Physics

1. **(a)**
2. **(c)** 0.153 nm de Broglie wavelength associated with electron is,

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2\,m_e eV}}$$

For electron, putting the values, we get,

$$\lambda = \frac{1.227}{\sqrt{V}}\ \text{nm}$$
$$\Rightarrow \lambda = \frac{1.227}{\sqrt{64}} = \frac{1.227}{8} = 0.153\ \text{nm}$$

3. **(b)**
4. **(d)**
5. **(c)**
6. **(a)** To find the change in angular momentum of the electron when it transitions from the 5 th orbit to the 3rd orbit in a hydrogen atom, we need to use the formula for the angular momentum of an electron in a hydrogen atom:

$$L = n\hbar$$

where:

n is the principal quantum number (orbit -number)

$\hbar$ is the reduced Planck constant $\left(\hbar - \frac{h}{2\pi}\right)$.

The angular momentum for an electron in the n-th orbit is given by:

$$L_n - n\hbar$$

For the 5th orbit:

$$L_5 - 5\hbar$$

For the 3rd orbit:

$$L_3 - 3\hbar$$

The change in angular momentum ΔL when the electron transitions from the 5 th orbit to the 3 rd orbit is:

$$\Delta L - L_5 - L_3 - 5\hbar - 3\hbar - 2\hbar$$

Since $\hbar - \frac{h}{2\pi}$:

$$\Delta L - 2\left(\frac{h}{2\pi}\right) - \frac{h}{\pi}$$

So, the change in angular momentum is: $\frac{h}{\pi}$

7. **(c)** To determine how long it will take for the activity of a radioactive isotope to reduce to 1.5625% of its original value, we use the concept of half-life.

Here's the step-by-step process:

Understand the Percentage Reduction:
To find out how many half-lives are needed to reach 1.5625%, note that 1.5625% is equivalent to $\frac{1.5625}{100} - 0.015625$ of the original amount.

Determine the Decimal Equivalent:
0.015625 can be written as $\frac{1}{64}$. This means the remaining amount is $\frac{1}{64}$ of the original amount.

Calculate the Number of Half-Lives:
Each half-life reduces the remaining amount by half. To find the number of half-lives required to reach $\frac{1}{64}$, we use the fact that $\frac{1}{64}$ is 2^{-6}. This indicates that it takes 6 half-lives to reduce to $\frac{1}{64}$ of the original amount.

Calculate the Time Required:
Given that the half-life of the isotope is 2.5 years, the total time required for 6 half-lives is:

$$6 \times 2.5 \text{ years } - 15 \text{ years}$$

Therefore, it will take 15 years for the activity of the isotope to reduce to 1.5625% of its original value.

8. (d)
9. (c)
10. (a)
11. (b)
12. (b) Spectral range of visible light is from 0.4μm to 0.7μm. i.e. from about 3 eV to 1.8 eV. Hence semiconductor used for fabrication of visible LEDs must have at least a gap of 1.8 eV.
13. (b)
14. (b)
15. (b)
16. (a)
17. (d)
18. (d)
19. (c)
20. (a) maximum when the battery is connected across $10 \text{ cm} \times 1 \text{ cm}$ faces.
21. (d)
22. (d) The electron will continue to move with uniform velocity along the axis of the solenoid.
Let the electron (e) is projected with a uniform velocity (v) in a uniform magnetic field B. The magnitude of force on it is

$$|\bar{F}| = -e|\bar{v} \times \bar{B}| = -evB\sin\theta$$
$$\text{As } \theta = 0^\circ, |\bar{F}| = -evB\sin 0^\circ$$

Hence the electron will continue to move with uniform velocity along the axis of the solenoid.

23. (c)
24. (b)
25. (d) To find the value of the shunt resistor required to increase the range of a galvanometer by a factor of 10, we can use the formula previously mentioned. Given:

The resistance of the galvanometer $R_g = 18\Omega$.

The desired increase in range is by a factor of 10.

We use the formula:

$$R_s = \frac{R_g}{\frac{1}{I_g} - 1}$$

where $\frac{I}{I_9} = 10$ (since the range is increased by 10 times).
Substitute $\frac{I}{I_9} = 10$ into the formula:

$$R_s = \frac{R_o}{10 - 1}$$
$$R_s = \frac{18\Omega}{9}$$
$$R_s = 2\Omega$$

So, the value of the shunt resistor needed is 2Ω.
The correct choice is (d) 2Ω.

26. (a) When a bar magnet is divided into two equal parts along its length, the changes in pole strength and magnetic moment can be analyzed as follows:

Pole Strength: When the bar magnet is divided along its length, each part will have the same pole strength as the original magnet because pole strength is not dependent on the length of the magnet. Thus, the pole strength of each new part remains q_m.

Magnetic Moment: The magnetic moment m of a bar magnet is given by $m = q_m \times l$, where l is the length of the magnet.

After dividing the magnet into two equal parts, the length of each part is $l/2$. Therefore, the magnetic moment of each part will be $m' = q_m \times (l/2) = m/2$.

So, the new pole strength remains q_m, and the new magnetic moment becomes $m/2$.

27. (b)
28. (b) The magnetic flux is given by

$$\phi = LI$$

The dimensional formula of self- inductance, $[L] = \frac{[BA]}{[I]}$ ... (1)
Force, $f = qvB$

$$[M^1 L^1 T^{-2}] = [TA] \cdot [L^1 T^{-1}] \cdot [B]$$
$$[B] = [M^1 T^{-2} A^{-1}]$$
$$[BA] = [M^1 L^2 T^{-2} A^{-1}]$$

From equation (1), we get

$$[\phi] = [M^1 L^2 T^{-2} A^{-2}]$$

29. (b)
30. (c)
31. (a)
32. (b)
33. (b) To find the peak current I_m for the given step-down transformer, we need to follow these steps:

Determine the RMS Current:

Given the output voltage V_{RMS} is 24 V and the power P is 12 W.

Using the formula for power P in terms of RMS voltage and RMS current:

$P - V_{RMS} \times I_{RMS}$

Solving for I_{ILMS} :

$$I_{RMS} - \frac{P}{V_{RMS}} - \frac{12\ W}{24\ V} - 0.5\ A$$

Convert RMS Current to Peak Current:

The peak current I_m is related to the RMS current I_{RMS} by the following relationship:

$I_m - I_{RMS} \times \sqrt{2}$

Substituting $I_{RMS} - 0.5\ A$:

$$I_m - 0.5\ A \times \sqrt{2} \approx 0.5\ A \times 1.414 \approx 0.707\ A$$

Rounding to the nearest option:

$I_m \approx 0.71\ A$

Therefore, the value of the peak current I_m is:

34. **(d)** The electric field and the magnetic field of an Electromagnetic wave are mutually perpendicular to each other and their direction of propagation is perpendicular to both the electric and magnetic fields. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of electromagnetic wave, then the direction of propagation of electromagnetic wave is along the direction of vector $\vec{E} \times \vec{B}$. The vector product $\vec{B} \times \vec{E}$ gives the negative direction of the propagation of wave.

35. **(c)**

36. **(c)** The refractive index of air with respect to a vacuum is very close to 1 , since the refractive index of vacuum is defined as 1 . For practical purposes, the refractive index of air is approximately 1.00029, which accounts for the slight difference due to the presence of air compared to a perfect vacuum.

37. **(a)** To determine the type of lens and its focal length given the power, use the following relationship:

$\text{Power (P)} - \frac{1}{\text{Focal Length (f)}}$

where the focal length f is in meters and the power P is in diopters (D). If the power is negative, the lens is concave, if positive, it is convex.

Given:

Power $P - -4.0D$

We need to find the focal length f :

$$f - \frac{1}{P}$$

Substituting the given power:

$$f - \frac{1}{-4.0}\ \text{meters}\ - -0.25\ \text{meters}\ - -25.0\ \text{cm}$$

Therefore, the lens is a concave lens with a focal length of -25.0 cm.

38. (a) Given data

Earth takes 24 h to rotate once about its axis.

That is, it takes 24 h to rotate 360°.

Time taken to shift by 1°

Earth takes 24 h to rotate 360°.

24 h means $24 \times 60 = 1440$ min

Time taken to rotate 1° is $\frac{1440}{360} = 4$ min

Hence, time taken to rotate 1° is 4 min .

39. (b)

40. (a)

Chemistry

41. (c) The compound with the formula $CH_2 - CH - CHO$ is known by its common name "Acrolein."

Here's the breakdown:

Structure of the compound:

$CH_2 - CH - CHO$ is an alpha, beta-unsaturated aldehyde.

It contains a vinyl group ($CH_2 - CH$) attached to an aldehyde group (- CHO).

Common Name:

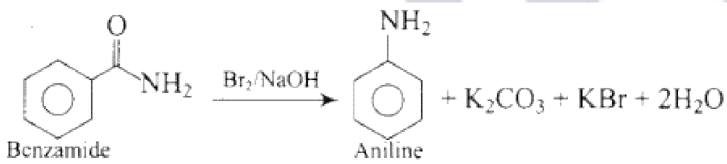
Acrolein is a well-known compound with this structure. It is an important chemical used in various industrial applications and is known for its pungent odor.

42. (a)

43. (c)

44. (a) Hoffman bromamide degradation reaction is shown by $ArCONH_2$.

Where the aryl amide is converted to aryl amine in the presence of Br_2 and NaOH.



45. (d)

46. (b)

47. (d)

48. (a) Uracil is not found in DNA as it uracil has more base pair affinity to adenine, guanine and cytosine. Instead thymine is present in DNA.

49. (c)

50. (c)

51. (d) The artificial sweetening agent that is limited in use for cold food and soft drinks is:

Aspartame can break down into its components when exposed to heat for extended periods, which makes it less suitable for cooking or for products that will be stored for a long time in warm conditions.

52. (b) Polyethylene glycols are used in the preparation of non-ionic detergents

Polyethylene glycols are used in the preparation of non-ionic detergents. Nonionic detergents do not contain any ion in their constitution.

53. (a) Packing efficiencies of different cells are shown in the above table.
Hence, correct order is fcc (74%) > bcc(68%) > simple cubic (52%).

Unit cell	Packing efficiency
fcc	74%
bcc	68%
Simple cubic	52%

54. (d) The defect obtained by heating of zinc oxide (ZnO) is:
When zinc oxide is heated, zinc ions can be lost, creating vacancies in the lattice and leading to a metal excess defect where there are extra zinc ions in the lattice, compensating for the missing zinc atoms. This defect is also known as the zinc oxide defect.

55. (c) The boiling point of an aqueous solution depends on the number of particles the solute produces when dissolved. This is known as the van't Hoff factor (i), which is the number of particles into which a solute dissociates in solution.

Let's analyze each option:
(a) $0.1MKNO_3$: Potassium nitrate dissociates into 2 ions ($K^+$and NO_3) in solution. Thus, $i - 2$.
(b) 0.1 M urea: Urea does not dissociate in solution, so $i - 1$.
(c) $0.1MK[Fe(CN)_6]$: This compound dissociates into 5 ions (4 $K^+$and $[Fe(CN)_6]^{4-}$). Thus, $i - 5$.
(d) $0.1MNH_4NO_3$: Ammonium nitrate dissociates into 2 ions ($NH_4{}^+$and $NO_3{}^-$)in solution. Thus, $i -2$
Since the boiling point elevation is proportional to the van't Hoff factor i and the concentration of the solution, the solution with the highest boiling point will be the one with the highest i.

Therefore, the aqueous solution with the highest boiling point is:
(c) $0.1MK_4[Fe(CN)_6]$

56. (a) The van't Hoff factor for strong electrolyte is:
i = Total number of ions after dissociation/association/Total number of ions before dissociation/association.

For NaCl, the van't Hoff factor is 2 as it dissociates into two ions i.e.

$NaCl \rightarrow Na^+ + Cl^-$

Van't Hoff factor is independent of the molality of solute added.

Thus, $i_A = i_B = i_C$.

57. (c) To calculate the osmotic pressure (π) of a solution, we use the formula:

$\pi - i \cdot M \cdot R \cdot T$

where:

i is the van't Hoff factor,

M is the molarity of the solution,

R is the universal gas constant,

T is the temperature in Kelvin.

For NaCl, which dissociates into 2 ions (Na^+ and Cl^-) in solution, the van't Hoff factor i is 2 .
Given:

Molarity $M - 0.02M$

$i - 2$

The osmotic pressure can be calculated as:

$\pi - i \cdot M \cdot R \cdot T - 2 \cdot 0.02 \cdot R \cdot T - 0.04 \cdot R \cdot T$

Therefore, the osmotic pressure of the 0.02 M solution of NaCl is:

58. (a)
59. (b) To derive the correct Nernst equation for the given electrochemical cell, let's break down the cell:

$Mg(s)|Mg^{2+}(aq, 0.1M)||Cl^-(aq, 0.1M)|Cl_2(g, 1\text{ bar}) \mid Pt(s)$

This electrochemical cell can be described by the following half-reactions:

Anode (oxidation): $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$

Cathode (reduction): $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$

The overall cell reaction is:

$Mg(s) + Cl_2(g) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$

The Nernst equation for this cell is:

$$E_{cell} - E^0_{cell} - \frac{0.059}{n}\log\left(\frac{[\text{Products}]}{|\text{ Reactants}}\right)$$

For the given cell, the number of electrons n transferred is 2. The cell reaction can be expressed in terms of concentrations and partial pressures:

$$E_{cell} - E^0_{cell} - \frac{0.059}{2}\log\left(\frac{[Mg^{2+}] - 1}{|Cl|^2}\right)$$

Here, the concentration of Mg^{2+} is 0.1 M, and the concentration of Cl^- is 0.1 M, while the partial pressure of Cl_2 is considered to be 1 bar (which can be treated as unity for the logarithm term).

Therefore, the correct Nemst equation for this cell is:
(b) $E_{cell} - E^0_{cell} - \frac{0.059}{2}\log\left(\frac{|Mg^{2+}}{|Cl^2}\right)$

60. (b)
61. (b)
62. (c)
63. (a)
64. (d) High temperature is favourable for adsorption. It increases with increase in temperature
65. (a)
66. (c) German silver, also known as nickel silver, is an alloy that typically consists of copper, nickel, and zinc. It does not contain silver. The percentages of these elements in German silver are generally:

Copper: $60 - 65\%$

Nickel: $20 - 25\%$

Zinc: $10-15\%$

Since German silver does not contain silver, the percentage of silver in German silver alloy is:

67. (a) Malachite is a copper carbonate hydroxide mineral ore. It is sticking green and has a banded pattern, making it attractive. The chemical formula for malachite is $Cu_2CO_3(OH)_2$. It is the ore for secondary copper minerals. Malachite has a perfect cleavage, that is it can be split into thin sheets. Due to the pattern and beautiful color, it is widely used as ornamental items. Apart from this, all the given ores are oxides. Hematite is an iron oxide with a chemical formula of Fe_2O_3. Magnetite is an iron oxide ore with the chemical formula as Fe_3O_4. It is the most common and important iron ore. Zincate generally contain zinc oxide (ZnO).

68. (d)

69. (c) Among the oxides of manganese, the one that shows acidic properties is:
(c) Mn_2O_7

Manganese dioxide (MnO_2), manganese monoxide (MnO), and manganese(iii) oxide (Mn_2O_3) are typically basic or amphoteric oxides.

In contrast, Mn_2O_7 (manganese heptoxide) is a strong acidic oxide. It forms an acidic solution when dissolved in water, yielding manganese (VII) acid ($HMnO_4$):

$$Mn_2O_7 + 2H_2O \rightarrow 2HMnO_4$$

Therefore, Mn_2O_7 is the oxide that shows acidic properties.

70. (b) Peroxo acids are acids that contain the peroxo group $(-O-O-)$ within their structure. For sulfur, the peroxo acids include:

H_2SO_5 (Peroxomonosulfuric acid or Caro's acid)

$H_2\,S_2O_8$ (Peroxydisulfuric acid or Marshall's acid)

Thus, the correct option is:
(b) H_2SO_5 and $H_2\,S_2O_8$

71. (c) When alkaline potassium permanganate $(KMnO_4)$ is treated with iodide ions (I^-), the iodide ions are oxidized. In an alkaline medium, iodide ions are oxidized to iodate ions.

The balanced reaction is:

$$2MnO_4^- + 3I^- + 4OH^- \rightarrow 2MnO_2 + 3IO_3^- + 2H_2O$$

In this reaction:

Potassium permanganate $(KMnO_4)$ is reduced to manganese dioxide (MnO_2).

lodide ions $(I^-)$are oxidized to iodate ions $(IO_3{}^-)$.

Thus, the correct product of the oxidation of iodide ions by alkaline $KMnO_4$ is:

72. (a)

73. (b) Solute isomerism to shown when two compounds having the same molecular formula differ by whether it has solvent molecule is directly bonded to a metal ion or is present as free solvent molecules in the crystal lattice. When water is present as a solvent and shows this type of isomerism then it is known as hydrate isomerism or Solvate isomerism.
Coordination compound $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl^2H_2O.Cl_2$ are solvate isomers, because water is exchanged by chloride ion. This is why both of them show different colour on exposure to sunlight.

74. **(c)** On the basis of crystal field theory, for a d^4 ion, if $\Delta_\circ < P$, then the complex is a high spin complex formed by the association of weak field ligands with the metal.

As a result the fourth electron enters one of the e_g orbitals, there by exhibiting the electronic configuration : $t_{2g}^3 e_g^1$

75. **(a)** Complexes are formed when ligands donate a pair of electrons to metals. In ammonia, N atom has one lone pair of electrons. Nitrogen donates this lone pair of electrons to proton to form ammonium ion. So NH_4^+ion does not have a lone pair of electrons which it can donate to central metal ion. Hence it cannot behave as a ligand.

76. **(c)**

77. **(a)** Wutz reaction is a method for the formation of $CCl_2\ F_2$ from $CCl_4 CCl_2$ will be formed as an intermediate, and upon further reaction with fluorine, dichlorodifluoromethane will be formed. When CCl_4 will react with a strong base, a Chloride ion will be removed from CCl_4 and thus form CCl_2. Later CCl_2 will react with fluorine to form $CCl_2\ F_2$. Wurtz reaction, which converts aldehydes and ketones into olefins (alkenes).

78. **(d)**

79. **(a)**

80. **(d)**

Mathematics

81. **(c)**

82. **(b)**

83. **(c)**

84. **(d)**

85. **(a)**

86. **(a)**

87. **(b)**

88. **(c)**

89. **(c)** Consider $y = x^{1/4}$. Let $x = 81$ and $\Delta x = 0.5$

Then,

$$\Delta y = (x + \Delta x)^{\frac{1}{4}} - (x)^{\frac{1}{4}}$$
$$\Rightarrow (81.5)^{1/4} - (81)^{1/4}$$
$$\Rightarrow (81.5)^{1/4} - 3$$
$$\Rightarrow (81.5)^{1/4} = 3 + \Delta y$$

Now, dy is the approximately equal to Δy and is given by,

$$dy = \left(\frac{dy}{dx}\right)\Delta x = \frac{1}{4(x)^{\frac{3}{4}}}(\Delta x)\ \left(\text{ as } y = x^{1/4}\right)$$
$$== \frac{1}{4(3)^{\frac{3}{4}}}(0.5) = 0.5/108 = 0.0046$$

Hence, approximate value is 3.0046.

90. **(d)**

91. **(a)**

92. **(a)**

93. **(d)**

94. **(a)**

95. **(c)**

96. **(b)**

97. **(c)**

98. (a)
99. (b)
100. (d)
101. (a)
102. (a)
103. (b)
104. (d) It is given that $|\vec{a}| = 3$ and $|\vec{b}| = \frac{\sqrt{2}}{3}$.

We know that $\vec{a} \times \vec{b} = |\vec{a}||\vec{b}|\sin\theta\hat{n}$, where $\hat{n}$ is a unit vector perpendicular to both $\vec{a}$ and $\vec{b}$ and θ is the angle between $\vec{a}$ and $\vec{b}$.

Now, $\vec{a} \times \vec{b}$ is a unit vector if $|\vec{a} \times \vec{b}| = 1$

$$|\vec{a} \times \vec{b}| = 1$$
$$\Rightarrow ||\vec{a}||\vec{b}|\sin\theta\hat{n}| = 1$$
$$\Rightarrow |\vec{a}||\vec{b}||\sin\theta| = 1$$
$$\Rightarrow 3 \times \frac{\sqrt{2}}{3} \times \sin\theta = 1$$
$$\Rightarrow \sin\theta = \frac{1}{\sqrt{2}}$$
$$\Rightarrow \theta = \frac{\pi}{4}$$

Hence, $\vec{a} \times \vec{b}$ is a unit vector if the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{4}$.

105. (a)
106. (b)
107. (c)
108. (d)
109. (d)
110. (b)
111. (b)
112. (c)
113. (a)
114. (d)
115. (b)
116. (c)
117. (a)
118. (c)
119. (b)
120. (d)

Biology

121. (b)
122. (d)
123. (c)
124. (b)
125. (a)
126. (c)
127. (c)

128. (d)
129. (a)
130. (a)
131. (b)
132. (c)
133. (d)
134. (b)
135. (b)
136. (c)
137. (a)
138. (a)
139. (b)
140. (c)
141. (a)
142. (a)
143. (b)
144. (a)
145. (c)
146. (b)
147. (b)
148. (b)
149. (a)
150. (b)
151. (b)
152. (a)
153. (d)
154. (a)
155. (d)
156. (b)
157. (c)
158. (c)
159. (d)
160. (b)