MARKING SCHEME CODE: C

SECTION A

1.	(*c*) always a force and a torque	**1**
2.	(*a*) no net charge is enclosed by the surface	**1**
3.	(*b*) charge	**1**
4.	(*b*) decrease in relaxation time	**1**
5.	(*d*) material of the turns of the coil	**1**
6.	(*b*) diameter of objective	**1**
7.	(*a*) 1.47	**1**
8.	(*b*) M_2	**1**
9.	(*a*) Decreases	**1**
10.	(*d*) the stability of atom was established by the model	**1**
11.	(*b*) $\frac{evr}{2}$	**1**
12.	(*a*) Infrared region	**1**
13.	(*a*) X-rays	**1**
14.	(*a*) $\frac{1}{\sqrt{2}}$ A	**1**
15.	(*c*) A is true but R is false	**1**
16.	(*a*) Both A and R are true and R is the correct explanation of A	**1**
17.	(*a*) Both A and R are true and R is the correct explanation of A	**1**
18.	(*a*) Both A and R are true and R is the correct explanation of A	**1**

SECTION B

19.	(*a*) minimum wavelength : γ-rays	½
	(*b*) minimum frequency : Microwaves	½
	γ-rays are used to treat cancer.	½
	Microwaves are used in communication	½
20.	Values of *f* and *u* with sign convention	½
	Nature of image	½
	Position of image	**1**

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$f = \frac{-R}{2} = -30$ cm, $u = -20$ cm ½

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$ ½

$$\frac{1}{v} = \frac{1}{-30} + \frac{1}{20}$$

$\therefore$ $v = +60$ cm ½

Nature of image : virtual, erect and magnified ½

OR

Determining power of combination	1½
Nature of combination	½

$$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2}$$ ½

$$\frac{1}{f} = \frac{f_2 - f_1}{f_1 f_2}$$ ½

$\therefore$ $$P = \frac{f_2 - f_1}{f_1 f_2}$$ ½

Because $f_2 < f_1$ $\therefore$ P is negative

$\therefore$ nature is diverging lens ½

21.

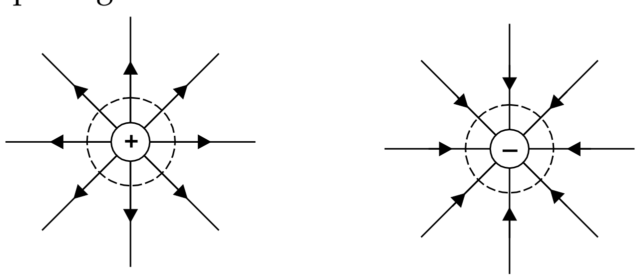
depletion layer and potential barrier	½+½
Effect on depletion layer	½
Effect on potential barrier	½

The small region near the junction which is depleted of free charge carrier and has only immobile ions is called depletion layer. ½

The accumulation of –ve charges in *p*-side and +ve charges in *n*-side acts as a barrier across junction is called barrier potential. ½

In forward biasing (*a*) width of depletion layer decreases (*b*) potential barrier decreases ½ + ½

22. Electric field lines are imaginary lines, can be straight or curved, tangent to it at any point gives the direction of electric field. **1**



½ + ½

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23. The source of light which emit continuous light of same wavelength same frequency and in same phase or having a constant phase difference are called coherent sources. **1**

Two independent sources of light cannot emit wave continuously.

Two identical sources of light will not have same phase or constant phase difference between them. **1**

24. Self inductance of a coil is equal to emf induced in the coil when rate of change of current through the coil is unity. **1**

$$[L] = [ML^2T^{-2}A^{-2}]$$ **1**

OR

Calculation of impedance	1½
Peak value of current	½

(*a*) $X_C = \frac{1}{\omega C}$

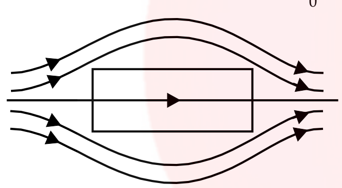
$X_C = 100\ \Omega, \quad R = 400\ \Omega$ ½

$X_L = \omega L$

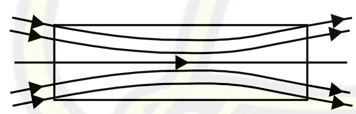
$X_L = 400\ \Omega$ ½

$Z = \sqrt{R^2 + (X_L - X_C)^2} = 500\ \Omega$ ½

(*b*) $I_0 = \; = 0.08$ A ½

25. 

Diamagnetic



Paramagnetic

1 + 1

SECTION C

26. Let $E = E_0 \sin \omega t$ be the alternating emf ...(1)

$$V = \frac{q}{C} = E_0 \sin \omega t$$

$$q = CE_0 \sin \omega t$$

$$I = \frac{dq}{dt} = \frac{d}{dt}(CE_0 \sin \omega t)$$ **1**

$$= \frac{E_0}{1/\omega C} \sin(\omega t + \pi/2)$$

The current will be maximum if $\sin(\omega t + \pi/2) = 1$

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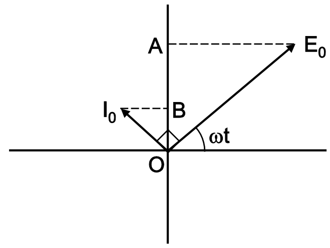
$$I = I_0 = \frac{E_0}{1/\omega C}$$

$\therefore \quad I = I_0 \sin(\omega t + \pi/2) \quad ...(2)$ **1**

It shows alternating current leads by $\pi/2$ to the alternating voltage.



1

$$OA = E = E_0 \sin \omega t$$

$$OB = I = I_0 \sin(\omega t + \pi/2)$$

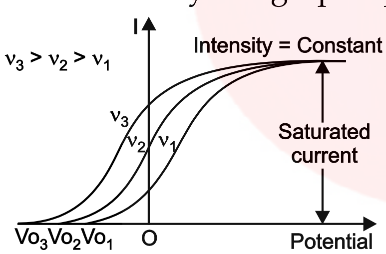
27. Current sensitivity is deflection produced in galvanometer when unit current is passed through it.

$$I_s = \frac{\theta}{I}$$ **1**

Voltage sensitivity is the deflection produced in galvanometer when unit potential difference is applied across it.

$$V_s = \frac{\theta}{V} = \frac{I_s}{R}$$ **1**

Senstivity of galvanometer can be increased by decreasing the twisting constant (k). It can be done by using a phosphor-bronze wire for suspension. **1**

28. 

1

* If we take radiations of different frequencies and same intensity then saturated current is same for all radiations but their stopping potential is different.
* Greater is the frequency of incident radiation, higher is the value of kinetic energy of photoelectron and hence more will be the stopping potential. **2**

29. Let

$$y_1 = a \sin \omega t$$

$$y_2 = b \sin(\omega t + \phi), \ \phi \text{ is the constant phase difference}$$

$$y = y_1 + y_2$$

$$= a \sin \omega t + b \sin(\omega t + \phi)$$

$$= a \sin \omega t + b [\sin \omega t \cos \phi + \cos \omega t \sin \phi]$$

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$$= \sin \omega t\,(a + b\cos\phi) + \cos\omega t \,.\, b\sin\phi$$ **1**

Put $a + b\cos\phi = R\cos\theta$ ...(1) and $b\sin\phi = R\sin\theta$ ...(2)

$$y = \sin\omega t \,.\, R\cos\theta + \cos\omega t\,.\, R\sin\theta$$

$$= R\,[\sin(\omega t + \theta)]$$

R = amplitude of resultant wave

Sq. and adding (1) and (2), we get

$$R = \sqrt{a^2 + b^2 + 2ab\cos\phi}$$ **1**

For constructive interference

$$\cos\phi = \max = +1$$

$\therefore$ $\phi = 0, 2\pi, 4\pi, ...$

i.e. $\boxed{\phi = 2n\pi}$ where $n = 0, 1, 2, ...$

For destructive interference

$$\cos\phi = \min = -1$$

$\therefore$ $\phi = \pi, 3\pi, 5\pi, ...$

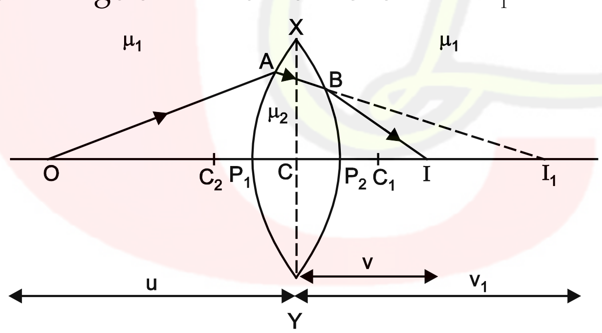
$\therefore$ $\boxed{\phi = (2n-1)\pi}$ where $n = 1, 2, 3, ...$ **1**

OR

Consider a pt. object O lying on the principal axis of the lens.

If the lens material were continuous and there were no second surface XP_2Y.

Therefore I_1 is real image of O after refraction at XP_1Y.



$\therefore$ $$\frac{\mu_1}{-u} + \frac{\mu_2}{v_1} = \frac{\mu_2 - \mu_1}{R}$$ ...(1) **1**

Actually, the lens material is not continuous. For refraction at XP_2Y, we take I_1 as a virtual object whose real image is formed at I.

$\therefore$ $$\frac{\mu_2}{-v_1} + \frac{\mu_1}{v} = \frac{\mu_1 - \mu_2}{R_2} = -\frac{(\mu_2 - \mu_1)}{R_2}$$ ...(2) **1**

Add (1) and (2)

$$\frac{\mu_1}{-u} + \frac{\mu_1}{v} = (\mu_2 - \mu_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

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$$\mu_1\left(\frac{1}{v}-\frac{1}{u}\right) = (\mu_2-\mu_1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\boxed{\frac{1}{f} = (\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)}$$ **1**

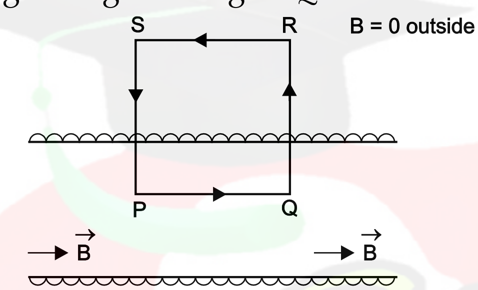
30. Magnetic field inside a solenoid is uniform.

Let n be the no. of turns per unit length of solenoid

I be the current flowing through it

Consider a rectangular loop $PQRS$ such that $PQ = L$

Total current flowing through rectangle $PQRS = nLI$ **1**



From ampere circuital law

$$\oint \vec{B}\cdot\vec{dl} = \mu_0 \text{(total current through loop)}$$

$$= \mu_0 (nLI)$$ **1**

$$\int_P^Q \vec{B}\cdot\vec{dl} + \int_Q^R \vec{B}\cdot\vec{dl} + \int_R^S \vec{B}\cdot\vec{dl} + \int_S^P \vec{B}\cdot\vec{dl} = \mu_0 nLI$$

$$\int_P^Q \vec{B}\cdot\vec{dl} = \mu_0 nLI$$

$$B\int dl = BL = \mu_0 nLI$$

$$\boxed{B = \mu_0 nI}$$ **1**

OR

(*a*) (*i*) normal to field	**1**
(*ii*) opp. to field	**1**
(*b*) torque in case (*i*)	**½**
torque in case (*ii*)	**½**

(*a*) (*i*)

$$W = -MB(\cos\theta_2 - \cos\theta_1)$$

$$= -1.5 \times 0.22 (\cos 90° - \cos 0°)$$

$$= 0.33 \text{ J}$$ **1**

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(*ii*) $\theta_2 = 180°$

$W = -1.5 \times 0.22 (\cos 180° - \cos 0°)$

$= 1.5 \times 0.22 (1 + 1)$

$= 0.66$ J **1**

(*b*) $Z = MB \sin \theta$

(*i*) $\theta = 90°$ $Z = 1.55 \times 0.22 \sin 90°$

$= 0.33$ Nm **½**

(*ii*) $\theta = 180°$ $Z = 0$ **½**

SECTION D

31. (*i*) (*a*) electrons **1**

(*ii*) (*c*) An electric charge on the surface of an object. **1**

(*iii*) (*a*) Attracts the paper piece **1**

(*iv*) (*d*) All of the above **1**

OR

(*c*) Your pants sticking to your legs.

32. (*i*) (*a*) equal **1**

(*ii*) (*a*) decreases **1**

(*iii*) (*a*) *P* **1**

(*iv*) Net charge = 0 **1**

OR

The process of adding impurity atom to the pure semiconductors is called doping. **1**

SECTION E

33. Huygen's Principle: Acc. to Huygen's principle

(*i*) Every point on primary wave front acts as fresh source of disturbance which travel in all direction with velocity of light and called as secondary wavelets.**1**

(*ii*) Surface obtained by joining secondary wavelets tangentially in forward direction called secondary wavefront. **1**

Refraction of plane wavefront

If c_1 is the speed of light in rarer medium and c_2 is speed of light in denser medium then $\mu = \frac{c_1}{c_2}$ ...(1)

AB is a plane wavefront incident on *XY*. Acc. to Huygen's principle, every pt. on *AB* is a source of secondary wavelets.

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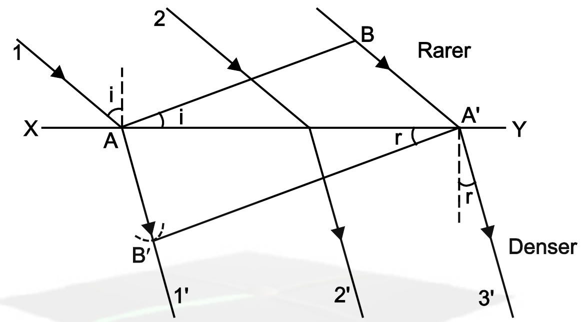
Let secondary wavelets from B strike XY at A' in t-seconds.

$\therefore \quad BA' = c_1 \times t \quad ...(2)$ **1**

Taking $c_2 \times t$ as radius draw an arc at B' with A as a centre.

$A'B'$ is secondary wavefront.

$\therefore \quad AB' = c_2 \times t \quad ...(3)$ **1**



In $\Delta AA'B$ $\quad \sin i = \dfrac{BA'}{AA'} = \dfrac{c_1 \times t}{AA'}$

In $\Delta AA'B'$ $\quad \sin r = \dfrac{AB'}{AA'} = \dfrac{c_2 \times t}{AA'}$

Divide $\quad \dfrac{\sin i}{\sin r} = \dfrac{c_1}{c_2} = \mu$

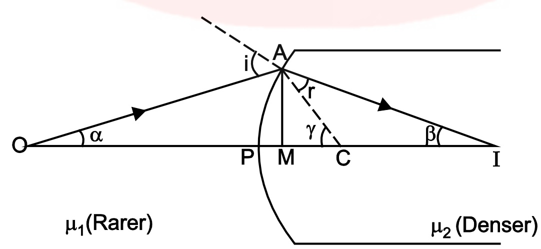
or $\quad \boxed{\mu = \dfrac{\sin i}{\sin r}}$ **1**

It is clear that incident rays, normal and refracted rays all lie in the same plane.

OR

Refraction of light is the phenomenon of change in path of light, when it goes from one medium to another. **1**

Refraction at convex spherical refracting surface



1

From A draw normal $AM \perp OI$.

$$i = \alpha + \gamma \quad ...(1)$$

$$\gamma = r + \beta \Rightarrow r = \gamma - \beta \quad ...(2)$$

Apply Snell's law $\quad \dfrac{\sin i}{\sin r} = \dfrac{\mu_2}{\mu_1}$ **1**

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$$\approx \frac{i}{r} = \frac{\mu_2}{\mu_1}$$

$$i\,\mu_1 = r\,\mu_2$$

$$\mu_1(\alpha + \gamma) = \mu_2(\gamma - \beta)$$

$$\mu_1\left(\frac{AM}{MO} + \frac{AM}{MC}\right) = \mu_2\left(\frac{AM}{MC} - \frac{AM}{MI}\right)$$ **1**

If aperture is small.

$$\frac{\mu_1}{PO} + \frac{\mu_1}{PC} = \frac{\mu_2}{PC} - \frac{\mu_2}{PI}$$

$PO = -u, \quad PC = +R, \quad PI = v$

$$\Rightarrow \quad \frac{\mu_1}{-u} + \frac{\mu_1}{R} = \frac{\mu_2}{R} - \frac{\mu_2}{v}$$

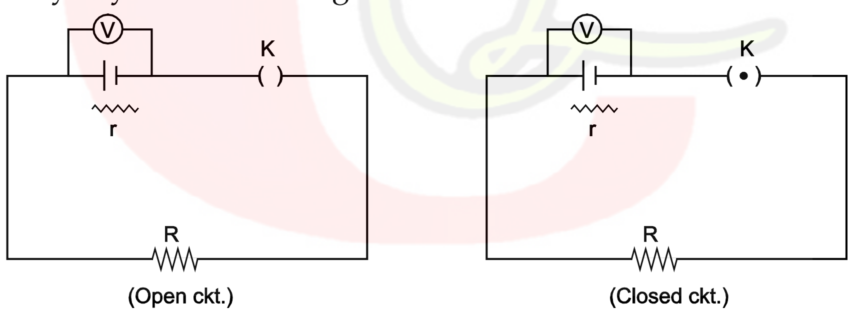
$$\therefore \quad \boxed{\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}}$$ **1**

34. Internal resistance of a cell is the resistance offered by the electrolyte and electrodes of a cell. **1**

It depends upon nature of electrodes and electrolyte, distance between the electrodes and area of electrodes immersed in the electrolyte. **1**

Expression for internal resistance

A cell of emf *E* and internal resistance (*r*) is connected to external resistance (*R*) with one way key as shown in figure.



1

When ckt. is open *i.e.*, no current is flowing, then reading of voltmeter is equal to emf of cell.

When key is closed $\quad I = \frac{E}{R + r}$

Reading of voltmeter is equal to terminal potential difference.

$\therefore \quad V = E - Ir$ **1**

Also $\quad V = IR = \frac{E}{(R + r)}R$

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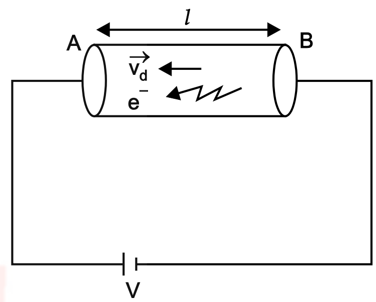
$\therefore \qquad R + r = \frac{E}{V}R \quad \Rightarrow \quad \boxed{r = \left(\frac{E}{V} - 1\right)R}$ **1**

OR

Drift velocity is the average velocity with which free electrons are drifted towards +ve end of conductor under the influence of external electric field. **1**

If $\vec{u}_1, \vec{u}_2, \vec{u}_3 \ldots\ldots\ldots \vec{u}_n$ be the thermal velocities of n electrons in a metal.

$$\vec{u}_{av} = \frac{\vec{u}_1, \vec{u}_2, \vec{u}_3 \ldots\ldots \vec{u}_n}{n} = 0$$ **1**



Electric field $\qquad E = \frac{V}{l}$

Force on electron = F

$$F = -e\vec{E} = ma$$

$$\Rightarrow \qquad \vec{a} = \frac{-e\vec{E}}{m}$$

Let an e^- having accelerates for time τ_1, then

$$\vec{v}_1 = \vec{u}_1 + \vec{a}\tau_1,\ \vec{v}_2 = \vec{u}_2 + \vec{a}\tau_2, \ldots\ldots\ldots \vec{v}_n = \vec{u}_n + \vec{a}\tau_n$$ **1**

$$\therefore \qquad \vec{v}_d = \frac{\vec{v}_1 + \vec{v}_2 + \ldots\ldots + \vec{v}_n}{n}$$

$= 0 + \vec{a}\tau$ $\qquad$ where τ = Av. relaxation time

$$\boxed{\vec{v}_d = \frac{-e\vec{E}\tau}{m}}$$ **1**

–ve sign shows that drift velocity is opposite to electric field.

Relation b/w drift velocity and mobility

$$\boxed{\mu = \frac{v_d}{E}}$$ **1**

35. $\qquad$ K.E. $= \frac{1}{2}mv^2$ $\qquad \left[\because \frac{mv^2}{r} = \frac{KZe^2}{r}\right]$

$\therefore \qquad$ K.E. $= \frac{KZe^2}{2r}$

Potential energy of electron = potential × charge

$$= \frac{q}{4\pi\varepsilon_0 r}(-e)$$

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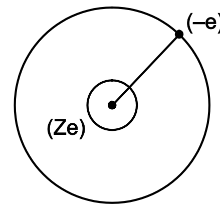
$\therefore \qquad \text{P.E.} = \frac{KZe}{r}(-e) = \frac{-KZe^2}{r}$ **1**

Total energy, $E = \text{K.E} + \text{P.E}$

$$= \frac{KZe^2}{2r} - \frac{KZe^2}{r}$$

$$= -\frac{KZe^2}{2r}$$

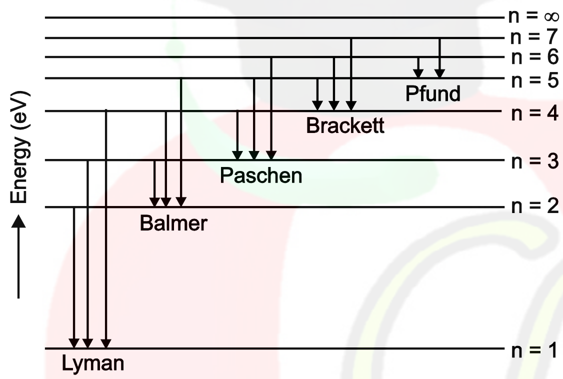


1

We get $E = -\frac{2\pi^2 mK^2Z^2e^4}{n^2h^2}$ $\left[\text{Put } r = \frac{n^2h^2}{4\pi^2 mKZe^2}\right]$

On putting values for **H-atom**

$$E = -\frac{13.6}{n^2}\text{ eV}$$ **1**



2

OR

Radioactivity	**1**
expression for *r*	**2**
Formula of *b*	**1**
values for θ	**½ + ½**

Radioactivity is the property by virtue of which a heavy nuclei disintegrates itself without any external agent. **1**

Expression for radius:

$$\frac{mv^2}{r} = \frac{KZe^2}{r^2} \qquad ...(1)$$ **½**

$$mvr = \frac{nh}{2\pi} \qquad ...(2)$$ **½**

$$\Rightarrow \qquad v = \frac{nh}{2\pi mr}$$

Put in (1)

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$$\frac{m}{r}\frac{n^2h^2}{4\pi^2m^2r^2} = \frac{KZe^2}{r^2}$$

$$r = \frac{n^2h^2}{4\pi^2mKZe^2}$$

for H-atom $z = 1$

$$\boxed{r = \frac{n^2h^2}{4\pi^2mKe^2}}$$

Formula of *b*

$$b = \frac{1}{4\pi\in_0}\frac{Ze^2\cot\theta/2}{\left(\frac{1}{2}mv^2\right)}$$ **1**

If $\theta = 0°$ impact parameter is infinite. **½**

If $\theta = 180°$ impact parameter is zero. **½**

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