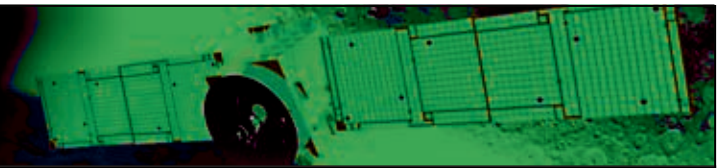
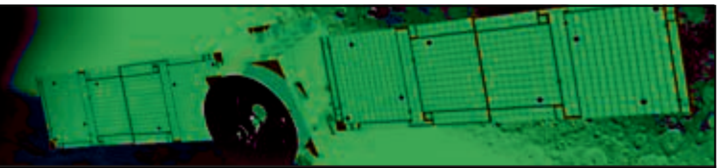


Electricity and Magnetism: Set 8

Set	Problem	Solution
8	1a	P = V I = 3000 V × 20 A = 60 kW
	1b	E = P × t = 60,000 W × 0.005 s = 300 J
	1c	R = V / I = 3000 V / 20 A = 150 Ω
	2a	1373 J × 0.1 = 137.3 J m^{-2} usable energy $\frac{2000\ J}{137.3\ Jm^{-2}} = 14.6\ m^2$
	2b	$R = \frac{V^2}{P} = \frac{50^2 V}{2000\ W} = 1.25\Omega$
	3a	$I = \frac{P}{V} = \frac{1.25 \times 10^3 W}{1.5 \times 10^3 V} = 83\ A$
	3b	$R = \frac{V}{I} = \frac{1.5 \times 10^3 V}{83.3\ A} = 18\Omega$
	4	The thicker coil belongs to the secondary coil. From $V_pI_p = V_s I_s$ if $V_s < V_p$ then I_p is increased and thicker wire is needed to prevent the coil from melting.
	5	Using the R.H. screw rule the field in the secondary coil is such that the field lines point up the page. Lenz's law tells us that an induced current will be in the direction such that the flux it creates will oppose the change in the flux that created it. There is an increasing flux up the page so the induced flux down the page so using the R.H. screw rule the induced current will be in the clockwise direction.
	6a	240× Ip = 12,000 I_s Therefore I_s is 0.0200 times I_p
	6b	$N_s = \frac{200}{0.02}$ N_s = 10 000 turns
	6c	0.02 × 0.98 = 0.0196, therefore 0.0196 $I_p = I_s$
	7a	$R = \frac{V^2}{P} = \frac{240^2 V}{2500\ W} = 23\ \Omega$
	7b	$I = \frac{V}{R} = \frac{240\ V}{23\ \Omega} = 10.4\ A$ Q = I × t = 10.4 A × 2 × 60 s = 1250 C
	8a	If motor is 80% efficient then actual power used to start = 1000 W × 1.2 = 1200 W $I = \frac{P}{V} = \frac{1200\ W}{12.0\ V} = 100\ A$
	8b	It will be much larger as it uses a larger current than the electrical appliances in the car.
	9a	The role of a substation is to reduce the high voltage electricity in the transmission line to a smaller voltage that can be supplied to homes.
	9b	It is likely that the train will require a higher voltage than homes.
	9c	From P = IV, if power is to remain constant then a higher voltage means a lower current. Lower current results in lower energy losses from resistive heating.
	10a	$I = \frac{P}{V} = \frac{500{,}000\ W}{2000\ V} = 250\ A$ Energy loss $P = I^2 R = (250\ A)^2 \times 0.5\ \Omega$ = 31.3 kW
	10b	When V = 20 kV, I = 25 A Using the same method as 10a, P = 0.31 kW
	10c	Increasing the voltage by a factor of 10, reduces power loss by a factor of 100.
	11	The intense electric field near a small point at a high voltage can ionise the air close to it. This is called the corona effect. The corona effect would also arise from the electric field around a single high voltage cable. Up to about 500 kV this is avoided by using 4 cables held apart by spacers. The corona effect makes transmission voltages of 1000 kV impractical.
	12a	P = I V = 200 A × 10 V = 2.00 kW
	12b	$R = \frac{P}{I^2} = \frac{2000\ W}{(200\ A)^2} = 0.05\Omega$ $length = \frac{0.05\ \Omega}{0.4\ \Omega m^{-1}} = 0.125\ m$



Electricity and Magnetism: Set 8

Set	Problem	Solution
8	12c	Increase the output voltage from the transformer.
	13a	5000 W /80% = 6.25 kW
	13b	Possible reasons are: from resistive heating in wires, heat energy loss due to friction between moving parts
	14	The magnetic fields created by the devices are oscillating due to the fact that they are induced by an alternating current. These oscillating fields are capable of inducing an alternating current in closed circuits. This could increase the p.d. available to other devices, increase the temperature of supply lines and the brightness of lights. In practice this is unlikely to happen since the strength of a magnetic field decreases with $^1/_{r^2}$ so unless circuits are very close to each other no effect will be felt.
	15	Current in wire = P/V = 3×10^6 W / 25 × 10^3 V = 120 A Power loss = 5 × 10^3 V × 120 A = 6 × 10^5 W $R = \frac{P}{I^2} = \frac{6 \times 10^5 W}{(120\ A)^2} = 41.7\ \Omega$ $distance\ from\ substation\ (km) = \frac{41.7\ \Omega}{1.2\ \Omega\ km^{-1}} = 35\ km$