

34. In an n-p-n common emitter (CE) transistor the collector current changes from 5 mA to 16 mA for the change in base current from 100 μ A and 200 μ A, respectively. The current gain of transistor is _____.

- (1) 110 (2) 0.9
(3) 210 (4) 9

Official Ans. by NTA (1)

Ans. (1)

Sol. Current gain in common emitter transistor

$$\beta = \frac{\Delta I_c}{\Delta I_b} = \frac{16\text{mA} - 5\text{mA}}{200\mu\text{A} - 100\mu\text{A}} = \frac{11\text{mA}}{100\mu\text{A}} = 110$$

35. If the r.m.s. speed of chlorine molecule is 490 m/s at 27° C, the r.m.s. speed of argon molecules at the same temperature will be (Atomic mass of argon = 39.9u, molecular mass of chlorine = 70.9u)

- (1) 751.7 m/s (2) 451.7 m/s
(3) 651.7 m/s (4) 551.7 m/s

Official Ans. by NTA (3)

Ans. (3)

Sol.
$$V_{\text{rms}} = \sqrt{\frac{3RT}{M}} \quad \frac{v_{\text{Ar}}}{v_{\text{Cl}}} = \sqrt{\frac{M_{\text{Cl}}}{M_{\text{Ar}}}}$$

$$\Rightarrow v_{\text{Ar}} = 1.33 \times 490 = 651.7 \text{ m/s}$$

36. A proton and an α -particle are accelerated from rest by 2V and 4V potentials, respectively. The ratio of their de-Broglie wavelength is:

- (1) 4:1 (2) 2:1
(3) 8:1 (4) 16:1

Official Ans. by NTA (1)

Ans. (1)

Sol.
$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mqV}} = \frac{h}{\sqrt{2mq\Delta V}}$$

$$\frac{\lambda_{\alpha}}{\lambda_p} = \sqrt{\frac{m_p V_p q_p}{m_{\alpha} V_{\alpha} q_{\alpha}}}$$

$$\Rightarrow \frac{\lambda_{\alpha}}{\lambda_p} = \sqrt{\frac{1 \times 2 \times 1}{4 \times 4 \times 2}} = \frac{1}{4}$$

$$\Rightarrow \lambda_p : \lambda_{\alpha} = 4 : 1$$

37. Given below are two statements:

Statement I : The diamagnetic property depends on temperature.

Statement II : The included magnetic dipole moment in a diamagnetic sample is always opposite to the magnetizing field.

In the light of given statement, choose the correct answer from the options given below:

- (1) Statement I is incorrect but Statement II is true
(2) Both Statement I and Statement II are true.
(3) Both Statement I and Statement II are false.
(4) Statement I is correct but Statement II is false.

Official Ans. by NTA (1)

Ans. (1)

Sol. Conceptual

38. A wire of resistance 160 Ω is melted and drawn in wire of one-fourth of its length. The new resistance of the wire will be

- (1) 10 Ω (2) 640 Ω
(3) 40 Ω (4) 16 Ω

Official Ans. by NTA (1)

Ans. (1)

Sol. Volume = Constant

$$A_1 L_1 = A_2 L_2$$

$$A_1 L = A_2 \frac{L}{4}$$

$$4A_1 = A_2$$

$$R_1 = \frac{\rho L_1}{A_1}$$

$$R_2 = \frac{\rho L_2}{A_2}$$

$$\frac{R_2}{R_1} = \frac{L_2 A_1}{A_2 L_1} = \frac{L}{4} \frac{A_1}{4 A_1 L}$$

$$R_2 = \frac{1}{16} R_1 = 10 \Omega$$

39. Match List I with List II

List I		List II	
A.	Spring constant	I.	(T^{-1})
B.	Angular speed	II.	(MT^{-2})
C.	Angular momentum	III.	(ML^2)
D.	Moment of Inertia	IV.	(ML^2T^{-1})

Choose the correct answer from the options given below:

- (1) A-II, B-I, C-IV, D-III
(2) A-IV, B-I, C-III, D-II
(3) A-II, B-III, C-I, D-IV
(4) A-I, B-III, C-II, D-IV

Official Ans. by NTA (1)

Ans. (1)

Sol. Spring Constant

$$[K] = \frac{[F]}{[x]} = \frac{MLT^{-2}}{L} = MT^{-2}$$

$$[\omega] = \frac{[\theta]}{[t]} = \frac{1}{T} = T^{-1}$$

40. Three force $F_1 = 10N$, $F_2 = 8 N$, $F_3 = 6 N$ are acting on a particle of mass 5 kg. The forces F_2 and F_3 are applied perpendicular so that particle remains at rest. If the force F_1 is removed, then the acceleration of the particle is:

- (1) 2 ms^{-2} (2) 0.5 ms^{-2}
 (3) 4.8 ms^{-2} (4) 7 ms^{-2}

Official Ans. by NTA (1)

Ans. (1)

Sol. Resultant of \vec{F}_2 and \vec{F}_3 should be opposite to \vec{F}_1

$$a = \frac{10}{5} = 2 \text{ m/s}^2$$

41. A body cools from 80°C to 60°C in 5 minutes. The temperature of the surrounding is 20°C . The time it takes to cool from 60°C to 40°C is:

- (1) 500 s (2) $\frac{25}{3}$ s
 (3) 450 s (4) 420 s

Official Ans. by NTA (1)

Ans. (1)

Sol. Rate of cooling \propto Temperature difference

$$\frac{80}{5} = k\{70 - 20\} \text{ --- (1)}$$

$$\frac{60 - 40}{t} = k[50 - 20] \text{ ---- (2)}$$

$$\frac{4t}{20} = \frac{50}{30}$$

$$t = \frac{25}{3} \text{ min} = 500 \text{ sec}$$

$$\Rightarrow t = 500 \text{ seconds}$$

42. An engine operating between the boiling and freezing points of water will have

1. efficiency more than 27%
2. efficiency less than the efficiency a Carnot engine operating between the same two temperatures.
3. efficiency equal to 27%
4. efficiency less than 27%

- (1) 2, 3 and 4 only (2) 2 and 3 only
 (3) 2 and 4 only (4) 1 and 2 only

Official Ans. by NTA (3)

Ans. (3)

Sol. $\eta = \left(1 - \frac{273}{373}\right) \times 100 = 26.8\%$

43. Given below are two statements:

Statement I : A truck and a car moving with same kinetic energy are brought to rest by applying brakes which provide equal retarding forces. Both come to rest in equal distance.

Statement II : A car moving towards east takes a turn and moves towards north, the speed remains unchanged. The acceleration of the car is zero.

In the light of given statements, choose the most appropriate answer from the options given below.

- (1) Statement I is correct but Statement II is incorrect
- (2) Statement I is incorrect but Statement II is correct
- (3) Both Statement I is correct but Statement II are incorrect
- (4) Both Statement I is correct but Statement II are correct

Official Ans. by NTA (1)

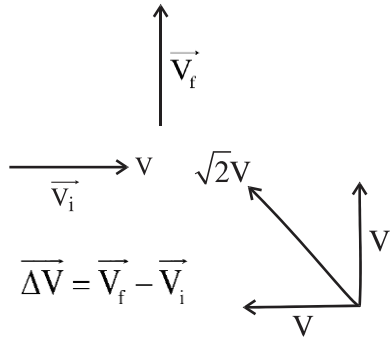
Ans. (1)

Sol. Work done = ΔKE
 Work done = $-FS = 0 - K$

$$S = \frac{K}{F}$$

Statement 1 \rightarrow correct

Statement 2 \rightarrow incorrect



Velocity is changing $\Rightarrow \vec{a} \neq 0$

Ans. 1

44. A particle is executing Simple Harmonic Motion (SHM). The ratio of potential energy and kinetic energy of the particle when its displacement is half of its amplitude will be:

- (1) 1 : 1 (2) 2 : 1
 (3) 1 : 4 (4) 1 : 3

Official Ans. by NTA (4)

Ans. (4)

Sol. $x = \frac{A}{2}$, P.E. = $\frac{1}{2} kx^2$

$$K.E. = \frac{1}{2} kA^2 - \frac{1}{2} kx^2$$

$$\frac{P.E.}{K.E.} = \frac{\frac{1}{2} kx^2}{\frac{1}{2} kA^2 - \frac{1}{2} kx^2} = \frac{A^2}{4 \left(\frac{3A^2}{4} \right)} = \frac{1}{3}$$

45. A ball is thrown vertically upward with an initial velocity of 150 m/s. The ratio of velocity after 3 s and 5 s is $\frac{x+1}{x}$. The value of x is _____.

Take ($g = 10 \text{ m/s}^2$).

- (1) 6 (2) 5
 (3) -5 (4) 10

Official Ans. by NTA (2)

Ans. (2)

Sol. $\vec{v} = \vec{u} + \vec{a}t$

$$V = 150 - 10t$$

$$V(3) = 150 - 30 = 120$$

$$V(5) = 150 - 50 = 100$$

$$\frac{120}{100} = \frac{x+1}{x} = \frac{6}{5} \Rightarrow x = 5$$

Ans. (2)

46. Given below are two statement: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : If an electric dipole of dipole moment $30 \times 10^{-5} \text{ Cm}$ is enclosed by a closed surface, the net flux coming out of the surface will be zero.

Reason R : Electric dipole consists of two equal and opposite charges.

In the light of above, statements, choose the correct answer from the options given below:

- (1) Both A and R are true and R is the correct explanation of A
 (2) A is true but R is false
 (3) Both A and R true but R is NOT the correct explanation of A
 (4) A is false but R is true

Official Ans. by NTA (1)

Ans. (1)

Sol. $\vec{P} = 30 \times 10^{-5} \text{ Cm}$

Using Gauss law

$$\phi = \frac{Q_{in}}{\epsilon_0} \text{ and } Q_{in} = 0$$

$$\Rightarrow \phi = 0$$

Statement 1 and Statement 2 are correct.

Ans. (1)

47. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : EM waves used for optical communication have longer wavelengths than that of microwave, employed in Radar technology.

Reason R : Infrared EM waves are more energetic than microwaves, (used in Radar)

In the light of given statements, choose the correct answer from the options given below:

- (1) A is false but R is true
 (2) A is true but R is false
 (3) Both A and R true but R is NOT the correct explanation of A
 (4) Both A and R true and r is the correct explanation of A

Official Ans. by NTA (1)

Ans. (1)

Sol. Optical communication is performed in the frequency range of 1THz to 1000 THz.

(Microwave to UV)

So, EM waves used for optical communication have shorter wavelength than that of microwaves used in RADAR.

Also, $\nu_{\text{INFRARED}} > \nu_{\text{MICROWAVE}}$

\therefore Infrared EM waves are more energetic than microwave

48. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. The number of spectral lines emitted will be:

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

Official Ans. by NTA (3)

Ans. (3)

Sol. According to Bohr's postulates, an electron makes jump to higher energy orbital if it absorbs a photon of energy equal to difference between the energies of an excited state and the ground state. Assuming that collided electron takes energy equal to 10.2 eV or 12.09 eV from incoming electron beam (some part lost due to collision). The maximum excited state is $n = 3$. So, number of spectral lines is _____

49. The ratio of escape velocity of a planet to the escape velocity of earth will be:

Given : Mass of the planet is 16 times mass of earth and radius of the planet is 4 times the radius of earth.

- (1) 4 : 1 (2) 2 : 1
(3) 1 : $\sqrt{2}$ (4) 1 : 4

Official Ans. by NTA (1)

Ans. (2)

Sol. $V_{\text{escape}} = \sqrt{\frac{2GM}{R}}$

$$\therefore V_{\text{escape}} \text{ for planet} = \sqrt{\frac{2G(16M_E)}{(4R_E)}} = 2\sqrt{\frac{2GM_E}{R_E}}$$

$$= 2(V_{\text{escape}} \text{ for Earth})$$

50. Given below are two statements :

Statement I : When the frequency of an a.c. source in a series LCR circuit increases, the current in the circuit first increases, attains a maximum value and then decreases.

Statement II : In a series LCR circuit, the value of power factor at resonance is one.

In the light of given statements, choose the most appropriate answer from the options given below:

- (1) Statement I is incorrect but Statement II is true.
(2) Both Statement I and Statement II are false.
(3) Statement I is correct but Statement II is false.
(4) Both Statement I and Statement II are true.

Official Ans. by NTA (4)

Ans. (4)

Sol. Both statements are correct. Theory based.

SECTION-B

51. For a certain organ pipe, the first three resonance frequencies are in the ratio of 1:3:5 respectively. If the frequency of fifth harmonic is 405 Hz and the speed of sound in air is 324 ms^{-1} the length of the organ pipe is _____ m.

Official Ans. by NTA (1)

Ans. (1)

Sol. For 5th harmonic in closed organ pipe,

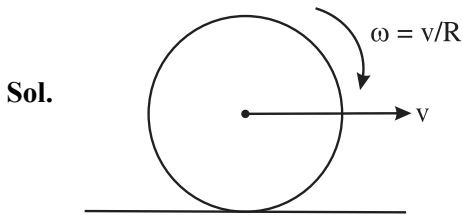
$$f_5 = \frac{5V}{4\ell} \Rightarrow 405 = \frac{5 \times 324}{4\ell}$$

$$\Rightarrow \ell = 1\text{m}$$

52. For a rolling spherical shell, the ratio of rotational kinetic energy and total kinetic energy is $\frac{x}{5}$. The value of x is _____.

Official Ans. by NTA (2)

Ans. (2)



$$\frac{K_{\text{rot}}}{K_{\text{Total}}} = \frac{\frac{1}{2} \left(\frac{2}{3} mR^2 \right) \left(\frac{V}{R} \right)^2}{\frac{1}{2} mv^2 + \frac{1}{2} \left(\frac{2}{3} mR^2 \right) \left(\frac{V}{R} \right)^2}$$

$$\Rightarrow \frac{x}{5} = \frac{2}{5} \Rightarrow x = 2$$

53. A compass needle oscillates 20 times per minute at a place where the dip is 30° and 30 times per minute where the dip is 60° . The ratio of total magnetic field due to the earth at two place respectively is $\frac{4}{\sqrt{x}}$. The value of x is

Official Ans. by NTA (243)

Ans. (243)

- Sol. Period of oscillation $\propto \frac{1}{\sqrt{B_H}}$

$$T \propto \frac{1}{\sqrt{B \cos \theta}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2 \cos \theta_2}{B_1 \cos \theta_1}}$$

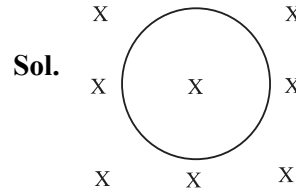
$$\Rightarrow \frac{60/20}{60/30} = \sqrt{\frac{B_2 \cos 60^\circ}{B_1 \cos 30^\circ}} \Rightarrow \frac{3}{2} = \sqrt{\frac{B_2}{\sqrt{3}B_1}}$$

$$\Rightarrow \frac{9}{4} = \frac{B_2}{\sqrt{3}B_1} \Rightarrow \frac{B_1}{B_2} = \frac{4}{9\sqrt{3}} = \frac{4}{\sqrt{243}}$$

54. A conducting circular loop is placed in a uniform magnetic field of 0.4 T with its plane perpendicular to the field. Somehow, the radius of the loop starts expanding at a constant rate of 1 mm/s. The magnitude of induced emf in the loop at an instant when the radius of the loop is 2 cm will be _____ μV .

Official Ans. by NTA (50)

Ans. (50)



$$\frac{dr}{dt} = 10^{-3} \text{ m/s}$$

$$\frac{dA}{dt} = 2\pi r \frac{dr}{dt}$$

$$\varepsilon = \left| \frac{-d\phi}{dt} \right| = \left| \frac{BdA}{dt} \right|$$

$$= 0.4 \times 2 \times \pi \times 2 \times 10^{-2} \times 10^{-3} \text{ V}$$

$$= 16\pi \mu\text{V} = 50.24 \mu\text{V}$$

55. To maintain a speed of 80 km/h by a bus of mass 500 kg on a plane rough road for 4 km distance, the work done by the engine of the bus will be _____ KJ. [The coefficient of friction between tyre of bus and road is 0.04].

Official Ans. by NTA (784)

Ans. (784)

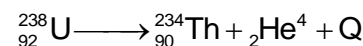
- Sol. For constant speed, WD by engine + WD by friction = 0 [by WET]

$$WD_{\text{engine}} = -WD_{\text{friction}} = -[\mu mgx]$$

$$= 0.04 \times 500 \times 9.8 \times 4 \times 10^3$$

$$= 784 \text{ KJ}$$

56. A common example of alpha decay is



Given :

$${}_{92}^{238}\text{U} = 238.05060 \text{ u},$$

$${}_{90}^{234}\text{Th} = 234.04360 \text{ u},$$

4

$$1 \text{ u} = 931 \frac{\text{V}}{c^2}$$

The energy released (Q) during the alpha decay of

$${}_{92}^{238}\text{U} \text{ is } \underline{\hspace{2cm}} \text{ MeV}$$

Official Ans. by NTA (4)

Ans. (4)

- Sol. Energy released = $(\Delta m)_{\text{amu}} \times 931.5 \text{ MeV}$
 $= (m_{\text{u}} - m_{\text{Th}} - m_{\text{He}})_{\text{amu}} \times 931.5 \text{ MeV}$
 $= 0.0044 \times 931.5 \text{ MeV} = 4.0986 \text{ MeV}$

57. The current flowing through a conductor connected across a source is 2A and 1.2 A at 0°C and 100°C respectively. The current flowing through the conductor at 50°C will be _____ × 10² mA.

Official Ans. by NTA (15)

Ans. (15)

Sol. $i_0 R_0 = i_{100} R_{100}$ [For same source]

$$\Rightarrow 2 R_0 = 1.2 R_0 [1 + 100\alpha] \quad \dots (1)$$

$$\Rightarrow 1 + 100\alpha = \frac{5}{3} \Rightarrow 100\alpha = \frac{2}{3}$$

$$\Rightarrow 50 \alpha = \frac{1}{3}$$

$$\therefore i_{50} R_{50} = i_0 R_0$$

$$\Rightarrow i_{50} = \frac{i_0 R_0}{R_{50}} = \frac{2 \times R_0}{2 R_0} = 2$$

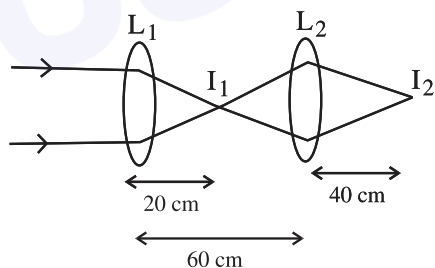
$$= 15 \times 10^2 \text{ mA}$$

58. Two convex lenses of focal length 20 cm each are placed coaxially with a separation of 60 cm between them. The image of the distant object formed by the combination is at _____ cm from the first lens.

Official Ans. by NTA (100)

Ans. (100)

Sol. $f_1 = 20 \text{ cm}$ $f_2 = 20 \text{ cm}$



1st refraction in L₁(I₁)

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

$$\frac{1}{v} - \frac{1}{\infty} = \frac{1}{f}$$

$$\therefore v = f$$

2nd refraction in L₂

I₁ → object

I₂ → image

$$u = -40 \text{ cm}$$

$$f = 20 \text{ cm}$$

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

$$\frac{1}{v} - \frac{1}{(-40)} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{40} = \frac{6-3}{120}$$

$$\frac{1}{v} = \frac{3}{120} = \frac{1}{40}$$

$$\therefore v = 40 \text{ cm}$$

Correct Answer is 100.

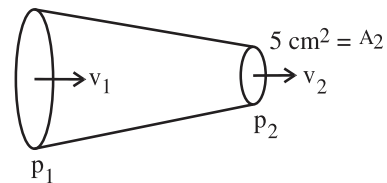
59. Glycerine of density $1.25 \times 10^3 \text{ kg m}^{-3}$ is flowing through the conical section of pipe. The area of cross-section of the pipe at its ends is 10 cm^2 and 5 cm^2 and pressure drop across its length is 3 Nm^{-2} . The rate of flow of glycerine through the pipe is $x \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$. The value of x is _____.

Official Ans. by NTA (4)

Ans. (4)

Sol.

$$A_1 = 10 \text{ cm}^2$$



$$\Delta P = P_1 - P_2 = 3 \text{ N/m}^2 \text{ (given)}$$

By continuity eqⁿ

$$A_1 v_1 = A_2 v_2$$

$$\therefore v_1 = \frac{A_2}{A_1} v_2 \quad \dots (1)$$

By Bernoulli's eqⁿ

$$P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho v_2^2$$

$$P_1 - P_2 = \frac{1}{2} \rho (v_2^2 - v_1^2)$$

$$\Delta P = \frac{1}{2} \rho \left(v_2^2 - \frac{A_2^2}{A_1^2} v_2^2 \right)$$

$$\Delta P = \frac{1}{2} \rho \left[1 - \left(\frac{A_2}{A_1} \right)^2 \right] v_2^2$$

$$3 = \frac{1}{2} \times 1.25 \times 10^3 \left[1 - \left(\frac{5}{10} \right)^2 \right] v_2^2$$

$$3 = \frac{1}{2} \times 1.25 \times 10^3 \left[1 - \frac{1}{4} \right] v_2^2$$

$$3 = \frac{1}{2} \times 1.25 \times 10^3 \times \frac{3}{4} v_2^2$$

$$\therefore v_2 = 8 \times 10^{-2} \text{ m/s}$$

So discharge rate = $A_2 v_2$

$$= 5 \times 10^{-4} \times 8 \times 10^{-2}$$

$$= 4 \times 10^{-5} \text{ m}^3/\text{s}$$

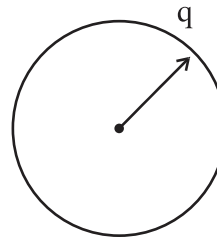
Correct ans is x = 4

60. 64 identical drops each charged upto potential of 10 mV are combined to form a bigger drop. The potential of the bigger drop will be _____ mV.

Official Ans. by NTA (160)

Ans. (160)

Sol.



Let q = charge on each drop

$$V = \frac{Kq}{r} \text{ ---- (1)}$$

Now for combination of 64 drop

$$64 \times \frac{4}{3} \pi r^3 = \frac{4}{3} \pi R^3$$

$$R = 4r$$

$$\text{And } Q = 64 q$$

Potential of bigger drop

$$= \text{ ---- }$$

$$= 16 \times 10 \text{ mV} = 160 \text{ mV.}$$

Correct answer is 160.