Electromagnetic Induction – Topic Test / A Physics

1. Define with suitable words, formulae, units, ...

(a) Faraday's Laws – basic Laws, and formulae for (i) wire cutting flux (ii) flux changing in a coil (5)

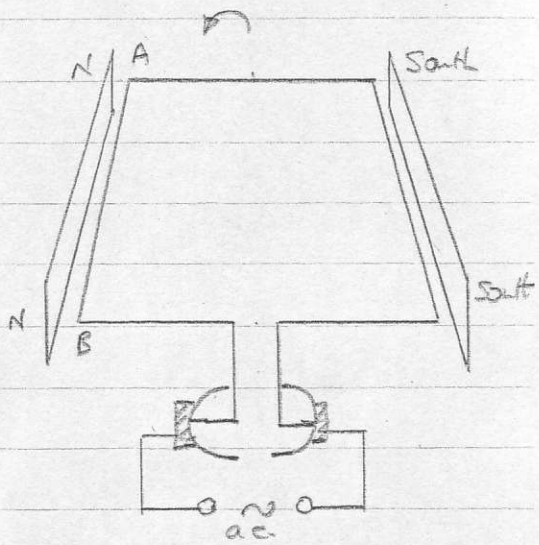
(b) Lenz's Law. (2)

[7]

A retired Physics Teacher gets a job as a Lighthouse keeper, and builds his own alternator + power supply.

2. The Alternator

Basic data: flux density 0,8T, coil size 6 cm × 10 cm



(a) Which way will electrons flow in AB when the coil is rotated as shown? (1)

(b) The alternator must produce a.c. with a peak voltage of 380 V, and frequency of 50 Hz.
How many Turns of wire should be on the rotating coil? (2)

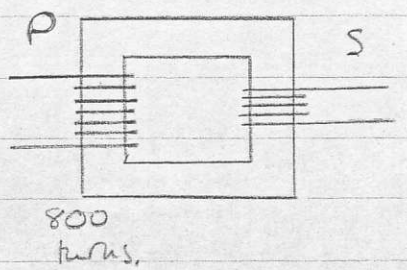
(c) Sketch a graph (labelled axes + scales) to show 2 complete cycles of the output (5)

(d) Mark on the graph ....
H – where the coil is horizontal (parallel to field)
V – where coil is vertical (at 90° to field) (2)

[10]

3 The Transformer

The alternator supplies a.c. at a p.d. of 260 V, and a.current of 800 mA
A 12 V supply is needed to run the radio.



(a) How many turns should be on the secondary coil? (2)

Summary .... ☺ [1] /7 [2] /10 [3] /10 [4] /7 [5] /22 Total /57

Induction – Test 1/2 — A Physics

3 (b) If the transformer is 85% efficient, what is the maximum current it can deliver at 12 V? (3)

(c) In what form is the energy lost? (1)

(d) What are the 4 ways that the transformer loses energy? (4)

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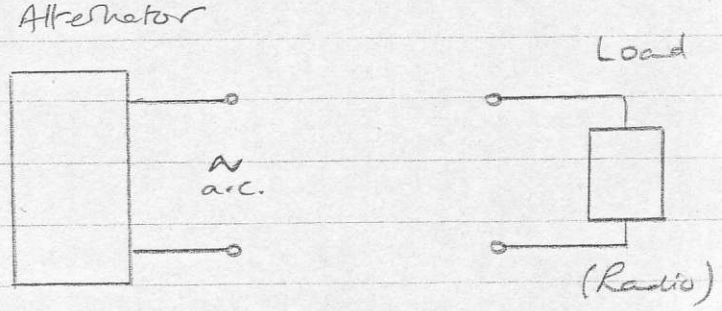
4. The Rectifier

(a) The lighthouse keeper want a smooth d.c. supply. Copy the diagram and add to it to show how this can be done (4)



(b) Sketch and label a simple current/time graph (no scales) to show (i) half wave rectified d.c. (ii) the smoothed waveform. (3)

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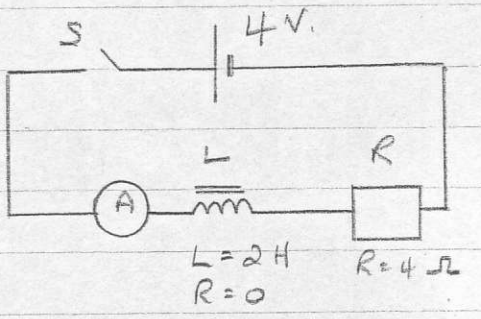
The Inductor

5. The diagram shows a pure inductor in series with a resistor



(a) "The inductor has a self-inductance of 2 H" – what does this mean? (2)

(b) At the moment the current is switched on, what is ....

- current in circuit? (1)
- p.d. across L? (2)
- p.d. across R? (1)

(c) Calculate ...

- the final current. (2)
- the initial rate of current rise (2)

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(d) Sketch a graph (axes + scales) to show how current changes with time from switching on. (4)

(e) Explain the shape of the graph – at short and long times (4 + 2)

(f) Explain the effect of (i) decreasing L only (1)
(ii) decreasing R only (1)

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E.7. Induction – Test Answers A Physics

1. (a) EMF induced is proportional to the rate of flux line cutting or the rate of change of flux linkage through the circuit ①

Wire cutting flux: $\mathcal{E} = B l v$ ① (emf volts / flux density T / length in m ① / velocity m/s)

Flux in coil: $\mathcal{E} = N \frac{d\Phi}{dt}$ ① (5) (emf / turns / change in flux/sec T/sec ①)

(b) Lenz – the direction of induced emf/current is always opposing the change that produced it

2. (a) RH Rule ... A → B ① (c) $T = 1/f = 0.02$ sec

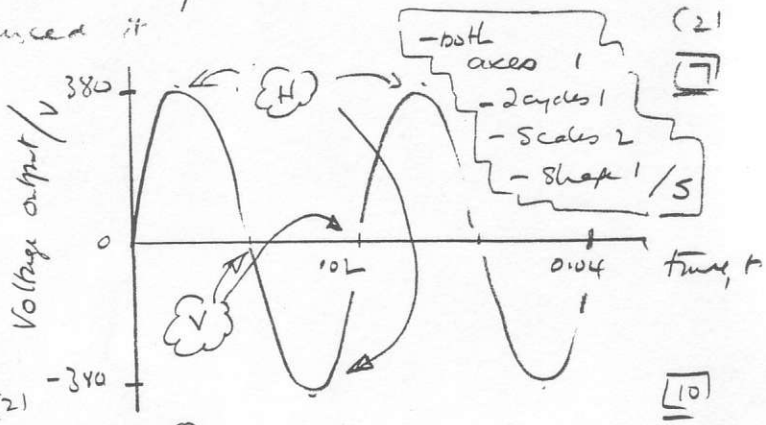
(b) $E_{max} = BAN 2\pi f$ ①

So $N = E_{max}/BA2\pi f$

$= 252$ turns ① (2)

(a) H – max. rate of flux change → E_{max}

V – 0 rate of flux change → $\mathcal{E} = 0$ (2)



3. (a) $N_S/N_p = V_S/V_p$ ① → $N_S = 12/260 \times 800 = 37$ ① turns (2)

(b) $I_p V_p$ (IN) = $I_S V_S$ (out) ① → $I_S = I_p V_p / V_S = 0.8 \times 260/12 = 17.3$ A ①

85% efficiency → I at max = $17.3 \times 0.85 = 14.7$ A ① (3)

(c) Heat ①

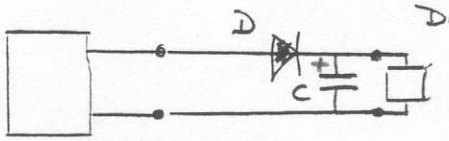
(d) Copper losses – heat due to current in wire coils

– heat due to eddy currents

Iron losses – flux escaping from core

– energy needed to keep reversing flux in core (1)

4. (a)

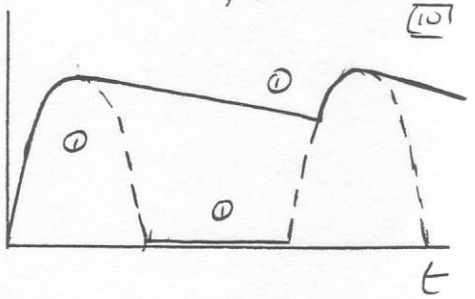


Diode – Symbol ①

– series ①

Cap. – present ①

– parallel ①



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5. Sorry – answer missing.

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