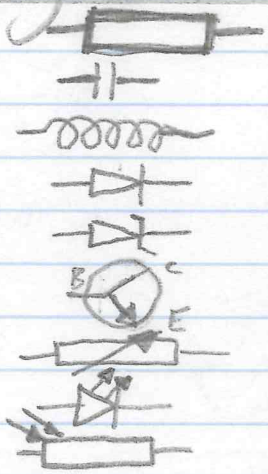
Electronics + Magnetism Revision

(7d.)

1.



Component	Symbol	Notes
Resistor		Decreases current + voltage
Capacitor		Builds up and stores current.
Inductor		Creates a magnetic field
Diode		Allows current to move in only 1 direction
Zener diode		Smooths rectified current
Transistor		Can be used as a switch or amplifier (voltage)
Variable resistor		Vary the resistance Rheostat
LED		Light Emitting Diode
LDR		Light Dependant Resistor

2. Conventional current flows from positive to neg. whilst electron flow is neg. to positive.

3. a) Series?

$R_T = R_1 + R_2 \ldots$

$R_T = 10 + 10$

$R_T = 20\Omega$

b. Parallel?

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$

$= \frac{1}{10} + \frac{1}{10}$

$= \frac{2}{10}$

$\frac{1}{R_T} = 0.2$

$R_T = \frac{1}{0.2}$

$= 5\Omega$

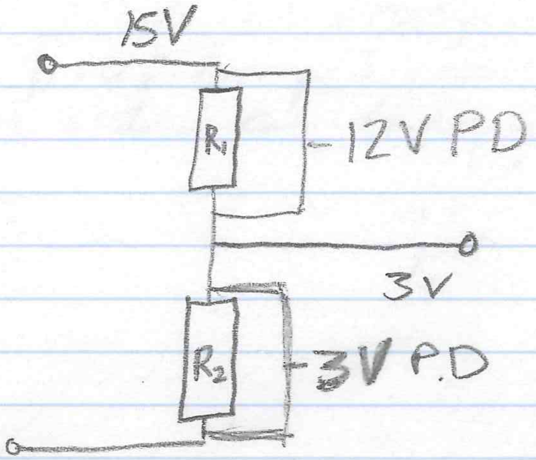
4. Resistors connected in series tend to "use up" voltage. The greater the resistance of the resistor, the more voltage (potential difference) that is "used up". If two resistors are connected in parallel they create a proportional relationship with the voltage used up. This is summarised in the formula below

$V_1 : V_2 = R_1 : R_2$

Resistors connected in parallel tend to split current proportionatly dependant on the amount of V + R.

$I_t = I_1 + I_2 \ldots$ and $V = IR$

5.



Remember

$V_1 : V_2 = R_1 : R_2$

∴ the resistance would be anything that followed a 12:3 ratio.

6. Capacitance Parallel

$C_e = C_1 + C_2 \ldots$

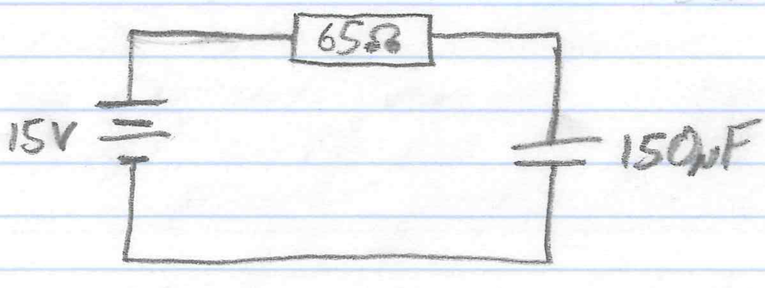
$C_e = 150\mu F + 150\mu F + 150\mu F$
$= 450\mu F$

Capacitance Series

$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} \ldots$

$\frac{1}{C_e} = \frac{1}{150} + \frac{1}{150} + \frac{1}{150}$
$= \frac{3}{450}$
$\frac{1}{C_e} = 0.006\bar{6}$
$C_e = 150\mu F$

7. a.)



$t = RC$ (t: time constant, R: Resistance, C: Capacitance)

$t = RC$
$= 65 \times 150$
$t = 0.00975$

b.) There are 5 time constants until the capacitor is considered to be fully charged. Therefore

Time untill fully charged $= 0.00975 \times 5$
$= 0.04875$

c.) $Q = CV$ (C: capacitance, V: Voltage)
Charge (Coulombs) $= 150 \times 10^{-6} \times 15$
$= 0.00225$ Coulombs (Charge)

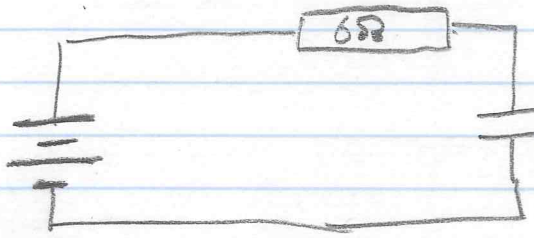
d.) First find the fraction 3V is of 15V. This fraction is then found on the left hand side of the graph.

$\frac{3}{15} = 0.2$ This reads as approx. 1.7 time constants on the graph.

Then multiple the no. of time constants by the time for 1 time constant.

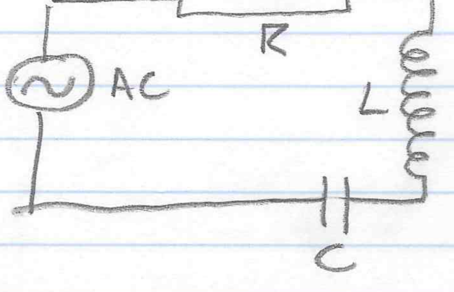
$1.7 \times 0.00975 = 0.0166$ secs

8.



This circuit can be turned into a radio transmitter by adding an inductor.

When a capacitor and inductor are in the same circuit they form a resonant LC circuit which is capable of emitting EM waves. The circuit can be converted to a LCR circuit with an AC power supply instead of a DC power supply. Also add an inductor



To find frequency we use the following equation.

$f = 107.7 \times 10^6$
$L =$
$C =$

$f = \frac{1}{2\pi\sqrt{LC}}$

rearrange

$\sqrt{LC} = \frac{1}{2\pi f}$

$= \frac{1}{2 \times 3.14 \times 107.7 \times 10^6}$

$\sqrt{LC} = 1.48 \times 10^{-9}$

$LC = (1.48 \times 10^{-9})^2$

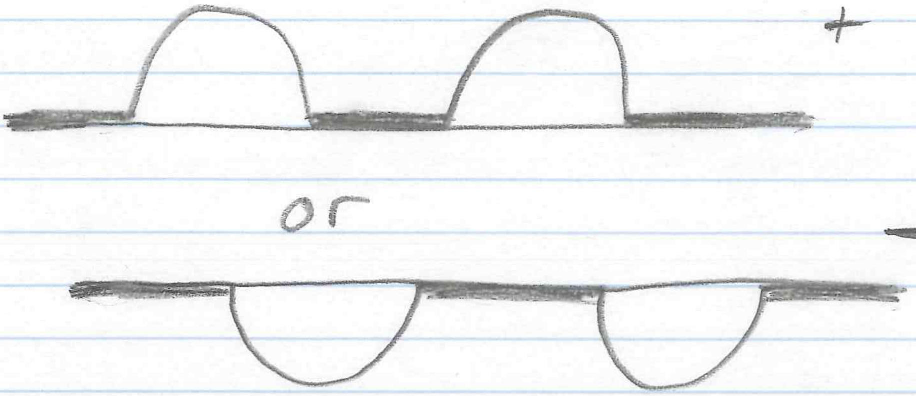
$LC = 2.19^{-18}$

If we keep the capacitor at 150nF the added inductor is:

$\frac{2.18 \times 10^{-18}}{150 \times 10^{-6}} = 1.46 \times 10^{-14}$

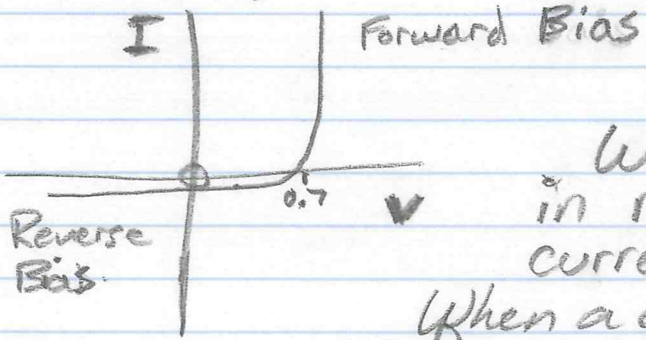
or any other combination.

9.



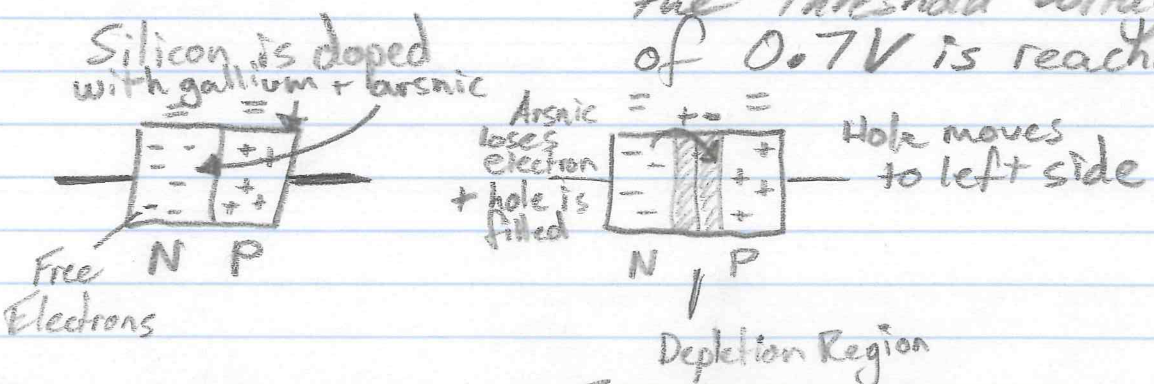
Rectification with a diode

The diode allows the current to flow once the threshold voltage (0.7V) is reached.

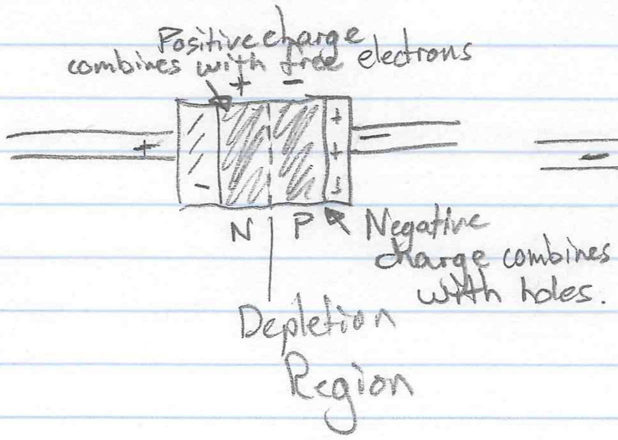


When a diode is in reverse bias current will not flow

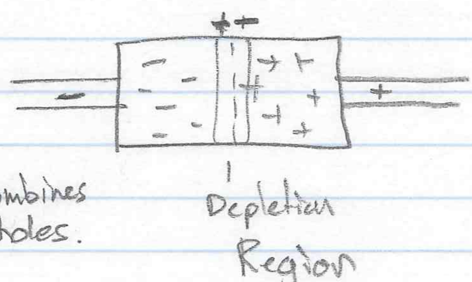
When a diode is in forward bias current will flow as soon as the threshold voltage of 0.7V is reached.



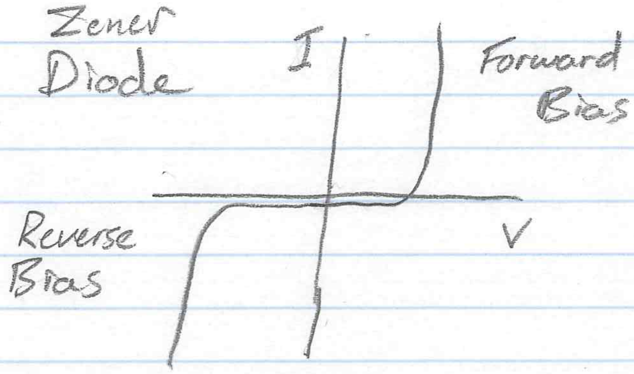
Reverse Bias



Forward Bias



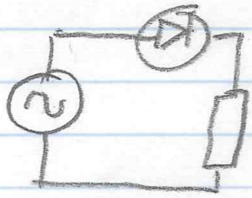
10.



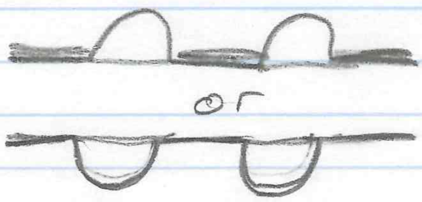
A zener diode is similar to a normal diode when forward biased but when reversed biased it conducts at a predetermined voltage. Zener diodes are very useful when rectifing signals.

11. a. When AC current is converted into DC. The easiest way to do this is by using a diode.

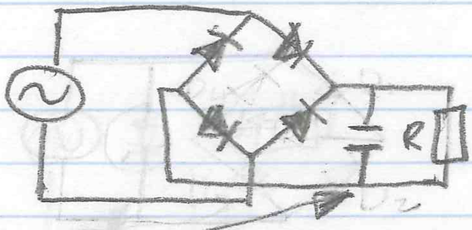
b.



c.



d.



Current always travels through the resistor in the same direction.

(F.) Capacitor in parallel to load resister.

e.

f. You could use a capacitor in parallel to the load. You could also use a zener diode to smooth the signal. (Zener Diode positioned in rear bias) It would need to be connected to the output side of the rectifier circuit.

12. The transistor will not allow current to flow through it unless a current flows into (npn) or out of (pnp) the base.

13. A transistor works as a switch by not allowing current to flow from collector to emitter unless a small current runs through the base first. This opens up the "switch" allowing current to flow through. The working principles are much like a diodes.

A transistor works as an amplifier by supplying a small current to the base which then is amplified in the collector current. The collector current is directly proportional to the base current.

14. Worked example on pg. 39 Heinemann.

15. Read pg 122-123 Heinemann.

16. Amplification factor/Gain is the ratio of base current to collector current. It is calculated using the formula below.

$$\beta \text{ (Current Gain)} = \frac{I_c \text{ (Collector Current)}}{I_b \text{ (Base Current)}}$$

17. a) $\beta = \frac{\Delta I_c}{\Delta I_b}$

$\beta = \frac{20-5\,mA}{60-30\,\mu A}$

$= \frac{15 \times 10^{-3}}{30 \times 10^{-6}}$

$\beta = 500$

b) $\beta = \frac{\Delta I_c}{\Delta I_b}$

$\beta = \frac{40-10}{40-25}$

$= \frac{30 \times 10^{-3}}{15 \times 10^{-6}}$

$= 2000$

Magnetism

1.

	Description		Unit	Formula
Magnetic Flux Density	The strength of a magnetic field	B	Teslas (T)	$B = \frac{F}{IL}$ $B = \frac{kI}{d}$ $B = 2\pi kNI$
Magnetic Flux	Magnetic flux density multiplied by relevent area.	Φ	Webbers (Wb)	$\Phi = BA\cos\theta$
Magnetic Force	The force a magnet exerts on a current carrying wire	F	Newtons (N)	$F = BIL\sin\theta$ (sinθ only if not at right angle)
Electromotive Force	A voltage is produced when a wire crosses magnetic field lines.	ε	Volts (V)	$\varepsilon = -BLv$ $\varepsilon = \frac{-BL\Delta d}{\Delta t}$ $\varepsilon = \frac{\Delta\Phi}{\Delta t}$ $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$

2. Right hand grip rule.

For solenoids

* Fingers show direction of current.
* Thumb shows North pole of magnet and flow of current.

Right hand slap rule

Used when the force from a magnet is acting on a wire.

* Fingers show magnetic field (B)
* Palm shows force. (F)
* Thumb is the current.

3.

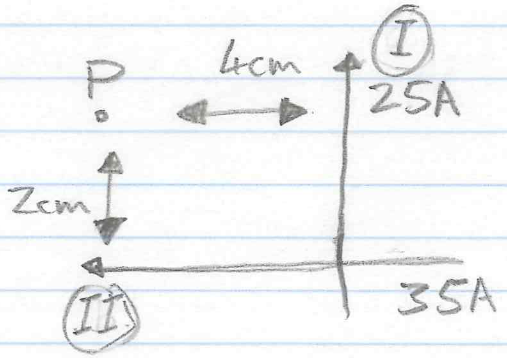
$I = 8A$
$d = ?$
$B = 1\times10^{6}$
$k = 2\times10^{-7}$

$B = \frac{kI}{d}$ so $d = \frac{kI}{B}$

$= \frac{2\times10^{-7}\times8}{1\times10^{-3}}$

$= 1.6\times10^{-3}$ m

$k = 2\times10^{-7}$
$d_I = 0.04m$
$d_{II} = 0.02m$
$I_I = 25A$
$I_{II} = 35A$



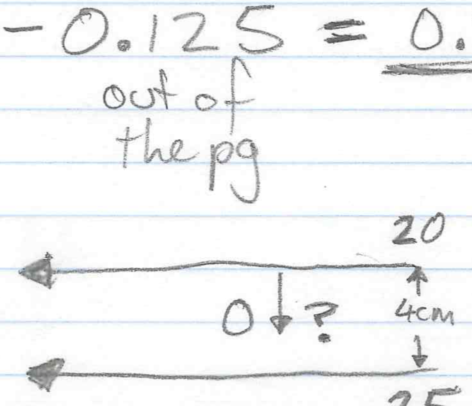
Flux density at P due to wire I

$B = \frac{kI}{d} = \frac{2\times10^{-7}\times25}{0.04} = 0.125$ out of pg.

Flux density at P due to wire II

$B = \frac{kI}{d} = \frac{2\times10^{-7}\times35}{0.02} = 0.35$ into pg.

$0.35 - 0.125 = \underline{0.225T}$ into the pg.
(0.35: Into the pg; 0.125: out of the pg)



If the currents are travelling in the same direction the magnetic fields between them are in opposite directions.

Let the distance from the 20A wire be (d), and the distance from the 25A wire be 0.04 − d

$\frac{k\times20}{d} = \frac{k\times25}{0.04-d}$ minus k from both sides then cross multiply

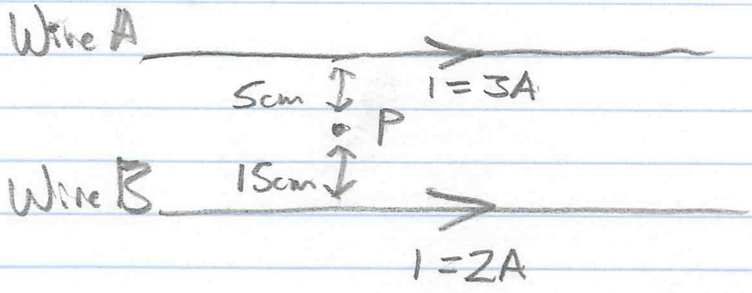
$20(0.04-d) = 25d$

$0.8 - 20d = 25d$

$0.8 = 45d$

$\frac{0.8}{45} = d$ → $0.01\bar{7} = d$

1.8cm ≈ d

4. 

Magnetic Field Strength at point P due to A.

$B = \frac{kI}{d} = \frac{2\times10^{-7}\times3}{0.05} = 0.000012T$ into the page

Magnetic Field Strength at point P due to B.

$B = \frac{kI}{d} = \frac{2\times10^{-7}\times2}{0.15} = 0.0000026T$ out of the page

$0.000012 - 0.0000026 = 9.4\times10^{-6}$ into the pg

5.

6. a) Down b.) Left

When a question asks for direction of force use right hand palm rule.

7. Purpose - Converts electrical energy to kinetic energy.

Components - Horseshoe magnet (Field magnet)
Electromagnet Armature (Coil of wire)
Battery + connecting wires.
Split ring commutator.

Working Principles - Ampere's Law - Wires attract one another if current is running in same directi
Wires repel each other if running in opposite direction. Current carrying wire produces a magnetic field.

- Magnetic Fields exert forces on current carrying wires
- Maximum torque on the loop is when it is at right angles to the field lines.
- To enable the loop to experience a torque which causes it to be constantly turned in the same direction the current needs to change direction every half turn. This can be acheived by using a split ring commutator or AC current.

8. Purpose - Convert kinetic energy to electrical energy

Components - Horseshoe magnet (Field Magnet)
Electromagnet Armature (Coil of Wire)
External energy supply (Dynamo, Turbine)
Split ring commutator

Working Principles - Electromagnetic induction (Faraday's Law, Neumanns Law + Lenz's Law)

- External energy supply is used to turn loop of wire in an magnetic field, inducing an electric current in the wires.

- The EMF (Electromotive Force) alternates and an alternating current (AC) is generated within the loop. This AC is converted to a DC by use of a split ring commutator.

9. This question requires an understanding of Lenz's Law.
- When the magnet is dropped through the coil on the left hand side the coil tries to oppose the force. It does this by creating a <u>North pole</u> at the top of the left coil. This also creates a <u>North Pole</u> on the top of the <u>right coil</u>, causing the sprung magnet to move slightly down.

When the magnet drops out of the <u>left coil</u> it causes the solenoid to switch poles meaning the bottom of the solenoid is the <u>North pole</u>. This switches polarity in the right hand solenoid causing the sprung magnet to move upward.

10.

Step up Transformer - Increase Voltage
Step down Transformer - Decrease Voltage

Primary Coil	N_p
Secondary Coil	N_s
Primary Voltage	V_p
Secondary Voltage	V_s
Primary Current	Current in Primary coil of transformer
Secondary Current	Current in Secondary coil
Primary Power	Found by using $P = IV$
Power Loss	Power lost due to resistance $P_{loss} = IR$

11. c Step down and voltage will be halved.

12. $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$\frac{N_s}{2000} = \frac{6.3}{240}$

$N_s = \frac{6.3}{240} \times 2000$

$N_s = 52.5$ turms

13.

14. Ampere - Current carring wire creates a magnetic field. Two wire running in same direction attract one another (if parallel) and repel one another if moving in opposite directions.

Faraday - Electric current can be induced in a wire if it crosses magnetic field lines.

Neumann - $\text{Electromotive force} = \frac{\text{Change in Flux}}{\text{Change in Time}}$ (Field lines passing through area)

Lenz - If a current is induced in the windings of a solenoid, the solenoid's magnetic field must oppose the change by having a repelling magnetic charge.