Name of Student	**Roll No.**

Problem 1 — 20 marks

Free radicals

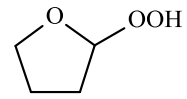
1.1 c) **X**

1.2 b) **X**

1.3 C_1: C_2 = 1: 3.85 or 7: 27 or 0.259: 1

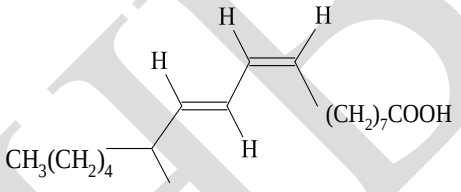
1.4 d) **X**

1.5

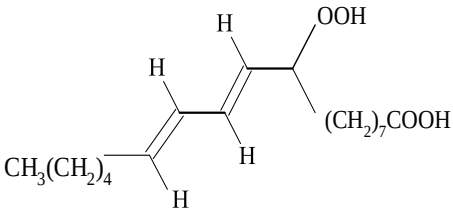


A

1.6

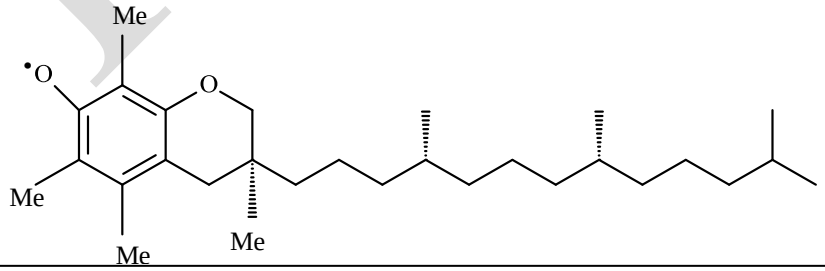


and



B

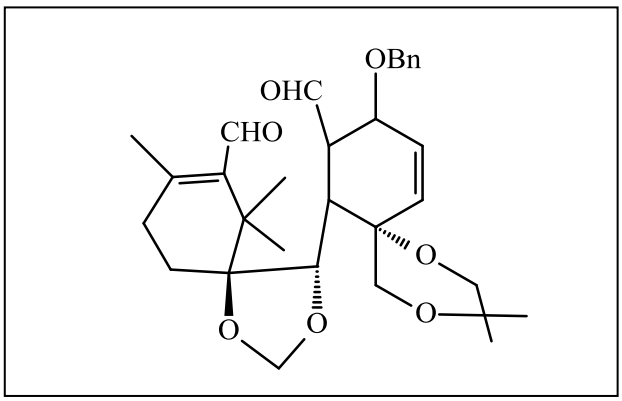
1.7



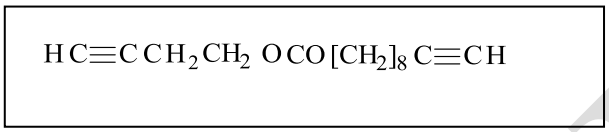
1.8 b) **X**

HBCSE

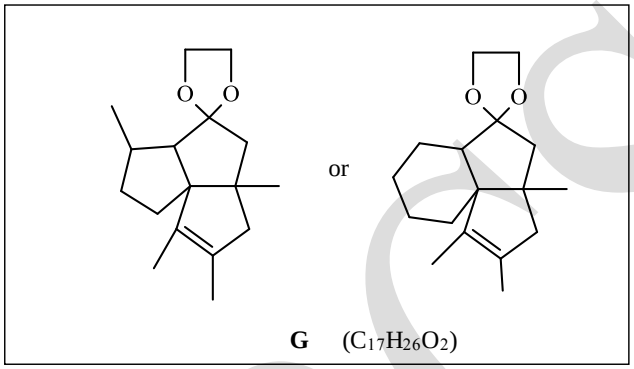
1.9 i)



ii)

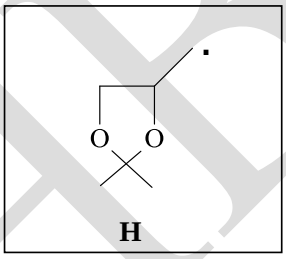


1.10

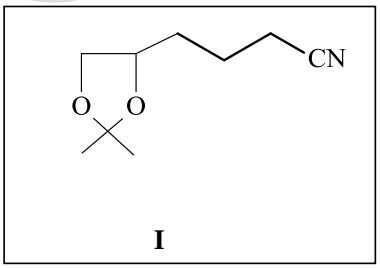


G ($C_{17}H_{26}O_2$)

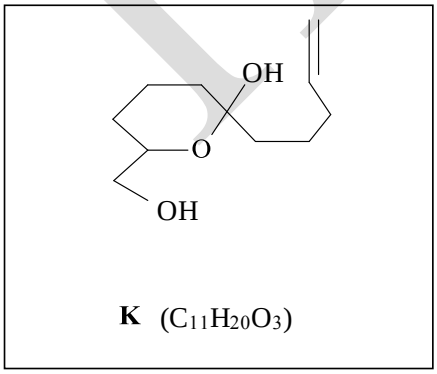
1.11



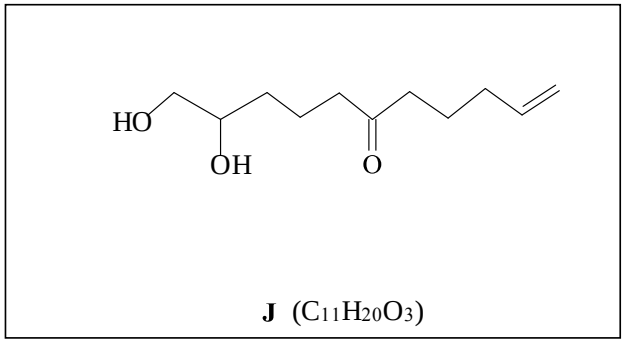
H



I



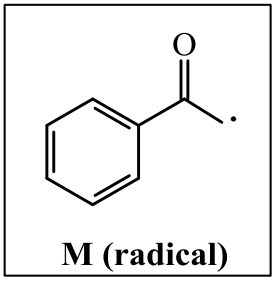
K ($C_{11}H_{20}O_3$)



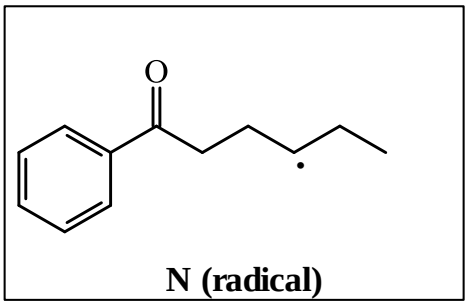
J ($C_{11}H_{20}O_3$)

HBCSE

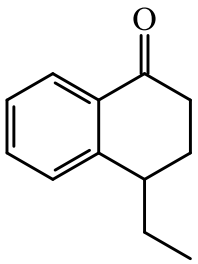
1.12



M (radical)

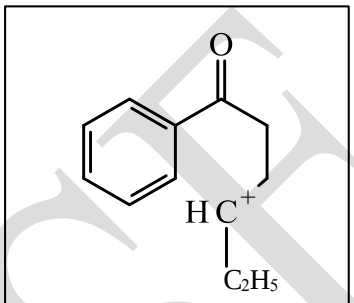


N (radical)



P ($C_{12}H_{14}O$)

P does not decolourise Br



O

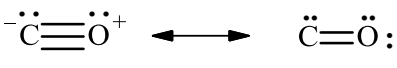
HBCSE

Name of Student	Roll No.

Problem 2 **18 marks**

Transition Metal Chemistry

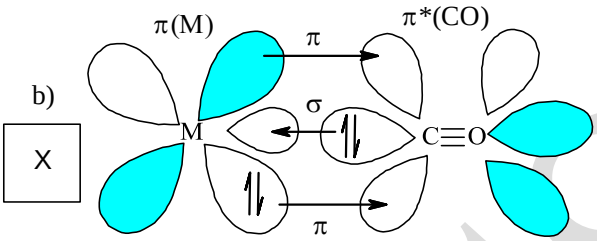
2.1



I II

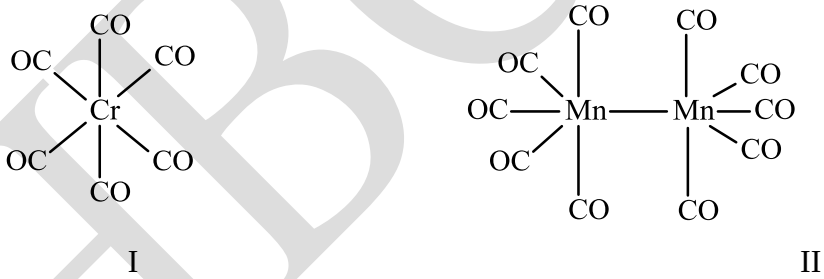
I follows octet rule

2.2



2.3 I) $Cr_x(CO)_y$ x = 1 y = 6

II) $[Mn_x(CO)_y]$ x = 2 y = 10 or 11



2.4

1) b **2)** c **3)** a

2.5

$2[Ni(CN)] + 4CO \rightarrow [Ni(CO)_4] + [Ni(CN)_2]$

2.6

$\bar{\upsilon}$ (CO) = 2143cm $^{-1}$ or 6.424×10^{13} Hz

$\mu = 1.1386\times10^{-26}$ kg

HBCSE

2.7

i) a) MCO b) M_2CO c) M_3CO

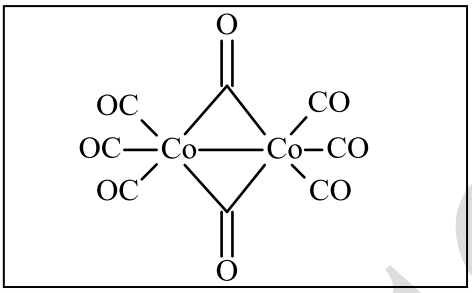
[a] > [b] > [c]

ii) a) $[Ni(CO)_3PMe_3]$ b) $[Ni(CO)_3PF_3]$ c) $[Ni(CO)_3PPh_3]$

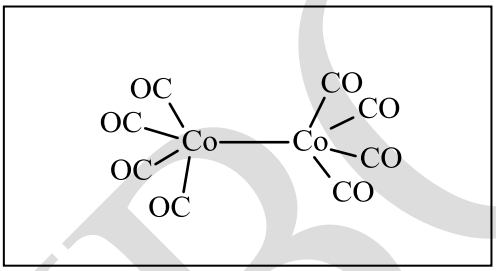
[b] > [c] > [a]

2.8

i)



ii)



2.9

Step No.	Reaction type (Choose from the above list and write only the alphabet)	Formal oxidation state of **metal** in the product obtained at the **end** of the step	Number of d electrons
3	d	+1	8
6	e	+3	6
7	b	+1	8

HBCSE

Name of Student **Roll No.**

Problem 3 14 marks

Synthesis of natural products

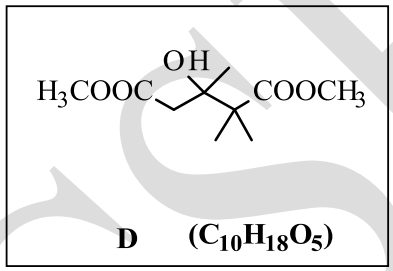
3.1 (b) ketonic carbonyl [x]

(d) no unsaturation [x]

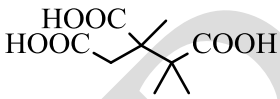
3.2 Number of acidic functional groups present in **B** = 02 and **C** =03

3.3

ii)2 mole CH_3I
P



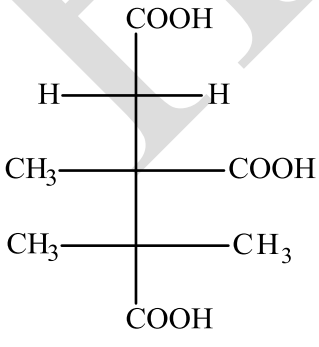
D **($C_{10}H_{18}O_5$)**



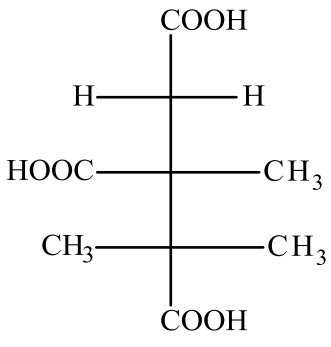
C **($C_9H_{14}O_6$)**

E ($C_{11}H_{17}NO_4$)

3.5



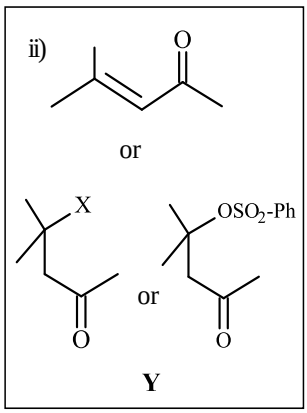
S

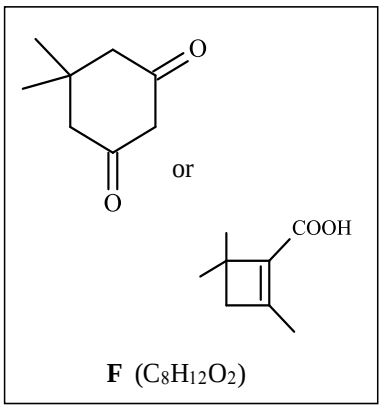


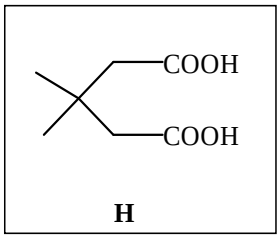
R

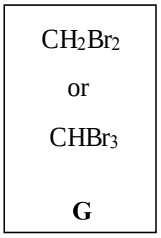
HBCSE

3.6

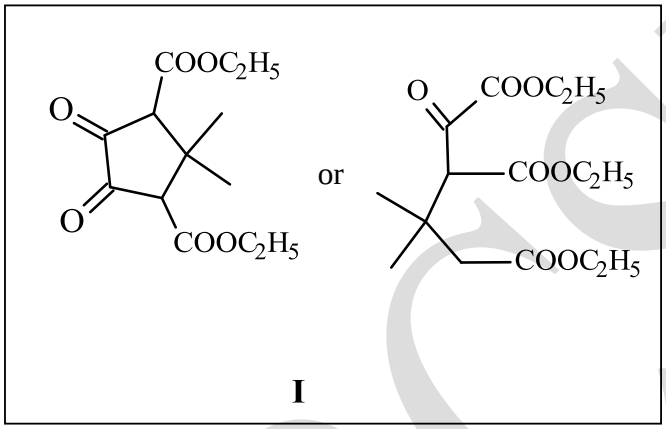


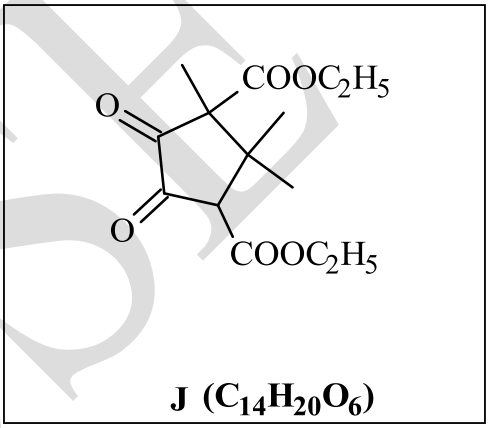


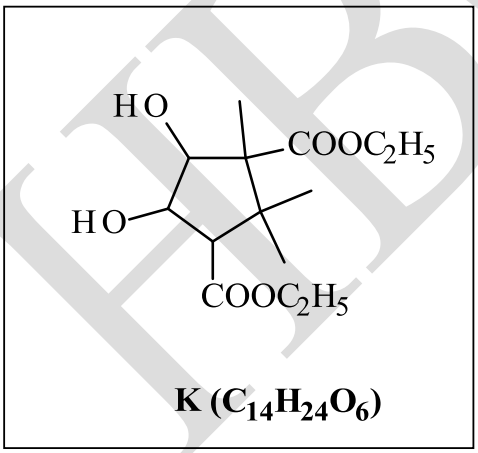


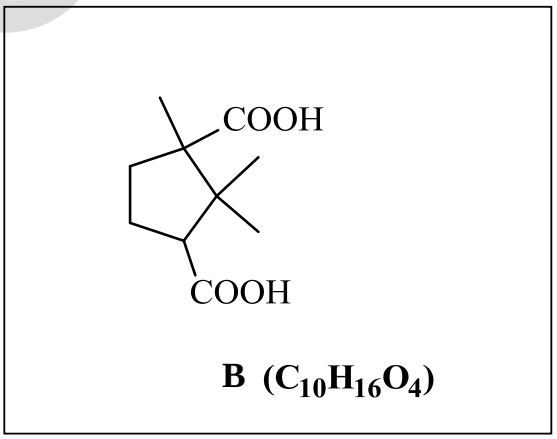


3.7









3.8

1, 2, 2-Trimethylcyclopentane-1,3-dicarboxylic acid

HBCSE

Name of Student	**Roll No.**

Problem 4 **18 marks**

Hydrogen as a fuel

A.

4.1 p = 64.58 kg m^{-3}

4.2

i) $\Delta H = -143$ kJ g^{-1} of hydrogen

ii) $\Delta H = -32.8$ kJ g^{-1} of carbon

4.3

(i) max work = -1.2×10^5 kJ or 1.18×10^5 kJ

(ii) Heat engine = -6.9×10^4 kJ

4.4

(i) 46.3 months or 45.7 months

(ii) I = 0.813 A

B.

4.5 $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

4.6 Conversion (methane) = 66%

4.7

Total pressure at 1100 K = 6.550 bar

Conversion (methane) ≅ 49 %

C.

4.8

1) $T_1 = 300K$
2) $T_2 = 600K$
3) $T_3 = 1200K$
4) $T_4 = 600K$

HBCSE

4.9

(i) For path 1→2:
$\Delta E_{int,12} = 3.74kJ$

(ii) For path 2→3:
$\Delta E_{int,23} = 7.5kJ$

(iii) For path 3→ 4:
$\Delta E_{int,34} = -7.48kJ$

(iv) For path 4→1:
$\Delta E_{int,41} = -3.75kJ$

4.10

The efficiency of the cycle is given by: $\varepsilon \approx 15\%$

4.11

(a) $\Delta S_1 + \Delta S_2 + \Delta S_3 + \Delta S_{system} = 0$

(b) $T_3 = 267K$

HBCSE

Name of Student	**Roll No**

Problem 5 — 15 marks

Acid-Base Equilibria

5.1 $K_a' = 7.9\times10^{-7}$

5.2 i) $[HCO_3^-]/[CO_2(\text{dissolved})] = 20/1$

$[HCO_3^-] = 20/21\times 2.52\times10^{-2} = 2.4\times10^{-2}$ M

$[CO_2(\text{dissolved})] = 1.2\times10^{-3}$ M

ii) pH = 6.58

iii) pH = 7.29

5.3 $[HCO_3^-]_{CO2\ rich\ blood} = 25.8\times10^{-3}$

$[CO_2]_{CO2\ rich\ blood} = 1.39\times10^{-3}$

5.4 i) In presence of CO_2, higher p_{o_2} is needed for a given percent saturation **X**

iii) In absence of CO_2, maximum saturation of haemoglobin occurs at lower p_{o_2} **X**

5.5

Normal Hb-Curve1: (0.98 – 0.17) mol × 4 ≈ 3.2 mol

Abnormal Hb- Curve 2: (1.00 – 0.60) mol × 4 ≈ 1.6 mol

Abnormal Hb- Curve 3: (0.73 – 0.01) mol × 4 ≈ 2.9 mol

5.6 pH = 3.16

5.7 $K_1 = 3.11\times10^2$

5.8 Max. Concentration of "free" Ca^{2+} ions: $[Ca^{2+}]_{max} = 1.9\times10^{-4}$ M

HBCSE

Name of Student **Roll No**

Problem 6 **12 marks**

Electrochemistry

6.1 a)

$2Ag_{(s)} + SO_4^{-2}{}_{(aq)} \rightleftharpoons Ag_2SO_{4\,(s)} + 2e^-$

$2H^+_{(aq)} + 2e^- \rightleftharpoons H_2(g)$

$2Ag_{(s)} + 2H^+_{(aq)} + SO_4^{-2} \rightleftharpoons Ag_2SO_{4\,(s)} + H_2$

Other accepted cell reactions:

$2Ag_{(s)} + H_2SO_4 \rightleftharpoons Ag_2SO_{4(s)} + H_2$

b) E = – 0.6977 V or – 0.6565 V

c) ii) The given cell does not require a salt bridge **X**

iii) It is not possible to draw current from the cell as represented **X**

6.2 a) $k = 1.58 \times 10^{-41}$

b) i) E will be less negative at 35° C X

6.3 a) $K = 6.998 \times 10^{-7}$

b) $[Cu^+] = 8.37 \times 10^{-5}$

6.4 a)

$Pb^{2+}_{(aq)} + 2Ag_{(s)} + 2Cl^-_{(aq)} \rightleftharpoons Pb_{(s)} + 2AgCl_{(s)}$

Other accepted form:

$Pb^{2+}_{(aq)} + 2Ag_{(s)} \rightleftharpoons Pb_{(s)} + 2Ag^+_{(aq)}$

b) $[Pb^{2+}] = 3.35 \times 10^{-3}$ M

HBCSE