ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

DISTANCE LEARNING PROGRAMME
(Academic Session : 2024 - 2025)

JEE (Main)
UNIT TEST # 10
22-12-2024

JEE(Main) : LEADER TEST SERIES / JOINT PACKAGE COURSE

ANSWER KEY

PART-1 : PHYSICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	B	C	D	B	C	A	B	C	B	D
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	D	A	C	A	C	B	C	B	B	C
SECTION-II	Q.	1	2	3	4	5					
	A.	14	100	10	20	7					

PART-2 : CHEMISTRY

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	C	D	B	A	B	C	D	A	C	D
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	A	D	D	C	A	D	B	B	B	D
SECTION-II	Q.	1	2	3	4	5					
	A.	4	5	3	4	5					

PART-3 : MATHEMATICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	A	C	A	C	C	B	D	C	C	A
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	B	A	D	A	C	A	A	C	C	B
SECTION-II	Q.	1	2	3	4	5					
	A.	5	7	105	1	1					

HINT – SHEET

PART-1 : PHYSICS

SECTION-I

2. Ans (C)

Check truth table

X	Y	R
0	1	0
1	1	0
1	0	1
0	0	0

3. Ans (D)

From the figure, all four gate is NOR gate

A	B	$(y_1 = \overline{A+B})$	$(y^n = \overline{A+y^1})$	$y^m = \overline{(B+y^1)}$	$y = \overline{y^n + y^m}$
0	0	1	0	0	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

So

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

4. Ans (B)

Forbidden energy gap in conductors is least and that in insulators in very large.

5. Ans (C)

$\sigma = ne(\mu_e + \mu_h)$

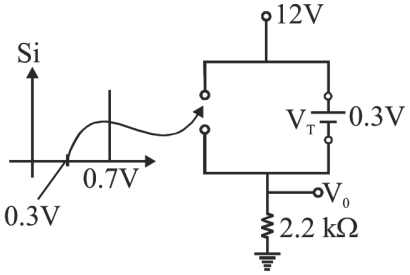
$\sigma = 1.6 \times 10^{-19} \times (1.072 \times 10^{10})$

$\times [1350 + 480]$

$= 3.14 \times 10^{-6}$ mho/cm

6. Ans (A)

In the circuit the direction of conventional current will be same as the arrow head of diodes; hence it may appear that both the diodes are in "on" state. Voltage drop across the silicon diode is 0.7V and germanium diode is 0.3V. In a parallel branches potential difference across each branch must be same. Here 0.7V drop across silicon diode does not match that of 0.3V across germanium diode. This complexity is voltage increases form 0 to 12V in a time of the order of millisecond. As soon as the voltage across the germanium diode reaches 0.3V, it is in "on" stage and it maintains a level of 0.3V. The voltage drop across silicon diode never reaches 0.7V; hence it remains in its open circuit state. The resulting circuit is shown in figure.



$V_0 = 12 - 0.3 = 11.7\,V$

7. Ans (B)

D_1 - Reverse bias

D_2 - Reverse bias

D_3 - Forwards bias

$V = iR$

$1.5 = 21 \times i$

$i = \frac{1.5}{21}$ Amp.

9. Ans (B)

$V_{rms} = \frac{V_0}{2} = \frac{200}{2} = 100V$

10. Ans (D)

Intensity reduced, current reduced, frequency increased, stopping potential increased.

11. Ans (D)

as $\longrightarrow \boxed{TE = \frac{1}{2}kA^2}$

12. Ans (A)

From given figure

$A\omega = 0.4$

$\omega = \frac{0.4}{10} \times 100 = 4$

$\Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{4} = \frac{\pi}{2}$

13. Ans (C)

For A if spring const = K for B if spring const

for each = 3K.

$T_A = 2\pi\sqrt{\frac{m}{k}}$ Keq = 9K

so $T_B = 2\pi\sqrt{\frac{m}{9k}}$

$\frac{T_A}{T_B} = \frac{3}{1}$

14. Ans (A)

$y = 1 \sin \omega t + \sqrt{3}\cos\omega t$

$y = 2\sin(\omega t + \frac{\pi}{3})$

For breaking off plank

$\omega_{min} = \sqrt{\frac{g}{a}} = \sqrt{\frac{g}{2}}$

At $t = 0$, $\phi_0 = \frac{\pi}{3}$, It leaves when $\phi = \frac{\pi}{3}$

$\Delta\phi = \frac{\pi}{2} - \frac{\pi}{3} = \frac{\pi}{6}$

$t = \frac{T}{12} = \frac{1}{12} \times 2\pi\sqrt{\frac{2}{g}}$

$= \frac{\sqrt{2}}{6}\frac{\pi}{\sqrt{g}} = \frac{\pi}{6}\sqrt{\frac{2}{g}}$

15. **Ans (C)**

$$\frac{1}{2}kx_0^2 = \frac{1}{2}\frac{mM}{m+M}\omega^2 x_0^2$$

$$\omega = \sqrt{\frac{k(m+M)}{mM}} = \frac{2\pi}{T}$$

$$T = 2\pi\sqrt{\frac{mM}{(m+M)k}}$$

16. **Ans (B)**

Change in surface energy $= 2 \times 10^{-4}$ J

$$\Delta A = 10 \times 6 - 8 \times 3.75 = 30 \text{ cm}^2$$

$$= 30 \times 10^{-4} \text{ m}^2$$

Work done W = T × 2 × (Change in area)

Now, Change in surface energy = Work done

$2 \times 10^{-4} = T \times 2 \times 30 \times 10^{-4}$

$\therefore \quad T = 3.3 \times 10^{-2}$ N/m

17. **Ans (C)**

$$hR = h\frac{r}{\cos\theta} = \text{constant}$$

$$\Rightarrow \frac{h}{\cos\theta} = \text{constant}$$

$$\frac{2}{\cos 0^\circ} = \frac{1}{\cos\theta} \Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = 60^\circ$$

18. **Ans (B)**

$$U = \frac{1}{2}(\text{stress})(\text{Strain})(\text{Volume})$$

$$U = \frac{1}{2}\frac{(\text{Stress})^2}{Y}(\text{Volume})$$

$$\frac{U}{\text{vol.}} = \frac{1}{2}\frac{(\text{Stress})^2}{Y} = \frac{S^2}{2Y}$$

19. **Ans (B)**

$$\Delta\ell = \frac{FL}{AY}$$

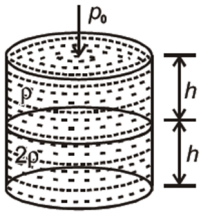
Here $\Delta\ell$, F,L are same

$$A \propto \frac{1}{Y}$$

$$\therefore \frac{R_B^2}{R_S^2} = \frac{Y_S}{Y_B} = \frac{2 \times 10^{10}}{10^{10}} = 2$$

$$R_B = \sqrt{2}R_S \text{ or } R_S = \frac{R_B}{\sqrt{2}}$$

20. **Ans (C)**



Pressure at bottom

$= P_0 + \rho hg + 2\rho hg = P_0 + 3\rho hg$

PART-1 : PHYSICS

SECTION-II

1. **Ans (14)**

$\text{Speed}_{max} = 7 \times 10^5$ m/s

kinetic energy of

$$e^- = \frac{1}{2}mv^2 = \frac{1}{2}m \times (7 \times 10^5)^2$$

$$= \frac{1}{2} \times 9.1 \times 10^{-31} \times 49 \times 10^{10}$$

$$= 9.1 \times 10^{-21} \times 49 \times 0.5 \text{ J}$$

Given incident frequency $= 8 \times 10^{14}$ Hz

$\therefore$ From photoelectric equation $k_{max} = h\nu - h\nu_0$

$\Rightarrow \quad h\nu_0 = h\nu - k_{max}$

$$= 6.6 \times 10^{-34} \times 8 \times 10^{14} - 91 \times 49 \times 5 \times 10^{-23}$$

$$= [6.6 \times 8 \times 10^{-20} - 91 \times 49 \times 5 \times 10^{-23}]$$

$$= 10^{-21}[66 \times 8 - 91 \times 49 \times 5 \times 10^{-2}]$$

$$= [528 - 223] \times 10^{-21} = 6.6 \times 10^{-34}\ \nu_0$$

$$\nu_0 = \frac{305}{6.6} \times 10^{-21} \times 10^{34} = \frac{30.5}{6.6} \times 10^{14} = \nu_0$$

$\Rightarrow 4.64 \times 10^{14}$ Hz

2. **Ans (100)**

The equation is

$$O^{17} \longrightarrow {}_0n^1 + O^{16}$$

$\therefore$ Energy required

= B.E of O^{17} – B.E of O^{16}

$= 17 \times 7.75 - 16 \times 7.97$

= 4.23 MeV

3. **Ans (10)**

$$\text{L.C.} = \frac{1\ \mu\ \text{SD}}{n}$$

$$0.005\ \text{cm} = 0.5\ \text{mm} = \frac{0.5\ \text{mm}}{n}$$

$$n = \frac{0.5\ \text{mm}}{0.05\ \text{mm}} = \frac{5 \times 100}{5 \times 10} = 10$$

$$n = 10$$

4. **Ans (20)**

$$\text{Area of tube} = \pi r^2$$

$$\Rightarrow \frac{A_2}{A_1} = \left(\frac{r_2}{r_1}\right)^2 \Rightarrow \left(\frac{r_2}{r_1}\right) = \left(\frac{A}{4A}\right)^{\frac{1}{2}} = \frac{1}{2}$$

$$h \propto \frac{1}{r} \Rightarrow \frac{h_2}{10\text{cm}} = \frac{r_1}{r_2} = 2$$

$$\Rightarrow h_2 = 20\ \text{cm}$$

5. **Ans (7)**

$$F = \eta\ A\ \frac{v}{\ell} = 0.07 \times 0.1 \times \frac{1}{10^{-3}}$$

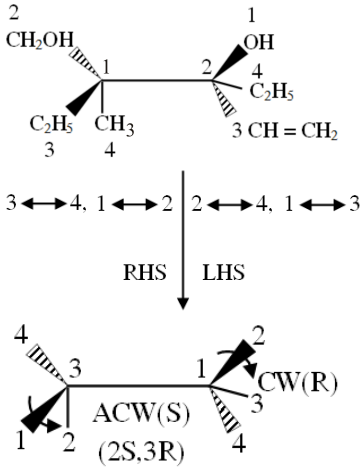
$$= 7N$$

PART-2 : CHEMISTRY

SECTION-I

1. **Ans (C)**

The absolute configuration of the below figure is :

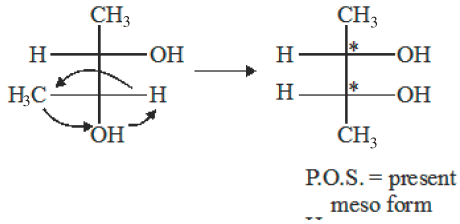


Least prority group always takes at inward the plane.

By even exchange between the groups about chiral carbon then configuration remains same.

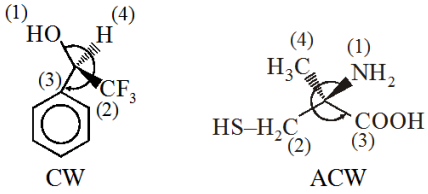
Locant number of chiral carbon decided by IUPAC rule

2. **Ans (D)**



P.O.S. = present
meso form

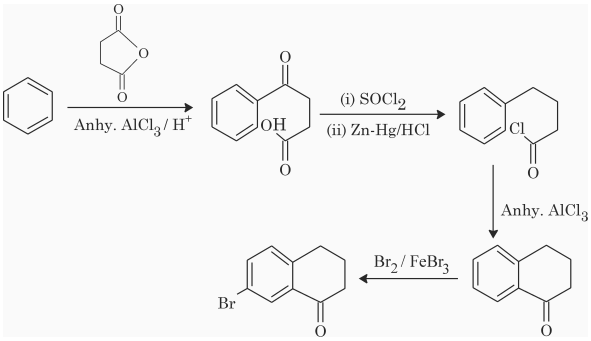
5. **Ans (B)**



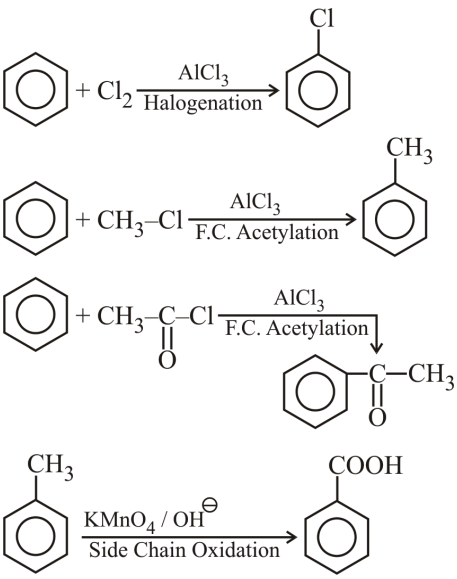
6. **Ans (C)**

Enol content of acetyl acetone is greater than acetone.

7. **Ans (D)**



8. **Ans (A)**



9. **Ans (C)**

P ⇒ Cumene hydroperoxide to phenol.

Q ⇒ Benzene diazonium chloride to benzene.

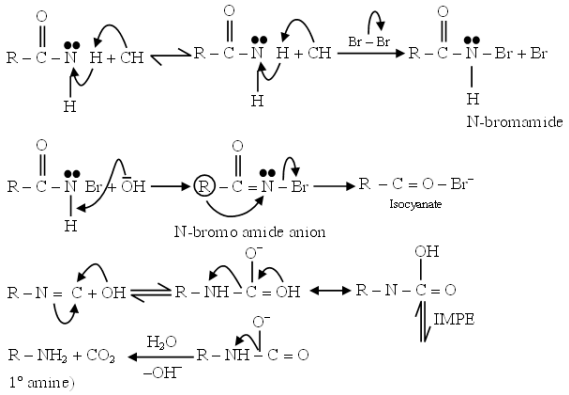
R ⇒ Salicylic acid to benzoic acid.

S ⇒ Paracetyl toluene to ptere phthalic acid.

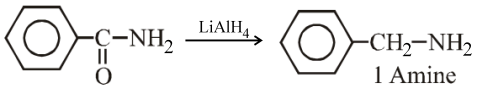
10. **Ans (D)**

This is Hofmann bromanide reaction and $RCONBr_2$ does not form in this reaction. See mechanism for it :

$RCO - NH_2 + Br_2 + 4KOH \longrightarrow R - NH_2 + K_2CO_3 + 2KBr + 2H_2O$



11. **Ans (A)**



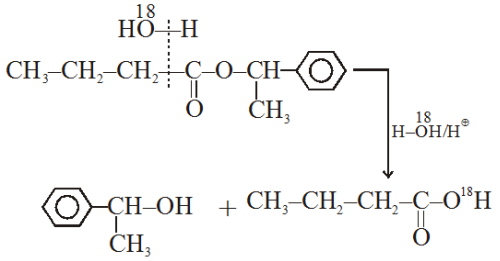
12. **Ans (D)**

Only 1° amine gives Hoffmann bromamide reaction.

17. **Ans (B)**

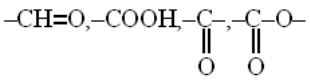
The Carius technique involves heating an organic compound in a sealed tube with silver nitrate in strong nitric acid to determine the quantity of sulphur and halogens present.

19. **Ans (B)**

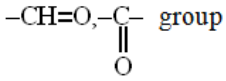


20. **Ans (D)**

$LiAlH_4$ reduced ⟶



$NaBH_4$ reduced ⟶ Only

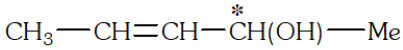


⟶ 4 group ⟶ 2 group

PART-2 : CHEMISTRY

SECTION-II

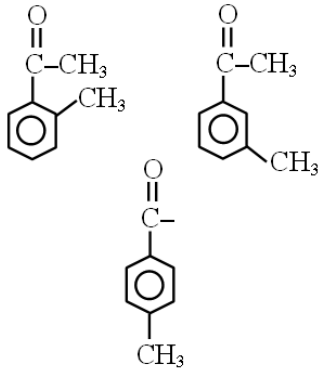
1. **Ans (4)**



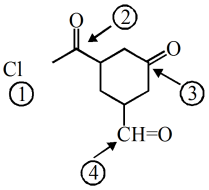
$2^2 = 4$ Stereoisomer.

3. **Ans (3)**

Since A is reacting with 2,4-DNP and showing iodoform reaction, it must be an aromatic methyl ketone.



4. **Ans (4)**



Consumed mole of R.MgX = 4

PART-3 : MATHEMATICS

SECTION-I

2. **Ans (C)**

$A = \{-2, -1, 0, 1, 2\}$

$R = \{(-2, 2) (0, 0) (1, 1), (2, 2)\}$

$n(P(R)) = 2^4 = 16$

3. Ans (A)

Check for reflexivity:

As $3(a-a)+\sqrt{7}=\sqrt{7}$ which belongs to relation so relation is reflexive

Check for symmetric:

Take $a=\frac{\sqrt{7}}{3}, b=0$

Now $(a, b) \in R$ but $(b, a) \notin R$

As $3(b-a)+\sqrt{7}=0$ which is rational so relation is not symmetric.

Check for Transitivity:

Take (a, b) as $\left(\frac{\sqrt{7}}{3}, 1\right)$

& (b, c) as $\left(1, \frac{2\sqrt{7}}{3}\right)$

So now $(a, b) \in R$ & $(b, c) \in R$ but $(a, c) \notin R$ which means relation is not transitive

4. Ans (C)

Given mean $(\bar{x})=\frac{9}{2}$

$$\bar{x}_{new}=\frac{12\times\frac{9}{2}+7+14-9-10}{12}=\frac{14}{3} \quad ..(i)$$

Given, $\sigma^2=4$

$$\sigma^2=\frac{\sum x_i^2}{12}-\left(\frac{9}{2}\right)^2$$

$$4=\frac{\sum x_i^2}{12}-\frac{81}{4}$$

$$\frac{\sum x_i^2}{12}=\frac{97}{4}$$

$$\sum x_i^2=291$$

Now,

$$\sum\left(x_i^2\right)_{new}=291-9^2-10^2+7^2+14^2=355$$

$$\therefore \sigma_{new}^2=\frac{\sum\left(x_i^2\right)_{new}}{12}-(\bar{x}_{new})^2$$

5. Ans (C)

$np=\alpha$ .....(1)

$npq=\alpha/3$ .....(2)

From (1) & (2)

$q=1/3$ & $p=2/3$

$${}^nC_1\, q^{n-1}p^1=\frac{4}{243}$$

$$\frac{n}{3^n}=\frac{2}{243}$$

$n=6$

$$P(4 \text{ or } 5)={}^6C_4\left(\frac{2}{3}\right)^4\left(\frac{1}{3}\right)^2+{}^6C_5\left(\frac{2}{3}\right)^5.\left(\frac{1}{3}\right)^0$$

$$=\frac{16}{27}$$

6. Ans (B)

x_i	f_i	C.F.	$\lvert d_i = x_i - M \rvert$	$f_i \lvert d_i \rvert$
3	8	8	14	12
9	10	18	8	80
17	12	30	0	0
23	9	39	6	54
27	5	44	10	50

$\sum f_i|d_i| = 296$

median = 17

$$\text{M.D.}=\frac{\sum f_i|d_i|}{\sum f_i}=\frac{296}{44}$$

7. Ans (D)

Let the other two numbers be x and y.

According to the question.

$\text{Mean} = \dfrac{-1+1+2+x+y}{5} = 0$

$\Rightarrow x + y = -2$ .....(i)

Also, $\sigma^2 = 2$

$\Rightarrow \dfrac{(-1-0)^2+(1-0)^2+(2-0)^2+(x-0)^2+(y-0)^2}{5} = 2$

$\Rightarrow 1 + 1 + 4 + x^2 + y^2 = 10$

$\Rightarrow x^2 + y^2 = 4$ ....(ii)

$\Rightarrow (x + y)^2 - 2xy = 4$

$\Rightarrow 4 - 2xy = 4$

$\Rightarrow xy = 0$ .....(iii)

Now, $(x - y)^2 = x^2 + y^2 - 2xy = 4 - 0 = 4$

{using (ii) and (iii)} .....(iv)

$\Rightarrow x - y = \pm 2$

Solving (i) and (iv), we get

If $x - y = 2$, $x = 0$, $y = -2$

If $x - y = -2$, $x = -2$, $y = 0$

So, the other two numbers are -2, 0

8. Ans (C)

Standard deviation of ungrouped data, $\sigma = \sqrt{\dfrac{\sum (x_i - \bar{x})^2}{n}}$

Here,

$\bar{x} = \dfrac{12+23+34+45+56+67+78}{7} = \dfrac{315}{7} = 45$

$\sum_{i=1}^{7} (x_i - \bar{x})^2 = (12-45)^2 + (23-45)^2 + (34-45)^2 +$

$(45-45)^2 + (56-45)^2 + (67-45)^2 + (78-45)^2$

$= 1089 + 484 + 121 + 0 + 121 + 484 + 1089 = 3388$

$\therefore \sigma = \sqrt{\dfrac{3388}{7}} = \sqrt{484} = 22$

11. Ans (B)

Each ball can be placed in 5 ways

$\therefore$ Total no of ways $= 5^5$

2 empty boxes can be selected in 5_{C_2} ways and 5 balls can be placed in the remaining 3 boxes in group of 2,2,1 or 3,1,1 in

$3!\left[\dfrac{5!}{2!2!2!} + \dfrac{5!}{3!2!}\right] = 150$ ways

$\therefore$ favourable cases $= 5_{C_2}.150$

$\therefore P = \dfrac{5_{C_2}.150}{5^5} = \dfrac{12}{25}$

12. Ans (A)

${}_9C^3 \left(\dfrac{1}{6}\right)^3 \left(\dfrac{5}{6}\right)^6 \times \left(\dfrac{1}{6}\right)$

$= \dfrac{84 \times 5^6}{6^{10}}$

13. Ans (D)

Required probability

$\Rightarrow P = \dfrac{\frac{1}{3} \times \frac{1}{5}}{\frac{1}{3} \times \frac{1}{5} + \frac{1}{3} \times \frac{1}{6} + \frac{1}{3} + \frac{1}{7}} = \dfrac{42}{107}$

14. Ans (A)

Total ways $= {}^{10}C_3$

Fav. cases $= {}^{8}C_3$

$P = \dfrac{{}^{8}C_3}{{}^{10}C_3} = \dfrac{7}{15}$

15. Ans (C)

Digits = 3, 3, 4, 4, 4, 5, 5

Total 7 digit numbers $= \dfrac{7!}{2!\,2!\,3!}$

Number of 7 digit number divisible by 2

$\Rightarrow$ last digit = 4

						4

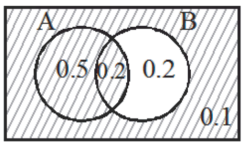
3 , 3 , 4 , 4 , 5 , 5

Now 7 digit numbers which are divisible by 2

$= \dfrac{6!}{2!\,2!\,2!}$

Required probability $= \dfrac{\frac{6!}{2!\,2!\,2!}}{\frac{7!}{3!\,2!\,2!}} = \dfrac{3}{7}$

16. Ans (A)



$P(A \cup B^c)$ = Total case

= stirded region

So, $P\left[\frac{B}{A \cup B^c}\right] = \frac{0.2}{0.8} = \frac{1}{4}$

17. Ans (A)

$P(A_F) = \frac{1}{5}, P(B_F) = \frac{3}{10}$

$P(A_F \cup B_F) = P(A_F) + (B_F) - P(A_F \cap B_F)$

$= \frac{1}{5} + \frac{3}{10} - \frac{1}{5} \times \frac{3}{10} = \frac{10+15-3}{50}$

$= \frac{22}{50} = \frac{11}{25}$

18. Ans (C)

Total ways = $\frac{16!}{(2!)^8 8!}$

Number of ways in which P_4 and P_9 are in same groups = $\frac{14!}{(2!)^7 7!}$

Number of ways in which they are in different groups = $\frac{16!}{(2!)^8 8!} - \frac{14!}{(2!)^7 7!}$

$= \frac{14!}{(2)^7 7!}\left(\frac{15.16}{2.(8)} - 1\right) = \frac{14.14!}{(2)^7 7!}$

Probability = $\frac{\frac{14.14!}{(2)^7.7!}}{\frac{16!}{(2)^8.8!}} = \frac{14.8.2}{15.16} = \frac{14}{15}$

19. Ans (C)

Total case

= (5, 1) (5, 2) (5, 3) (5, 4) (5, 5) (5, 6) = 6

Favorable case = (5, 4) = 1

Required probability = $\frac{1}{6}$

20. Ans (B)

$P(B_1) = \frac{1}{2}$; $P(B_2) = \frac{1}{3}$ & $P(B_3) = \frac{1}{6}$

$P(B_2/P) = \frac{P(B_2)P(P/B_2)}{P(B_1)P(P/B_1) + P(B_2)P(P/B_2) + P(B_3)P(P/B_3)}$

$= \frac{\frac{1}{3} \times \frac{2}{5}}{\left(\frac{1}{2} \times \frac{1}{3} + \frac{1}{3} \times \frac{2}{5} + \frac{1}{6} \times \frac{3}{7}\right)} = \frac{14}{39}$

PART-3 : MATHEMATICS

SECTION-II

1. Ans (5)

The smallest equivalence relation is the identify relation

$R_1 = \{(a, a), (b, b), (c, c)\}$

Then, two ordered pairs of two distinct elements can be added to give three more equivalence relations

$R_2 = \{(a, a), (b, b), (c, c), (a, b) (b, a)\}$

Similarly R_3 and R_4.

Finally, the largest equivalence relation, that is the universal

$R_5 = \{(a, a), (b, b), (c, c), (a, b),(b, a),(a, c),(c, a), (b, c), (c, b)\}$

2. Ans (7)

For reflexive

(1,1), (2,2), (3,3) to be add

For symmetric

(2,1), (3,2) to be add

for transitive (1,3) to be add

& again for symmetry (3,1) to be add

3. Ans (105)

$\uparrow\mu_1\uparrow\mu_2\uparrow\mu_3\uparrow\mu_4\uparrow\mu_5\uparrow\mu_6\uparrow\ {}^7C_3 \times 3 = 105$

4. Ans (1)

Exhaustive cases = 26, 34, 43, 62 = 4

Favorable cases = 34, 43 = 2

$\therefore$ Required probability = $\frac{1}{2}$

5. Ans (1)

$P(2, 4, 5) = \frac{3}{6} = \frac{1}{2}$

P(at must 15 success) = P(0 to 15 times success)

= (16 to 31 times success) = $\frac{1}{2} = 0.5$