### JEE April 2019

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<th>Candidate Name</th>
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<td>Paper I EH</td>
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**Subject**: Paper I EH  
**Section**: Physics

#### Q.1
A shell is fired from a fixed artillery gun with an initial speed \( u \) such that it hits the target on the ground at a distance \( R \) from it. If \( t_1 \) and \( t_2 \) are the values of the time taken by it to hit the target in two possible ways, the product \( t_1 t_2 \) is:

**Options**
1. \( \frac{R}{4g} \)
2. \( \frac{R}{g} \)
3. \( \frac{R}{2g} \)
4. \( \frac{2R}{g} \)

**Question Type**: MCQ  
**Question ID**: 41652914862  
**Option 1 ID**: 41652958229  
**Option 2 ID**: 41652958227  
**Option 3 ID**: 41652958226  
**Option 4 ID**: 41652958228  
**Status**: Answered  
**Chosen Option**: 3

#### Q.2
The trajectory of a projectile near the surface of the earth is given as \( y = 2x - 9x^2 \). If it were launched at an angle \( \theta_0 \) with speed \( v_0 \) then \( g = 10 \text{ ms}^{-2} \):

**Options**
1. \( \theta_0 = \sin^{-1} \left( \frac{1}{\sqrt{5}} \right) \) and \( v_0 = \frac{5}{3} \text{ ms}^{-1} \)
2. \( \theta_0 = \cos^{-1} \left( \frac{2}{\sqrt{5}} \right) \) and \( v_0 = \frac{3}{5} \text{ ms}^{-1} \)
3. \( \theta_0 = \cos^{-1} \left( \frac{1}{\sqrt{5}} \right) \) and \( v_0 = \frac{5}{3} \text{ ms}^{-1} \)
4. \( \theta_0 = \sin^{-1} \left( \frac{2}{\sqrt{5}} \right) \) and \( v_0 = \frac{3}{5} \text{ ms}^{-1} \)

**Question Type**: MCQ  
**Question ID**: 41652914857  
**Option 1 ID**: 41652958206  
**Option 2 ID**: 41652958209  
**Option 3 ID**: 41652958207  
**Option 4 ID**: 41652958208  
**Status**: Answered

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https://cdn3.digialm.com//per/g21/pub/2083/touchstone/AssessmentQPHMLMode1//2083O1951/2083O1951S11D37487/15550789492345932...
Q.3  Shown in the figure is a shell made of a conductor. It has inner radius \( a \) and outer radius \( b \), and carries charge \( Q \). At its centre is a dipole \( \mathbf{p} \) as shown. In this case:

![Diagram of a shell with dipole](image)

**Options**

1. Surface charge density on the inner surface is uniform and equal to \( \frac{Q}{2 \pi a^2} \).
2. Electric field outside the shell is the same as that of a point charge at the centre of the shell.
3. Surface charge density on the outer surface depends on \( |\mathbf{p}| \).
4. Surface charge density on the inner surface of the shell is zero everywhere.

Q.4  When \( M_1 \) gram of ice at \(-10^\circ C\) (specific heat = 0.5 cal g\(^{-1}\) C\(^{-1}\)) is added to \( M_2 \) gram of water at \(50^\circ C\), finally no ice is left and the water is at \(0^\circ C\). The value of latent heat of ice, in cal g\(^{-1}\) is:

**Options**

1. \( \frac{50M_2}{M_1} = 5 \)
2. \( \frac{5M_1}{M_2} = 50 \)
3. \( \frac{50M_2}{M_1} \)
4. \( \frac{5M_2}{M_1} = 5 \)

Question Type: MCQ  
Question ID: 41652914870  
Option 1 ID: 41652958260  
Option 2 ID: 41652958261  
Option 3 ID: 41652958259  
Option 4 ID: 41652958258  
Status: Answered  
Chosen Option: 2
Q.5  The truth table for the circuit given in the fig. is:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>Y</th>
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Options

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
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<tr>
<td>4</td>
<td>0</td>
<td>1</td>
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Q.6  

Question Type: MCQ
Question ID: 41652914884
Option 1 ID: 41652958317
Option 2 ID: 41652958316
Option 3 ID: 41652958314
Option 4 ID: 41652958315
Status: Answered
Chosen Option: 3
A circular disc of radius $b$ has a hole of radius $a$ at its centre (see figure). If the mass per unit area of the disc varies as $\left(\frac{\rho_0}{r}\right)$, then the radius of gyration of the disc about its axis passing through the centre is:

\[ \sqrt{\frac{a^2 + b^2 + ab}{2}} \]
\[ \frac{a + b}{2} \]
\[ \sqrt{\frac{a^2 + b^2 + ab}{3}} \]
\[ \frac{a + b}{3} \]

Q. 7

The stopping potential $V_o$ (in volt) as a function of frequency ($\nu$) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be:

(Given: Planck's constant $\hbar = 6.63 \times 10^{-34}$ Js, electron charge $e = 1.6 \times 10^{-19}$ C)

Options
1. 1.82 eV
2. 1.66 eV
3. 1.95 eV
4. 2.12 eV
Q.8 A uniform rod of length \( l \) is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is \( T(x) \) at a distance \( x \) from the axis, then which of the following graphs depicts it most closely?

Options

1. \[
\begin{array}{c}
T(x) \\
\hline
l \\
x
\end{array}
\]

2. \[
\begin{array}{c}
T(x) \\
\hline
l \\
x
\end{array}
\]

3. \[
\begin{array}{c}
T(x) \\
\hline
l \\
x
\end{array}
\]

4. \[
\begin{array}{c}
T(x) \\
\hline
l \\
x
\end{array}
\]

Question Type: MCQ
Question ID: 41652914861
Option 1 ID: 41652958222
Option 2 ID: 41652958225
Option 3 ID: 41652958223
Option 4 ID: 41652958224
Status: Answered
Chosen Option: 3

Q.9

https://cdn3.digialm.com///per/g21/pub/2083/touchstone/AssessmentQPHTMLMode1//2083O1951/2083O1951S11D37487/15550789492345932...
To verify Ohm’s law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained:

![Diagram of Ohm's Law circuit with a voltmeter and ammeter](https://cdn3.digialm.com//per/g21/pub/2083/touchstone/AssessmentQPHTMLMode1//2083O1951/2083O1951S11D37487/15550787942345932)

If $V_o$ is almost zero, identify the correct statement:

Options

1. The emf of the battery is 1.5 V and its internal resistance is 1.5 $\Omega$
2. The value of the resistance $R$ is 1.5 $\Omega$
3. The potential difference across the battery is 1.5 V when it sends a current of 1000 mA
4. The emf of the battery is 1.5 V and the value of $R$ is 1.5 $\Omega$

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**Q.10** A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of $40 \pi$ rad/s$^{-1}$ about its axis, perpendicular to its plane. If the magnetic field at its centre is $3.8 \times 10^{-9}$ T, then the charge carried by the ring is close to ($\mu_0 = 4\pi \times 10^{-7}$ N/A$^2$).

Options

1. $2 \times 10^{-6}$ C
2. $3 \times 10^{-5}$ C
3. $4 \times 10^{-5}$ C
4. $7 \times 10^{-6}$ C
Q.11
An electromagnetic wave is represented by the electric field
\[ \vec{E} = E_0 \hat{n} \sin (\omega t + (6y - 8z)) \]. Taking unit vectors in \( x, y \) and \( z \) directions to be \( \hat{i}, \hat{j}, \hat{k} \), the direction of propagation \( \hat{s} \), is:

Options
1. \[ \hat{s} = \frac{3\hat{i} - 4\hat{j}}{5} \]
2. \[ \hat{s} = \frac{-4\hat{k} + 3\hat{j}}{5} \]
3. \[ \hat{s} = \left( -\frac{3\hat{j} + 4\hat{k}}{5} \right) \]
4. \[ \hat{s} = \frac{4\hat{j} - 3\hat{k}}{5} \]

Q.12
A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40 times per minute where the dip is 30°. If \( B_1 \) and \( B_2 \) are respectively the total magnetic field due to the earth at the two places, then the ratio \( B_1/B_2 \) is best given by:

Options
1. 1.8
2. 0.7
3. 3.6
4. 2.2
Q.13 At 40°C, a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from 40°C to 20°C it regains its original length of 0.2 m. The value of M is close to:

(Coefficient of linear expansion and Young's modulus of brass are 10^{-5}/°C and 10^{11} N/m^2, respectively; g = 10 ms^{-2})

Options
1. 9 kg
2. 0.5 kg
3. 1.5 kg
4. 0.9 kg

Q.14 A galvanometer of resistance 100 Ω has 50 divisions on its scale and has sensitivity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0-2V, 0-10 V and 0-20 V. The appropriate circuit to do so is:

Options
1. \[ \begin{align*} R_1 & = 2000 \, \Omega \\ R_2 & = 8000 \, \Omega \\ R_3 & = 10000 \, \Omega \\ \end{align*} \]
2. \[ \begin{align*} R_1 & = 1900 \, \Omega \\ R_2 & = 9900 \, \Omega \\ R_3 & = 19900 \, \Omega \\ \end{align*} \]
3. \[ \begin{align*} R_1 & = 1900 \, \Omega \\ R_2 & = 8000 \, \Omega \\ R_3 & = 10000 \, \Omega \\ \end{align*} \]
4. \[ \begin{align*} R_1 & = 1900 \, \Omega \\ R_2 & = 9900 \, \Omega \\ R_3 & = 1900 \, \Omega \\ \end{align*} \]

Q.15

https://cdn3.digialm.com//per/g21/pub/2083/touchstone/AssessmentQPHTMLMode1//2083O1951/2083O1951S11D37487/15550789492345932...
A progressive wave travelling along the positive $x$-direction is represented by $y(x,t) = A\sin(kx - \omega t + \phi)$. Its snapshot at $t = 0$ is given in the figure.

For this wave, the phase $\phi$ is:

Options
1. $-\frac{\pi}{2}$
2. $\pi$
3. 0
4. $\frac{\pi}{2}$

Q.16 The value of numerical aperature of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be:

Options
1. 0.24 μm
2. 0.38 μm
3. 0.12 μm
4. 0.48 μm

Q.17 A point dipole $\vec{p} = -p_0 \hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the $y$-axis at a distance $d$ are, respectively: (Take $V = 0$ at infinity)

Options
Q.18 The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 Watt. The value of R is:

\[ \frac{4R}{4\pi \varepsilon_0 d^2} \frac{-p}{4\pi \varepsilon_0 d^3} \]

Options 1. 6 Ω
2. 8 Ω
3. 1 Ω
4. 16 Ω

Q.19
The transfer characteristic curve of a transistor, having input and output resistance 100 Ω and 100 kΩ respectively, is shown in the figure. The Voltage and Power gain, are respectively:

$$I_C (mA)$$

$$I_B (μA)$$

Options:
1. $$2.5 \times 10^4, 2.5 \times 10^6$$
2. $$5 \times 10^4, 5 \times 10^6$$
3. $$5 \times 10^4, 5 \times 10^5$$
4. $$5 \times 10^4, 2.5 \times 10^6$$

Q.20 Which of the following combinations has the dimension of electrical resistance ($$ε_0$$ is the permittivity of vacuum and $$μ_0$$ is the permeability of vacuum)?

Options:
1. $$\sqrt{μ_0 \over ε_0}$$
2. $$μ_0 \over ε_0$$
3. $$ε_0 \sqrt{ε_0 \over μ_0}$$
4. $$ε_0 \over μ_0$$
Q.21 A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is $-180 \text{ J}$. The gas absorbs $250 \text{ J}$ of heat along the path ab and $60 \text{ J}$ along the path bc. The work done by the gas along the path abc is:

\[ W = \int_{a}^{b} P \, dV + \int_{b}^{c} P \, dV + \int_{c}^{a} P \, dV \]

\[ W = \Delta U + Q + W_{int} \]

\[ W = 120 \text{ J} \]
\[ W = 130 \text{ J} \]
\[ W = 100 \text{ J} \]
\[ W = 140 \text{ J} \]

Q.22 The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of $1 \text{ cm/s}$. At some instant, a part of L is in a uniform magnetic field of $1 \text{ T}$, perpendicular to the plane of the loop. If the resistance of L is $1.7 \Omega$, the current in the loop at that instant will be close to:

\[ I = \frac{BLv}{R} \]

\[ I = 60 \mu\text{A} \]
\[ I = 170 \mu\text{A} \]
\[ I = 150 \mu\text{A} \]
\[ I = 115 \mu\text{A} \]
Q.23  Two identical parallel plate capacitors, of capacitance \( C \) each, have plates of area \( A \), separated by a distance \( d \). The space between the plates of the two capacitors is filled with three dielectrics, of equal thickness and dielectric constants \( K_1 \), \( K_2 \) and \( K_3 \). The first capacitor is filled as shown in Fig. I, and the second one is filled as shown in Fig. II.

If these two modified capacitors are charged by the same potential \( V \), the ratio of the energy stored in the two, would be (\( E_1 \) refers to capacitor (I) and \( E_2 \) to capacitor (II)) :

\[
\frac{E_1}{E_2} = \frac{K_1 K_2 K_3}{(K_1 + K_2 + K_3)(K_2 K_3 + K_3 K_1 + K_1 K_2)}
\]

Options

1. \( \frac{K_1 K_2 K_3}{(K_1 + K_2 + K_3)(K_2 K_3 + K_3 K_1 + K_1 K_2)} \)
2. \( \frac{K_1 K_2 K_3}{9 K_1 K_2 K_3} \)
3. \( \frac{9 K_1 K_2 K_3}{(K_1 + K_2 + K_3)(K_2 K_3 + K_3 K_1 + K_1 K_2)} \)
4. \( \frac{9 K_1 K_2 K_3}{(K_1 + K_2 + K_3)(K_3 K_1 + K_2 K_2)} \)

Q.24  A person of mass \( M \) is, sitting on a swing of length \( L \) and swinging with an angular amplitude \( \theta_0 \). If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance \( l (<< L) \), is close to :

Options

1. \( Mg l (1 - \theta_0^2) \)
2. \( Mg l (1 + \theta_0^2) \)
3. \( Mg l \)
4. \[ \text{MgI} \left( 1 + \frac{a_0^2}{2} \right) \]

Q.25 Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume? (\( R = 8.3 \text{ J/mol K} \))

Options
1. 19.7 J/mol K
2. 15.7 J/mol K
3. 17.4 J/mol K
4. 21.6 J/mol K

Q.26 A submarine (A) travelling at 18 km/hr is being chased along the line of its velocity by another submarine (B) travelling at 27 km/hr. B sends a sonar signal of 500 Hz to detect A and receives a reflected sound of frequency \( v \). The value of \( v \) is close to: (Speed of sound in water = 1500 ms\(^{-1}\))

Options
1. 504 Hz
2. 507 Hz
3. 499 Hz
4. 502 Hz

Q.27

Question Type: MCQ
Question ID: 41652914859
Option 1 ID: 41652958215
Option 2 ID: 41652958217
Option 3 ID: 41652958214
Option 4 ID: 41652958216
Status: Answered
Chosen Option: 1

Question Type: MCQ
Question ID: 41652914866
Option 1 ID: 41652958244
Option 2 ID: 41652958242
Option 3 ID: 41652958243
Option 4 ID: 41652958245
Status: Answered
Chosen Option: 3

Question Type: MCQ
Question ID: 41652914868
Option 1 ID: 41652958252
Option 2 ID: 41652958253
Option 3 ID: 41652958251
Option 4 ID: 41652958250
Status: Answered
Chosen Option: 4
A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of 0.70 m s⁻¹ with respect to the man. The speed of the man with respect to the surface is:

Options 1. 0.28 m s⁻¹
2. 0.20 m s⁻¹
3. 0.47 m s⁻¹
4. 0.14 m s⁻¹

Q.28 A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to:
(Refractive index of water = 1.33)

Options 1. 6.7 cm
2. 13.4 cm
3. 8.8 cm
4. 11.7 cm

Q.29
An excited $\text{He}^+$ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number $n$, corresponding to its initial excited state is (for photon of wavelength $\lambda$, energy $E = \frac{1240 \text{ eV}}{\lambda \text{(in nm)}}$):

Options
1. $n = 4$
2. $n = 5$
3. $n = 7$
4. $n = 6$

Q.30 In a double slit experiment, when a thin film of thickness $t$ having refractive index $\mu$ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of $t$ is ($\lambda$ is the wavelength of the light used):

Options
1. $\frac{2\lambda}{(\mu - 1)}$
2. $\frac{\lambda}{2(\mu - 1)}$
3. $\frac{\lambda}{(\mu - 1)}$
4. $\frac{\lambda}{(2\mu - 1)}$

Section: Chemistry

Q.1 An example of a disproportionation reaction is:

Options
1. $2 \text{MnO}_4^- + 10 \text{I}^- + 16 \text{H}^+ \rightarrow 2 \text{Mn}^{2+} + 5 \text{I}_2 + 8 \text{H}_2\text{O}$
2. \(2 \text{NaBr} + \text{Cl}_2 \rightarrow 2 \text{NaCl} + \text{Br}_2\)

3. \(2 \text{KMnO}_4 \rightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2\)

4. \(2 \text{CuBr} \rightarrow \text{CuBr}_2 + \text{Cu}\)

Q.2  The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg\(^{-1}\)) of the aqueous solution is:

Options
1. \(13.88 \times 10^{-2}\)
2. \(13.88 \times 10^{-1}\)
3. 13.88
4. \(13.88 \times 10^{-3}\)

Q.3  An ideal gas is allowed to expand from 1 L to 10 L against a constant external pressure of 1 bar. The work done in kJ is:

Options
1. \(-9.0\)
2. \(+10.0\)
3. \(-0.9\)
4. \(-2.0\)

Q.4  Which of the following is a thermosetting polymer?

Options
1. Bakelite
2. Buna-N
3. Nylon 6
4. PVC

Q.5 The major product(s) obtained in the following reaction is/are:

\[
\text{Br} \xrightarrow{\text{KOBu}} \xrightarrow{\text{O}_2/\text{Me}_2\text{S}} \]

Options
1. OHC-\(\text{CHO}\) and OHC-\(\text{CHO}\)
2. OHC-\(\text{CHO}\)
3. OHC-\(\text{CHO}\)
4. OHC-\(\text{CHO}\)

Question Type: MCQ
Question ID: 41652914892
Option 1 ID: 41652958347
Option 2 ID: 41652958349
Option 3 ID: 41652958348
Option 4 ID: 41652958346
Status: Answered
Chosen Option: 1

Q.6 The metal that gives hydrogen gas upon treatment with both acid as well as base is:

Options
1. magnesium
2. mercury
3. zinc
4. iron

Question Type: MCQ
Question ID: 41652914894
Option 1 ID: 41652958354
Option 2 ID: 41652958355
Option 3 ID: 41652958356
Option 4 ID: 41652958357
Status: Not Answered
Chosen Option: --

Q.7

Question Type: MCQ
Question ID: 41652914898
Option 1 ID: 41652958370
Option 2 ID: 41652958373
Option 3 ID: 41652958372
Option 4 ID: 41652958371
Status: Answered
Chosen Option: 3
The major product of the following reaction is:

\[
\begin{array}{c}
\text{HO} \\
\text{HO} \quad (1) \text{CrO}_3 \\
\text{SOCl}_2/\Delta \\
(3) \Delta
\end{array}
\]

Options
1. [Image of option 1]
2. [Image of option 2]
3. [Image of option 3]
4. [Image of option 4]

Q.8 Glucose and Galactose are having identical configuration in all the positions except position.

Options 1. C-3
2. C-4
3. C-2
4. C-5
Q.9
The major product of the following addition reaction is
\[ \text{CH}_3 \text{CH} - \text{CH} = \text{CH}_2 + \text{Cl}_2 / \text{H}_2\text{O} \]

Options
1. \( \text{CH}_3 \text{CH} \text{CH} \text{CH} \)
   \[ \text{Cl} \text{Cl} \text{OH} \]
2. \( \text{H}_3\text{C} \text{CH} - \text{CH}_2 \)
   \[ \text{OH} \text{Cl} \]
3. \( \text{H}_3\text{C} \text{O} \)
4. \( \text{H}_3\text{C} \text{OCH}_3 \)

Question Type : MCQ
Question ID : 41652914890
Option 1 ID : 41652958338
Option 2 ID : 41652958339
Option 3 ID : 41652958340
Option 4 ID : 41652958341
Status : Answered
Chosen Option : 2

Q.10
Given:
\[ \text{Co}^{3+} + e^- \rightarrow \text{Co}^{2+}; E^o = +1.81 \text{ V} \]
\[ \text{Pb}^{4+} + 2e^- \rightarrow \text{Pb}^{2+}; E^o = +1.67 \text{ V} \]
\[ \text{Ce}^{4+} + e^- \rightarrow \text{Ce}^{3+}; E^o = +1.61 \text{ V} \]
\[ \text{Bi}^{3+} + 3e^- \rightarrow \text{Bi}; E^o = +0.20 \text{ V} \]

Oxidizing power of the species will increase in the order:

Options
1. \( \text{Ce}^{4+} < \text{Pb}^{4+} < \text{Bi}^{3+} < \text{Co}^{3+} \)
2. \( \text{Bi}^{3+} < \text{Ce}^{4+} < \text{Pb}^{4+} < \text{Co}^{3+} \)
3. \( \text{Co}^{3+} < \text{Ce}^{4+} < \text{Bi}^{3+} < \text{Pb}^{4+} \)
4. \( \text{Co}^{3+} < \text{Pb}^{4+} < \text{Ce}^{4+} < \text{Bi}^{3+} \)

Question Type : MCQ
Question ID : 41652914913
Option 1 ID : 41652958433
Option 2 ID : 41652958432
Option 3 ID : 41652958430
Option 4 ID : 41652958431
Status : Answered
Chosen Option : 2

Q.11
Which of the following statements is not true about RNA?

Options
1. It controls the synthesis of protein
2. It has always double stranded α-helix structure
3. It usually does not replicate
4. It is present in the nucleus of the cell
Q.12  The group number, number of valence electrons, and valency of an element with atomic number 15, respectively, are:

Options 1. 16, 5 and 2
2. 15, 5 and 3
3. 16, 6 and 3
4. 15, 6 and 2

Q.13  The basic structural unit of feldspar, zeolites, mica, and asbestos is:

Options 1. \((\text{SiO}_3)^2-\)
2. \(\text{SiO}_2\)
3. \((\text{SiO}_4)^4-\)

\[
\frac{\text{R}}{\text{Si}} - \frac{\text{O}}{\text{O}} - \frac{\text{R}_1}{\text{R}} (R = \text{Me})
\]
4. \((\text{SiO}_4)^4-\)

Q.14  In the following reaction; \(xA \rightarrow yB\)

\[
\log_{10} \left[ -\frac{d[A]}{dt} \right] = \log_{10} \left[ \frac{d[B]}{dt} \right] + 0.3010
\]

‘A’ and ‘B’ respectively can be:

Options 1. n-Butane and Iso-butane
2. \(\text{C}_2\text{H}_2\) and \(\text{C}_6\text{H}_6\)
3. \(\text{C}_2\text{H}_4\) and \(\text{C}_4\text{H}_8\)
4. \( \text{N}_2\text{O}_4 \) and \( \text{NO}_2 \)

**Q.15** The increasing order of the \( pK_a \) of the following compound is:

(A) ![Structure A]

(B) ![Structure B]

(C) ![Structure C]

(D) ![Structure D]

Options:
1. \((A) < (C) < (D) < (B)\)
2. \((C) < (A) < (D) < (B)\)
3. \((B) < (D) < (A) < (C)\)
4. \((B) < (D) < (C) < (A)\)

**Q.16**

![Image of question 16]
The electrons are more likely to be found:

Options:
1. in the region a and c
2. in the region a and b
3. only in the region a
4. only in the region c

Q.17 The correct sequence of thermal stability of the following carbonates is:

Options:
1. BaCO₃ < CaCO₃ < SrCO₃ < MgCO₃
2. MgCO₃ < CaCO₃ < SrCO₃ < BaCO₃
3. MgCO₃ < SrCO₃ < CaCO₃ < BaCO₃
4. BaCO₃ < SrCO₃ < CaCO₃ < MgCO₃

Q.18 The complex ion that will lose its crystal field stabilization energy upon oxidation of its metal to +3 state is:

(Phen = [N\_3]^- and ignore pairing energy)

Options:
1. [Co(phen)₃]^{2+}
2. [Ni(phen)₃]^{2+}
3. [Zn(phen)$_3$]$^{2+}$
4. [Fe(phen)$_3$]$^{2+}$

Q.19 But-2-ene on reaction with alkaline KMnO$_4$ at elevated temperature followed by acidification will give:

Options
1. CH$_3$ - CH - CH - CH$_3$
   OH   OH
   one molecule of CH$_3$CHO and one molecule of CH$_3$COOH
2. 2 molecules of CH$_3$COOH
3. 2 molecules of CH$_3$CHO

Q.20 Complete removal of both the axial ligands (along the z-axis) from an octahedral complex leads to which of the following splitting patterns? (relative orbital energies not on scale).

Options
1. E
   d$_{x^2-y^2}$
   d$_{xy}$
   d$_{z^2}$
   d$_{xz}$, d$_{yz}$
2. E
   d$_{x^2}$
   d$_{x^2-y^2}$
   d$_{xz}$, d$_{yz}$
   d$_{xy}$
Q.21 An organic compound ‘A’ is oxidized with Na₂O₂ followed by boiling with HNO₃. The resultant solution is then treated with ammonium molybdate to yield a yellow precipitate. Based on above observation, the element present in the given compound is:

Options
1. Nitrogen
2. Phosphorus
3. Fluorine
4. Sulphur

Q.22 The correct set of species responsible for the photochemical smog is:

Options
1. N₂, NO₂ and hydrocarbons
2. CO₂, NO₂, SO₂ and hydrocarbons
3. NO, NO₂, O₃ and hydrocarbons
4. N₂, O₂, O₃ and hydrocarbons
Q.23 Peptization is a:

Options
1. process of bringing colloidal molecule into solution
2. process of converting precipitate into colloidal solution
3. process of converting a colloidal solution into precipitate
4. process of converting soluble particles to form colloidal solution

Status: Answered
Chosen Option: 2

Q.24 The correct statement among the following is:

Options
1. (SiH$_3$)$_3$N is planar and less basic than (CH$_3$)$_3$N.
2. (SiH$_3$)$_3$N is pyramidal and more basic than (CH$_3$)$_3$N.
3. (SiH$_3$)$_3$N is pyramidal and less basic than (CH$_3$)$_3$N.
4. (SiH$_3$)$_3$N is planar and more basic than (CH$_3$)$_3$N.

Status: Answered
Chosen Option: 2

Q.25 Enthalpy of sublimation of iodine is 24 cal g$^{-1}$ at 200 °C. If specific heat of I$_2$(s) and I$_2$(vap) are 0.055 and 0.031 cal g$^{-1}$K$^{-1}$ respectively, then enthalpy of sublimation of iodine at 250 °C in cal g$^{-1}$ is:

Options
1. 2.85
2. 5.7
3. 22.8
Q.26 An element has a face-centred cubic (fcc) structure with a cell edge of a. The distance between the centres of two nearest tetrahedral voids in the lattice is:

Options
1. $\sqrt{2}a$
2. $a$
3. $\frac{a}{2}$
4. $\frac{3a}{2}$

Q.27 What is the molar solubility of $\text{Al(OH)}_3$ in 0.2 M NaOH solution? Given that, solubility product of $\text{Al(OH)}_3 = 2.4 \times 10^{-24}$:

Options
1. $3 \times 10^{-19}$
2. $12 \times 10^{-21}$
3. $3 \times 10^{-22}$
4. $12 \times 10^{-23}$

Q.28
The major products of the following reaction are:

1. \( \text{CHCl}_3/\text{aq. NaOH} \)
2. \( \text{HCHO, NaOH (conc.)} \)
3. \( \text{H}_3\text{O}^+ \)

Options

1. \( \text{OH} \)
\( \text{COOH} \)
\( \text{Cl} \)
and Methanol

2. \( \text{OH} \)
\( \text{COOH} \)
\( \text{Cl} \)
and Methanol

3. \( \text{OH} \)
\( \text{OH} \)
\( \text{Cl} \)
and Formic acid

4. \( \text{OH} \)
\( \text{OH} \)
\( \text{Cl} \)
and Formic acid

Q.29

5 moles of \( \text{AB}_2 \) weigh \( 125 \times 10^{-3} \) kg and 10 moles of \( \text{A}_2\text{B}_7 \) weigh \( 300 \times 10^{-3} \) kg. The molar mass of \( \text{A} \) \((M_A)\) and molar mass of \( \text{B} \) \((M_B)\) in kg mol\(^{-1}\) are:

Options

1. \( M_A = 10 \times 10^{-3} \) and \( M_B = 5 \times 10^{-3} \)
2. \( M_A = 50 \times 10^{-3} \) and \( M_B = 25 \times 10^{-3} \)
3. \( M_A = 25 \times 10^{-3} \) and \( M_B = 50 \times 10^{-3} \)
4. \( M_A = 5 \times 10^{-3} \) and \( M_B = 10 \times 10^{-3} \)
Q.30 The idea of froth floatation method came from a person X and this method is related to the process Y of ores. X and Y, respectively, are:

Options
1. fisher woman and concentration
2. washer woman and concentration
3. fisher man and reduction
4. washer man and reduction

Section: Mathematics

Q.1 If A is a symmetric matrix and B is a skew-symmetric matrix such that

\[ A + B = \begin{bmatrix} 2 & 3 \\ 5 & -1 \end{bmatrix} \]

then AB is equal to:

Options
1. \[ \begin{bmatrix} -4 & -2 \\ -1 & 4 \end{bmatrix} \]
2. \[ \begin{bmatrix} 4 & -2 \\ -1 & -4 \end{bmatrix} \]
3. \[ \begin{bmatrix} 4 & -2 \\ 1 & -4 \end{bmatrix} \]
4. \[ \begin{bmatrix} -4 & 2 \\ 1 & 4 \end{bmatrix} \]
If $e^y + xy = e$, the ordered pair \( \left( \frac{dy}{dx}, \frac{d^2y}{dx^2} \right) \)

at $x = 0$ is equal to:

Options

1. \( \left( \frac{1}{e}, -\frac{1}{e^2} \right) \)
2. \( \left( \frac{1}{e^2}, \frac{1}{e} \right) \)
3. \( \left( \frac{1}{e}, \frac{1}{e^2} \right) \)
4. \( \left( \frac{1}{e^2}, -\frac{1}{e} \right) \)

Q.3 If the angle of intersection at a point where the two circles with radii 5 cm and 12 cm intersect is 90°, then the length (in cm) of their common chord is:

Options

1. \( \frac{13}{5} \)
2. \( \frac{120}{13} \)
3. \( \frac{60}{13} \)
4. \( \frac{13}{2} \)

Q.4 If the area (in sq. units) of the region \( \{(x, y) : y^2 \leq 4x, x + y \leq 1, x \geq 0, y \geq 0\} \) is $a\sqrt{2} + b$, then $a - b$ is equal to:

Options

1. \( \frac{10}{3} \)
Q.5 For \( x \in \mathbb{R} \), let \([x]\) denote the greatest integer \( \leq x \), then the sum of the series
\[
\left[ \frac{1}{3} \right] + \left[ \frac{1}{3} + \frac{1}{100} \right] + \left[ \frac{1}{3} + \frac{2}{100} \right] + \cdots + \left[ \frac{1}{3} + \frac{99}{100} \right]
\]
is:

Options 1. \(-153\)
2. \(-133\)
3. \(-131\)
4. \(-135\)

Q.6 The number of ways of choosing 10 objects out of 31 objects of which 10 are identical and the remaining 21 are distinct, is:

Options 1. \(2^{20} - 1\)
2. \(2^{21}\)
3. \(2^{20}\)
4. \(2^{20} + 1\)
The integral \( \int \frac{2x^3 - 1}{x^4 + x} \, dx \) is equal to:

(Here \( C \) is a constant of integration)

Options
1. \( \frac{1}{2} \log_e \left| \frac{x^3 + 1}{x^2} \right| + C \)
2. \( \frac{1}{2} \log_e \left( \frac{x^3 + 1}{|x^3|} \right)^2 + C \)
3. \( \log_e \left| \frac{x^3 + 1}{x} \right| + C \)
4. \( \log_e \left( \frac{x^3 + 1}{x^2} \right) + C \)

---

Q.8 The equation \( y = \sin(x + 2) - \sin^2(x + 1) \) represents a straight line lying in:

Options
1. second and third quadrants only
2. first, second and fourth quadrants
3. first, third and fourth quadrants
4. third and fourth quadrants only

---

Q.9 Let \( f : \mathbb{R} \to \mathbb{R} \) be a continuously differentiable function such that \( f(2) = 6 \) and

\[
f'(2) = \frac{1}{48}.
\]

If \( \int_0^{f(x)} 4t^2 \, dt = (x - 2)g(x) \),

then \( \lim_{x \to 2} g(x) \) is equal to:

Options
1. 18
2. 24
3. 12
4. 36
Q.10 The coefficient of \(x^{18}\) in the product \((1+x)(1-x)^{10}(1+x+x^2)^9\) is:

Options
1. 84
2. -126
3. -84
4. 126

Q.11 If three of the six vertices of a regular hexagon are chosen at random, then the probability that the triangle formed with these chosen vertices is equilateral is:

Options
1. \(\frac{1}{10}\)
2. \(\frac{1}{5}\)
3. \(\frac{3}{10}\)
4. \(\frac{3}{20}\)

Q.12 Consider the differential equation,
\[y^2dx + \left(x - \frac{1}{y}\right)dy = 0.\] If value of \(y\) is 1 when \(x = 1\), then the value of \(x\) for which \(y = 2\), is:

Options
1. \( \frac{5}{2} + \frac{1}{\sqrt{e}} \)

2. \( \frac{3}{2} - \frac{1}{\sqrt{e}} \)

3. \( \frac{1}{2} + \frac{1}{\sqrt{e}} \)

4. \( \frac{3}{2} - \sqrt{e} \)

Q.13

Let \( \vec{a} = 3\hat{i} + 2\hat{j} + 2\hat{k} \) and \( \vec{b} = \hat{i} + 2\hat{j} - 2\hat{k} \) be two vectors. If a vector perpendicular to both the vectors \( \vec{a} + \vec{b} \) and \( \vec{a} - \vec{b} \) has the magnitude 12 then one such vector is:

Options

1. \( 4(2\hat{i} + 2\hat{j} + \hat{k}) \)

2. \( 4(2\hat{i} - 2\hat{j} - \hat{k}) \)

3. \( 4(2\hat{i} + 2\hat{j} - \hat{k}) \)

4. \( 4(-2\hat{i} - 2\hat{j} + \hat{k}) \)

Q.14

Let a random variable \( X \) have a binomial distribution with mean 8 and variance 4.

If \( P(X \leq 2) = \frac{k}{2^{16}} \), then \( k \) is equal to:

Options

1. 17

2. 121

3. 1

4. 137
Q.15 The number of solutions of the equation 
\[ 1 + \sin^4 x = \cos^2 3x, \quad x \in \left[ -\frac{5\pi}{2}, \frac{5\pi}{2} \right] \] is:

Options
1. 3
2. 5
3. 7
4. 4

Q.16 The equation \( |z - i| = |z - 1|, \quad i = \sqrt{-1}, \) represents:

Options
1. a circle of radius \( \frac{1}{2} \).
2. the line through the origin with slope 1.
3. a circle of radius 1.
4. the line through the origin with slope \(-1\).

Q.17 If the truth value of the statement 
\[ p \rightarrow (\neg q \vee r) \] is false (F), then the truth values of the statements \( p, q, r \) are respectively:

Options
1. T, T, F
2. T, F, F
3. T, F, T
4. F, T, T

Q.18
If \( \int_0^{\frac{\pi}{2}} \frac{\cot x}{\cot x + \csc x} \, dx = m(\pi + n) \), then 
\( m \cdot n \) is equal to:

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

Q.19
For \( x \in \left(0, \frac{3\pi}{2}\right)\), let \( f(x) = \sqrt{x}, g(x) = \tan x \)
and \( h(x) = \frac{1 - x^2}{1 + x^2} \). If \( \phi(x) = ((h \circ f \circ g)(x)) \),
then \( \phi \left( \frac{\pi}{3} \right) \) is equal to:

Options
1. \( \tan \frac{\pi}{12} \)
2. \( \tan \frac{11\pi}{12} \)
3. \( \tan \frac{7\pi}{12} \)
4. \( \tan \frac{5\pi}{12} \)
Q.20  
The value of \( \sin^{-1}\left(\frac{12}{13}\right) - \sin^{-1}\left(\frac{3}{5}\right) \) is equal to:

Options

1. \( \pi - \sin^{-1}\left(\frac{63}{65}\right) \)
2. \( \frac{\pi}{2} - \sin^{-1}\left(\frac{56}{65}\right) \)
3. \( \frac{\pi}{2} - \cos^{-1}\left(\frac{9}{65}\right) \)
4. \( \pi - \cos^{-1}\left(\frac{33}{65}\right) \)

---

Q.21  
A 2 m ladder leans against a vertical wall. If the top of the ladder begins to slide down the wall at the rate 25 cm/sec., then the rate (in cm/sec.) at which the bottom of the ladder slides away from the wall on the horizontal ground when the top of the ladder is 1 m above the ground is:

Options

1. \( 25\sqrt{3} \)
2. \( \frac{25}{\sqrt{3}} \)
3. \( \frac{25}{3} \)
4. 25

---

Q.22  
If \( \alpha \) and \( \beta \) are the roots of the equation \( 375 x^2 - 25x - 2 = 0 \), then

\[ \lim_{n \to \infty} \sum_{r=1}^{n} \alpha^{r} + \lim_{n \to \infty} \sum_{r=1}^{n} \beta^{r} \]

is equal to:

---
Q.23

If the normal to the ellipse \(3x^2 + 4y^2 = 12\) at a point \(P\) on it is parallel to the line, \(2x + y = 4\) and the tangent to the ellipse at \(P\) passes through \(Q(4, 4)\) then \(PQ\) is equal to:

Options

1. \(\frac{5\sqrt{5}}{2}\)
2. \(\frac{\sqrt{61}}{2}\)
3. \(\frac{\sqrt{221}}{2}\)
4. \(\frac{\sqrt{157}}{2}\)

Q.24

If \(m\) is the minimum value of \(k\) for which the function \(f(x) = x\sqrt{kx} - x^2\) is increasing in the interval \([0, 3]\) and \(M\) is the maximum value of \(f\) in \([0, 3]\) when \(k = m\), then the ordered pair \((m, M)\) is equal to:

Options

1. \((4, 3\sqrt{2})\)
2. \((4, 3\sqrt{3})\)
3. \((3, 3\sqrt{3})\)
4. \( (5, 3\sqrt{6}) \)

Q.25 Let \( S_n \) denote the sum of the first \( n \) terms of an A.P. If \( S_4 = 16 \) and \( S_6 = -48 \), then \( S_{10} \) is equal to:

Options
1. -260
2. -410
3. -320
4. -380

Q.26 If the data \( x_1, x_2, \ldots, x_{10} \) is such that the mean of first four of these is 11, the mean of the remaining six is 16 and the sum of squares of all of these is 2,000; then the standard deviation of this data is:

Options
1. \( 2\sqrt{2} \)
2. 2
3. 4
4. \( \sqrt{2} \)

Q.27 Let \( P \) be the point of intersection of the common tangents to the parabola \( y^2 = 12x \) and the hyperbola \( 8x^2 - y^2 = 8 \). If \( S \) and \( S' \) denote the foci of the hyperbola where \( S \) lies on the positive x-axis then \( P \) divides \( SS' \) in a ratio:

Options
1. 13 : 11
2. $14 : 13$
3. $5 : 4$
4. $2 : 1$

Q.28
If $B = \begin{bmatrix} 5 & 2\alpha & 1 \\ 0 & 2 & 1 \\ \alpha & 3 & -1 \end{bmatrix}$ is the inverse of a $3 \times 3$ matrix $A$, then the sum of all values of $\alpha$ for which $\det(A) + 1 = 0$, is:
Options:
1. 0
2. $-1$
3. 1
4. 2

Q.29
If the volume of paralleloiped formed by the vectors $\hat{i} + \lambda \hat{j} + \hat{k}$, $\hat{j} + \lambda \hat{k}$ and $\lambda \hat{i} + \hat{k}$ is minimum, then $\lambda$ is equal to:
Options:
1. $-\frac{1}{\sqrt{3}}$
2. $\frac{1}{\sqrt{3}}$
3. $\sqrt{3}$
4. $-\sqrt{3}$
Q.30

If the line \( \frac{x-2}{3} - \frac{y+1}{2} = \frac{z-1}{-1} \) intersects the plane \( 2x + 3y - z + 13 = 0 \) at a point P and the plane \( 3x + y + 4z = 16 \) at a point Q, then PQ is equal to:

Options:
1. 14
2. \( \sqrt{14} \)
3. 2\( \sqrt{7} \)
4. 2\( \sqrt{14} \)

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