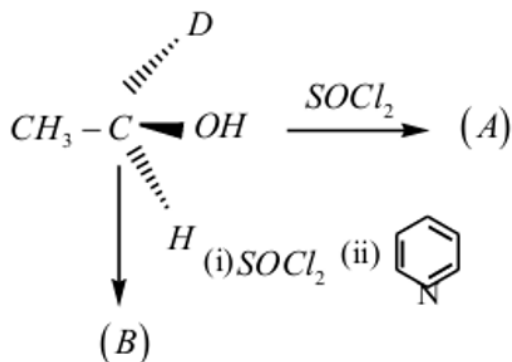


Chemistry

1. Amongst the following, the right statements are: A) In S_N1 reactions, if the reactant has R configuration, the product will have S configuration. B) In S_N2 reactions, the configuration of the reactant gets inverted. C) In S_N2 reactions, if the reactant is dextrorotatory, the product is laevorotatory. D) In S_N1 reactions, if the reactant has R configuration, the product can have both R and S configurations.

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

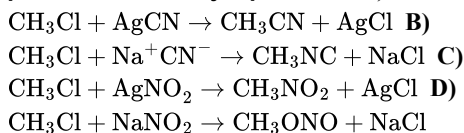
2.



Which of the following statements is/are true? A) Retention of configuration takes place in reaction (A). B) Inversion of configuration takes place in reaction (B). C) Retention of configuration takes place in reaction (B). D) Inversion of configuration takes place in reaction (A).

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

3. Which of the following reaction(s) give(s) the given product as the major product? A)



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

4. Bottles containing $\text{C}_6\text{H}_5\text{I}$ and $\text{C}_6\text{H}_5\text{CH}_2\text{I}$ lost their original labels. They were labelled A and B for testing. A and B were separately taken in test tubes and boiled with NaOH solution. The end solution in each tube was made acidic with dilute HNO_3 and then some AgNO_3 solution was added. Substance B gives a yellow precipitate. Which one of the following statements is true for this experiment? A) A was $\text{C}_6\text{H}_5\text{I}$ B) B was $\text{C}_6\text{H}_5\text{CH}_2\text{I}$ C) B was $\text{C}_6\text{H}_5\text{I}$ D) Addition of HNO_3 was unnecessary

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

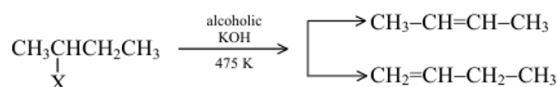
5. Which of the following statement(s) is/are incorrect about alkyl/aryl halides? A) Alkyl halides are less reactive than aryl halides towards nucleophilic substitution reactions. B) Alkyl halides are more reactive than aryl halides towards nucleophilic substitution reactions. C) The presence of an electron-withdrawing substituent at ortho and/or para position decreases the reactivity of nucleophilic substitution of chlorine in substituted chlorobenzene. D) The replacement of chlorine in chlorobenzene by strong bases proceeds by S_N1 mechanism.

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

6. Correct statement(s) among the following is/are: A) Ethanol reacts with aqueous NaCl to give ethyl chloride. B) When ethanol is treated with red phosphorus and HI , ethyl iodide is formed. C) The addition of aqueous Br_2 to ethylene in the presence of NaCl forms dibromoethane, bromochloroethane, and bromoalcohol. D) An electron withdrawing group G in $p\text{-G-C}_6\text{H}_4\text{Cl}$ increases the rate of nucleophilic aromatic substitution.

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

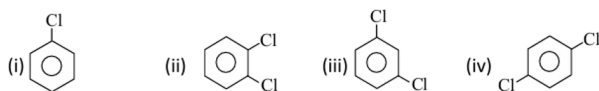
7. For the reaction:



- A) $\text{CH}_3\text{-CH=CH-CH}_3$ (Saytzeff product) predominates when $\text{X} = \text{Cl}$. B) $\text{CH}_2=\text{CH-CH}_2\text{CH}_3$ (Hofmann product) predominates when $\text{X} = \text{F}$. C) Both are formed in equal amounts regardless of X . D) The product ratio is dependent on the halogen X .

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

8. Which of the following substituted benzene derivatives would furnish three isomers when one more electrophilic substituent is introduced?



A) (i) B) (ii) C) (iii) D) (iv)

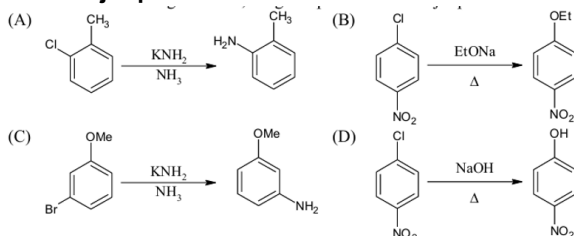
A) B, C

B) D, A

C) A, C

D) D, C

9. In which of the following reactions, the given product is the major product?



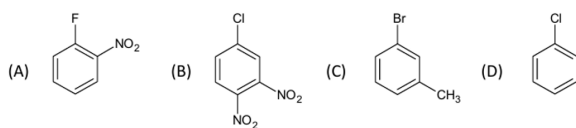
A) A

B) B

C) C

D) A, B, C, D

10. Which of the following compounds undergo nucleophilic substitution by addition-elimination mechanism (S_NAr) when treated with $MeONa$?



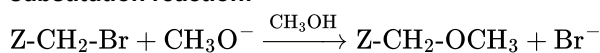
A) A and B

B) B and C

C) C and D

D) D

11. Match List-I with List-II for the nucleophilic substitution reaction:



List - I	List - II
(Z)	(Relative reactivity)
(P) H—	(1) 0.1
(Q) CH ₃ —	(2) 3
(R) C ₂ H ₅ —	(3) 1
(S) 	(4) 100

A) P-4, Q-2, R-3, S-1

B) P-4, Q-2, R-1, S-3

C) P-2, Q-4, R-3, S-1

D) P-1, Q-2, R-3, S-4

12. Match List-I with List-II for substrate/reagent combinations and products formed:

Column I (Substrate + reagent)	Column II (Product)
(P) $CH_3-CH_2-CH_2-Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	1) $CH_3-CH_2-CH=CH_2$
(Q) $CH_3-C(CH_3)(Cl)-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	2) $CH_3-CH=CH-CH_3$
(R) $CH_3-CH_2-\overset{+}{N}Me_3-CH_2-Cl \xrightarrow{NaOH}$	3) $CH_3-CH=CH_2$
(S) $CH_3-CH_2-\overset{+}{N}Me_3-CH_2-Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	4) $CH_3-C(CH_3)=CH_2$

A) P-1, Q-2, R-3, S-4

B) P-3, Q-1, R-4, S-2

C) P-3, Q-4, R-1, S-2

D) P-1, Q-3, R-2, S-4

13. Match List-I with List-II for relative rates of electrophilic aromatic bromination:

List - I (Compounds)	List - II (relative rate of bromination)
(P) $C_6H_5-OCH_3$	(1) 10^9
(Q) $(H_3C)_3N-CH_3$	(2) 10
(R) $C_6H_5-CH_3$	(3) 1
(S) C_6H_6	(4) 10^{14}

A) P-3, Q-4, R-1, S-2

B) P-1, Q-4, R-2, S-3

C) P-1, Q-4, R-3, S-2

D) P-4, Q-1, R-2, S-3

14. Match Column I with Column II:

Column I	Column II
(P) $CH_3-CHBr-CD_3$ on treatment with alc. KOH gives $CH_2=CH-CD_3$	(1) E1CB reaction
(Q) Reactivity increases as $1^\circ RX > 2^\circ RX > 3^\circ RX$	(2) S_N2
(R) Leaving ability increases as $F > Cl > Br$	(3) E2 reaction
(S) $Ph-CH_2-CH_2Br$ on treatment with $C_2H_5OD/C_2H_5O^-$ gives $Ph-CD=CH_2$ as the major product.	(4) S_NAr

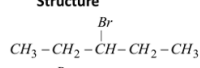
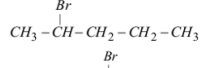
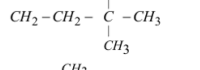
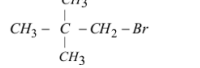
A) P-4, Q-1, R-2, S-3

B) P-3, Q-2, R-4, S-1

C) P-3, Q-1, R-4, S-2

D) P-4, Q-3, R-1, S-2

15. Match List-I (Structure) with List-II (Property):

List - I Structure	List - II Property
P) 	1) E_1 at fastest rate
Q) 	2) incapable of E_2
R) 	3) two alkene in E_2 which are not constitutional isomers
S) 	4) most complex mixture of alkenes in E_2

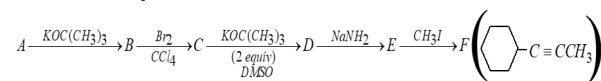
A) P-2, Q-3, R-1, S-4

B) P-4, Q-3, R-1, S-2

C) P-3, Q-1, R-2, S-4

D) P-3, Q-4, R-1, S-2

16. Match List-I with List-II for the reaction steps in the reaction sequence:



List - I	List - II
P) $A \longrightarrow B$	1) Acid - base reaction
Q) $B \longrightarrow C$	2) Nucleophilic substitution
R) $D \longrightarrow E$	3) Elimination
S) $E \longrightarrow F$	4) Electrophilic addition

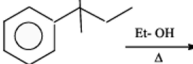
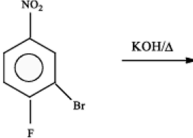
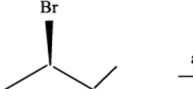
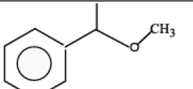
A) P-1, Q-3, R-2, S-4

B) P-3, Q-4, R-1, S-2

C) P-3, Q-2, R-4, S-1

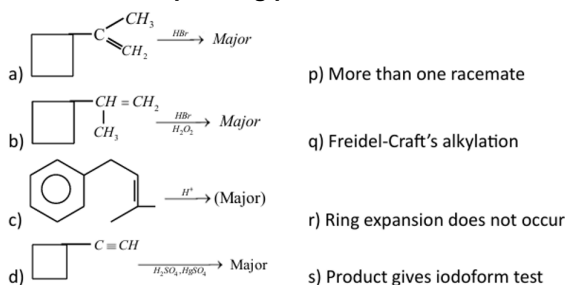
D) P-1, Q-2, R-3, S-4

17. Match List-I with List-II for reaction types:

	List - I	List - II
P)		1) Nucleophilic aromatic substitution ($SN\text{-}Ar$)
Q)		2) Unimolecular Substitution (SN_1)
R)		3) Bimolecular Elimination (E_2)
S)		4) Unimolecular Elimination (E_1)

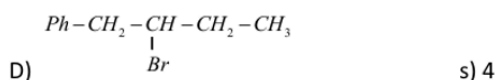
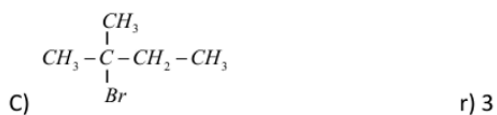
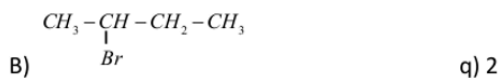
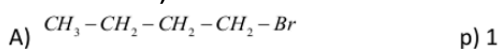
- A)** P-1, Q-2, R-4, S-3 **B)** P-2, Q-3, R-1, S-4
C) P-4, Q-1, R-3, S-2 **D)** P-2, Q-1, R-3, S-4

18. Match reaction conditions for cyclobutyl derivatives with their corresponding product characteristics:



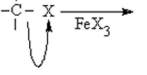
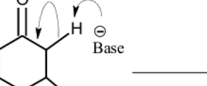
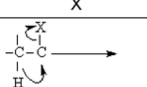
- A)** a-p,r; b-p,r; c-q; d-r,s **B)** a-p; b-r; c-q; d-r,s
C) a-r; b-r; c-q; d-r,s **D)** a-p; b-r; c-q; d-r

19. Match Column-I with Column-II for number of dehydrohalogenation products (including stereoisomers):



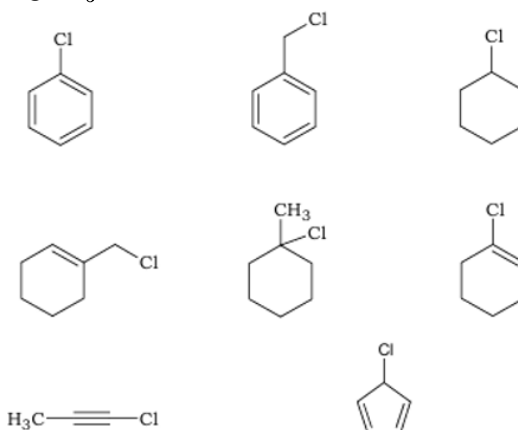
- A)** A-p, B-r, C-q, D-s
B) A-p, B-s, C-q, D-r
C) A-s, B-r, C-q, D-p
D) A-p, B-r, C-s, D-q

20. Match Column-I with Column-II with respect to rate-determining step/mechanism:

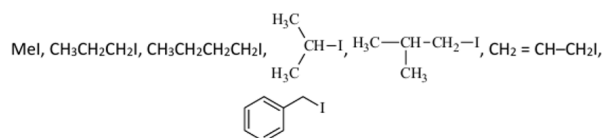
Column I	Column II
(a) 	(p) E^1
(b) 	(q) E^2
(c) 	(r) E^1cB
(d) 	(s) SN^1

- A)** A-p,s; B-r; C-r; D-q
B) A-p,s; B-r; C-q; D-q
C) A-p,s; B-r; C-q; D-s
D) A-p,s; B-r; C-q; D-r

21. The number of compounds among the following which give a white precipitate of AgCl with aqueous AgNO_3 is:

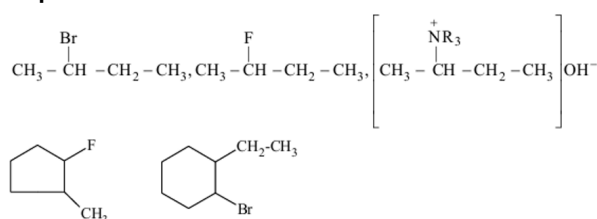


22. How many of the following compounds are less reactive than $\text{CH}_3\text{CH}_2\text{I}$ in an S_N2 reaction?



23. Number of different products formed in mononitration of 1,3-dibromobenzene including minor products is:

24. How many of the following compounds can undergo elimination by Hofmann's orientation on heating in the presence of alcoholic KOH?



25. A chemist reacted 300 g of 1-butene with excess Br_2 in CCl_4 at 25°C . He isolated 418 g of 1,2-dibromobutane. The percent yield is $6x\%$. The value of x is:

Maths

26. The length of the chord of the ellipse $\frac{x^2}{4} + \frac{y^2}{2} = 1$, whose mid-point is $(1, \frac{1}{2})$, is:
- A) $\frac{2}{3}\sqrt{15}$ B) $\frac{1}{3}\sqrt{15}$
C) $\sqrt{15}$ D) $\frac{5}{3}\sqrt{15}$
27. The equation of the chord, of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$, whose mid-point is $(3, 1)$ is:
- A) $5x + 16y = 31$ B) $48x + 25y = 169$
C) $4x + 122y = 134$ D) $25x + 101y = 176$
28. If the length of the minor axis of an ellipse is equal to one fourth of the distance between the foci, then the eccentricity of the ellipse is:
- A) $\frac{3}{\sqrt{19}}$ B) $\frac{\sqrt{3}}{16}$
C) $\frac{4}{\sqrt{17}}$ D) $\frac{\sqrt{5}}{7}$
29. The locus of mid-points of the line segments joining $(-3, -5)$ and the points on the ellipse $\frac{x^2}{4} + \frac{y^2}{9} = 1$ is:
- A) $9x^2 + 4y^2 + 18x + 8y + 145 = 0$ B) $9x^2 + 4y^2 + 18x + 8y + 145 = 0$
C) $36x^2 + 16y^2 + 108x + 80y + 3645 = 0$ D) $36x^2 + 16y^2 + 108x + 80y + 145 = 0$
30. Let the foci of a hyperbola coincide with the foci of the ellipse $\frac{x^2}{36} + \frac{y^2}{16} = 1$. If the eccentricity of the hyperbola is 5, then the length of its latus rectum is:
- A) $\frac{96}{\sqrt{5}}$ B) $24\sqrt{5}$
C) 12 D) 16
31. Let the foci of a hyperbola be $(1, 14)$ and $(1, -12)$. If it passes through the point $(1, 6)$, then the length of its latus-rectum is:
- A) $\frac{25}{6}$ B) $\frac{144}{5}$
C) $\frac{288}{5}$ D) $\frac{24}{5}$
32. Let the foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{7} = 1$ and the hyperbola $\frac{x^2}{144} - \frac{y^2}{\alpha} = \frac{1}{25}$ coincide. Then the length of the latus rectum of the hyperbola is:
- A) $\frac{32}{9}$ B) $\frac{18}{5}$
C) $\frac{27}{4}$ D) $\frac{27}{10}$
33. If $5x + 9 = 0$ is the directrix of the hyperbola $16x^2 - 9y^2 = 144$, then its corresponding focus is:
- A) $(\frac{5}{3}, 0)$ B) $(5, 0)$
C) $(-5, 0)$ D) $(-\frac{5}{3}, 0)$

34. If e_1 and e_2 are the eccentricities of the ellipse, $\frac{x^2}{18} + \frac{y^2}{4} = 1$ and the hyperbola, $\frac{x^2}{9} - \frac{y^2}{4} = 1$ respectively and (e_1, e_2) is a point on the ellipse, $15x^2 + 3y^2 = k$, then k is equal to:

- A) 17 B) 16
C) 15 D) 14

35. The vertices of a hyperbola are at $(0, 0)$ and $(10, 0)$ and one of its foci is at $(18, 0)$. The equation of the hyperbola is:

- A) $\frac{x^2}{25} - \frac{y^2}{144} = 1$ B) $\frac{(x-5)^2}{25} - \frac{y^2}{144} = 1$
C) $\frac{x^2}{25} - \frac{(y-5)^2}{144} = 1$ D) $\frac{(x-5)^2}{25} - \frac{(y-5)^2}{144} = 1$

36. If the latus rectum of an hyperbola be 8 and eccentricity be $\frac{3}{\sqrt{5}}$, then the equation of the hyperbola is:

- A) $4x^2 - 5y^2 = 100$ B) $5x^2 - 4y^2 = 100$
C) $4x^2 + 5y^2 = 100$ D) $5x^2 + 4y^2 = 100$

37. If the centre, vertex and focus of a hyperbola be $(0, 0)$, $(4, 0)$ and $(6, 0)$ respectively, then the equation of the hyperbola is:

- A) $4x^2 - 5y^2 = 8$ B) $4x^2 - 5y^2 = 80$
C) $5x^2 - 4y^2 = 80$ D) $5x^2 - 4y^2 = 8$

38. The eccentricity of the conic defined by

$$\left| \sqrt{(x-1)^2 + (y-2)^2} - \sqrt{(x-5)^2 + (y-5)^2} \right| = 3$$

- A) $\frac{5}{2}$ B) $\frac{5}{3}$
C) $\sqrt{2}$ D) $\sqrt{11}/3$

39. If the latus rectum of a hyperbola forms an equilateral triangle with the centre of the hyperbola, then the eccentricity is:

- A) $\frac{\sqrt{3}-1}{2\sqrt{3}}$ B) $\frac{\sqrt{3}+1}{2\sqrt{3}}$
C) $\frac{\sqrt{13}+1}{2\sqrt{3}}$ D) $\frac{\sqrt{3}-1}{\sqrt{3}}$

40. The foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{b^2} = 1$ and the hyperbola $\frac{x^2}{144} - \frac{y^2}{81} = \frac{1}{25}$ coincide then the value of b^2 is:

- A) 1 B) 5
C) 7 D) 9

41. If $(5, 12)$ and $(24, 7)$ are the foci of a hyperbola passing through origin, then its eccentricity is:

- A) Eccentricity = $\frac{\sqrt{386}}{13}$ B) Eccentricity = $\frac{\sqrt{386}}{12}$
C) Length of latus rectum = $\frac{5}{6}$ D) Length of conjugate axis = $\sqrt{242}$ key

42. The length of latus-rectum of the conic

$$\left| \sqrt{x^2 + y^2} - \sqrt{(x-1)^2 + (y-3)^2} \right| = \sqrt{5} \text{ is:}$$

- A) $\sqrt{10}$ B) $\sqrt{5}$
C) $5\sqrt{2}$ D) cannot be evaluated

43. Length of the latus rectum of the hyperbola $(10x - 5)^2 + (10y - 2)^2 = 9(3x + 4y - 7)^2$ is:

- A) $\frac{282}{100}$ B) $\frac{141}{100}$
C) $\frac{228}{100}$ D) $\frac{822}{100}$

44. For the hyperbola $\frac{x^2}{\cos^2 \alpha} - \frac{y^2}{\sin^2 \alpha} = 1$ where the value of α changes, which of the following remain constant?

- A) Abscissae of the vertices B) Abscissae of the foci
C) Eccentricity D) Directrices

45. The ellipse $4x^2 + 9y^2 = 36$ and the hyperbola $a^2x^2 - y^2 = 4$ intersect at right angles then the equation of the circle through the points of intersection of two conics is:

- A) $x^2 + y^2 = 5$ B) $\sqrt{5}(x^2 + y^2) - 3x - 4y = 0$
C) $\sqrt{5}(x^2 + y^2) + 3x + 4y = 0$ D) $x^2 + y^2 = 25$

46. If the midpoint of a chord of the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ is $(\sqrt{2}, 4/3)$, and the length of the chord is $\frac{2\sqrt{\alpha}}{3}$, then α is:

47. If $\alpha x + \beta y = 109$ is the equation of the chord of the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$, whose mid point is $(\frac{5}{2}, \frac{1}{2})$, then $\alpha + \beta$ is equal to:

48. If the equation of the hyperbola with foci $(4, 2)$ and $(8, 2)$ is $3x^2 - y^2 - \alpha x + \beta y + \gamma = 0$, then $\alpha + \beta + \gamma$ is equal to:

49. Let the sum of the focal distances of the point $P(4, 3)$ on the hyperbola $H : \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ be $8\sqrt{\frac{5}{3}}$. If for H , the length of the latus rectum is l and the product of the focal distances of the point P is m , then $9l^2 + 6m$ is equal to:

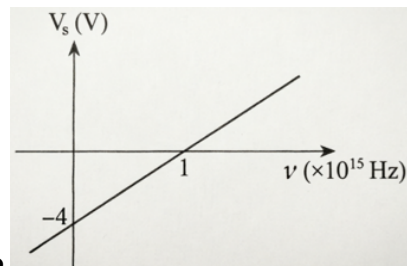
50. Consider the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ having one of its focus at $P(-3, 0)$. If the latus rectum through its other focus subtends a right angle at P and $a^2b^2 = \alpha\sqrt{2} - \beta$, $\alpha, \beta \in \mathbb{N}$, then $\alpha + \beta$ is:

Physics

51. In a photoelectric experiment both lithium (work function = 2.5 eV) and tungsten (work function = 4.5 eV) metals were illuminated by an ultraviolet light of same wavelength. If the stopping potential for tungsten is measured to be 2.0 V, the value of the stopping potential for lithium will be

- A) 6 V B) 4 V
C) 8 V D) 2 V

52. The figure shows the results obtained during a photoelectric effect experiment where the stopping potential V_s is plotted against the frequency ν of the incident radiation. The work function of the metal is



close to

- A) -4 eV B) 1 eV
C) 6 eV D) 4 eV

53. Light described by the equation

$$E = (120 \text{ V/m}) [\sin(3.14 \times 10^{15} s^{-1}t) + \sin(12.56 \times 10^1$$

is incident on a metal surface. The work function of the metal is 2.28 eV. The maximum kinetic energy of the photoelectrons will be

- A) 2 eV B) 4 eV
C) 6 eV D) 8 eV

54. Photons with an energy of 9.4 eV strike a clean sodium plate, causing the emission of photoelectrons with a maximum velocity of $1.5 \times 10^6 \text{ m/s}$. The work function of the sodium plate is

- A) 2 eV B) 3 eV
C) 5 eV D) 6 eV

55. Given that the work-function of a metal is 3 eV and that photons of 28 eV are incident on it, the maximum velocity of emitted electrons is approximately

- A) $2 \times 10^6 \text{ m/s}$ B) $4 \times 10^6 \text{ m/s}$
C) $1 \times 10^6 \text{ m/s}$ D) $3 \times 10^6 \text{ m/s}$

56. The work function of a substance is 3.1 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately

- A) 600 nm B) 400 nm
C) 200 nm D) 800 nm

57. Photo-energy of 7.8 eV is incident on a surface of work function 2.8 eV. What is the stopping potential for the emitted photoelectrons?

- A) -2 V B) -5 V
C) -7 V D) -9 V

58. Light of two different frequencies whose photons have energies 1.8 eV and 4.2 eV respectively, successively illuminates a metal of work function 0.6 eV. The ratio of maximum kinetic energies of the emitted electrons will be

- A) 1 : 4 B) 1 : 2
C) 1 : 5 D) 1 : 3

59. Photoelectric emission is observed from a metallic surface for frequencies ν_1 and ν_2 of the incident light rays ($\nu_1 > \nu_2$). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of $k : 1$, then the threshold frequency of the metallic surface is

- A) $\frac{\nu_1 - \nu_2}{k - 1}$ B) $\frac{k\nu_1 - \nu_2}{k - 1}$
C) $\frac{k\nu_2 - \nu_1}{k - 1}$ D) $\frac{\nu_2 - \nu_1}{k - 1}$

60. When green light incident on a surface no electrons are emitted while blue light can emit. If yellow light is incident on the surface then

- A) Photons are emitted B) No electrons are emitted
C) Electrons of higher energy are emitted D) Electrons of lower energy are emitted

61. The work functions of metals A and B are in the ratio $1 : 3$. If light of frequencies f and $3f$ are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is (f is greater than threshold frequency of A, $3f$ is greater than threshold frequency of B)

- A) $1 : 1$ B) $1 : 2$
C) $1 : 3$ D) $1 : 4$

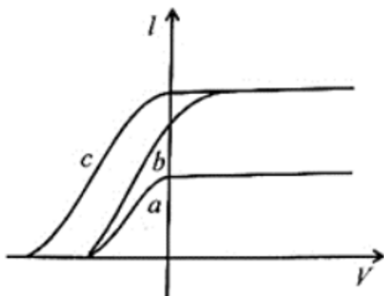
62. When a metal surface is illuminated by light of wavelength 400 nm and 250 nm the maximum velocities of the photoelectrons ejected are v and $2v$ respectively. The work function of the metal is ($h = \text{Planck's constant}$, $c = \text{velocity of light in air}$)

- A) $2hc \times 10^6 J$ B) $1.5hc \times 10^6 J$
C) $hc \times 10^6 J$ D) $0.5hc \times 10^6 J$

63. The work functions of metals A and B are in the ratio $1 : 2$. If light of frequencies f and $2f$ are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is (f is greater than threshold frequency of A, $2f$ is greater than threshold frequency of B)

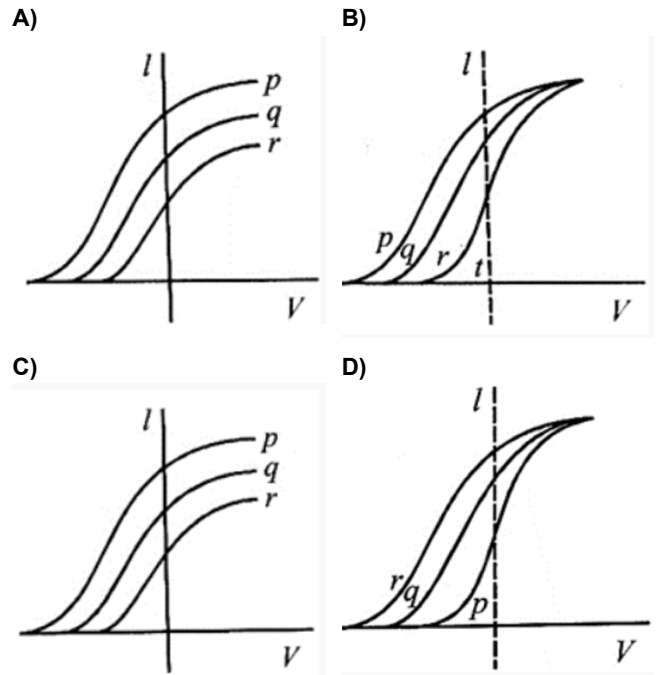
- A) $1 : 1$ B) $1 : 2$
C) $1 : 3$ D) $1 : 4$

64. The figure shows the variation of photocurrent with anode potential for a photosensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b, and c respectively

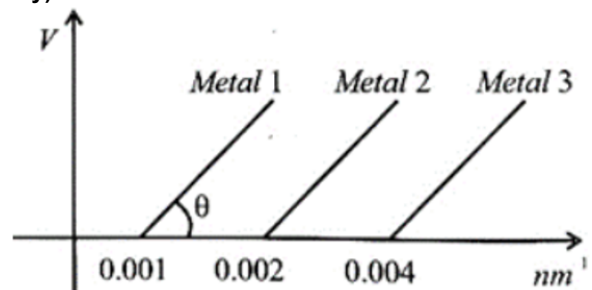


- A) $f_a = f_b$ and $I_a \neq I_b$ B) $f_a = f_c$ and $I_a = I_c$
C) $f_a = f_b$ and $I_a = I_b$ D) $f_b = f_c$ and $I_b = I_c$

65. Photoelectric effect experiments are performed using three different metal plates p, q, and r having work function $\phi_p = 2.0 \text{ eV}$, $\phi_q = 2.5 \text{ eV}$ and $\phi_r = eV$, respectively. A light beam containing wavelengths of 550 nm , 450 nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is



66. The graph between $1/\lambda$ and stopping potential (V) of three metal having work function ϕ_1, ϕ_2 and ϕ_3 in an experiment of photoelectric is plotted as shown in the figure. Which of the following statement (s) is/are correct? (Here, λ is the wavelength of the incident ray).



- A) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$ B) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$
C) $\tan \theta$ is directly proportional to hc/e where h is Planck's constant and c is the speed of light. D) The violet colour light can eject photoelectrons from metal 2 and 3

67. Photon of Frequency ν incident on a Photo Sensitive Metal with work function ϕ . Knocks out electron in a direction perpendicular to the Metal surface. A Magnetic field is applied parallel to the surface. Find the radius of trajectory of electron.

- A) $\frac{mv}{eB}$ B) $\frac{\sqrt{2m(h\nu - \phi)}}{eB}$
C) $\frac{\sqrt{m(h\nu - \phi)}}{eB}$ D) $\frac{\sqrt{m(h\nu - \phi)}}{2eB}$

68. The work function of a metal is 3 eV if $2480 \text{ \AA}$ wavelength of light is incident on the metal. Is there any photo electric effect?

- A) Yes, with maximum kinetic energy 4 eV B) No, because $E < \phi$
 C) Yes, with maximum kinetic energy 2 eV D) Data insufficient

69. A metallic surface of work function $h\nu$ is illuminated by a radiation beam of frequency 3ν . Stopping potential observed is X . What will be stopping potential if the surface is illuminated by radiations of 7ν frequency?

- A) $2.0X$ B) $1.5X$
 C) $3.0X$ D) $2.5X$

70. A monochromatic light incident on metal 'A' having threshold frequency ν_0 . It emits photo electrons of maximum kinetic energy K . Now incident frequency is made two times and fall on a metal 'B' having threshold frequency $3\nu_0$. What will maximum kinetic energy of photo electrons emitted by metal 'B'?

- A) $2K + h\nu_0$ B) $2K - h\nu_0$
 C) $3K - h\nu_0$ D) $K - 3h\nu_0$

71. When incident wavelength is λ , stopping potential is $4V_0$. If incident wavelength is 2λ then stopping potential is V_0 . Find out threshold wavelength in terms of λ will be.

72. Threshold frequency of a surface is ν_0 . It is illuminated by $2\nu_0$ frequency, then maximum speed of photo electrons is $V \text{ m/sec}$. What will be maximum speed if incident frequency is $10\nu_0$ ___ V ?

73. The wavelength of photons in two cases are $6200 \text{ \AA}$ and $3100 \text{ \AA}$ respectively what is difference in stopping potential for these two ___ V ?

74. In a photo cell 3 unit photo electric current is flowing, the distance between source and cathode is 6 unit. Now distance between source and cathode becomes 2 unit. What will be photo electric current now will be ___ units?

75. The work function of a metal is 2.0 eV and the wavelength of incident photon is $3.1 \times 10^{-7} \text{ m}$. Find maximum kinetic energy of photo electrons will be ___ eV .

ANSWER KEY

Chemistry

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

Maths

26.	1	33.	3	40.	3	47.	58
27.	2	34.	2	41.	2	48.	141
28.	3	35.	2	42.	2	49.	185
29.	3	36.	1	43.	1	50.	1944
30.	1	37.	3	44.	2		
31.	3	38.	2	45.	1		
32.	4	39.	3	46.	22		

Physics

51.	2	58.	4	65.	2	72.	3
52.	4	59.	3	66.	1	73.	2
53.	3	60.	2	67.	2	74.	27
54.	2	61.	3	68.	3	75.	2
55.	4	62.	1	69.	3		
56.	2	63.	2	70.	2		
57.	2	64.	1	71.	3		

SOLUTIONS

Q1.

Answer: A

Explanation:

S_N2 reactions proceed via a backside nucleophilic attack leading strictly to Walden inversion of stereochemical configuration. S_N1 reactions proceed via a planar carbocation intermediate, yielding racemization (a mixture of R and S configurations). Optical rotation sign (d/l) does not strictly correlate with absolute configuration (R/S).

Q2.

Answer: B

Explanation:

Treatment of alcohols with SOCl_2 alone proceeds via an S_Ni mechanism with internal return, leading to retention of stereochemical configuration. In the presence of pyridine, pyridinium hydrochloride is formed, providing chloride ions for a backside S_N2 attack that results in inversion of configuration.

Q3.

Answer: C

Explanation:

Silver salts (AgCN , AgNO_2) are predominantly covalent, directing attack through the more nucleophilic nitrogen atom to yield isocyanides and nitromethane, respectively. Sodium salts (NaCN , NaNO_2) are ionic, providing free ambident anions that attack via carbon or oxygen.

Q4.

Answer: B

Explanation:

Benzyl iodide ($\text{C}_6\text{H}_5\text{CH}_2\text{I}$) undergoes nucleophilic substitution easily with aqueous NaOH to release iodide ions (I^-), which react with AgNO_3 to form a yellow precipitate of AgI . Iodobenzene ($\text{C}_6\text{H}_5\text{I}$) is unreactive due to partial double bond character of the $\text{C}_{sp^2} - \text{I}$ bond [3, 4]. Dilute HNO_3 is essential to neutralize excess NaOH .

Q5.

Answer: D

Explanation:

Aryl halides are far less reactive than alkyl halides toward nucleophilic substitution due to $\text{C}_{sp^2} - \text{X}$ partial double-bond character and resonance. Electron-withdrawing groups at ortho/para positions increase reactivity toward $S_N\text{Ar}$ substitution. Nucleophilic aromatic substitution with strong bases proceeds via an elimination-addition (benzyne) mechanism or $S_N\text{Ar}$, not S_N1 .

Q6.

Answer: C

Explanation:

Ethanol does not react with aqueous NaCl because Cl^- is a weaker base than OH^- . Red P + HI reduces alcohols to alkanes (ethane). Electrophilic addition of Br_2 to ethylene generates a bromonium ion intermediate, which can be trapped by competing nucleophiles (Br^- , Cl^- , H_2O). Electron-withdrawing groups increase $S_N\text{Ar}$ rates.

Q7.

Answer: A

Explanation:

Dehydrohalogenation of alkyl halides follows Saytzeff's rule (more substituted, thermodynamically stable alkene) for good leaving groups like Cl , Br , and I . For alkyl fluorides ($\text{X} = \text{F}$), the poor leaving ability develops carbanionic character in the transition state, favoring the Hofmann product (less substituted alkene).

Q8.

Answer: C

Explanation:

To determine the number of monoderivatives formed upon further electrophilic aromatic substitution, evaluate the non-equivalent aromatic positions available on the ring.

Q9.

Answer: D

Explanation:

Reactions (A) and (C) proceed via benzyne intermediates where nucleophilic addition gives the indicated major substituted aniline derivatives. Reactions (B) and (D) proceed via activated $S_N\text{Ar}$ addition-elimination mechanisms facilitated by strong ortho/para nitro electron-withdrawing groups.

Q10.

Answer: A

Explanation:

The addition-elimination ($S_N\text{Ar}$) mechanism requires a good leaving group and strong electron-withdrawing groups ($-\text{NO}_2$) situated at positions ortho and/or para to the halogen to stabilize the anionic Meisenheimer complex intermediate.

Q11.

Answer: A

Explanation:

The reaction is a bimolecular nucleophilic substitution (S_N2) on a primary alkyl bromide ($\text{Z-CH}_2\text{-Br}$). Steric hindrance at the β -carbon increases from H- to isopropyl, drastically reducing S_N2 reactivity: Methyl(100) > Ethyl(3) > Propyl(1) > Isobutyl(0.1).

Q12.

Answer: C

Explanation:

Primary halide gives propene. Tertiary halide gives 2-methylpropene via E2. Quaternary ammonium hydroxide undergoes Hofmann elimination to yield 1-butene. Secondary alkyl halide follows Saytzeff elimination to yield 2-butene.

Q13.

Answer: B

Explanation:

Electrophilic aromatic substitution rates depend on ring activation. Benzene is the reference (1). Toluene is activated by hyperconjugation (10). Anisole is strongly activated by resonance of oxygen lone pair (10^9). N,N-dimethylaniline is exceptionally strongly activated by nitrogen lone pair resonance (10^{14}).

Q14.

Answer: B

Explanation:

Elimination of HBr from 2-bromopropane-1,1,1- d_3 occurs via concerted E2. S_N2 reactivity order is $1^\circ > 2^\circ > 3^\circ$. Leaving group ability for S_NAr follows carbon-halogen bond strength ($F^- > Cl^- > Br^-$ rate). Deuterium exchange in phenylethyl bromide via strong base indicates an E1cB pathway.

Q15.

Answer: D

Explanation:

3-bromopentane gives (*E*)- and (*Z*)-pent-2-ene (stereoisomers) upon E2. 2-bromopentane gives pent-1-ene, (*E*)-pent-2-ene, and (*Z*)-pent-2-ene (complex mixture). 2-bromo-2-methylbutane is a 3° alkyl halide that undergoes E1 fastest. Neopentyl bromide has no β -hydrogens and cannot undergo E2.

Q16.

Answer: B

Explanation:

The reaction sequence involves: (1) E2 elimination to alkene, (2) electrophilic addition of Br_2 to dibromide, (3) double E2 elimination to alkynyl derivative, (4) acid-base deprotonation of terminal alkyne by $NaNH_2$, and (5) S_N2 alkylation with CH_3I .

Q17.

Answer: C

Explanation:

(P) Tertiary benzylic iodide in polar protic ethanol undergoes unimolecular solvolysis/elimination ($E1/S_N1$). (Q) Activated aryl fluoride undergoes S_NAr . (R) Secondary alkyl halide with strong base undergoes E2. (S) Ether cleavage of benzylic ether via acid hydrolysis proceeds via S_N1 .

Q18.

Answer: B

Explanation:

Oxymercuration/hydration of ethynylcyclobutane gives 1-cyclobutylethanone, which has a $CH_3C=O$ group and gives a positive iodoform test without ring expansion. Electrophilic protonation of phenylalkene yields a carbocation that performs intramolecular Friedel-Crafts alkylation.

Q19.

Answer: A

Explanation:

1-bromobutane gives 1 alkene (but-1-ene). 2-bromobutane gives 3 alkenes (but-1-ene, cis-but-2-ene, trans-but-2-ene). 2-bromo-2-methylbutane gives 2 alkenes (2-methylbut-1-ene, 2-methylbut-2-ene). 1-phenyl-2-bromobutane gives 4 alkenes including cis/trans stereoisomers.

Q20.

Answer: D

Explanation:

Carbocation formation via halide abstraction by Lewis acid occurs in E1 and S_N1 . Elimination in α -halo ketones proceeds via acidic α -proton removal (E1cB). Standard base-catalyzed elimination with good leaving group is E2. Deuterium exchange in phenylethyl halide occurs via E1cB.

Q21.

Answer: 4

Explanation:

Precipitation of AgCl with aqueous $AgNO_3$ requires S_N1 ionization to form a stable carbocation. Benzyl chloride, allyl chloride, tert-butyl chloride, and 2-chlorocyclopent-2-en-1-one derivatives (or cyclohexyl chloride depending on solvolysis conditions) form stable carbocations. Vinylic, alkynyl, and aryl chlorides do not ionize.

Q22.

Answer: 4

Explanation:

S_N2 reactivity is retarded by α -branching and β -branching. Substrates less reactive than ethyl iodide (CH_3CH_2I) are those with greater alkyl chain length or steric crowding: propyl iodide, butyl iodide, isopropyl iodide, and neopentyl iodide. Allyl iodide, benzyl iodide, and methyl iodide are more reactive.

Q23.

Answer: 3

Explanation:

Electrophilic aromatic nitration of 1,3-dibromobenzene can occur at three distinct non-equivalent positions on the benzene ring: position 2 (between two Br atoms), position 4 (ortho to one Br, para to other), and position 5 (meta to both Br atoms).

Q24.

Answer: 3

Explanation:

Hofmann elimination (formation of the less substituted alkene) occurs when the leaving group is poor (e.g., fluoride F^-) or bulky (e.g., quaternary ammonium $-N^+R_3$). Alkyl fluorides and quaternary ammonium salts undergo Hofmann elimination.

Q25.

Answer: 6

Explanation:

Calculate the theoretical yield of 1,2-dibromobutane from 300 g of 1-butene using stoichiometry [18, 19]. Divide the actual isolated yield (418 g) by the theoretical yield to find the percent yield ($36.4\% \approx 36\% = 6 \times 6$) [18, 19]. Thus, $x = 6$.

Q26.

Answer: A

Explanation:

Using the chord equation $T = S_1$ for an ellipse with a given midpoint, we find the equation of the chord, substitute it back into the ellipse equation to get a quadratic in x , and calculate the distance between the intersection points.

Q27.

Answer: B

Explanation:

The equation of a chord of a conic with a given midpoint (x_1, y_1) is represented by $T = S_1$. Substituting the coordinates (3, 1) into the formula directly yields the linear equation of the line.

Q28.

Answer: C

Explanation:

Relate the semi-minor axis b and focal distance ae using the given proportion, substitute into the standard eccentricity identity $b^2 = a^2(1 - e^2)$, and solve for e .

Q29.

Answer: C

Explanation:

Express any point (x_1, y_1) on the ellipse in terms of the midpoint (h, k) of the line segment joining $(-3, -5)$ and (x_1, y_1) , then substitute into the ellipse equation.

Q30.

Answer: A

Explanation:

Calculate the focal distance of the ellipse, set it equal to the focal distance of the hyperbola to find its semi-transverse axis a_H , and compute its latus rectum $2b_H^2/a_H$.

Q31.

Answer: C

Explanation:

Use the geometric focal distance definition $|PF_1 - PF_2| = 2b$ for a vertical hyperbola to find b , determine a^2 using $c^2 = a^2 + b^2$, and calculate the latus rectum $2a^2/b$.

Q32.

Answer: D

Explanation:

Determine the focus c_E of the ellipse, set $c_H = c_E$ for the hyperbola to find its conjugate axis b_H^2 , and compute its latus rectum.

Q33.

Answer: C

Explanation:

Convert the hyperbola equation to standard form to find a , b , calculate $c = ae$, and match the given negative directrix $x = -9/5$ to its corresponding negative focus $(-c, 0) = (-5, 0)$.

Q34.

Answer: B

Explanation:

Calculate e_1^2 for the ellipse and e_2^2 for the hyperbola, then substitute (e_1, e_2) into $15x^2 + 3y^2 = k$ to solve for k .

Q35.

Answer: B

Explanation:

Find center $(5, 0)$ as the midpoint of vertices, compute semi-transverse axis $a = 5$ and focal distance $c = 13$, determine $b^2 = 144$, and write standard form.

Q36.

Answer: A

Explanation:

Equate latus rectum $2b^2/a = 8 \implies b^2 = 4a$, substitute into $e^2 = 1 + b^2/a^2 = 9/5$ to find $a = 5$, $b^2 = 20$, and construct the equation.

Q37.

Answer: C

Explanation:

From center $(0, 0)$, vertex $(4, 0) \implies a = 4$, and focus $(6, 0) \implies c = 6$, calculate $b^2 = 20$, and write the equation $x^2/16 - y^2/20 = 1$.

Q38.

Answer: B

Explanation:

Identify foci $F_1(1, 2)$ and $F_2(5, 5)$, compute $2c = 5$, note $2a = 3$ from the focal difference definition, and evaluate $e = 2c/2a = 5/3$.

Q39.

Answer: C

Explanation:

In an equilateral triangle formed by latus rectum L_1L_2 and center $C(0, 0)$, $\tan 30^\circ = \frac{b^2/a}{ae}$, solving $\sqrt{3}e^2 - e - \sqrt{3} = 0$ gives $e = \frac{\sqrt{13}+1}{2\sqrt{3}}$.

Q40.

Answer: C

Explanation:

Find $c_H^2 = a_H^2 + b_H^2 = 9$ for the hyperbola, set $c_E^2 = c_H^2 = 9$ for the ellipse, and solve $16 - b^2 = 9 \implies b^2 = 7$.

Q41.

Answer: B

Explanation:

Calculate focal distance $2c = \sqrt{386}$, determine $2a = |OF_1 - OF_2| = 12$ using origin $O(0, 0)$, and evaluate $e = 2c/2a = \sqrt{386}/12$.

Q42.

Answer: B

Explanation:

Foci are $(0, 0)$ and $(1, 3) \implies 2c = \sqrt{10}$, $2a = \sqrt{5} \implies e = \sqrt{2}$, $b^2 = 5/4$, so latus rectum $2b^2/a = \sqrt{5}$.

Q43.

Answer: A

Explanation:

Convert to focus-directrix form $SP^2 = e^2PM^2 \implies e = 3/2$, find focus-directrix distance $d = 47/50$, and compute latus rectum $2ed = 282/100$.

Q44.

Answer: B

Explanation:

Focal distance squared is $c^2 = a^2 + b^2 = \cos^2 \alpha + \sin^2 \alpha = 1 \implies c = 1$. The foci are $(\pm 1, 0)$, so their abscissae are constant regardless of α .

Q45.

Answer: A

Explanation:

Confocal condition $A_1 - B_1 = A_2 - B_2$ yields $a^2 = 4$. Solving the intersection $4x^2 + 9y^2 = 36$ and $4x^2 - y^2 = 4$ gives $x^2 = 9/5$, $y^2 = 16/5$, so $x^2 + y^2 = 5$.

Q46.

Answer: 22

Explanation:

Find the equation of the chord using $T = S_1$, find the intersection points with the ellipse to express the chord length in terms of a radical, and solve for α .

Q47.

Answer: 58

Explanation:

Apply $T = S_1$ at the midpoint $(\frac{5}{2}, \frac{1}{2})$ to obtain the equation of the chord, clear fractions to match the given form $\alpha x + \beta y = 109$, and compute $\alpha + \beta$.

Q48.

Answer: 141

Explanation:

Determine the center $(6, 2)$ and focal distance $c = 2$, build the standard hyperbola equation, expand to find α, β, γ , and sum them together.

Q49.

Answer: 185

Explanation:

Find e, a^2, b^2 using the sum of focal distances $2ex_1$, compute latus rectum l and focal product m , and evaluate $9l^2 + 6m$.

Q50.

Answer: 1944

Explanation:

Set up the right-angle condition for the latus rectum endpoints subtending 90° at the opposite focus, solve for a, b , and compute $\alpha + \beta$.

Q51.

Answer: B

Explanation:

From Einstein's photoelectric equation, $hc/\lambda = \phi + eV_s$. Since the incident wavelength is same for both metals, the photon energy is same: $\phi_W + eV_W = \phi_{Li} + eV_{Li}$. Thus $eV_{Li} = 4.5 + 2.0 - 2.5 = 4.0$ eV, which gives $V_{Li} = 4$ V.

Q52.

Answer: D

Explanation:

From Einstein's photoelectric equation, $eV_s = h\nu - \phi$, so the straight line is $V_s = \frac{h}{e}\nu - \frac{\phi}{e}$. The intercept on the V_s axis equals $-\frac{\phi}{e}$, which from the graph is -4 V, giving $\phi = 4$ eV. This is confirmed by the threshold frequency intercept $\nu_0 = 1 \times 10^{15}$ Hz, since $\phi = h\nu_0 \approx 4.1$ eV.

Q53.

Answer: C

Explanation:

The light contains two frequency components; the photon with the higher frequency $\nu = \omega/2\pi = 2 \times 10^{15}$ Hz carries energy $h\nu = 8.28$ eV, so the maximum kinetic energy is $K_{max} = h\nu - \phi = 8.28 - 2.28 = 6$ eV.

Q54.

Answer: B

Explanation:

The maximum kinetic energy of the photoelectrons is $K_{max} = \frac{1}{2}mv_{max}^2 \approx 6.4$ eV, so by Einstein's photoelectric equation the work function is $\phi = E - K_{max} = 9.4 - 6.4 = 3$ eV.

Q55.

Answer: D

Explanation:

The kinetic energy of the fastest electron is $K_{max} = E - \phi = 28 - 3 = 25$ eV $= 4.0 \times 10^{-18}$ J, and using $K_{max} = \frac{1}{2}mv^2$ this gives $v \approx 3 \times 10^6$ m/s.

Q56.

Answer: B

Explanation:

The longest (threshold) wavelength corresponds to a photon whose energy exactly equals the work function: $\lambda_0 = \frac{hc}{\phi} = \frac{1240 \text{ eV}\cdot\text{nm}}{3.1 \text{ eV}} = 400 \text{ nm}$.

Q57.

Answer: B

Explanation:

The maximum kinetic energy of the photoelectrons is $K_{max} = E - \phi = 7.8 - 2.8 = 5.0$ eV, and since $eV_s = K_{max}$, the stopping potential has magnitude 5 V, i.e. -5 V in the retarding sign convention.

Q58.

Answer: D

Explanation:

Using $K = E - \phi$, the two maximum kinetic energies are $K_1 = 1.8 - 0.6 = 1.2$ eV and $K_2 = 4.2 - 0.6 = 3.6$ eV, so the ratio is $K_1 : K_2 = 1.2 : 3.6 = 1 : 3$.

Q59.

Answer: C

Explanation:

Writing $K_1 = h(v_1 - v_0)$ and $K_2 = h(v_2 - v_0)$ with $\frac{K_1}{K_2} = \frac{k}{1}$ gives $v_1 - v_0 = k(v_2 - v_0)$, which solves to $v_0 = \frac{kv_2 - v_1}{k-1}$.

Q60.

Answer: B

Explanation:

Photoemission requires the incident frequency to exceed the threshold frequency. Since green light (higher frequency than yellow) fails to eject electrons, the threshold frequency lies above green, and yellow light, having still lower frequency (and lower photon energy), cannot cause emission.

Q61.

Answer: C

Explanation:

Taking $\phi_A = \phi$ and $\phi_B = 3\phi$, we get $K_A = hf - \phi$ and $K_B = 3hf - 3\phi = 3(hf - \phi)$, so the ratio $K_A : K_B = 1 : 3$.

Q62.

Answer: A

Explanation:

By using $E = W_0 + K_{\max} \Rightarrow \frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$
 $\frac{hc}{400 \times 10^{-9}} = W_0 + \frac{1}{2}mv^2 \dots (1)$ And $\frac{hc}{250 \times 10^{-9}} = W_0 + \frac{1}{2}m(2v)^2$
 $\dots (2)$ From equation (1) and (2) $W_0 = 2hc \times 10^6 J$

Q63.

Answer: B

Explanation:

By using $E = W_0 + K_{\max} \Rightarrow E_A = hf = W_A + K_A$ and
 $E_B = h(2f) = W_B + K_B$ So, $\frac{1}{2} = \frac{W_A + K_A}{W_B + K_B} \dots (i)$ also it is given
that $\frac{W_A}{W_B} = \frac{1}{2} \dots (ii)$ From equation (i) and (ii) we get $\frac{K_A}{K_B} = \frac{1}{2}$

Q64.

Answer: A

Explanation:

Analyze the photoelectric equation relating stopping potential (V_s) and incident frequency (f), given by $eV_s = hf - \Phi$. The stopping potential determines the frequency of the incident radiation. Observe that curves a and b intersect the stopping potential axis at the same negative potential, meaning their frequencies are equal ($f_a = f_b$). Note that the saturation photocurrent (I_{sat}) depends on light intensity. Curves a and b have different saturation current plateaus, indicating different intensities ($I_a \neq I_b$). Combine these properties to write the relation for curves a and b :
 $f_a = f_b$ and $I_a \neq I_b$ Conclude that the correct option matching this condition is Option 1.

Q65.

Answer: B

Explanation:

Calculate the maximum energy (minimum wavelength, $\lambda_{min} = 350 \text{ nm}$) of the incident light beam to find the maximum energy of photons: $E_{max} = \frac{hc}{\lambda_{min}}$ Determine the threshold wavelength (λ_0) or maximum work function scenario for each metal plate: For plate p ($\Phi_p = 2.0 \text{ eV}$): $\lambda_{0p} = \frac{hc}{\Phi_p} \approx 620 \text{ nm}$ For plate q ($\Phi_q = 2.5 \text{ eV}$): $\lambda_{0q} = \frac{hc}{\Phi_q} \approx 496 \text{ nm}$ For plate r ($\Phi_r = 1 \text{ eV}$): $\lambda_{0r} = \frac{hc}{\Phi_r} \approx 1240 \text{ nm}$ Analyze which wavelengths can cause emission for each plate: Plate r emits photoelectrons for all three wavelengths (550 nm, 450 nm, 350 nm). Plate p emits photoelectrons for 450 nm and 350 nm. Plate q emits photoelectrons only for 350 nm. Evaluate the stopping potentials (V_s) corresponding to the highest energy incident photon ($\lambda = 350 \text{ nm}$) for each metal: $eV_s = \frac{hc}{\lambda} - \Phi$ Since $\Phi_r < \Phi_p < \Phi_q$, the stopping potentials follow the order: $|V_{sr}| > |V_{sp}| > |V_{sq}|$ Match the resulting saturation currents and stopping potentials to Option 2, where the correct threshold and maximum kinetic energy boundaries are properly depicted.

Q66.

Answer: A

Explanation:

Write Einstein's photoelectric equation relating stopping potential (V), work function (Φ), and wavelength (λ):
 $eV = \frac{hc}{\lambda} - \Phi \Rightarrow V = \left(\frac{hc}{e}\right)\frac{1}{\lambda} - \frac{\Phi}{e}$ Identify the x-intercept from the given graph where $V = 0$, which corresponds to the reciprocal of the threshold wavelength ($\frac{1}{\lambda_0}$): For Metal 1: $\frac{1}{\lambda_{01}} = 0.001 \text{ nm}^{-1}$ For Metal 2: $\frac{1}{\lambda_{02}} = 0.002 \text{ nm}^{-1}$ For Metal 3: $\frac{1}{\lambda_{03}} = 0.004 \text{ nm}^{-1}$ Relate the work functions using $\Phi = \frac{hc}{\lambda_0}$: $\Phi_1 : \Phi_2 : \Phi_3 = \frac{1}{\lambda_{01}} : \frac{1}{\lambda_{02}} : \frac{1}{\lambda_{03}}$ Substitute the values from the intercepts: $\Phi_1 : \Phi_2 : \Phi_3 = 0.001 : 0.002 : 0.004 = 1 : 2 : 4$ Conclude that the ratio of work functions is 1 : 2 : 4, making Option 1 the correct statement.

Q67.

Answer: B

Explanation:

Use Einstein's photoelectric equation to find the maximum kinetic energy K_{max} of the emitted electron: $K_{max} = h\nu - \Phi$ Relate the maximum kinetic energy to the electron velocity v and mass m :
 $\frac{1}{2}mv^2 = h\nu - \Phi \Rightarrow v = \sqrt{\frac{2(h\nu - \Phi)}{m}}$ Recall the formula for the radius r of a charged particle moving in a uniform magnetic field B perpendicular to its velocity: $r = \frac{mv}{eB}$ Substitute the velocity expression into the radius formula: $r = \frac{m}{eB} \sqrt{\frac{2(h\nu - \Phi)}{m}}$ Simplify the expression to obtain the final radius of the trajectory:
 $r = \frac{\sqrt{2m(h\nu - \Phi)}}{eB}$ which corresponds to Option 2.

Q68.

Answer: C

Explanation:

The photon energy is $E = \frac{hc}{\lambda} = \frac{1240 \text{ eV} \cdot \text{nm}}{248 \text{ nm}} = 5 \text{ eV}$, which exceeds the work function $\phi = 3 \text{ eV}$, so emission occurs with $K_{max} = E - \phi = 5 - 3 = 2 \text{ eV}$.

Q69.

Answer: C

Explanation:

From Einstein's equation, $eX = h(3\nu) - h\nu = 2h\nu$, and for the new frequency $eX' = h(7\nu) - h\nu = 6h\nu$, so
 $X' = \frac{6h\nu}{2h\nu} X = 3.0X$.

Q70.

Answer: B

Explanation:

From metal A, $K = h\nu - h\nu_0$, so $h\nu = K + h\nu_0$. For metal B with frequency 2ν :
 $K_B = 2h\nu - 3h\nu_0 = 2(K + h\nu_0) - 3h\nu_0 = 2K - h\nu_0$.

Q71.

Answer: 3

Explanation:

Writing $eV_s = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$ for both cases and subtracting eliminates λ_0 , giving $eV_0 = \frac{hc}{6\lambda}$; substituting back yields $\frac{hc}{\lambda_0} = \frac{hc}{3\lambda}$, so $\lambda_0 = 3\lambda$.

Q72.

Answer: 3

Explanation:

Since $\frac{1}{2}mv^2 = h(\nu - \nu_0)$, the kinetic energies in the two cases are $h\nu_0$ and $9h\nu_0$; because speed scales as the square root of kinetic energy, the new speed is $\sqrt{9}V = 3V$.

Q73.

Answer: 2

Explanation:

Since $eV_s = \frac{hc}{\lambda} - \phi$, the work function cancels in the difference:
$$\Delta V = \frac{hc}{e} \left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1} \right) = 1240 \times \left(\frac{1}{310} - \frac{1}{620} \right) = 2 \text{ V}.$$

Q74.

Answer: 27

Explanation:

The saturation photocurrent is proportional to the light intensity at the cathode, and intensity from a point source obeys the inverse square law, so $i_2 = i_1 \left(\frac{d_1}{d_2} \right)^2 = 3 \times \left(\frac{6}{2} \right)^2 = 27$ units.

Q75.

Answer: 2

Explanation:

The photon energy is $E = \frac{hc}{\lambda} = \frac{1240 \text{ eV}\cdot\text{nm}}{310 \text{ nm}} = 4.0 \text{ eV}$, so the maximum kinetic energy is $K_{max} = E - \phi = 4.0 - 2.0 = 2 \text{ eV}$.