The INChO Examination Board when it met in March 2009 reconsidered the solutions to INChO 2009. The answer key to Q.No 7.8 was revised and the answer scripts of **all** students were reassessed for this question. In light of the above, all students whose marks have changed are being sent fresh performance cards. The OCSC list for chemistry which is displayed on the website has been prepared taking into account this change of marks.

Equivalent Solutions may exist.

Problem 1

Hydrogen atom

1.1 $\boxed{-5.45 \times 10^{-19} \text{J}}$

1.2 $\boxed{10.2 \text{ eV}}$

1.3 $\boxed{121.9 \text{ nm}}$

1.4 $\boxed{2}$

1.5 Ans: 16

1.6

Ground state energy = −13.6 eV
K.E = +13.6 eV
P.E = −27.2 eV

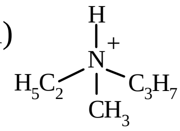
1.7 a) Ans : 4

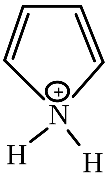
b) $\boxed{2}$

1.8 $\boxed{79.0 \text{ eV}}$

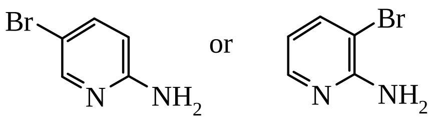
Problem 2

Nitrogen containing compounds

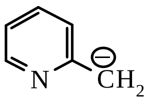
2.1 ii) 

2.2 ii) 

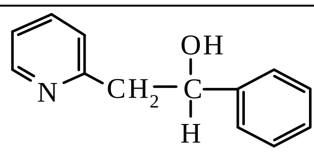
2.3 a) CH_3COCHN_2

b) 

2.4



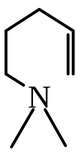
B



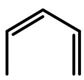
C

2.5 i) **D** is more basic than **E**

2.6



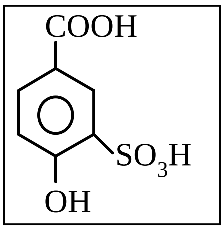
G

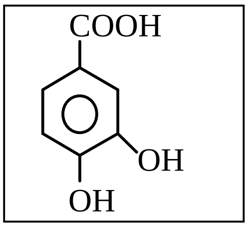


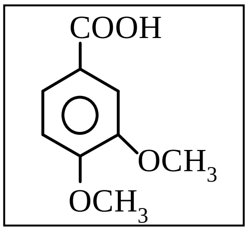
H

2.7 i) $C_{16}H_{13}NO_4$

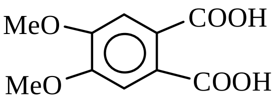
2.8



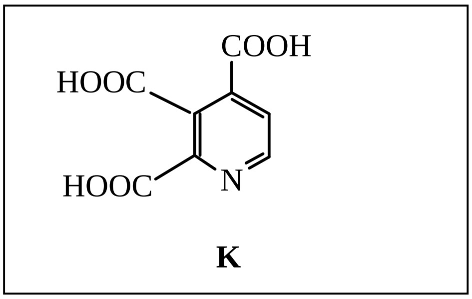




2.9 i)

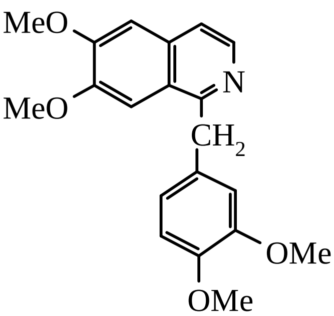


2.10

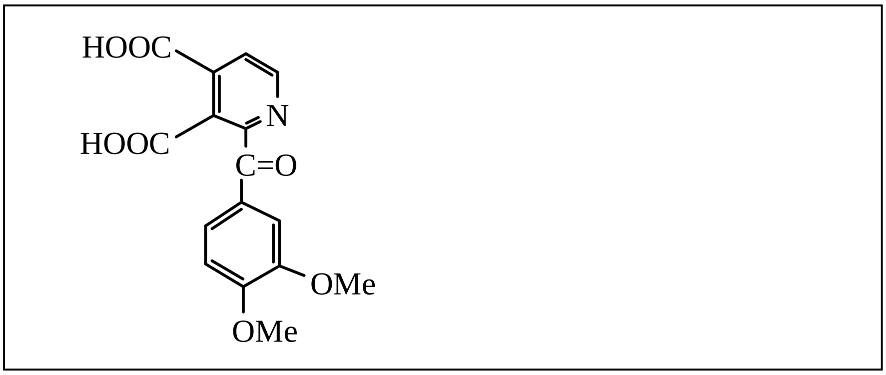


2.11

iii)



2.12



Problem 3

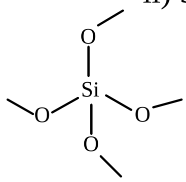
Chemistry of silicon

3.1

i) CO_2

$O{=}C{=}O$

ii) SiO_2



3.2. b) carbon has small size and forms a π bond with good overlap whereas silicon has larger size hence has a poor π overlap

3.3 b) silicon has larger atomic size than carbon

c) silicon has 3d orbitals which form an sp^3d^2 hybrid orbitals

3.4

C > Si > Ge

3.5 c) bond strength

3.6

$$SiO_2 + 2C \xrightarrow{\Delta} Si + 2CO$$

3.7

$$Si + 2Cl_2 \rightarrow SiCl_4$$

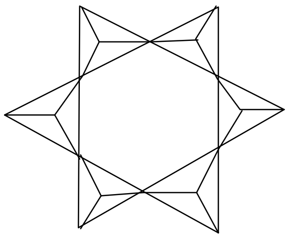
$$SiCl_4 + 2H_2 \xrightarrow{\Delta} Si + 4HCl$$

3.8 b) impurities are more soluble in liquid phase than in solid

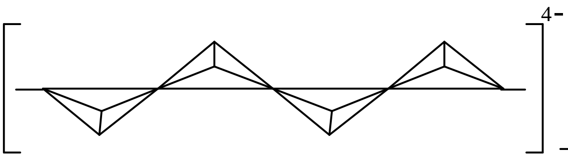
3.9 c) silicon has low lying unoccupied orbitals

3.10

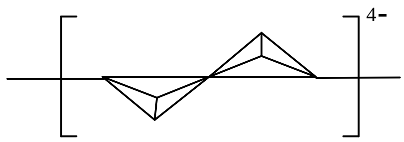
n = –12



3.11



or

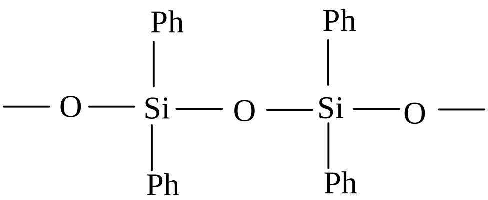


3.12

A = Ph_2SiCl_2

Linear polymer

B =

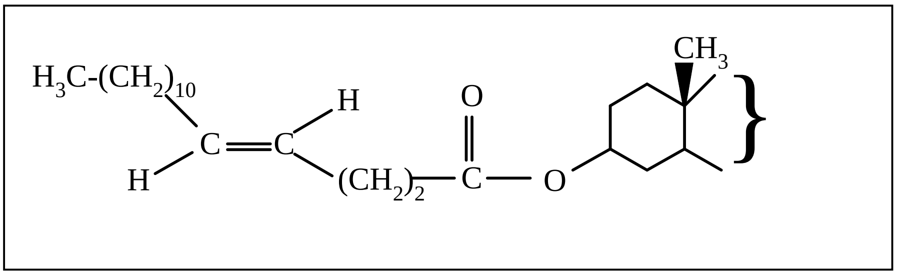


Problem 4

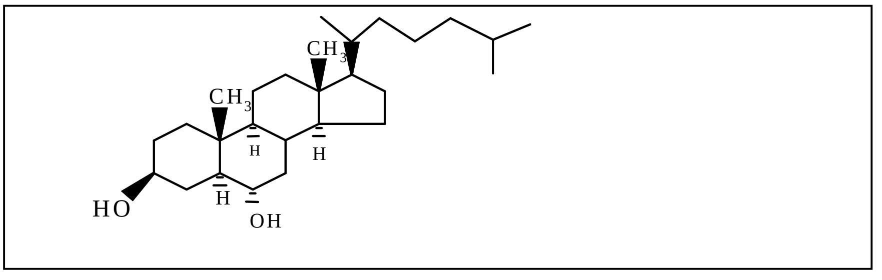
Natural compounds and intermediates

4.1 b) 256

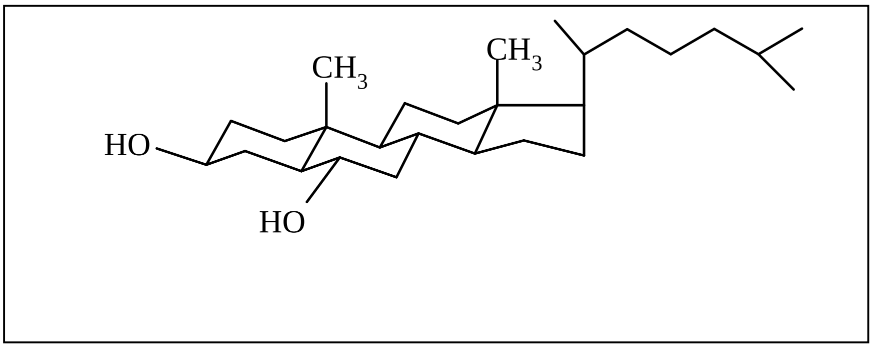
4.2



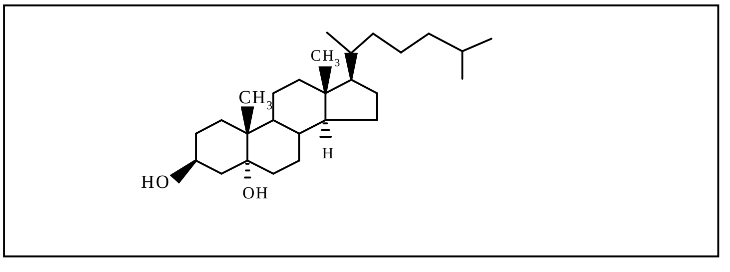
4.3 a)



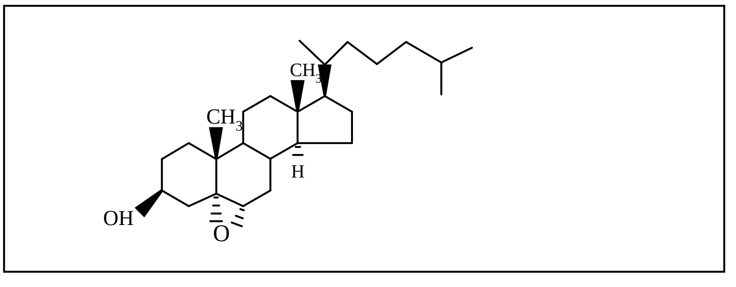
b)



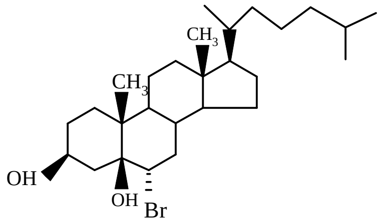
c) i)



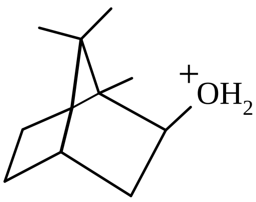
ii)



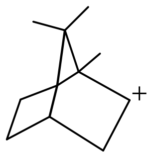
iii)



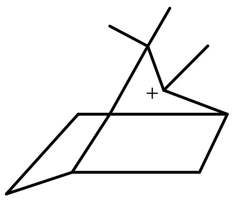
4.4



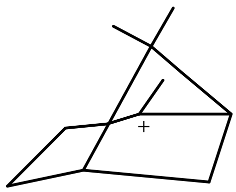
C



Intermediate **D**

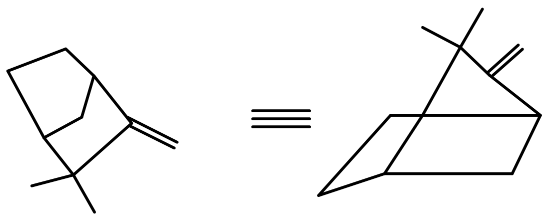


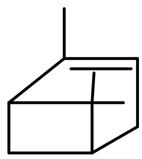
or



Intermediate **E**

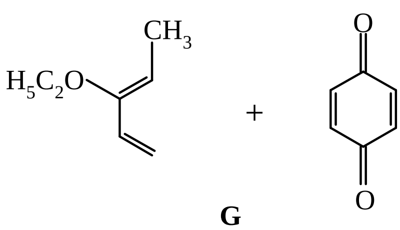
[Note: Conversion of **D**→**E** involves formation of a more stable species]



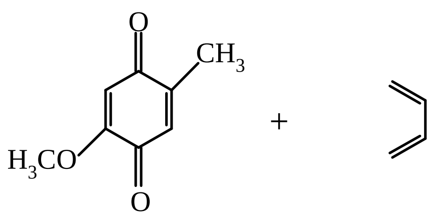


F

4.5

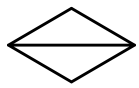


G

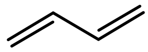


H

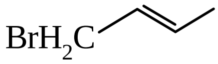
4.6



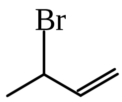
J



K



L

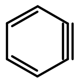


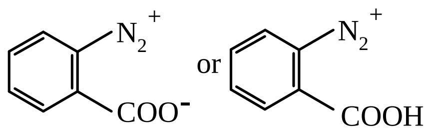
M

4.7

N_2

CO_2

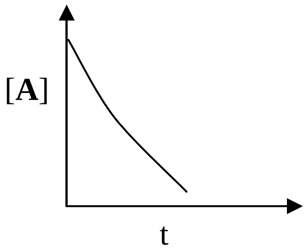




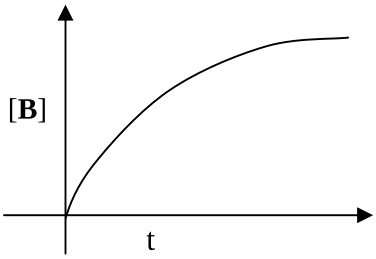
Problem 5

Chemical kinetics

5.1



5.2



5.3 a) $\frac{d[A]}{dt} = -k$

b) $[A] = [A]_0 - kt$

c) $t_{0.5} = \frac{[A]_0}{2k}$

5.4 a) 0

b) 0.11 torr/s

5.5 a) 1

b) $2.3 \times 10^{-5}\ s^{-1}$

5.6 3240 years

(i) 3.05×10^{-7} mol

ii) 6.3×10^{16}

iii) 1.9×10^{17}

iv) $6.2 \times 10^{23}\ mol^{-1}$

Problem 6

A. Kinetic theory of gases and Gas Laws

6.1. i)

Curve	**Temperature**
Curve a	100K
Curve b	300K
Curve c	700 K

ii) True

6.2

Curve	**Gas**
Curve a	H_2
Curve b	CH_4
Curve c	NH_3
Curve d	Ar

6.3 iii) $H_2 < CH_4 < NH_3$

6.4 2 atm

6.5 134.7 J

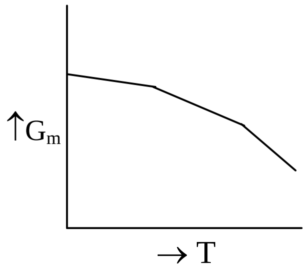
6.6 6.7%

B.

6.7 Solid/vapor

6.8 T= 217 K and P = 5.2 atm

6.9



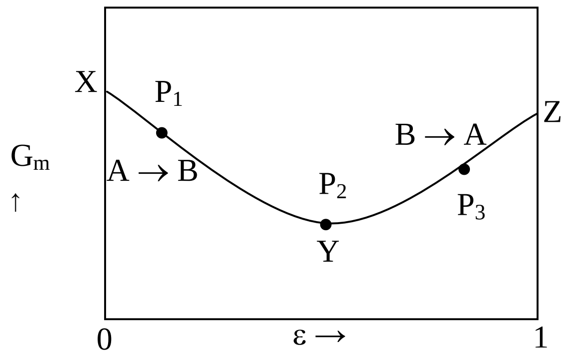
6.10 a) All the three phases are in equilibrium

b) Molar Gibbs energy for the three phases is the same

6.11 a) increase

6.12 Single

6.13



Point P_1 is any point between X and Y
Point P_3 is any point between Y and Z

Point P_2 is point Y

6.14 a) K decreases as the temperature rises

Problem 7

Acid-Base chemistry

Part A

7.1 a) B b) D c) F

7.2 4.4

7.3 Methyl orange

Part B

7.4

$CO_3^{2-} + H^+ \rightarrow HCO_3^-$

$HCO_3^- + H^+ \rightarrow H_2CO_3$ or $H_2O + CO_2$

7.5

a) 1.104×10^{-3} mol HCl

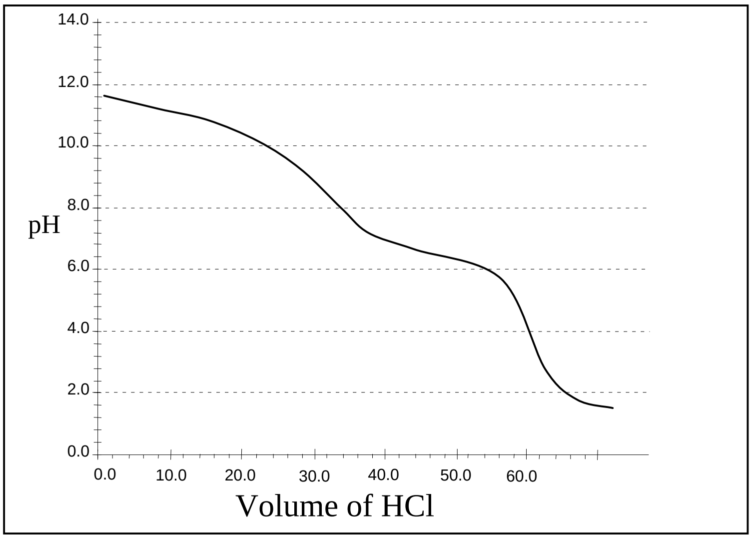
b) 3.944×10^{-3} mol HCl

7.6

46.8 % Na_2CO_3

29.1 % $NaHCO_3$

7.7



7.8 i) The total volume of HCl required to reach the 2nd end point is twice that of the first one

ii) Number of moles of CO_3^{2-} is equal to the number of moles of HCO_3^- at some point on this curve

iii) Number of moles of HCO_3^- is equal to twice the number of moles of CO_3^{-2} at some point on this curve