Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	B	D
2.	A	B	B
3.	A	B	C
4.	D	C	B
5.	B	A	A
6.	C	C	B
7.	A	A	C
8.	B	C	C
9.	B	A	B
10.	A	B	A
11.	C	B	D
12.	C	B	D
13.	B	A	A
14.	B	B	D
15.	C	D	D
16.	A	B	B
17.	B	B	D
18.	B	C	B
19.	B	C	C
20.	A	B	A
21.	B	A	A
22.	B	D	D
23.	C	A	C
24.	C	B	D
25.	B	B	A
26.	C	B	D
27.	A	B	C
28.	C	D	B
29.	B	B	C
30.	B	A	D

1. $\omega L = 1/\omega c$ (for resonance)
$\omega^2 = 1/LC$ . . . (i)
for case (ii)
$(2\omega)^2 = 1/LC_1$ . . . (ii)
(ii) divide (i) $\Rightarrow 4 = C/C_1$
$\Rightarrow \; C_1 = C/4$.
The capacitance is to be reduced by 75%.

2. The velocity of P along AP equals that of A along AP.

3. $$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{3R} + \frac{1}{3R} = \frac{1}{R} + \frac{2}{3R}$$
$$= \frac{3+2}{3R} = \frac{5}{3R}$$
$$\therefore \; R_{eq} = \frac{3}{5}R$$

4. flux = $\frac{1}{2}\left(\frac{q}{24\varepsilon_0}\right)$

5. Charge on the outside surface of conducting sphere is zero so field or potential at any point outside the sphere is zero.

6. At time t = 0, the inductor will show infinite resistance, so the current will be zero. Hence emf across L is ε with A at higher potential.

7. Force by liquid = Mg
$\Rightarrow \; \rho(Av)v = Mg$
But $Av = 1 \times 10^{-3}$ m^3/s and
$$v = \sqrt{(20)^2 - 2\times10\times5} = 10 \text{ m/s}$$
$\therefore$ M = 1 kg

9. The motion of the particle within the tunnel is simple harmonic.

10. Total mechanical energy = gravitational P.E. + K.E., total mechanical energy is conserved.

11. $dQ = n\left(\frac{\gamma R}{\gamma - 1}\right)dT$, $dU = \frac{nR}{\gamma - 1}dT$
$dW = nRdT$
dQ : dW : dU
$\Rightarrow \; \gamma : \gamma - 1 : 1$

12. Using equation of Trajectory, we get
$u = 15\sqrt{2}$ m/s

14. From the free body diagram, we get,
$N = mg\cos\alpha + ma_0\cos\alpha$
$Mg\sin\alpha + ma_0\sin\alpha = ma$

$a = (a_0 + g)\sin\alpha$

$$L = \frac{1}{2}(a_0 + g)\sin\alpha t^2$$

$$t = \sqrt{\frac{2L}{(a_0 + g)\sin\alpha}}$$

15. $F\cos\theta = \mu N$ .....(A)

$N = F\sin\theta + mg$ .....(B)

By (A) and (B)

$F\cos\theta = \mu(F\sin\theta + mg)$

$F\cos\theta - \mu F\sin\theta = \mu mg$

$F(\cos\theta - \mu\sin\theta) = \mu mg$

if F is ∞. Hence $\cos\theta - \mu\sin\theta = 0$

$\cos\theta - \mu\sin\theta = 0 \Rightarrow \cot\theta = \mu$

$\Rightarrow \theta = \cot^{-1}(\mu)$

16. B at all the point lying on OP is zero so u will not be affected by the magnetic force. Hence K.E. will remain unchanged.

17. We write Einstein's equation for the photoelectric effect,

$hf - W = E_K$ ...(i)

$3hf - W = E'_K$ ...(ii)

from (i) and (ii), we get,

$E'_K - 3E_K = 2W > 0$.

18. $Q = C^2\left[m_{nuc}\left({}^{A}_{Z}X\right) - m_{nuc}\left({}^{A}_{Z-1}Y\right) - m_{e^+}\right]$ by definition.

Putting,

$m_{nuc}\left({}^{A}_{Z}X\right) = m\left({}^{A}_{Z}X\right) - Zm_e$

and similarly for ${}^{A}_{Z-1}Y$,

we get the final result.

19. Since rays are bending toward the normal $\Rightarrow \mu_2 > \mu_1$.

21. Stress = Y × strain

force $F = Y\left(\frac{A\Delta\ell}{\ell}\right)$

$\Rightarrow F = \pi r^2 Y\left(\frac{A\Delta\ell}{\ell}\right)$

22. $\ell_2 - \ell_1 = (\ell'_0 - \ell_0) + t(\ell'_0\alpha_2 - \ell_0\alpha_1)$

By the condition given in the question,

$\ell_2 - \ell_1 = \ell'_0 - \ell_0$

$\therefore t(\ell'_0\alpha_2 - \ell_0\alpha_1) = 0$

$\ell'_0 = 60$ cm

23. $f_{max} = md\omega_{0_{max}}^2$

$$\omega_{0_{max}} = \sqrt{\frac{\mu mg}{md}} = \sqrt{\frac{\mu g}{d}}$$

24. $y = x$

$PE = \frac{1}{2}m\omega^2 y^2$

$KE = \frac{1}{2}m\omega^2(a^2 - y^2)$

TE = PE + KE

$= \frac{1}{2}m\omega^2 a^2$

25. $\phi = \vec{B}\cdot\vec{A} = BA\cos 60^\circ = \frac{1}{2500}$

$\therefore \quad e = -\frac{d\phi}{dt} = \frac{1}{2500 \times 0.2} = 2 \times 10^{-3}\,V$

26. $T = Kx = m\omega^2 r$

where $r = \ell_0 + x$

$\therefore \quad Kx = m\omega^2(\ell_0 + x)$

$\Rightarrow \quad x = \frac{m\omega^2 \ell_0}{K - m\omega^2}$

$\therefore \quad r = \ell_0 + x = \frac{K\ell_0}{K - m\omega^2}$.

27. $V_{max} = (2\pi f)\,A$

$a_{max} = (2\pi f)^2 A$

$\frac{a_{max}}{V_{max}} = (2\pi f)$.

28. Acceleration $\propto$ - displacement

29. In second harmonic of an organ pipe pressure antinode will be at $\frac{\lambda}{4}$ from the either side of the open organ pipe and $\lambda = L$ (length of the organ pipe).

30. $W_{agent} = \Delta K + \Delta U$

for minimum work done $\Delta K = 0$

$W_{agent} = \Delta U = mgR$

1. $\alpha = 0.08$; So $K_c = \frac{[H_3BO_3 - \text{Glycerine}]}{(H_3BO_3)(\text{Glycerine})} = 0.95 = \frac{0.08}{(0.1 - 0.08)(a - 0.08)}$
So, $a \simeq 4.29$

2. $N = N_o e^{-\lambda t}$, where N = parent remaining (R) and N_o = initial parent = parent remaining (R) + daughter formed (d)
$R = (R + d)e^{-\lambda t}$ or $\ell n\frac{(R+d)}{R} = \lambda t$, $t = \frac{1}{\lambda}\ell n\left(1 + \frac{d}{R}\right)$

3. S.A. and S. base show steeped rise in pH range.

4. $K = \frac{[RNH_3^+][OH^-]}{[RNH_2]}$
$8 \times 10^{-6} = \frac{x \times x}{0.5}, [OH^-] = 2 \times 10^{-3} M$
pOH = 2.7, pH = 14 – 2.7 = 11.3

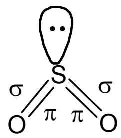
5. For a combine cell E^o_{cell} $E_{cathode} - E_{anode}$

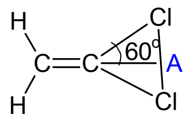
6. $K_4[Fe(CN)_6] \longrightarrow 4K^+ + [Fe(CN)_6]^{-4}$
So, $0.7 = \frac{i-1}{5-1}$ ——

7. Let number of atoms of A used in packing = n
Number of tetrahedral voids = 2n
Number of atoms of B = $\frac{2}{3} \times 2n = \frac{4n}{3}$
Formula of the compound A : B = $n : \frac{4}{3}n$ = 3 : 4
Formula of compound = A_3B_4

8. Weight of Ag deposited = $80 \times 5 \times 10^{-4} \times 10.8$ = 0.432 g
$t = \frac{0.432 \times 96500}{108 \times 4}$ = 96.5 S

9. $T^{\gamma}P^{1-\gamma} = \text{constant}$
So for monoatomic gas $\gamma = 1.66$ and $(300)^{1.66}(200)^{0.66} = (90)^{1.66}(10)^{0.66}$

10. 

11. 

Cl – A sin60° = 2.35 × 0.866

= 2.035 Å

Distance = 2.035 × 2 = 4.07×10^{-8} cm

12. $Mn(Co)_5 + e^- \longrightarrow Mn(Co)_5^-$

less stable EAN = 36

13. Addition of H_2O occurs according to Markonikov's rule.

$$CH_3-\underset{}{\overset{CH_3}{\overset{|}{C}}}=CH_2 + H_2O \xrightarrow{H^+} CH_3-\underset{\underset{CH_3}{|}}{\overset{CH_3}{\overset{|}{C}}}-OH$$

Hence, **(A)** is the correct answer.

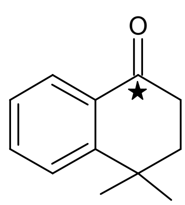
15. $AgNO_3 \xrightarrow{\Delta} Ag + NO_2 + \frac{1}{2}O_2$

$Ag + HNO_3 \longrightarrow AgNO_3$

$NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$

16. Mn, Fe and C

17. As $NaBH_4$ reduces only aldehyde and ketone group.

18. 

∗C will deactivate the benzene ring. So it will direct the upcoming group at meta position.

19. It is planar, cyclic following $(4n)\pi e^-$ **rule**

Hence, n = 2.

20. $-COO^-$ **behaves as a strong base.**

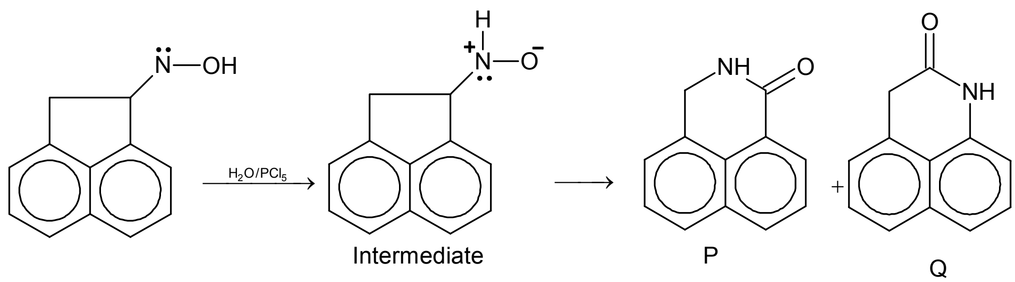
So, pH > 7 for this Zwitter ion.

21. Small surface area of conjugate base of 'A' greater acidic.

22. **As form 2 is more stable than form 1. So, concentration of 2 is greater than concentration of 1. Due to hydrogen bonding.**

23. In this reaction nitrine intermediate is not formed.

24.



6 membered ring is none stable.

25. As 2^o amine is more basic than 1^o and the N of pyridine is highly crowded so the H^+ will attack on position 2 as compare to 1 and H_2N group of 3 position is involved in conjugation.

26. CH_2^+ form after removal of Cl^- is more stabilized.

27. Cations with pseudo noble gas configuration possess more covalent character than noble gas configuration according to Fajan's Rule.
Also, smaller is size of cation more is covalent character according to Fajan's Rule.

30. Conductivity of Na_2SO_4 = 2. 6 × 10^{-4}

$\Lambda_m(Na_2SO_4) \equiv \frac{2.6\times10^{-4}\times1000}{0.001} = 260\ S\ cm^2\ mol^{-1}$

$\Lambda_{SO_4^{-2}} = \Lambda_m(Na_2SO_4) - 2\lambda_m(Na^+) = 260 - 2\times50 = 160\ S\ cm^2\ mol^{-1}$

Conductivity of $CaSO_4$ solution = 7 × 10^{-4} – 2.6 × 10^{-4}
= 4.4 × 10^{-4} S cm^{-1}

$\Lambda_m CaSO_4 = \lambda_m(Ca^{+2}) + \lambda_m(SO_4^{-2})$

= 120 + 160 = 280 S cm^2 $mole^{-1}$

Solubility $C \equiv \frac{1000\times K}{\Lambda_m} \equiv \frac{1000\times4.4\times10^{-4}}{280}$

$C \equiv 1.57\times10^{-3}$ M

$[Ca^{+2}] = 1.57\times10^{-3}$ M

$[SO_4^{-2}] \approx 2.57\times10^{-3}$

$K_{sp} = [Ca^{+2}][SO_4^{-2}]$

= 1.57 × 10^{-3} × 2.57 × 10^{-3}

$\approx 4\times10^{-6}$

2. $\log_2\left(1+\sqrt{6x-x^2-8}\right) \geq 0$

$\Rightarrow 1+\sqrt{6x-x^2-8} \geq 1 \Rightarrow 6x - x^2 - 8 \geq 0$

$\Rightarrow x^2 - 6x + 8 \leq 0$

$\Rightarrow (x-2)(x-4) \leq 0$

$\Rightarrow 2 \leq x \leq 4.$

Now $f'(x) = x^2 + 2x + 2 > 0 \ \forall\ x \in R$

$\Rightarrow$ f(x) is strictly increasing in [2, 4]

$f(x) = \frac{x^3}{3} + x^2 + 2x$

$\alpha = f(2) = \frac{8}{3} + 4 + 4 = \frac{32}{3}$

$\beta = f(4) = \frac{64}{3} + 16 + 8 = \frac{136}{3}$

$|\alpha - \beta|\text{max} = \frac{104}{3}.$

3. Given inequation is $(a-1)x^2 - (a+1)x + a - 1 \geq 0$

$a(x^2 - x + 1) - (x^2 + x + 1) \geq 0$

$\Rightarrow a \geq \frac{x^2+x+1}{x^2-x+1} = 1 + \frac{2x}{x^2-x+1} = 1 + \frac{2}{x+\frac{1}{x}-1}$ …(1)

let $y = x + \frac{1}{x}$

y is increasing in $[2, \infty)$

$\Rightarrow 1 + \frac{2}{x+\frac{1}{x}-1} \in \left(1, \frac{7}{3}\right]$

for all $x \geq 2$ (1) should be true

$\Rightarrow a \geq \frac{7}{3}.$

4. $A = \begin{bmatrix} 5 & -2 \\ -7 & 5 \end{bmatrix}\begin{bmatrix} 2 & -1 \\ 0 & 4 \end{bmatrix}\begin{bmatrix} 1 & -1 \\ 2 & -1 \end{bmatrix} = \begin{bmatrix} -16 & 3 \\ 24 & -5 \end{bmatrix}$

5. $E_1 \Rightarrow$ Person is accident person

$E_2 \Rightarrow$ Person is not accident person

A = person will have an accident with in a year

$P(A) = P(E_1)\,P(A/E_1) + P(E_2)P(A/E_2) = 0.3 \times 0.6 + 0.7 \times 0.8 = 0.74$

6. Normal vector to plane P_1 $3\hat{k}$

Normal vector to plane P_2 $2\hat{i} - 4\hat{j} - 3\hat{k}$

$\vec{a} = \lambda\left(2\hat{i} + \hat{j}\right)$

angle between $\vec{a}$ and vector $\hat{i} - 2\hat{j} + 2\hat{k}$ is given by

$\cos\theta = \dfrac{\lambda(2\hat{i}+\hat{j})\cdot(\hat{i}-2\hat{j}+2\hat{k})}{\lambda\sqrt{5}\sqrt{9}} = 0$

$\Rightarrow \theta = \dfrac{\pi}{2}$.

7. Let $\dfrac{1}{H_{i+1}} - \dfrac{1}{H_i} = k$

$\sum_{i=1}^{2n}(-1)^i\left(\dfrac{H_i+H_{i+1}}{H_i-H_{i+1}}\right) = \sum_{i=1}^{2n}\dfrac{(-1)^i}{k}\left(\dfrac{1}{H_{i+1}}+\dfrac{1}{H_i}\right) = 2n$

8. Given that $X = AB + BA \Rightarrow X = X^T$
and $Y = AB - BA \Rightarrow Y = -Y^T$
Now $(XY)^T = Y^TX^T = -YX$.

9. We have $(2+\sqrt{5})^p + (2-\sqrt{5})^p$
$= 2[2^p + {}^pC_2\, 2^{p-2}\, 5 + {}^pC_4\, 2^{p-4}\, 5^2 + \ldots + {}^pC_{p-1}\, 2\,.\, 5^{(p-1)/2}]$ …(1)
From (1), $(2+\sqrt{5})^p + (2-\sqrt{5})^p$ is an integer and $-1 < (2-\sqrt{5})^p < 0$
(as p is odd), so $\left[(2+\sqrt{5})^p\right] = (2+\sqrt{5})^p - (2-\sqrt{5})^p$
$= 2^{p+1} + {}^pC_2\, 2^{p-1}\, 5 + \ldots + {}^pC_{p-1}\, 2^2\, 5^{(p-1)/2}$
$\therefore \left[(2+\sqrt{5})^p\right] - 2^{p+1} = 2[{}^pC_2\, 2^{p-2}\, 5 + {}^pC_4\, 2^{p-4}\, 5^2 + \ldots + {}^pC_{p-1}\, 2\,.\, 5^{(p-1)/2}]$.
Now all the binomial coefficients ${}^pC_2 = \dfrac{p(p-1)}{1\cdot 2}$, ${}^pC_4 = \dfrac{p(p-1)(p-2)(p-3)}{1\cdot 2\cdot 3\cdot 4}$, …, ${}^pC_{p-1} = p$
are divisible by the prime p. Thus R.H.S is divisible by p.

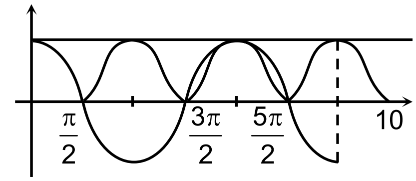
10. Given determinant $\Rightarrow 2a(bc - 4a^2) + b(2ac - b^2) + c(2ab - c^2) = 0$
$\Rightarrow 6abc - 8a^3 - b^3 - c^3 = 0$
$\Rightarrow (2a + b + c)[(2a - b)^2 + (b - c)^2 + (c - 2a)^2] = 0$
$\Rightarrow 2a + b + c = 0$ (as $b \neq c$)
Let $f(x) = 8ax^3 + 2bx^2 + cx$
$f(0) = 0$
$f\left(\dfrac{1}{2}\right) = a + \dfrac{b}{2} + \dfrac{c}{2} = \dfrac{2a+b+c}{2} = 0$.
So, f (x) satisfies the Rolle's Theorem condition so, $f'(x) = 0$ has atleast one root in $\left[0, \dfrac{1}{2}\right]$.

12. $-1 \le x^2 - 10x + 26 \le 1 \Rightarrow x = 5$ only and at x = 5
$\dfrac{\pi}{2} = 0$ which not possible. Hence $a \in \phi$.

13. $z = \begin{vmatrix} \omega & \omega^2 & \omega \\ 2i & -3i & 7i \\ \omega^2 & \omega & \omega^2 \end{vmatrix}$ $R_1 \to (R_1 + R_3)$ $= \begin{vmatrix} -1 & -1 & -1 \\ 2i & -3i & 7i \\ \omega^2 & \omega & \omega^2 \end{vmatrix}$
$= -1(-3\omega^2 i - 7\omega i) + (2\omega^2 i - 7\omega^2 i) \Rightarrow -1(2\omega i + 3\omega^2 i) = 5i(\omega - \omega^2) = -5\sqrt{2}$

14. According to Rolls theorem $f'(x) = 0$

Atleast one $x \in \left(\frac{\pi}{2}, \frac{3\pi}{2}\right) \cup \left(\frac{3\pi}{2}, \frac{5\pi}{2}\right)$

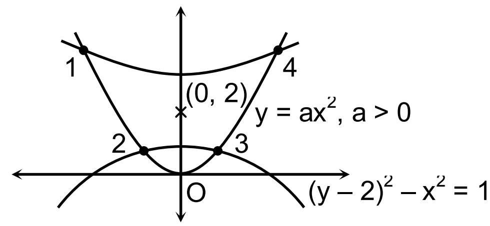


15. for $5 \le f(a) < 6$ x $[f(x)] = 5$

Hence cont. at x = a

16. $(y-2)^2 - x^2 - 1$

$y = ax^2$



17. $f'(x) = 6x^2 + 2\alpha x + \beta$

$3 \cdot 3^t = -\frac{2\alpha}{6} = -\frac{\alpha}{3}$

$3^{(t+1)} = -\frac{\alpha}{3}$

$f''(x) = 12x + 2\alpha = 0$ at $x = \frac{5}{2}$

$\Rightarrow -\alpha = \frac{12 \cdot (5/2)}{2} = 15$

$\Rightarrow 3^{(t+1)} = 5 \Rightarrow (t+1) = \log_3 5$

$\Rightarrow t = \log_3\left(\frac{5}{3}\right)$

18. Let $S = \sum_{n=2}^{\infty} \log_2\left(1 - \frac{1}{n^2}\right) = \sum_{n=2}^{\infty}\left(\log_2\left(1-\frac{1}{n}\right) + \log_2\left(1+\frac{1}{n}\right)\right) = \sum_{n=2}^{\infty}\left(\log_2\left(\frac{n-1}{n}\right) - \log_2\left(\frac{n}{n+1}\right)\right)$

Let $V_r = \log_2\left(\frac{r-1}{r}\right) \Rightarrow V_{r+1} = \log_2\left(\frac{r}{r+1}\right)$

$\Rightarrow S = \sum_{r=2}^{\infty}(V_r - V_{r+1}) = V_2 = \log_2\left(\frac{1}{2}\right) = -1$

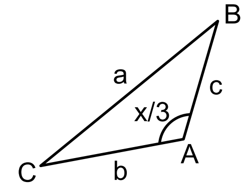
19. $\int_0^2 f'(2t)e^{f(2t)}dt = 5 \Rightarrow e^{f(4)} - e^{f(0)} = 10 \Rightarrow f(4) = \ln 11$.

20. a + b = 20, a + c = 21

$\cos A = \left(\frac{b^2 + c^2 - a^2}{2bc}\right)$

$\Rightarrow 2a^2 - 123a + 1261 = 0$

$\Rightarrow a = 13$



21. $f'(x) = \log_{|\sin x|}\left(\sin x + \frac{1}{2}\right)$

$\Rightarrow\ 0 < \sin x + \frac{1}{2} < 1 \Rightarrow\ x \in \left(0,\ \frac{\pi}{6}\right) \cup \left(\frac{5\pi}{6},\ \frac{7\pi}{6}\right) \cup \left(\frac{11\pi}{6},\ 2\pi\right)$

22. Sum of all possible $a_i = \sum_{r=2}^{n-2} r \cdot \left({}^{n-r}C_2\right) = {}^{n+1}C_4$

23. Let X = x – 3, Y = y – 1
$\Rightarrow$ |X + Y| = 5, |X| + |Y| = 5
$\Rightarrow$ |X + Y| = |X| + |Y| $\Rightarrow$ X.Y $\geq$ 0
Hence number of points are 8

24. $f(x, y) = 2y^2(x + 2)^2 + (x – 1)^2 + 3$
$\Rightarrow$ least f(x, y) = 3 for x = 1 and y = 0

25. $9x^2 – 12x + n – \frac{8}{x} + \frac{4}{x^2}$ is perfect square

$\Rightarrow \left(3x + \frac{2}{x}\right)^2 - 4\left(3x + \frac{2}{x}\right) + (n - 12)$ is perfect square

$\Rightarrow$ n – 12 = 4 $\Rightarrow$ n = 16

26. a, b are odd integers

$\Rightarrow \prod_{i=1}^{10} \alpha_i = b\ \in$ odd integers $\Rightarrow \alpha_i$ = odd integer

$\Rightarrow \sum \alpha_i$ = even integer $\neq$ – a

Hence $\alpha_i \notin I$

27. D.R's of normal to plane x + y + z – 1 = 0 and x + ky + 3z – 1 = 0 is (1, 1, 1) and (1, k, 3) respectively
$\Rightarrow$ D.R. of normal to a plane perpendicular to given planes

$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ 1 & k & 3 \end{vmatrix} = \hat{i}(3-k) - \hat{j}(2) + \hat{k}(k-1)$

$\Rightarrow \frac{1+2\lambda}{3-k} = \frac{2+\lambda}{-2} = \frac{1+3\lambda}{k-1} \Rightarrow –2 – 4\lambda = 6 + 3\lambda – 2k – \lambda k$ and $–2 – 6\lambda = –2 – \lambda + 2k + \lambda k$

$–4 – 10\lambda = 4 + 2\lambda \Rightarrow 12\lambda = –8 \Rightarrow \lambda = -\frac{2}{3}$

$\Rightarrow\ -2 + \frac{8}{3} = 6 - 2 - 2k + 2 - k = 3\ \Rightarrow\ \frac{2}{3} - 4 = -\frac{4}{3}k\ \Rightarrow\ -\frac{10}{3} = -\frac{4}{3}k\ \Rightarrow k = \frac{5}{2}$

28. $x^n + \alpha x + \beta = (x - \alpha_1)^2 (x - \alpha_2).....(x - \alpha_{n-1})$

$\Rightarrow \frac{x^n + \alpha x + \beta}{(x - \alpha_1)^2} = (x - \alpha_2)(x - \alpha_3).....(x - \alpha_{n-1})$

$$\Rightarrow (\alpha_1-\alpha_2)(\alpha_1-\alpha_3).....(\alpha_1-\alpha_{n-1}) = \lim_{x\to\alpha_1}\left(\frac{x^n+\alpha x+\beta}{(a-\alpha_1)^2}\right) = \frac{n(n-1)}{2}\cdot\alpha_1^{n-2}$$

29. Favourable cases

X	Y
GGGGG	BBB
BBBGG	GGG

$\Rightarrow$ Required probability = $\frac{{}^5C_5}{{}^8C_5}+\frac{{}^5C_3}{{}^8C_3}=\frac{11}{56}$

30. $f(\pi) = 4 - \pi$