboratory (where gravity acts down). The lower plate is charged positively, the upper negatively. Which of the following statements is **NOT TRUE.**



(a) The electric field between the plates points up.
(b) The pellet is charged negatively.
(c) The magnitude of the electrostatic force equals the pellet's weight.
(d) The plates are at different potentials.

17. When two identical resistors are connected in series across a battery, the power dissipated by them is 20 Watts. If these resistors were instead connected in parallel across the same battery, the total power dissipated would be

(a) 5 Watts
(b) 10 Watts
(c) 20 Watts
(d) 40 Watts
(e) 80 Watts

Series: $I = \frac{V}{2R}$; $P = IV = \frac{V^2}{2R}$

Parallel $P = \frac{V^2}{R} + \frac{V^2}{R} = \frac{2V^2}{R}$

4 times as much

18. A beam of radioactive particles travels at a speed v=0.8c in a nuclear physics laboratory. If the halflife of these particles is 10 ns (10×10^{-9} s), over what flight-distance in the laboratory must these particles travel to have one-half of their number disintegrate?

(a) 1.6 meters
(b) 2.4 meters
(c) 4.0 meters
(d) 6.0 meters

$$X = \frac{vt}{\sqrt{1-v^2/c^2}} = \frac{(0.8)(3\times10^8 m/s)(10\times10^{-9}s)}{\sqrt{1-(.8)^2}} = \frac{2.4}{0.6}$$

4.0m

19. A person traveling at a very high speed compares her height, weight, and age with the values on her driver's licence, which were measured at a much lower speed. She will find that

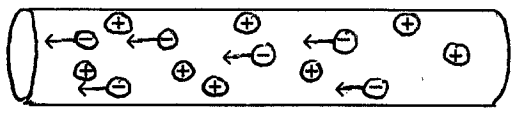
(a) her height has decreased slightly.
(b) her weight has increased slightly.
(c) she is aging more slowly.
(d) her height, weight and aging are the same as at low velocities.

20. A stick moves past an observer at a speed u in a direction parallel to the length of the stick. The observer measures the stick and concludes that it is 2 m in length. Another observer, at rest relative to the stick, will conclude that the length of the stick is

(a) less than 2 m.
(b) equal to 2 m
(c) greater than 2 m
(d) either (a) or (c), depending on whether the stick was approaching or receding.

Confusing Wording. Credit given for Both.

21. A positive charge Q moves parallel to and in the same direction as the drift of electrons in a current carrying wire, as shown below. The force on the charge Q is



V ← Q

(a) toward the wire, up the page on the diagram.
(b) away from the wire, down the page on the diagram.
(c) inward, into the page on the diagram.
(d) outward, out of the page on the diagram.

22. In order for any consequences of Einstein's Special Theory to be observed experimentally, it is necessary for the particles studied to be accelerated to speeds very close to the speed of light.

(a) True
(b) False

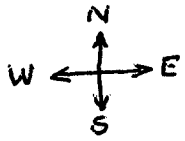
23. If a magnet (possessing one north and one south pole) is cut in half, each half will have both a north and a south pole.

(a) True
(b) False

(Error on Key was corrected)

24. A positively charged particle moves north through a magnetic field that points towards the center of the earth. The particle will feel a force in the direction

(a) North ↑
(b) South ↓
(c) East →
(d) West ←
(e) Up ⊙



⊙ up
⊗ down

25. Two closely spaced parallel wires that carry equal currents in the *same* direction will tend to repel each other.

(a) True
(b) False