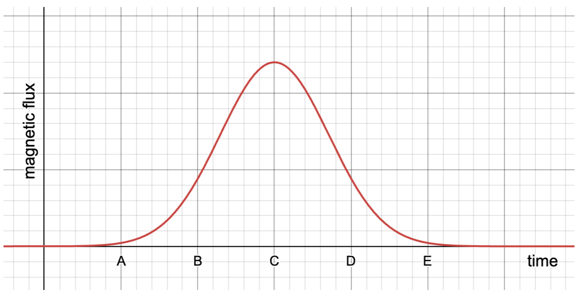
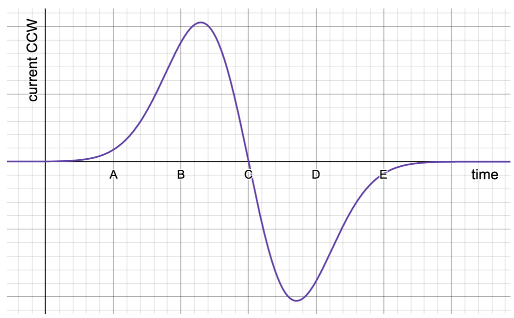
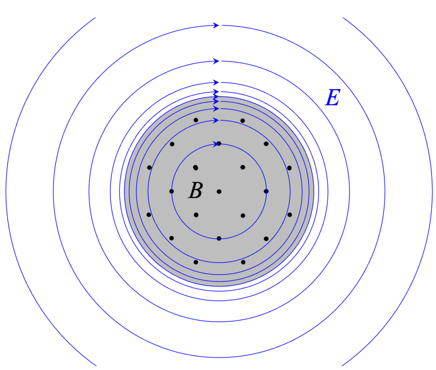
Answers APP Physics C Assignment – Induction and Inductance

1. a. positive   b. negative   c. negative
2. a.


b.


3. a. flux increases; current clockwise
b. flux is constant; current is zero
c. flux decreases; current counterclockwise
d. flux increases; current clockwise
e. flux decreases; current counterclockwise
f. flux decreases; current counterclockwise
g. flux is constant; current is zero
4. a. 4.9×10^{-3} Tm^2
b. 2.5 mV, CW
c. 74 mA, CW
5. a. 7.5 mV, CW
b. 0
c. 15 mV, CCW
d. 15 mV, CCW
6. a. Doubling of the width of the square quadruples the area of the square. Because flux is proportional to area, the emf will be quadrupled from the previous results.
b. The current in the larger square should be only twice that of the smaller square. Although the emf quadruples, the resistance will double because the length of wire is the perimeter of the square, which doubles if the width doubles.
7. 2.4 C
8. a.


b. 1.3×10^{-4} N/C, opp. dir. of current
c. $r = 4.0$ cm
d. -5.2×10^{-24} J

9. $E = \frac{\mu_0 n r I_0 k e^{-kt}}{2}$, CW $r \le R$

$E = \frac{\mu_0 n R^2 I_0 k e^{-kt}}{2r}$, CW $r \ge R$

10. a. $I = \frac{BLv}{R}$

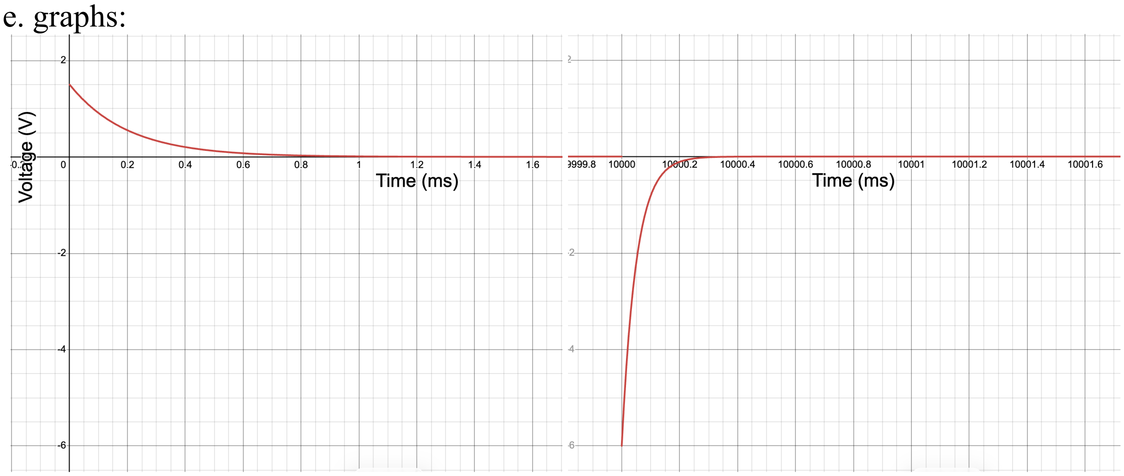
b. $F = \frac{B^2 L^2 v}{R}$, down

c. $E = \frac{B^2 L^3 v}{R}$

11. a. 2.98×10^{-6} Tm^2
b. CW seen from above
c. 24.6 s
12. a. East
b. 1.0 mV
c. 0.50 mV
13. 2.4 mV, near end = +
14. a. 67 mA, CW
b. 2.7 mN
c. 13 mW
d. 13 mW
15. a. 3.5 A, CCW
b. 5.0 A, CCS
16. a. 1.02×10^{-7} T m^2
b. 1.07×10^{-5} V
17. a. 15.3 V
b. 78.2 mW
c. 3310 rpm
18. a. 95 s^{-1}
b. 390
c. 1.05 rad, 11 ms
19. a. The current increases as the load on the motor increases. The rotation rate decreases due to greater torque from friction opposing the motion of the drill bit. The reduction in angular speed causes a corresponding reduction in back emf. With less back emf opposing the source voltage there is a greater net voltage across the fixed resistance of the wire in the coils of the motor.
b. When the current increases there is greater torque. The torque results from magnetic force acting on a current carrying wire and this force is direct proportional to the current. For example, if the current doubles, the force on the current carrying wires double, and therefore the torque also doubles.
20. 3.64 V

21. Even if operating with absolutely no friction and no air resistance, an electric motor will reach a top speed. As its rotation rate increases, so too does the "back emf". The back emf has an opposite polarity to that of the battery – the difference in these two voltages causes current through the loops of wire in the spinning armature of the motor. The current through the wire decreases as the emf increases until the emf equals that of the battery (at which point it spins frictionlessly at a certain angular speed forever). A real motor reaches a state at which there is just enough current to create a torque to oppose whatever friction and/or load is acting on the armature.
22. If there were no "displacement current" added to Ampere's Law, there would be no way to generate a magnetic field except for motion of charges (*i.e.* currents). And yet an electromagnetic wave has a magnetic field that is oscillating and as such must be continually generated. Electromagnetic waves are mutually generated electric and magnetic fields – the change in one generates the other.
23. Coulomb's Law can be derived from Gauss's Law for static electric fields. Use Gauss's Law to determine the electric field produced by a point charge.
24. a. Any and every current produces a magnetic field that wraps around the wire. This will create a net magnetic field passing through the "inside" of any loop, and hence magnetic flux.
    b. The magnetic field is proportional to current in all cases by the Biot-Savart Law. Therefore when current increases, the magnetic field increases, and therefore the magnetic flux increases.
    c. The induced emf will oppose the change in flux, which would create a current in the opposite direction of the current described in part b.
    d. This induced emf acts to "push the current in the opposite direction" because there is now an electric field pointing opposite to whatever is driving the current through the wire.
    e. If current decreases, the flux decreases, and the induced emf and field will serve to push the current in the same direction.
25. a. Any and every circuit has inductance because a circuit by definition is a closed loop (or multiple loops) in which current flows.
    b. Unless there are coils with multiple turns the inductance of an ordinary circuit is negligible because there will be very, very little magnetic flux.
26. a. 0
    b. 6$\underline{0}$ mV
    c. 24 mV
    d. −24 mV
27. a. −0.10 V
    b. −0.14 V
    c. −0.09 V
28. 8.8 mH
29.
30. a. 1.2 mH
    b. 1380
31. a. 4.0 mH
    b. 8.0 mH

32. a. 68 mV
    b. 228 mV
    c. 833 rad/s
33. a. 0.0 A, 12.0 V
    b. 0.120 A, −60.0 V
    c. graphs
    d. $12\underline{0}0$ A/s, $-60\underline{0}0$ A/s
    e.
34. a. $I = \dfrac{\varepsilon}{R}, \quad \varepsilon_L = \varepsilon$
    b. $I = \dfrac{\varepsilon}{2R}, \quad \varepsilon_L = -\dfrac{\varepsilon}{2}$
35. a. $V_1 = 1.50$ V,
       $V_2 = 4.50$ V
    b. 30.0 kV/s
    c. $V_1 = -6.00$ V,
       $V_2 = -18.0$ V
    d. $-12\underline{0}$ kV/s
    e. graphs:



36. a. 0.57 A
    b. 3.8×10^{-5} s
    c. emf = 0.57 V,
       $V =$ 4.67 V
37. a. 11 V
    b. −150 A/s
    c. 9.6 mA, 5.3 V
    d. 1.5×10^{-5} J
    e. 0.25 μF, 2.7 μC

38. a. 0.12 A
    b. 4.05 ms
    c. 2.03 ms
    d. graph:

39. a. 32 Hz
    b. 2.7 A, t = 7.7 ms
    c. 0.0396 J
    d. 4.2 V, 1.9 A
40. a. 500 kHz
    b. 67 mJ
    c. 3.8 A
    d. 8.5 nF
41. a. 480 Hz
    b. 17 mH, 6.7 μF