Unit 18

Answers: Electromagnetic Induction

Quick checks

1 c

2 b

3 b

south

4 c

5 c

6 b

7 c

8 c

9 b

10 a

11 b

12 b

13 **c**

P S S P

14 **b**

15 **b**

16 **b**

17 **a**

18 **c**

19 **b**

20 **b**

21 **d**

22 **c**

23 **c**

11. **First law:**

Second law:

$$\varepsilon = -N\,\frac{d\Phi}{dt}$$

$$|\varepsilon| = \frac{N\,\Delta\Phi}{t} = \frac{5000 \times 8 \times 10^{-4}}{0.1} = \mathbf{40\ V}$$

opposite

towards

like

12.

clockwise

$$\varepsilon = -\frac{d\Phi}{dt} = -BA\omega\cos\omega t$$

$$\varepsilon_0 = BA\omega = 4.5\times10^{-3}\times2.8\times10^{-3}\times\omega = 1.26\times10^{-5}\,\omega$$

$$F = BIl = 4.5\times10^{-3}\times2.5\times0.070 = \mathbf{7.9\times10^{-4}\ N}$$

13.

into

anticlockwise

Self-induction

$$L = \frac{\mu_0 N^2 A}{l}$$

zero

$$\omega = \frac{2\varepsilon}{Br^2} = \frac{2 \times 10^{-2}}{5 \times 10^{-5} \times 1.2^2} = 278\,, \qquad f = \frac{\omega}{2\pi} = \mathbf{44\ rev/s}$$

14.

$$\varepsilon = -N\,\frac{d\Phi}{dt}$$

Lenz's law:

$$\Delta\Phi = 2BA = 2 \times 0.19 \times 1.5 \times 10^{-4} = 5.7 \times 10^{-5}$$

$$\varepsilon = \frac{N\,\Delta\Phi}{t} = \frac{120 \times 5.7 \times 10^{-5}}{0.13} = \mathbf{0.053\ V}$$

	before the current changes	during the change, when the current is zero	after the current changes
voltmeter on coil C (V)	0	0.053	0
voltmeter on the Hall probe (V)	0.20	0	−0.20

15.

right-hand grip rule

conservation of energy

opposite to P

$$\varepsilon = \frac{N \times 2BA}{t} = \frac{75 \times 2 \times 1.4 \times 10^{-3} \times 7.0 \times 10^{-4}}{0.12} = \frac{1.47 \times 10^{-4}}{0.12} = \mathbf{1.2 \times 10^{-3}\ V}$$

16.

$$E_S = \frac{P}{I_S} = \frac{15}{0.5} = 30$$

$$N_P = N_S \times \frac{E_P}{E_S} = 20 \times \frac{220}{30} = 146.7 \approx \mathbf{147\ turns}$$

$$I_P = \frac{15}{220} = \mathbf{0.068\ A}$$

17.

Side to side

zero

Up and down

backwards and forwards

18. **down into**

up and out

other

zero

X: **Y:**

19. **Parallel**

$$F = \frac{\tau}{BC} = \frac{2.1 \times 10^{-3}}{0.028} = \mathbf{7.5 \times 10^{-2}\ N}$$

along **zero**

$$B = \frac{F}{NIl} = \frac{7.5 \times 10^{-2}}{140 \times 0.170 \times 0.045} = 0.070\ = \mathbf{70\ mT}$$

$$\varepsilon = -N\,d\Phi/dt$$

$$\Delta(N\Phi) = NBA = 140 \times 0.070 \times 0.045 \times 0.028 = 1.23 \times 10^{-2}$$
$$\varepsilon = \frac{1.23 \times 10^{-2}}{0.14} = 8.8 \times 10^{-2}\ = \mathbf{88\ mV}$$

20.

21.

step-up

step-down

$$I = \frac{P}{V} = \frac{690}{230} = \mathbf{3\ A}$$

$$E = Pt = 690 \times 10 \times 60 = 414\,000\ = \mathbf{4.14 \times 10^{5}\ J}$$