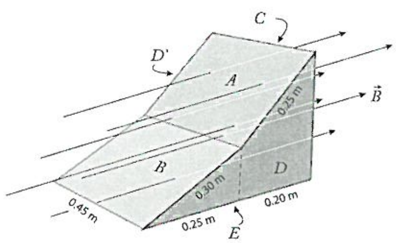
Student 8
Average 27.1/50
Best 40.0/50

12^{th} Physics (2017 – 18)

(4thQ, #1 Mini Test) 4-19-2018

Class	No.	Name Solutions



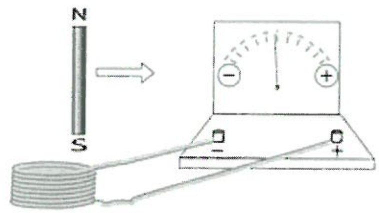
In a calculation problem, describe equations clearly and systematically enough to show how to solve the problem. <u>**If not enough, you won't get any point.**</u>

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Atmospheric Pressure	$1.00\ atm = 1.013 \times 10^5\ Pa$
Avogadro's Number	$N_A = 6.022 \times 10^{23}$ molecule / mol
Universal Gas Constant	$R = 8.31\ J/(mol \cdot K)$
Boltzmann Constant	$k = 1.38 \times 10^{-23}\ J/K$
Elementary Charge	$e = 1.60 \times 10^{-19}\ C$
Electron Mass	$m_e = 9.11 \times 10^{-31}\ kg$
Proton Mass	$m_p = 1.673 \times 10^{-27}\ kg$
Coulomb's Law Constant	$k = 8.99 \times 10^9\ N \cdot m^2/C^2$
Permittivity of Free Space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N \cdot m^2)$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Avogadro's Number	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Magnetic Permeability of Free Space	$\mu_0 = 4\pi \times 10^{-7}\ T \cdot m/A$
Coulomb's Law Constant for Magnets	$k_m = \frac{1}{4\pi\mu_0}\ N \cdot m^2/Wb^2$

4 pt/question x 13 questions = 52 pt   Max 50 pt

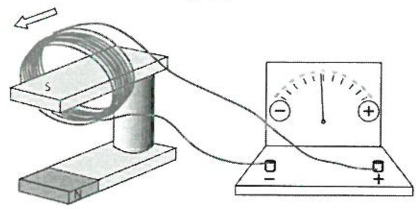
/[Total 50 pt]

(1-a) When the magnet is moved as shown, the galvanometer shows a swing to the positive or negative side. Answer "positive" (+) or "negative" (−).



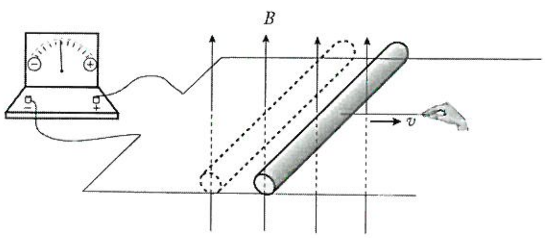
(1-a)

(1-b) When the coil is moving as shown, the galvanometer may show a swing to the positive side negative side or no swing. Answer "positive" (+) , "negative" (−) or no swing (0).



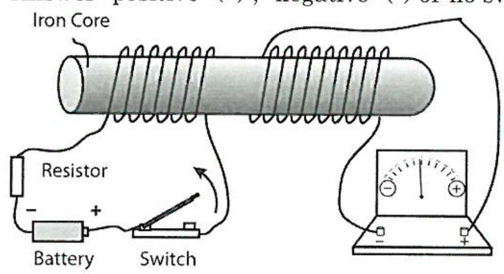
(1-b)

(1-c) When the rod is moving as shown, the galvanometer may show a swing to the positive side negative side or no swing. Answer "positive" (+) , "negative" (−) or no swing (0).



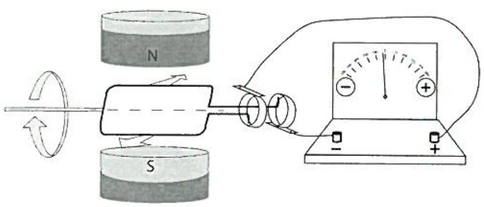
(1-c)

(1-d) The instance the current is switched off in the coil at the left, the galvanometer may show a swing to the positive side negative side or no swing. Answer "positive" (+) , "negative" (−) or no swing (0).



(1-d)

(1- e) The figure shows a generator. The coil rotates around the rotating rod in the direction shown. The galvanometer may show a swing to the positive side negative side or no swing. Answer "positive" (+) , "negative" (−) or no swing (0).



(1-e)

Answer

(1-a)	−
(1-b)	+
(1-c)	−
(1-d)	+
(1-e)	+

91%

(2) At a certain location, the Earth's magnetic field has a magnitude of 5.9×10^{-5} T and points in a direction that is 72° below the horizontal. Find the magnitude of the magnetic flux through the top of a desk at this location that measures 130 cm by 82 cm.

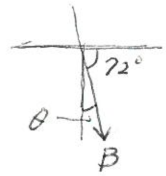
(Equations)

$B = 5.9 \times 10^{-5}$ T

$A = 1.3 \times 0.82$

$= 1.066\ m^2$

$\theta = 90° - 72° = 18°$



$\Phi = BA\cos\theta$

$= 5.9 \times 10^{-5} \times 1.066 \cos 18°$

$= 5.98 \times 10^{-5} \longrightarrow 6.0 \times 10^{-5}$ (Wb)

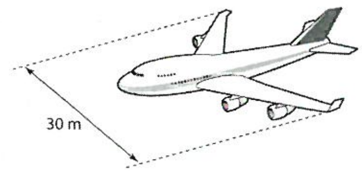
(2) Answer

6.0×10^{-5} Wb

75%

T·m² is OK

(3) A metal airplane with a wingspan of 30 m flies horizontally at a constant speed of 320 km/h in a region where the vertical component of the Earth's magnetic field is 5.0×10^{-5} T. Find the magnitude and signs of emf produced between the ends of the wings.



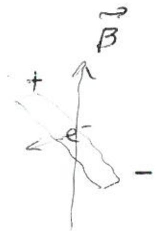
(Equations)

$$v = 320 \frac{km}{hr} \times \frac{10^3 m}{1 km} \times \frac{1h}{3.6 \times 10^3 s} = \frac{320}{3.6} \frac{m}{s}$$

$$= 88.89 \ m/s$$

$$B_\perp = 5.0 \times 10^{-5} \ T$$

$$\begin{cases} F = evB \\ F = eE \\ E = V/\ell \end{cases}$$



$$V = v\ell B$$

$$= 88.89 \times 30 \times 5.0 \times 10^{-5}$$

$$= 0.133 \ V \rightarrow 0.13 \ V$$

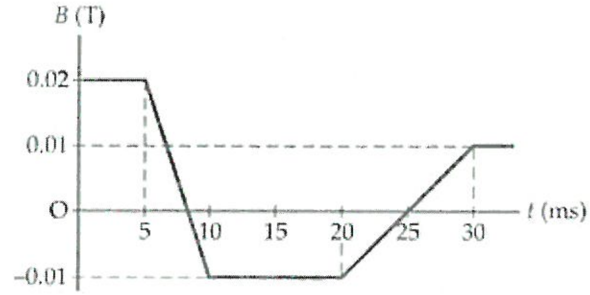
(3) Answer

Magnitude 0.13 V

Signs Right +
Left −

53%

(4,5) A magnetic field with the time dependence shown in the figure is at right angles to a 155-turn circular coil with a diameter of 3.75 cm. What is the induced emf (voltage) in the coil at the following times:



(4-a) t = 2.50 ms
(4-b) t = 7.50 ms
(5-c) t = 15.0 ms
(5-d) t = 25.0 ms.

(Equations)

$N = 155$

$A = \pi\left(\frac{D}{2}\right)^2$

$= \pi \times \left(\frac{0.0375}{2}\right)^2 = 0.001105\ (m^2)$

$V = N\left|\frac{\Delta\Phi}{\Delta t}\right| = NA\frac{\Delta B}{\Delta t}$

(a) $\frac{\Delta B}{\Delta t} = 0 \rightarrow V = 0$

(b) $V = 155 \times 0.001105 \times \left|\frac{-0.01 - 0.02}{(10-5)\times 10^{-3}}\right|$

$= 1.028 \rightarrow 1.03\ (V)$

(c) $\frac{\Delta B}{\Delta t} = 0 \rightarrow V = 0$

(d)

$V = 155 \times 0.001105 \times \left|\frac{0.01 - (-0.01)}{(30-20)\times 10^{-3}}\right|$

$= 0.3426 \rightarrow 0.343\ V$

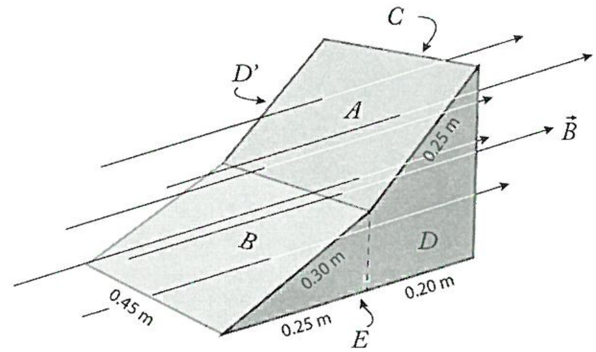
(4-a) Answer	0
(4-b) Answer	1.03 V

25%

(5-c) Answer	0
(5-d) Answer	0.343 V

6%

(6,7) A uniform magnetic filed of 0.50 T penetrates a double incline block as shown in the figure. Determine the magnetic flux through the following surfaces:

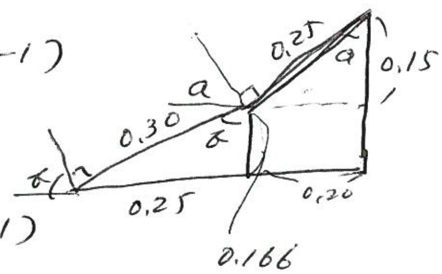


(6-a) Upper inclined surface, A.
(6-b) Lower inclined surface, B
(7-c) Vertical back surface, C
(7-d) Vertical side surface, D (or D')
(7-e) Horizontal bottom surface, E
(7-f) Total flux through all the outside surfaces.

(Equations)

(a) $\phi_A = BA_A \cos\theta_a = 0.50 \times (0.45 \times 0.25) \times \frac{15}{25}(-1)$

$-0.0\overline{338}$



(b) $\phi_B = BA_B \cos\theta_b = 0.50 \times (0.45 \times 0.30) \times \frac{16.6}{30}(-1)$

$-0.0\overline{374}$

(c) $\cos\theta_c = 1$

$\phi_c = BA_c \cos\theta_c = 0.50\{0.45 \times (0.166 + 0.15)\}$

$= 0.0\overline{711}$

(d) $\phi_D = 0$

(e) $\phi_E = 0$

(f) $\phi = \phi_A + \phi_B + \phi_c$

$= -0.0\overline{338} - 0.0\overline{374} + 0.0\overline{711}$

$= 0$

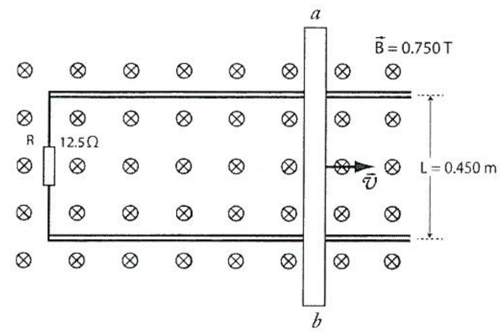
(6-a) Answer	−0.034 wb
(6-b) Answer	−0.037 wb

20%

(7-c) Answer	0.071 wb
(7-d) Answer	0
(7-e) Answer	0
(7-f) Answer	0

52%

(8,9) The figure shows a zero-resistance rod sliding to the right on two zero-resistance rails separated by the distance L = 0.450 m. The rails are connected by a 12.5-Ω resistor, and the entire system is in a uniform magnetic field with a magnitude of 0.750 T.



(8-a) Find the speed at which the bar must be moved to produce a current of 0.155 A in the resistor.
(8-b) Find the force that must be exerted on the rod to maintain a constant of 0.155 A in the resistor.

(9-c) What is the rate of energy dissipation in the resistor?
(9-d) What is the mechanical power delivered to the rod?

(Equations)

(a) $V = IR = 0.155 \times 12.5 = 1.938$ (V)

$V = Bvl \rightarrow v = \frac{V}{Bl} = \frac{1.938}{0.750 \times 0.450} = 5.741 \rightarrow 5.74$

(b) $F = IlB$

$= 0.155 \times 0.450 \times 0.750 = 0.05231 \rightarrow 0.0523$ (N)

(c) $P = VI$

$= 1.938 \times 0.155$

$= 0.3004 \rightarrow 0.300$ W

(d) $P = Fv$

$= 0.0523 \times 5.741$

$= 0.3003 \rightarrow 0.300$ W

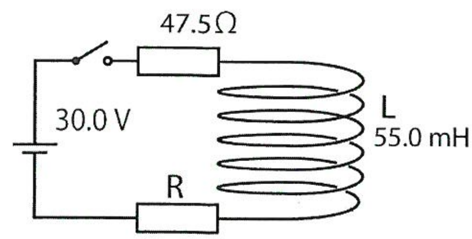
(8-a) Answer
5.74 m/s
(8-b) Answer
0.0523 N

58%

(9-c) Answer
0.300 W
(9-d) Answer
0.300 W

73%

(10) After the switch in the circuit shown has been closed a long time, the energy stored in the inductor is 3.11 x 10^{-3} J. What is the value of the resistance R?



(Equations)

$$U = \frac{1}{2} L I^2$$

$$I = \sqrt{\frac{2U}{L}} = \sqrt{\frac{2 \times 3.11 \times 10^{-3}}{55 \times 10^{-3}}}$$

$$= 0.3363$$

$$I = \frac{V}{47.5 + R}$$

$$R = \frac{V}{I} - 47.5 = \frac{30.0}{0.3363} - 47.5$$

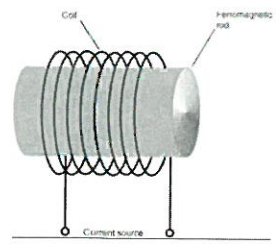
$$= 89.21 - 47.5$$

$$= 41.71 \longrightarrow 41.7$$

41.7 Ω

52%

(11) The coil in an electromagnet has an inductance of 2.9 mH and carries a constant direct current of 5.6 A. A switch is suddenly opened, allowing the current to drop to zero over a small interval of time, Δt. If the magnitude of the average induced emf during this time is 7.3 V, what is Δt?



(Equations)

$L = 2.9 \times 10^{-3}$ H

$I = 5.6$ A , $V = 7.3$ V

$$V = L\left|\frac{\Delta I}{\Delta t}\right|$$

$$\Delta t = L\left|\frac{\Delta I}{V}\right| = 2.9 \times 10^{-3}\left|\frac{0 - 5.6}{7.3}\right|$$

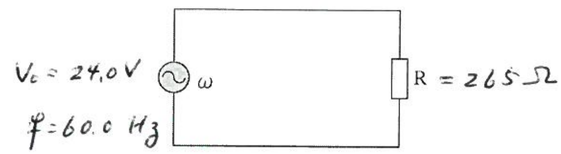
$$= 2.22 \times 10^{-3} \text{ (s)} \longrightarrow 2.2 \times 10^{-3} \text{ s}$$

2.2 ms

64%

(12) An AC generator with a maximum voltage of 24.0 V and frequency of 60.0 Hz is connected to a resistor with a resistance R=265 Ω. Find (a) the rms voltage and (b) rms current in the circuit.

(Equations)



(a) $V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{24.0}{\sqrt{2}}$

$= 16.97 \rightarrow 17.0$

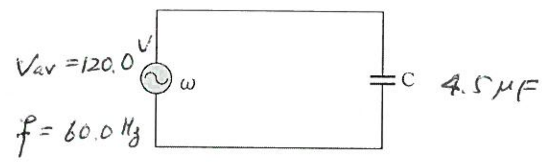
(b) $I_{rms} = \frac{V_{rms}}{R} = \frac{16.97}{265} = 0.06404 \rightarrow 0.0640$

(12) Answer

a 17.0 V   b 0.0640 A

50%

(13-a) An AC generator with a rms voltage of 120.0 V and frequency of 60.0 Hz is connected to a capacitor with a capacitance C=4.5 μ F. Find rms current in the circuit.



(13-a)

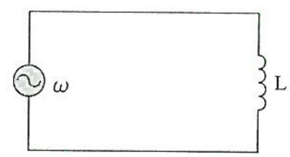
(Equations)

$$I = \frac{V}{X_c} , \quad X_c = \frac{1}{2\pi f C}$$

$$I = 2\pi \times 60 \times 4.5 \times 10^{-6} \times 120$$

$$= 0.204 \rightarrow 0.20$$

(13-b) An AC generator with a rms voltage of 24 V and frequency of 60.0 Hz is connected to a inductor with a inductance L=21 mH. Find rms current in the circuit.



(13-b)

(Equations)

$$I = \frac{V}{X_L} \quad X_L = 2\pi f L$$

$$I = \frac{24}{2\pi \times 60.0 \times 21 \times 10^{-3}}$$

$$= 3.03 \rightarrow 3.0$$

(13-a) Answer
0.20 A
(13-b) Answer
3.0 A

28%

The solution will be shown on the Website of Physic Class tonight.)