

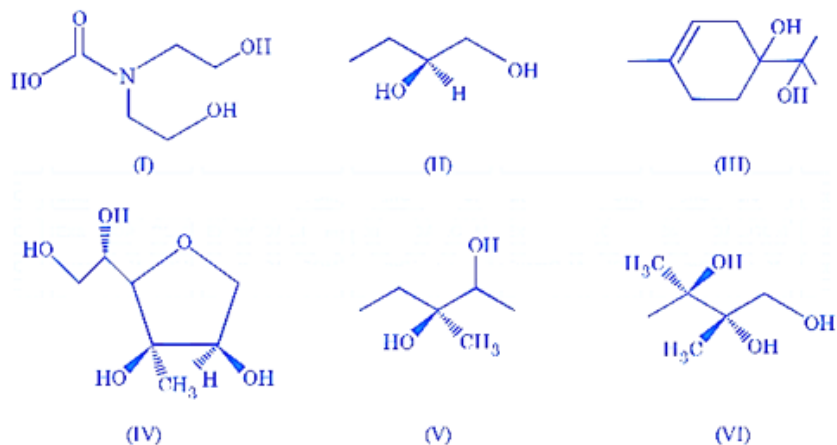
Max Marks: 300

SR_WEEK-14(FTB) (21-09-2026)

Time: 180 mins

Chemistry

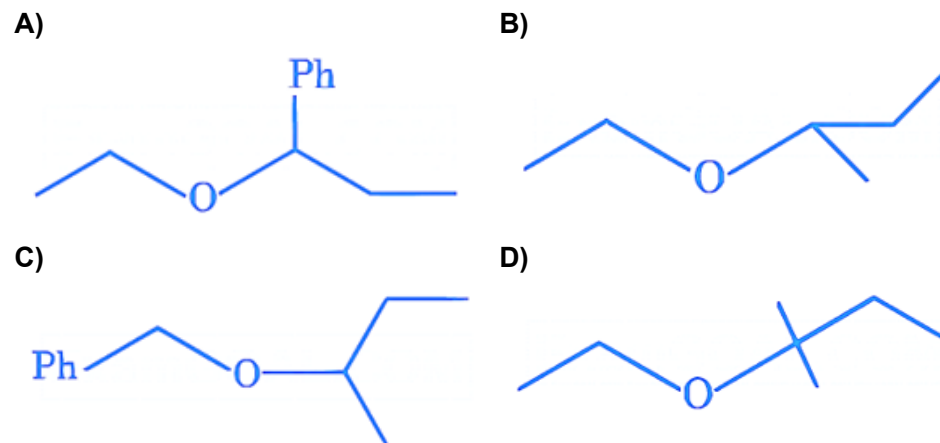
1. From the following, how many compounds contain at least one secondary alcohol?



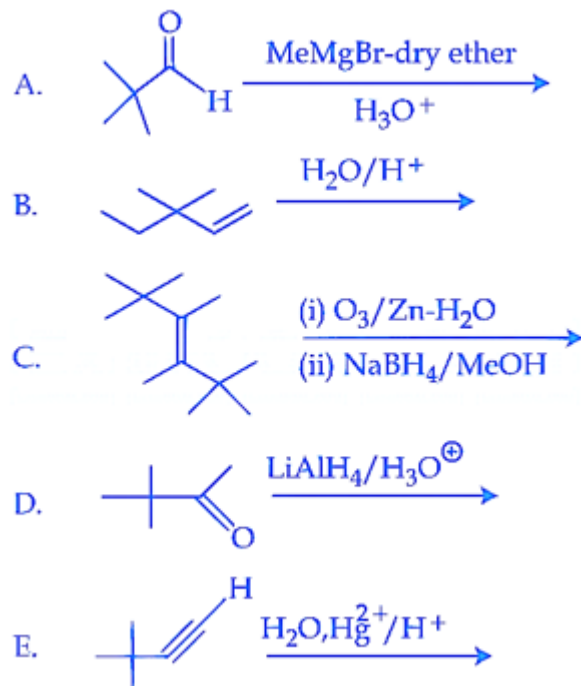
Choose the correct answer from the options given below :

- | | |
|----------|---------|
| A) Three | B) Two |
| C) Four | D) Five |

2. A mixed ether (P), when heated with excess of hot concentrated hydrogen iodide produces two different alkyl iodides which when treated with aq. NaOH give compounds (Q) and (R). Both (Q) and (R) give yellow precipitate with NaOI. Identify the mixed ether (P) :



3. 3, 3-Dimethyl-2-butanol cannot be prepared by :



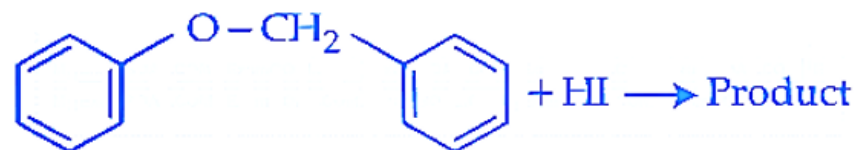
Choose the correct answer from the options given below :

- A) B and E Only B) B, C and E Only
C) B and C Only D) B Only

4. Given below are two statements : Statement I : Phenol on treatment with CHCl_3 / aq. KOH under refluxing condition, followed by acidification produces *p*-hydroxy benzaldehyde as the major product and *o*-hydroxy benzaldehyde as the minor product
Statement II : The mixture of *p*-hydroxybenzaldehyde and *o* hydroxybenzaldehyde can be easily separated through steam distillation. In the light of the above statements, choose the correct answer from the options given below

- A) Statement I is true but Statement II is false B) Both Statement I and Statement II are true
C) Both Statement I and Statement II are false D) Statement I is false but Statement II is true

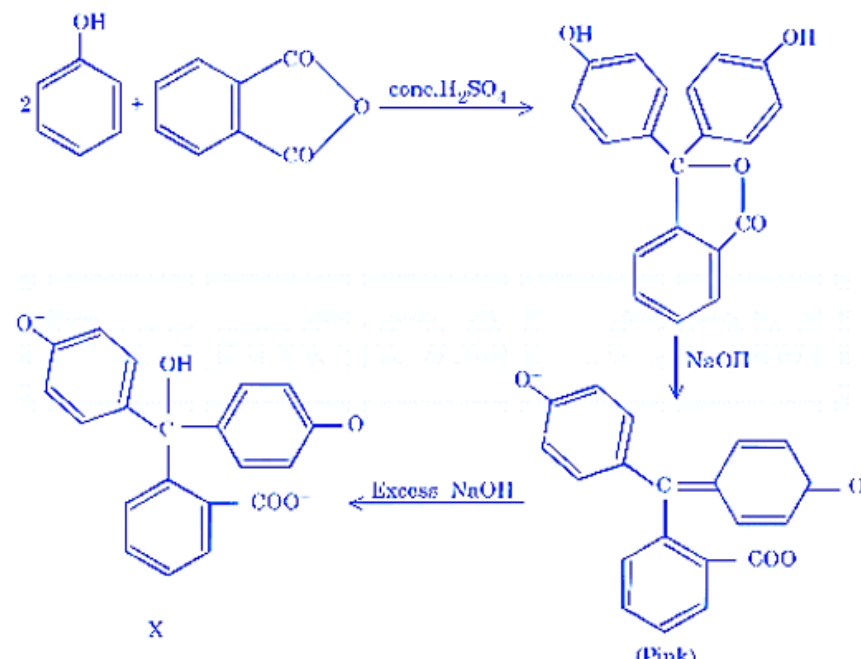
5. Consider the following reaction.



Statement I : In the above reaction, product formed will be a mixture of benzyl alcohol and iodobenzene. Statement II : In the above reaction, the $-\text{O}-\text{CH}_2-$ bond is cleaved to give the product. In the light of the above statements, choose the correct answer from the options given below :

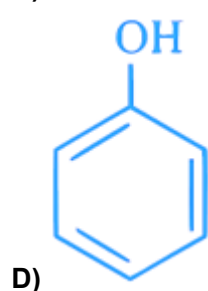
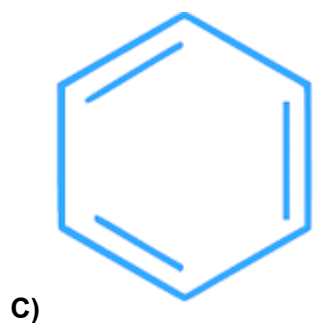
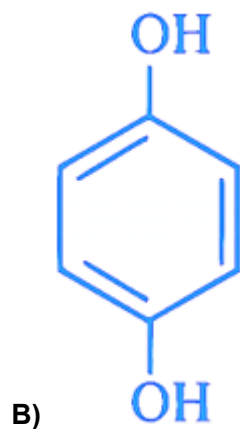
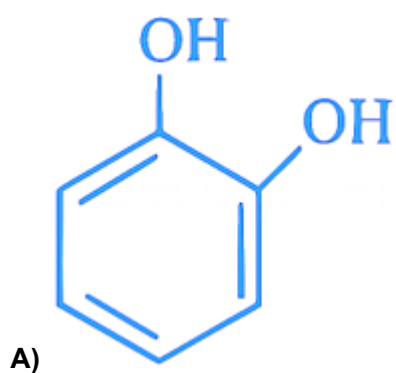
- A) Both Statement I and Statement II are true B) Both Statement I and Statement II are false
C) Statement I is true but Statement II is false D) Statement I is false but Statement II is true

6. Identify the colour of compound 'X' in the sequence of the reaction.



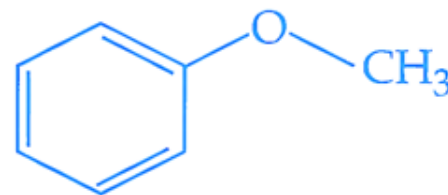
- A) Violet B) Green
C) Red D) Colourless

7. Benzene is treated with oleum to produce compound (X) which when further heated with molten sodium hydroxide followed by acidification produces compound (Y). The compound Y is treated with zinc metal to produce compound (Z). Identify the structure of compound (Z) from the following option.

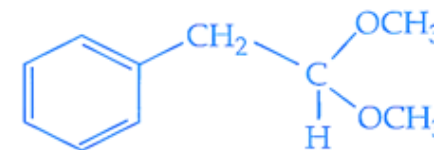


8. Which one of the following, with HBr will give a phenol?

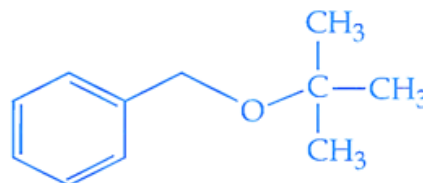
A)



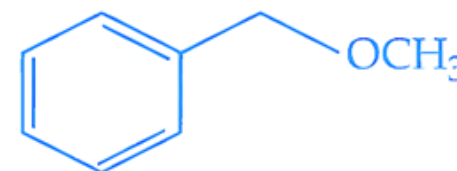
B)



C)



D)



9. Given below are two statements: Statement I: The boiling points of alcohols and phenols increase with increase in the number of C-atoms. Statement II: The boiling points of alcohols and phenols are higher in comparison to other class of compounds such as ethers and haloalkanes. In the light of the above statements, choose the correct answer from the options given below:

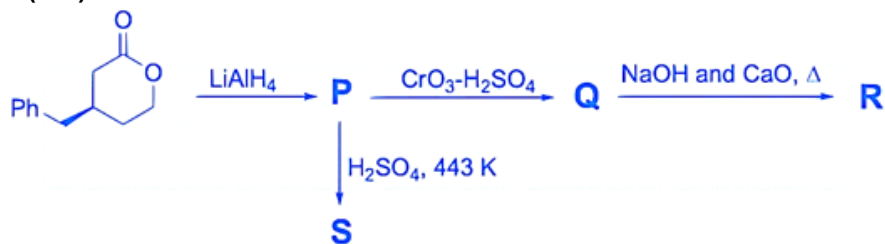
A) Statement I is false but Statement II is true

B) Both Statement I and Statement II are true

C) Statement I is true but Statement II is false

D) Both Statement I and Statement II are false

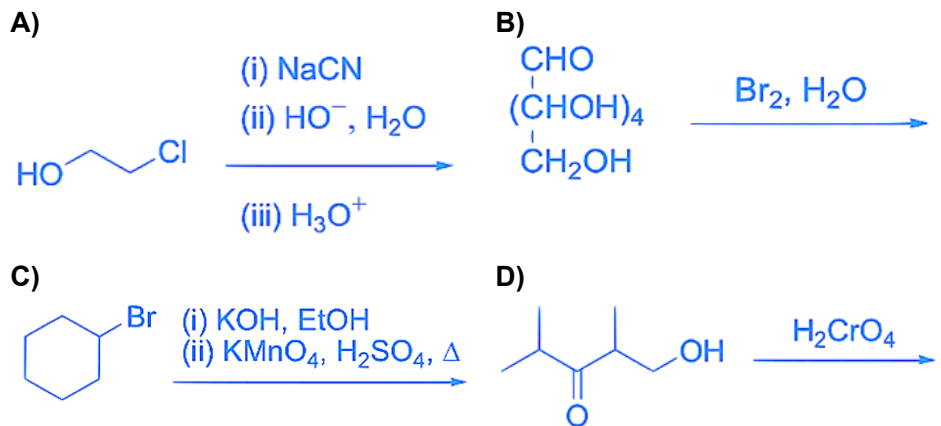
10. For the reaction sequence given below, the correct statement(s) is(are):



A) *P* is optically active. B) *S* gives Bayer's test. C) *Q* gives effervescence with aq. NaHCO_3 . D) *R* is an alkyne.

- A) B, C B) A, D
 C) B, D D) C, D

11. The correct reaction/reaction sequence that would produce a dicarboxylic acid as the major product is:

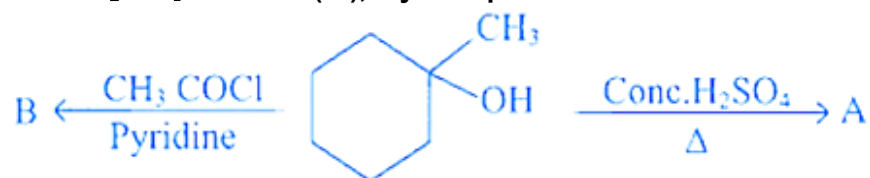


12. Match List I with List II:

List - I (Reactions)		List - I (Products)	
(A)	<chem>Nc1ccccc1 >> (i) NaNO_2 + HCl, (ii) H_2O, warm >> O=Cc1ccccc1O</chem>	(I)	<chem>O=Cc1ccccc1O</chem>
(B)	<chem>Oc1ccccc1 >> Na_2Cr_2O_7, H_2SO_4 >> Oc1ccccc1</chem>	(II)	<chem>Oc1ccccc1</chem>
(C)	<chem>Oc1ccccc1 >> (i) CHCl_3 + aq NaOH, (ii) H^+ >> Oc1ccccc1C(=O)O</chem>	(III)	<chem>Oc1ccccc1C(=O)O</chem>
(D)	<chem>Oc1ccccc1 >> (i) NaOH, (ii) CO_2, (iii) H^+ >> O=C1C=CC(=O)C=C1</chem>	(IV)	<chem>O=C1C=CC(=O)C=C1</chem>

- A) (A)-(II), (B)-(IV), (C)-(I), (D)-(III) B) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)
 C) (A)-(III), (B)-(II), (C)-(I), (D)-(IV) D) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

13. Identify the major products *A* and *B* respectively in the following set of reactions: When *o*-cresol (2-methylphenol) is treated with CH_3COCl and pyridine, it yields product *B*, and when treated with conc. H_2SO_4 and heat (Δ), it yields product *A*.



- A) $\text{A} = \text{cyclohexene}$ and $\text{B} = \text{2-methyl-2-cyclohexanol}$
- B) $\text{A} = \text{1-methylcyclohexene}$ and $\text{B} = \text{2-methyl-2-cyclohexanone}$
- C) $\text{A} = \text{cyclohexene}$ and $\text{B} = \text{2-methyl-2-cyclohexanone}$
- D) $\text{A} = \text{1-methylcyclohexene}$ and $\text{B} = \text{2-methyl-2-cyclohexanol}$

14. In the Reimer-Tiemann reaction, phenol is converted into salicylaldehyde through an intermediate. The structure of this intermediate is:

- A)
- B)
- C)
- D)

15. Given below are two statements: Statement I: Bromination of phenol in a solvent with low polarity such as CHCl_3 or CS_2 requires a Lewis acid catalyst. Statement II: The Lewis acid catalyst polarises the bromine to generate Br^+ . In the light of the above statements, choose the correct answer from the options given below:

- A) Statement I is true but Statement II is false
- B) Both Statement I and Statement II are true
- C) Statement I is false but Statement II is true
- D) Both Statement I and Statement II are false

16. Match List I with List II:

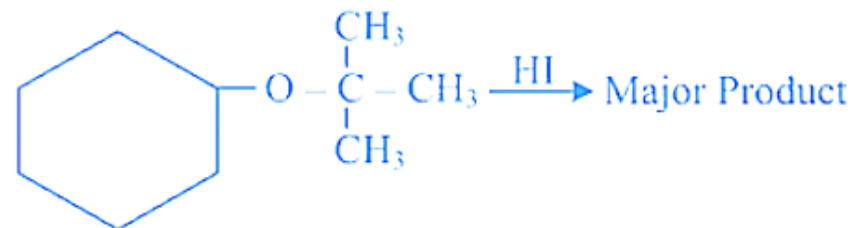
List I (Reactants)	List II (Product)
(A) Phenol, Zn/ Δ	(I) Salicylaldehyde
(B) Phenol, CHCl_3 , NaOH, HCl	(II) Salicylic acid
(C) Phenol, CO_2 , NaOH, HCl	(III) Benzene
(D) Phenol, Conc. HNO_3	(IV) Picric acid

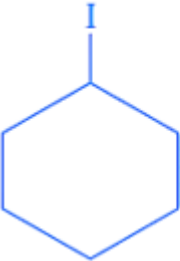
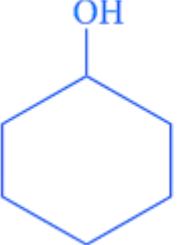
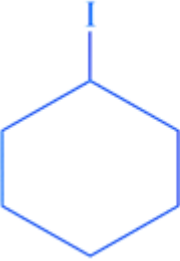
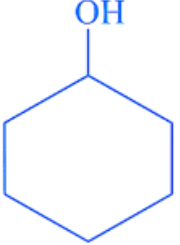
- A)** (A)-(IV), (B)-(I), (C)-(II), (D)-(III) **B)** (A)-(III), (B)-(I), (C)-(II), (D)-(IV)
C) (A)-(IV), (B)-(II), (C)-(I), (D)-(III) **D)** (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

17. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R: Assertion A: pK_a value of phenol is 10.0 while that of ethanol is 15.9. Reason R: Ethanol is stronger acid than phenol. In the light of the above statements, choose the correct answer from the options given below:

- A)** A is false but R is true. **B)** Both A and R are true but R is NOT the correct explanation of A.
C) Both A and R are true and R is the correct explanation of A. **D)** A is true but R is false.

18. Major product formed in the following reaction is a mixture of:
 Reactant: tert-butyl cyclohexyl ether (or an alkoxy cyclohexane where an oxygen connects a cyclohexane ring to a $-\text{C}(\text{CH}_3)_3$ group) reacting with HI.



- A)**  and $(\text{CH}_3)_3\text{Cl}$
B)  and $(\text{CH}_3)_3\text{COH}$
C)  and $(\text{CH}_3)_3\text{COH}$
D)  and $\text{CH}_3-\text{C}(\text{CH}_3)_2-\text{I}$

19. Match List - I (Reaction) with List - II (Reagent(s)):

	List - I (Reaction)		List - II (Reagent(s))
(A)		(I)	$\text{Na}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4$
(B)		(II)	(i) NaOH , (ii) CH_3Cl
(C)		(III)	(i) NaOH , CHCl_3 , (ii) NaOH , (iii) HCl
(D)		(IV)	(i) NaOH , (ii) CO_2 , (iii) HCl

A) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

C) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

B) (A)-(IV), (B)-(III), (C)-(II), (D)-(II)

D) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

20. Match List I with List II

	List - I (Compound)		List - II (pK_a value)
(A)	Ethanol	(I)	10.0
(B)	Phenol	(II)	15.9
(C)	m-Nitrophenol	(III)	7.1
(D)	p-Nitrophenol	(IV)	8.3

Choose the correct answer from the options given below:

A) A-I, B-II, C-III, D-IV

B) A-IV, B-I, C-II, D-III

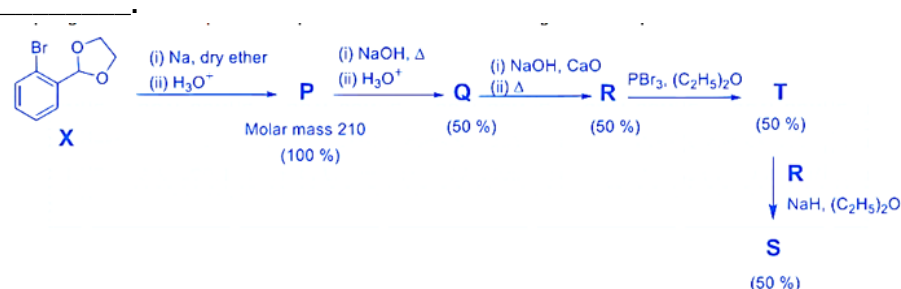
C) A-II, B-I, C-IV, D-III

D) A-III, B-IV, C-I, D-II

21. 4.7 g of phenol is heated with Zn to give product X. If this reaction goes to 60% completion then the number of moles of compound X formed will be $\text{_____} \times 10^{-2}$. (Nearest Integer) (Given molar mass in g mol^{-1} : H : 1, C : 12, O : 16)

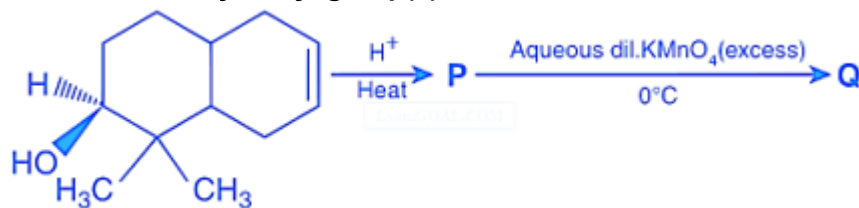
22. What amount of bromine will be required to convert 2 g of phenol into 2,4,6-tribromophenol? (Given molar mass in g mol^{-1} of C, H, O, Br are 12, 1, 16, 80 respectively)

23. The reaction sequence given below is carried out with 16 moles of X . The yield of the major product in each step is given below the product in parentheses. The amount (in grams) of S produced is

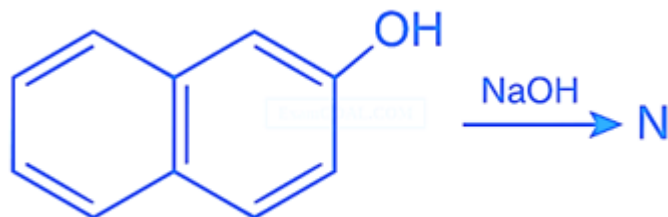


(Use: Atomic mass (in amu): H = 1, C = 12, O = 16, Br = 80)

24. The number of hydroxyl group(s) in Q is



25. The number of resonance structure for N is



Maths

26. $\int \frac{e^{9 \log x} - e^{8 \log x}}{e^{4 \log x} - e^{3 \log x}} dx =$

- A) $e \cdot 6^{-6x} + c$
C) $e^{6 \log x} + c$

- B) $\frac{x^6}{6} + c$
D) None of these

27. $\int \frac{x^4 + x^2 + 1}{x^2 + x + 1} dx =$

- A) $\frac{1}{3}x^3 + \frac{1}{2}x^2 + x + c$
C) $\frac{1}{3}x^3 - \frac{1}{2}x^2 + x + c$

- B) $\frac{1}{3}x^3 - \frac{1}{2}x^2 - x + c$
D) None of these

28. $\int \frac{\csc \theta + \cot \theta}{\csc \theta - \cot \theta} d\theta =$

- A) $2 \csc \theta + 2 \cot \theta + \theta + c$
C) $2 \csc \theta - 2 \cot \theta + \theta + c$

- B) $-2 \csc \theta - 2 \cot \theta - \theta + c$
D) None of these

29. $\int \sin^3 x dx =$

- A) $\frac{1}{4} \left(\frac{\cos 3x}{3} - 3 \cos x \right) + c$
C) $\frac{\sin^4 x}{4} + c$

- B) $\frac{1}{4} (\cos 3x + 3 \cos x) + c$
D) $\frac{1}{3} (\cos 3x + \sin x) + c$

30. $\int \sin^4 x dx =$

- A) $\frac{3x}{8} + \frac{\sin 2x}{4} + \frac{\sin 4x}{32} + c$
C) $\frac{3x}{8} - \frac{\sin 2x}{4} + \frac{\sin 4x}{32} + c$

- B) $\frac{x}{4} - \frac{\sin 2x}{2} + \frac{\sin 4x}{8} + c$
D) None of these

31. $\int \sin^2 x \cos^2 x dx =$

- A) $\frac{x}{8} + \frac{\sin 4x}{32} + c$
C) $\frac{\sin^3 x \cos^3 x}{3} + c$

- B) $\frac{x}{8} - \frac{\sin 4x}{32} + c$
D) None of these

32. $\int \left(\frac{x^2 + \sin^2 x}{1 + x^2} \right) \sec^2 x dx =$

- A) $\tan x + \tan^{-1} x + c$
C) $-\tan x + \tan^{-1} x + c$

- B) $-\tan x - \tan^{-1} x + c$
D) $\tan x - \tan^{-1} x + c$

33. Given, $|x| < 1$, find $\int (2 + 6x + 12x^2 + 20x^3 + \dots) dx$

- A) $(1 + x)^{-2} + c$
C) $(1 - x)^{-2} + c$

- B) $2(1 - x)^{-1} + c$
D) None of these

34. $\int \sin^2 x \cos 2x dx =$

- A) $-\frac{\sin 2x}{4} + \frac{x}{4} + \frac{\sin 4x}{16} + c$
C) $\frac{\sin 2x}{4} + \frac{x}{4} + \frac{\sin 4x}{16} + c$

- B) $\frac{\sin 2x}{4} - \frac{x}{4} - \frac{\sin 4x}{16} + c$
D) None of these

35. $\int \frac{3+4x^2}{x^2(1+x^2)} dx =$

- A) $-\frac{3}{x} + \tan^{-1} x + c$
 C) $-\frac{3}{x} - \tan^{-1} x + c$

- B) $\frac{3}{x} + \tan^{-1} x + c$
 D) None of these

36. Evaluate the integral $\int \frac{x^3}{x^8+1} dx$

- A) $\frac{1}{4} \ln(1+x^8) + c$
 C) $\frac{1}{4} \tan^{-1}(x^4) + c$

- B) $\tan^{-1}(x^4) + c$
 D) $\frac{1}{8} \ln(1+x^8) + c$

37. Evaluate the integral $\int x^6 \cos(x^7) dx$

- A) $-\frac{1}{7} \sin(x^7) + c$
 C) $\sin(x^7) + c$

- B) $\frac{1}{7} \sin(x^7) + c$
 D) $\frac{1}{6} \sin(x^6) + c$

38. Evaluate the integral $\int (\sin^5 x) e^{\log(\cos x)} dx$

- A) $-\frac{\sin^6 x}{6} + c$
 C) $\frac{\sin^6 x}{6} + c$

- B) $\frac{\cos^6 x}{6} + c$
 D) None of these

39. Evaluate the integral $\int \frac{\sqrt{\cot x}}{\sin x \cos x} dx$

- A) $2\sqrt{\cot x} + c$
 C) $-\frac{2}{\sqrt{\cot x}} + c$

- B) $\frac{2}{\sqrt{\cot x}} + c$
 D) $-2\sqrt{\cot x} + c$

40. $\int \sin^3 x dx =$

- A) $\cos x + \frac{\cos^3 x}{3} + c$
 C) $\frac{\cos^3 x}{3} - \cos x + c$

- B) $\sin x - \frac{\sin^3 x}{3} + c$
 D) None of these

41. $\int \cos^4 2x dx =$

- A) $\frac{3x}{8} + \frac{\sin 4x}{8} + \frac{\sin 8x}{64} + c$
 C) $\frac{3x}{8} + \frac{\sin 4x}{4} + \frac{\sin 8x}{32} + c$

- B) $\frac{3x}{8} - \frac{\sin 4x}{8} + \frac{\sin 8x}{64} + c$
 D) None of these

42. $\int x^3 \sqrt{2+7x^4} dx =$

- A) $(2+7x^4)^{\frac{3}{2}} + c$
 C) $\frac{1}{28} (2+7x^4)^{\frac{3}{2}} + c$

- B) $\frac{1}{7} (2+7x^4)^{\frac{3}{2}} + c$
 D) $\frac{1}{42} (2+7x^4)^{\frac{3}{2}} + c$

43. $\int \frac{e^{2\sqrt{x}} \sin e^{2\sqrt{x}}}{\sqrt{x}} dx =$

- A) $\cos e^{2\sqrt{x}} + c$
 C) $2 \sin e^{2\sqrt{x}} + c$

- B) $-2 \cos e^{2\sqrt{x}} + c$
 D) $-\cos e^{2\sqrt{x}} + c$

44. $\int \frac{\cos x}{\cos(x+a)} dx =$

- A) $x \cos a - \sin a \ln |\sec(x+a)| + c$
 C) $x \sin a + \cos a \ln |\sec(x+a)| + c$

- B) $x \cos a + \sin a \ln |\sec(x+a)| + c$
 D) None of these

45. $\int \frac{dx}{\sin(x-a) \sin(x-b)} =$

- A) $\frac{1}{\sin(a-b)} \ln \left| \frac{\sin(x-a)}{\sin(x-b)} \right| + c$
 C) $\frac{1}{\cos(a-b)} \ln \left| \frac{\sin(x-a)}{\sin(x-b)} \right| + c$

- B) $\frac{1}{\sin(b-a)} \ln \left| \frac{\sin(x-a)}{\sin(x-b)} \right| + c$
 D) None of these

46. The value of the integral $\int \frac{8x}{x^2+9} dx$ is $a \ln(x^2+b^2) + C$, then a+b is

47. The value of the integral $\int 4x(x^2+3)^5 dx$, is $\frac{(x^2+p)^q}{r} + C$ then p+q+r is

48. The value of the integral $\int 3x^2 e^{x^3} dx$ is $pe^{x^q} + C$ then p+q is

49. The value of the integral $\int \frac{x}{\sqrt{x^2+16}} dx$ is $p\sqrt{x^2+16} + C$ then p is

50. The value of the integral $\int \frac{x}{\sqrt{4x^2+25}} dx$ is $\frac{\sqrt{px^2+q^2}}{4} + C$ then p+q is

Physics

51. The ratio of areas within the electron orbits for the second excited state to the ground state for hydrogen atom is

- A) 9: 1**
- B) 27: 1**
- C) 81: 1**
- D) 3: 1**

52. The ratio of the wavelengths for $2 \rightarrow 1$ transition in Be^{+++} , Li^{++} and He^+ is

- A)** 9: 16: 36 **B)** 4: 9: 16
C) 36: 16: 9 **D)** 16: 9: 4

53. Energy E of a hydrogen-like atom with principal quantum number n is given by $E = \frac{-36}{n^2}$ eV. The energy of a photon ejected when the electron jumps from $n = 3$ state to $n = 2$ state of this atom is approximately

- A) 13 eV** **B) 4 eV**
C) 9 eV **D) 5 eV**

54. In the Bohr model of the hydrogen atom, let R , v and E represent the radius of the orbit, the speed of electron and the total energy of the electron respectively. Which of the following quantity is proportional to the cube of the quantum number n

- A) Rv** **B) E/v**
C) R/v **D) RE**

55. The energy of hydrogen atom in n th orbit is E_n , then the energy in n th orbit of doubly ionised lithium atom will be

- A)** $3E_n$
- B)** $E_n/3$
- C)** $9E_n$
- D)** $E_n/9$

56. The wavelength of radiation emitted is λ_0 when an electron jumps from the second to the first orbit of hydrogen atom. For the electron jump from the fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be

- A)** $2\lambda_0$
- B)** $\lambda_0/4$
- C)** $4\lambda_0$
- D)** $8\lambda_0$

57. When an electron in hydrogen atom is excited from its 3rd to 6th stationary orbit, the change in angular momentum of electron is.

Planck's constant is $h = 6.28 \times 10^{-34}$ J-s

- A)** 2×10^{-34} J-s **B)** 3×10^{-34} J-s
C) 6×10^{-34} J-s **D)** 1×10^{-34} J-s

58. In Bohr model of hydrogen atom, the ratio of periods of revolution of an electron in $n = 3$ and $n = 1$ orbits is

- A) 9: 1**
- B) 3: 1**
- C) 81: 1**
- D) 27: 1**

59. The absorption transitions between two energy states of hydrogen atom are 4. The emission transitions between these states will be

- A) 10**
- B) 6**
- C) 8**
- D) 4**

60. A stationary nucleus of mass M splits into two fragments of masses m and $3m$ having non zero velocities. Find out the ratio of the de-Broglie wavelengths of the two fragments.

- A) 3: 1** **B) 1: 3**
C) $\sqrt{3} : 1$ **D) 1: 1**

61. What is the effective mass of a photon having frequency ν ?

- A) $\frac{h\nu}{c}$
B) $\frac{hc}{\nu}$
C) $\frac{c^2}{h\nu}$
D) $\frac{h\nu}{c^2}$

62. The de Broglie wavelength of particles of mass m with average momentum p at a temperature T in two dimensions is given by

A) $\lambda = \frac{h}{\sqrt{2mk_B T}}$

B) $\lambda = \frac{h}{\sqrt{3mk_B T}}$

C) $\lambda = \frac{h}{\sqrt{mk_B T}}$

D) $\lambda = \frac{h}{\sqrt{k_B T/m}}$

63. An electron is moving in Bohr's third orbit. The circumference of the orbit is C . What is its de Broglie wavelength?

A) $3C$

B) $C/3$

C) C

D) $9C$

64. The velocities of two particles A & B are 0.08 m/s & 0.01 m/s respectively. The mass of B is two times of mass of A. The ratio of their de-Broglie wavelength is

A) 4: 1

B) 2: 1

C) 1: 2

D) 1: 4

65. The de Broglie wavelength of a proton of energy E_p is four times the de Broglie wavelength of an alpha particle of energy E_α . The ratio of $\frac{E_p}{E_\alpha}$ is

A) 4

B) 1/4

C) 1

D) 16

66. The de-Broglie wavelength of a charged particle accelerated through a potential difference V is proportional to

A) $1/V$

B) $V^{1/2}$

C) $1/V^{1/2}$

D) V^2

67. The de-Broglie wavelength of an electron with a kinetic energy of 12270 eV is nearly

A) 100 pm

B) 1000 pm

C) 10 pm

D) 1 pm

68. A particle of mass M at rest decays into two particles of masses m_1 and m_2 having nonzero velocities. The ratio of their kinetic energies (K_1/K_2) is

A) m_1/m_2

B) m_2/m_1

C) 1

D) $\sqrt{m_2/m_1}$

69. The de Broglie wavelength λ for an electron of energy 1.5 eV is

A) 10^{-10} m

B) 10^{-11} m

C) 10^{-12} m

D) 10^{-9} m

70. A double charged lithium atom is equivalent to hydrogen whose atomic number is 3. The wavelength of required radiation for emitting electron from first to second Bohr orbit in Li^{++} will be. Ionisation energy of hydrogen atom is 13.6 eV (take $hc = 12400$ eV-)

A) 270

B) 135

C) 540

D) 45

71. Energy of the electron in n th orbit of a hydrogen-like atom is given by $E_n = \frac{-18}{n^2}$ eV. The amount of energy needed to transfer electron from first orbit to third orbit is ___eV

72. If the binding energy of the electron in a hydrogen atom is 16 eV, the energy required to remove the electron from the first excited state of Li^{++} is ___eV

73. In hydrogen atom, if the difference in the energy of the electron in $n = 3$ and $n = 6$ orbits is E , the ionization energy of hydrogen atom is ___E

74. Find out velocity of an electron so that its momentum is equal to that of photon with a wavelength of $\lambda = 2600$ Å. ___m/s

75. The innermost orbit of the hydrogen atom has a diameter 1.06 . The diameter of the twentieth orbit is____

ANSWER KEY

Chemistry

1.	1	8.	1	15.	3	22.	10.22
2.	2	9.	2	16.	2	23.	175
3.	1	10.	1	17.	4	24.	4
4.	4	11.	3	18.	4	25.	9
5.	4	12.	1	19.	3		
6.	4	13.	2	20.	3		
7.	3	14.	2	21.	3		

Maths

26.	2	33.	3	40.	3	47.	12
27.	3	34.	2	41.	1	48.	4
28.	2	35.	1	42.	4	49.	1
29.	1	36.	3	43.	4	50.	9
30.	3	37.	2	44.	2		
31.	2	38.	3	45.	1		
32.	4	39.	4	46.	7		

Physics

51.	3	58.	4	65.	2	72.	36
52.	1	59.	1	66.	3	73.	12
53.	4	60.	4	67.	3	74.	2800
54.	3	61.	4	68.	2	75.	424
55.	3	62.	1	69.	4		
56.	3	63.	2	70.	2		
57.	2	64.	4	71.	16		

SOLUTIONS

Q1.

Answer: A

Q2.

Answer: B

Q3.

Answer: A

Q4.

Answer: D

Q5.

Answer: D

Q6.

Answer: D

Q7.

Answer: C

Explanation:

Benzene reacts with oleum to give benzene sulfonic acid (compound X). Fusing compound X with molten NaOH followed by acidification yields phenol (compound Y). Subsequent reduction of phenol with zinc dust removes the hydroxyl group, yielding benzene (compound Z).

Q8.

Answer: A

Explanation:

When anisole (methoxybenzene) reacts with HBr, the lone pair of the oxygen atom is protonated by HBr to form an oxonium ion. The nucleophile (Br^-) then attacks the methyl carbon via an $\text{S}_{\text{N}}2$ mechanism, resulting in the cleavage of the $\text{O} - \text{CH}_3$ bond to yield phenol and methyl bromide.

Q9.

Answer: B

Explanation:

Alcohols and phenols experience stronger intermolecular van der Waals forces as their molecular size (number of carbon atoms) increases, leading to higher boiling points. Additionally, their ability to form strong intermolecular hydrogen bonds gives them significantly higher boiling points than ethers or haloalkanes of comparable molecular mass.

Q10.

Answer: A

Explanation:

In the given reaction sequence starting from phenyl ethyl ketone/cyclic acetal derivative, reduction with LiAlH_4 yields alcohol *P*, oxidation with $\text{CrO}_3 - \text{H}_2\text{SO}_4$ gives carboxylic acid *Q*, decarboxylation with NaOH and CaO produces hydrocarbon *R*, and acid-catalyzed dehydration yields alkene *S*. Compound *S* is an alkene which responds to Bayer's test, and compound *Q* contains a carboxylic acid group which releases CO_2 gas (effervescence) when treated with aqueous NaHCO_3 .

Q11.

Answer: C

Explanation:

When bromocyclohexane undergoes dehydrohalogenation with alcoholic KOH, it forms cyclohexene. Subsequent oxidation of cyclohexene with acidic potassium permanganate (KMnO_4 and H_2SO_4) under heating cleaves the double bond to yield hexane-1,6-dioic acid (adipic acid), which is a dicarboxylic acid.

Q12.

Answer: A

Explanation:

Reaction (A): Diazotization of aniline followed by warming with water yields phenol. Thus, (A) matches with (III). Reaction (B): Oxidation of phenol with chromic acid ($\text{Na}_2\text{Cr}_2\text{O}_7$, H_2SO_4) gives conjugated dione, i.e., benzoquinone (quinone). Thus, (B) matches with (IV). Reaction (C): Reimer-Tiemann reaction of phenol with chloroform and aqueous NaOH followed by acidification yields salicylaldehyde. Thus, (C) matches with (I). Reaction (D): Kolbe's reaction involving sodium phenoxide, CO_2 , and acidification produces salicylic acid. Thus, (D) matches with (II).

Q13.

Answer: B

Explanation:

The reaction of *o*-cresol with CH_3COCl in the presence of pyridine is an acetylation of the phenolic $-\text{OH}$ group, yielding an ester (*B*). On the other hand, the reaction of *o*-cresol with concentrated H_2SO_4 under heating conditions undergoes electrophilic aromatic sulfonation, predominantly substituting at the para position relative to the $-\text{OH}$ group due to steric hindrance and thermodynamic control, yielding product *A*.

Q14.

Answer: B

Explanation:

During the Reimer-Tiemann reaction, phenol reacts with chloroform (CHCl_3) in the presence of an aqueous base (NaOH). The base generates dichlorocarbene ($:\text{CCl}_2$), an electrophile, which attacks the phenoxide ion ring. This electrophilic addition forms a benzal chloride intermediate containing an $-\text{O}^-\text{Na}^+$ group and a $-\text{CHCl}_2$ group at the ortho position.

Q15.

Answer: C

Explanation:

Phenol is a highly activated aromatic system due to the strong +M effect of the phenolic group ($-\text{OH}$). Because of this high activation, bromination of phenol proceeds readily even in low-polarity solvents like CS_2 or CHCl_3 without requiring any Lewis acid catalyst (making Statement I false). However, Statement II is true because a Lewis acid catalyst (when used in electrophilic halogenation) functions by polarizing the halogen molecule to generate a strong electrophile such as Br^+ .

Q16.

Answer: B

Explanation:

Each given reactant pair undergoes a specific named or characteristic organic reaction involving phenol: heating with zinc dust reduces phenol to benzene; treatment with chloroform and sodium hydroxide yields salicylaldehyde via the Reimer-Tiemann reaction; reaction with carbon dioxide and sodium hydroxide produces salicylic acid via the Kolbe-Schmitt reaction; and nitration with concentrated nitric acid forms picric acid (2,4,6-trinitrophenol).

Q17.

Answer: D

Explanation:

A lower pK_a value indicates a stronger acid. Since phenol has a pK_a of 10.0 and ethanol has a pK_a of 15.9, phenol is a much stronger acid than ethanol. Thus, Assertion A is true, while Reason R stating that ethanol is a stronger acid is false.

Q18.

Answer: D

Q19.

Answer: C

Q20.

Answer: C

Explanation:

The acidity of organic compounds is inversely proportional to their pK_a values ($pK_a = -\log K_a$). Ethanol (A) is a weaker acid than water, with a pK_a around 15.9 (Matches II). Phenol (B) is more acidic than aliphatic alcohols due to resonance stabilization of the phenoxide ion, having a pK_a around 10.0 (Matches I). Nitrophenols are stronger acids than phenol because the electron-withdrawing nitro ($-NO_2$) group stabilizes the conjugate base via -M and -I effects. The pK_a of p-nitrophenol is approximately 7.1 (Matches III) and m-nitrophenol is approximately 8.3 (Matches IV).

Q21.

Answer: 3

Explanation:

Moles of phenol are calculated from its given mass and molar mass. Since 1 mole of phenol yields 1 mole of benzene (X) upon heating with zinc, the theoretical yield is equal to the moles of phenol. Adjusting for a 60% completion rate gives the final moles of product X formed.

Q22.

Answer: 10.22

Explanation:

One mole of phenol reacts with three moles of aqueous bromine to form 2,4,6-tribromophenol. By determining the moles of phenol from its given mass and molar mass, the required moles of bromine are calculated using the stoichiometry of the reaction, which are then converted into mass to find the final answer.

Q23.

Answer: 175

Explanation:

Starting with 16 moles of reactant X , the reaction sequence proceeds through Wurtz-Fittig coupling, acetal hydrolysis, Cannizzaro reaction, decarboxylation, halogenation with PBr_3 , and finally Williamson ether synthesis. Factoring in the percentage yield for each step, the final moles of product S are determined, which are then multiplied by its molar mass to calculate the final mass in grams.

Q24.

Answer: 4

Explanation:

1. Acid-Catalyzed Dehydration (Formation of P): Treatment of the starting alcohol with H^+ and heat leads to the elimination of the hydroxyl group to form a more stable, conjugated or tetrasubstituted alkene P . 2. Cold Dilute $KMnO_4$ Oxidation (Formation of Q): Subsequent treatment of the alkene P with cold dilute alkaline $KMnO_4$ (Baeyer's reagent) effects syn-hydroxylation across all double bonds present in the system, converting them into vicinal diols (hydroxyl groups). Counting all the resulting $-OH$ groups in product Q gives a total of 4.

Q25.

Answer: 9

Explanation:

1. Generation of the Anion (N): Treatment of 2-naphthol with NaOH removes the phenolic proton to generate the corresponding naphtholate ion N . 2. Resonance Delocalization: The negative charge on the oxygen atom can be delocalized into the naphthalene ring system. By writing all possible canonical structures involving the resonance between the oxygen atom and the aromatic rings (including both rings of the naphthalene system), we arrive at a total of 9 resonance structures.

Q26.

Answer: B

Explanation:

Using the identity $e^{k \log x} = x^k$, the integrand becomes $\frac{x^9 - x^8}{x^4 - x^3} = \frac{x^8(x-1)}{x^3(x-1)} = x^5$, and integrating gives $\int x^5 dx = \frac{x^6}{6} + c$.

Q27.

Answer: C

Explanation:

The numerator factors as $x^4 + x^2 + 1 = (x^2 + x + 1)(x^2 - x + 1)$, so the integrand reduces to $x^2 - x + 1$, whose integral is $\frac{1}{3}x^3 - \frac{1}{2}x^2 + x + c$.

Q28.

Answer: B

Explanation:

Multiplying numerator and denominator by $(\csc \theta + \cot \theta)$ makes the denominator $\csc^2 \theta - \cot^2 \theta = 1$, so the integrand becomes $(\csc \theta + \cot \theta)^2 = 2 \csc^2 \theta + 2 \csc \theta \cot \theta - 1$, which integrates to $-2 \cot \theta - 2 \csc \theta - \theta + c$.

Q29.

Answer: A

Explanation:

Using the identity $\sin 3x = 3 \sin x - 4 \sin^3 x$, we get $\sin^3 x = \frac{1}{4}(3 \sin x - \sin 3x)$, and integrating term by term gives $\frac{1}{4} \left(\frac{\cos 3x}{3} - 3 \cos x \right) + c$.

Q30.

Answer: C

Explanation:

Using $\sin^2 x = \frac{1 - \cos 2x}{2}$, we get $\sin^4 x = \frac{3}{8} - \frac{1}{2} \cos 2x + \frac{1}{8} \cos 4x$, and integrating term by term yields $\frac{3x}{8} - \frac{\sin 2x}{4} + \frac{\sin 4x}{32} + c$.

Q31.

Answer: B

Explanation:

Using $\sin x \cos x = \frac{1}{2} \sin 2x$, the integrand becomes $\frac{1}{4} \sin^2 2x = \frac{1}{8} (1 - \cos 4x)$, and integrating term by term gives $\frac{x}{8} - \frac{\sin 4x}{32} + c$.

Q32.

Answer: D

Explanation:

Expanding the integrand gives $\frac{x^2 \sec^2 x + \tan^2 x}{1+x^2}$, and using $\tan^2 x = \sec^2 x - 1$ simplifies it to $\sec^2 x - \frac{1}{1+x^2}$, whose integral is $\tan x - \tan^{-1} x + c$.

Q33.

Answer: C

Explanation:

The series $2 + 6x + 12x^2 + 20x^3 + \cdots = \sum_{n=0}^{\infty} (n+1)(n+2)x^n$ sums to $2(1-x)^{-3}$ for $|x| < 1$, and integrating gives $(1-x)^{-2} + c$.

Q34.

Answer: B

Explanation:

Using $\sin^2 x = \frac{1 - \cos 2x}{2}$, the integrand becomes $\frac{1}{2} \cos 2x - \frac{1}{4} - \frac{1}{4} \cos 4x$, and integrating term by term gives $\frac{\sin 2x}{4} - \frac{x}{4} - \frac{\sin 4x}{16} + c$.

Q35.

Answer: A

Explanation:

Splitting the numerator as $3 + 4x^2 = 3(1+x^2) + x^2$ gives the integrand $\frac{3}{x^2} + \frac{1}{1+x^2}$, whose integral is $-\frac{3}{x} + \tan^{-1} x + c$.

Q36.

Answer: C

Explanation:

Substituting $u = x^4$ (so $du = 4x^3 dx$) transforms the integral into $\frac{1}{4} \int \frac{du}{u^2+1} = \frac{1}{4} \tan^{-1} u + c = \frac{1}{4} \tan^{-1}(x^4) + c$.

Q37.

Answer: B

Explanation:

Substituting $u = x^7$ (so $du = 7x^6 dx$) transforms the integral into $\frac{1}{7} \int \cos u du = \frac{1}{7} \sin u + c = \frac{1}{7} \sin(x^7) + c$.

Q38.

Answer: C

Explanation:

Since $e^{\log(\cos x)} = \cos x$, the integral reduces to $\int \sin^5 x \cos x dx$, and substituting $u = \sin x$ gives $\frac{\sin^6 x}{6} + c$.

Q39.

Answer: D

Explanation:

Writing $\sin x \cos x = \frac{\cot x}{\csc^2 x}$ converts the integrand to $\frac{\csc^2 x}{\sqrt{\cot x}}$, and substituting $u = \cot x$ (with $du = -\csc^2 x \, dx$) gives $-2\sqrt{\cot x} + c$.

Q40.

Answer: C

Explanation:

Writing $\sin^3 x = \sin x(1 - \cos^2 x) = \sin x - \sin x \cos^2 x$ and integrating term by term gives $-\cos x + \frac{\cos^3 x}{3} + c$.

Q41.

Answer: A

Explanation:

Using $\cos^2 2x = \frac{1+\cos 4x}{2}$, we get $\cos^4 2x = \frac{3}{8} + \frac{1}{2}\cos 4x + \frac{1}{8}\cos 8x$, and integrating term by term yields $\frac{3x}{8} + \frac{\sin 4x}{8} + \frac{\sin 8x}{64} + c$.

Q42.

Answer: D

Explanation:

Substituting $u = 2 + 7x^4$ (so $du = 28x^3 \, dx$) gives $\frac{1}{28} \int \sqrt{u} \, du = \frac{1}{28} \cdot \frac{2}{3} u^{\frac{3}{2}} + c = \frac{1}{42} (2 + 7x^4)^{\frac{3}{2}} + c$.

Q43.

Answer: D

Explanation:

Substituting $u = e^{2\sqrt{x}}$ gives $du = \frac{e^{2\sqrt{x}}}{\sqrt{x}} \, dx$, so the integral becomes $\int \sin u \, du = -\cos u + c = -\cos e^{2\sqrt{x}} + c$.

Q44.

Answer: B

Explanation:

Writing $\cos x = \cos((x+a) - a) = \cos(x+a)\cos a + \sin(x+a)\sin a$, the integrand becomes $\cos a + \sin a \tan(x+a)$, which integrates to $x \cos a + \sin a \ln |\sec(x+a)| + c$.

Q45.

Answer: A

Explanation:

Introducing $\sin(a-b) = \sin((x-b) - (x-a))$ in the numerator splits the integrand into $\frac{1}{\sin(a-b)} [\cot(x-a) - \cot(x-b)]$, which integrates to $\frac{1}{\sin(a-b)} \ln \left| \frac{\sin(x-a)}{\sin(x-b)} \right| + c$.

Q46.

Answer: 7

Explanation:

Substituting $u = x^2 + 9$ (so $du = 2x \, dx$) turns the integral into $4 \int \frac{du}{u} = 4 \ln |u| + C = 4 \ln(x^2 + 9) + C$.

Q47.

Answer: 12

Explanation:

Substituting $u = x^2 + 3$ (so $du = 2x \, dx$) turns the integral into $2 \int u^5 \, du = \frac{2u^6}{6} + C = \frac{(x^2+3)^6}{3} + C$.

Q48.

Answer: 4

Explanation:

Substituting $u = x^3$ (so $du = 3x^2 \, dx$) turns the integral into $\int e^u \, du = e^u + C = e^{x^3} + C$.

Q49.

Answer: 1

Explanation:

Substituting $u = x^2 + 16$ (so $du = 2x dx$) gives
 $\frac{1}{2} \int u^{-1/2} du = \sqrt{u} + C = \sqrt{x^2 + 16} + C.$

Q50.

Answer: 9

Explanation:

Substituting $u = 4x^2 + 25$ (so $du = 8x dx$) gives
 $\frac{1}{8} \int u^{-1/2} du = \frac{1}{4} \sqrt{u} + C = \frac{\sqrt{4x^2 + 25}}{4} + C.$

Q51.

Answer: C

Explanation:

In the Bohr model, the radius of the n th orbit scales as n^2 , so the enclosed area scales as n^4 . For the second excited state ($n = 3$) and the ground state ($n = 1$), the area ratio is $3^4 : 1^4 = 81 : 1$.

Q52.

Answer: A

Explanation:

From the Rydberg formula, $\frac{1}{\lambda} = RZ^2 \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$, so for the same transition $\lambda \propto \frac{1}{Z^2}$. With $Z = 4, 3, 2$, the ratio is $\frac{1}{16} : \frac{1}{9} : \frac{1}{4} = 9 : 16 : 36$.

Q53.

Answer: D

Explanation:

The photon energy equals the difference between the two level energies:

$$\Delta E = E_3 - E_2 = \frac{-36}{9} - \left(\frac{-36}{4} \right) = -4 + 9 = 5 \text{ eV}.$$

Q54.

Answer: C

Explanation:

Using the Bohr model dependences $R \propto n^2$, $v \propto \frac{1}{n}$ and $E \propto \frac{1}{n^2}$, the combination $\frac{R}{v} \propto n^2 \times n = n^3$, so R/v is proportional to n^3 .

Q55.

Answer: C

Explanation:

For a hydrogen-like ion, the energy of the n th orbit scales as Z^2 , so $E_n(Z) = Z^2 E_n$. For doubly ionised lithium, $Z = 3$, giving $3^2 E_n = 9 E_n$.

Q56.

Answer: C

Explanation:

Using the Rydberg formula, $\frac{1}{\lambda_0} = R \left(1 - \frac{1}{4} \right) = \frac{3R}{4}$ for the $2 \rightarrow 1$ jump and $\frac{1}{\lambda} = R \left(\frac{1}{4} - \frac{1}{16} \right) = \frac{3R}{16}$ for the $4 \rightarrow 2$ jump, so $\lambda = 4\lambda_0$.

Q57.

Answer: B

Explanation:

By Bohr's quantization condition, $L_n = \frac{nh}{2\pi}$, so the change is $\Delta L = (6 - 3) \frac{h}{2\pi} = 3 \times \frac{6.28 \times 10^{-34}}{6.28} = 3 \times 10^{-34} \text{ J-s}.$

Q58.

Answer: D

Explanation:

The period of revolution is $T = \frac{2\pi r}{v}$, and since $r \propto n^2$ and $v \propto \frac{1}{n}$, we get $T \propto n^3$. Hence the ratio is $3^3 : 1^3 = 27 : 1$.

Q59.

Answer: A

Explanation:

The number of absorption transitions equals $n_2 - n_1 = 4$, so the number of levels involved is $N = 5$. The emission transitions are all possible downward jumps between these levels: $\frac{N(N-1)}{2} = \frac{5 \times 4}{2} = 10$.

Q60.

Answer: D

Explanation:

Since the nucleus was initially at rest, momentum conservation gives the two fragments equal and opposite momenta: $p_1 = p_2$. As $\lambda = \frac{h}{p}$, the wavelengths are equal, giving 1 : 1 regardless of the masses.

Q61.

Answer: D

Explanation:

The photon energy is $E = h\nu$, and by mass-energy equivalence $E = mc^2$, so the effective mass is $m = \frac{E}{c^2} = \frac{h\nu}{c^2}$.

Q62.

Answer: A

Explanation:

In two dimensions the average kinetic energy is $E = 2 \times \frac{1}{2} k_B T = k_B T$, so the average momentum is $p = \sqrt{2mE} = \sqrt{2mk_B T}$ and the de Broglie wavelength is $\lambda = \frac{h}{\sqrt{2mk_B T}}$.

Q63.

Answer: B

Explanation:

Bohr's quantization condition in standing wave form states that the circumference equals an integral number of wavelengths: $C = 2\pi r = n\lambda$. For the third orbit, $n = 3$, so $\lambda = \frac{C}{3}$.

Q64.

Answer: D

Explanation:

The de-Broglie wavelength is $\lambda = \frac{h}{mv}$, so $\frac{\lambda_A}{\lambda_B} = \frac{m_B v_B}{m_A v_A} = \frac{2m \times 0.01}{m \times 0.08} = \frac{0.02}{0.08} = \frac{1}{4}$, i.e. 1 : 4.

Q65.

Answer: B

Explanation:

Using $\lambda = \frac{h}{\sqrt{2mE}}$, the condition $\lambda_p = 4\lambda_\alpha$ gives $m_\alpha E_\alpha = 16m_p E_p$, so $\frac{E_p}{E_\alpha} = \frac{m_\alpha}{16m_p} = \frac{4}{16} = \frac{1}{4}$.

Q66.

Answer: C

Explanation:

The particle gains kinetic energy $E = qV$, so its de-Broglie wavelength is $\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqV}}$, which shows $\lambda \propto \frac{1}{V^{1/2}}$.

Q67.

Answer: C

Explanation:

Using $\lambda = \frac{h}{\sqrt{2mE}} \approx \frac{12.27}{\sqrt{V}}$ Å with $V = 12270$ V, we get $\lambda \approx \frac{12.27}{110.8} \approx 0.111$ Å = 11.1 pm, which is nearest to 10 pm.

Q68.

Answer: B

Explanation:

Momentum conservation for the decay at rest gives both products equal momentum magnitudes p . Since $K = \frac{p^2}{2m}$, the ratio is $\frac{K_1}{K_2} = \frac{m_2}{m_1}$.

Q69.

Answer: D

Explanation:

Using $\lambda = \frac{h}{\sqrt{2mE}} \approx \frac{12.27}{\sqrt{V}}$ Å with $V = 1.5$ V, we get $\lambda \approx \frac{12.27}{1.225} \approx 10$ Å = 10^{-9} m.

Q70.

Answer: B

Explanation:

The excitation energy is $\Delta E = 13.6 \times Z^2 \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = 13.6 \times 9 \times \frac{3}{4} = 91.8$ eV, so the wavelength is $\lambda = \frac{hc}{\Delta E} = \frac{12400}{91.8} \approx 135$.

Q71.

Answer: 16

Explanation:

The energy absorbed equals the difference between the final and initial orbit energies: $\Delta E = E_3 - E_1 = \frac{-18}{9} - \left(\frac{-18}{1}\right) = -2 + 18 = 16 \text{ eV}$.

Q72.

Answer: 36

Explanation:

For a hydrogen-like ion, the binding energy scales as $\frac{Z^2}{n^2}$, so $E = 16 \times \frac{Z^2}{n^2} \text{ eV}$. For Li^{++} ($Z = 3$) in the first excited state ($n = 2$), this gives $16 \times \frac{9}{4} = 36 \text{ eV}$.

Q73.

Answer: 12

Explanation:

Writing $E_n = \frac{-E_i}{n^2}$ where E_i is the ionization energy, the given difference is $E = E_i \left(\frac{1}{9} - \frac{1}{36}\right) = \frac{E_i}{12}$, so $E_i = 12E$.

Q74.

Answer: 2800

Explanation:

Equating the momenta, $m_e v = \frac{h}{\lambda}$, so $v = \frac{h}{m_e \lambda} = \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 2600 \times 10^{-10}} \approx 2800 \text{ m/s}$.

Q75.

Answer: 424

Explanation:

In the Bohr model the radius (and hence the diameter) of the n th orbit scales as n^2 , so $d_n = d_1 n^2$. With $d_1 = 1.06$ and $n = 20$, the diameter is $1.06 \times 400 = 424$.