Electrostatics

1. Given $\vec{A} = i - j$, $\vec{B} = 2k$ and $\vec{C} = -i + 3j$. Find $A \cdot B \times C$ and $A \times (B \times C)$.

2. Given $\vec{A} = 2i - j$, $\vec{B} = 3i + j$ and $\vec{C} = -2i + 6j - 4k$. Show that $\vec{C}$ is $\perp$ to both $\vec{A}$ and $\vec{B}$.

3. Given $\vec{A} = i + j$, $\vec{B} = i + 2k$ and $\vec{C} = 2j + k$. Determine $(A \times B) \times C$ and $A \times (B \times C)$ and also determine $A \cdot (B \times C)$ and $A \times B) \cdot C$. Does change in order of operation change anything?

4. Find unit vector directed from $(2, -5, -2)$ towards $(14, -5, 3)$.

5. How many electrons are contained in 1.0 C of charge? What is the mass of the electrons in 1.0C of charge

6. If two charges each of 1C, were separated in air by a distance of 1km, what would be the force between them?

7. A point charge of -30 μC is placed at the origin of coordinates. Find the electric field at the point x=5.0m on the x-axis.

8. For the situation shown in fig.1 . Find (a) the electric field E at point, (b) the force on a -40 nC charge place at point p and (c) where in the region the electric field would be zero (in absence of -40nC)

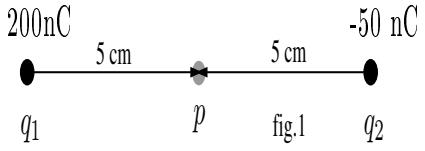


fig.1

9. Three charges are placed on three corners of a square, as shown in fig.2 . Each side of the square is 30.0 cm. (a) Compute E at the forth corner. (b) What would be the force on a 6μC charge placed at the vacant corner?

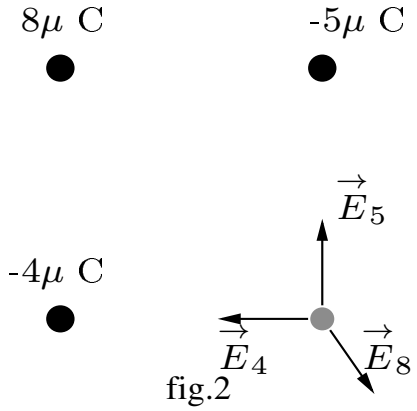


fig.2

10. Three point charges are placed along the x-axis as 2.0μC at x=0, -3.0μC at x=40cm, -5.0 μC at x=120 cm as illustrated in fig. 3. Find the force (a) on the -3.0 μC charge (b) on the -5 μC charge.

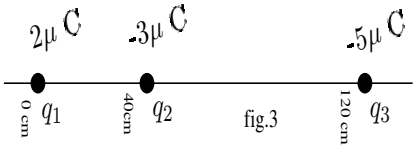
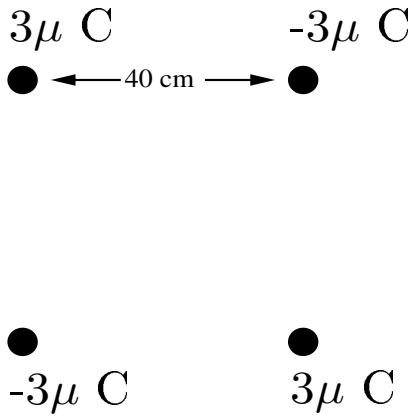


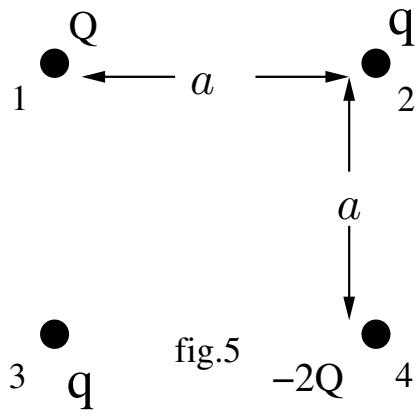
fig.3

11. Four point charges of +3.0μC are placed at the four corner of a square that is 40 cm on a side. Find the force on any one of the charges.

12. Four equal magnitude point charges 3.0μC are placed at the corners of a square that is 40 cm on a side (see fig. 4). Two diagonally opposite charges are positive, and other two are negative. Find the force on either negative charges.



13. Four particles form a square. The charges are $q_1 = Q$, $q_2 = q_3 = q$, and $q_4 = -2Q$(see fig. 5). What is q/Q if the net electrostatic force on particle 1 is zero?



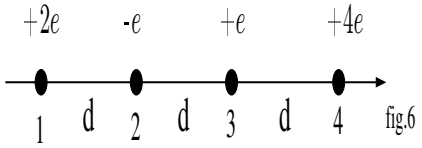
14. A charge of $+6.0\mu$C experiences a force of 2.0 mN on the +x-direction at a certain point in space (a) what was the electric field there (b) describe the -2μC charge would experience if it were used in place of $+6\mu$C charge.

15. Two point charges $Q_1 = 50\mu$C and $Q_2 = 10\mu$C, are located at $(-1, 1, -3)$m and $(3, 1, 0)$m, respectively find the force on Q_1.

16. Four equal-magnitude 4.0 μC charges are placed at the four corners of a square that is 20 cm each side. Find the electric field at the center of the square (a) if the charges are all positive, (b) if the charges alternate in sign around the perimeter of the square, (c) if the charges have the following sequence around the square plus, plus, minus, minus.

17. Point charges of 50nC each are located at A(1,0,0), B(-1,0,0), C(0,1,0), and D(0,-1,0) in free space. Find the total force on the charge at A.

18. In fig. 6 four particles are fixed along x-axis, separated by distance d=2.0 cm. The charges are $q_1 = +2e$, $q_2 = -e$, $q_3 = +e$ and $q_4 = +4e$, with $e = 1.60 \times 10^{-19}$. In unit-vector notation what is the net electrostatic force (a) on particle 1 and (b) on particle 2 due to other particles.



19. In fig. 7 three identical charges form an equilateral tri-angles of side 20 cm. The charges $q_a = -2$ nC, $q_b = -4nC$ and $q_c = 8nC$ (a) what is the magnitude of the

electrostatic force between A and C. (b) Now B and C are connected momentarily (via a wire) now what is the magnitude of force between B and C.

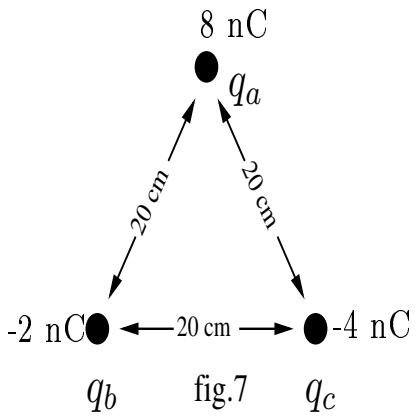


fig.7

20. In fig. 8, six charged particles surround particle 7 at a radial distance of either d=10cm or 2d as illustrated. The charges are $q_1 = +2e$, $q_2 = +4e$, $q_3 = +e$, $q_4 = +4e$, $q_5 = +2e$, $q_6 = +8e$, and $q_7 = +6e$ what is the magnitude of net electrostatic force on particle 7?

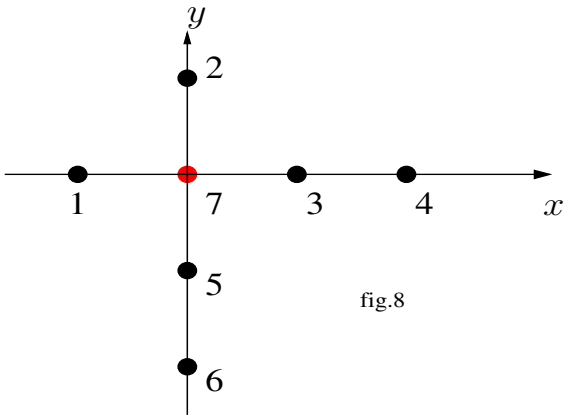


fig.8

62. In fig. 9, what are the magnitude and direction of net electrostatic force on particle 4 due to all other particles when $q_1 = -2e$, $q_2 = +2e$, $q3 = 4e$ and $q4 = 2e$; $\theta_1 = 35°$, $d_1 = 3.0$ cm , $d_2 = d_3 = 2.0$ cm.

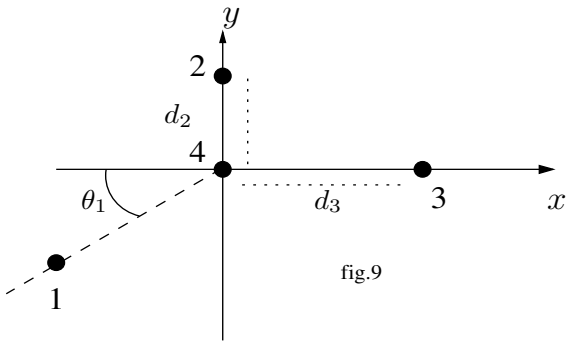


fig.9

21. Find E at $(0, 3, 4)$m in Cartesian coordinates due to a point charge $Q = 0.5\mu$C at the origin.

22. Please refer to fig. 10. Point charge $Q_1 = 300\mu$C, located at $(1, -1, -3)$m, experience a force $F_1 = 8a_x - 8a_y + 4a_z$N, due to point charge Q_2 at $(3, -3, -2)$m, determine Q_2.

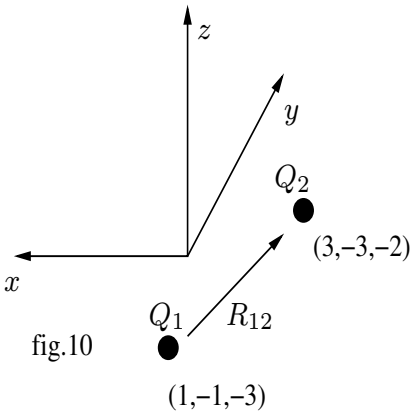


fig.10

23. Find E at the origin due to a point charge of 64.4 nC located at (-4,3,2)m in Cartesian coordinates.

24. Find E at $(0, 0, 5)$m due to Q_1=0.35μC at $(0, 4, 0)$m and Q_2= $-$ 0.55μC at $(3, 0, 0)$m please refer to fig.11.

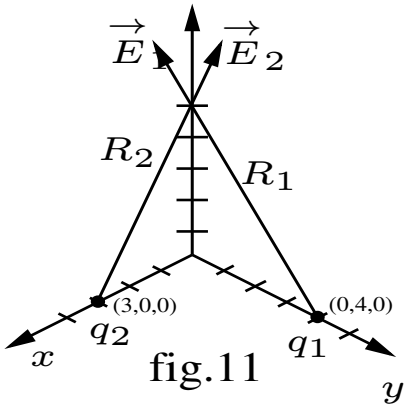


fig.11

25. Please refer to fig. 12. Find the force on a 100 μC charge at $(0, 0, 3)$m if for like charges of 20μC are located on the x and y axes at $\pm$4m.

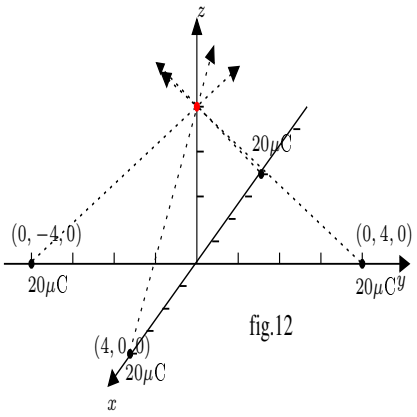


fig.12

26. Find the expression for the electric field at P (x, y, z) due to a point charge Q at (x_1, y_1, z_1). Repeat with the charge placed at the origin.

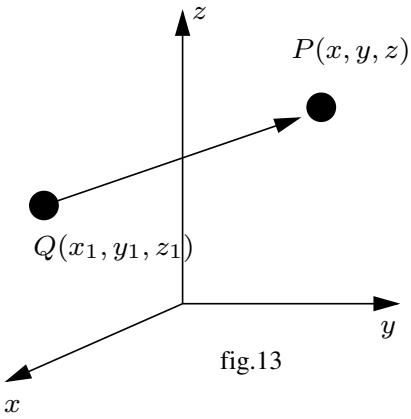
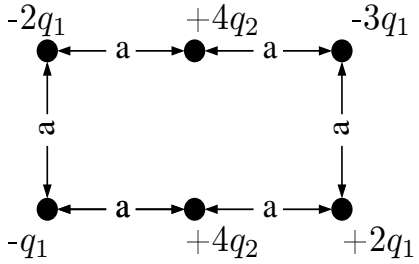


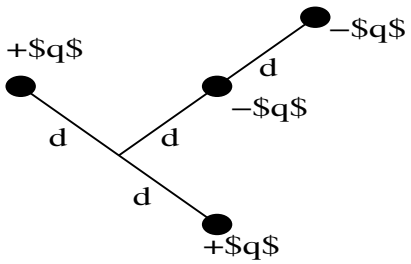
fig.13

Electric Potential

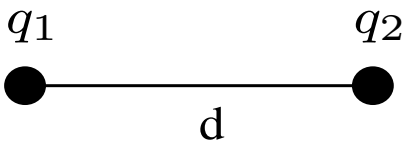
1. Figure below shows a rectangular array of the charged particles fixed in place, with a distance $a = 39.0$cm and the charges shown as integer multiples of $q_1 = 3.4pC$ and $q_2 = 6.0pC$. With $v = 0$ at infinity, what is the net electric potential at the rectangles center (Thoughtful examination would reduce the calculation)



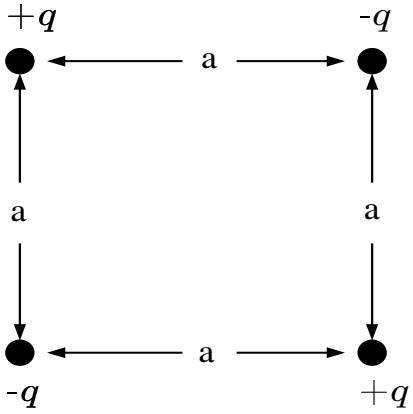
2. in figure below , what is the net electric potential at point P due to four particles if $V = 0$ at infinity $q = 5fC$ and $d = 4.0$ cm



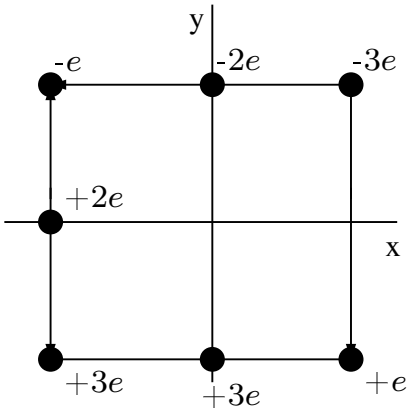
3. In figure below, particles with charges $q_1 = +5e$ and $q_2 = -15e$ are fixed in place with a separation of d=24.0cm. With electric potential defined as V=0 at infinity, what are the finite (a) positive and (b) negative values of x at which the net electric potential on the x-axis is zero.



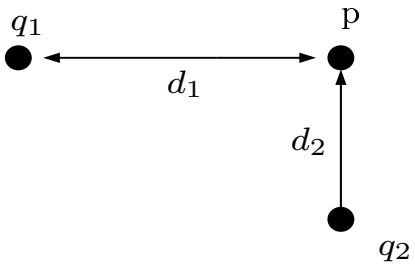
4. How much work is required to set up the arrangement illustrated below if $q = 2.3pC$, $a = 64$ cm and the particles are initially infinitely far apart and at rest?



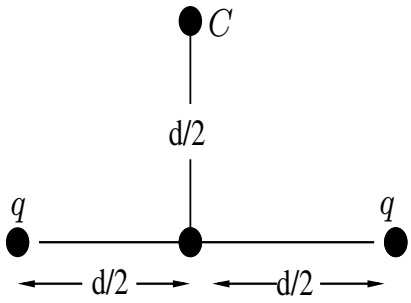
5. As illustrated seven charged particles are fixed in place to form a square with an edge length of 4.0cm. How much work must be done to bring a charge +6e to the center of the square.



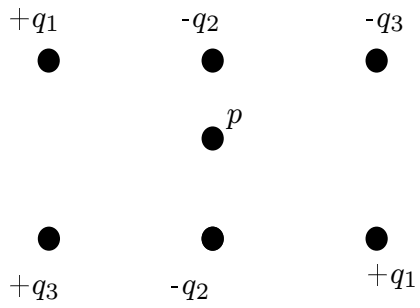
6. As shown below, point p is at distance $d_1 = 4.0m$ from the particle 1 ($q_1 = -2e$) and distance d_2 = 2.0m from the particle 2 (+2e), with both particles fixed in place (a) with v=0 at infinity, what is V at P, If we bring at particle $q_3 = +2e$ from infinity to P, (b) how much work do we do and what is the potential energy of the 3 particle system.



7. Two charges $q = +2\mu C$ are fixed at a distance d=2.0cm apart as illustrated (a) with $v = 0$ at infinity, what is the electric potential at charge C (b) work done to bring a $q = +2\mu C$ from infinity to C.



8. As illustrated, point P is at the center of the rectangle. with V=0 at infinity, $q_1 = 5.0fC$, $q_2 = 2.0fC$, $q_3 = 3.0fC$ and $d = 2.54$cm, what is the net electric potential at P due to six charged particles.



Resistivity and Resistance

1. A metal rod is 2 meter long and has a diameter of 8mm. Compute its resistance if the resistivity of the metal is 1.76×10^{-8} Ω·m

2. A wire has a diameter of 2.59mm, How many meters of wire would be needed to have a net resistance of 1.0Ω, when rho for aluminum is 2.8×10^{-8}

3. The resistance of a coil of copper wire is 3.5Ω at 0°C. What is the resistance at 50°C, for copper the drift coefficient is $\alpha = 4.3 \times 10^{-3}$ $^{\circ}C^{-1}$.

4. Calculate the resistance of an aluminum cable of length 10 km and diameter 20 mm if the resistivity of aluminum is 2.7×10^{-8} $\Omega \cdot m$.

5. Calculate the resistance of a copper wire of length 2m and area of cross section 10^{-6} m^2. Resistivity of copper is 1.7×10^{-8} Ω·m.

6. What is the current through an 8Ω resistance toaster when operating at 120V?

7. What is the potential difference is 3.0 A are passing through 28Ω.

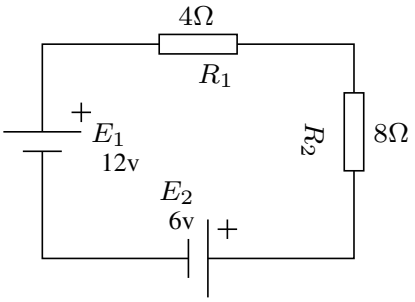
8. An electrical connection is setup between to points using copper cable, the length of the connection is 200 meters. The resistance of the link must be less than 1 Ω, what should be radius of the conductor assuming $\rho = 1.7 \times 10^{-8}$ $\Omega \cdot$ m.

9. An electrical connection is setup between to points using copper cable, the radius of conductor is $r = 1$mm. The resistance of the link must be less than 5 Ω, what is the range of this cable, assuming $\rho = 1.7 \times 10^{-8}$ $\Omega \cdot$ m.

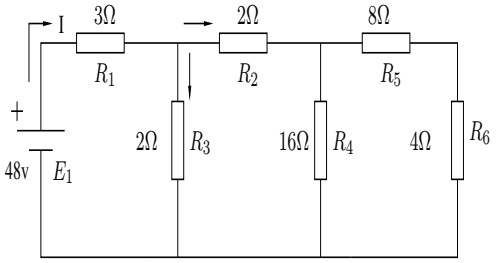
10. Resistance of a given wire of length L is 4Ω. The wire is stretched uniformly such that its length becomes $3L$. Find the new resistance of the stretched wire.

Linear Circuit Analysis

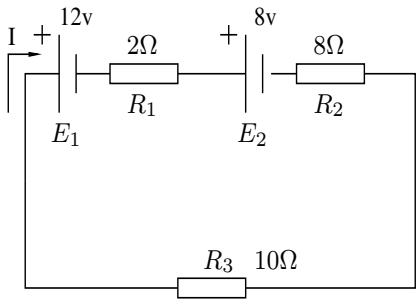
1. For the following circuit write the KVL equation and determine the current flowing through the circuit.



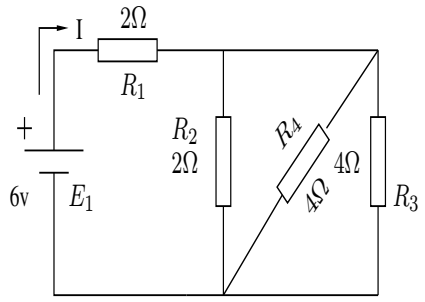
2. For the following circuit, find the equivalent resistance, determine the current I, I_1, I_2 and I_3 flowing through the circuit.



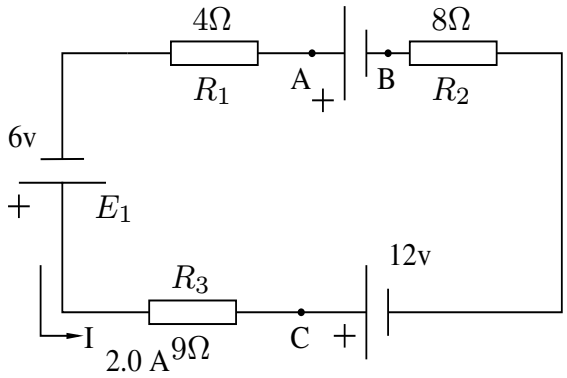
3. For the following circuit write the KVL equation and determine the current flowing through the circuit.



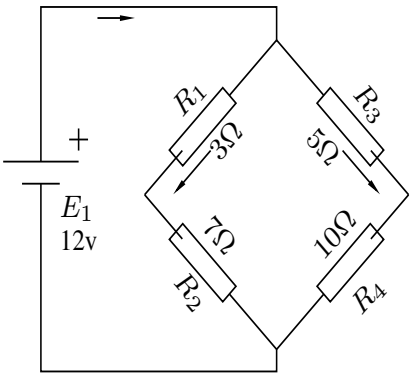
4. For the following circuit determine the equivalent resistance of the circuit and determine the current flowing through the circuit.



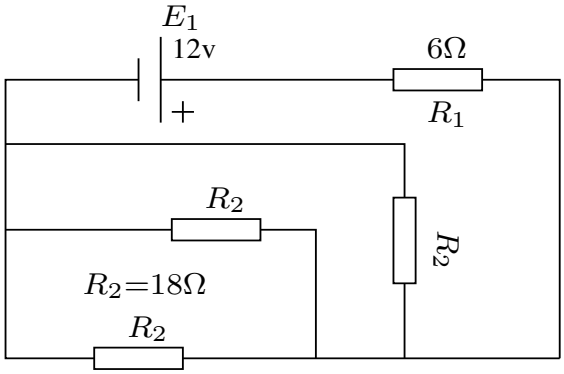
5. For the given circuit determine the unknown voltage source to make this circuit work, draw the potential difference diagram of this circuit.



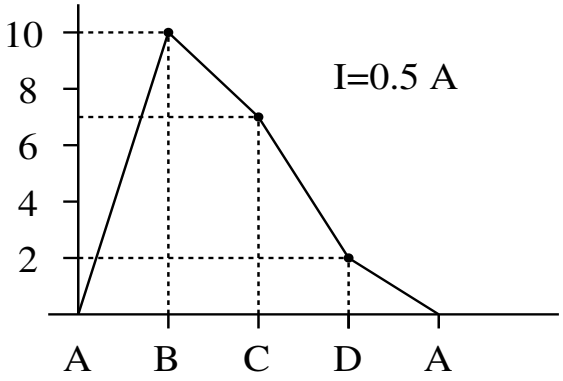
6. For the given circuit determine the equivalent resistance of the circuit and determine currents i_1 and i_2.



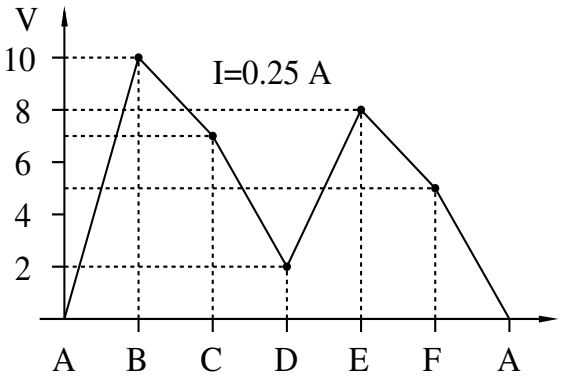
7. For the given circuit determine the equivalent resistance, determine the net current flowing through the circuit.



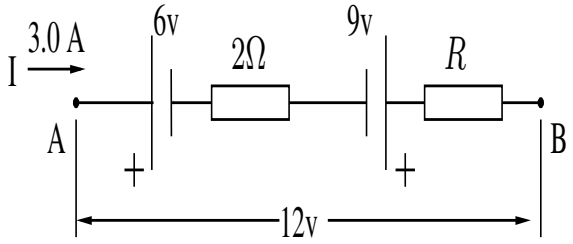
8. For the given diagram determine the single loop circuit which corresponds to this potential difference diagram, determine the value of resistances, assuming 0.5A of current is passing through the circuit and draw the circuit.



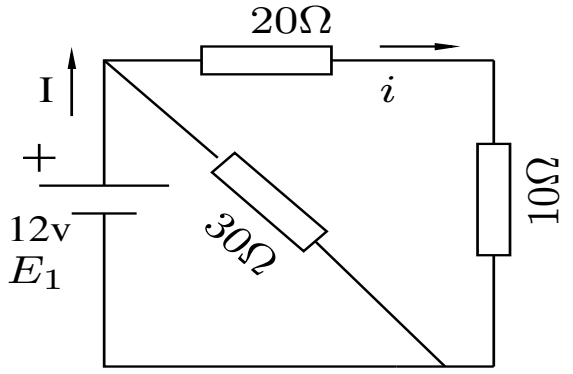
9. For the given diagram determine the single loop circuit which corresponds to this potential difference diagram, determine the values of resistance assuming 0.25A of current is passing through the circuit. Draw the equivalent circuit diagram

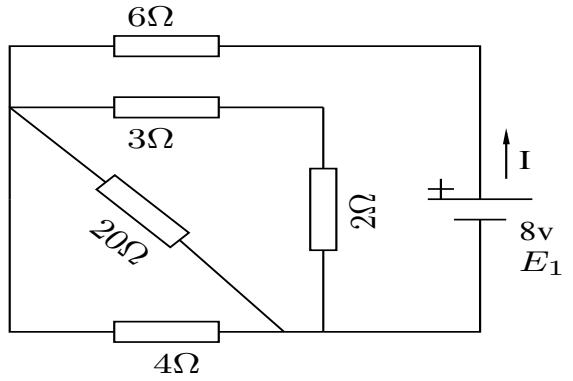


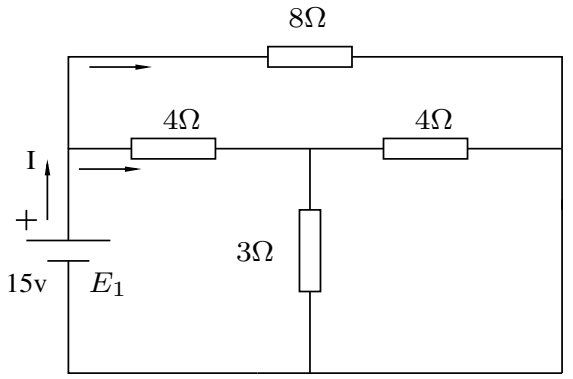
10. For the given diagram Assume that the potential difference between points A and B is 12v, what should be the value of unknown resistance **R**?

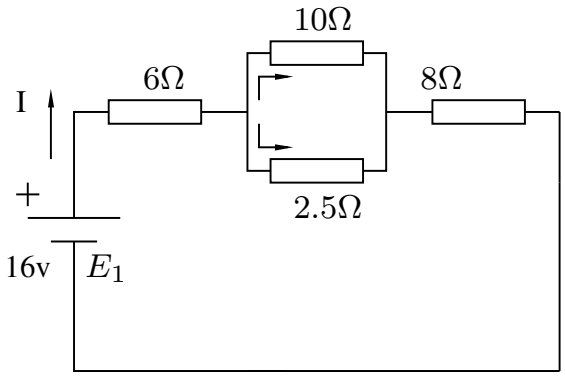


11. For the following set of circuits determine all the useful information such as equivalent resistance, net current and potential at certain nodes.








10Ω
6Ω
8Ω
I
+
2.5Ω
16v
E_1

Transistor Based Circuits

1. In a common base connection $I_e = 1\text{mA}$, $I_c = 0.95\text{mA}$ find I_b.

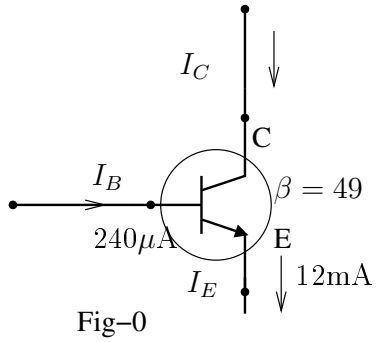
2. In a common base connection, current amplification factor is 0.9. In the emitter current is 1mA determine value of the base current.

3. In a common base connection, $I_c = 0.95\text{mA}$, $I_b = 0.05\text{mA}$ find α.

4. Find value of β if (i) $\alpha = 0.9$, (ii) $\alpha = 0.98$, (iii) $\alpha = 0.99$.

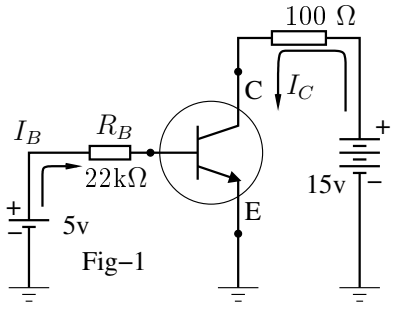
5. Calculate I_e in a transistor ($\beta = 50, \quad I_b = 20\mu A$).

6. Find α rating of transistor, determine I_c using both α and β rating of transistor.



Fig–0

7. For the given circuit determine the following parameters.

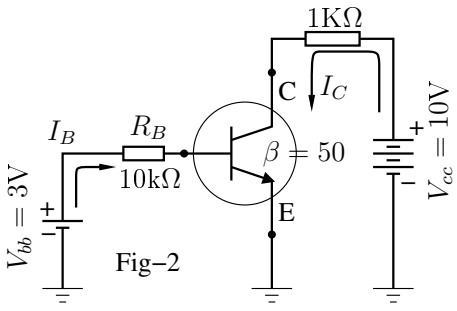


Fig–1

(a) I_b (b) I_c (c) α/β
(d) V_{cb} (e) V_{ce}

Is this circuit in saturation?

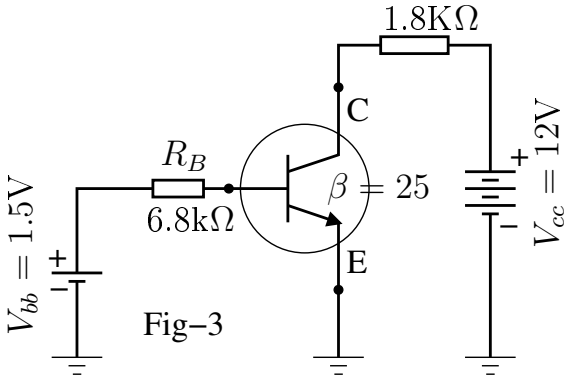
8. For the given circuit determine the following parameters.



(a) I_b (b) I_c (c) $I_{c(\text{sat})}$

Is this circuit in saturation?

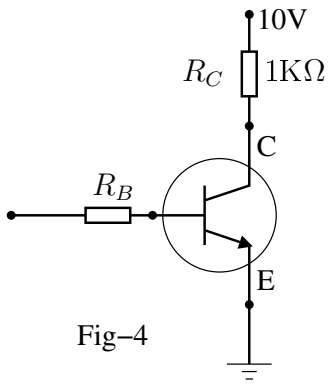
9. For the given circuit determine the following parameters.



(a) I_b (b) I_c (c) $I_{c(\text{sat})}$

Is this circuit in saturation?

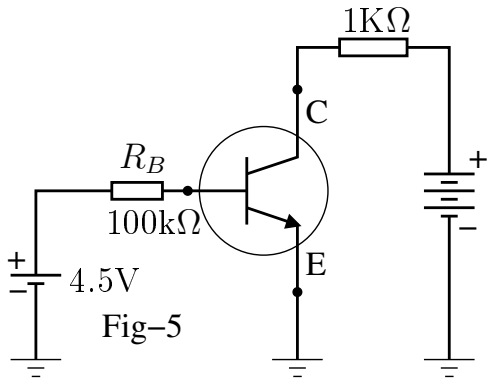
10. For this problem consider the following circuit:



- For the transistor circuit what is the V_{ce} when $V_{\text{in}} = 0$.

- What is the minimum I_B required to saturate the transistor if $\beta = 200$.
- calculate the maximum value of R_B if $V_{\text{in}} = 5.0\text{V}$.

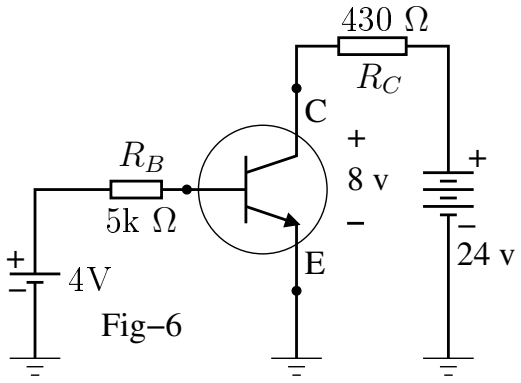
11. For this problem consider the following circuit:



Fig–5

$I_B = 50\mu$A and a voltage of 5V drops across R_C, determine α and β.

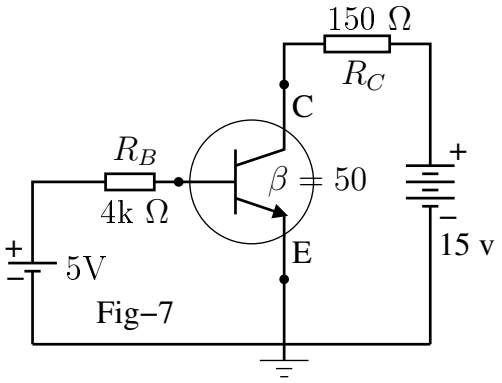
12. For this problem consider the following circuit:



Fig–6

$V_{\rm BB} = 4$V, $V_{\rm CC} = 24$V R_B and R_C respectively 5kΩ and 430 Ω respectively, determine α and β.

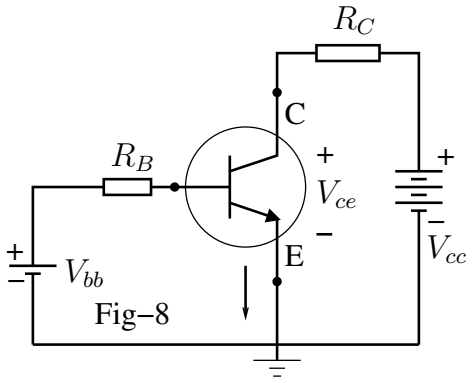
13. For this problem consider the following circuit:



Fig–7

Find $V_{\rm CE}$, $V_{\rm BE}$ and $V_{\rm CB}$.

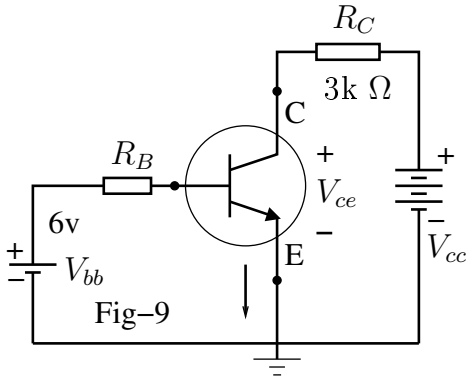
14. The transistor has $\alpha = 0.98$ and base current of 30μA:



Fig–8

Find β, $I_{\rm C}$ and $I_{\rm E}$.

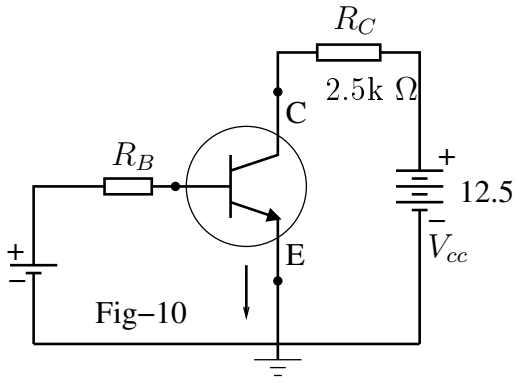
15. The transistor has a base current of 40μA, $V_{\rm BB}$ =6V and $V_{\rm CC}$ =15V:



Fig–9

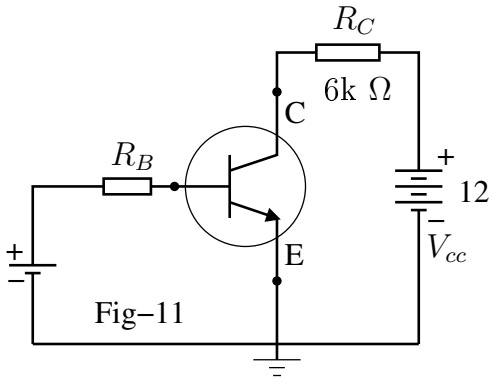
Find R_B, $V_{\rm CE}$ and $I_{\rm E}$.

16. For the circuit illustrated below draw the load line



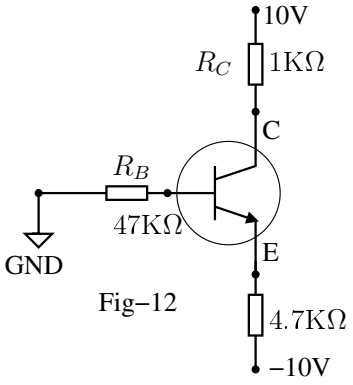
Fig–10

17. For the circuit illustrated below draw the load line



Fig–11

18. For the circuit illustrated below draw the load line



Fig−12