Q.1 At 300 K, the rms speed of oxygen molecules is \( \sqrt{\frac{22}{7}} \) times that of its average speed in the gas. Then, the value of \( n \) will be

\[
\text{(used } n = \frac{22}{7})
\]

Options:
1. 24
2. 27
3. 32
4. 28

Q.2 The time taken by an object to slide down 45° rough inclined plane in \( n \) times as it takes to slide down a perfectly smooth 45° incline plane. The coefficient of kinetic friction between the object and the incline plane is:

Options:
1. \( \frac{1}{n^2} \)
2. \( 1 + \frac{1}{n^2} \)
3. \( \sqrt{1 - \frac{1}{n^2}} \)
4. \( \frac{1}{\sqrt{1 - n^2}} \)

Q.3 The ratio of de-Broglie wavelength of an \( \alpha \) particle and a proton accelerated from rest by the same potential is \( \frac{1}{\sqrt{m}} \), the value of \( m \) is:

Options:
1. 3
2. 4
3. 2
4. 16

Q.4 A point charge \( 2 \times 10^{-2} \) is moved from \( P \) to \( S \) in a uniform electric field of 30 NC\(^{-1}\) directed along positive x-axis. If coordinates of \( P \) and \( S \) are \((1, 2, 0) \) m and \((0, 0, 0) \) m respectively, the work done by electric field will be

Options:
1. 600 mJ
2. 1200 mJ
3. 1200 μJ
4. 600 μJ

Q.5 A square loop of area 25 cm\(^2\) has a resistance of 10 Ohm. The loop is placed in uniform magnetic field of magnitude 400 T. The plane of loop is perpendicular to the magnetic field. The work done in pulling the loop out of the magnetic field slowly and uniformly in 1.0 sec, will be

Options:
1. \( 1.0 \times 10^{-1} \) J
2. \( 5 \times 10^{-3} \) J
3. \( 2.5 \times 10^{-3} \) J
4. \( 1.0 \times 10^{-3} \) J

Q.6 A fully loaded Boeing aircraft has a mass of 5.4 \times 10^5 kg. Its total wing area is 500 m\(^2\). It flies in level flight with a speed of 1080 km/h. If the density of air is 1.2 kg/m\(^3\), the fractional increase in the speed of the air on the upper surface of the wing relative to the lower surface in percentage will be. (\( \rho = 10 \text{ m/s}^2 \))

Options:
1. 16
2. 6
3. 8
4. 10

Q.7 Heat energy of 184 kJ is given to ice of mass 600 g at -12°C. Specific heat of ice is 2232.3 J kg\(^{-1}\)°C\(^{-1}\) and latent heat of ice is 334 kJ kg\(^{-1}\). Which of the following is correct?

A. Final temperature of system will be 0°C.
B. Final temperature of the system will be greater than 0°C.
C. The final system will have a mixture of ice and water in the ratio of 5:1.
D. The final system will have a mixture of ice and water in the ratio of 1:5.
E. The final system will have water only.
Choose the correct answer from the options given below:

Options:
1. A and E Only
2. A and C Only
3. B and D Only
4. A and D Only

Q.8 Substance A has atomic mass number 36 and half life of 1 day. Another substance B has atomic mass number 32 and half life of \( \frac{1}{2} \) day. If both A and B simultaneously start undergoing radioactive decay at the same time with initial mass 320 \( \mu \) each, how many total atoms of A and B combined would be left after 2 days?

Options:
1. \(1.69 \times 10^{22}\)
2. \(8.76 \times 10^{22}\)
3. \(3.38 \times 10^{24}\)
4. \(5.76 \times 10^{24}\)

Q.9 Given below are two statements:

Statement I: Electromagnetic waves are not deflected by electric and magnetic field.
Statement II: The amplitude of electric field and the magnetic field in electromagnetic waves are related to each other as \( E_0 = \frac{B_0}{\sqrt{\mu_0}} \).

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

Options:
1. Both statement I and statement II are true
2. Statement I is false but statement II is true
3. Statement I is true but statement II is false
4. Both statement I and statement II are false

Q.10 The electric current in a circular coil of four turns produces a magnetic induction \( M2 \) T at its centre. The coil is unwound and is rewound into a circular coil of single turn, the magnetic induction at the centre of the coil by the same current will be:

Options:
1. 4 T
2. 2 T
3. 8 T
4. 16 T

Q.11 For the given logic gate combination, the correct truth table will be

Options:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Q.12 The modulation index for an A.M. wave having maximum and minimum peak-to-peak voltages of 14 mV and 6 mV respectively is:

Options:
1. 0.6
2. 0.4
3. 0.2
4. 1.4

Q.13 The time period of a satellite of earth is 24 hours. If the separation between the earth and the satellite is decreased to one-fourth of the previous value, then its new time period will become:

Options:
1. 4 hours
2. 6 hours
3. 9 hours
4. 12 hours
G.14 With the help of potentiometer, we can determine the value of emf of a given cell. The sensitivity of the potentiometer is

(A) directly proportional to the length of the potentiometer wire
(B) inversely proportional to the potential gradient of the wire
(C) inversely proportional to the potential gradient of the wire
(D) inversely proportional to the length of the potentiometer wire

Choose the correct option for the above statements:

Options
1. A and C only
2. B and D only
3. C only
4. A only

G.15 For the given figure(s), choose the correct option:

Options
1. At resonance, current in (b) is less than that in (a)
2. The rms current in circuit (b) can be larger than that in (a)
3. The rms current in figure (a) is always equal to that in figure (b)
4. The rms current in circuit (b) can never be larger than that in (a)

G.16 The equation of a circle is given by \( x^2 + y^2 = a^2 \), where \( a \) is the radius. If the equation is modified to change the origin other than \((0, 0)\), then find out the correct dimensions of \( A \) and \( B \) in a new equation: \( (x-a)^2 + (y-b)^2 = a^2 \). The dimensions of \( t \) is given as \([T^{-1}]\).

Options
1. \( A = [L^{-1}T^{-1}], B = [LT] \)
2. \( A = [L^{-1}T], B = [LT^{-1}] \)
3. \( A = [L^{-1}T^2], B = [LT^{-1}] \)
4. \( A = [L^{-1}], B = [LT^{-1}] \)

G.17 A scientist is observing a bacteria through a compound microscope. For better analysis and to improve its resolving power he should. (Select the best option.)

Options
1. Increase the wave length of the light
2. Decrease the diameter of the objective lens
3. Decrease the focal length of the eye piece.
4. Increase the refractive index of the medium between the object and objective lens

G.18 A force acts for 20 s on a body of mass 20 kg, starting from rest, after which the force ceases and the body describes 50 m in the next 10 s. The value of force will be:

Options
1. 5 N
2. 20 N
3. 40 N
4. 10 N

G.19 Identify the correct statements from the following:

A. Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket is negative.
B. Work done by gravitational force in lifting a bucket out of a well by a rope tied to the bucket is negative.
C. Work done by friction on a body sliding down an inclined plane is positive.
D. Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity in zero.
E. Work done by the air resistance on an oscillating pendulum is negative.

Choose the correct answer from the options given below:

Options
1. A and C Only
2. B, D and E only
3. B and E only
4. B and D only

G.20 An object moves at a constant speed along a circular path in a horizontal plane with center at the origin. When the object is at \( r = 2 \) m, its velocity is \(-4i\) m/s.

The object's velocity \( v \) and acceleration \( a \) at \( r = 3 \) m will be.
Q.21 In an experiment of measuring the refractive index of a glass slab using travelling microscope in physics lab, a student measures real thickness of the glass slab as 5.25 mm and apparent thickness of the glass slab as 5.00 mm. Travelling microscope has 20 divisions in one cm. on main scale and 50 divisions on vernier scale is equal to 49 divisions on main scale. The estimated uncertainty in the measurement of refractive index of the slab is \( \frac{1}{x} \) mm, where \( x \) is ______.

Given Answer: 2

Q.22 A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential acceleration and centripetal acceleration are equal. The time taken by the car to complete first quarter of revolution, if it is moving with an initial speed of 54 km/hr is \( \frac{1}{e} \). The value of \( e \) is ______.

Given Answer: __________

Q.23 Unpolarised light is incident on the boundary between two dielectric media, whose dielectric constants are 2.8 (medium 1) and 6.8 (medium 2), respectively. To satisfy the condition, so that the reflected and refracted rays are perpendicular to each other, the angle of incidence should be \( \tan^{-1} \left( \frac{1}{6} \right)^{\frac{1}{2}} \). The value of \( \theta \) is ______.

(Given for dielectric media, \( \mu = 1 \))

Q.24 A null point is found at 200 cm in potentiometer when cell in secondary circuit is shunted by 50Ω. When a resistance of 15Ω is used for shunting, null point moves to 200 cm. The internal resistance of the cell is ______ Ω.

Given Answer: __________

Q.25 An inductor of inductance 2 \( \mu \) H is connected in series with a resistance, a variable capacitor and an AC source of frequency 7 kHz. The value of capacitance for which maximum current is drawn into the circuit is \( \frac{1}{\sqrt{L}} \), where the value of \( x \) is ______.

(Take \( \pi = \frac{22}{7} \))

Given Answer: __________

Q.26 A particle of mass 100 g is projected at time \( t = 0 \) with a speed 20 m/s \(^{-1} \) at an angle 45° to the horizontal as given in the figure. The magnitude of the angular momentum of the particle about the starting point at time \( t = 2s \) is found to be \( \sqrt{K} \) kg m/s. The value of \( K \) is ______.

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

Given Answer: __________

Q.27 A particle of mass 250 g executes a simple harmonic motion under a periodic force \( F = -25x \) N. The particle attains a maximum speed of 4 m/s during its oscillation. The amplitude of motion is ______ cm.

Given Answer: 40

Q.28 For a charged spherical ball, electrostatic potential inside the ball varies with \( r \) as \( V = 2\alpha r^3 + \beta \).

Here, \( \alpha \) and \( \beta \) are constant and \( r \) is the distance from the center. The volume charge density inside the ball is \( -\lambda \text{A} \cdot \text{m}^2 \). The value of \( \lambda \) is ______.

\( \varepsilon_0 \) – permittivity of the medium

Given Answer: __________

Q.29 When two resistances \( R_1 \) and \( R_2 \) connected in series and introduced into the left gap of a meter bridge and a resistance of 10 \( \Omega \) is introduced into the right gap, a null point is found at 60 cm from left side. When \( R_1 \) and \( R_2 \) are connected in parallel and introduced into the left gap, a resistance of 3 \( \Omega \) is introduced into the right gap to get null point at 40 cm from left end. The product of \( R_1 \) and \( R_2 \) is ______ \( \Omega^2 \)

Given Answer: __________

Q.30 A metal block of base area 0.20 \( \text{m}^2 \) is placed on a table, as shown in figure. A liquid film of thickness 0.25 mm is inserted between the block and the table. The

Given Answer: __________
block is pushed by a horizontal force of 0.1 N and moves with a constant speed. If the viscosity of the liquid is $5.0 \times 10^{-3}$ Pa·s, the speed of block is $10^{-2}$ m/s.

Given Answer: --

Section: Chemistry Section A

C.31 An indicator 'X' is used for studying the effect of variation in concentration of iodide in the rate of reaction of iodide ion with $\text{H}_2\text{O}_2$ at room temp. The indicator 'Y' forms blue colored complex with compound 'A' present in the solution. The indicator 'X' and compound 'A' respectively are

Options
1. starch and iodine
2. starch and $\text{H}_2\text{O}_2$
3. Methyl orange and iodine
4. Methyl orange and $\text{H}_2\text{O}_2$

C.32 Match List I and List II

<table>
<thead>
<tr>
<th>List I</th>
<th>List II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Osmosis</td>
<td>I. Solvent molecules pass through semi-permeable membrane towards solvent side</td>
</tr>
<tr>
<td>B. Reverse osmosis</td>
<td>II. Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes</td>
</tr>
<tr>
<td>C. Electro osmosis</td>
<td>III. Solvent molecules pass through semi-permeable membrane towards solution side</td>
</tr>
<tr>
<td>D. Electrophoresis</td>
<td>IV. Movement of charged particles towards oppositely charged electrodes</td>
</tr>
</tbody>
</table>

Choose the correct answer from the options given below:

Options
1. A-III, B-II, C-I, D-IV
2. A-I, B-III, C-II, D-IV
3. A-I, B-II, C-IV, D-III
4. A-II, B-I, C-II, D-IV

C.33 The concentration of dissolved oxygen in water for growth of fish should be more than $X$ ppm and biochemical oxygen demand in clean water should be less than $Y$ ppm. $X$ and $Y$ in ppm are, respectively.

Options
1. $X$ 5
2. $Y$ 6
3. $X$ 15
4. $Y$ 8
5. $X$ 6
6. $Y$ 12

C.34 Find out the major product for the following reaction.

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}_2\text{O}^+ \\
\rightarrow \\
\text{Major Product} \\
\end{array}
\]

Options
1. 
2. 
3. 
4. 

C.35 The major component of which of the following ore is sulphide based mineral?

Options
1. Malachite
2. Calamine
3. Sphalerite
4. Siderite

C.36 Given below are two statements:

Statement I: The decrease in first ionization enthalpy from B to Al is much larger than that from Al to Ga.

Statement II: The d orbitals in Ga are completely filled.

Options
1. Option 1
2. Option 2
3. Both
4. Neither

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

**Options**
1. Statement I is incorrect but statement II is correct
2. Both the statements I and II are incorrect
3. Both the statements I and II are correct
4. Statement I is correct but statement II is incorrect

**G.37**
A solution of C₂O₄ in amyl alcohol has a ___________ colour.

**Options**
1. Yellow
2. Green
3. Blue
4. Orange-Red

**G.38**
Which of the following relations are correct?
(A) \( \Delta U = q - p \Delta V \)
(B) \( \Delta G = \Delta H - T \Delta S \)
(C) \( \Delta S = \frac{q_{sp}}{T} \)
(D) \( \Delta H = AU - ArrE \)

Choose the most appropriate answer from the options given below:

**Options**
1. B and D Only
2. C and D Only
3. B and C Only
4. A and B Only

**G.39**
Correct order of spin only magnetic moment of the following complexes is:
(Given At.no. For: 26, Co; 27)

**Options**
1. \([\text{Co}(C₂O₄)₃]^{3-} > [\text{Fe}(C₂O₄)₃]^{3-} > [\text{Fe}(C₂O₄)²⁺]^{3-} \)
2. \([\text{Fe}(C₂O₄)²⁺]^{3-} > [\text{Co}(C₂O₄)₃]^{3-} > [\text{Fe}(C₂O₄)²⁺]^{3-} \)
3. \([\text{Fe}(C₂O₄)²⁺]^{3-} > [\text{Co}(C₂O₄)₃]^{3-} > [\text{Fe}(C₂O₄)²⁺]^{3-} \)
4. \([\text{Co}(C₂O₄)₃]^{3-} > [\text{Fe}(C₂O₄)²⁺]^{3-} > [\text{Co}(C₂O₄)₃]^{3-} \)

**G.40**
Find out the major products from the following reaction sequence.

**Options**
1. \[A \rightarrow \text{NaCN} \rightarrow \text{H}_2\text{O} \rightarrow A \]
2. \[A \rightarrow \text{NaOH, H}_2\text{O} \rightarrow A \]
3. \[A \rightarrow \text{H}_2\text{O} \rightarrow A \]
4. \[A \rightarrow \text{NaOH} \rightarrow A \]

**G.41**
When a hydrocarbon \( A \) undergoes combustion in the presence of air, it requires 9.5 equivalents of oxygen and produces 3 equivalents of water. What is the molecular formula of \( A \)?

**Options**
1. \( C_9H_3 \)
2. \( C_9H_5 \)
3. \( C_9H_7 \)
4. \( C_9H_9 \)

**G.42**
Following tetrapeptide can be represented as

**Options**
1. Not Answered
2. Not Answered
3. Not Answered
4. Not Answered
(F, L, D, Y, I, Q, P are one letter codes for amino acids)

Options
1. YQLF
2. PIQY
3. FLFY
4. FLDF

G. 43. Reaction of propargylamine with \( \text{Br}_2/\text{KOH(aq)} \) produces:

Options
1. Ethyl nitrite
2. Propylamine
3. Propynitrile
4. Ethyamine

G. 44. Match List I with List II

<table>
<thead>
<tr>
<th>List I</th>
<th>List II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. van't Hoff factor, ( \lambda )</td>
<td>I. Cryoscopic constant</td>
</tr>
<tr>
<td>B. ky</td>
<td>II. Isotonic solutions</td>
</tr>
<tr>
<td>C. Solution with same osmotic pressure</td>
<td>III. Normal molal mass</td>
</tr>
<tr>
<td>D. Azeotrope</td>
<td>IV. Solutions with same composition of vapour above it</td>
</tr>
</tbody>
</table>

Choose the correct answer from the options given below:

Options
1. A, II, C, IV, D
2. A, II, C, IV, D
3. A, II, C, IV, D
4. A, II, C, IV, D

G. 45. A doctor prescribed the drug Suralin to a patient. The patient was likely to have symptoms of which disease?

Options
1. Stomach ulcers
2. Hypersensitivity
3. Anxiety and stress
4. Depression and hypertension

G. 46. The one giving maximum number of isomeric alkenes on dehydrohalogenation reaction is (excluding rearrangement)

Options
1. 2-Bromopropane
2. 1-Iodo-2-methylbutane
3. 2-Bromocyclopentane
4. 2-Brom-3,3-dimethylpentane

G. 47. Match List I with List II

<table>
<thead>
<tr>
<th>List I</th>
<th>List II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Elastomeric polymer</td>
<td>I. Unsaturated aldehyde resin</td>
</tr>
<tr>
<td>B. Fiber Polymer</td>
<td>II. Polyurethane</td>
</tr>
<tr>
<td>C. Thermosetting Polymer</td>
<td>III. Polyester</td>
</tr>
<tr>
<td>D. Thermoplastic Polymer</td>
<td>IV. Neoprene</td>
</tr>
</tbody>
</table>

Choose the correct answer from the options given below:

Options
1. A, IV, B, III, C, II
2. A, II, B, I, C, IV, D, III
3. A, II, B, III, C, IV, D, IV
4. A, IV, B, III, C, IV, D, III

G. 48. Given below are two statements:

Statement I: Nickel is being used as the catalyst for producing syn gas and edible fats.

Statement II: Silicon forms both electron rich and electron deficient hydrides.

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

Options
1. Statement I is correct but statement II is incorrect
2. Statement I is incorrect but statement II is correct
3. Both the statements I and II are correct
4. Both the statements I and II are incorrect

G. 49. The set of correct statements is:

(i) Manganese exhibits +7 oxidation state in its oxide.
(ii) Ruthenium and Osmium exhibit +8 oxidation in their oxides.
(iii) Se shows -4 oxidation state which is oxidizing in nature.
(iv) Cr shows oxidising nature in +6 oxidation state.

Options
1. (i), (ii), (iii) and (iv)
2. (i) and (iii)
3. (ii) and (iii)
4. (i), (ii) and (iv)

G.20 According to MO theory the bond orders for O_2^2-, CO and NO^- respectively, are

Options
1. 1.3 and 2
2. 2, 1 and 3
3. 1, 3 and 2
4. 1, 2 and 2

Section : Chemistry Section A
G.21 The volume of HCl, containing 73 g L^-1, required to completely neutralise NaOH obtained by reacting 0.68 g of metallic sodium with water, is ______ ml. (Nearest Integer)
(Given: Molar masses of Na, Cl, O, H, are 23, 35.5, 16 and 1 g mol^-1 respectively)

Given Answer: 2

G.23 When 0.01 mol of an organic compound containing 50% carbon was burnt completely, 4.4 g of CO_2 was produced. The molar mass of compound is___________ g mol^-1 (Nearest integer).

Given Answer: -

G.24 For conversion of compound A → B, the rate constant of the reaction was found to be 4.6 × 10^-3 L mol^-1 s^-1. The order of the reaction is ________.

Given Answer: -

G.24 On heating, LiNO_3 gives how many compounds among the following?
Li_2O, N_2, O_3, LiNO_2, NO_2

Given Answer: -

G.25 A metal M forms hexagonal close-packed structure. The total number of voids in 0.02 mol of it is ______ x 10^-12 (Nearest integer).
(Given N_A = 6.02 × 10^23)

Given Answer: -

G.26 Total number of acidic oxides among N_2O_3, NO_2, N_2O_4, Cl_2O_7, SO_3, CO_2, CaO, N_2O_3, O and NO is ________.

Given Answer: -

G.27 At 298 K

N_2 (g) + 3H_2 (g) ⇌ 2NH_3 (g), K_1 = 4 × 10^5

N_2 (g) + O_2 (g) ⇌ 2NO (g), K_2 = 1.6 × 10^11

H_2 (g) + 1/2 O_2 (g) ⇌ H_2O (g), K_3 = 1.0 × 10^15

Based on above equilibria, the equilibrium constant of the reaction, 2NH_3 (g) = 5/2 O_2 (g) ⇌ 2NO (g) + 3H_2O (g) is ________ x 10^-33
(Nearest integer).

Given Answer: -

G.28 The density of the liquid present in the Fleming's reagent is ________.

Given Answer: -

G.29 The equilibrium constant for the reaction

Zn(s) + Sn^2+ (aq) ⇌ Zn^2+ (aq) + Sn(s) in 1 × 10^20 at 298 K. The magnitude of standard electrode potential of Sn/Sn^2+ if E_Sn^{2+/0} = -0.76 V is ________ x 10^-2 V.
(Nearest integer).

Given: \( \frac{2.303RT}{F} = 0.059 \)

Given Answer: -

G.29 Assume that the radius of the first Bohr orbit of hydrogen atom is 0.6 Å. The radius of the third Bohr orbit of He^+ is ________ angstrom. (Nearest Integer)

Given Answer: -
Let $S = \{w_1, w_2, \ldots, w_n\}$ be the sample space associated to a random experiment. Let $P(w_i) = \frac{1}{2}$, $i \geq 2$. Let $A = \{w_i \mid i \in \mathbb{N}\}$ and $B = \{w_i \mid i \in A\}$. Then $P(B)$ is equal to:

1. $\frac{1}{2}$
2. $\frac{1}{64}$
3. $\frac{1}{32}$
4. $\frac{1}{16}$

The statement $B \Rightarrow (\sim A) \lor B$ is equivalent to:

1. $B \Rightarrow (A \Rightarrow B)$
2. $A \Rightarrow (\sim A \Rightarrow B)$
3. $A \Rightarrow (\sim A \Rightarrow B)$
4. $A \Rightarrow (\sim A \Rightarrow B)$

The number of 3 digit numbers, that are divisible by either 3 or 4 but not divisible by 48, is:

1. 472
2. 432
3. 507
4. 400

Consider a function $f : \mathbb{N} \rightarrow \mathbb{R}$, satisfying:

$f(1) + 2f(2) + 3f(3) + \cdots + xf(x) = x(x+1)f(x)$, $x \geq 2$ with $f(1) = 1$.

Then $\frac{1}{f(2n)} + \frac{1}{f(3n)}$ is equal to:

1. 8100
2. 8700
3. 8000
4. 8400

Let $K$ be the sum of the coefficients of the odd powers of $x$ in the expansion of $(1 - x)^9$. Let $a$ be the middle term in the expansion of $\left(1 + \frac{1}{\sqrt{3}}\right)^n$. If $\frac{a}{n}$ is equal to:

1. $\frac{1}{51}$
2. $\frac{2}{53}$
3. $\frac{3}{55}$
4. $\frac{4}{57}$

The shortest distance between the lines $\frac{x-1}{2} = \frac{y+8}{3} = \frac{z+6}{5}$ and $\frac{x-1}{2} = \frac{y-2}{1} = \frac{z-6}{3}$ is:

1. $3\sqrt{3}$
2. $2\sqrt{3}$
3. $\sqrt{3}$
4. $4\sqrt{3}$

The value of the integral $\int_1^2 \frac{f'(x)^2}{f(x)+1} \, dx$ is:

1. $\tan^{-1}2 - \frac{1}{3} \tan^{-1}8 + \frac{\pi}{3}$
2. $\tan^{-1}2 - \frac{1}{3} \tan^{-1}8 - \frac{\pi}{3}$
3. $\tan^{-1}2 - \frac{1}{3} \tan^{-1}8 + \frac{\pi}{3}$
4. $\tan^{-1}2 - \frac{1}{3} \tan^{-1}8 - \frac{\pi}{3}$

Let $f$ and $g$ be twice differentiable functions on $\mathbb{R}$ such that

$f''(x) = g''(x) + 6x$
$f'(1) = 4g'(1) - 3 = 9$
$f(2) = 3g(2) = 12$.

Then which of the following is NOT true?
Let \( R \) be a relation defined on \( \mathbb{N} \) as \( a R b \) if \( 2a + 3b \) is a multiple of 5. Is \( R \) transitive but not symmetric?

Options:
1. Transitive but not symmetric
2. An equivalence relation
3. Not reflexive
4. Symmetric but not transitive

If the tangent at a point \( P \) on the parabola \( y^2 = 2x \) is parallel to the line \( x + 2y = 1 \) and the tangents at the points \( Q \) and \( R \) on the ellipse \( \frac{x^2}{4} + \frac{y^2}{9} = 1 \) are perpendicular to the line \( x - y = 2 \), then the area of the triangle \( PQR \) is:

\[
\frac{3}{2} \sqrt{5} \\
2 \sqrt{5} \\
3 \sqrt{5} \\
\frac{9}{2} \sqrt{5}
\]

If \( \mathbf{a} = i + 2k, \ \mathbf{b} = i + j + k, \ \mathbf{c} = i - 2j + 3k, \ \mathbf{d} = 2i + 3j - k \) and \( \mathbf{a} \cdot \mathbf{b} = 0 \) and \( \mathbf{a} \cdot \mathbf{c} = 0 \), then \( \mathbf{a} \cdot \mathbf{d} \) is equal to:

Options:
1. 10
2. 22
3. 28
4. 18

If the lines \( \frac{x-1}{1} = \frac{y-2}{2} = \frac{z+3}{3} \) and \( \frac{x-1}{3} = \frac{y-2}{4} = \frac{z-3}{5} \) intersect at the point \( P \), then the distance of the point \( P \) from the plane \( z = 0 \) is:

Options:
1. 10
2. 22
3. 28
4. 18

The value of the integral \( \int_{0}^{1} \frac{1}{\sqrt{x}} \, dx \) is equal to:

Options:
1. \( 2 \log_2 2 \)
2. \( \frac{2}{3} \log_2 2 \)
3. \( \frac{2}{2} \log_2 2 \)
4. \( \frac{1}{2} \log_2 2 \)

The plane \( 2x - y + z = 4 \) intersects the line segment joining the points \( A(a, -2, 1) \) and \( B(b, -2, -3) \) at the ratio 2:1 and the distance of the point \( C \) from the origin is \( \sqrt{7} \). If \( ab < 0 \) and \( P \) is the point \( (a - b, b, 2b - a) \) then \( CP^2 \) is equal to:

Options:
1. 16
2. 17
3. 13
4. 12

The area of the region \( A = \left\{ (x, y) \mid \cos x - \sin x |x| \leq \sin x, 0 \leq x \leq \frac{\pi}{2} \right\} \) is:

Options:
1. \( \sqrt{2} + \sqrt{2} + 1 \)
2. \( \frac{3}{2} \sqrt{2} + \sqrt{3} \)
3. \( \frac{3}{2} \sqrt{2} \)
4. \( \sqrt{2} + \sqrt{5} - \sqrt{3} \)

The letter of the word "OUGHT" are written in all possible ways and these words are arranged as in a dictionary, in a series. Then the serial number of the word "TOUGH" is:

Options:
1. 79
2. 86
3. 84
4. 89
Let \( \vec{a} = 4\hat{i} + 3\hat{j} \) and \( \vec{b} = 5\hat{i} - 4\hat{j} + 5\hat{k} \). If \( \vec{c} \) is a vector such that 
\[ \vec{c} \cdot \left( \hat{i} \times \hat{k} \right) + 25 = 0, \quad \vec{c} \cdot (\hat{i} + \hat{j} - \hat{k}) = 4, \]  
and projection of \( \vec{c} \) on \( \vec{a} \) equals \( \frac{1}{\sqrt{5}} \), then the projection of \( \vec{c} \) on \( \vec{b} \) equals \( \frac{1}{4} \).}


**Options**
1. \( \frac{1}{\sqrt{5}} \)
2. \( \frac{1}{5} \)
3. \( \frac{1}{\sqrt{2}} \)
4. \( \frac{3}{\sqrt{5}} \)
Let \( a_1 = b_1 = 1 \) and \( a_n = a_{n-1} + (n-1), b_n = b_{n-1} + a_{n-1}, \forall n \geq 2 \). If \( S = \sum_{n=1}^{\infty} \frac{a_n}{2^n} \) and \( T = \sum_{n=1}^{\infty} \frac{n}{2^n} \), then \( 2^7 (3S - T) \) is equal to ________.

**Q.51** A circle with centre \((2, 3)\) and radius 4 intersects the line \(x + y = 7\) at the points \(P\) and \(Q\). If the tangents at \(P\) and \(Q\) intersect at the point \(S(a, \beta)\), then \(4a - 7\beta\) is equal to ________.

**Q.52** Let \(\{a_k\}\) and \(\{b_k\}\), \(k \in \mathbb{N}\), be two G.P.s with common ratios \(r_1\) and \(r_2\) respectively such that \(a_1 = b_1 = 1\) and \(r_1 < r_2\). Let \(c_k = a_k + b_k, k \in \mathbb{N}\). If \(c_1 = 8\) and \(c_2 = 13\), then \(\sum_{k=1}^{5} c_k -(12a_k + 8b_k)\) is equal to ________.

**Q.53** Let \( a = 8 - 14i; A = \left\{ z \in \mathbb{C}; \frac{a_1 - a_2}{z^2 - \overline{z}^2} = 1 \right\} \) and \( B = \{ z \in \mathbb{C}; \mid z + 3i \mid = 4 \} \). Then \(\sum_{z \in A \cap B} (\Re z - \Im z)\) is equal to ________.

**Q.54** Let \( a = 8 - 14i; A = \left\{ z \in \mathbb{C}; \frac{a_1 - a_2}{z^2 - \overline{z}^2} = 1 \right\} \) and \( B = \{ z \in \mathbb{C}; \mid z + 3i \mid = 4 \} \). Then \(\sum_{z \in A \cap B} (\Re z - \Im z)\) is equal to ________.