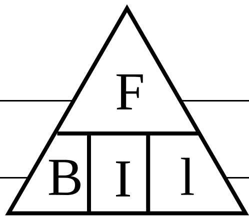
P15 Electromagnetism Calculations

The three equations you need to be able to use are provided on the equation sheet as given below.

force on a conductor (at right angles to a magnetic field) carry current = magnetic flux density x current x length	$F = B\,I\,l$
potential difference across primary coil / potential difference across secondary coil = number of turns in primary coil / number of turns in secondary coil	$V_p / V_s = n_p / n_s$
potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil	$V_s\,I_s = V_p\,I_p$

They can be simplified to



force = field x current x length
voltage in ÷ voltage out = primary turns ÷ secondary turns
current in x voltage in = current out x voltage out or power in = power out

To solve problems using the F=BIl equation use the rule that you multiply all three together if you are calculating the force **or** that the answer is always the force divided by the other two values given in the question.

Force on top unless that's what want. F = 1 × 2 × 3 or Answer = Force ÷ (1 × 2)

To solve problems with voltages and turns write out the equation with the values you are given substituted in. Calculate the value of the fraction you know then rearrange to get the answer.

$$\frac{V_p}{V_s} = \frac{n_p}{n_s} \rightarrow \frac{200}{Vs} = \frac{400}{50} \rightarrow \frac{200}{Vs} = 8 \rightarrow Vs = 8 / 200 = 25\text{ V}$$

The voltage does what the turns do and vice versa.

If the voltage goes up 3 times then so do the turns.

e.g. If V_p = 200 V , n_p = 400 turns and n_s = 50 turns then the turns go down by 400 / 50 = 8 times.
This means the voltage must go down by 8 times as well. So V_s = 200 / 8 = 25 V

For calculations with voltage and current **move one value across and down** to get the equation you need and then substitute in the values given in the question to calculate the answer.

e.g. If V_p = 25 V , I_p = 9 A and I_s = 3 A then to calculate V_s

$$V_s\,I_s = V_p\,I_p \rightarrow V_s = \frac{V_p\,I_p}{I_s} \rightarrow V_s = \frac{25 \times 9}{3} = 75\text{ V}$$

Watch out in case you are given a power – its already I × V as Power = Current × Voltage

Calculate the missing values in the table using the **two** transformer equations.

	n_p / Turn	n_s / Turn	V_p / V	V_s / V	I_p / A	I_s / A
Q1	125	250	180			0.63
Working						
Q2	300	26	230		0.71	
Working						
Q3	213	43		36		3.82
Working						
Q4		250	80	100	0.43	
Working						
Q5	180		45	25		0.44
Working						
Q6		60	65	13	0.21	
Working						
Q7		228	65		0.75	0.25
Working						
Q8		280		2100	4.8	0.60
Working						

Calculate the missing values in the table using the $F = BIl$ equation.

	F / N	B / T	I / A	l / m
Q1		2.0	2.0	2.0
Working				
Q2	0.3938		3.5	0.45
Working				
Q3	4.05	4.50		1.20
Working				
Q4	240	0.0100	120	
Working				
Q5	3.44×10^{-5}	5.00×10^{-5}		0.55
Working				
Q6	0.0130		2.70	0.400
Working				
Q7		6.50×10^{-6}	12.0	1200
Working				
Q8	1.52×10^{-5}		1.55	2.80
Working				

Answers

	F	B	I	L
1	8.0	2.0	2.0	2.0
2	0.3938	0.25	3.5	0.45
3	4.05	4.50	0.75	1.20
4	240	0.0100	120	200
5	3.44×10^{-5}	5.00×10^{-5}	1.25	0.55
6	0.0130	0.0120	2.70	0.400
7	0.0936	6.50×10^{-6}	12.0	1200
8	1.52×10^{-5}	3.50×10^{-6}	1.55	2.80

np	ns	Vp	Vs	Ip	Is
125	250	180	360	1.26	0.63
300	26	230	19.9	0.71	8.19
213	43	178	36	0.77	3.82
200	250	80	100	0.43	0.34
180	100	45	25	0.24	0.44
300	60	65	13	0.21	1.05
76	228	65	195	0.75	0.25
35	280	263	2100	4.8	0.60