JEE Main 2024 Question Paper with Solution Jan 30 Shift 2 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. Two particles are projected from a tower of height 400 m & angles 45° & 60° horizontally. If they have the same time of flight, find the ratio of their velocities.

A. √3/√2
B. √5/√2
C. √3/√4
D. 1

Ans. A

Solution: To find the ratio of their velocities, we first need to find the velocities of the two particles. We can use the fact that the time of flight is the same for both particles.

The time of flight for a projectile launched at an angle θ with an initial velocity v is given by:

$$T = \frac{2v\sin(\theta)}{g}$$

Where:

- T is the time of flight,
- v is the initial velocity,
- θ is the launch angle,
- g is the acceleration due to gravity (approximately 9.8m/s^2)

For both particles, the time of flight is the same. So, we can set up the following equation:

$$\frac{2v_1 \sin(45^\circ)}{g} = \frac{2v_2 \sin(60^\circ)}{g}$$

Simplify:

$$v_1 \sin(45^\circ) = v_2 \sin(60^\circ)$$

Now, we need to find v1 and v2.
For the first particle:

$$v_1 = \frac{g \cdot T}{2 \sin(45^\circ)}$$

For the second particle:

$$v_1 = \frac{g \cdot T}{2 \sin(45^\circ)}$$

Since *g* and *T* are common to both, we can cancel them out:

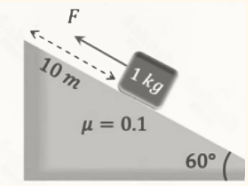
$$\frac{v_1}{v_2} = \frac{\sin(60^\circ)}{\sin(45^\circ)}$$

Now, let's calculate:

$$\frac{v_1}{v_2} = \frac{\sqrt{3}/2}{\sqrt{2}/2} = \sqrt{\frac{3}{2}} = \frac{\sqrt{3}}{\sqrt{2}}$$

So, the ratio of their velocities is $\frac{\sqrt{3}}{\sqrt{2}}$.
Therefore, the correct answer is option A

Ques 2. A block of mass 1 kg is ascended on an inclined plane by a distance of 10 m as shown in diagram, with the help of force of 10 N along the incline. Find work done against the friction.

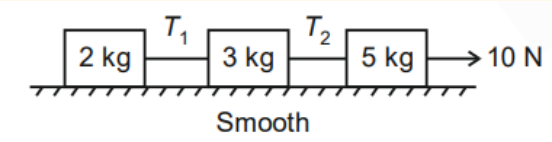


A. 10 J
B. 5 √(3) J

C. 5J
D. (10 - 5 √(3) J

Ans. C

Ques 3. A force of 10 N is applied on a three block system as shown. Find the two tensions T_1 and T2.



A. 2N,5 N
B. 5N, 2 N
C. 3N, 4 N
D. 4N,3 N

Ans. A

Ques 4. The slope of graph between stopping potential (Vo) and Frequency of incident photon (f) in photoelectric effect is (h= Plank's Constant, e = charge on electron)

A. h/e
B. h/2e
C. 2h/e
D. e/h

Ans. A

Solution: The stopping potential (Vo) in the photoelectric effect is given by the equation:

$$V_0 = \frac{hf}{e} - \frac{W}{e}$$

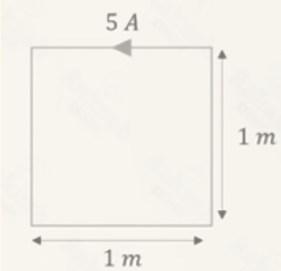
Where:

- *h* is Planck's constant,
- *f* is the frequency of the incident photon,

- *e* is the charge on an electron,
- *W* is the work function of the material.

In this case, we are considering the stopping potential (Vo) as a function of the frequency of the incident photon (*f*).
So, if we plot Vo against *f* we get a straight line with slope h/e This is because the only variable in the equation that depends on *f* is *hf* and the coefficient of *hf* is h/e.
Thus, the slope of the graph between the stopping potential (Vo) and the frequency of the incident photon (*f*) in the photoelectric effect is h/e.
Therefore, the correct answer is option A.

Ques 5. A square loop of side 1 m is carrying a current of 5 A as shown. If the magnetic field at the center is x√2 * 10^{-7} find x.



Ans. 40

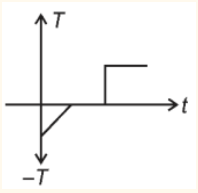
Ques 6. A planet exists of mass 1^{th}/6 of the earth's mass and radius 1^{rd}/3 of the earth's radius. If the escape speed for earth is 11.2km / s then the escape speed for the planet shall be km/s. (nearest integer)

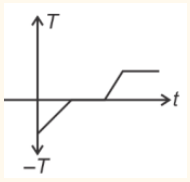
Ans. 8

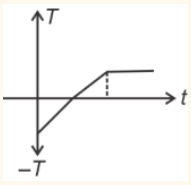
Ques 7. An electron in the 5th excited state of He+ atom moves to the 1st excited state. Find the number of possible spectral lines formed.

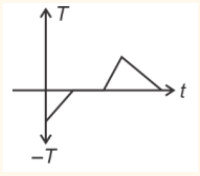
Ans. 10

Ques 8. Ice at temperature –10°C is converted to steam at 100°C, the curve plotted between temperature (T) and time (t) when it is being heated by constant power source is

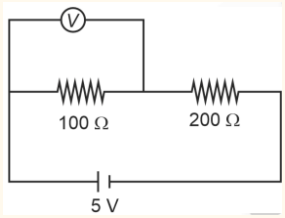
A. 

B. 

C. 

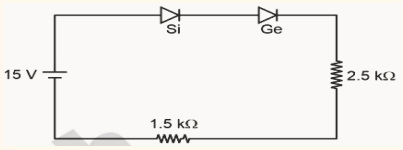
D . 

Ans. B

Ques 9. In given circuit, reading of voltmeter is 1 V, then resistance of voltmeter is 

A. 100 Ω
B. 200 Ω
C. 200√5 Ω
D. 50 Ω

Ans. A

Ques 10. In the circuit shown if the potential drop in forward bias across Si and Ge diodes are 0.7 V and 0.3 V, find the potential difference across 2.5 k resistor 

A. 9.25 V
B. 6.25 V
C. 8.75 V
D. 9.75 V

Ans. C

Ques 11. A point source is placed at origin. Its intensity at distance of 2 cm from source is I then intensity at distance 4 cm from the source shall be.

- **A. I/2**
- **B. I/16**
- **C. I/4**
- **D. I**

Ans. C

Solution: The intensity (*I*) of light from a point source decreases with the square of the distance from the source according to the inverse square law. Mathematically, it is represented as:

$$I \propto \frac{1}{r^2}$$

Where *r* is the distance from the source.
If the intensity at a distance of 2 cm from the source is *I*, then at a distance of 4 cm, the intensity (*I'*) can be found using the ratio of the distances:

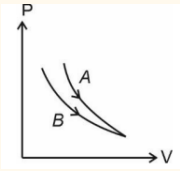
$$\frac{I'}{I} = \left(\frac{r_1}{r_2}\right)^2$$

Where r1 = 2 cm (initial distance) and r2 = 4 cm (final distance).
Substituting the values:

$$\frac{I'}{I} = \left(\frac{2}{4}\right)^2$$
$$\frac{I'}{I} = \left(\frac{1}{2}\right)^2$$
$$\frac{I'}{I} = \frac{1}{4}$$

Therefore, the intensity at a distance of 4 cm from the source (*I'*) is one-fourth of the intensity at a distance of 2 cm from the source (*I*).
So, the correct answer is option C.

Ques 12. The Pressure (P) versus volume (V) of thermodynamic process shown in figure. The select the correct options (Take γ= 1.1)



A. For process A : PV^{Y} = constant, For process B : PV^{Y} = constant
B. For process A : $PV^{1/Y}$ = constant For process B : PV = constant
C. For process A : $PV^{1.05}$ = constant For process B : PV^{Y} = constant
D. For process A : $PV^{1.2}$ = constant For process B : PV = constant

Ans. D

Ques 13. Voltage across a 5Ω resistor is given as V = 200 sin(100πt). Find out time required for current through io it to change from $i_0/2$ to i_0 [i_0 is peak current]

A. 1/300 s
B. 1/600 s
C. 1/150 s
D. 1/1200 s

Ans. A

Ques 14. A nucleus of mass M breaks into 3 nuclei with a mass defect of Δm. Find the speed of each daughter nuclei if they have equal mass.

A. c √(6Δm/(M-Δm)
B. c √(2Δm/(M-Δm)
C. c √(3Δm/(M-Δm)
D. c √(Δm/(M-Δm)

Ans. B

Ques 15. In a vernier caliper 49 main scale divisions are equal to 50 vernier scale divisions. If one main scale division is 0.5 mm, then the vernier constant is

A. 0.01 mm
B. 0.1 mm
C. 0.1 cm
D. 0.01 cm

Ans. A

Ques 16. 6×10^5 J of electromagnetic energy is incident on a surface in time t_0 . Find the total momentum imparted if the surface is completely absorbing.

A. $2 * 10^{-3}$ kgm / s
B. 10^{-3} kgm / s
C. 10^{-2} kgm / s
D. $2 * 10^{-4}$ kgm / s

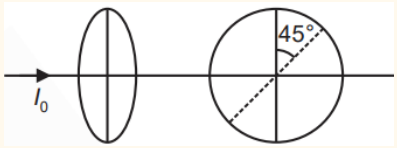
Ans. A

Ques 17. A particle is placed on an upward parabolic curve $y = x^2/4$ having coefficient of friction (μ) = 0.5 . What should be the maximum height above x-axis so that it does not slip.

A. ¼ m
B. ½ m
C. ⅓ m
D. ¾ m

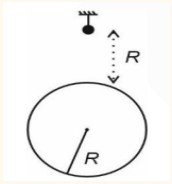
Ans. A

Ques 18. Two polaroids are placed at angle of 45° to each other. If unpolarized light of intensity I_0 falls as one polaroid, then intensity of light leaves the second polaroid.



A. $I_0/2$
B. $I_0/2\sqrt{2}$
C. $I_0/4$
D. $I_0/8$

Ans. C

Ques 19. A simple pendulum of length 4 m is located at a height R above the surface of earth. The time period of the simple pendulum is $2\pi\sqrt{(8/x)}$ seconds. Find x. 

Ans. 5

Ques 20. Mass can be expressed as $M = C^pG^{-1/2}h^{1/2}$, where C is speed of light, G is gravitational constant and is Planck's constant. Find p.

A. 1
B. 0.5
C. -1
D. -0.5

Ans. B

JEE Main Chemistry Questions

Ques 1. Why does $KMnO_4$ show colour?

A. Due to d-d transition

B. Due to metal to ligand charge transfer
C. Due to ligand to metal charge transfer
D. Due to F-center

Ans. C

Solution: The color of a compound like $KMnO_4$ arises from the absorption of light by certain electronic transitions within the molecule. In the case of $KMnO_4$, it's important to understand its electronic structure to determine why it shows color.

$KMnO_4$ consists of manganese (Mn) in a high oxidation state (+7) surrounded by oxygen atoms. The color in $KMnO_4$ is primarily due to the presence of Mn(VII) ions.

Among the options provided:

A. "Due to d-d transition": This option is usually associated with transition metal compounds where electrons in the d orbitals undergo electronic transitions. However, $KMnO_4$ does not exhibit d-d transitions because the Mn ion in $KMnO_4$ is in the +7 oxidation state, where there are no electrons in the d orbitals to transition.

B. "Due to metal to ligand charge transfer": This occurs when an electron transfers from the metal atom/ion to the ligand. However, this explanation doesn't fit $KMnO_4$, as the color is not primarily due to metal-to-ligand charge transfer.

C. "Due to ligand to metal charge transfer": This occurs when an electron transfers from the ligand to the metal. In the case of $KMnO_4$, the color is indeed due to ligand-to-metal charge transfer (LMCT). In $KMnO_4$, the oxygen atoms (ligands) donate electrons to the Mn(VII) ion, resulting in LMCT, which contributes to the observed color.

D. "Due to F-center": This term usually refers to a type of color center in ionic crystals where an anion vacancy is filled by an electron. It doesn't apply to KMnO4.

Therefore, the correct option explaining the color of KMnO4 is C.

Ques 2. C is added to solution of A and B, find mole fraction of C

A. $n_c /(n_A + n_B + n_C)$
B. $n_c/(n_A . n_B + n_c)$
C. $n_c/(n_A . n_c+n_B)$
D. $n_c /(n_A + n_B)$

Ans. A

Ques 3. Which of the following solution will have lowest freezing point

A. 180 g of glucose in 1 L solution
B. 180 g of benzoic acid in 1 L solution
C. 180 g of CH3COOH in 1 L solution
D. 180 g of sucrose in 1 L solution

Ans. C

Solution: To determine which solution will have the lowest freezing point, we can use the concept of freezing point depression, which is a colligative property. The freezing point depression is given by the formula:

$$\Delta T_f = i \cdot K_f \cdot m$$

Where:

- ΔT_f is the freezing point depression,
- i is the van't Hoff factor (the number of particles the solute dissociates into or associates with in the solution),
- K_f is the cryoscopic constant (a constant specific to the solvent),
- m is the molality of the solution (moles of solute per kilogram of solvent).

In this case, we're comparing solutions with the same concentration (all have 180 g of solute in 1 L solution), so the *m* value will be the same for all solutions.

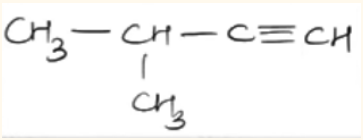
The van't Hoff factor *i* depends on the degree of dissociation or association of the solute particles. For glucose (option A) and sucrose (option D), they do not dissociate or associate significantly in solution, so *i* = 1.

For benzoic acid (option B), it primarily remains as molecules in solution, so *i* = 1.

However, for acetic acid (option C), it partially dissociates in solution into acetate ions and hydrogen ions, so *i* will be greater than 1.

Now, since $i \cdot Kf$ is constant for a given solvent, the solution with the highest value of *i* will have the lowest freezing point depression and thus the lowest freezing point.

Therefore, the solution with 180 g of CH3COOH (acetic acid) in 1 L solution (option C) will have the lowest freezing point among the given options.

Ques 4. IUPAC name of compound 

A. 2-Methylbutane
B. 3-Methylbut-1-yne
C. 2-Methylbutene
D. 3-Methylbutane

Ans. B

Ques 5. Which reagent on reacting with phenol gives salicylaldehyde?

A. CO_2, NaOH
B. $CHCl_3$, NaOH
C. CCl_4, NaOH
D. H_2O, H^+

Ans. B

Solution: The correct answer is option B: CHCl3, NaOH.

Salicylaldehyde can be obtained by the Reimer-Tiemann reaction. In this reaction, phenol reacts with chloroform (CHCl3) and a strong base such as sodium hydroxide (NaOH) to yield salicylaldehyde.

The reaction mechanism involves the generation of dichlorocarbene from chloroform in the presence of a strong base. The dichlorocarbene then reacts with phenol to form an intermediate, which undergoes further reaction to yield salicylaldehyde.

The reaction can be summarized as follows:

$$\text{Phenol} + \text{CHCl}_3 + \text{NaOH} \rightarrow \text{Salicylaldehyde} + \text{NaCl} + \text{H}_2\text{O}$$

Therefore, the correct reagent combination for the synthesis of salicylaldehyde from phenol is CHCl3 and NaOH, which corresponds to option B.

Ques 6. Which of the following has a square pyramidal shape?

A. PCl5
B. BrF_5
C. PF_5
D. $[Ni(CN)_4]^{2-}$

Ans. B

Solution: A square pyramidal shape is a molecular geometry where there is a central atom bonded to five other atoms and one lone pair, resulting in a structure that resembles a square pyramid. Let's analyze each option:

A. PCl5 (Phosphorus Pentachloride) - This molecule has a trigonal bipyramidal geometry, where phosphorus is bonded to five chlorine atoms. It doesn't have a square pyramidal shape.

B. BrF5 (Bromine Pentafluoride) - This molecule has a square pyramidal geometry. Bromine is bonded to five fluorine atoms, and it has one lone pair, resulting in a square pyramidal shape.

C. PF5 (Phosphorus Pentafluoride) - This molecule has a trigonal bipyramidal geometry, similar to PCl5. Phosphorus is bonded to five fluorine atoms, but there are no lone pairs. It doesn't have a square pyramidal shape.

D. [Ni(CN)4]2- (Tetracyanonickelate(II)) - This complex ion has a square planar geometry, where nickel is bonded to four cyanide ligands. It doesn't have a square pyramidal shape.

Therefore, the molecule with a square pyramidal shape is option B: BrF5.

Ques 7. Consider the following statements:
Statement I: Since electronegativity of F > H, so dipole moment of NF3 > NH3
Statement II: Lone pair dipole in NH3 is not in the direction of resultant bond dipole while in case of NF3 the lone pair dipole is in the direction of resultant bond dipole

A. **Statement I: True Statement II: False**
B. **Statement I: True Statement II: True**
C. **Statement I: False Statement II: False**
D. **Statement I: False Statement II: True**

Ans. C

Ques 8. Arrange the following according to their decreasing oxidizing power BrO_4^-, IO_4^-, ClO^-_4

A. $ClO^-_4 > IO_4^- > BrO_4^-$

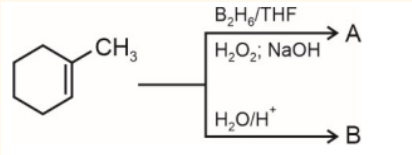
B. $BrO_4^- > IO_4^- > ClO^-_4$

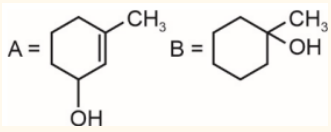
C. $IO_4^- > BrO_4^- > ClO^-_4$

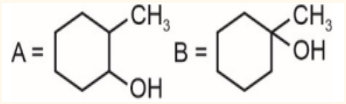
D. $BrO_4^- > ClO^-_4 > IO_4^-$

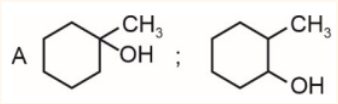
Ans. B

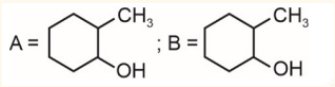
Ques 9. Complete the following reactions and find major products A and B



A. 

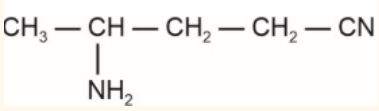
B. 

C. 

D. 

Ans. B

Ques 10. What is the correct IUPAC name of the given compound?



A. **4-Aminopentane Tile**

B. 2-Aminopentane Tile
C. 3-Aminobutane Tile
D. 2-Aminobenzonitrile

Ans. A

Ques 11. In the given reactions A and B respectively are:

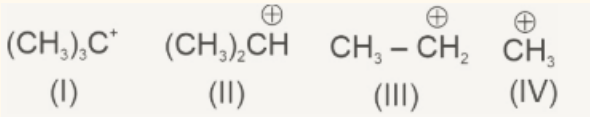
$CrO_2Cl_2 + NaOH \rightarrow A + Nacl + H_20$

$H2SO4 + A + H_20_2 \rightarrow B$

A. Na2CrO4 and CrO5 B.
B. CrO5 and Na2CrO4 C.
C. Na2CrO4 and CrO3
D. Na2Cr2O7 and Na2CrO4

Ans. A

Ques 12. Find out correct order of stability for given carbocations



A. II > I > III > IV
B. I > II > III > I V
C. IV > III > II > I
D. I > II > IV > III

Ans. B

Ques 13. Statement I : Halogen attached to bulky group undergo SN2 reaction.

Statement II : Secondary alkyl halide react with excess C2H5OH undergo SN1 reaction.

A. Both statements are true
B. Statement I is true, II is false
C. Both statements are false

D. Statement I is false, Statement II is true

Ans. D

Ques 14. Magnetic moment due to the motion of the electron in n^{th} orbit of Bohr atom is proportional to n^x. The value of x is

A. 0
B. 1
C. 2
D. 3

Ans. B

Ques 15. What is the structure of $Mn_2(CO)_{10}$?

A. Two square pyramidal units joined by bridging CO ligands
B. Two square pyramidal units joined by Mn-Mn bond
C. Two tetrahedral units joined by Mn-Mn bond
D. Two square planar units joined by Mn-Mn bond

Ans. B

Ques 16. Which of the following is a purification method which is based on solubility of compound.

A. Distillation
B. Sublimation
C. Crystallization
D. Column Chromatography

Ans. C

Solution: The purification method based on the solubility of a compound is:

C. Crystallization.

Crystallization is a technique used to purify solid compounds based on their differences in solubility in a given solvent. In this process, the impure solid is dissolved in a hot solvent, and as the solution cools, the solubility of the compound decreases, leading to the formation of crystals. The impurities remain dissolved in the solvent or are excluded from the growing crystals, resulting in a purified compound. This technique is widely used in the purification of organic and inorganic compounds.

Ques 17. Statement 1 : H_2Te is more acidic than H_2S Statement 2 : H2Te has more B.D.E than H2S

A. **Statement 1 and 2 both are correct**
B. **Statement 1 and 2 both are incorrect**
C. **Statement 1 is incorrect and statement 2 is correct**
D. **Statement 1 is correct and statement 2 is incorrect**

Ans. D

Ques 18. Number of elements which give flame test from following Sr, Cu, Co, Ca, Ni, Fe

Ans. 4

Ques 19. Statement-I: There is a regular increase in chemical reactivity from group 1 to group 18.
Statement-II: Oxides of group-1 elements are basic and oxide of group 17 are acidic

A. **Both statement-I and statement-II are true**
B. **Statement-I is true and statement-II is false**
C. **Statement-I is false and statement-II is true**
D. **Statement-I and statement-II both are false**

Answer C

Ques 20. How many of the following shows disproportionation reactions?
H_2O_2 , Ag, Cu^- , K^+ , F_2 , Cl_2 , ClO_3^-

Ans. 4

Solution: Disproportionation reactions are chemical reactions in which a single compound undergoes both oxidation and reduction simultaneously, resulting in the formation of two different oxidation states of the same element.

Among the species listed:

H2O2 (Hydrogen peroxide) - Shows disproportionation reaction. It can undergo disproportionation to produce water and oxygen gas:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Ag (Silver) - Does not undergo disproportionation reaction. Silver is typically unreactive under normal conditions.

Cu- (Copper ion) - Does not undergo disproportionation reaction. Copper ions are typically involved in single electron transfer reactions, but they do not undergo disproportionation.

K+ (Potassium ion) - Does not undergo a disproportionation reaction. Potassium ions are typically involved in single electron transfer reactions, but they do not undergo disproportionation.

F2 (Fluorine) - Shows disproportionation reaction. Fluorine gas can undergo disproportionation to produce fluorides of both oxidation states -1 and +1:

$$3F_2 \rightarrow 2F^- + F_2^+$$

Cl2 (Chlorine) - Shows disproportionation reaction. Chlorine gas can undergo disproportionation to produce chlorides of both oxidation states -1 and +1:

$$Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$$

ClO3- (Chlorate ion) - Shows disproportionation reaction. Chlorate ions can undergo disproportionation to produce chlorite ions and chloride ions:

$$3ClO_3^- \rightarrow 2ClO_2^- + Cl^-$$

So, out of the species listed, H2O2, F2, Cl2, and ClO3- undergo disproportionation reactions. Therefore, the total number of species showing disproportionation reactions is 4.

JEE Main Mathematics Questions

Ques 1. Bag A contains 7 white balls & 3 red balls. Bag B contains 3 white balls & 2 red balls. A ball is chosen randomly & found to be red then find the probability that it is taken from bag A.

A. 7/20
B. ½
C. 3/7
D. ⅕

Ans. C

Ques 2. Given $|\vec{b}|$ **=2,** $|\vec{b} \times \vec{a}|$ **=2, then the value of** $|\vec{b} \times \vec{a} - \vec{b}|^2$ **is**

A. 0
B. 8
C. 1
D. 10

Ans. B

Ques 3. If $f(x) = \ln (2x/(4x^2-x-3)) + \cos^{-1} ((2x+1)/(x+2))$ if domain of f(x) is [α, β), then 5a - 4ß is:

- **A. -2**
- **B. 3**
- **C. -4**
- **D. 1**

Ans. A

Ques 4. If $f(x) = (x - 2)^2 (x - 3)^3$ and $x \in [1, 4]$ If M and m denotes maximum and minimum values respectively, then M - m is

Ans. 12

Ques 5. f * (y - 2) ^ 2 = (x - 1) and x - 2y + 4 = 0 then find the area bounded by the curves between the coordinate axis in first quadra (in sq. units)

Ans. 3

Ques 6. If 1st term of a GP is 'a' and 3rd term is 'b' and in 2nd GP 1st term is 'a' and 5th term is 'b' and 11th term of 1st GP common to which term of 2nd GP

- **A. 24**
- **B. 25**
- **C. 21**
- **D. 18**

Ans. C

Ques 7. $z^{1985} + z^{100} + 1 = 0$ and $z^3 + 2z^2 + 2z + 1 = 0$ **then number of common roots of equation is**

A. 1
B. 2
C. 3
D. 4

Ans. B

Ques 8. If $x^2 - y^2 + 2hxy + 2gx + 2fy + c = 0$ **is the locus of points such that it is equidistant from the lines x + 2y - 8 = 0 and 2x + y + 7 = 0 then value of h + g + f + c is**

A. 15
B. -15
C. 20
D. -20

Ans. C

Ques 9. $A = \begin{bmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \end{bmatrix}$

$$\frac{x}{\sin\theta} = \frac{y}{\sin\left(\theta + \frac{2\pi}{3}\right)} = \frac{z}{\sin\left(\theta + \frac{4\pi}{3}\right)}$$

Then
Statement 1: Tr(A) = 0
Statement 2: Tr(adj(adj A))

A. Statement 1 & 2 are true

B. Statement 1 is true
C. Statement 2 is true
D. None of these

Ans. A

Ques 10. If $S_n = 3 + 7 + 11 +$ **.... upto n terms And** $40 < \frac{6}{n(n+1)} \sum_{k=1}^{n} S_k < 45,$ **then n is**

A. 9
B. 10
C. 11
D. 12

Ans. A

Ques 11. In a paper there are 3 sections A, B and C which have 8, 6 and 6 questions each. A student have to attempt 15 questions such that they have to attempt at least 4 questions out of each sections, then number of ways of attempting these questions are

A. 11,300
B. 11,376
C. 12,576
D. 13,372

Ans. B