FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 27-01-2019

ANSWERS, HINTS & SOLUTIONS

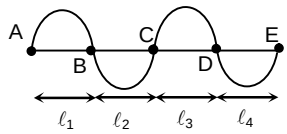
Physics

PART – I

SECTION – A

1. A, B, C, D

Sol. $\ell_1 + \ell_2 + \ell_3 + \ell_4 = 100$ cm



Let n_1, n_2, n_3 and n_4 are fundamental frequencies of these segments respectively.

$$\frac{n_1}{n_2} = \frac{1}{2}, \frac{n_2}{n_3} = \frac{2}{3}, \frac{n_3}{n_4} = \frac{3}{4}, \frac{n_2}{n_4} = \frac{2}{4} = \frac{1}{2}$$

$$n = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} \Rightarrow n\ell = \text{constant}$$

$$n_1\ell_1 = n_2\ell_2 = n_3\ell_3 = n_4\ell_4$$

$$\ell_1 = \frac{n_2}{n_1}\ell_2,\ \ell_3 = \frac{n_2}{n_3}\ell_2, \ell_4 = \frac{n_2}{n_4}\ell_2$$

$\ell_1 + \ell_2 + \ell_3 + \ell_4 = 100$ cm

$$2\ell_2 + \ell_2 + \frac{2}{3}\ell_2 + \frac{\ell_2}{2} = 100$$

$\ell_2 = 24$ cm

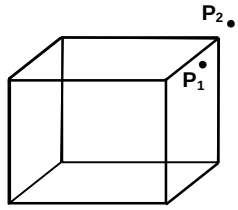
So, $\ell_1 = 48$ cm

$\ell_3 = 16$ cm

$\ell_4 = 12$ cm

2. A, B, C, D

Sol. Using symmetry if charged particle lies at P_1 then $\phi_{OCDE} = \frac{q}{24\varepsilon_0}$



and $\phi_{OABC} = \frac{\left(\frac{q}{\varepsilon_0} - \frac{q}{8\varepsilon_0}\right)}{3} = \frac{7q}{24\varepsilon_0}$

If the charge particle lies at P_2 then

$\phi_{OCDE} = \frac{q}{24\varepsilon_0}$

and $\phi_{OABC} = \frac{q}{24\varepsilon_0}$

3. A, B, C

Sol. $AB \rightarrow U\rho$ = constant

$nC_vT\frac{PM}{RT} = \text{constant}$

P = constant

Isobaric process

$BC \rightarrow \rho$ = constant

$\frac{PM}{RT} = \text{constant}$

$P \propto T$

Isochoric process

$CA \rightarrow U$ = constant

$U = nC_vT$ = constant

T = constant

Isothermal process

4. A, C, D

Sol. Just after cutting the string B, block looses the contact with the rod.

taking torque about P

$mg\frac{\ell}{4} = \left(\frac{m\ell^2}{12} + \frac{m\ell^2}{16}\right)\alpha$

$\alpha = \frac{12}{7}\frac{g}{\ell}$, $a_{cm} = \frac{\ell}{4}\alpha = \frac{3}{7}g$

$mg - T = ma_{cm}$

$T = \frac{4}{7}mg$

5. A, D

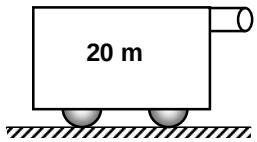
Sol. Work performed = $\int_R^{3R} \frac{1}{2}\varepsilon_0 E^2 dV + \int_{5R}^{7R} \frac{1}{2}\varepsilon_0 E^2 dV = \frac{kq^2}{3R} + \frac{kq^2}{35R}$

6. A, D

Sol. In both case (A) and (D) the source and observer are relatively at rest. Thus there is no change in the frequency.

7. B

Sol. If first 8m, then 4m, then 2m fired, then velocity of tank



$$v = \left(\frac{8}{20}+\frac{4}{12}+\frac{2}{8}\right)v_0 = \frac{59}{60}v_0$$

If first 8m, then 2m, then 4m fired, then velocity of tank

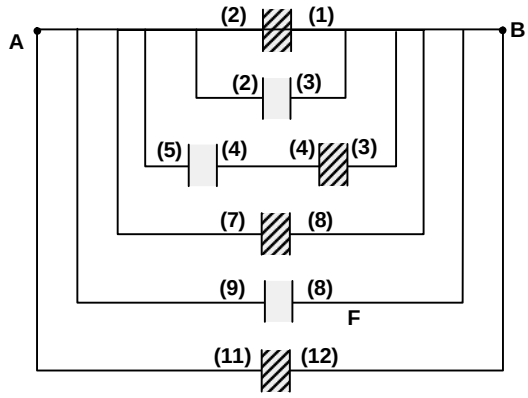
$$v = \left(\frac{8}{20}+\frac{2}{12}+\frac{4}{10}\right)v_0 = \frac{29}{30}v_0$$

If only shell 4m is fired first velocity of shell = $v_0 - \frac{4v_0}{20} = \frac{4}{5}v_0$

If only shell 2m is fired first velocity of shell = $v_0 - \frac{2v_0}{20} = \frac{9v_0}{10}$

8. D

Sol. Apply Kirchoff's Law on the equivalent circuit shown in the diagram.



9. C

Sol. In each case

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

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{F}{\ell}\frac{x}{m/\ell}} = \sqrt{\frac{Fx}{m}}$$

$$\frac{dx}{dt} = \sqrt{\frac{Fx}{m}}$$

$$\int_0^{\ell}\frac{dx}{\sqrt{x}} = \sqrt{\frac{F}{m}}\int_0^t dt, \quad t = 2\sqrt{\frac{m\ell}{F}}$$

10. C

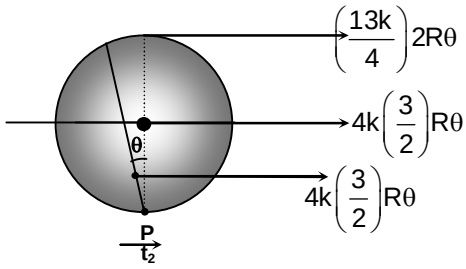
Sol. (P) Case (i)

Torque about 'P'

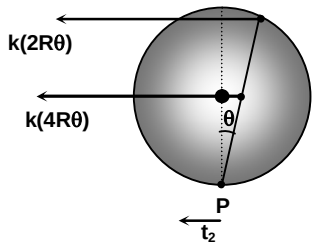
$$\frac{3}{2}mR^2\alpha = -18kR^2\theta$$

$$\alpha = -\left(\frac{36k}{3m}\right)\theta$$

$$t_1 = \frac{\pi}{6}\sqrt{\frac{3m}{k}}$$



Case (ii)



$$\frac{3}{2}mR^2\alpha = -8kR^2\theta$$

$$\alpha = -\left(\frac{16k}{3m}\right)\theta$$

$$t_2 = \frac{\pi}{4}\sqrt{\frac{3m}{k}}$$

$$T = t_1 + t_2 = \frac{5\pi}{12}\sqrt{\frac{3m}{k}}$$

(Q) $K_{eq_1} = 2(8k\cos^2 30°) + 2(8k\cos^2 60°) = 12k + 4k = 16k$

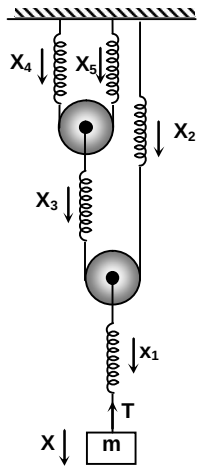
So, $K_{eq} = \frac{(16.16)}{32}k = 8k$

(R) $x = x_1 + \frac{x_2 + x_3}{2} + \frac{x_4 + x_5}{4}$

$$\frac{T}{k_{eq}} = \frac{T}{k} + \frac{T}{k} + \frac{2T}{k} + \frac{T}{k} + \frac{2T}{k}$$

$$k_{eq} = \frac{k}{7}$$

$$T = 2\pi\sqrt{\frac{7m}{k}}$$



(S) Block is displaced by 'x' along x–axis.

Torque about P

$$8k(2x_1)\ell = 4k(x - x_1)\frac{\ell}{2}$$

$$x_1 = \frac{x}{9}$$

Torque about Q

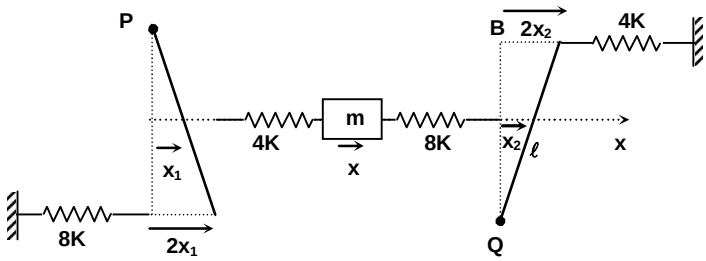
$$4k.2x_2.\ell = 8k(x - x_2)\frac{\ell}{2}$$

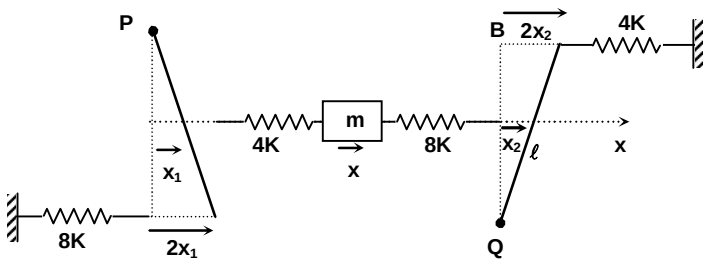
$$x_2 = \frac{x}{3}$$

$$ma = -\frac{80}{9}kx$$

$$a = -\left(\frac{80k}{9m}\right)x$$

$$T = 2\pi\sqrt{\frac{9m}{80k}} = \frac{3\pi}{2}\sqrt{\frac{m}{5k}}$$





SECTION – D

11. 00000.25

Sol. $T = \frac{2u\sin\theta}{g} = 4\sec$

When the ball collide with the wall B, time elapsed

$= \frac{10}{20} + \frac{15}{10} = 2\sec$

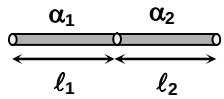
So remaining time = 2 sec

Velocity of the ball after the collision with ball = $\frac{5}{2} = 2.5$ m/s

$e = \frac{2.5}{10} = 0.25$

12. 00000.50

Sol. $\Delta\ell_1 + \Delta\ell_2 = \Delta\ell$



$\ell_1\alpha_1\Delta T + \ell_2\alpha_2\Delta T = (\ell_1 + \ell_2)\alpha\Delta T$

$\frac{\ell_1}{\ell_1+\ell_2} = \frac{\alpha - \left(\frac{\ell_2}{\ell_1+\ell_2}\right)\alpha_2}{\alpha_1}$ …(i)

Let $\frac{\ell_1}{\ell_1+\ell_2} = x$, so $\frac{\ell_2}{\ell_1+\ell_2} = 1-x$ …(ii)

$x = \frac{\alpha - (1-x)\alpha_2}{\alpha_1}$

$\alpha_1 x = \alpha - \alpha_2 + \alpha_2 x$

$x = \left(\frac{\alpha-\alpha_2}{\alpha_1-\alpha_2}\right) = \frac{17\times10^{-6} - 11\times10^{6}}{23\times10^{-6} - 11\times10^{-6}} = \frac{6}{12} = 0.50$

13. 00143.75

Sol. When S_1 is closed and S_2 is open

Current through R_1

$I_1 = \frac{\varepsilon_0}{1+3.68} = \frac{\varepsilon_0}{4.68}$

Potential difference across $\frac{\ell}{2}$ length $= \left(\frac{\varepsilon_0}{4.68}\right)\times 1.84 = \varepsilon$

Similarly in the second case

$I_2 = \frac{\varepsilon_0}{R_2+1} = \frac{468\varepsilon}{184(R_2+1)}$

Potential difference across $\frac{2\ell}{3}$ length of $R_2 = \frac{2}{3}R_2.I_2 = \frac{2}{3}\times\frac{468\varepsilon R_2}{184(R_2+1)}$

$\frac{2}{3}\times\frac{468\varepsilon R_2}{184(R_2+1)} = \varepsilon$

$64\,R_2 = 92$

$\Rightarrow R_2 = 1.4375\ \Omega$

14. 00006.28

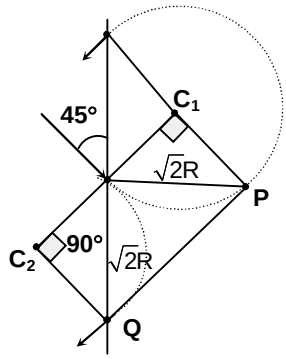
Sol. Negatively charged particle exit from magnetic field first and at the time separation is maximum

$$t_Q = \left(\frac{2\pi m}{qB}\right)\frac{\pi/2}{2\pi} = \frac{\pi m}{2qB}$$

Angle rotated by positively charged particle in the same time = $\pi/2$

So, separation between A and B= 2R

$= 2 \times 3.14 = 6.28$



15. 00002.25

Sol. On releasing the particles, if their acceleration is same, they will stay at a constant distance

Acceleration of charged particle

$$a = \frac{F - 2qE}{2m} \text{ and } a = \frac{qE - F}{m}$$

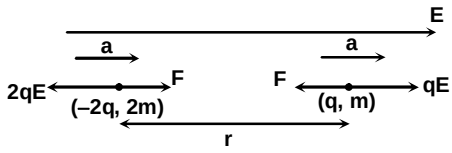
So, $F - 2qE = 2qE - 2F$

$3F = 4qE$

$$F = \frac{4qE}{3}$$

When they stay at a constant distance from each other

$$\frac{k.q.2q}{r^2} = \frac{4qE}{3} \Rightarrow r = \sqrt{\frac{3kq}{2E}}$$



16. 00367.80

Sol. Block on the wedge remains in rest

$$a_{60} = a_{30} = \frac{600 - 300}{90} = \frac{10}{3}\ m/s^2$$

So tension in the rope which is connected with 86.44 kg

T = 800 N

f = 800 – 864.4 sin 30° = 367.80

17. 00025.50

Sol. 6 V = 15S

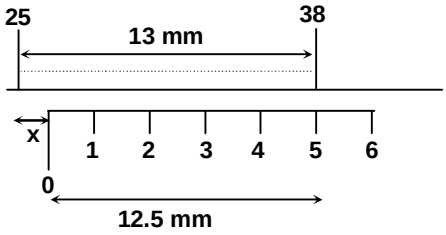
V = 2.5 mm

So, 5V = 12.5 mm

X = 13 mm – 12.5 mm

= 0.50 mm

So, measured value = 25.50 mm



18. 00000.60

Sol. If at O there is dark fringe, then

$\Delta x = SO'' O - SO' O = 2\sqrt{D^2 + d^2} - 2D = \frac{d^2}{D}$

$\frac{d^2}{D} = \frac{\lambda}{2}$ for d_{min}.

$d_{min} = \sqrt{\frac{D\lambda}{2}}$ …(i)

The bright fringe is formed at P. So,

$\Delta x = SO'P - SO''P$

$= D + \sqrt{D^2 + x^2} - \sqrt{D^2 + d^2} - \sqrt{D^2 + (x-d)^2} = \lambda$

$\Rightarrow x = \frac{D\lambda}{d}$

x for d_{min}

$x = \frac{D\lambda}{d_{min}} = \frac{D\lambda}{\sqrt{\frac{D\lambda}{2}}} = \sqrt{2D\lambda} = 0.6 \times 10^{-3}$.

Chemistry

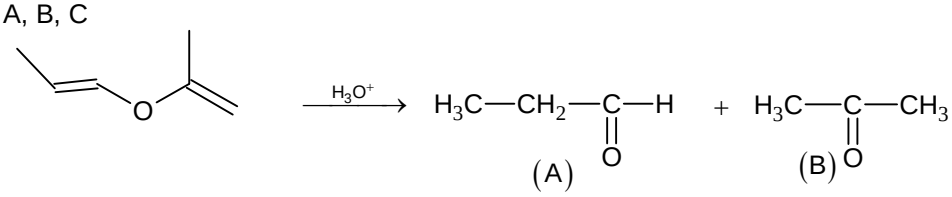
PART – II

SECTION – A

19. A, B, C, D

20. A, B, C

Sol.



21. A, B, D

Sol. Na/C_2H_5OH can not reduce acid.

22. B, C

23. A, B, D

24. A, B, C, D

25. C

26. D

27. A

28. B

SECTION – D

29. 00006.50

Sol. $2H_2O_2 \longrightarrow 2H_2O + O_2$

32 g O_2 is obtained from 68 g H_2O_2

52 g O_2 is obtained from $\frac{68}{32} \times 52g$

$$\frac{M \times 34}{2} = \frac{68}{32} \times 52$$

$$M = \frac{68 \times 52 \times 2}{32 \times 34} = 6.50$$

30. 00001.80

31. 00000.80

Sol. N_2O, CO_2, HCN and $\overset{+}{N}O_2$ are linear.

32. 00006.02

Sol. $ClO_4^- \Rightarrow 35.5 + 16 \times 4$

= 99.5 g

Number of moles $= \frac{1990 \times 10^{-3}}{99.5}$

$= 20 \times 10^{-3}$

Number of moles of electron = $20 \times 10^{-3} \times 50 = 1$

33. 00001.25

Sol. Number of atoms of X in FCC packing (at corners and face centres of cubic unit cell)

$= 8\times\frac{1}{8}+6\times\frac{1}{2}=4$

Number of atoms of Y at octahedral voids = 4

Along one body diagonal there are two X atoms and one Y-atom.

No. of effective atoms of X after removal $=4-2\times\frac{1}{8}=\frac{15}{4}$

No. of atoms of Y after removal = 4 – 1 = 3

$x : y = \frac{15}{4} : 3$

= 5 : 4

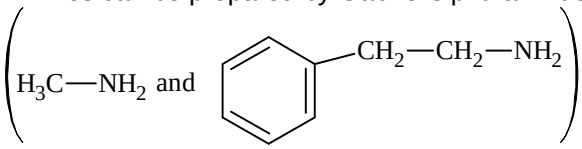
Simplest formula = X_5Y_4

a = 5, b = 4, a/b = 1.25

34. 00002.50

Sol. Stronger base than benzyl amine (a) = 5.

Amines can be prepared by Gabriel's phthalimide method (b) = 2.



35. 00002.50

36. 00004.98

Sol. Concentration per litre $=\frac{6}{60}+\frac{18}{180}=0.2$

$\pi = 0.2\times 0.083\times 300$

= 4.98 bar

Mathematics

PART – III

SECTION – A

37. A, B, C
Sol. Using integration by part

38. A, B, C
Sol. $\prod_{r=1}^{n} \frac{2r-1}{2r} \le \frac{1}{\sqrt{3n+1}}$

39. A, B
Sol. $|z| = 1$

40. A, C, D
Sol. Such n digit number will be sum of coefficient of x^{3k} in $(x^2 + x^3 + x^7 + x^9)^n = \frac{4^n + 2}{3}$

41. B, C
Sol. $P(x) = \int_0^x f^3(t)dt - \int_0^x f^2(t)dt$
$P'(x) = f^3(x) - f(x)^2 = f^2(x)\cdot(f(x) - 1) < 0$

42. A, C
Sol. B(4, 0) is focus and x = 0 is directrix of parabola

43. D
Sol. $|2A^2B^{-3}| = 8 \times 1^2 \times \frac{1}{27}$
(P) $|A_{4\times3} B_{3\times4}|$ is 0
(Q) $|A| = 0$ and $|B| = 0$
(R) $AB^T = B^TA$

44. C
Sol. Equation of circle $3x^2 + 3y^2 + 2x + 4y = 0$ and minimum value of PA + BP + CP + DP = 15

45. D
Sol. $\frac{(x+y)^2}{18} + \frac{(x-y)^2}{2} = 1$

46. B
Sol. Volume of tetrahedron = $\frac{1}{2} \times$ base area $\times$ height

SECTION – D

47. 00004.00

Sol. When x is $\frac{\pi}{4}^{-}$ then $\sqrt{2}\cos x + 2 > 3$

48. 00010.00

Sol. Inter change m and n

49. 00000.50

Sol. $\lim\limits_{K\to\infty} Kd_K = \lim\limits_{K\to\infty} \frac{K\left(\sqrt{1+K^2}-K\right)}{\sqrt{2}}$

50. 00008.00

Sol. $\prod\limits_{k=0}^{n-1}\cos\left(\theta+\frac{k\pi}{n}\right) = \frac{\cos n\theta}{(-1)^{\frac{n-1}{2}}\cdot 2^{n-1}}$ if n odd

51. 00001.00

Sol. $\frac{ab-r_1r_2}{r_3} = \frac{\Delta}{s}$ and $\angle C = \frac{\pi}{2}$

52. 00050.00

Sol. Put x = r cos θ and y = r sin θ will give area = $\frac{\pi}{4}$

53. 00005.00

Sol. $\vec{p}\cdot\vec{q} \le |\vec{p}||\vec{q}|$

54. 00000.95

Sol. $\cos^3 3x + \cos^3 5x = (\cos 5x + \cos 3x)^3$