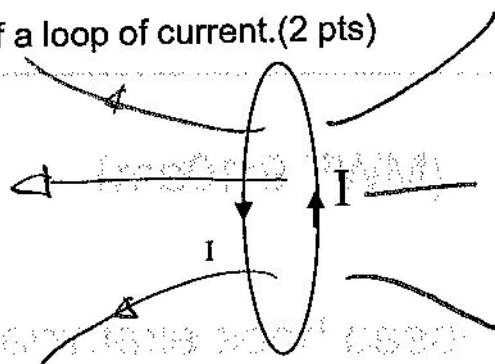


# Multiple Choice (2 pts each, s

k)

a) Sketch the magnetic field of a loop of current.(2 pts)



b) A magnetic field of 0.27 T makes an angle with respect to the velocity of a particle with charge  $1.0 \times 10^{-12}$  C traveling at 1000 m/s. If the magnitude of the force on the particle due to the magnetic field is  $1.0 \times 10^{-10}$  N, which of these angles best describes the angle of the magnetic field with respect to the particle velocity? (2 pts)

i) 22°

ii) 34°

iii) 1°

iv) 5°

v) 11°

c) An proton is in a circular orbit in a magnetic field of 1.0 milli-Tesla. What is the magnitude of the angular frequency with which this particle rotates(hint:  $\omega = v/r$ )? 2 pts)

i) 96 kilo-rads/sec

ii) 0.11 rads/sec

iii) 8.8 rads/sec

iv) 1.0 milli-rads/sec

v) 10 pico-rads/sec

d) What is the magnetic field in the center of a 0.5 m long solenoid with 5000 turns that carries ~~10~~ 4.0 A?(2pts)

4.0 A

i) 5 micro-Tesla

ii) 1.3 Tesla

iii) 0.06 Tesla

iv) 0.05 Tesla

v) 130000 Tesla

## Multiple Choice (contd.)

e) With an decrease in temperature inside a conductor like tungsten, should you expect the drift velocity to increase, decrease or remain the same?

(Please give a ~ 5 word justification for your answer. You can use formulas in your explanation.)(2pts)

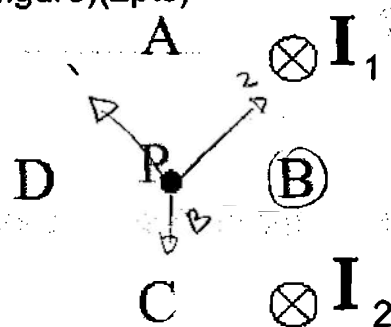
(Stay the same.)

(Increase.)

(Decrease.)

f) 2 wires carry identical current and are situated as shown in the figure below. Where must a 3rd wire, which carries an identical current, in an opposite direction to the 1st 2 wires, be placed to eliminate the magnetic field at point P due to the original 2 wires? (Draw Magnetic field directions on figure)(2pts)

- i) Point D
- ii) Point A
- iii) Point B
- iv) Point P
- v) Point C



g) An capacitor in air is connected to a battery and has a stored energy of 1.0 nano-J. If we now insert a dielectric material of dielectric constant  $k=1.3$  into the gap of the capacitor while it is still connected to the battery, what is the new stored energy of the capacitor?(2pts)

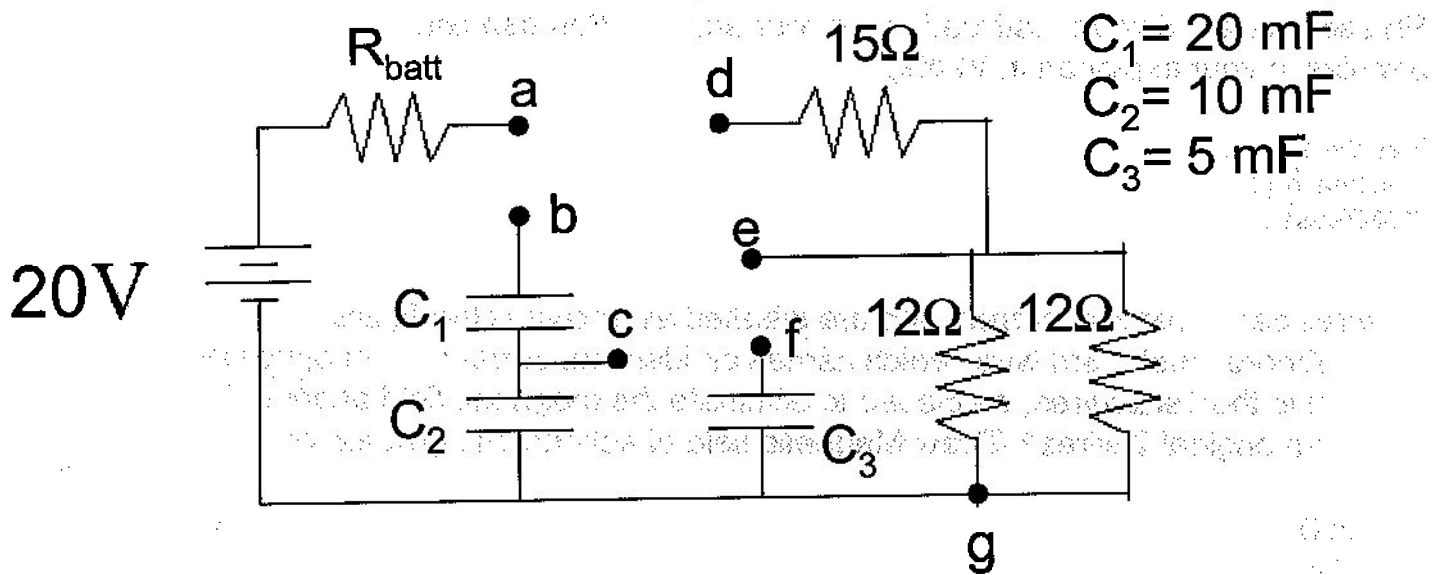
- i) 1.7 nano-J
- ii) 0.77 nano-J
- iii) 1.3 nano-J
- iv) 0.59 nano-J
- v) 1.0 nano-J

h) What is the resistivity of a conducting wire of length 4.0 m, cross-sectional area of  $1.0 \text{ mm}^2$ , and resistance of 1.0 Ohm? (2 pts.)

- i) 40 Ohm-m
- ii) 0.25 micro-Ohm-m
- iii) 4.0 micro-Ohm-m
- iv) 40 Mega-Ohm-m
- v) 4.0 Ohm-m

## 2) Circuit (16 pts)

(In the diagram below, all capacitors are initially uncharged. All wires used are conducting wires.)



i) What is the equivalent resistance between points e) and g)?(1pts)

$$R_{eg} = 6 \Omega$$

ii) What is the equivalent resistance between points d) and g)?(2pts)

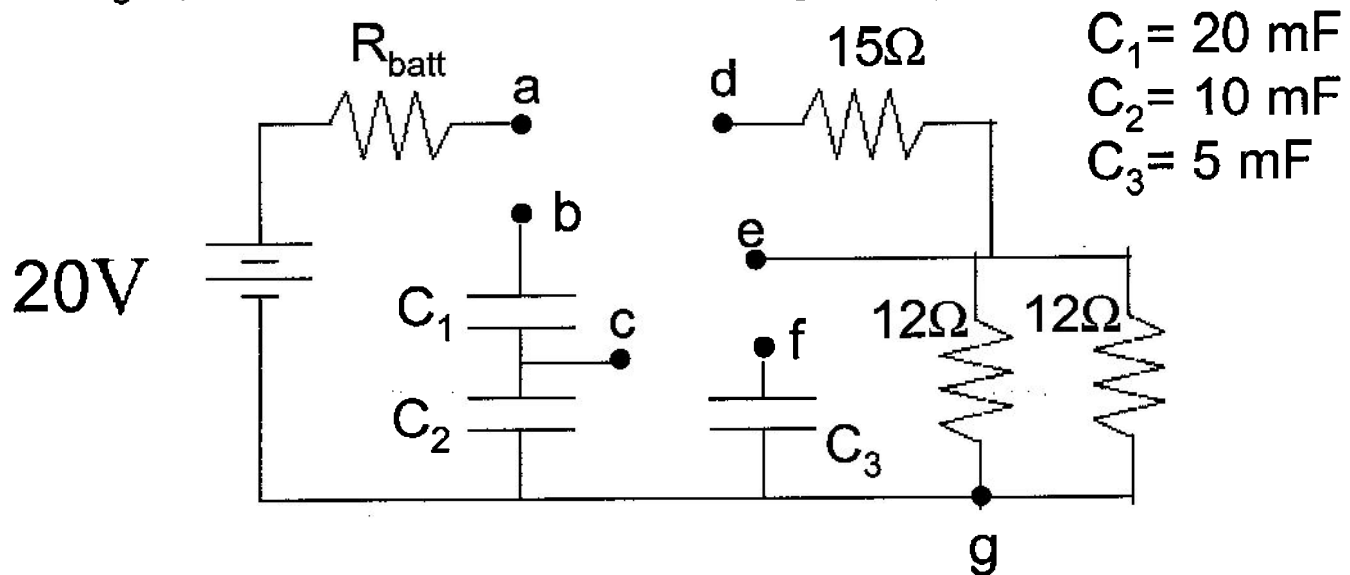
$$R_{dg} = 21 \Omega$$

iii) If point "a" is connected to point "d" with a wire and 0.80 Amps of current flow through  $R_{batt}$ , what is  $R_{batt}$ ?(3pts)

$$\frac{20V}{.8A} = 25 \Omega$$

$$R_{batt} = 4 \Omega$$

2) Circuit (contd.) (In the diagram below, all capacitors are initially uncharged, and all wires used are conducting wires.)



iv) Now, the wire between points "a" and "d" is removed. Then point "a" is connected to point "f" with a wire, and we wait for the current to stop flowing (i.e. after a very long time). What will be the charge on capacitor  $C_3$  after a very long time? (3pts)

$$V \text{ is } 20V \text{ after long time}$$

$$Q = CV = (5\text{mF})(20V) = 0.1C$$

$$Q = 0.1C$$

v) Now, the wire between points "a" and "f" is removed without changing the charge (from "after a very long time" in part iv)) on  $C_3$ . Then point "b" is connected to point "f" with a wire. What is the charge on  $C_2$  after the charges have stopped moving? (4pts)

$$Q_{12} = Q_3 + Q_{12} \quad \frac{Q_3}{C_3} = \frac{Q_{12}}{C_{12}} \quad Q_{12} = Q_3 = Q_2$$

$$\frac{1}{C_{12}} = \frac{1}{20\text{mF}} + \frac{1}{10\text{mF}} \quad Q_{12} = Q_{12} \frac{C_3}{C_{12}} + Q_{12}$$

$$Q = 0.057C$$

$$C_{12} = 6.66\text{mF} \quad Q_{12} = Q_{12} / (1 + \frac{C_3}{C_{12}}) = 0.1C / (1 + \frac{5\text{mF}}{6.66\text{mF}}) = 0.057C$$

vi) Now, the wire between points "b" and "f" is removed without changing the charges (from "after the charges have stopped moving" in part v)) on  $C_1$ ,  $C_2$ , or  $C_3$ . Then, point "c" is connected to point "e" with a wire. How long will it take the charge on  $C_2$  to go to 10% of its initial value? (3pts)

$$RC = 6.66\text{mF} \cdot 10\text{mF} = 0.06s$$

$$- \ln(0.1)(0.06s)$$

$$= 0.138s$$

$$t = 0.138s$$