PHYS.2B s 2 Midterm1 Sol. Fall 15

1. Two charges, +Q and –Q, are located 2 meters apart and there is a point P along the line that is equidistant from the two charges as indicated. Which vector best represents the direction of the electric field E at that point?
   1. Vector Ea
   2. Vector Eb
   3. Vector Ec
   4. The electric field at that point is zero

-Q○ Ea

E(-Q)

P E(due to +Q)

+Q ○

The resultant vector is Ea

For charges +Q and +Q:

+Q○

E

P Eb

E

+Q ○

The resultant is vector Eb

1. In the diagram below, the current in the 3.0Ω resistor is 4.0 A. The potential difference between points A and B is:

2.0Ω 3.0Ω

A ○ ○B

* 1. 0.75V
  2. 0.8V
  3. 1.25V
  4. 12V
  5. **20V**

The current is the same for the resistors in series.

VAB=I\*Req=I\*(3.0+2.0)Ω=20V

1. In the circuit below, the charge on the capacitor C2 is Q2=16μC. What is the charge Q1 on the capacitor C1?

C1 C2

12V

**Q1=Q2=16μC** (series connection of capacitors)

1. The potential difference between two points is 100V. If 2.0C of charge is transported from one point to another, the change of its potential energy is:
   1. **200J**
   2. 100J
   3. 50J
   4. 100V
   5. 2.0J

ΔPE=Q\*ΔV=2.0C\*100V=200J

1. An ordinary light bulb is marked “60W, 120V”. Its (heated) resistance is:
   1. 60Ω
   2. 120Ω
   3. 180Ω
   4. 240Ω
   5. 15Ω

P=V2/R

60W=(120V)2/R

R=(120V)2/60W=240Ω

Part 2

1. Three point charges q1=-10 nC, q2=-10nC, and q3=+3 nC are arranged along a line as shown in the sketch.

What is the potential at point P perpendicular to the line connecting all three charges at the distance 0.3m from the charge q2 ?

◦P

r1 r2 r3

0.4m 90o 0.8m

○ ○ ○

q1 q2 q3

V=k(q1/r1+ q2/r2+ q3/r3)

r1=sqrt((0.4m)2+(0.3m)2)=0.5m

r2=0.3m

r3= sqrt((0.8m)2+(0.3m)2)=0.85m

# V=9.0\*109 Nm2/C2\*(-10\*10-9C/0.5m+-10\*10-9C/0.3m+3.0\*10-9C/0.85m)=-448V

2. Charges q1=+8 μC, q2=-8 μC, and q3=+2μC are placed at the vertices of an equilateral triangle with the side a=0.5m. as shown. Find the total force exerted on the charge q3. Draw the vectors of the forces F13, F23, and the resultant force.

F13y F13 F23x

F13x Fnet

q3 ○ Fnet

F23x F13x

F23y

F23

q1○ 0.5m ○q2

F13=F23= kq1q3/r2=9.0\*109 Nm2/C2\*(8\*10-6C\*2\*10-12C)/(0.5m)2=0.58N

F13x=F23x= F13\*cos60o=0.87N

F13y=-F13\*sin60o

F23y=+F13\*sin60o

F13y+ F23y=0

Fnet=058N (along positive x-axis)

If all charges are positive, the net vector of the force is in positive y-direction:

Fnet

F23 F13

q3 ○

=

q1 ○ ○q2

1. How much power is being dissipated by one of 10-Ω resistor?

R2 = 20Ω

R1= 2.0Ω I2

R3= 10Ω I3

I1

R4= 10Ω

I4

ε= 12V

I

R1 R234

R2 , R3, and R4 are in parallel;

R234=(1/ R2 +1/ R3+1/ R4 )-1 =4.0Ω

R234 in series with R1 : Req=6.0Ω

I=I1=I234=12V/6.0Ω=2.0A

V234=V2=V3=V4=2.0A\*4.0Ω=8.0V

P3=V32/R3=6.4W

Extra credit (4 points)

In the circuit segment shown if I=7mA and q=50µC, what is a potential difference VA-VB?

15V + 1.5kΩ

A○ ○B

I

0.5µF

VAB=-15V+50µC/0.5µF-I\*R=-15V+100V-1.5\*103Ω\*7\*10-3A=100V-25.5V=74.5V