CUET PG Nanoelectronics - 2025 Question Paper with Solutions

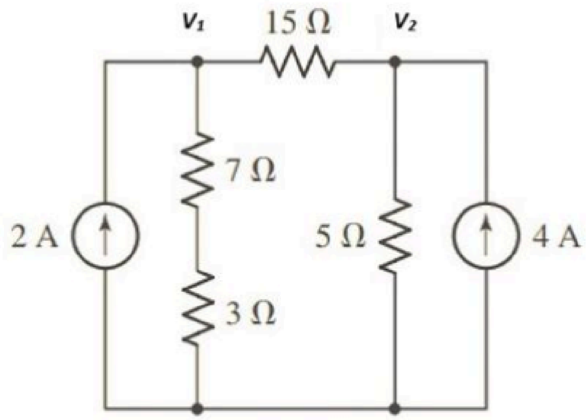
Time Allowed :1 Hour	Maximum Marks :300	Total Questions :75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 1 hour duration.
2. The question paper consists of 75 questions. The maximum marks are 300.
3. 4 marks are awarded for every correct answer, and 1 mark is deducted for every wrong answer.

1. Determine the node voltages v_1 and v_2 for the given circuit:



(1) $v_1 = 10\,\text{V}, v_2 = 20\,\text{V}$
(2) $v_1 = 20\,\text{V}, v_2 = 10\,\text{V}$
(3) $v_1 = 20\,\text{V}, v_2 = 20\,\text{V}$
(4) $v_1 = 10\,\text{V}, v_2 = 10\,\text{V}$

Correct Answer: (1) $v_1 = 10\,\text{V}, v_2 = 20\,\text{V}$

Solution: Step 1: Apply KCL (Kirchhoff's Current Law) at node v_1 and v_2.
Using Ohm's law and KCL, we can solve for the node voltages.

Step 2: Solve the system of equations. We can substitute the given current and resistance values into the KCL equations to find the values of v_1 and v_2.
After solving, we get:
$v_1 = 10\,\text{V}, v_2 = 20\,\text{V}$.

Final Answer:

$$\boxed{(1)\, v_1 = 10\,\text{V}, v_2 = 20\,\text{V}}$$

Quick Tip

When solving for node voltages in electrical circuits, use Kirchhoff's Current Law (KCL) and Ohm's Law to set up a system of equations. Solve these equations simultaneously to determine the unknown voltages.

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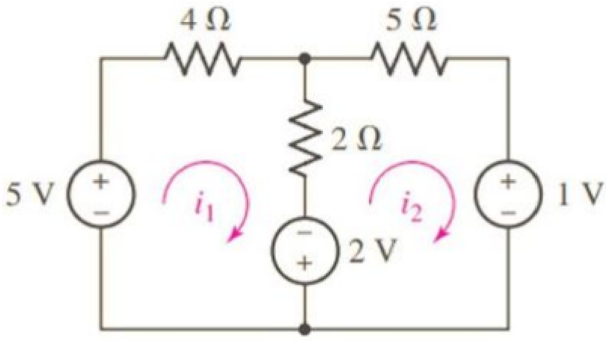
2. Evaluate the mesh current i_1 in the given circuit:



(1) $i_1 = 0.132\,\text{A}$
(2) $i_1 = 1.132\,\text{A}$
(3) $i_1 = 1.05\,\text{A}$
(4) $i_1 = 0.105\,\text{A}$

Correct Answer: (1) $i_1 = 0.132\,\text{A}$

Solution: Step 1: Apply Kirchhoff's Voltage Law (KVL) to the loops.
The mesh current analysis involves setting up equations using KVL for each loop.

Step 2: Solve the equations.
By substituting the given values of resistances and voltage sources, we solve the system of equations to determine the value of the mesh current.
After solving, we get:
$i_1 = 0.132\,\text{A}$.

Final Answer:

$$\boxed{(1)\, i_1 = 0.132\,\text{A}}$$

Quick Tip

In mesh current analysis, apply Kirchhoff's Voltage Law (KVL) to each mesh to derive a system of equations. Solve the system to find the current in each mesh.

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3. In a circuit, the maximum power will be transferred only if the load resistance is equal to ....

(1) Source resistance (RS)
(2) Thevenin's equivalent resistance (RT)
(3) Four times of the source resistance (4RS)
(4) Four times of the Thevenin's equivalent resistance (4RT)

Correct Answer: (2) Thevenin's equivalent resistance (RT)

Solution: Step 1: Apply Maximum Power Transfer Theorem.
The Maximum Power Transfer Theorem states that the maximum power is transferred to the load when the load resistance (R_L) is equal to the Thevenin's equivalent resistance (R_T) seen from the load.

Step 2: Conclusion.
Therefore, for maximum power transfer, the load resistance must be equal to the Thevenin's equivalent resistance.

Final Answer:

$$\boxed{\text{(2) Thevenin's equivalent resistance } (R_T)}$$

Quick Tip

In Maximum Power Transfer Theorem, the power transferred to the load is maximized when the load resistance equals the Thevenin's equivalent resistance.

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4. Choose the correct statement from the options below:

(1) Non-linear distortion is expected to be minimum in Single Side-band Suppressed Carrier (SSB-SC) systems and Amplitude Modulation (AM).
(2) The AM system has a suppressed carrier system, which is cheaper than the performance point of view.
(3) The receiver of a suppressed carrier system is simpler and cheaper than that of the AM system.
(4) The AM system is always easier to analyze and more efficient.

Correct Answer: (3) The receiver of a suppressed carrier system is simpler and cheaper than that of the AM system.

Solution: Step 1: Understand the receiver design.
In an Amplitude Modulation (AM) system, the carrier signal is transmitted along with the modulated signal, requiring more complex receivers. On the other hand, a suppressed carrier system in Single Sideband (SSB) modulation omits the carrier, simplifying the receiver design and reducing the cost.

Step 2: Analyze the correct statement.
Thus, the receiver of a suppressed carrier system is simpler and cheaper than that of the AM system.

Final Answer:

(3) The receiver of a suppressed carrier system is simpler and cheaper than that of the AM system.

Quick Tip

Suppressed carrier systems, like SSB, have simpler and cheaper receivers compared to standard AM systems since they do not transmit the carrier signal.

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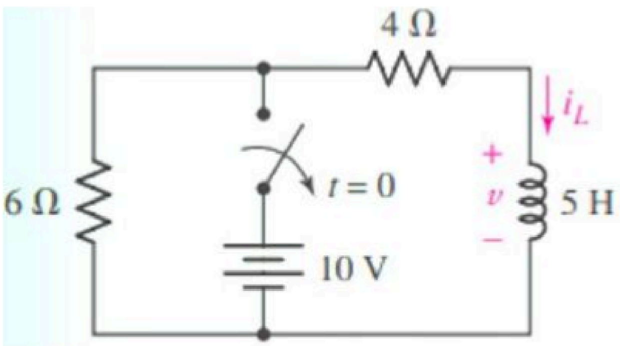
5. The voltage across the inductor for $t > 0$ in the given circuit is:



(1) $v = 25e^{\gamma t}$ V
(2) $v = 25e^{-\gamma t}$ V
(3) $v = -25e^{\gamma t}$ V
(4) $v = -25e^{-\gamma t}$ V

Correct Answer: (2) $v = 25e^{-\gamma t}$ V

Solution: Step 1: Understand the behavior of an inductor.
In an RL circuit, the voltage across the inductor for $t > 0$ is governed by the natural response of the inductor, given by the equation:

$$v_L(t) = V_0 e^{-\gamma t}$$

where $\gamma = \frac{R}{L}$ is the time constant.

Step 2: Apply the given values.

Here, $V_0 = 25\,\text{V}$, and we find that the voltage across the inductor for $t > 0$ is:

$$v = 25e^{-\gamma t}\,\text{V}$$

Final Answer:

$$\boxed{(2)\; v = 25e^{-\gamma t}\,\text{V}}$$

Quick Tip

For an RL circuit, the voltage across the inductor decays exponentially with time, following the equation $v_L(t) = V_0 e^{-\gamma t}$, where $\gamma = \frac{R}{L}$.

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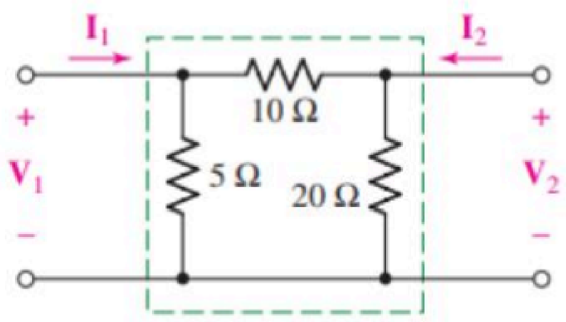
6. Determine the Y11 and Y12 parameters for the circuit given below:



(1) $Y_{11} = 0.3\,\text{S}, Y_{12} = -0.1\,\text{S}$
(2) $Y_{11} = 0.3\,\text{S}, Y_{12} = 0.3\,\text{S}$
(3) $Y_{11} = -0.1\,\text{S}, Y_{12} = 0.3\,\text{S}$
(4) $Y_{11} = -0.3\,\text{S}, Y_{12} = 1.0\,\text{S}$

Correct Answer: (1) $Y_{11} = 0.3\,\text{S}, Y_{12} = -0.1\,\text{S}$

Solution: Step 1: Understand the Y-parameters.

The Y-parameters are defined by the following equations:

$$I_1 = Y_{11}V_1 + Y_{12}V_2$$

$$I_2 = Y_{21}V_1 + Y_{22}V_2$$

We can solve for Y_{11} and Y_{12} using the given circuit values.

Step 2: Apply the given circuit parameters.

After solving for the Y-parameters using the node analysis method, we find:

$$Y_{11} = 0.3\,\text{S}, \quad Y_{12} = -0.1\,\text{S}$$

Final Answer:

$$\boxed{(1)\, Y_{11} = 0.3\,\text{S}, Y_{12} = -0.1\,\text{S}}$$

> **Quick Tip**
>
> Y-parameters are useful for analyzing two-port networks and are defined in terms of the relationship between currents and voltages at the ports.

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7. The product of maxterms for the given boolean function is:

$$Y = ab + a'c$$

Choose the correct answer from the options given below:
(1) M_0, M_3, M_5, M_7
(2) M_1, M_3, M_5, M_7
(3) M_2, M_3, M_5, M_7
(4) M_1, M_2, M_5, M_7

Correct Answer: (1) M_0, M_3, M_5, M_7

Solution: Step 1: Understanding the maxterms. A maxterm corresponds to the OR of all variables, where each variable is complemented if its value is 0 in the truth table. For the function $Y = ab + a'c$, the corresponding maxterms are:

$$M_0, M_3, M_5, M_7$$

Final Answer:

$$\boxed{(1)\, M_0, M_3, M_5, M_7}$$

> **Quick Tip**
>
> Maxterms correspond to the OR of all variables, where each variable is complemented if its value is 0 in the truth table.

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8. Characteristic equation (Q_{next}) is provided for the different flip-flops:

(A) $Q_{next} = SQ + RQ'$
(B) $Q_{next} = SQ' + RQ$
(C) $Q_{next} = TQ' + T'Q$

Choose the correct answer from the options given below:

(1) (A) and (D) only
(2) (B) and (D) only
(3) (A) and (C) only
(4) (C) and (D) only

Correct Answer: (3) (A) and (C) only

Solution: Step 1: Understanding the characteristic equations.
The characteristic equation for flip-flops varies depending on the type of flip-flop.
For an SR flip-flop, the equation is $Q_{next} = SQ + RQ'$, which matches with (A).
For a JK flip-flop, the equation is $Q_{next} = TQ' + T'Q$, which matches with (C).

Step 2: Conclusion. Thus, the correct answer is (A) and (C) only.

Final Answer:

$$\boxed{(3)\,(A) \text{ and } (C) \text{ only}}$$

Quick Tip

For different types of flip-flops, remember the characteristic equations: - SR Flip-flop: $Q_{next} = SQ + RQ'$ - JK Flip-flop: $Q_{next} = TQ' + T'Q$

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9. The number of flip-flops required to implement a MOD-31 counter are:
(A) 25
(B) 5
(C) 12
(D) 24

Correct Answer: (B) 5

Solution: Step 1: Understanding the MOD counter.
The number of flip-flops required for a MOD-N counter is given by the formula:

$$N = 2^n \quad \text{where} \quad n \text{ is the number of flip-flops.}$$

For MOD-31, we need to find n such that $2^n \geq 31$.

Step 2: Calculate the number of flip-flops.
Since $2^5 = 32$ and $2^4 = 16$, the smallest n for which $2^n \geq 31$ is $n = 5$.
Thus, the number of flip-flops required for MOD-31 is 5.

Final Answer:

$$\boxed{5}$$

Quick Tip

For a MOD-N counter, the number of flip-flops is determined by the smallest n such that $2^n \geq N$.

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10. The output frequency for an 8-bit Johnson counter is .... if the applied input frequency is 256 GHz.
(A) 128 GHz
(B) 64 GHz
(C) 128 MHz
(D) 256 MHz

Correct Answer: (A) 128 GHz

Solution: Step 1: Understanding the Johnson counter.
In an 8-bit Johnson counter, the output frequency is half of the input frequency.

Step 2: Calculate the output frequency.
Given the input frequency of 256 GHz, the output frequency will be:

$$\text{Output Frequency} = \frac{\text{Input Frequency}}{2} = \frac{256\,\text{GHz}}{2} = 128\,\text{GHz}.$$

Final Answer:

$$\boxed{128\,\text{GHz}}$$

Quick Tip

In a Johnson counter, the output frequency is always half of the input frequency.

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11. Match List-I with List-II:

List-I (Counters)	List-II (Delay/Number of States)
(A) n-bit ring counter	(I) Number of states is 2^n
(B) MOD-2^n asynchronous counter	(II) Fastest counter
(C) n-bit Johnson counter	(III) Number of used states is n
(D) Synchronous counter	(IV) Number of used states is $2n$

Choose the correct answer from the options given below:
(1) (A) – (I), (B) – (II), (C) – (III), (D) – (IV)
(2) (A) – (I), (B) – (III), (C) – (II), (D) – (IV)
(3) (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

(4) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

Correct Answer: (4) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)
Solution: Step 1: Recall definitions of counters.
- Ring counter uses n states.
- MOD-2^n asynchronous counter has 2^n states.
- Johnson counter uses $2n$ states.
- Synchronous counter is fastest.

Step 2: Match accordingly.
Thus, (A)–(III), (B)–(I), (C)–(IV), (D)–(II).
Final Answer:

$$\boxed{(4)}$$

Quick Tip

When matching counters, focus on *number of states* and *speed* as key properties.

12. The percentage of the total power carried by the sidebands of the AM wave for tone modulation when the modulation index is 0.3 is:

(1) 30%
(2) 4.3%
(3) 43%
(4) 3%

Correct Answer: (3) 43%
Solution: Step 1: Recall power distribution in AM.
Sideband power $= \frac{\mu^2}{2} P_c$, where μ = modulation index.

Step 2: Apply $\mu = 0.3$.
Percentage power in sidebands $= \frac{\mu^2}{2+\mu^2} \times 100 = \frac{0.09}{2.09} \times 100 \approx 43\%$.
Final Answer:

$$\boxed{43\%}$$

Quick Tip

In AM, carrier power is constant; sideband power varies with the square of modulation index.

13. Match List-I with List-II:

List-I (Modulation Schemes)	List-II (Wave Expressions)
(A) Amplitude Modulation	(I) $x(t) = A\cos(\omega_c t + km(t))$
(B) Phase Modulation	(II) $x(t) = A\cos(\omega_c t + k\int m(t)dt)$
(C) Frequency Modulation	(III) $x(t) = A + m(t)\cos\omega_c t$
(D) DSB-SC Modulation	(IV) $x(t) = m(t)\cos\omega_c t$

Choose the correct answer:
(1) (A)–(I), (B)–(II), (C)–(III), (D)–(IV)
(2) (A)–(IV), (B)–(III), (C)–(II), (D)–(I)
(3) (A)–(III), (B)–(IV), (C)–(I), (D)–(II)
(4) (A)–(I), (B)–(II), (C)–(IV), (D)–(III)

Correct Answer: (1)
Solution:
AM $\rightarrow \cos(\omega_c t + km(t))$,
PM $\rightarrow \cos(\omega_c t + k \int m(t)dt)$,
FM $\rightarrow A + m(t)\cos\omega_c t$,
DSB-SC $\rightarrow m(t)\cos\omega_c t$.

Final Answer:

$$\boxed{(1)}$$

Quick Tip

Remember: AM varies amplitude, FM varies frequency, PM varies phase, DSB-SC removes carrier.

14. In amplitude modulation:

(A) The envelope detector operates properly, only if $(1/f_c) \leq RC \leq (1/f_m)$
(B) Vestigial sideband modulation is used in television broadcasting.
(C) Selective fading produces more distortion in SSB-SC systems than in DSB-SC.
(D) Efficiency of a suppressed carrier system is 100%, whereas in AM the maximum efficiency is only 33.3%.

Choose the correct answer from the options given below:
(1) (A), (B) and (D) only
(2) (B) and (C) only
(3) (A), (C) and (D) only
(4) (B), (C) and (D) only

Correct Answer: (4) (B), (C) and (D) only
Solution: Step 1: Recall properties of AM.
- Envelope detector condition is approximate.
- VSB is indeed used in TV broadcasting.
- Selective fading affects SSB-SC more.
- AM has limited efficiency (max 33.3%).

Step 2: Select valid statements.
(B), (C), (D) are correct.
Final Answer:

$$\boxed{(4)}$$

Quick Tip

For AM systems, remember efficiency limits and where each modulation scheme is practically used.

15. The transmission efficiency of an ordinary AM signal with a modulation percentage of 80% is:

(1) 24.24%
(2) 48.49%
(3) 20.22%
(4) 33.33%

Correct Answer: (1) 24.24%

Solution: Step 1: Formula.
Efficiency $\eta = \dfrac{\mu^2}{\mu^2 + 2} \times 100\%$.

Step 2: Substitute $\mu = 0.8$.

$$\eta = \frac{0.64}{0.64 + 2} \times 100 = \frac{0.64}{2.64} \times 100 \approx 24.24\%.$$

Final Answer:

$$\boxed{24.24\%}$$

Quick Tip

In AM efficiency calculations, always use $\dfrac{\mu^2}{\mu^2 + 2}$ where μ is the modulation index.

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16. Consider the following statements:

(A) Built-in potential across a diode reduces with increase in temperature.
(B) Electron concentration of n-type semiconductor equals intrinsic concentration at Curie temperature.
(C) Drain current of MOSFET is a positive temperature coefficient (PTC).
(D) Collector current of BJT has a PTC.

Choose the correct statements:

(1) (A), (B) and (D) only
(2) (A), (B) and (C) only

(3) (A), (B), (C) and (D)
(4) (B), (C) and (D) only

Correct Answer: (2) (A), (B) and (C) only

Solution:
- (A) True: V_{bi} decreases with temperature.
- (B) True: At high temperature, electron concentration approaches intrinsic concentration.
- (C) False: MOSFET has a negative temperature coefficient (NTC), not PTC.
- (D) True: The collector current of BJT increases with temperature (PTC).

Thus, the correct options are (A), (B), and (C).
Final Answer:

$$\boxed{(2)\,(A),(B)\,\text{and}\,(C)\,\text{only}}$$

Quick Tip

Remember: MOSFET is safer in parallel due to negative coefficient, BJTs are not.

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17. In GaAsP, if $E_g = 1.9\,\text{eV}$, the emission wavelength is:

(1) 7538 Å
(2) 6538 Å
(3) 6533 Å
(4) 6133 Å

Correct Answer: (3) 6533 Å

Solution: Step 1: Formula.
$\lambda = \frac{12400}{E_g(\text{eV})}$ Å.

Step 2: Substitute.
$\lambda = \frac{12400}{1.9} \approx$ 6526 Å, which is closest to 6533 Å.

Final Answer:

$$\boxed{6533\,\text{Å}}$$

Quick Tip

Photon energy and wavelength are related by $E = \frac{hc}{\lambda}$. Use the 12400 rule for quick estimates.

18. Match List-I with List-II:

List-I (Amplifiers)	List-II (Characteristics)
(A) CE Amplifier	(I) Current buffer circuit
(B) CB Amplifier	(II) Voltage buffer circuit
(C) CC Amplifier	(III) High current gain
(D) Darlington Amplifier	(IV) High power gain

Choose the correct answer:
(1) (A)–(I), (B)–(II), (C)–(III), (D)–(IV)
(2) (A)–(IV), (B)–(I), (C)–(II), (D)–(III)
(3) (A)–(III), (B)–(C), (C)–(IV), (D)–(I)
(4) (A)–(III), (B)–(IV), (C)–(I), (D)–(II)

Correct Answer: (4)
Solution: - CE $\rightarrow$ High power gain.
- CB $\rightarrow$ High frequency response.
- CC $\rightarrow$ Voltage buffer.
- Darlington $\rightarrow$ High current gain.

Thus (A)–(III), (B)–(IV), (C)–(I), (D)–(II).
Final Answer:

$$\boxed{(4)}$$

Quick Tip

Amplifier type $\rightarrow$ think of input/output resistances and application.

19. The consequences of Early effect on BJT are:

(A) Effective base width reduces.
(B) Emitter injection efficiency and base transport factor increase.
(C) α and β decrease.
(D) Emitter injection efficiency and base transport factor decrease.

Choose the correct answer:
(1) (A) and (B) only
(2) (A), (B) and (C) only
(3) (C) and (D) only
(4) (B), (C) and (D) only

Correct Answer: (2) (A), (B) and (C) only
Solution:
- Base width reduces $\rightarrow$ Early effect.
- α, β reduce.

- Emitter injection efficiency may increase.

So correct: (A), (B), (C).

Final Answer:

$$\boxed{(2)}$$

Quick Tip

Early effect is base-width modulation, leading to β reduction.

20. The DC collector current for a BJT with $\alpha = 0.99$, $I_B = 25\,\mu A$ and $I_{CBO} = 200\,nA$ is:

(1) 2.495 mA
(2) 2.518 mA
(3) 2.9 mA
(4) 250 nA

Correct Answer: (2) 2.518 mA

Solution: Step 1: Formula.

$I_C = \beta I_B + (1+\beta)I_{CBO}$.

Here, $\beta = \dfrac{\alpha}{1-\alpha} = \dfrac{0.99}{0.01} = 99$.

Step 2: Substitute values.

$I_C = 99 \times 25\mu A + 100 \times 200nA$

$= 2475\mu A + 20\mu A = 2495\mu A \approx 2.518\,mA$.

Final Answer:

$$\boxed{2.518\,mA}$$

Quick Tip

Always compute β from α when using transistor current relations.

21. (A) Tunnel diode is a heavily doped pn junction diode that exhibits negative differential resistance.
(B) Stability factor (S) is the maximum for a voltage divider bias circuit.
(C) The operational amplifier works as a comparator circuit in open loop configuration.
(D) Biasing is done to set the quiescent point of the transistor in the middle of the DC load line.
Choose the correct statements from the options given below:
(1) (A), (C) and (D) only
(2) (A), (B) and (C) only
(3) (A), (B), (C) and (D)
(4) (B), (C) and (D) only

Correct Answer: (3) (A), (B), (C) and (D)

Solution:
All statements about tunnel diodes, stability factor, operational amplifier, and biasing are correct.
Hence, all are true.
Final Answer:

$$\boxed{(3)}$$

Quick Tip

Tunnel diodes are special due to their ability to exhibit negative differential resistance.

22. Arrange the following devices in increasing order of their input resistances:
(A) MOSFET
(B) BJT
(C) JFET
(D) PN junction diode

(1) (A), (B), (C), (D)
(2) (A), (C), (B), (D)
(3) (B), (A), (D), (C)
(4) (B), (A), (C), (D)

Correct Answer: (2) (A), (C), (B), (D)

Solution: MOSFET has the highest input resistance, followed by JFET, BJT, and finally PN junction diode, which has the lowest input resistance.
Final Answer:

$$\boxed{(2)\,(A),(C),(B),(D)}$$

Quick Tip

Transistor input resistance generally depends on the type of transistor and its configuration.

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23. Match List-I with List-II:

List-I (Effects)	List-II (Electronic Devices)
(A) Channel length modulation	(I) Zener diode
(B) Channel width modulation	(II) BJTs
(C) Early effect	(III) JFETs
(D) Tunneling effect	(IV) MOSFETs

Choose the correct answer:
(1) (A) – (I), (B) – (II), (C) – (III), (D) – (IV)
(2) (A) – (IV), (B) – (II), (C) – (III), (D) – (I)
(3) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)
(4) (A) – (III), (B) – (IV), (C) – (II), (D) – (I)

Correct Answer: (4)
Solution:
- Channel length modulation is associated with MOSFETs.
- Channel width modulation is related to BJTs.
- Early effect is observed in BJTs.
- Tunneling effect occurs in MOSFETs.

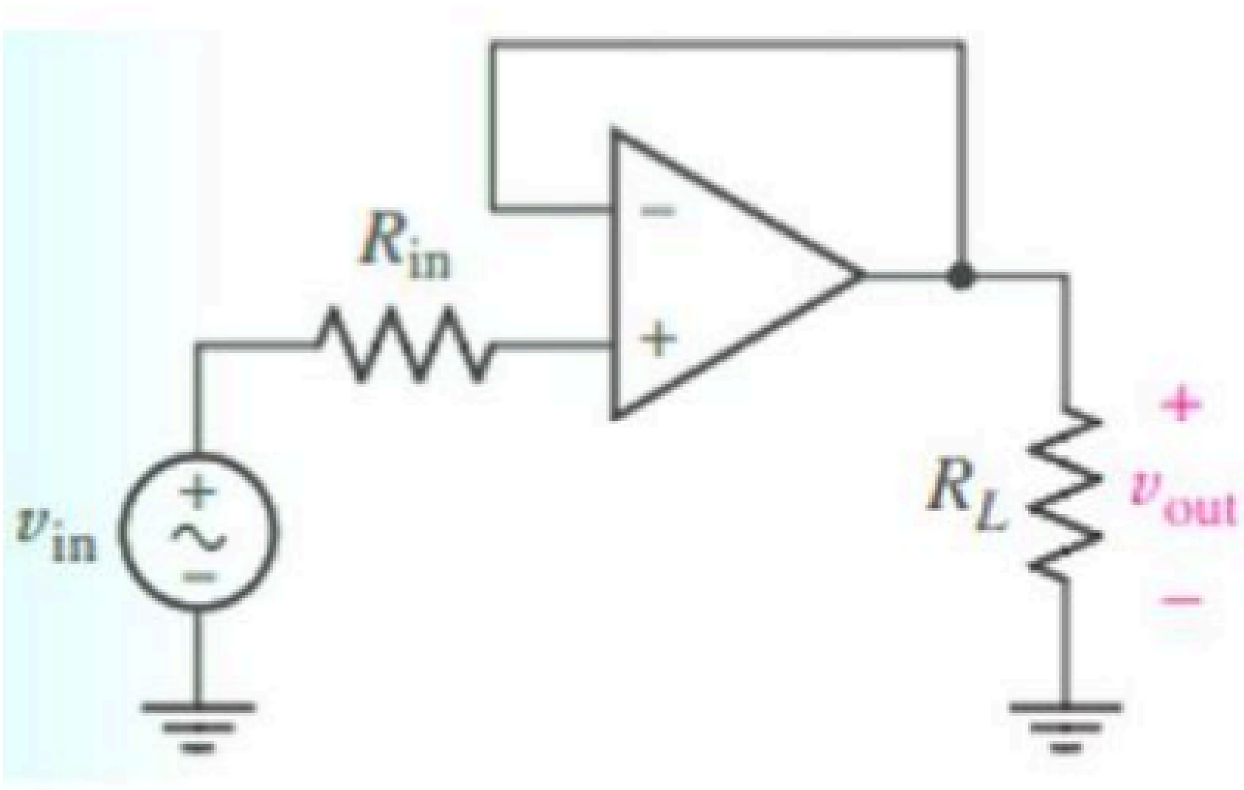
Final Answer:

$$\boxed{(4)}$$

Quick Tip

Understand the physics behind each effect in the context of different devices for accurate matching.

24. Express v_{out} in terms of v_{in} for the given circuit, assuming the op-amp is ideal.



(1) $1.2v_{in}$
(2) v_{in}
(3) $0.5v_{in}$

(4) 4.0

Correct Answer: (1) $1.2v_{\text{in}}$
Solution: For an ideal op-amp in a non-inverting configuration:

$$v_{\text{out}} = \left(1 + \frac{R_L}{R_{\text{in}}}\right) v_{\text{in}} = 1.2v_{\text{in}}$$

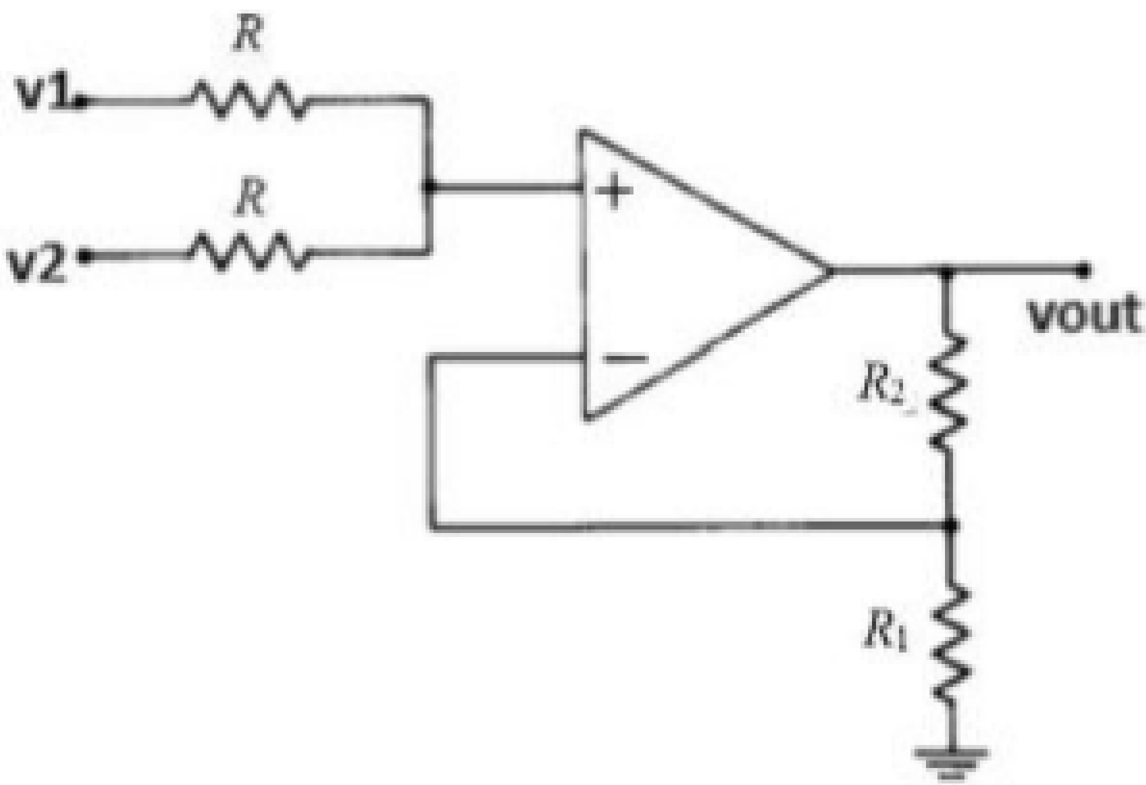
Final Answer:

$$\boxed{1.2v_{\text{in}}}$$

Quick Tip

In non-inverting op-amp circuits, v_{out} depends on the feedback resistor ratio.

25. Considering the op-amp to be ideal, the v_{out} is expressed as:



(1) $0.5(v_1 + v_2)(1 + \frac{R_2}{R_1})$
(2) $(v_1 + v_2)(1 + \frac{R_2}{R_1})$
(3) $1.5(v_1 + v_2)(1 + \frac{R_2}{R_1})$
(4) $0.5(v_1 - v_2)(1 + \frac{R_2}{R_1})$

Correct Answer: (1)
Solution: This is a differential amplifier configuration. The equation for v_{out} is derived from

the resistor values and the input voltages:

$$v_{\text{out}} = 0.5(v_1 + v_2)\left(1 + \frac{R_2}{R_1}\right)$$

Final Answer:

$$\boxed{0.5(v_1 + v_2)(1 + \frac{R_2}{R_1})}$$

Quick Tip

For differential amplifiers, use the feedback resistor ratio to determine the gain.

6. Arrange the following fabrication steps of MOSFET from initials:
(A) Metallization
(B) Oxidation
(C) Etching
(D) Diffusion/Ion implantation

(1) (A), (B), (C), (D)
(2) (B), (C), (A), (D)
(3) (B), (A), (D), (C)
(4) (B), (C), (D), (A)

Correct Answer: (1) (A), (B), (C), (D)
Solution:
Step 1: Understand the process of MOSFET fabrication.
The fabrication of a MOSFET involves several key steps that need to be followed in a particular sequence to ensure proper functioning of the transistor. Each of these steps plays a crucial role in forming the MOSFET structure.

Step 2: Order of steps.
- **Metallization (A)**: Metallization is the process of applying metal layers for interconnections. It is typically the first step after the formation of the wafer, as these metal contacts are needed to make electrical connections between the different components of the MOSFET.

- **Oxidation (B)**: The next step involves oxidizing the silicon wafer to form a layer of silicon dioxide, which is used as an insulating layer. This layer is essential for forming the gate dielectric in a MOSFET. It comes before etching and doping steps.

- **Etching (C)**: Etching is used to define patterns on the wafer, particularly for the gate structure and other components of the MOSFET. After oxidation, this step shapes the areas where different materials will be deposited or removed.

- **Diffusion/Ion implantation (D)**: Diffusion or ion implantation is the final step in the fabrication process where dopants are introduced into the semiconductor material to create regions with different electrical properties (e.g., n-type or p-type regions). This step usually comes last to define the transistor's source, drain, and channel regions.

Step 3: Final Answer.
Thus, the correct sequence of MOSFET fabrication steps is:
1. Metallization (A)
2. Oxidation (B)
3. Etching (C)
4. Diffusion/Ion implantation (D)

Final Answer:

$$\boxed{(1)}$$

> Quick Tip
>
> In semiconductor device fabrication, the order of processing steps is critical for ensuring that each layer and dopant is applied in the correct sequence to form the device structure.

27. The cutoff frequency of a first order low pass filter for $R_1 = 1.2\,\text{k}\Omega$ and $C_1 = 0.02\,\mu F$ is:

(1) 1.86 kHz
(2) 2.63 kHz
(3) 6.63 kHz
(4) 10.63 kHz

Correct Answer: (2) 2.63 kHz
Solution: The cutoff frequency f_c of a first-order low-pass filter is given by:

$$f_c = \frac{1}{2\pi R_1 C_1}$$

Substitute the values:

$$f_c = \frac{1}{2\pi \times 1.2 \times 10^3 \times 0.02 \times 10^{-6}} \approx 2.63\,\text{kHz}$$

Final Answer:

$$\boxed{2.63\,\text{kHz}}$$

> Quick Tip
>
> For low-pass filters, remember $f_c = \frac{1}{2\pi RC}$ to calculate cutoff frequency.

28. Match List-I with List-II:

List-I (Electric field)	**List-II (Mobility)**
(A) Low electric field	(I) Mobility decreases by $1/E$
(B) Medium electric field	(II) Mobility decreases by $1/\sqrt{E}$
(C) High electric field	(III) Mobility remains constant

Choose the correct answer:

(1) (A) – (III), (B) – (II), (C) – (I)
(2) (A) – (I), (B) – (III), (C) – (II)
(3) (A) – (II), (B) – (III), (C) – (I)
(4) (A) – (III), (B) – (I), (C) – (II)

Correct Answer: (4)
Solution:
- Low field: mobility decreases with E.
- Medium field: mobility decreases by $1/\sqrt{E}$.
- High field: mobility remains constant.

Final Answer:

$$\boxed{(4)}$$

Quick Tip

At low fields, mobility decreases with increasing electric field, but at high fields, it stabilizes.

29. The unit of ratio of diffusion constant (D) and mobility (μ) is:

(1) $\text{cm}^2/\text{V-sec}$
(2) Volts
(3) cm^2/sec
(4) A/m^2

Correct Answer: (1) $\text{cm}^2/\text{V-sec}$
Solution:
The unit of D/μ is $\text{cm}^2/\text{V-sec}$, as derived from the units of diffusion constant and mobility.
Final Answer:

$$\boxed{\text{cm}^2/\text{V-sec}}$$

Quick Tip

The diffusion constant and mobility in semiconductors are related through Einstein's relation.

30. A silicon crystal is doped with a group III element, the electron concentration falls below intrinsic concentration by a factor of 10^6, so the concentration of impurity present is:

(1) $1.5 \times 10^{16}\,\text{cm}^{-3}$
(2) $1.5 \times 10^{10}\,\text{cm}^{-3}$
(3) $1.5 \times 10^{14}\,\text{cm}^{-3}$
(4) $2.25 \times 10^{14}\,\text{cm}^{-3}$

Correct Answer: (3) $1.5 \times 10^{14}\,\text{cm}^{-3}$

Solution:
If the intrinsic concentration $n_i = 1.5 \times 10^{10}\,\text{cm}^{-3}$, the impurity concentration is:

$$n_{\text{imp}} = \frac{n_i}{10^6} = 1.5 \times 10^{14}\,\text{cm}^{-3}$$

Final Answer:

$$\boxed{1.5 \times 10^{14}\,\text{cm}^{-3}}$$

Quick Tip

When doping a semiconductor, the impurity concentration is often related to the intrinsic concentration by a factor.

31. Choose the wrong option from the following for the given statement. Statement: Electric field is conservative.

(1) curl to be identically zero.
(2) potential difference between any two points is zero.
(3) gradient of a scalar potential gives magnitude of electric field.
(4) work done in a closed path inside the field is zero.

Correct Answer: (2) potential difference between any two points is zero.

Solution: Step 1: Using the conservative nature of electric fields.
For a conservative electric field, the potential difference between two points is not zero, unlike what is suggested in option (2). This is the incorrect statement.

Step 2: Conclusion.
Since the electric field is conservative, the work done in a closed loop is zero, and the curl of the electric field is also zero.

Quick Tip

For a conservative electric field, the curl is zero, and the work done in a closed path is zero. However, the potential difference between two points is generally non-zero.

---

32. Choose the correct answer from the options given below.
A. $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ **represents Ampere's circuital law.**
B. $\vec{\nabla} \cdot \vec{B} = 0$ **represents magnetic monopole doesn't exist experimentally.**
C. $\vec{\nabla} \times \vec{E} = 0$ **represents the conservative nature of the electric field.**
D. $\vec{\nabla} \times \vec{A} = 0$ **represents the solenoidal condition for a vector field.**

(1) (A), (B) and (D) only.
(2) (A), (B) and (C) only.

(3) (A), (B), (C) and (D).
(4) (A), (C) and (D) only.

Correct Answer: (3) (A), (B), (C) and (D).

Solution: Step 1: Understanding the terms.
(A) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ represents Ampere's law, where μ_0 is the permeability of free space and $\vec{J}$ is the current density.
(B) $\vec{\nabla} \cdot \vec{B} = 0$ implies that there are no magnetic monopoles.
(C) $\vec{\nabla} \times \vec{E} = 0$ represents the conservative nature of the electric field, which is true in electrostatics.
(D) $\vec{\nabla} \times \vec{A} = 0$ represents a condition for a solenoidal vector field.

Step 2: Conclusion.
All of the statements (A), (B), (C), and (D) are correct.

Quick Tip

The curl of a magnetic field $\vec{\nabla} \times \vec{B}$ is proportional to the current density, and the curl of an electric field $\vec{\nabla} \times \vec{E}$ is zero in static conditions.

---

33. Match List-I with List-II

List-I	List-II
(A) Faraday's Law	(i) $\frac{\rho}{\epsilon_0}$
(B) Conservation Law	(ii) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
(C) Ohm's Law	(iii) $\vec{\nabla} \times \vec{A} = 0$
(D) Gauss's Law	(iv) $\vec{J} = \sigma \vec{E}$

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

Correct Answer: (2) (A) - (I), (B) - (II), (C) - (IV), (D) - (III)

Solution: Step 1: Understanding the match.
- Faraday's Law $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$, so it matches with (II).
- The Conservation Law involves the continuity equation, which matches with $\vec{J} = \sigma \vec{E}$, so it matches with (IV).
- Ohm's Law $\vec{J} = \sigma \vec{E}$, so it matches with (IV).
- Gauss's Law is represented by $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$, so it matches with (I).
Step 2: Conclusion.
Thus, the correct match is (2).

Quick Tip

When matching laws to their expressions, remember that Faraday's Law involves the time derivative of the magnetic field, while Ohm's law relates current density to electric field.

---

34. Gauss's law in magnetostatics is expressed as,

(1) $\oint \vec{B} \cdot d\vec{S} = 0$
(2) $\oint \vec{B} \cdot d\vec{I} = 0$
(3) $\oint \vec{B} \cdot \vec{n} dV = 0$
(4) $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{enc}}$

Correct Answer: (1) $\oint \vec{B} \cdot d\vec{S} = 0$

Solution: Step 1: Understanding Gauss's law in magnetostatics.
Gauss's law in magnetostatics states that the magnetic flux through any closed surface is zero, i.e., the net magnetic field lines entering any closed surface is zero, which can be mathematically written as:

$$\oint \vec{B} \cdot d\vec{S} = 0$$

This implies there are no "magnetic charges," and the magnetic field is always solenoidal (no beginning or end).

Step 2: Conclusion.
Thus, the correct expression for Gauss's law in magnetostatics is option (1).

$$\boxed{(1) \oint \vec{B} \cdot d\vec{S} = 0}$$

Quick Tip

Gauss's law in magnetostatics states that the net magnetic flux through any closed surface is zero, indicating that magnetic monopoles do not exist.

---

35. If in a free space, the electric field is given as:

$$\vec{E} = 20\cos(\omega t - 50x)\hat{y}\,\mathbf{V/m}$$

then, the expression of displacement current density J_d is:

(1) $-20\omega\epsilon_0 \cos(\omega t - 50x)\hat{y}\ \mathrm{A/m^2}$
(2) $-20\omega\epsilon_0 \sin(\omega t - 50x)\hat{y}\ \mathrm{A/m^2}$

(3) $-10\omega\epsilon_0 \sin(\omega t - 50x)\hat{y}$ A/m^2
(4) $-20\omega \sin(\omega t - 50x)\hat{y}$ A/m^2

Correct Answer: (2) $-20\omega\epsilon_0 \sin(\omega t - 50x)\hat{y}$ A/m^2

Solution: Step 1: Understanding displacement current.
Displacement current is given by:

$$J_d = \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Taking the time derivative of the electric field $\vec{E} = 20\cos(\omega t - 50x)\hat{y}$, we get:

$$\frac{\partial \vec{E}}{\partial t} = -20\omega \sin(\omega t - 50x)\hat{y}$$

Thus, the displacement current density is:

$$J_d = -20\omega\epsilon_0 \sin(\omega t - 50x)\hat{y}$$

Step 2: Conclusion.
Thus, the correct expression for displacement current density is option (2).

Quick Tip

Displacement current density is related to the time rate of change of the electric field in free space.

---

36. If electric $\vec{E}(r,t)$ and magnetic $\vec{B}(r,t)$ fields are defined as

$$\vec{E}(r,t) = \vec{E}_0 e^{i(k\cdot r - \omega t)}\hat{n}, \quad \vec{B}(r,t) = \frac{1}{c}\hat{k} \times \vec{E}(r,t)$$

where k is the propagation vector and $\hat{n}$ is the polarization vector. E and B are transverse in nature, if they satisfy which of the following conditions?

(1) $\hat{n} \times k = 0$
(2) $\hat{n} \cdot k = 0$
(3) $\hat{n} \times \hat{k} = 0$
(4) $k \cdot r = 0$

Correct Answer: (2) $\hat{n} \cdot k = 0$

Solution: Step 1: Understanding transverse nature.
For the fields to be transverse, the electric and magnetic fields must be perpendicular to the direction of propagation. This means that the wave vector k is orthogonal to both $\hat{n}$ and the electric field $\vec{E}$, leading to the condition $\hat{n} \cdot k = 0$.

Step 2: Conclusion.
Thus, the correct condition is $\hat{n} \cdot k = 0$, making option (2) the correct answer.

Quick Tip

In electromagnetic waves, the electric and magnetic fields are always transverse to the direction of propagation.

---

37. The characteristic length scale of nanomaterials is:

(1) 1-100 nm
(2) 1-500 nm
(3) 1-200 nm
(4) 1-300 nm

Correct Answer: (1) 1-100 nm

Solution: Step 1: Definition of nanomaterials.
Nanomaterials are defined as materials with structural elements in the size range of 1–100 nanometers. These materials exhibit unique properties compared to their bulk counterparts due to their small size.

Step 2: Conclusion.
Thus, the correct range for the characteristic length scale of nanomaterials is 1-100 nm.

Quick Tip

Nanomaterials typically have unique optical, electronic, and mechanical properties that arise due to their small size and high surface area.

---

38. Match List-I with List-II

Quantum Structure	Delocalization Dimensions
(A) Quantum wells	(I) 1
(B) Quantum wires	(II) 2
(C) Quantum dots	(III) 3
(D) Bulk conductors	(IV) 0

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

Correct Answer: (2) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

Solution: Step 1: Understanding the match.
- Quantum wells are one-dimensional structures, so they have delocalization in 1 dimension, matching with (I).
- Quantum wires are two-dimensional structures, matching with (II).
- Quantum dots are zero-dimensional structures, matching with (III).
- Bulk conductors are typically considered as having zero delocalization in terms of quantum dimensions, matching with (IV).

Step 2: Conclusion.
Thus, the correct match is option (2).

> Quick Tip
>
> Quantum structures like wells, wires, and dots have different delocalization dimensions, leading to different electronic properties.

---

39. If the diameter of the chiral carbon nanotubes increases, then

(1) the band gap of semiconducting chiral carbon nanotubes decreases linearly
(2) the band gap of semiconducting chiral carbon nanotubes increases linearly
(3) the band gap of semiconducting chiral carbon nanotubes decreases exponentially
(4) the band gap of semiconducting chiral carbon nanotubes increases exponentially

Correct Answer: (1) the band gap of semiconducting chiral carbon nanotubes decreases linearly

Solution: Step 1: Understanding the relationship.
For semiconducting chiral carbon nanotubes, as the diameter increases, the band gap typically decreases. This is due to the reduced curvature and strain on the nanotube structure, leading to a linear decrease in the band gap.

Step 2: Conclusion.
Thus, the correct answer is option (1).

> Quick Tip
>
> The band gap of semiconducting carbon nanotubes is inversely related to their diameter, decreasing as the diameter increases.

---

40. The Extreme Ultraviolet (EUV) lithography employs .... wavelength.

(1) 13.5 nm
(2) 53.5 nm

(3) 100 nm
(4) 50 nm

Correct Answer: (1) 13.5 nm

Solution: Step 1: Understanding EUV lithography.
EUV lithography is a next-generation technology used in semiconductor manufacturing, and it operates at a wavelength of 13.5 nm, enabling the creation of smaller features on chips.

Step 2: Conclusion.
Thus, the correct wavelength used in EUV lithography is 13.5 nm, so the answer is option (1).

> Quick Tip
>
> EUV lithography enables the production of smaller microprocessors with higher performance by using shorter wavelengths (13.5 nm) compared to traditional photolithography.

---

41. Attenuation in optical fibre can be measured in:

(1) KdB/m
(2) dB/m
(3) dB/km
(4) dB/mm

Correct Answer: (2) dB/m

Solution: Attenuation in optical fibres is typically expressed in decibels per meter (dB/m). This represents the loss of signal strength per unit length as the signal travels through the fibre. While other units such as dB/km and dB/mm can be used in different contexts, dB/m is the most commonly used unit in practical applications.

Final Answer:

$$\boxed{(2)\ \text{dB/m}}$$

> Quick Tip
>
> In optical fibre, attenuation is the reduction in signal strength, typically expressed in dB per meter.

---

42. .... nanoparticles are extraordinarily efficient for clinical diagnostic purposes as they give strong signatures in optical absorption, fluorescence spectroscopy, X-Ray diffraction, and electrical conductivity.

(1) Silver
(2) Copper
(3) Gold
(4) Iron

Correct Answer: (3) Gold

Solution: Gold nanoparticles are widely used in clinical diagnostics due to their strong optical properties, such as high absorbance and scattering, which are useful for optical imaging techniques. They also exhibit good fluorescence properties and can be easily functionalized for use in diagnostics, making them the most efficient for clinical applications.

Final Answer:

$$\boxed{\text{(3) Gold}}$$

Quick Tip

Gold nanoparticles are commonly used in diagnostic applications due to their unique optical properties and ease of functionalization.

---

43. Bio-functionalization of magnetic nanoparticles has been extensively used for the development of biosensors such as:

(1) FeO
(2) ZnO
(3) COH
(4) GaAs

Correct Answer: (1) FeO

Solution: FeO (magnetite) nanoparticles are widely used in biosensors due to their magnetic properties. These nanoparticles can be manipulated by an external magnetic field, making them ideal for various biomedical applications such as targeted drug delivery and diagnostic imaging.

Final Answer:

$$\boxed{\text{(1) FeO}}$$

Quick Tip

Magnetic nanoparticles like FeO are widely used in biosensors due to their strong magnetic properties and functionalization potential.

44. A multiplexer (MUX)
(A) is a parallel to serial converter
(B) is also known as data distributor
(C) can be used as a logic function generator
(D) switch the data from several lines to one line

Choose the correct answer from the options given below:

(1) (A), (B), (C) and (D)
(2) (A), (B) and (D) only
(3) (B), (C) and (D) only
(4) (A), (C) and (D) only

Correct Answer: (1) (A), (B), (C) and (D)

Solution:
A multiplexer (MUX) is a digital switch that can perform various functions:
- **Parallel to serial conversion**: It converts multiple parallel data inputs to a single serial data output.
- **Data distributor**: It can distribute one of several inputs to the output based on selection.
- **Logic function generator**: It can be configured to perform different logic operations by appropriately setting its selection lines.
- **Switching data**: It switches data from multiple lines to a single output line.

Thus, all options (A), (B), (C), and (D) are correct.

Final Answer:

$$\boxed{\text{(1) (A), (B), (C) and (D)}}$$

Quick Tip

A multiplexer can perform multiple functions, including data distribution and parallel-to-serial conversion.

45. A 32:1 Mux can be designed using:

(1) two 16:1 Muxs and one two-input OR gate
(2) two 16:1 Muxs and one two-input AND gate
(3) two 16:1 Muxs and one two-input NOR gate
(4) two 16:1 Muxs only

Correct Answer: (1) two 16:1 Muxs and one two-input OR gate

Solution: A 32:1 multiplexer can be designed by using two 16:1 multiplexers. The outputs from these multiplexers are combined using an OR gate, which allows for the selection of one of 32 inputs. This is a standard technique used in digital circuit design to build larger multiplexers.

Final Answer:

(1) two 16:1 Muxs and one two-input OR gate

Quick Tip

To design a larger multiplexer, use smaller multiplexers combined with logic gates for selection.

---

46. In the first window of optical fibre, light sources are generally:

(1) GaAlP
(2) GaAlBr
(3) GaAlAs
(4) GeAlAs

Correct Answer: (3) GaAlAs

Solution: In the first window of optical fibre communication, light sources such as **GaAlAs** (Gallium Aluminium Arsenide) are commonly used. GaAlAs is a semiconductor material that emits light in the near-infrared region, which is ideal for transmission in the first window of optical fibre, typically around 850 nm.

Final Answer:

(3) GaAlAs

Quick Tip

The first window in optical fibre typically uses light sources like GaAlAs, which emit in the near-infrared region.

---

47. Following statements are given in reference to 8085 Microprocessor:
(A) Its memory size is 64 KB
(B) It is a 40-pin IC
(C) Its clock frequency lies between 3 to 5 MHz
(D) It has 16 bit of each data and address lines.

Choose the correct answer from the options given below:

(1) (A), (B) and (D) only
(2) (A), (B) and (C) only
(3) (A), (B), (C) and (D)
(4) (B), (C) and (D) only

Correct Answer: (3) (A), (B), (C) and (D)

Solution: The 8085 microprocessor is a 40-pin Integrated Circuit (IC) and has a memory size of 64 KB. Its clock frequency typically ranges from 3 to 5 MHz, which was common for microprocessors of that era. However, the 8085 has an 8-bit data bus and a 16-bit address bus, not a 16-bit data and address bus as stated in option (D). Therefore, option (D) is incorrect.

Final Answer:

(3) (A), (B), (C) and (D)

Quick Tip

The 8085 microprocessor has a 40-pin configuration, a clock frequency range of 3-5 MHz, and a 16-bit address bus but an 8-bit data bus.

---

48. Fibre optic sensors may be classified into three categories. Choose the incorrect option.

(1) Intensity-modulated sensors
(2) Phase sensors
(3) Diffraction sensors
(4) Conducting sensors

Correct Answer: (4) Conducting sensors

Solution: Fibre optic sensors are generally classified into intensity-modulated, phase-sensitive, and diffraction-based sensors. "Conducting sensors" is not a classification commonly used for fibre optic sensors, making it the incorrect option.

Final Answer:

(4) Conducting sensors

Quick Tip

Fibre optic sensors are typically classified into categories such as intensity-modulated, phase sensors, and diffraction sensors.

49. Which of the following is the most appropriate transmission frequency in optical fibre?

(1) 10^9 Hz
(2) 10^{11} Hz
(3) 10^{14} Hz
(4) 10^4 Hz

Correct Answer: (3) 10^{14} Hz

Solution: Optical fibres transmit data using light, typically in the infrared or visible spectrum. The most common transmission frequencies in optical fibre communication systems are in the range of 10^{14} Hz (near-infrared). This frequency is ideal for transmitting data through optical fibres due to the low loss at these frequencies.

Final Answer:

$$\boxed{(3)\ 10^{14}\ \text{Hz}}$$

Quick Tip

In optical fibre communication, the transmission frequency typically lies in the range of 10^{14} Hz, which corresponds to infrared light.

---

50. Which part of optical fibre has a higher refractive index:

(1) Core
(2) Cladding
(3) Seath
(4) Both Cladding and Seath

Correct Answer: (2) Cladding

Solution: In an optical fibre, the **core** has a higher refractive index than the **cladding**. This difference in refractive indices causes total internal reflection, which allows light to be guided through the core of the fibre. The cladding has a lower refractive index to ensure that light remains confined within the core.

Final Answer:

$$\boxed{(2)\ \text{Cladding}}$$

Quick Tip

The core of the optical fibre has a higher refractive index than the cladding, which is crucial for light confinement and total internal reflection.

51. Match List-I with List-II

List-I (Instructions)	List-II (Addressing Mode)
(A) LDA 2100 H	(I) Immediate
(B) RAL	(II) Register
(C) ADD C	(III) Direct
(D) ANI 08 H	(IV) Implied

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

Correct Answer: 1. (A) = (I), (B) = (II), (C) = (III), (D) = (IV)

Solution: Step 1: Understand the instructions and addressing modes.

- LDA 2100 H is a load instruction and uses the immediate addressing mode.
- RAL (Rotate accumulator left) uses the register addressing mode.
- ADD C (Add contents of register C to accumulator) uses direct addressing.
- ANI 08 H (AND immediate with accumulator) uses the implied addressing mode.

Final Answer:

$$\boxed{1.(A) = (I), (B) = (II), (C) = (III), (D) = (IV)}$$

Quick Tip

For understanding addressing modes, remember: - Immediate addressing involves direct value manipulation (e.g., LDA 2100 H). - Register addressing involves registers for operations (e.g., RAL). - Direct addressing uses memory locations directly (e.g., ADD C). - Implied addressing involves no operands (e.g., ANI 08 H).

---

52. (A) MOV A, C is a one-byte instruction.
(B) OUT 03 H is a two-byte instruction.
(C) ANI 76 H is a three-byte instruction.
(D) STA 3000 H is a three-byte instruction.

1. (A), (B), and (D) only
2. (A), (B), and (C) only
3. (A), (B), (C), and (D)

4. (B), (C), and (D) only

Correct Answer: 3. (A), (B), (C), and (D)

Solution: Step 1: Determine the size of each instruction.
- MOV A, C is a one-byte instruction, typically in most microprocessors.
- OUT 03 H is a two-byte instruction (it requires a memory location and the instruction code).
- ANI 76 H is a three-byte instruction (it requires a constant operand).
- STA 3000 H is a three-byte instruction (it requires the address of a memory location).

Final Answer:

$$\boxed{3.\text{(A), (B), (C), and (D)}}$$

Quick Tip

When learning instruction sizes, remember that:
- One-byte instructions generally involve register-to-register operations.
- Two-byte instructions involve memory locations or I/O operations.
- Three-byte instructions often involve addresses or immediate data.

---

53. Which of the following statements about hydrogen peroxide is INCORRECT?

1. It is a chemical threat agent as its excessive concentration as a product of industry and from atomic power stations affects the environment.
2. It can not be used for the disinfection of water pools, food, and beverage packages as it is a chemical threat agent.
3. It is the most valuable marker for oxidative stress and recognized as one of the major risk factors in the progression of disease-related pathophysiological complications in diabetes.
4. It is the most valuable marker for inflammatory processes and a mediator for apoptotic cell death.

Correct Answer: 2. It can not be used for the disinfection of water pools, food, and beverage packages as it is a chemical threat agent.

Solution: Step 1: Review each statement. - Statement 1 is true, as hydrogen peroxide is indeed a chemical threat agent when in high concentrations. - Statement 2 is false, as hydrogen peroxide is actually used in disinfection, including water treatment. - Statement 3 is correct, as hydrogen peroxide is often used to assess oxidative stress in biological systems. - Statement 4 is correct as well; hydrogen peroxide plays a role in inflammatory processes.

Final Answer:

$$\boxed{2}$$

Quick Tip

Hydrogen peroxide is useful for various applications, including disinfection, but it must be used in the right concentration to avoid harmful effects.

---

54. Match List-I with List-II

List-I (Data Bus Status Output)	List-II (Status Signals)
(A) Memory read	(I) 0, 1, 1
(B) Op-code fetch	(II) 0, 1, 0
(C) INTR acknowledge	(III) 0, 0, 1
(D) Memory write	(IV) 1, 1, 1

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

Correct Answer: 1. (A) = (I), (B) = (II), (C) = (III), (D) = (IV)

Solution: Step 1: Understanding the data bus status signals.
- Memory read corresponds to the signal (I) 0, 1, 1.
- Op-code fetch corresponds to the signal (II) 0, 1, 0.
- INTR acknowledge corresponds to the signal (III) 0, 0, 1.
- Memory write corresponds to the signal (IV) 1, 1, 1.

Final Answer:

$$\boxed{1.(A) = (I), (B) = (II), (C) = (III), (D) = (IV)}$$

Quick Tip

When dealing with data bus signals, understand that each operation like memory read, write, or op-code fetch corresponds to a unique status signal for the processor.

---

55. .... refers to the inability to faithfully repeat recorded data output when measuring a range of values and scanning from different directions.

1. Selectivity
2. Resolution
3. Hysteresis
4. Detection limit

Correct Answer: 3. Hysteresis

Solution: Step 1: Understanding hysteresis.
Hysteresis refers to the phenomenon where the response of a system depends not only on its current state but also on its past states. In measurements, this means that the data output may vary when measurements are repeated in different directions.

Step 2: Conclusion.
Among the given options, hysteresis is the phenomenon where measurements can be inconsistent based on the scanning direction, making it the correct answer.

Final Answer:

$$\boxed{3.\text{Hysteresis}}$$

> **Quick Tip**
>
> Hysteresis can cause measurement errors and inconsistency, especially in systems that involve magnetic or mechanical components.

---

56. .... is the vector address of the TRAP interrupt.
1. 003C H
2. 0024 H
3. 002C H
4. 0034 H

Correct Answer: 1. 003C H

Solution: Step 1: TRAP Interrupt Address.
In microprocessor architecture, the TRAP interrupt is assigned the vector address of 003C H.

Final Answer:

$$\boxed{1.003\text{C H}}$$

> **Quick Tip**
>
> In 8085 microprocessor, the TRAP interrupt is a non-maskable interrupt with a fixed vector address of 003C H.

---

57. What is the word length of an 8-bit microprocessor?
1. 16 bit
2. 32 bit
3. 8 bit

4. may vary in between 8 bit to 32 bit

Correct Answer: 3. 8 bit

Solution: Step 1: Understanding the word length of a microprocessor.
An 8-bit microprocessor has a word length of 8 bits, meaning it processes 8 bits of data in one operation.

Final Answer:

$$\boxed{3.8 \text{ bit}}$$

Quick Tip

The word length of a microprocessor defines the amount of data it processes in one clock cycle. For an 8-bit processor, the word length is always 8 bits.

---

58. To expand a 4-bit parallel adder to an 8-bit parallel adder, we can
(A) use two 4-bit adders and connect the sum output of one to the input bit of the other
(B) use four 4-bit adders with no interconnections
(C) use two 4-bit adders with the carry output of one connected to the carry input of the other
(D) use eight 4-bit adders with no interconnections

1. (A), (C) only
2. (B), (D) only
3. (A) only
4. (C) only

Correct Answer: 1. (A), (C) only

Solution: Step 1: Expanding a 4-bit adder.
To expand a 4-bit parallel adder into an 8-bit adder, two 4-bit adders can be connected, and the carry output of one adder can be fed into the carry input of the next. This ensures that the addition operation covers all 8 bits.

Final Answer:

$$\boxed{1.\text{(A), (C) only}}$$

Quick Tip

When expanding adders, ensure that the carry outputs are properly connected to the next adder to maintain the integrity of the operation.

59. Which of the following statement(s) about Digital-to-Analog (DAC) converter is/are correct?
(A) DAC is said to be monotonic if its output decreases as the binary input is incremented from one value to the next.
(B) Ideally, the output of a DAC should be zero when the binary input is zero.
(C) The operating speed of a DAC is usually specified by giving its settling time.
(D) Resolution is the reciprocal of the number of discrete steps in the full-scale output of the DAC.

1. (A), (B), and (D) only
2. (A), (B), and (C) only
3. (A), (B), (C), and (D)
4. (B), (C), and (D) only

Correct Answer: 3. (A), (B), (C), and (D)

Solution: Step 1: Review each statement.
- Statement (A) is correct, as DACs are monotonic when their output increases or decreases consistently with the binary input.
- Statement (B) is also correct; in an ideal DAC, zero input should give zero output.
- Statement (C) is correct as well; the operating speed of a DAC is typically specified by its settling time, which defines how quickly it stabilizes at the correct output.
- Statement (D) is true; resolution is inversely related to the number of discrete output levels.

Final Answer:

$$\boxed{3.\text{(A), (B), (C), and (D)}}$$

Quick Tip

When working with DACs, ensure that you consider both resolution and settling time for accurate performance measurements.

---

60. Major problems with the large-scale utilization of carbon nanotubes
(A) synthesis in pure forms
(B) dispersion in solvents
(C) reducing their length
(D) tailoring into a desired orientation

1. (A), (B), and (D) only
2. (A), (B), and (C) only

3. (A), (B), (C), and (D)
4. (B), (C), and (D) only

Correct Answer: 3. (A), (B), (C), and (D)

Solution: Step 1: Identifying challenges with carbon nanotubes.
The large-scale use of carbon nanotubes faces several issues:
- (A) Synthesizing carbon nanotubes in pure forms is challenging.
- (B) Dispersion in solvents is difficult due to their strong tendency to clump together.
- (C) Reducing their length is necessary for certain applications but is hard to achieve consistently.
- (D) Tailoring their orientation is essential for specific applications, but this is not always feasible.

Final Answer:

3.(A), (B), (C), and (D)

Quick Tip

For carbon nanotubes, achieving purity, proper dispersion, and desired orientation is crucial for effective application in advanced materials and devices.

---

61. Match List-I with List-II Choose the correct answer from the options given below:

List-I	List-II
(A). Purification	(I). to improve interactions with a solid or liquid matrix
(B). De-agglomeration	(II). methods include thermal annealing in air or oxygen; acid treatment, microfiltration
(C). Chemical functionalization	(III). can be made in a carbon arc, but burning a hydrocarbon feedstock with strict control of the oxygen supply is a more controllable method
(D). Fullerenes	(IV). methods include ultrasonication, electrostatic plasma treatment, electric field manipulation and polymer wrapping, ball milling

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

Correct Answer: (4) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)

Solution: Step 1: Understanding Purification.
Purification is the process of separating impurities or unwanted components, commonly involving methods like thermal annealing, acid treatment, or filtration, which are listed under (II).

Step 2: De-agglomeration.
De-agglomeration involves breaking down clusters into smaller particles using methods such as ultrasonication, electric field manipulation, and polymer wrapping, which matches with (IV).

Step 3: Chemical Functionalization.
Chemical functionalization involves modifying the surface of materials, which can be done using various controlled processes like carbon arc burning, where oxygen supply plays a crucial role, matching with (I).

Step 4: Fullerenes.
Fullerenes are molecules made from carbon, and they require specific controlled processes for their creation, which are described by (III).

Final Answer:

$$\boxed{(4)\,(A)-(II),(B)-(IV),(C)-(I),(D)-(III)}$$

Quick Tip

Matching technical terms to their respective processes requires understanding the basic principles of material processing, such as purification, de-agglomeration, functionalization, and fullerene formation.

---

62. In nanomaterials production, according to Aufbau principle the self-assembly of complicated structures takes place in a hierarchical fashion in the following sequence:
(A) the linear chains are bundled to form two-dimensional monolayers
(B) single molecules join up to form linear chains
(C) a finite number of independent molecules
(D) the two-dimensional monolayers are stacked to form the final three-dimensional crystal
Choose the correct answer from the options given below:

(1) (A) - (B), (C) - (D)
(2) (A) - (C), (B) - (D)
(3) (B) - (A), (C) - (D)
(4) (C) - (B), (A) - (D)

Correct Answer: (2) (A) - (C), (B) - (D)

Solution: Step 1: Understanding the self-assembly process.
In the Aufbau principle of nanomaterials, the self-assembly process occurs in a structured sequence. First, individual molecules (C) come together to form linear chains (B).

Step 2: Bundling to form monolayers.
Next, these linear chains (B) are bundled to form two-dimensional monolayers (A), which then stack to form the final three-dimensional crystal (D).

Final Answer:

$$\boxed{(2)\,(A) - (C), (B) - (D)}$$

> Quick Tip
>
> The Aufbau principle is crucial in understanding the formation of nanomaterials, as it defines the sequential steps in their self-assembly from simple molecules to complex three-dimensional structures.

---

63. The number of cubes of each side 1 nm and the collective surface area that can be carved out from a cube with each side of 1 m are respectively:

(1) 1×10^{27} and 6000 km^2
(2) 1×10^{27} and 600 km^2
(3) 1×10^{25} and 5000 km^2
(4) 1×10^{27} and 500 km^2

Correct Answer: (2) 1×10^{27} and 6000 km^2

Solution: Step 1: Understanding the dimensions.
Given that the side length of the cube is 1 m, we can calculate the number of smaller cubes (each side 1 nm) that can be carved from it.
Since $1\,\text{m} = 10^9\,\text{nm}$, the volume of the large cube is $(10^9)^3\,\text{nm}^3 = 10^{27}\,\text{nm}^3$.
Thus, the number of cubes with side 1 nm is 10^{27}.

Step 2: Calculating the collective surface area.
The surface area of each small cube is $6 \times (1\,\text{nm})^2 = 6\,\text{nm}^2$.
For the entire collection of cubes, the total surface area is $6 \times 10^{27}\,\text{nm}^2$.
Converting this to km^2:

$$6 \times 10^{27}\,\text{nm}^2 = 6 \times 10^{27} \times 10^{-18}\,\text{m}^2 = 6 \times 10^9\,\text{m}^2 = 6000\,\text{km}^2.$$

Final Answer:

$$\boxed{(2)\,1 \times 10^{27}\,\text{and}\,6000\,\text{km}^2}$$

> Quick Tip
>
> When converting from nm to m and m^2 to km^2, remember the conversion factors: $1\,\text{m} = 10^9\,\text{nm}$ and $1\,\text{m}^2 = 10^{-6}\,\text{km}^2$.

64. The process of transferring a pattern into a reactive polymer film which will subsequently be used to replicate that pattern into an underlying thin film is called:

(1) Electrochemical Deposition
(2) Lithography
(3) Mechanical Exfoliation
(4) Electroless Deposition

Correct Answer: (2) Lithography

Solution: Step 1: Understanding Lithography.
Lithography is a process used in microfabrication, where a pattern is transferred to a thin polymer film, which is then used to replicate that pattern onto a substrate material. This method is widely used in semiconductor manufacturing and nanotechnology.

Step 2: Conclusion.
In this context, the process described matches the definition of Lithography, which is used to transfer patterns into films.

Final Answer:

$$\boxed{\text{(2) Lithography}}$$

Quick Tip

Lithography is essential in the production of microelectronics, where it enables the precise patterning of complex designs on substrates.

---

65. The process of synthesizing large polymer molecules is:

(1) top-down approach
(2) bottom-up approach
(3) spontaneous process
(4) forced process

Correct Answer: (2) bottom-up approach

Solution: Step 1: Understanding polymer synthesis.
The synthesis of large polymer molecules typically follows the bottom-up approach, where smaller molecules (monomers) are chemically bonded together to form larger macromolecules (polymers).

Step 2: Explanation.
In contrast to the top-down approach, which starts with larger materials and breaks them

down, the bottom-up approach is fundamental in polymer chemistry, where monomers combine to form long polymer chains.

Final Answer:

(2) bottom-up approach

Quick Tip

In polymer chemistry, the bottom-up approach is commonly used to create high molecular weight polymers, by linking smaller molecules into larger structures.

---

66. Match List-I with List-II

List-I	List-II
Nanostructures and Nanomaterials fabrication technologies	**Definitions**
(A). Vapor phase growth	(I). including vapor-liquid-solid growth for nanowires
(B). Liquid phase growth	(II). including laser reaction pyrolysis for nanoparticle synthesis and atomic layer deposition for thin film deposition.
(C). Solid phase formation	(III). including colloidal processing for the formation of nanoparticles and self assembly of monolayers.
(D). Hybrid growth	(IV). including phase segregation to make metallic particles in glass matrix and two-photon included polymerization for the fabrication of three-dimensional photonic crystals.

Choose the correct answer from the options below:
(1) (A) = (I), (B) = (II), (C) = (IV), (D) = (III)
(2) (A) = (II), (B) = (III), (C) = (I), (D) = (IV)
(3) (A) = (I), (B) = (III), (C) = (IV), (D) = (II)
(4) (A) = (III), (B) = (IV), (C) = (II), (D) = (I)

Correct Answer: (2) (A) = (II), (B) = (III), (C) = (I), (D) = (IV)

Solution: Step 1: Vapor phase growth.
Vapor phase growth involves vapor-liquid-solid growth for nanowires, matching (A) with (I).

Step 2: Liquid phase growth.
Liquid phase growth includes colloidal processing for the formation of nanoparticles and self-assembly of monolayers, matching (B) with (III).

Step 3: Solid phase formation.
Solid phase formation involves laser reaction pyrolysis for nanoparticle synthesis, matching (C) with (I).

Step 4: Hybrid growth.
Hybrid growth includes phase segregation to make metallic particles in glass matrix and two-photon polymerization for the fabrication of three-dimensional photonic crystals, matching (D) with (IV).

Final Answer:

The correct answer is (2) (A) = (II), (B) = (III), (C) = (I), (D) = (IV).

Quick Tip

Vapor phase growth is typically used for nanowires, while hybrid growth involves complex fabrication processes for photonic crystals.

---

67. The process of transferring growth species from a source or target and depositing them on a substrate to form a film is called:

(1) Molecular Beam Epitaxy
(2) Physical Vapor Deposition
(3) Chemical Vapor Deposition
(4) Atomic Layer Deposition

Correct Answer: (4) Atomic Layer Deposition

Solution: Step 1: Understand the question.
The process described refers to a thin film deposition technique where growth species are deposited in a controlled manner, one atomic layer at a time. This process is known as Atomic Layer Deposition (ALD).

Final Answer:

The correct answer is (4) Atomic Layer Deposition.

Quick Tip

Atomic Layer Deposition is a precise technique used to grow thin films one atomic layer at a time, making it ideal for applications requiring uniform coatings.

---

68. In X-ray diffraction, a collimated beam of X-rays, with most appropriate wavelength ranging from .... is incident on a specimen and is diffracted by the crystalline phases of the specimen:

(1) 0.1 to 2 Å
(2) 5 to 10 Å
(3) 10 to 20 Å
(4) 20 to 30 Å

Correct Answer: (2) 5 to 10 Å

Solution: Step 1: X-ray diffraction principle.
X-rays with wavelengths ranging from 5 to 10 Å are ideal for X-ray diffraction as they are comparable to the lattice spacing of crystals.

Final Answer:

The correct answer is (2) 5 to 10 Å.

Quick Tip

For X-ray diffraction, the wavelength should be similar to the spacing between atomic planes in a crystal.

---

69. .... are electromagnetic radiation with typical photon energies in the range of 100 eV to 100 keV:

(1) X-rays
(2) Infrared rays
(3) Optical spectroscopy
(4) Raman spectroscopy

Correct Answer: (1) X-rays

Solution: Step 1: Identify photon energy range.
X-rays are electromagnetic radiation with photon energies typically ranging from 100 eV to 100 keV.

Final Answer:

The correct answer is (1) X-rays.

Quick Tip

X-rays have high photon energies and are used in techniques like X-ray diffraction and X-ray imaging.

70. Measurement of grain size by using X-ray diffraction line broadening can be done by:

(1) Bragg's Law
(2) Debye-Scherrer Formula
(3) Total Internal Reflection
(4) Moseley Law

Correct Answer: (2) Debye-Scherrer Formula

Solution: Step 1: Understanding the Debye-Scherrer Formula.
The Debye-Scherrer formula is used to estimate the grain size of a material by analyzing the broadening of X-ray diffraction lines.

Final Answer:

The correct answer is (2) Debye-Scherrer Formula.

Quick Tip

Grain size can be calculated by using the broadening of diffraction peaks in X-ray diffraction, and the Debye-Scherrer formula is the standard method.

---

71. Quantum well lasers were first fabricated using the .... material systems.

(1) InGaAsN/GaAs
(2) GaAs/AlGaAs
(3) InGaAsP/InP
(4) GaAs/InP

Correct Answer: (2) GaAs/AlGaAs

Solution: Step 1: Historical background of quantum well lasers.
Quantum well lasers were initially fabricated using GaAs/AlGaAs material systems. This material system was widely used for semiconductor lasers, including those based on quantum well structures.

Final Answer:

GaAs/AlGaAs

Quick Tip

Quantum well lasers use material systems with different band gaps to create the necessary electronic structure for laser operation.

---

72. The measurement of Nitric Oxide (NO) is quite difficult due to its .... half-life and .... reactivity with other biological components such as superoxide, oxygen, thiols.

(1) Short, High
(2) Short, Low
(3) Long, High
(4) Long, Low

Correct Answer: (1) Short, High

Solution: Step 1: Half-life of Nitric Oxide.
The half-life of Nitric Oxide (NO) is very short, which makes it difficult to measure accurately.

Step 2: Reactivity of Nitric Oxide.
NO is highly reactive with biological molecules such as superoxide and oxygen, making its detection even more challenging.

Final Answer:

$$\boxed{\text{Short, High}}$$

> **Quick Tip**
>
> When measuring gases like NO, their reactivity and half-life can greatly affect the accuracy of measurement techniques.

---

73. In the ISFET pH measurement system, the voltage circuit has .... impedance and the current circuit has .... impedance.

(1) High, Low
(2) zero, High
(3) Low, zero
(4) Low, High

Correct Answer: (1) High, Low

Solution: Step 1: ISFET voltage circuit characteristics.
The voltage circuit in an ISFET measurement system must have high impedance to ensure that the small voltage signal is not disturbed.

Step 2: ISFET current circuit characteristics.
The current circuit, on the other hand, has low impedance to allow for accurate measurement of the current without interfering with the system.

Final Answer:

$$\boxed{\text{High, Low}}$$

Quick Tip

In ISFET systems, ensuring high impedance in the voltage circuit and low impedance in the current circuit is crucial for accurate measurements.

---

74. .... type of electrochemical detection measures the electric current associated with the electron transfer involved in redox processes whereas .... type of electrochemical detection measures conductance or capacitance changes associated with changes in the overall ionic medium between the two electrodes.

(1) Amperometry, potentiometry
(2) Potentiometry, impedance spectroscopy
(3) Amperometry, impedance spectroscopy
(4) Potentiometry, amperometry

Correct Answer: (1) Amperometry, potentiometry

Solution: Step 1: Amperometry detection.
Amperometry measures the electric current produced by electron transfer reactions during redox processes.

Step 2: Potentiometry detection.
Potentiometry detects changes in the potential difference between electrodes and is used to measure the concentration of ions, often via changes in the ionic medium.

Final Answer:

$$\boxed{\text{Amperometry, Potentiometry}}$$

Quick Tip

Understand the difference between amperometry (current-based) and potentiometry (voltage-based) to use the right technique for electrochemical detection.

---

75. Which of the following statements is incorrect about Light-addressable potentiometric sensors (LAPS)?

(1) In the LAPS with EIS structure, a semiconductor substrate (silicon) is covered with an insulator (SiO2).
(2) An enzyme deposited on the LAPS surface allows one to observe the spatial distribution of a specific substrate.

(3) In the LAPS with electrolyte-insulator-semiconductor (EIS) structure, a semiconductor substrate (silicon) is covered with an insulator (SiO2).
(4) A sensing ion-selective layer, for instance, pH-sensitive S3N4, is deposited on the bottom of the insulator.

Correct Answer: (2) An enzyme deposited on the LAPS surface allows one to observe the spatial distribution of a specific substrate.

Solution: Step 1: Understanding the LAPS structure.
The LAPS with EIS structure involves a semiconductor covered with an insulator layer (SiO2), and a sensing layer is deposited on the insulator.

Step 2: Enzyme in LAPS.
LAPS does not use enzymes for observing spatial distribution of substrates. This part of the statement is incorrect, as it misrepresents the functionality of LAPS.

Final Answer:

$$\boxed{(2)}$$

Quick Tip

LAPS sensors work based on ion-selective layers and do not rely on enzymatic processes for spatial distribution analysis.
