IMPORTANT PROBLEMS IN PHYSICS FOR SSC MARCH – 2016

1. What would be the final temperature of a mixture of 50 g of water at 20°C temperature and 50 g of water at 40°C temperature?

A. Mass (m_1) = 50 gm
Temperature (T_1) = 20°C
Mass (m_2) = 50 gm
Temperature(T_2) = 40°C
Final temperature as per Method of mixtures

$(T) = \frac{m_1T_1+m_2T_2}{m_1+m_2} = \frac{50X20+50X40}{50+50} = \frac{1000+2000}{100}$

$= \frac{3000}{100}$ = 30°C

2. Answer these.

a) How much energy is transferred when 1gm of boiling water at 100°C condenses to water a 100°C?

b) How much energy is transferred when 1gm of boiling water at 100°C cools to water at 0°C?

c) How much energy is released or absorbed when 1 gm of water at 0°C freezes to ice at 0°C?

d) How much energy is released or absorbed when 1 gm of steam at 100°C turns to ice at 0°C?

A. a) 1gm of boiling water at 100°C condenses to water at 100°C.
Heat transferred (Q_1) = mL
= 1x540 = 540 cal
The latent heat of vaporization of water is
(L) = 540 cal/gm.

b) 1gm of boiling water at 100°C cools to water at 0°C.
Heat transferred (Q_2) = m.s.ΔT
= 1x1x100
= 100 cal

c)1gm of water at 0°C freezes to ice at 0°C.
Heat transferred (Q_3) = mL
= 1x80 = 80 cal
The latent heat of fusion of ice is
(L) = 80 cal/gm.

d) 1gm of steam at 100°C turns to ice at 0°C.
Heat transferred (Q) = Q_1+ Q_2+ Q_3
= 540+100+80
= 720 cal

3. Convert 20°C into Kelvin scale.

A. t°C = (t + 273)K
20°C = (20 + 273)K = 293K

4. Calculate the amount of Aluminium required to get 1120 Kg of Iron by the following reacton.
$Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe$
(Atomic masses Al-27U, Fe-56U, O-16U)

A. $Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe$
(27Kg) (56Kg)
Amount of Aluminium required to get
56 Kg of Iron = 27 Kg
Amount of Aluminium required to get
1120 Kg of Iron = $\frac{1120}{56}$ X 27 Kg
= 20 X 27 Kg
= 520 Kg

5. Calculate the volume, mass and number of molecules of hydrogen liberated when 230 g of sodium reacts with excess of water at STP. (atomic masses of Na = 23U, O = 16U, and H = 1U)

A. The balanced equation for the reaction is,
$2Na (s) + 2H_2O (l) \rightarrow 2NaOH (aq) + H2 (g)$

(2x23)U	2(18)U	2(40)U	(2x1)U
46 U	36 U	80 U	2 U
46 g	36 g	80 g	2 g

The Hydrogen produced by 46g of Na = 2 g
The Hydrogen produced by 230g of Na
= $\frac{230}{46}$ X 2 g = 10 g
1 gram molar mass of any gas at STP occupies 22.4 litres
2 g of hydrogen occupies 22.4 litres at STP.
10 g of hydrogen occupies $\frac{10}{2}$ X 22.4
= 112 litres at STP.
2 g of Hydrogen (1 mole) contains
$6.02x10^{23}$ molecules
10 g of hydrogen contain $\frac{10}{2}$ X $6.02x10^{23}$
= 30.10×10^{23} molecules

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6. Find the distance of the image when an object is placed on the principal axis at a distance of 10cm in front of a concave mirror whose radius of curvature is 8cm.

A. Distance of the object (u) = 10cm

Radius of curvature (R) = 8cm

Focal length (f) = $\frac{R}{2} = \frac{8}{2}$ = 4cm

Distance of the image (v) = ?

Formula : $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{4} - \frac{1}{10} = \frac{10-4}{40} = \frac{6}{40} = \frac{3}{20}$

$v = \frac{20}{3}$ = 6.6 cm (on the object side)

7. A convex mirror with a radius of curvature of 3m is used as rear view in an automobile. If a bus is located at 5m from this mirror, find the position, nature and size of the image.

A. (for convex mirror u taken with negative sign)

Distance of the object (u) = -5m

Radius of curvature (R) = 3m

Focal length (f) = $\frac{R}{2} = \frac{3}{2}$ = 1.5m

Distance of the image (v) = ?

Formula : $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{1.5} - \frac{1}{-5} = \frac{2}{3} + \frac{1}{5} = \frac{10+3}{15} = \frac{13}{15}$

$v = \frac{15}{13}$ = 1.15 m

Image formed behind the mirror and it is virtual, erect, diminished.

8. An object is placed at a distance of 10cm a convex mirror of focal length 15cm. Find the position and nature of the image.

A. (for convex mirror u taken with negative sign)

Distance of the object (u) = -10cm

Focal length (f) = 15cm

Radius of curvature (R) = 2f = 30cm

Distance of the image (v) = ?

Formula : $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{15} - \frac{1}{-10} = \frac{10+15}{150} = \frac{25}{150}$

$v = \frac{150}{25}$ = 6cm

Image formed behind the mirror and it is virtual, erect, diminished.

9. The speed of the light in a diamond is 1, 24, 000 km/s. Find the refractive index of diamond if the speed of light in air is 3,00,000 km/s.

A. Speed of light in air (v_1) =300000km/s

Speed of light in diamond (v_2) =124000km/s

Refractive index of diamond = $\frac{v_1}{v_2}$

$= \frac{300000}{124000}$ = 2.42

10. Refractive index of glass relative to water is 9/8. What is the refractive index of water relative to glass?

A. Refractive index of glass relative to water is

$n_{gw} = \frac{n_g}{n_w} = \frac{9}{8}$

Refractive index of water relative to glass is

$n_{wg} = \frac{n_w}{n_g} = \frac{8}{9}$

11. The absolute refractive index of water is 4/3. What is the critical angle?

A. Absolute refractive index of water (n) = $\frac{4}{3}$

Critical angle (c) = ?

Sin C = $\frac{1}{n}$

Sin C = $\frac{3}{4}$ = 0.75 = Sin 48^o36^l

➔ C = 48^o36^l

12. Determine the refractive index of benzene if the critical angle is 42^0.

A. Refractive index of Benzene (n) = ?

Critical angle (c) = 42^o

Sin C = $\frac{1}{n}$

n = $\frac{1}{\text{Sin C}} = \frac{1}{\text{Sin } 42} = \frac{1}{0.6691}$ = 1.4945

13. A light ray is incident on air-liquid interface at $45^0$and is refracted at 30^0. What is the refractive index of the liquid? For what angle of incidence will the angle between reflected ray and refracted ray be 90^0?

A. Case(i) : angle of incidence (i) = 45^o

angle of refraction (r) = 30^o

Refractive index (n) = $\frac{Sin\ i}{Sin\ r}$

$= \frac{Sin\ 45}{Sin\ 30} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}}$

$= \frac{2}{\sqrt{2}} = \sqrt{2}$

= 1.414

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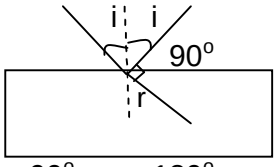
Case(ii) : Angle between reflected ray and refracted ray = 90^o



As per the figure : $i + 90^o + r = 180^o$

$\rightarrow r = 90^o - i$

$n = \frac{Sin\ i}{Sin\ r} = \frac{Sin\ i}{Sin\ (90-i)} = \frac{Sin\ i}{Cos\ i} = \tan i$

$\tan i = n$

$\tan i = 1.414$

$\tan i = \tan 54.7^o$

$i = 54.7^o$

14. The focal length of a converging lens is 20cm. An object is 60cm from the lens. Where will the image be formed and what kind of image is it?

A. Converging lens means convex lens.

For convex lens 'u' taken as negative.

Focal length (f) = 20cm

Object distance (u) = -60cm

Image distance (v) = ?

Lens formula : $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{20} + \frac{1}{-60} = \frac{1}{20} - \frac{1}{60} = \frac{60-20}{20\ X\ 60} = \frac{40}{1200}$

$\rightarrow \frac{1}{v} = \frac{1}{30} \rightarrow v = 30cm$

Here Object is placed beyond C. So image is formed between F and C. It is real, inverted and diminished.

15. A double convex lens has two surfaces of equal radii 'R' and refractive index n = 1.5. Find the focal length 'f'.

A. Let radius of curvatures of double convex lens are R_1 and R_2.

Given $R_1 = R_2 = R$

Refractive index (n) = 1.5

Focal length of the lens (f) = ?

Lens maker's formula : $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

for double convex lens

R_1 is positive and R_2 is negative.

So : $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

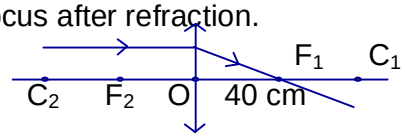
$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R} + \frac{1}{R}\right) = 0.5 \times \frac{2}{R} = \frac{1}{R}$

f = R

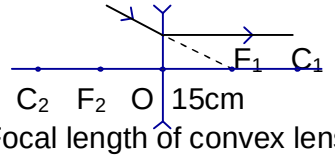
focal length is equal to the radius of curvature.

16. A parallel beam of rays is incident on a convergent lens with a focal length of 40cm. Where should a divergent lens with a focal length of 15 cm be placed for the beam of rays to remain parallel after passing through the two lenses? Draw a ray diagram.

A. (i) The incident ray which is parallel to the axis of convex lens, passes through the focus after refraction.



(ii) The incident ray passing towards the focus of a concave lens will take a path parallel to the axis after refraction.

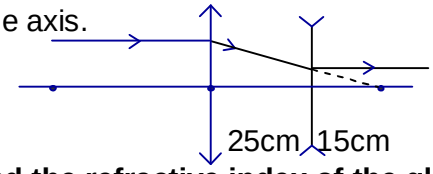


Now : Focal length of convex lens = 40cm

Focal length of concave lens = 15cm

Let we arrange the convex and concave lenses on a common axis such that the distance between the two lenses is 25cm.

The parallel incident rays on convex lens converges to its focus after refraction. The refracted rays passes towards the focus of concave lens and finally take a path parallel to the axis.



17. Find the refractive index of the glass which is a symmetrical convergent lens if its focal length is equal to the radius of curvature of its surface.

A. For symmetrical convergent lens $R_1 = R_2 = R$

Focal length of lens (f) = R

Lens maker's formula : $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

for double convex lens

R_1 is positive and R_2 is negative.

$\rightarrow \frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$\rightarrow \frac{1}{R} = (n-1)\left(\frac{1}{R} + \frac{1}{R}\right)$

$\rightarrow \frac{1}{R} = (n-1)\left(\frac{2}{R}\right)$

$\rightarrow 1 = 2n - 2 \rightarrow 2n = 3 \rightarrow n = \frac{3}{2} = 1.5$

Refractive index of lens (n) = 1.5

18. Find the radii of curvature of a convexo – concave convergent lens made of glass with refractive index n=1.5 having focal length of 24cm. One of the radii of curvature is double the other.

A. Let the centre of curvatures of convexo-concave lens are R_1 and R_2

Given that $R_2 = 2R_1$

Focal length of lens (f) = 24cm

Refractive index of the lens (n) = 1.5

Lens maker's formula : $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

for convexo-concave lens

R_1 is positive and R_2 is positive.

$\rightarrow \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\rightarrow \frac{1}{24} = (1.5-1)\left(\frac{1}{R_1} - \frac{1}{2R_1}\right)$

$\rightarrow \frac{1}{24} = (0.5)\left(\frac{2-1}{2R_1}\right)$

$\rightarrow 2R_1 = 12 \rightarrow R_1 = 6cm$

$R_2 = 2R_1 = 12cm$

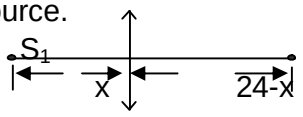
Radii of curvatures of lens are R_1=6cm,R_2=12cm

19. The distance between two point sources of light is 24cm .Where should a convergent lens with a focal length of f=9cm be placed between them to obtain the images of both sources at the same point?

A. Distance between two sources (d) = 24cm

Focal length (f) = 9cm

Let the lens be placed at a distance 'x' cm from the first source.



Lens formula : $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

For getting both images at same place there are two possibilities only. Either virtual image of S_1 or S_2 can be formed.

Let the image of two sources can be collected at 'v' distance from lens at S_2 side.

<u>For the first source :</u>

Object distance (u) = -x

Image distance (v) = v

Focal length (f) = 9cm

Now : $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \rightarrow \frac{1}{9} = \frac{1}{v} + \frac{1}{X}$ ……(1)

<u>For the first source :</u>

Object distance (u) = -(24-x)

Image distance (v) = -v

Focal length (f) = 9cm

Now : $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \rightarrow \frac{1}{9} = -\frac{1}{v} + \frac{1}{24-X}$ …..(2)

Add (1) + (2), we get $\frac{2}{9} = \frac{1}{X} + \frac{1}{24-X}$

$\rightarrow \frac{2}{9} = \frac{24}{X(24-X)}$

$\rightarrow \frac{1}{9} = \frac{12}{24X-X^2}$

$\rightarrow 24x - x^2 = 108$

$\rightarrow x^2 - 24x - 108 = 0$

$\rightarrow x^2 - 18x - 6x - 108 = 0$

$\rightarrow x(x-18) - 6(x-18) = 0$

$\rightarrow (x-18)(x-6) = 0$

$\rightarrow x-18 = 0$ or $x-6 = 0$

$\rightarrow x = 18cm$ or $6cm$.

So the lens should be placed either at 18 cm or at 6cm from the first source.

20. Doctor advised Ramu to use 2D lens. What is the focal length of the lens?

A. Power of lens (P) = 2D

Formula : $P = \frac{100}{f\ (in\ cms)}$

$f = \frac{100}{P} = \frac{100}{2} = 50$ cm

Focal length of the lens = 50 cm.

21. A light ray falls on one of the faces of a prism at an angle 40^o so that it suffers angle of minimum deviation of 30^o. Find the angle of prism and angle of refraction at the given surface.

A. Incident angle is (i) = 40^o

Angle of minimum deviation (D) = 30^o

Formula: $A + D = 2i$

$\rightarrow A = 2i - D$

$\rightarrow A = 2(40^o) - 30^o$

$\rightarrow A = 80^o - 30^o = 50^o$

Angle of prism (A) = 50^o

Angle of refraction (r) = $\frac{A}{2} = \frac{50}{2} = 25^o$

22. The focal length of a lens suggested to a person with Hypermetropia is 100cm. Find the distance of near point and power of the lens.

A. Focal length of lens (f) = 100 cm

Let 'd' is the distance of the near point.

Formula: $f = \frac{25d}{d-25}$

$\rightarrow 100 = \frac{25d}{d-25}$

$\rightarrow 100d - 2500 = 25d$

$\rightarrow 75d = 2500$

$\rightarrow d = \frac{2500}{75} = \frac{100}{3} = 33.33$ cm

Power of lens (P) = $\frac{100}{f\ (in\ cms)} = \frac{100}{100} = 1$ Diapter

23. What is the value of 1 KWH in joules?.

A. 1 KWH = 3.6 x 10^6 Joules.

24. Two bulbs have ratings 100W, 220V and 60W, 220V. Which one has the greater resistance?

A. Power of electricity : P = $\frac{V^2}{R}$ ➔ R = $\frac{V^2}{P}$

Case(i) For first bulb P = 100 W,

V = 220 V

R = $\frac{V^2}{P}$

= $\frac{220\ X\ 220}{100}$

= 484 Ω

Case(ii) For second bulb P = 60 W

V = 220 V

R = $\frac{V^2}{P}$

= $\frac{220\ X\ 220}{60}$

= 806.66 Ω

Second bulb has greater resistance.

25. A wire of length 1m and radius 0.1mm has a resistance of 100Ω. Find the resistivity of the material.

A. The length of resistance (l) = 1 m

Radius of the wire (r) = 0.1 mm

= 0.1 x 10^{-3} m

= 1 x 10^{-4} m

Area of cross section of wire (A) = $\pi\ r^2$

= $\frac{22}{7}$x$(1x10^{-4})^2$

= $\frac{22}{7}$ x 10^{-8}

Resistance (R) = 100 Ω

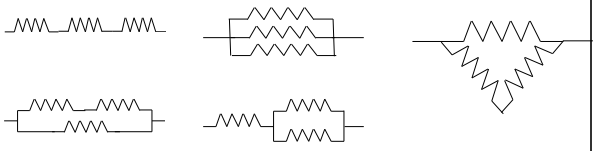
Resistivity (ρ) = $\frac{RA}{l}$

= $\frac{100\ X\ \left(\frac{22}{7}X\ 10^{-8}\right)}{1}$

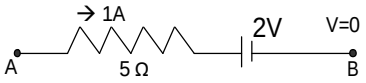
= 3.14 x10^{-6} Ω-m

26. Suppose that you have three resistors each of 30Ω. How many resistors can you obtain by various combinations of these three resistors? Draw the diagrams in support of your predictions.

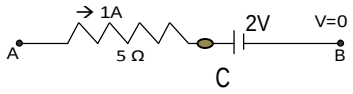
A. Three different resistors may connected in different ways to get different resistance values.



27. In the given figure, the potential at A is ……. When the potential at B is zero.



A. Potential difference is divided between A & B



$V_{BA} = V_{BC} + V_{CA}$

$V_A - V_B = +2 + (1x5)$

$V_A - 0 = 2 + 5$

$V_A = 7$ V

28. Observe the circuit and answer the questions given below.

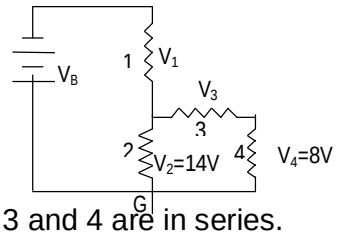
i) Are resistors 3 and 4 in series?

ii) Are resistors 1 and 2 in series?

iii) Is the battery in series with any resistor?

iv) What is the potential drop across the resistor 3?

v) What is the total emf in the circuit if the potential drop across resistor 1 is 6V?



A. (i) Resistors 3 and 4 are in series.

(ii) Resistors 1 and 2 are in series.

(iii) Yes

(iv) As resistor 2 connected parallel to 3 and 4

$V_2 = V_3 + V_4$ ➔ $14 = V_3 + 8$ ➔ $V_3 = 6$V

(v) Given $V_1 = 6$V

As battery connected in series to 1 and 2

$V_B = V_1 + V_2 = 6 + 14 = 20$V

29. If the resistance of your body is 100000Ω, what would be the current that flows in your body when you touch the terminals of a 12V battery?

A. Resistance (R) = 100000 Ω

Potential of the battery (V) = 12 V

Ohm's law : V = I R

I = $\frac{V}{R}$ = $\frac{12}{100000}$ = 12 x 10^{-5} A

The flow of current through the body is 12 x 10^{-5} Ampere

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30. A uniform wire of resistance 100Ω is melted and recast into wire of length double that of the original. What would be the resistance of the new wire formed?

A. A wire is melted and reshaped.

At first: Resistance (R_1) = 100 Ω

Length of wire (l_1) = l

Area of cross section(A_1) = A

As the wire is in cylindrical shape

The volume = A x l

At final: Resistance (R_2) = R Ω

Length of wire (l_2) = 2 l

Area of cross section(A_2) = $\frac{A}{2}$

Resistivity ($\rho = \frac{R\,A}{l}$) of a metal does not changes as per measurements.

$$\frac{R_1\,A_1}{l_1} = \frac{R_2\,A_2}{l_2}$$

$$\frac{100\,X\,A}{l} = \frac{R\,X\,\frac{A}{2}}{2\,l}$$

$$100 = \frac{R}{4}$$

R = 400 Ω

31. A house has 3 tube lights, two fans and a television. Each tube light draws 40W. The fan draws 80W and the television draws 60W. On the average, all the tube lights are kept on for five hours, two fans for 12 hours and television for five hours every day. Find the cost of electric energy used in 30 days at the rate of Rs. 3.00 per KWH.

A. Energy consumed in a day = $\frac{Wattage\ X\ Number\ of\ devices\ X\ usage\ hours\ per\ day}{1000}$

Device	Wattage	Number of devices	Usage hours per day	Consumed energy in KWH
Tube light	40	3	5	$\frac{40X3X5}{1000}$ = 0.6
Fan	80	2	12	$\frac{80X2X12}{1000}$ = 1.92
TV	60	1	5	$\frac{60X1X5}{1000}$ = 0.3

Energy consumed in a day = 0.6 +1.92 + 0.3

= 2.82 KWH

Energy consumed in 30 days = 30 X 2.82

= 84.6 KWH

Rate of current for 1 KWH = Rs. 3-00

Total cost (Current bill) = 84.6 X 3-00

= Rs. 253-80

32. An unknown circuit draws a current of 2A from a 12 V battery then find its equivalent resistance.

A. Flow of current (I) = 2 A

Voltage of battery (V) = 12 V

Ohm's law : V = IR

$$R = \frac{V}{I} = \frac{12}{2} = 6\ \Omega$$

Resistance (R) = 6 Ω

33. Three resistors of values 2 Ω, 4 Ω ,6 Ω are connected in series then find the equivalent resistance of that combination.

A. R_1 = 2 Ω, R_2 = 4 Ω, R_3 = 6 Ω

Let the resultant resistance in series combination is R.

$R = R_1 + R_2 + R_3 = 2 + 4 + 6 = 12\ \Omega$

34. Three resistors of values 2 Ω, 4 Ω ,6 Ω are connected in parallel then find the equivalent resistance of that combination.

A. R_1 = 2 Ω, R_2 = 4 Ω, R_3 = 6 Ω

Let the resultant resistance in series combination is R

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6}$$

$$\frac{1}{R} = \frac{6+3+2}{12}$$

$$\frac{1}{R} = \frac{11}{12}$$

$$R = \frac{12}{11} = 1.09\ \Omega$$

35. The value of magnetic field induction which is uniform is 2T. What is the flux passing through a surface of area 1.5m^2 perpendicular to the field?

A. Magnetic field induction B = 2T

Surface area A = 1.5 m^2

Magnetic flux Φ = ?

Formula: $B = \frac{\emptyset}{A}$ → $\emptyset$ = BA = 2x1.5 =3 Weber

36. An 8N force acts on a rectangular conductor 20cm long placed perpendicular to a magnetic field. Determine the magnetic field induction if the current in the conductor is 40A.?

A. Force on conductor (F) = 8N

Length of conductor (l) = 20cm = 20 x 10^{-2} m

Current in the conductor (i) = 40 A

Magnetic field induction (B) = ?

Formula: F = B i l

$$B = \frac{F}{i\,l} = \frac{8}{40\ X\ 20\ X\ 10^{-2}} = \frac{8\ X\ 10^2}{800} = \frac{800}{800} = 1\ Tesla$$