

Name of Student

Roll No.

Problem 1

20 marks

Free radicals

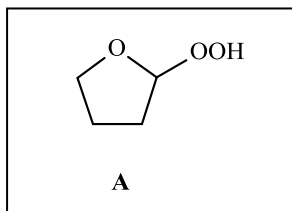
1.1 c) X

1.2 b) X

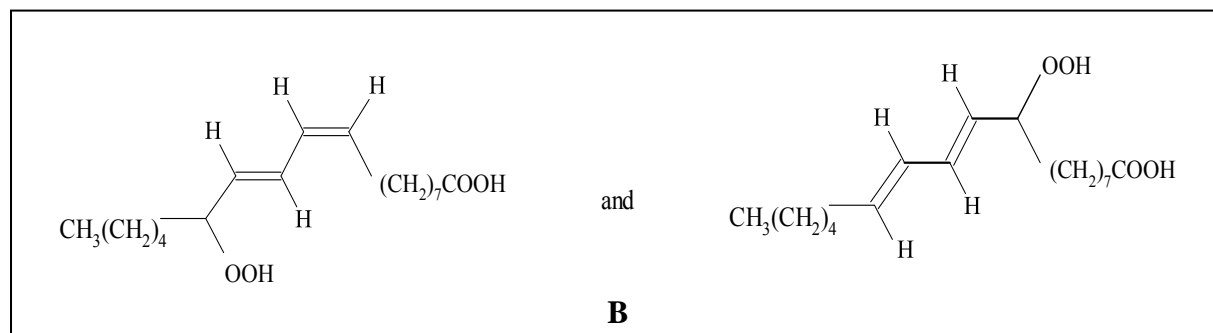
1.3 $C_1 : C_2 = 1 : 3.85$ or $7 : 27$ or $0.259 : 1$

1.4 d) X

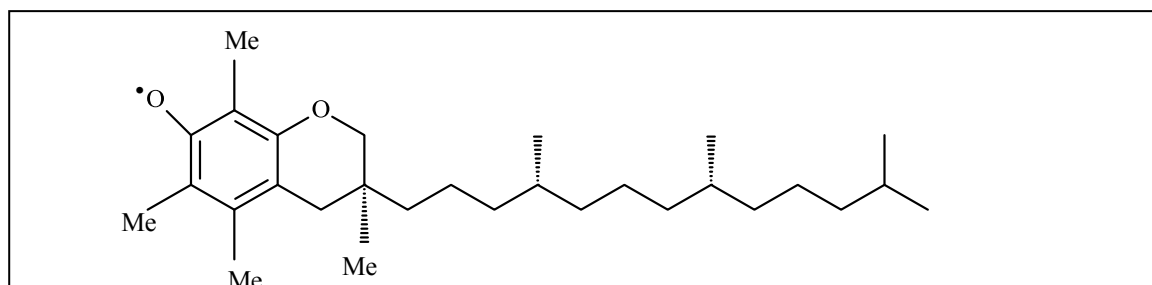
1.5



1.6

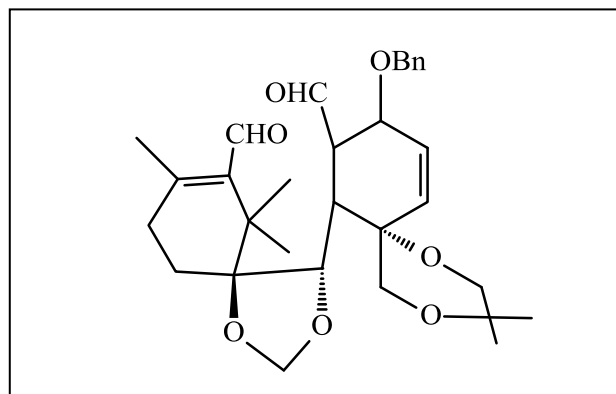


1.7

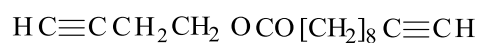


1.8 b) X

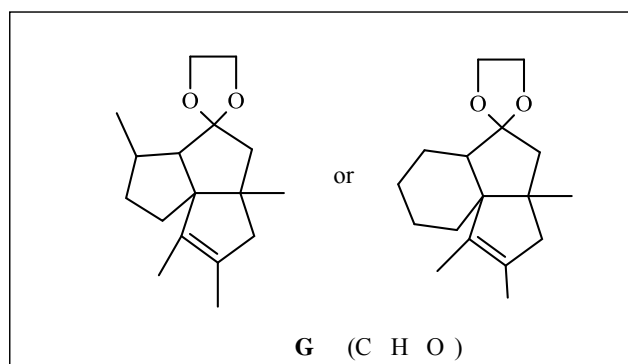
1.9 i)



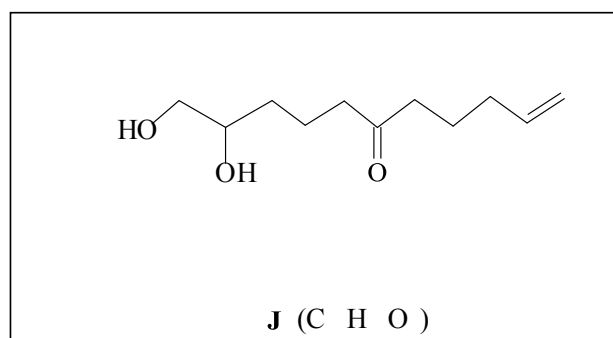
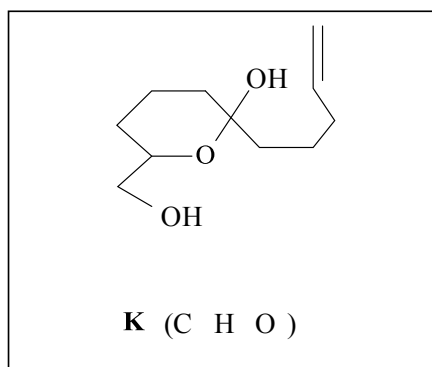
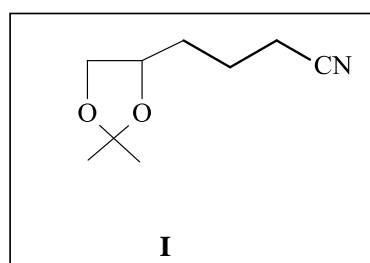
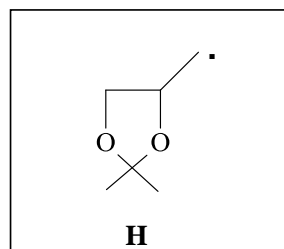
ii)



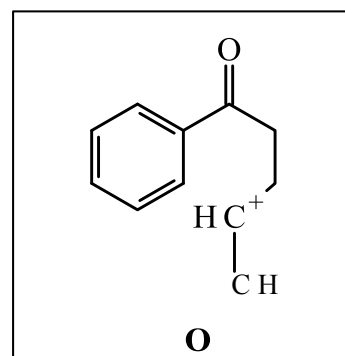
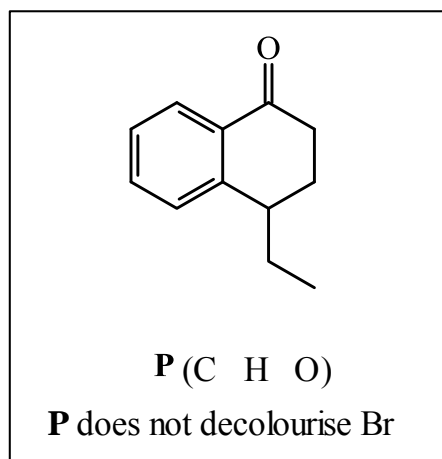
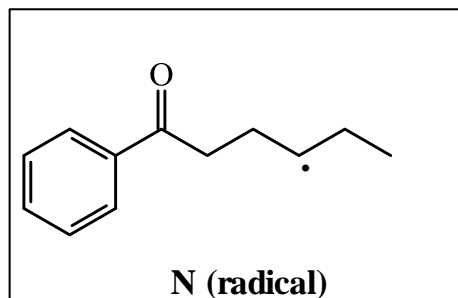
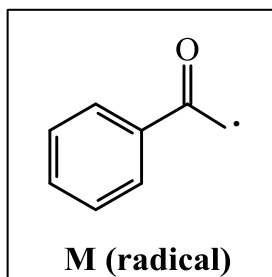
1.10



1.11



1.12



Name of Student

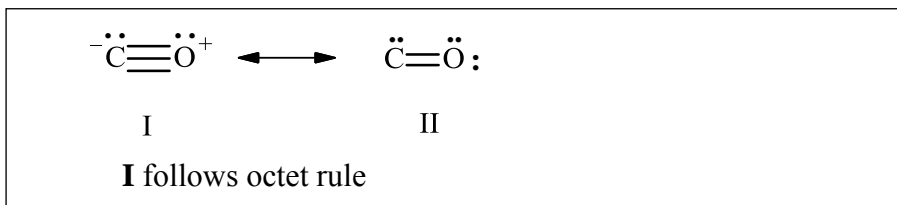
Roll No.

Problem 2

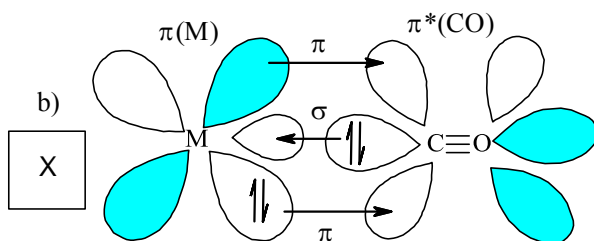
18 marks

Transition Metal Chemistry

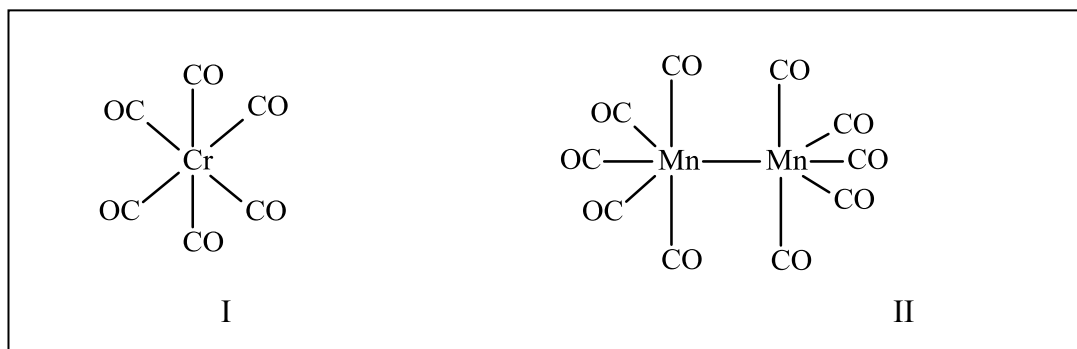
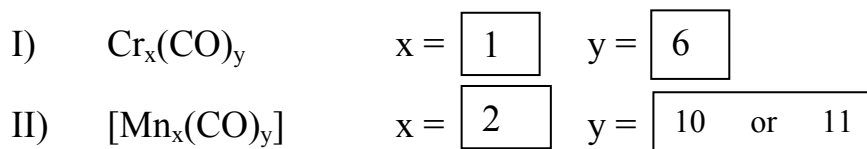
2.1



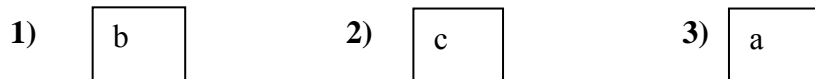
2.2



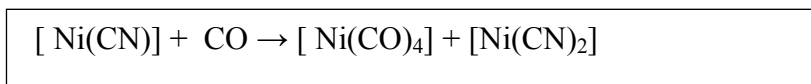
2.3



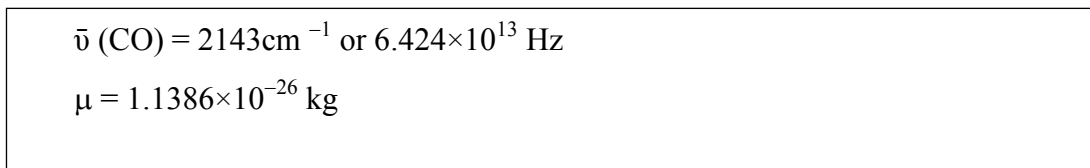
2.4



2.5

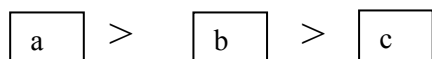


2.6

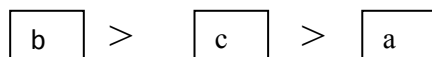


2.7

- i) a) MCO b) M_2CO c) M_3CO

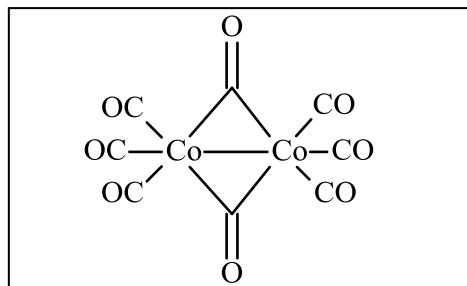


- ii) a) $[Ni(CO)_3PMe_3]$ b) $[Ni(CO)_3PF_3]$ c) $[Ni(CO)_3PPh_3]$

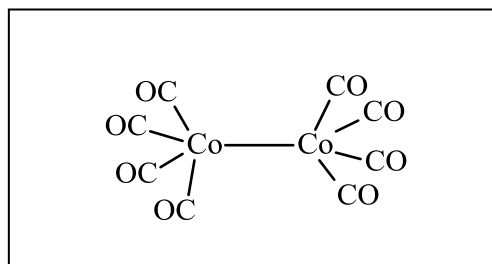


2.8

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

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Problem 3

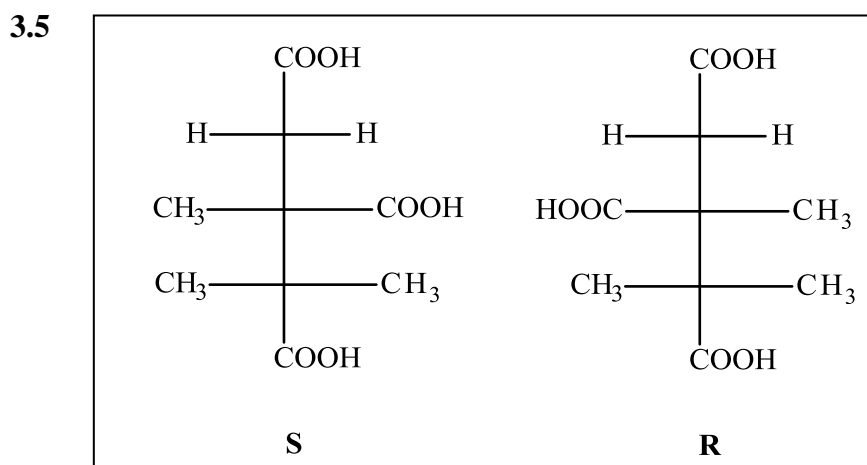
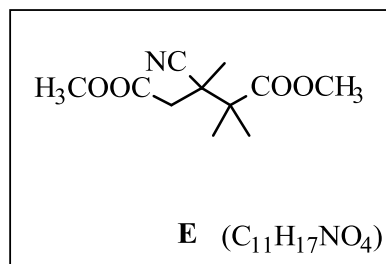
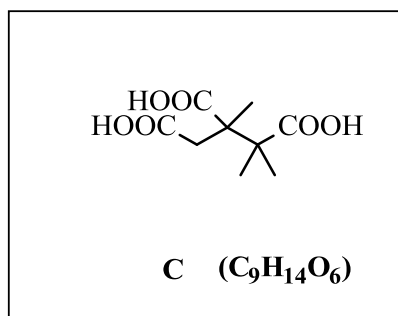
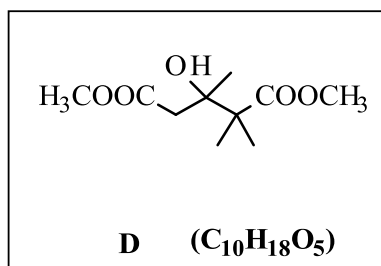
14 marks

Synthesis of natural products

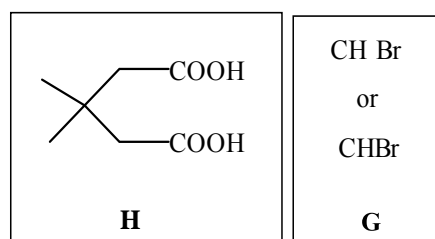
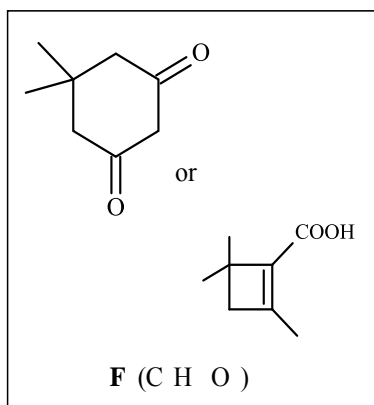
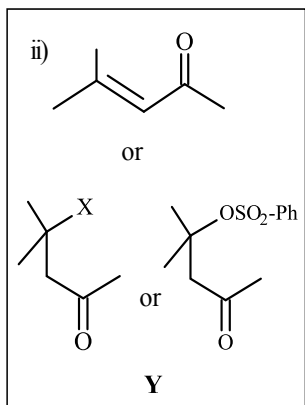
- 3.1 (b) ketonic carbonyl
- (d) no unsaturation

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

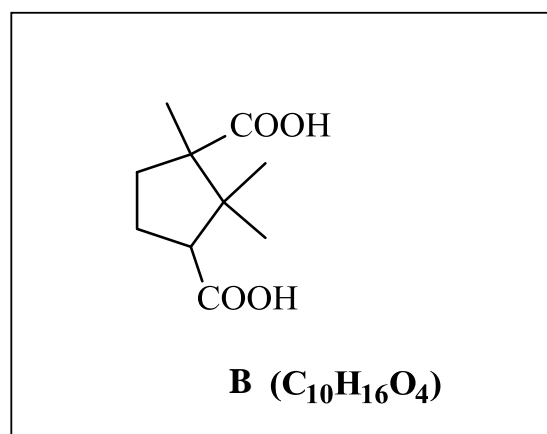
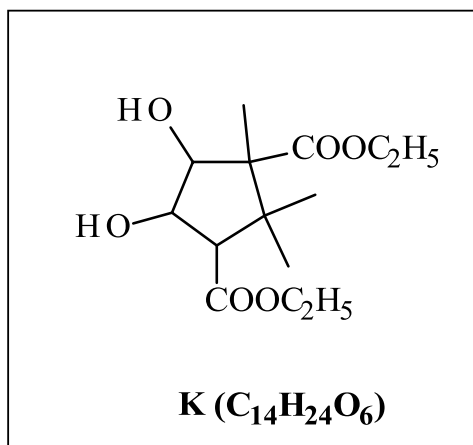
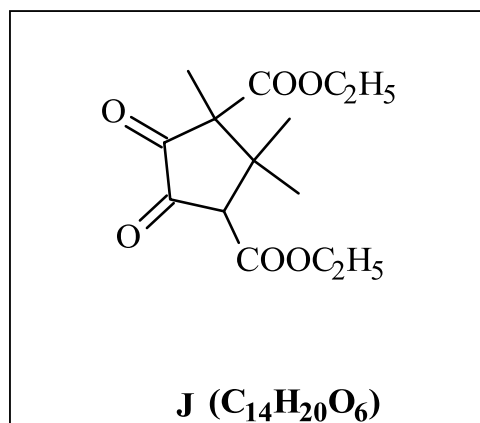
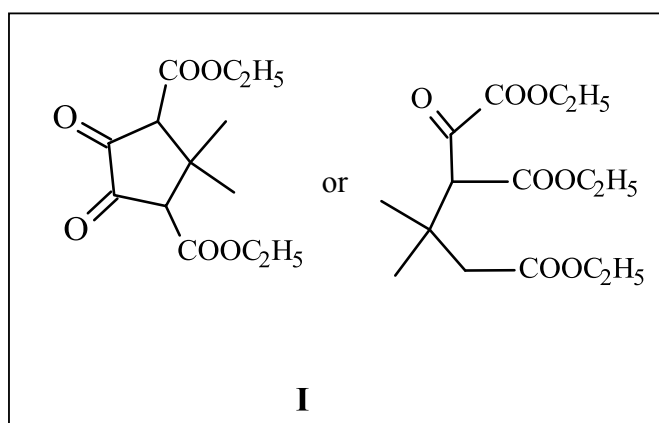
3.3 ii) mole CH I
P



3.6



3.7



3.8

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

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Problem 4

18 marks

Hydrogen as a fuel

A.

4.1

$$p = 64.58 \text{ kg m}^{-3}$$

4.2

i) $\Delta H = -143 \text{ kJ g}^{-1}$ of hydrogenii) $\Delta H = -32.8 \text{ kJ g}^{-1}$ of carbon

4.3

(i) max work = $-1.2 \times 10^5 \text{ kJ}$ or $1.18 \times 10^5 \text{ kJ}$ (ii) Heat engine = $-6.9 \times 10^4 \text{ kJ}$

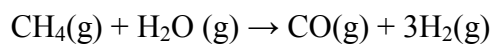
4.4

(i) 46.3 months or 45.7 months

(ii) $I = 0.813 \text{ A}$

B.

4.5



4.6

Conversion (methane) = 66%

4.7

Total pressure at 1100 K = 6.550 bar

Conversion (methane) $\cong 49 \%$

C.

4.8

1) $T_1 = 300\text{K}$ 2) $T_2 = 600\text{K}$ 3) $T_3 = 1200\text{K}$ 4) $T_4 = 600\text{K}$

- 4.9
- (i) For path 1→2:
 $\Delta E_{\text{int},12} = 3.74\text{kJ}$
 - (ii) For path 2→3:
 $\Delta E_{\text{int},23} = 7.5\text{kJ}$
 - (iii) For path 3→4:
 $\Delta E_{\text{int},34} = -7.48\text{kJ}$
 - (iv) For path 4→1:
 $\Delta E_{\text{int},41} = -3.75\text{kJ}$

- 4.10
- The efficiency of the cycle is given by: $\varepsilon \approx 15\%$

- 4.11
- (a) $\Delta S_1 + \Delta S_2 + \Delta S_3 + \Delta S_{\text{system}} = 0$
 - (b) $T_3 = 267\text{K}$

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Problem 5

15 marks

Acid-Base Equilibria

5.1

$$K'_a = 7.9 \times 10^{-7}$$

5.2 i)

$$[\text{HCO}_3^-]/[\text{CO}_2(\text{dissolved})] = 20/1$$

$$[\text{HCO}_3^-] = 20/21 \times 2.52 \times 10^{-2} = 2.4 \times 10^{-2} \text{ M}$$

$$[\text{CO}_2(\text{dissolved})] = 1.2 \times 10^{-3} \text{ M}$$

ii)

$$\text{pH} = 6.58$$

iii)

$$\text{pH} = 7.29$$

5.3

$$[\text{HCO}_3^-]_{\text{CO}_2 \text{ rich blood}} = 25.8 \times 10^{-3}$$

$$[\text{CO}_2]_{\text{CO}_2 \text{ rich blood}} = 1.39 \times 10^{-3}$$

5.4

i) In presence of CO_2 , higher pH needed for a given percent saturationiii) In absence of CO_2 , maximum saturation of haemoglobin occurs at lower P_{O_2}

5.5

$$\text{Normal Hb-Curve 1: } (0.98 - 0.17) \text{ mol} \times 4 \approx 3.2 \text{ mol}$$

$$\text{Abnormal Hb- Curve 2: } (1.00 - 0.60) \text{ mol} \times 4 \approx 1.6 \text{ mol}$$

$$\text{Abnormal Hb- Curve 3: } (0.73 - 0.01) \text{ mol} \times 4 \approx 2.9 \text{ mol}$$

5.6

$$\text{pH} = 3.16$$

5.7

$$K_1 = 3.11 \times 10^2$$

5.8

$$\text{Max. Concentration of "free" Ca}^{2+} \text{ ions: } [\text{Ca}^{2+}]_{\text{max}} = 1.9 \times 10^{-4} \text{ M}$$

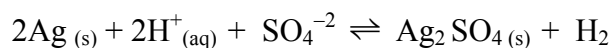
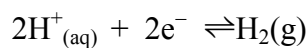
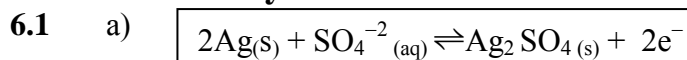
Name of Student

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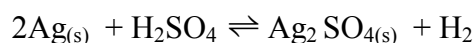
Problem 6

12 marks

Electrochemistry



Other accepted cell reactions:



b) $E = -0.6977 \text{ V or } -0.6565 \text{ V}$

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

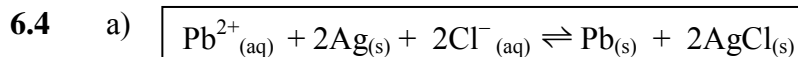
iii) It is not possible to draw current from the cell as represented

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

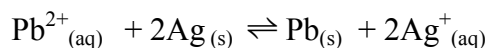
b) i) E will be less negative at 35° C

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

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



Other accepted form:



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