PHY 262 Exam 1 **7/23/12**

This exam is closed book and closed notes, but open calculator. You have the first 75 minutes of classtime on Monday to complete the exam (8:30 am – 9:45 am). In addition to a couple of written questions, there are 2 different types of scantron questions, each with their own point values. The scantron sheet must be used to record ALL of the m/c and t/f answers. You must return your exam and the scantron to get credit for this exam. There are TWO versions of this exam (white and colored). Please write the color of your exam somewhere on your scantron. You may write on the test.

This is the "cheat-sheet" that will be given to you for your exam.

Be careful with your time. Be careful with your time. Be careful with your time.

$D = Vt$ $V_f^2 = V_i^2 + 2a(\Delta R)$ $V_f = V_i + at$ $R = R_o + V_o t + (1/2)at^2$

sin = opp/hyp cos = adj/hyp tan = opp/adj $g = 9.8\ m/s^2$

$Area = \pi R^2$ $Vol = (4/3)\pi R^3$ $Cir = 2\pi R$ $F = qE$ $e_o = 8.85 \times 10^{-12}$

$E = kq/r^2$ $E = -dV/dx$ $V = kq/r = EPE/q$ $VC = Q$ $C = Ke_oA/d$

Cap energy $= (1/2)CV^2$ proton mass $= 1.67 \times 10^{-27}$ electron mass $= 9.11 \times 10^{-31}$

$q = 1.6 \times 10^{-19}$ Avogadro's # $= 6.02 \times 10^{23}$ $G = 6.67 \times 10^{-11}$ $k = 9 \times 10^9$

$R = (rho)L/A$ Watt = Joule/sec Volt = Joule/Coul. $KE = mv^2/2$

$I = dq/dt$ $\Delta V = IR$ $P = IV$

R(series) = add R(parallel) = add inverses Vice-versa for caps

$\Delta V = \Delta EPE/q = -W_{ab}/q$ $I = nqvA$

Flux = E • A Gauss' Law: $\oint E \bullet dA = q(enclosed)/e_o$ $J = \sigma E = I/A$

$p = 2aq$ $\tau = p \times E$ $U = -p \bullet E$ $C = KC_o$ $\Delta V_{ab} = -\int_a^b E \bullet dS$

RC = time constant

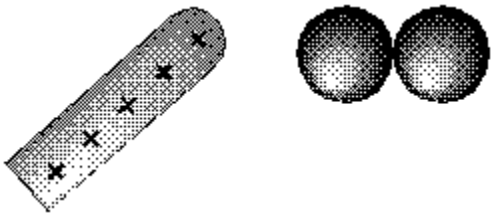
The following 40 questions are ONE point each examples. Examples of these questions are not given below, but you have seen many of them in your in-class quizzes. They will be short and true/false. They are also all conceptual—no math.

There are also some questions worth 2 pts each. Examples of these questions follow….

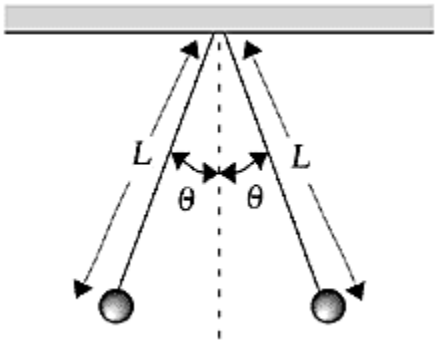
1. Electrons
   A) are about 2000 times more massive than protons.
   B) are about 2000 times less massive than protons.
   C) have 2000 times the charge of protons.
   D) have 1/2000 the charge of protons.
   E) can have any amount of charge.

2. Experimental evidence indicates that
   A) charge is quantized and conserved.
   B) charge is quantized but not conserved.
   C) charge is conserved but not quantized.
   D) charge is neither quantized nor conserved.
   E) None of these answers is correct.

3. If an object is determined to have a negative charge of 160 nC, you can conclude that the object has an excess of
   A) 10^{9} electrons
   B) 10^{10} electrons
   C) 10^{11} electrons
   D) 10^{12} electrons
   E) 10^{13} electrons
   Ans: D

4. 
   If you bring a positively charged insulator near two uncharged metallic spheres that are in contact and then separate the spheres, the sphere on the right will have
   A) no net charge.
   B) a positive charge.
   C) a negative charge.
   D) either a positive or negative charge.
   E) None of these is correct.
   Ans: B

5.



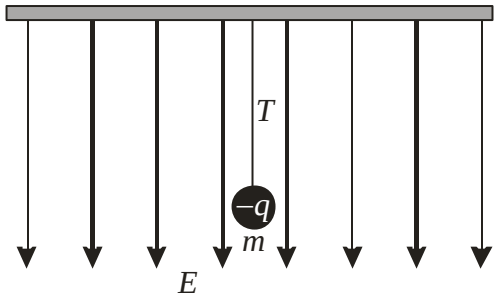
Two small spheres, each with mass m = 5.0 g and charge q, are suspended from a point by threads of length L = 0.30 m. What is the charge on each sphere if the threads make an angle θ = 20º with the vertical?

A) 7.9×10^{-7} C
B) 2.9×10^{-7} C
C) 7.5×10^{-2} C
D) 6.3×10^{-13} C
E) 1.8×10^{-7} C

Ans: B

Use the picture for the next two problems.

A conducting sphere has a net charge of $-q$ and of mass m is suspended from the ceiling by a light string. A uniform electric field E is applied vertical down on the sphere.



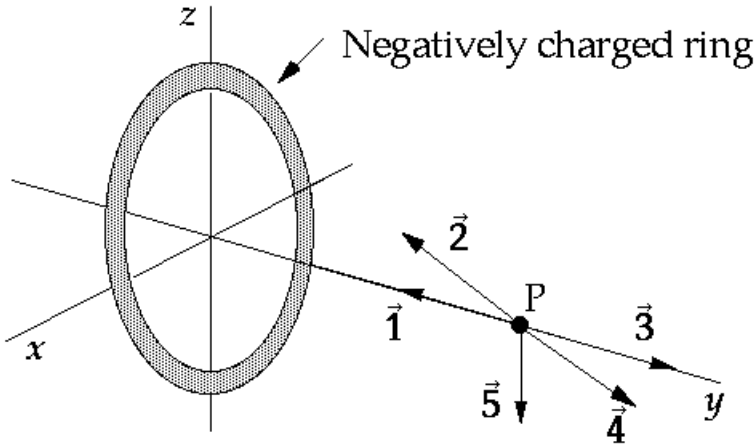
Section: 21–4 Topic: The Electric Field Type: Conceptual

6. The tension T in the string is ____ the weight mg.

A) less than
B) equal to
C) greater than
D) dependent on the strength of E in relation to
E) insufficient information to tell

Ans: A

7.

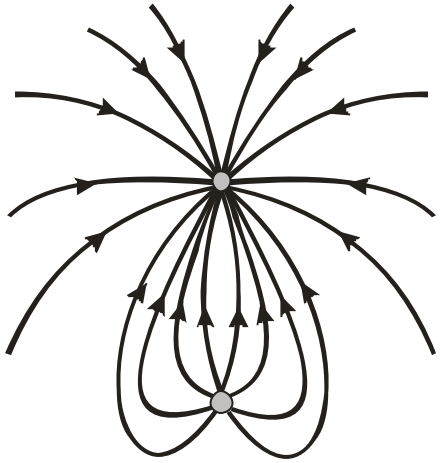


The point P is on the axis of a ring of charge, and all vectors shown lie in the *yz* plane. The negatively charged ring lies in the *xz* plane. The vector that correctly represents the direction of the electric field at this point is

A) $\vec{1}$ B) $\vec{2}$ C) $\vec{3}$ D) $\vec{4}$ E) $\vec{5}$

Ans: A

8.

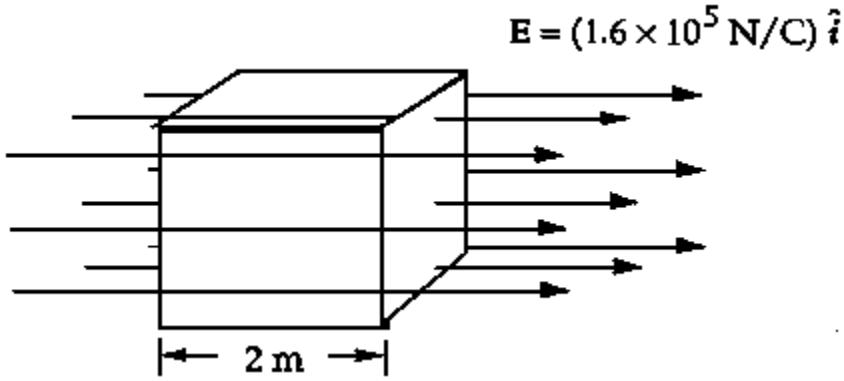


The figure shows the field lines for two charges. What is the ratio of the top charge to the bottom charge? Pay attention to the signs of the charges.

A) 1:2
B) –1:2
C) 2:1
D) –2:1
E) 2:–1

Ans: D

9.

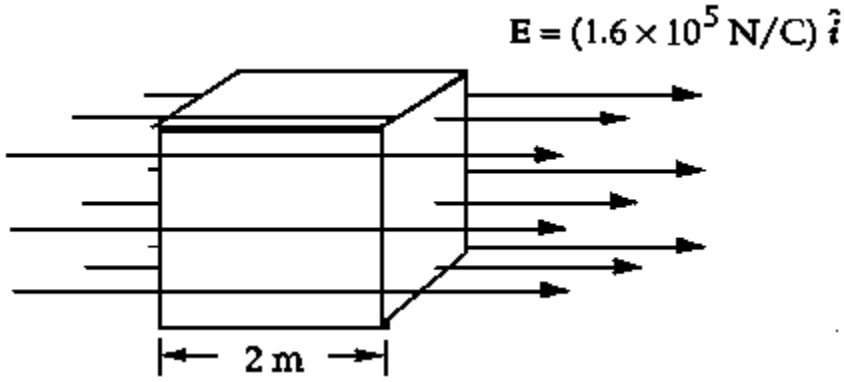


A cubical surface with no charge enclosed and with sides 2.0 m long is oriented with right and left faces perpendicular to a uniform electric field ***E*** of $(1.6 \times 10^5$ N/C) $\hat{i}$. The net electric flux ϕ_E through this surface is approximately

A) zero
B) 6.4×10^5 N · m^2/C
C) 13×10^5 N · m^2/C
D) 25×10^5 N · m^2/C
E) 38×10^5 N · m^2/C

Ans: A

10.



A cubical surface with sides 2.0 m long is oriented with right and left faces perpendicular to a uniform electric field $\vec{E}$ of $(1.6 \times 10^5$ N/C) $\hat{i}$. The net charge enclosed by this surface is approximately

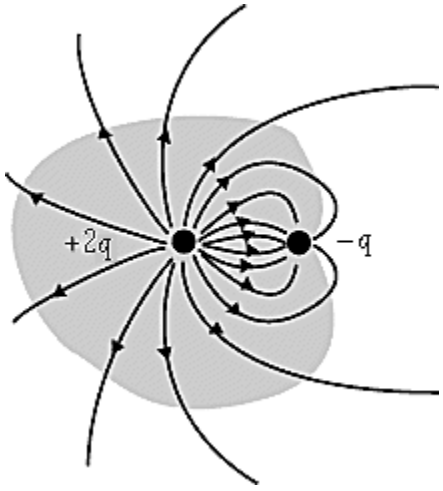
A) 25×10^5 μC
B) 6.4×10^5 μC
C) 13×10^5 μC
D) zero
E) 38×10^5 μC

Ans: D

11. Which of the following circumstances about Gauss's law is true?
A) Gauss's law is applicable in highly symmetric cases such as uniformly charged infinite plane, infinite cylinder, or sphere.
B) Gauss's law is applicable for a point charge.
C) Gauss's law is applicable for two or more point charges.
D) Gauss's law is applicable for any objects of any shape.
E) all of the above
Ans: E

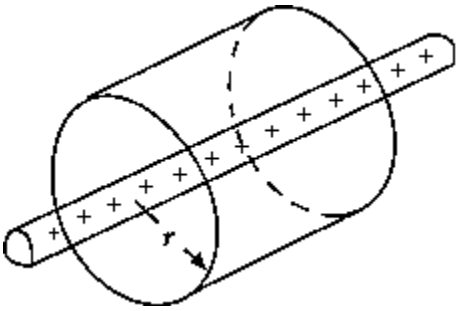
12. Consider a uniform electric field $\vec{E} = (5.0 \text{ kN/C})\ \hat{i}$. What is the flux of this field through a square of side 20 cm in a plane parallel to the *yz* plane?
A) 0.10 kN · m^2/C
B) 0.20 kN · m^2/C
C) 0.40 kN · m^2/C
D) 0.50 kN · m^2/C
E) 0.13 kN · m^2/C
Ans: B

13.



The figure shows a surface enclosing the charges $2q$ and $-q$. The net flux through the surface surrounding the two charges is
A) $q/\in_0$ B) $2q/\in_0$ C) $-q/\in_0$ D) zero E) None of these is correct.
Ans: A

14.



A rod of infinite length has a charge per unit length of λ (= q/l). Gauss's law makes it easy to determine that the electric field strength at a perpendicular distance r from the rod is, in terms of $k = (4\pi\in_0)^{-1}$,

A) $k\lambda/r^2$ B) $k\lambda/r$ C) $4\pi k\lambda/r$ D) $2k\lambda/r$ E) zero

Ans: D

15. The voltage between the cathode and the screen of a television set is 22 kV. If we assume a speed of zero for an electron as it leaves the cathode, what is its speed just before it hits the screen?

A) 8.8×10^7 m/s
B) 2.8×10^6 m/s
C) 6.2×10^7 m/s
D) 7.7×10^{15} m/s
E) 5.3×10^7 m/s

Ans: A

16. The voltage between the cathode and the screen of a computer monitor is 12 kV. If we assume a speed of zero for an electron as it leaves the cathode, what is its speed just before it hits the screen?

A) 8.8×10^7 m/s
B) 6.5×10^7 m/s
C) 4.2×10^{15} m/s
D) 7.7×10^{15} m/s
E) 5.3×10^7 m/s

Ans: B

17. When 2.0 C of charge moves at constant speed along a path between two points differing in potential by 6.0 V, the amount of work done is
A) 2 J B) 3 J C) 6 J D) 12 J E) 24 J
Ans: D

Section: 23–1 Topic: Potential Difference Type: Numerical

18. When 5.0 C of charge moves at constant speed along a path between two points differing in potential by 12 V, the amount of work done is
A) 2.4 J B) 0.42 J C) 5.0 J D) 12 J E) 60 J
Ans: E

19. The electron volt is a unit of
A) capacitance B) charge C) energy D) momentum E) potential
Ans: C

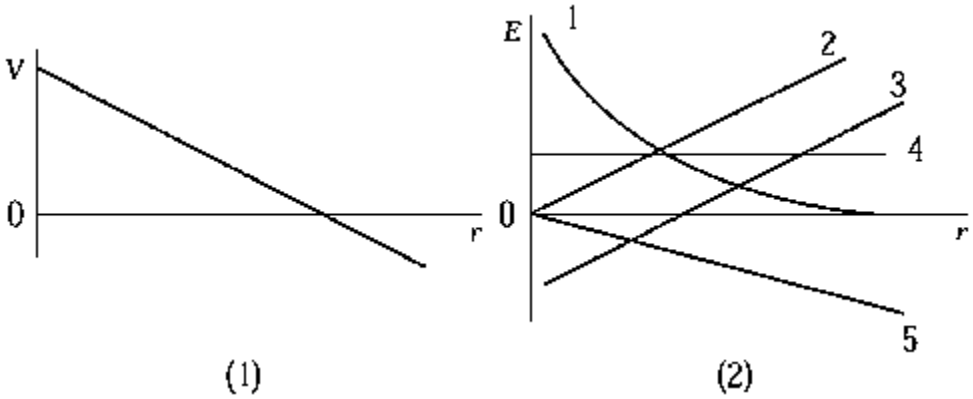
20. A uniform electric field exists between two parallel plates separated by 2.0 cm. The intensity of the field is 15 kN/C. What is the potential difference between the plates?
A) 0.75 MV B) 30 kV C) 15 kV D) 0.30 kV E) 54 kV
Ans: D

21. A uniform electric field exists between two parallel plates separated by 1.2 cm. The intensity of the field is 23 kN/C. What is the potential difference between the plates?

A) 7.5 MV
B) 3.0 MV
C) 15 kV
D) 0.30 kV
E) None of these is correct.

Ans: E

22.



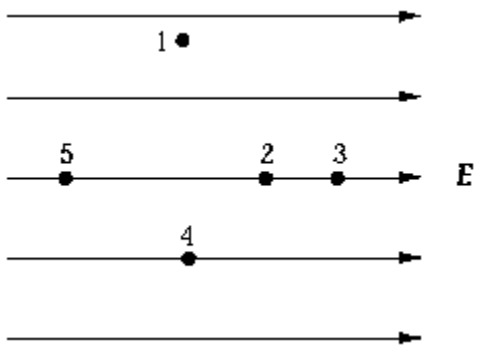
(1) (2)

The electrostatic potential as a function of distance along a certain line in space is shown in graph (1). Which of the curves in graph (2) is most likely to represent the electric field as a function of distance along the same line?

A) 1 B) 2 C) 3 D) 4 E) 5

Ans: D

Use the following to answer the next 3 questions:

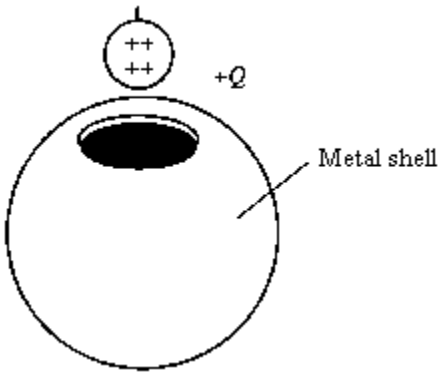


23. Which of the points shown in the diagram are at the same potential?
A) 2 and 5 B) 2, 3, and 5 C) 1 and 4 D) 1 and 5 E) 2 and 4
Ans: C

24. Which point in the electric field in the diagram is at the highest potential?
A) 1 B) 2 C) 3 D) 4 E) 5
Ans: E

25. Which point in the electric field in the diagram is at the lowest potential?
A) 1 B) 2 C) 3 D) 4 E) 5
Ans: C

26.



A metal ball of charge $+Q$ is lowered into an insulated, uncharged metal shell and allowed to rest on the bottom of the shell. When the charges reach equilibrium,

A) the outside of the shell has a charge of $-Q$ and the ball has a charge of $+Q$.
B) the outside of the shell has a charge of $+Q$ and the ball has a charge of $+Q$.
C) the outside of the shell has a charge of zero and the ball has a charge of $+Q$.
D) the outside of the shell has a charge of $+Q$ and the ball has zero charge.
E) the ouside of the shell has a charge of $+Q$ and the ball has a charge of $-Q$.

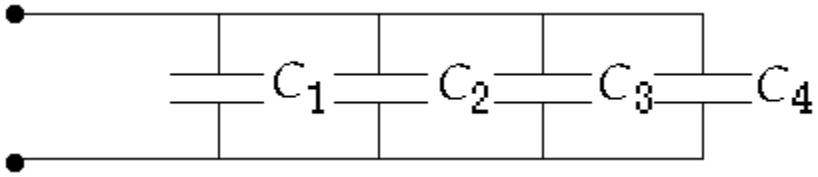
Ans: D

27. A capacitor of capacitance C holds a charge Q when the potential difference across the plates is V. If the charge Q on the plates is doubled to $2Q$,

A) the capacitance becomes $(1/2)V$.
B) the capacitance becomes $2C$.
C) the potential changes to $(1/2)V$.
D) the potential changes to $2V$.
E) the potential does not change.

Ans: D

28.

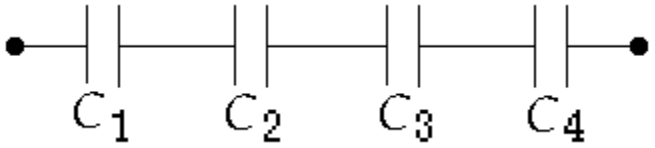


If $C_1 < C_2 < C_3 < C_4$ for the combination of capacitors shown, the equivalent capacitance

A) is less than C_1.
B) is more than C_4.
C) is between C_2 and C_3.
D) is less than C_2.
E) could be any value depending on the applied voltage.

Ans: B

29.



If $C_1 < C_2 < C_3 < C_4$ for the combination of capacitors shown, the equivalent capacitance

A) is less than C_1.
B) is more than C_4.
C) is between C_2 and C_3.
D) is more than C_2.
E) could be any value depending on the applied voltage.

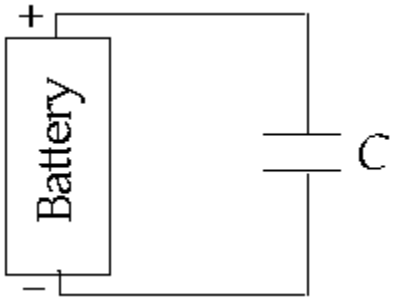
Ans: A

30. When you insert a piece of paper ($\kappa = 3.7$) into the air between the plates of a capacitor, the capacitance

A) increases.
B) decreases.
C) does not change.
D) could increase, decrease, or not change depending on the dielectric constant of the paper.
E) does none of these.

Ans: A

31.



A capacitor is connected to a battery as shown. When a dielectric is inserted between the plates of the capacitor,

A) only the capacitance changes.
B) only the voltage across the capacitor changes.
C) only the charge on the capacitor changes.
D) both the capacitance and the voltage change.
E) both the capacitance and the charge change.

Ans: E

32. For copper, $\rho = 8.93$ g/cm^3 and $M = 63.5$ g/mol. Assuming one free electron per copper atom, what is the drift velocity of electrons in a copper wire of radius 0.625 mm carrying a current of 3 A?

A) 3.54×10^{-4} m/s
B) 1.80×10^{-4} m/s
C) 4.26×10^{-4} m/s
D) 7.52×10^{-4} m/s
E) 2.46×10^{-4} m/s

Ans: B

33. For copper, $\rho = 8.93$ g/cm^3 and $M = 63.5$ g/mol. Assuming one free electron per copper atom, what is the drift velocity of electrons in a copper wire of radius 0.435 mm carrying a current of 5 A?

A) 5.43×10^{-4} m/s
B) 2.11×10^{-4} m/s
C) 4.67×10^{-4} m/s
D) 6.21×10^{-4} m/s
E) 8.37×10^{-4} m/s

Ans: D

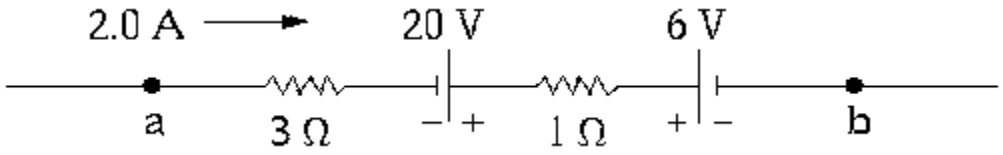
34. Which of the following statements is *false*?

A) When there is no electric field in a wire, the free electrons move in random directions with speeds of the order of 10^6 m/s.
B) By convention, electrons move in the direction opposite to the direction of current.
C) In the absence of an electric field, the average velocity of the electrons in a wire is very large.
D) The drift velocity of electrons in a typical metal is very small.
E) The motion of the free electrons in a metal is similar to that of the molecules of a gas.

Ans: C

35. The seemingly instantaneous propagation of electric current in a wire when a switch is closed can be understood in terms of
    A) the propagation of an electric field down the wire with nearly the speed of light.
    B) the acquisition of the drift velocities of the free electrons almost immediately.
    C) a very large number of charges slowly drifting down the wire.
    D) the replacement of charge flowing out of the wire at one end by charge entering the wire at the other end.
    E) all of the above
    Ans: E

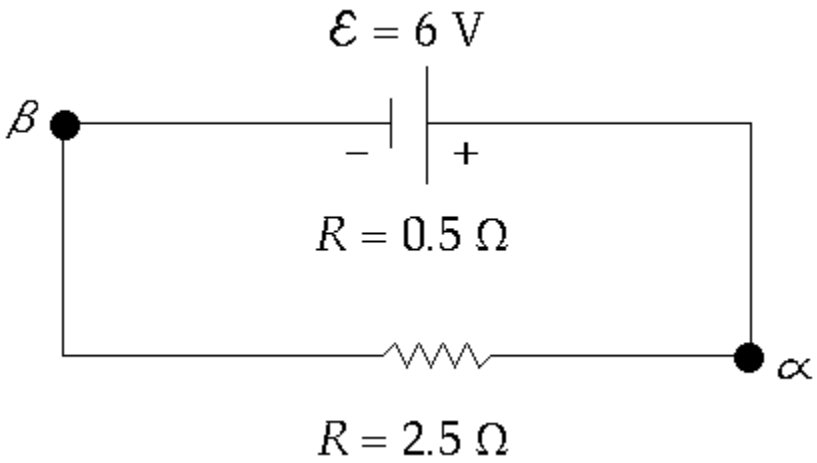
36. The resistivity of any given metal
    A) depends on its temperature.
    B) varies linearly with temperature.
    C) is the proportionality constant between the resistance, R, and the ratio of the length, L, to the cross-sectional area, A, of a wire made of the metal.
    D) has units of ohm-meter.
    E) is described by all of the above.
    Ans: E

37. 

    If a current of 2.0 A is flowing from point a to point b, the potential difference between the points is
    A) 6 V B) 8 V C) 14 V D) 20 V E) 22 V
    Ans: A

38. An energy efficient light bulb uses 15 W of power for an equivalent light output of a 60 W incandescent light bulb. How much money do you save each month by using the energy efficient light bulb instead of the incandescent light bulb for 6 hours a day? Assume that 1 kW·hr costs 14 cents and there are 30 days in one month.
    A) $0.39
    B) $0.76
    C) $1.51
    D) $0.57
    E) $1.13
    Ans: E

39.

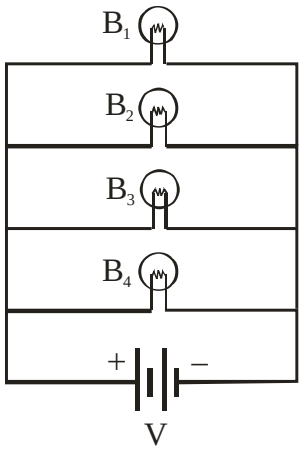


The circuit in the figure contains a battery and a resistor in series. Which of the following statements is not true?

A) The current in the circuit is 2 A.
B) Point α is at a higher potential than point β, and $V_{\alpha\beta}$ = 5 V.
C) The battery is supplying energy to the circuit at the rate of 6 W.
D) The rate of heating in the external resistor is 10 W.
E) The battery is being discharged.

Ans:

40.



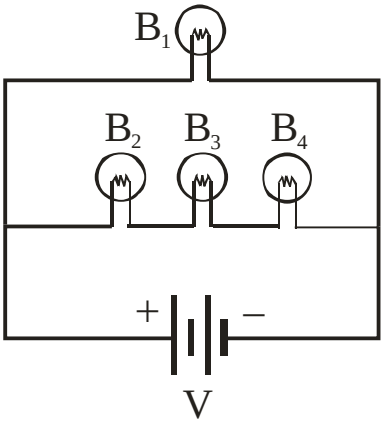
Four identical light bulbs are connected to a power supply as shown. Which light bulb consumes the most power?

A) B_1 B) B_2 C) B_3 D) B_4 E) They all consume the same amount of power.

Ans: E

Section: 25–4 Topic: Combinations of Resistors Type: Conceptual

41.



Four identical light bulbs are connected to a power supply as shown. Which light bulb consumes the most power?

A) B_1 B) B_2 C) B_3 D) B_4 E) B_2, B_3, and B_4

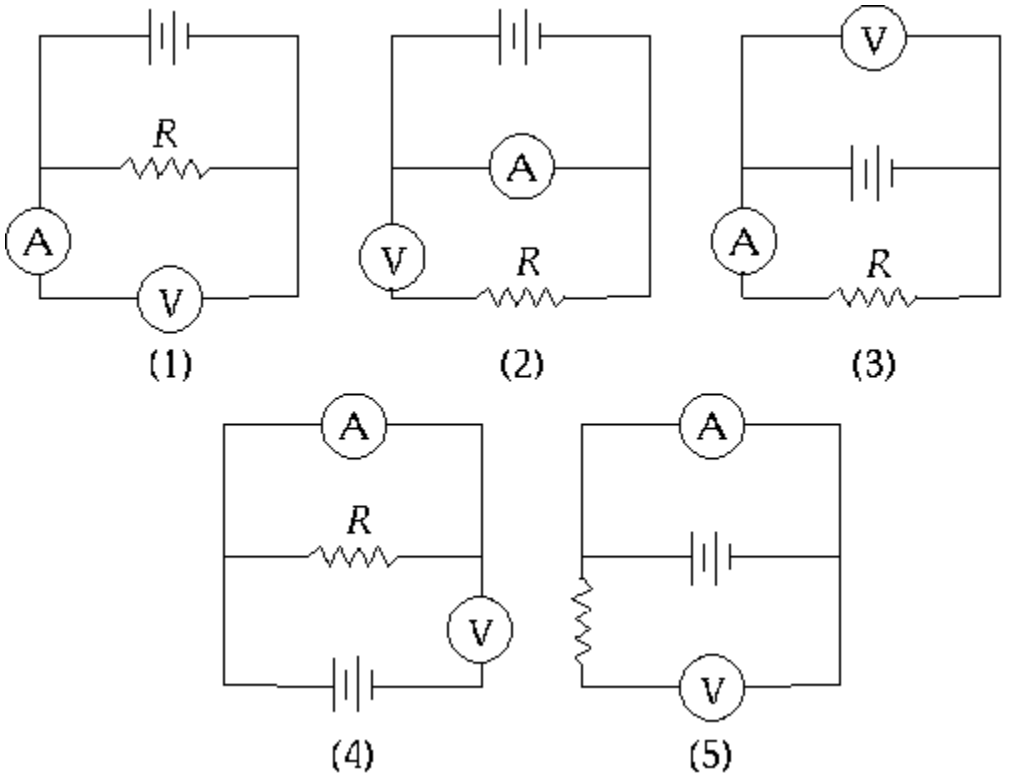
Ans: A

42. If two elements of a circuit are in parallel, they must have the same

A) charge.
B) potential difference across them.
C) resistance.
D) potential difference across them and the same charge.
E) current.

Ans: B

43.



The circuit in which the voltmeter (V) and the ammeter (A) are correctly arranged to determine the value of the unknown resistance R is

A) 1 B) 2 C) 3 D) 4 E) 5

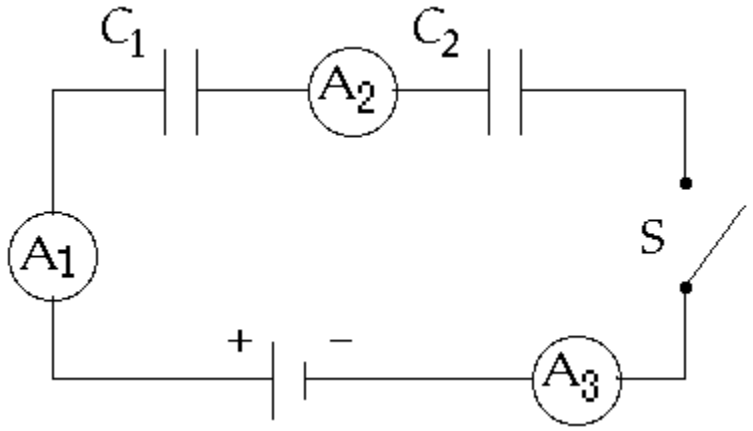
Ans: C

44. A battery is connected to a series combination of a switch, a resistor, and an initially uncharged capacitor. The switch is closed at $t = 0$. Which of the following statements is true?

A) As the charge on the capacitor increases, the current increases.
B) As the charge on the capacitor increases, the voltage drop across the resistor increases.
C) As the charge on the capacitor increases, the current remains constant.
D) As the charge on the capacitor increases, the voltage drop across the capacitor decreases.
E) As the charge on the capacitor increases, the voltage drop across the resistor decreases.

Ans: E

45.

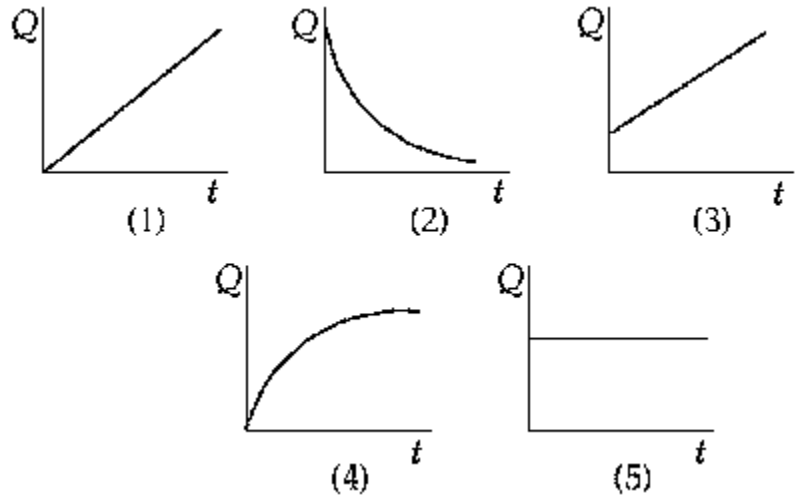


Capacitors C_1 and C_2 are connected in series to the battery as shown. When you close switch S, a momentary current is indicated by

A) ammeter A_1 only.
B) ammeter A_2 only.
C) ammeter A_3 only.
D) ammeter A_1 and A_3 only.
E) all of the ammeters.

Ans: E

46.

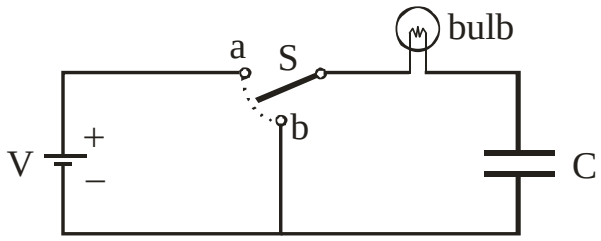


The curve that best represents the charge on the capacitor in a charging *RC* circuit as a function of time is

A) 1 B) 2 C) 3 D) 4 E) 5

Ans: D

Use the diagram for the next two problems:



Section: 25–6 Topic: RC Circuits Type: Conceptual

47. The switch *S* is initially at position *a* for a long time. It is then switched to position *b*. Describe what happens to the light bulb as a function of time when the switch is flipped from *a* to *b*?
    A) The light bulb was on but goes off immediately.
    B) The light bulb was off and stays off.
    C) The light bulb was on but its brightness decreases with time and eventually goes off.
    D) The light bulb was on and stays on.
    E) The light bulb was off. It then lights up but the brightness decreases with time and eventually goes off.

    Ans: E

Section: 25–6 Topic: RC Circuits Type: Conceptual

48. The switch *S* is initially at position *b* for a long time. It is then switched to position *a*. Describe what happens to the light bulb as a function of time when the switch is flipped from *b* to *a*?
    A) The light bulb was on but goes off immediately.
    B) The light bulb was off and stays off.
    C) The light bulb was on but its brightness decreases with time and eventually goes off.
    D) The light bulb was on and stays on.
    E) The light bulb was off. It then lights up but the brightness decreases with time and eventually goes off.

    Ans: E