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JEE (MAIN) 2024

MEMORY BASED QUESTIONS & SOLUTIONS

SHIFT-1

DATE & DAY: 30th January 2024 & Tuesday

PAPER-1

Duration: 3 Hrs.
Time: 09:00 - 12:00 IST

SUBJECT: PHYSICS

REGISTERED & CORPORATE OFFICE (CIN: U80302RJ2007PLC024029):
CG Tower, A-46 & 52, IPIA, Near City Mall, Jhalawar Road, Kota (Rajasthan) - 324005
0744-2777777 | 73400 10345 | contact@resonance.ac.in | www.resonance.ac.in | Follow Us: @ResonanceEdu | @Resonance_Edu

PART : PHYSICS

1. The ratio of KE : PE of an e^- in 5^{th} orbit ?

(1) $\frac{1}{2}$ (2) $-\frac{1}{2}$ (3) 2 (4) – 2

Ans. **(2)**

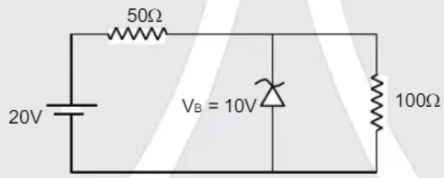
Sol. For orbiting electrons

$E = -K = \frac{U}{2}$

$\frac{KE}{PE} = -\frac{1}{2}$

$\frac{K}{U} = -\frac{1}{2}$

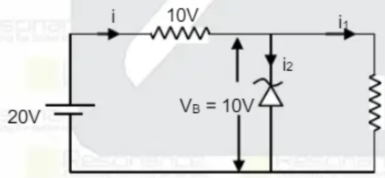
2. Find current through Zenor diode



(1) $\frac{1}{10}$ A (2) $\frac{1}{5}$ A (3) $\frac{1}{20}$ A (4) 1A

Ans. **(1)**

Sol.



$i = \frac{10}{50} = \frac{1}{5}$ A

$i_1 = \frac{10}{100} = \frac{1}{10}$ A

$i_2 = i - i_1 = \frac{1}{5} - \frac{1}{10}$

$i_2 = \frac{1}{10}$ A

3. At what temp $(V_{rms})_{H_2}$ is same as $(V_{rms})_{O_2}$ at temperature 47°C.

(1) 94 K (2) 293 K (3)20 K (4) 40K

Ans. **(3)**

Sol. $V_{rms} = \sqrt{\frac{3RT}{M}}$

$\frac{V_{H_2}}{V_{O_2}} = 1 = \sqrt{\frac{3RT_{H_2}}{3RT_{O_2}}} \times \sqrt{\frac{M_{O_2}}{M_{H_2}}}$

$\Rightarrow \sqrt{\frac{T_{H_2}}{(273+47)} \times \left(\frac{32}{2}\right)} = 1$

$\Rightarrow T_{H_2} = \frac{320}{16}$

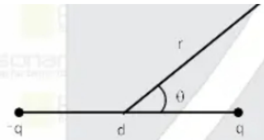
$\Rightarrow T_{H_2} = 20K$

4. The electrostatic potential due to a dipole at a distance r varies as :-

(1) $\frac{1}{r^2}$ (2) $\frac{1}{r}$ (3) r (4) r^2

Ans. **(1)**

Sol.



$V_p = \frac{KP\cos Q}{r^2}$

$\Rightarrow V_p \propto \frac{1}{r^2}$

5. If young's modulus of a wire is Y and Its length is 'L' and its cross sectional area is 'A'. If the length of the wire is doubled and cross sectional area is halved then young's modulus of the wire will be?

(1) Y (2) 2Y (3) $\frac{Y}{4}$ (4) $\frac{Y}{2}$

Ans. **(1)**

Sol. Young's modulus is the property of material. it does not depend on shape or geometry.

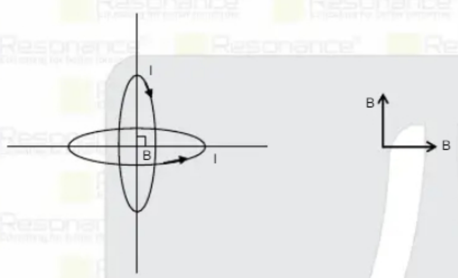
$\therefore$ Young's modulus remains constant.

6. Two current carrying ring of radius 'R' are mutually perpendicular and their centre coincide. Find net magnetic field at the centre.

(1) $\frac{\mu_0 I}{4R}$ (2) $\frac{\mu_0 I}{R}$ (3) $\frac{\sqrt{2}\mu_0 I}{R}$ (4) $\frac{\mu_0 I}{\sqrt{2}R}$

Ans. **(4)**

Sol.



$B_0 = \sqrt{2}B$

$B_0 = \frac{\sqrt{2}\mu_0 I}{2R}$

$B_0 = \frac{\mu_0 I}{\sqrt{2}R}$

7. If work function of a material is 3eV then find maximum wavelength for which photoelectric effect takes place.

(1) 0.30 μm (2) 0.41 μm (3) 0.60 μm (4) 0.1 μm

Ans. **(2)**

Sol. $\frac{hc}{\lambda_{max}} = \phi = 3eV$

$\Rightarrow \lambda_{max} = \frac{1.24 \times 10^{-6}}{3}$ m

$\Rightarrow \lambda_{max} = 0.41$ μm

8. A ball of mass 100 gm is dropped from a height of 10 m above the ground. It rebounds and reaches to a height of 5m above the ground. Find Impulse of force exerted on ball by the ground (in N-S)

(1) $1+\sqrt{2}$ (2) $1+\frac{1}{\sqrt{2}}$ (3) $3+\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

Ans. **(1)**

Sol. $I = \Delta P$

$\Rightarrow I = m\sqrt{2gh_1} + m\sqrt{2gh_2}$

$\Rightarrow I = 100 \times 10^{-3}\ \sqrt{2\times10}\left(\sqrt{10}+\sqrt{5}\right)$

$\Rightarrow I = 1+\sqrt{2}$

9. Half life of radio active sample is 36 hours. how much fraction remains un decayed after 24 hours. Antilog (0.2) = 1.587

(1) 0.63 (2) 0.37 (3) 0.75 (4) 0.80

Ans. **(2)**

Sol. $t_{\frac{1}{2}} = 36$ hr

Remaining fraction

$N = N_0 e^{-\lambda t} = N_0\, e^{-\frac{\ln^2}{t/2}t}$

$\Rightarrow \frac{N}{N_0} = e^{-\frac{\ln 2}{t_{1/2}}t}$

$\Rightarrow \frac{N}{N_0} = e^{-\frac{\ln 2}{36}24}$

= 0.37

10. (a) Surface Tension (i) $[M^1L^2T^{-2}]$

(b) Coefficient of viscosity (ii) $[M^1L^2T^{-1}]$

(c) Angular momentum (iii) $[M^1L^{-1}T^1]$

(d) Rotational kinetic energy (iv) $[M^1L^0T^{-2}]$

(1) (a) – (iv), b – (ii), c – (iii), d – (i) (2) (a) – (iv), b – (iii), c – (ii), d – (i)

(3) (a) – (ii), b – (iii), c – (iv), d – (i) (4) (a) – (i), b – (ii), c – (iii), d – (iv)

Ans. **(2)**

Sol. (i) $F = T\ell$

$T = \frac{F}{\ell}$

$[T] = \frac{[F]}{[L]} = \frac{MLT^{-2}}{[L]} = [ML^0T^{-2}]$

(ii) $F = -\eta A\frac{dv}{dx} \Rightarrow \eta = \left|\frac{-F}{A\left(\frac{dv}{dx}\right)}\right|$

$[\eta] = \frac{[MLT^{-2}]}{[L^2][T^{-1}]} = [ML^{-1}T^{-1}]$

(iii) $L = mvr$

$[L] = [M][LT^{-1}][L] = [ML^2T^{-1}]$

(iv) Rotational KE $= \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2$

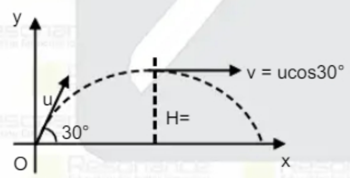
[Rotation KE] $= [ML^2T^{-2}]$

11. A particle of mass m is projected at an angle of 30° with initial velocity u. Find its angular momentum about point of projection at maximum height.

(1) $\frac{mu^3}{4g}$ (2) $\frac{\sqrt{3}}{16}\frac{mu^3}{g}$ (3) $\frac{\sqrt{2}mu^3}{2g}$ (4) $\frac{\sqrt{3}mu^3}{2g}$

Ans. **(2)**

Sol.



Angular momentum from point of projection

$L_0 = mvr_\perp$

$= m(u\cos 30°)H$

$= m\left[u\frac{\sqrt{3}}{2}\right]\left[\frac{u^2\sin^2 30}{2g}\right]$

$= m\left[u\frac{\sqrt{3}}{2}\right]\left[\frac{u^2}{8g}\right] = \frac{\sqrt{3}}{16}\frac{mu^3}{g}$

12. If a body is released from top of smooth inclined, then its velocity after descending height of $\frac{1}{2}$ m is

(1) 20 (2) $\sqrt{10}$ (3) $2\sqrt{10}$ (4) 10

Ans. **(2)**

Sol.

Find velocity at h=1/2

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

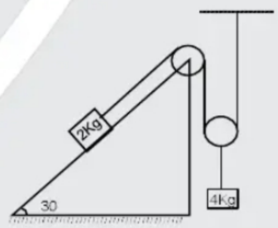
$V=\sqrt{2gh}$

$=\sqrt{2g\ 1/2}$

$=\sqrt{g}$

$=\sqrt{10}$

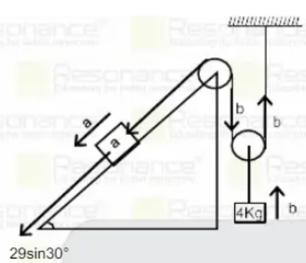
13. Find acceleration of 2 Kg block.



(1) g (2*) $\frac{g}{3}$ (3) $\frac{g}{4}$ (4) $\frac{g}{2}$

Ans. **(2)**

Sol.



by construired

$a - b - b = 0$

$b = \frac{a}{2}$

$2g\sin30 - T = 2a$ ——————(1)

$2T - 4g = 4\ \frac{a}{2}$ —————(2)

$4g\ \sin30 - 2T = 4a$ ———(1) × (2)

$4g\ (\sin30 - 1) = 6a$

$4g \times \left(-\frac{1}{2}\right) = 6a$

$a = -\frac{2g}{6} = -\frac{g}{3}$

14. Resistance of roster at 27°C is 60 Ω. Temperature coefficient of resistance is $\alpha = 2 \times 10^{-4}$ Per °C . Find temperature of resistance when voltage and current across resistance will be 210 Volt and 2.75 A.

(1) 1250 °C (2) 890 °C (3) 1693 °C (4) 2015 °C

Ans. (3)

Sol. $R_t = \frac{V}{I} = \frac{210}{2.75} = 80$

$R_t = R_0 (1 + \alpha\Delta t)$

$80 = 60 (1 + \alpha\Delta t)$

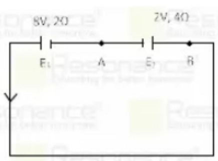
$20 = 60\, \alpha\Delta t$

$\Delta t = \frac{20}{60\alpha}$

$\Delta t = \frac{1}{3\times2\times10^{-4}} = \frac{10^4}{6} = 1666\ °C$

$t_f = 1666 + 27 = 1693\ °C$

15. In given electrical circuit Voltage drop across E_2 will be-



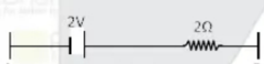
(1) 6 (2) $\frac{40}{3}$ (3) 3 (4) 10

Ans. (1)

Sol.

$E_1 > E_2$

$i = \frac{8-2}{2+4} = \frac{6}{6} = 1amp$



$V_{AB} = V_{EZ} = E_2 + i\,(4)$

$= 2 + 1(4)$

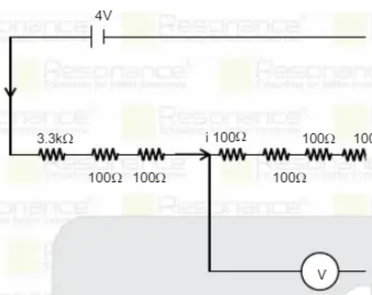
$= 6\ V$

16. In an electric circuit a resistance of 3.3 kΩ is connected with seven 100 Ω resistance in series. If all resistances are connected to a 4V battery then the reading of voltmeter connected across last 5 identical resistances will be-

(1) $\frac{1}{5}$ V (2) $\frac{1}{2}$ V (3) 2 V (4) 1V

Ans. (2)

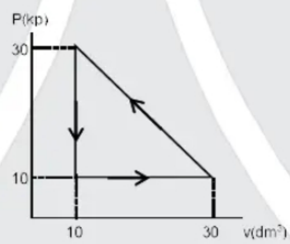
Sol.



$$i = \frac{4}{3300 + 100} = \frac{1}{1000} \text{ A}$$

$$V = I \times 5\,(100) = \frac{1}{2} \text{ v}$$

17. Find the work done by gas in cyclic process.



(1) 200 J (2) 200KJ (3) –200J (4) –200KJ

Ans. **(3)**

Sol. W = Area unclosed in loop

$$W = -\frac{1}{2} \times (30-10) \times (30-10) \times 10^{3} \times 10^{-3} \text{ J}$$

$$W = -200 \text{ J}$$

18. A particle travels 125 m with change in velocity as 50 m/s in t to (t + 1) second. Find the displacement in $(t + 2)^{th}$ sec.

(1) 100 m (2) 175 m (3) 225 m (4) 275 m

Ans. **(2)**

Sol. $a = \frac{\Delta v}{\Delta t} = 50 \text{ m/s}^2$

$S_n = u + \frac{a}{2}(2n - 1)$

Displacement in $(t + 1)^{th}$ second

$125 = u + \frac{a}{2}(2t + 1)$

$\Rightarrow 125 = u + \frac{50}{2}(2t + 1)$

$\Rightarrow 125 = u + 25(2t + 1)$

$\Rightarrow 125 = u + 50t + 25$ ...(1)

$100 = u + 50t$

$S_{t+2} = u + \frac{a}{2}(2(t + 2) - 1)$

$S_{t+2} = u + 25(2t + 3)$

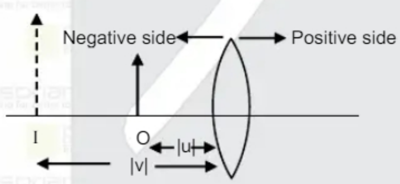
$S_{t+2} = 100 + 75 = 175$ m

19. In a convex lens the distance between object and image is 45 cm and magnification produced by lens is +2 then what would be the focal length of the lens.

(1) 30 cm (2) 45 cm (3) 60 cm (4) 90 cm

Ans. **(4)**

Sol.



$|v| - |u| = 2u - u$

$= u = 45$ cm

$\therefore \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{-90} - \frac{1}{-45} = \frac{1}{f}$

$\frac{1}{-90} + \frac{1}{45} = \frac{1}{f}$

$\frac{-1+2}{90} = \frac{1}{f}$

f = 90 cm

20. If a L-R circuit power factor is $\frac{1}{\sqrt{2}}$ for E= 25 sin (1000t). Then power factor for E = 20 sin(2000t) will be.

(1) $\frac{1}{\sqrt{5}}$ (2) $\frac{1}{\sqrt{7}}$ (3) $\frac{1}{\sqrt{3}}$ (4) $\frac{1}{\sqrt{2}}$

Ans. **(1)**

Sol. Power factor for first alternating EMF

$\cos\phi = \frac{1}{\sqrt{2}} = \frac{R}{\ldots}$ where ω = angular frequency of first EMF

$\sqrt{2}$ $\sqrt{R^2+\omega^2L^2}$

R = ωL

For second alternating EMF we can say that angular frequency of second alternating EMF is double of first alternating EMF

∴ angular frequency for second alternating EMF $\omega_2 = 2\omega$

Now power factor for second EMF

$$P.F. = \frac{R}{\sqrt{R^2+4\omega^2L^2}}$$

∵ R = ωL

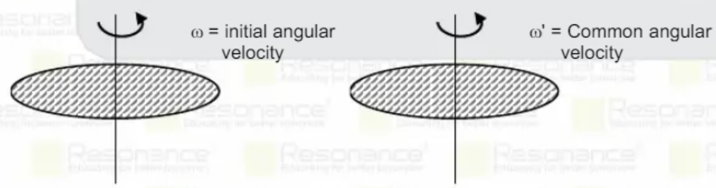
$$\therefore P.F. = \frac{R}{\sqrt{5}R} = \frac{1}{\sqrt{5}}$$

21. A Disc of mass m and radius R is rotating with angular speed ω about axis passing through centre of mass. Another identical disc is gently placed on it. Find out loss in Kinetic energy of system

(1) $\frac{1}{2}mR^2\omega^2$ (2) $\frac{1}{4}mR^2\omega^2$ (3) $\frac{1}{6}mR^2\omega^2$ (4) $\frac{1}{8}mR^2\omega^2$

Ans. (4)

Sol.



After placing same disc on rotating disc

By angular momentum conservation C.O.A.M.

$$\frac{1}{2}MR^2\omega = \left(\frac{1}{2}MR^2+\frac{1}{2}MR^2\right)\omega'$$

$\omega' = \omega/2$

∴ Loss in K.E. = $(K.E.)_1 - (K.E.)_f$

$$= \frac{1}{2}\times\frac{1}{2}MR^2.\omega^2 - \frac{1}{2}\times\frac{1}{2}MR^2.\frac{\omega^2}{4}$$

$$= \frac{1}{8}mR^2\omega^2$$

22. If current through a wire is $\sqrt{2}$ A then find force per unit length of wire due to a magnetic field of 3.5×10^{-5} T in the direction 45° from wire :

(1) $\frac{7}{2}\times10^{-5}\,\frac{N}{m}$ (2) $3.5\times10^{-5}\,\frac{N}{m}$ (3) $3.5\sqrt{2}\times10^{-5}\,\frac{N}{m}$ (4) $7\times10^{-5}\,\frac{N}{m}$

Ans. (2)

Sol. F = i Bl sinθ

$$\frac{F}{\ell} = (\sqrt{2})(3.5\times10^{-5})\sin(45^\circ)$$

$$\frac{F}{\ell} = 3.5\times10^{-5}\,\frac{N}{m}$$

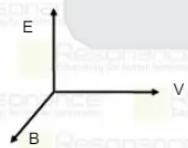
23. $E = E_0(\hat{i})\sin[(\omega t - kz)]$, then B will be

(1) $B = (E_0 c)\sin(\omega t - kz)\ \hat{j}$ (2) $B = (E_0/c)\sin(\omega t - kz)\ \hat{j}$

(3) $B = (E_0 c)\sin(\omega t - kz)\ \hat{i}$ (4) $B = (E_0/c)\sin(\omega t - kz)\ \hat{i}$

Ans. **(2)**

Sol.



$$B = \frac{\hat{k} \times \vec{E}}{\omega}$$

$$= \frac{(\hat{k} \times \hat{i})}{\omega / k} E_0 \sin(\omega t - kz)$$

$$= (E_0/c)\sin(\omega t - kz)\ \hat{j}$$

24. If gravitational potential at some height is $5.12 \times 10^7\ m^2/s^2$ and gravitational acceleration is $6.4\ m/s^2$, then find the height about earth surface :

(1) 3200 km (2) 1600 km

(3) 800 km (4) 800 km

Ans. **(2)**

Sol. $V_g = \frac{GM}{(R_e + h)}$

$g = \frac{GM}{(R_e + h)^2}$

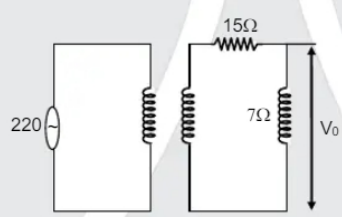
$\Rightarrow \frac{5.12 \times 10^7}{6.4} = R_e + h$

$\Rightarrow h = (8000 - R_e)$ km

$\Rightarrow h = (8000 - 6400)$ km

$\Rightarrow h = 1600$ km

25. Primary coil has 100 turns. & no. of turns in secondary coil is 10. Then find v_0 :

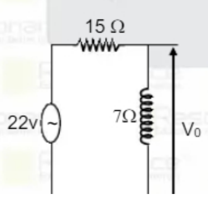


(1) 22 V (2) 7 V (3) 15 V (4) 20 V

Ans. **(2)**

Sol. $\frac{V_s}{V_p} = \frac{N_s}{N_p}$, $\frac{V_s}{220} = \frac{10}{100}$

$V_s = 22$ volt



by Kirchhoff's low

$i = \frac{22}{15+7} = 1$ Amp.

$V_0 = 7 \times 1 = 7$ volt

26. If Hydrogen electron is excited to an orbit of energy – 0.85 eV in an atom then maximum possible number of transitions to lowest energy levels is –––

(1) 6 (2) 3 (3) 5 (4) 2

Ans. (2)

Sol. $-\frac{13.6z^2}{n^2} = -0.85$

$\Rightarrow n = 4$

For max Transitions :

$4 \rightarrow 3 \rightarrow 2 \rightarrow 1$

3 transitions

27. The fundamental frequency of close organ pipe is 50 Hz. Now some water is filled then fundamental frequency becomes 110 Hz. If the cross sectional area of the pipe is 2 cm^2 then find the amount of water added in grams. Speed of sound in air = 330 m/sec.

(1) 90 grams (2) 180 grams (3) 300 grams (4) 18 grams

Ans. (2)

Sol. $f_o = 50 = \frac{v}{4\ell} = \frac{330}{4\ell}$

$\ell = \frac{33}{20}$ m

$f' = 110 = \frac{330}{4\ell'}$

$\ell' = \frac{3}{4}$ m

Water column height

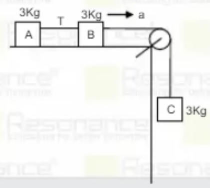
$(\ell - \ell') = \frac{33}{20} - \frac{3}{4} = \frac{18}{20} = \frac{9}{10} = 0.9$m

Volume of water

$A(\ell - \ell') = 2 \times 10^{-4} \times 0.9 = 1.8 \times 10^{-4}$m^3

Mass of water = $\rho A(\ell - \ell') = 1000 \times 1.8 \times 10^{-4} = 0.18$ kg = 180 gm

28. If young's modulus of all strings is 2×10^{11} N/m^2 and cross section area is 0.005 cm^2. Find the elongation in the string connected between blocks A and B, if the length of string AB is 1 m.



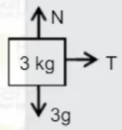
(1) 100 cm (2) 1 cm (3)0.1 cm (4) 0.01 cm

Ans. (4)

Sol. $a = \dfrac{\text{Net force along string}}{\text{total mass}}$

$a = \dfrac{3g}{3+3+3} = \dfrac{g}{3} = \dfrac{10}{3}\,m/s^2$

tension in string AB :



$\longrightarrow a = \dfrac{10}{3}\,m/s^2$

$T = 3a = 10$ N

Elongation in AB string

$\Delta\ell = \dfrac{T\ell}{YA} = \dfrac{10\times1}{2\times10^{11}\times5\times10^{-7}}$

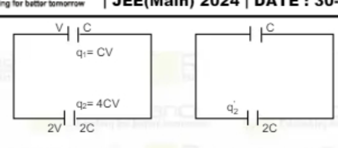
$\Delta\ell = 10^{-4}$m = 0.01 cm

29. Two capacitors of capacitance C and 2C and potential difference between plates V & 2V respectively are connected together then total energy loss is $\dfrac{x}{3}E$. Where E is the energy of capacitor of capacitance C and potential V. Then value of 'x' will be –

(1) 2 (2) 4 (3) 1 (4) 3

Ans. (1)

Sol.



From charge Conservation

$q_1' + q_2' = q_1 + q_2$

$\Rightarrow q_1 + q_2 = 5CV$ ______(1)

Also, $\frac{q_1'}{C} = \frac{q_2'}{2C}$

$2q_1' = q_2'$ ______(2)

From (1) and (2) –

$q_1' = \frac{5}{3}CV,\ q_2' = \frac{10}{3}CV$

Energy loss = $\Delta E = \frac{\Delta q_1^2}{2C_1} + \frac{\Delta q_2^2}{2C_2}$

$$\Delta E = \frac{\left(CV - \frac{5}{3}CV\right)^2}{2C} + \frac{\left(4CV - \frac{10}{3}CV\right)^2}{2(2C)}$$

$$\Delta E = \frac{4}{18}CV^2 + \frac{2}{18}CV^2$$

$$\Delta E = \frac{1}{3}CV^2$$

$$= \frac{2}{3} \times \frac{1}{2}CV^2$$

$$= \frac{x}{3} \times \frac{1}{2}CV^2$$

$\Rightarrow x = 2$


discussion class.
Syllabus Test
lectures
Approx 2500 practice Que.
Regular Test discussion classes for concept clearance
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