15. MAGNETIC EFFECT OF ELECTRIC CURRENT

HOMEWORK SOLUTIONS

1. Given :

Effective area,

$nA = 0.121\ m^2$

$\therefore\ nA = 1.21 \times 10^{-1}\ m^2$

$B = 10^{-4}\ Wb/m^2$

$i = 100\ mA$

$\therefore\ i = 10^{-1}\ A$

To Find :

$\tau_D = ?$

Formula :

$\tau_D = niAB$

Solution :

Deflecting torque acting on MCG is

$\tau_D = niAB$

$\therefore\ \tau_D = (nA)i.B$

$\therefore\ \tau_D = 1.21 \times 10^{-1} \times 10^{-1} \times 10^{-4}$

$\therefore\ \tau_D = 1.21 \times 10^{-6}\ Nm$

2. Given :

$n = 1000$

$l = 40\ mm$

$\therefore\ l = 4 \times 10^{-2}\ m$

$b = 30\ mm$

$\therefore\ b = 3 \times 10^{-2}\ m$

$B = 10^{-5}\ Wb/m^2$

$c = 10^{-7}\ Nm/deg$

$i = 200\ mA$

$\therefore\ i = 2 \times 10^{-1}\ A$

To Find :

$\theta = ?$

Formula :

$i = \frac{c\ .\ \theta}{nAB}$ &

$A = lb$

Solution :

Area of each turn of coil,

$A = lb$

$\therefore\ A = 4 \times 10^{-2} \times 3 \times 10^{-2}$

$\therefore\ A = 12 \times 10^{-4}\ m^2$

Now,

$$i = \frac{c\ .\ \theta}{nAB}$$

$$\therefore\ 2 \times 10^{-1} = \frac{10^{-7}}{1000 \times 12 \times 10^{-4} \times 10^{-5}}\ .\ \theta$$

$$\therefore\ \theta = \frac{2 \times 12 \times 10^{-7}}{10^{-7}}$$

$\therefore\ \theta = 24°$

3. Given :

Effective area,

$nA = 10^5 mm^2$

$\therefore\ nA = 10^5 \times 10^{-6}\ m^2$

$\therefore\ nA = 10^{-1}\ m^2$

$B = 10^{-1}\ Wb/m^2$

$S_i = 10$ degree / mA

$\therefore\ S_i = 10^4$ degree / A

To Find :

$c = ?$

Formula :

$$S_i = \frac{nAB}{c}$$

Solution :

Current sensitivity of MCG is given by,

$$S_i = \frac{nAB}{c}$$

$$\therefore\ c = \frac{nAB}{S_i}$$

$\therefore \quad c = \dfrac{10^{-1} \times 10^{-1}}{10^{4}}$

$\therefore \quad c = 10^{-6}$ Nm/degree

4. Given :

Effective area,

$nA = 10^{5}\,mm^{2} = 10^{-1}\ m^{2}$

$B = 5 \times 10^{-2}\ Wb/m^{2}$

$c = 10^{-7}$ Nm/degree

$\theta = 10°$

To Find :

$i = ?$

Formula :

$$i = \frac{c}{nAB} \cdot \theta$$

Solution :

Current through coil of MCG is given by,

$$i = \frac{c}{nAB} \cdot \theta$$

$$\therefore \quad i = \frac{10^{-7}}{10^{-1} \times 5 \times 10^{-2}} \times 10$$

$$\therefore \quad i = \frac{10^{-6}}{5 \times 10^{-3}}$$

$$\therefore \quad i = \frac{1}{5} \times 10^{-3}$$

$\therefore \quad i = 0.2$ mA

$\therefore \quad i = 200\ \mu A$

5. Given :

No. of divisions = 50

$i_g = 100\ \mu A$

$G = 1000\ \Omega$

To Find :

$S_i = ?$

$S_v = ?$

Formula :

$$S_i = \frac{\text{No. of divisions}}{i_g}$$

$$S_v = \frac{S_i}{G}$$

Solution :

$$\because \quad S_i = \frac{d\theta}{di}$$

$$\therefore \quad S_i = \frac{\text{No. of divisions}}{i_g}$$

$$\therefore \quad S_i = \frac{50\ \text{div}}{100\ \mu A}$$

$\therefore \quad S_i = 0.5$ div/μA

Also,

$$S_v = \frac{S_i}{G} = \frac{0.5\ \text{div}/\mu A}{1000\ \Omega}$$

$$\therefore \quad S_v = \frac{0.5}{10^{3}} \frac{\text{div}}{\text{mV}} = 0.5 \frac{\text{div}}{\text{mV}}$$

6. Given :

No. of divisions = 50

$V_g = 25$ mV

$S_i = \dfrac{1}{20} \dfrac{\text{div}}{\mu A}$

To Find :

$S_v = ?$

$G = ?$

Formula :

$$S_v = \frac{\text{No. of division}}{V_g} \quad \&$$

$$G = \frac{S_i}{S_v}$$

Solution :

$$\because \quad S_v = \frac{\text{No. of division}}{V_g}$$

$$\therefore \quad S_v = \frac{50\ \text{div}}{25\ \text{mV}}$$

$$\therefore \quad S_v = 2 \frac{\text{div}}{\text{mV}}$$

Now,

$$G = \frac{S_i}{S_v}$$

$$\therefore \quad G = \frac{\frac{1}{20}\ \frac{div}{\mu A}}{2\ \frac{div}{mV}}$$

$$\therefore \quad G = \frac{1}{40}\ \frac{mV}{\mu A}$$

$$\therefore \quad G = \frac{1}{40} \times \frac{10^{-3}\ V}{10^{-6}\ A}$$

$$\therefore \quad G = \frac{1}{40} \times 1000\ \Omega$$

$$\therefore \quad G = 25\ \Omega$$

7. Given :

$n = 100$

$A = 10\ cm^2 = 10^{-3} m^2$

$B = 2 \times 10^{-2}\ Wb/m^2$

$i = 5 \times 10^{-3}\ A$

$\theta = 60^o = \frac{\pi}{3}$

To Find :

$c = ?$

Solution :

$$c\,\theta = B\ i\ nA$$

$$\therefore \quad c = \frac{B\ i\ nA}{\theta}$$

$$c = \frac{2 \times 10^{-2} \times 5 \times 10^{-3} \times 100 \times 10^{-3}}{\pi/3}$$

$$c = \frac{3}{\pi} \times 10^{-5}\ Nm/rad$$

8. Given :

$n = 100$

$A = 5 \times 10^{-2}\ m^2$

$B = 10^{-2}\ Wb/m^2$

$c = 5 \times 10^{-9}\ Nm/deg$

To Find :

$Si = ?$

Solution :

$$S_i = \frac{nAB}{c}$$

$$= \frac{100 \times 5 \times 10^{-2} \times 10^{-2}}{5 \times 10^{-9}}$$

$$S_i = 10^7\ deg/A$$

9. Given :

$A = 0.05\ m^2$

$B = 0.05\ Wb/m^2$

$C = 10^{-8}\ Nm/degree$

$i = 100 \times 10^{-6}\ A$

$n = 1$

To Find :

$\theta = ?$

Formula :

$$I = \left(\frac{c}{nBA}\right)\theta$$

$$\therefore \quad \theta = \left(\frac{nBA}{c}\right)I$$

Solution :

$$\theta = \left(\frac{1 \times 0.05 \times 0.05}{10^{-8}}\right) \times 100 \times 10^{-6}$$

$$= \left(\frac{1 \times 5 \times 10^{-2} \times 5 \times 10^{-2}}{10^{-8}}\right) \times 10^{-4}$$

$$= \frac{25 \times 10^{-4} \times 10^{-4}}{10^{-8}}$$

$$\theta = 25^0$$

10. Given :

$G = 200\ \Omega$

$i_g = 5\ mA = 5 \times 10^{-3}\ A$

$V = 10\ V$

To Find : Resistance R to be connected in series with MCG to convert it to measure voltages upto 10 V

Formula :

$$R = \frac{V}{i_g} - G$$

Solution :

$R = \frac{V}{i_g} - G$

$\therefore R = \left(\frac{10}{5 \times 10^{-3}}\right) - 200$

$\therefore R = 1800\ \Omega$

11. Given :

$G = 10\ \Omega$

$i_g = 25\ mA = 25 \times 10^{-3}\ A$

$V = 25\ V$

To Find : Resistance R in series to convert milliammeter into voltmeter to measure upto 25 V.

Formula :

$R = \frac{V}{i_g} - G$

Solution :

$R = \frac{V}{i_g} - G$

$\therefore R = \left(\frac{25}{25 \times 10^{-3}}\right) - 10$

$\therefore R = 990\ \Omega$

12. Given :

$G = 9\ \Omega$

$i_g = 1\ mA = 1 \times 10^{-3}\ A$

$i = 1A$

To Find : Shunt S to be connected across milliammeter to measure upto 1A.

Formula :

$S = \frac{G \cdot i_g}{i - i_g}$

Solution :

$S = \frac{G \cdot i_g}{i - i_g}$

$\therefore S = \frac{9 \times 10^{-3}}{1 - 10^{-3}}$

$\therefore S = \frac{9 \times 10^{-3}}{1 - 0.001} = \frac{9 \times 10^{-3}}{0.999}$

$\therefore S = \frac{9}{999}$

$\therefore S = \frac{1}{111}\ \Omega = 0.009\ \Omega$

13. Given :

$G || S = 20\ \Omega$ where

$G = 500\ \Omega$

To Find :

S & increase in current range.

Formula :

i) Equivalent resistance for parallel combination. $= G \times S / G + S$

ii) $\frac{i_g}{i} = \frac{S}{G + S}$

Solution :

$\because G || S = 20$

$\therefore 500 || S = 20$

$\therefore \frac{500\ S}{500 + S} = 20$

$\therefore 500\ S = 10000 + 20\ S$

$\therefore 480\ S = 10000$

$\therefore S = \frac{10000}{480}$

$\therefore S = 20.83\ \Omega$

Also, $S = \frac{G \cdot i_g}{i - i_g}$

$\therefore iS - i_g S = G \cdot i_g$

$\therefore iS = (G + S)\, i_g$

$\therefore i = \left(\frac{G + S}{S}\right) i_g$

$\therefore i = \left(\frac{500 + 20.83}{20.83}\right) i_g$

$\therefore i = \left(\frac{520.83}{20.83}\right) i_g$

$\therefore i = 25 i_g$

14. Given :

$G = 1\ \Omega$

$i_g = 100\ mA = 10^{-1}\ A$

$i = 1A$

To Find :

i) Shunt (S) to be connected across MCG to convert it into ammeter

ii) Effective ammeter resistance

Formula :

i) $S = \frac{G.\ i_g}{i - i_g}$

ii) Effective ammeter resistance

$= G||S$

$= \frac{GS}{G + S}$

Solution :

i) $S = \frac{G.\ i_g}{i - i_g}$

$\therefore\ S = \frac{1 \times 10^{-1}}{1 - 0.1} = \frac{0.1}{0.9}$

$= 0.11\ \Omega$

ii) Effective ammeter resistance = $G||S$

$= \frac{GS}{G + S} = \frac{1 \times 0.11}{1 + 0.11}$

$= \frac{0.11}{1.11}$

$= 0.99\ \Omega$

15. Given :

$V_g = 25\ V$ &

$G = 200\ \Omega$

$V = 250\ V$

To Find : Resistance R in series with voltmeter to increase its range upto 250 V.

Formula :

$R = \frac{V}{i_g} - G$ where $i_g = \frac{V_g}{G}$

Solution :

Full scale deflection (f-s-d) current for voltmeter is

$i_g = \frac{V_g}{G} = \frac{25}{200} = \frac{1}{8} A$

Now,

$R = \frac{V}{i_g} - G$

$\therefore\ R = \frac{250}{1/8} - 200$

$\therefore\ R = 1800\ \Omega$

16. Given :

$i_g = 15\ mA$

$\therefore\ i_g = 15 \times 10^{-3}\ A$

$V_g = 0.75\ V$

$\therefore\ V_g = 7.5 \times 10^{-1}\ V$

$V = 150\ V$ &

$i = 25\ A$

To Find :

Shunt (S) & series resistance (R)

Formula :

$S = \frac{Gi_g}{i - i_g}$ &

$R = \frac{V}{i_g} - G$

Solution :

$S = \frac{Gi_g}{i - i_g}$

$\therefore\ S = \frac{(V_g/i_g) . i_g}{i - i_g}$

$\therefore\ S = \frac{V_g}{i - i_g}$

$\therefore \quad S = \dfrac{75 \times 10^{-2}}{25 - 0.015}$

$\therefore \quad S = \dfrac{75 \times 10^{-2}}{24.985}$

$\therefore \quad S = \dfrac{75}{2498.5}$

$\therefore \quad S = 0.03\ \Omega$ for 0 – 25 A range

Also,

$R = \dfrac{V}{i_g} - G$

$\therefore \quad R = \dfrac{V}{i_g} - \dfrac{V_g}{i_g}$

$\therefore \quad R = \dfrac{150}{15 \times 10^{-3}} - \dfrac{75 \times 10^{-2}}{15 \times 10^{-3}}$

$= 10^4 - 50$

$\therefore \quad R = 9950\ \Omega$ for 0 – 150V range

17. Given :

$G = 100\ \Omega,$

$i_g = 2\text{ mA}, \quad = 2 \times 10^{-3}\text{ V}$

$V = 5\text{ V}$

$V' = 3\text{V}$

To Find :

i) Resistance R in series with MCG to convert it into voltmeter to measure upto 5 V.

ii) Current reading when voltmeter measure 3 V.

Formula :

i) $R = \dfrac{V}{i_g} - G$

ii) $i' = \dfrac{V'}{R + G}$

Solution :

$R = \dfrac{V}{i_g} - G$

$\therefore \quad R = \left(\dfrac{5}{2 \times 10^{-3}}\right) - 100$

$\therefore \quad R = 2500 - 100$

$\therefore \quad R = 2400\ \Omega$

$\therefore$ Current flowing through voltmeter when it reads 3 V is

$i' = \dfrac{V'}{R + G}$

$\therefore \quad i' = \dfrac{3}{2400 + 100}$

$\therefore \quad i' = \dfrac{3}{2500}$

$\therefore \quad i' = \dfrac{30 \times 10^{-3}}{25}$

$\therefore \quad i' = 1.2\text{ mA}$

18. Given :

$i_g = 100\ \mu\text{A}$

$\therefore \quad i_g = 10^{-4}\text{ A},$

$V_g = 250\text{mV}$

$\therefore \quad V_g = 0.25\text{ V}$

$i = 10\text{ mA}$

$\therefore \quad i_g = 10^{-2}\text{ A} \quad \&$

$V = 10\text{ V}$

To Find :

$S = ?$

$R = ?$

Formula :

$S = \dfrac{G i_g}{i - i_g}$ where

$G = \dfrac{V_g}{i_g}$

Solution :

$S = \dfrac{V_g}{i - i_g}$

$\therefore \quad S = \dfrac{0.25}{0.01 - 0.0001}$

$\therefore$ S = $\frac{0.25}{0.0099}$

$\therefore$ S = 25.2 Ω for 0–10 mA meter

Also,

R = $\frac{V}{i_g}$ – G

$\therefore$ R = $\frac{10}{10^{-4}} - \frac{0.25}{10^{-4}}$

$\therefore$ R = $\frac{1}{10^{-4}}(9.75)$

$\therefore$ R = 97500 Ω for 0 - 10 V meter

19. Given :

No. of divisions = 50,

i_g = 250 μA,

V_g = 250 mV

i = 0.5 mA/div &

V = 0.5 V/div

To Find :

S = ?

R = ?

Formula :

S = $\frac{Gi_g}{i - i_g}$ &

R = $\frac{V}{i_g}$ – G

Solution :

$\because$ i = 0.5 mA/div

$\therefore$ i = 0.5 x 50

$\therefore$ i = 25 mA

Also,

V = 0.5 V/div

$\therefore$ V = 0.5 x 50

$\therefore$ V = 25 V

Now,

S = $\frac{G.i_g}{i - i_g}$

$\therefore$ S = $\frac{V_g}{i - i_g}$

$\therefore$ S = $\frac{250 \times 10^{-3}}{(25 \times 10^{-3} - 250 \times 10^{-6})}$

S = $\frac{0.25}{0.02475}$

$\therefore$ S = 10.1 Ω

Also,

R = $\frac{V}{i_g}$ – G

$\therefore$ R = $\left(\frac{25}{250 \times 10^{-6}}\right) - \frac{250 \times 10^{-3}}{250 \times 10^{-6}}$

$\therefore$ R = 100000 – 1000

$\therefore$ R = 99000 Ω

20. Given :

i_g = 100 mA

$\therefore$ i_g = 10^{-1} A,

V_g = 100 mV

$\therefore$ V_g = 10^{-1} V

V = 10 V,

V′ = 7.5 V

To Find :

i) G

ii) Resistance (R) in series with voltmeter to increase its range.

iii) Current flowing through meter when it reads 7.5 V

Formula :

i) G = $\frac{V_g}{i_g}$

ii) R = $\frac{V}{i_g}$ – G

iii) i′ = $\frac{V'}{R + G}$

Solution :

i) G = $\frac{V_g}{i_g}$

$\therefore \quad G = \dfrac{100\text{ mV}}{100\text{ mA}}$

$\therefore \quad G = 1\ \Omega$

ii) $R = \dfrac{V}{i_g} - G$

$\therefore \quad R = \dfrac{V}{i_g} - \dfrac{V_g}{i_g}$

$\therefore \quad R = \dfrac{1}{i_g}(V - V_g)$

$\therefore \quad R = \dfrac{1}{10^{-1}}(10 - 10^{-1})$

$\therefore \quad R = 10(9.9)$

$\therefore \quad R = 99\ \Omega$

iii) $i' = \dfrac{V'}{R + G}$

$\therefore \quad i' = \dfrac{7.5}{99 + 1}$

$\therefore \quad i' = \dfrac{7.5}{100}$

$\therefore \quad i' = 75\text{ mA}$

21. Given :

$i_g = 10\text{ mA}$

$V_g = 250\text{ mV}$

$i = 10\text{ A}$

$V = 100\text{ V}$

To Find :

$S = ?$

$R = ?$

Solution :

$S = \dfrac{G\, i_g}{i - i_g}$

$G = \dfrac{V_g}{i_g} = \dfrac{250}{10}$

$\therefore \quad G = 25\ \Omega$

$S = \dfrac{25\,(10^{-2})}{10 - 0.01}$

$\therefore \quad S = \dfrac{25}{9.99} \times 10^{-2}$

$\therefore \quad S = \dfrac{25}{999}\ \Omega$

$R = \dfrac{V}{i_g} - G$

$\therefore \quad R = \dfrac{100}{10^{-2}} - 25$

$\therefore \quad R = 9975\ \Omega$ in series

22. Given :

$G = 1000\Omega$

$G||S = 25\Omega$

To Find :

$S = ?$

Formula :

$G||S = \dfrac{GS}{G + S}$

Solution :

$\therefore \quad G||S = 25$

$\dfrac{G \times S}{G + S} = 25$

$\therefore \quad \dfrac{1000S}{1000 + S} = 25$

$\therefore \quad 1000\,S = 25000 + 25S$

$\therefore \quad 975\,S = 25000$

$\therefore \quad S = \dfrac{25000}{975}$

$S = 25.64\ \Omega$

23. Given :

$S_i = 5\text{ div/mA}$

$S_v = 1\text{ div/mV}$

Nof of div = 50

$i = 5\text{A}$

$V = 100\text{ V}$

To Find :

$S = ?$

$R = ?$

Solution :

$i_g = \frac{50}{5} = 10\ mA$

$= 10^{-2}\ A$

$V_g = \frac{50}{1} = 50\ mV$

$G = \frac{V_g}{i_g} = \frac{50 \times 10^{-3}}{10^{-2}}$

$= 5\ \Omega$

For Ammter

$S = \frac{i_g G}{i - i_g}$

$= \frac{10^{-2} \times 5}{5 - 10^{-2}}$

$= \frac{0.05}{50 - 0.01}$

$= \frac{0.05}{4.99}$

$\therefore S = \frac{5}{499}\ \Omega$

For Voltmeter

$R = \frac{V}{i_g} - G$

$= \frac{100}{10^{-2}} - 5$

$= 10^4 - 5$

$= 10000 - 5$

$\therefore R = 9995\ \Omega$

24. Given :

$S_i = 5\ div/mA$

$S_V = 2\ div/V$

$i_g = \frac{30}{5} = 6mA$

$V_g = \frac{30}{2} = 15\ V$

$i = 3A$

To Find :

$S = ?$

Solution :

$G = \frac{V_g}{i_g}$

$\therefore G = \frac{15}{6 \times 10^{-3}}$

$\therefore G = \frac{15000}{6} = 2500\ \Omega$

$S = \frac{G\ i_g}{(i - i_g)}$

$\therefore S = \frac{2500 \times 6 \times 10^{-3}}{3 - 6 \times 10^{-3}}$

$\therefore S = \frac{15000}{3000 - 6} = \frac{15000}{2994}$

$\therefore S = \frac{2500}{499}\ \Omega$

25. Given :

$r = 60\ cm$

$\therefore r = 6 \times 10^{-1}\ m$

$B = 0.8\ T$

$m = 4 \times 1.67 \times 10^{-27}\ kg$

To Find :

$KE = ?$

$f = ?$

$v = ?$

Formula :

$KE = \frac{q^2B^2r^2}{2m}$

$KE = \frac{1}{2}mv^2$

$v = r\omega$

$\omega = 2\pi f$

Solution :

$KE = \frac{q^2B^2r^2}{2m}\ 10^{-11}$

$KE = \frac{2^2 \times 1.6^2 \times 10^{-38} \times 0.8^2 \times 6^2 \times 10^{-2}}{2 \times 4 \times 1.67 \times 10^{-27}}$

$$KE = \frac{2.56 \times 6.4 \times 3.6 \times 10^{-3}}{8 \times 1.67}$$

$$KE = \frac{1.776 \times 10^{-12}}{1.6 \times 10^{-19}}$$

$$KE = \frac{1.776}{1.6} \times 10^{6}$$

$$\therefore KE = 11 \text{ MeV}$$

$$KE = \frac{1}{2} mv^2$$

$$v^2 = \frac{2KE}{m}$$

$$v^2 = \frac{2 \times 11 \times 1.6 \times 10^{-19} \times 10^{6}}{4 \times 1.67 \times 10^{-27}}$$

$$v^2 = 5.27 \times 10^{14}$$

$$\therefore v = 2.3 \times 10^{7} \text{ m/s}$$

$$v = r\omega$$

$$v = r.2\pi f$$

$$f = \frac{v}{2\pi r}$$

$$\therefore f = \frac{2.3 \times 10^{7}}{2 \times 3.14 \times 6 \times 10^{-1}}$$

$$\therefore f = 0.61 \times 10^{7} \text{ Hz}$$

26. Given :

$$f = 10^{7} \text{ Hz}$$

$$r = 0.5 \text{ m}$$

$$m = 3.34 \times 10^{-27} \text{ kg}$$

$$q = 1.6 \times 10^{-19} \text{ C}$$

To Find :

$$B = ?$$

$$KE = ?$$

Formula :

$$\frac{mv}{r} = qvB$$

$$KE = \frac{q^2B^2r^2}{2m}$$

Solution :

$$\frac{mv}{r} = qvB$$

$$\frac{mv}{r} = qB$$

$$B = \frac{mv}{qr} = \frac{mr.\omega}{qr}$$

$$B = \frac{3.34 \times 10^{-27} \times 2\pi (10^{7})}{1.6 \times 10^{-19}}$$

$$B = 13.10 \times 10^{-1}$$

$$B = 1.31 \text{ T}$$

$$KE = \frac{q^2B^2r^2}{2m}$$

$$KE = \frac{1.6^2 \times 10^{-38} \times 1.3 \times 1.3}{2 \times 3.34 \times 10^{-27}} \times \frac{1}{4}$$

$$KE = \frac{540.8}{3.34} \times 10^{-14}$$

$$KE = \frac{1.61 \times 10^{-12} \text{ J}}{1.6 \times 10^{-19}}$$

$$\therefore KE = 10.10 \text{ MeV}$$

27. Given :

$$r = 0.5 \text{ m}$$

$$B = 0.35 \text{ T}$$

$$m = 1.67 \times 10^{-27} \text{ kg}$$

To Find :

$$KE = ?$$

Formula :

$$KE = \frac{q^2B^2r^2}{2m}$$

Solution :

$$KE = \frac{q^2B^2r^2}{2m}$$

$$= \frac{1.6^2 \times 10^{-38} \times 35^2 \times 10^{-4} \times 0.25}{2 \times 1.67 \times 10^{-27}}$$

$$KE = \frac{245 \times 10^{-15} \text{ V}}{1.6 \times 10^{-19}}$$

$$KE = \frac{2450}{16} \times 10^{-2}$$

$$KE = 1.53 \text{ MeV}$$