

Do. Believe and Conquer.

2019 HSC CHEMISTRY LECTURE GIFT

1000 QUESTIONS
(FREE RESPONSE & MCQ QUESTIONS)

PART IV
(400/1000)

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Best,
ConquerHSC Team

Question 301: Compare the information that can be inferred using the spectra data of ^{13}C NMR and ^1H (proton) NMR.

Question 302: Describe how the spectra of ^{13}C and ^1H NMR are produced.

Question 303: Describe how the spectra of mass spectroscopy is produced.

Question 304: Describe how the spectra of infrared spectroscopy is produced.

Question 305: Describe how the spectra of UV-Vis spectroscopy is produced.

Question 306: UV-Vis spectroscopy can play important in the analysis of inorganic and organic substances. Describe the role of the technique in both areas of study.

Question 307: Explain the reason why the concentration of anions' are not analysed using atomic absorption spectroscopy.

Question 308: Define the term 'gravimetric analysis'.

Question 309: Define the term 'spectroscopy'.

Question 310: Describe the effects of poor water quality.

Question 311: Account for the reason why the bond energy

Question 312: Describe the difference between 'signals' and 'peaks' in NMR.

Question 313: Describe what unique signals displayed in a NMR spectrum means.

Question 314: Describe what the number of peaks in each signal displayed in a NMR spectrum output indicate.

Question 315: Describe the different 'chemical (or electronic) environments' in ^1H and ^{13}C NMR spectroscopy.

Question 316: State the three conditions for an atom to be NMR active.

Question 317: Explain the information that can be inferred from two NMR signals with different chemical shift values.

Question 318: Describe the role of concentration sulfuric acid in esterification.

Question 319: List three pieces of equipment that is used in esterification and outline their purpose.

Question 320: Explain what is meant by 'HOMO' and 'LUMO' in UV-Vis spectroscopy.

Question 321: Draw the structural formula for polyethylene with three monomer units.

Question 322: List the reactants that are required to manufacture butyl propanoate.

Question 323: Name the products of the reaction between ethanol and ethanoic acid.

Question 324: Write a chemical equation, showing reaction conditions, for the complete and incomplete combustion of ethanol.

Question 325: Write a chemical equation, showing reaction conditions, for the oxidation of a primary ethanol.

Question 326: Write a chemical equation, showing reaction conditions, for the oxidation of a secondary ethanol.

Question 327: Write a chemical equation, showing reaction conditions, for the dehydration of ethanol.

Question 328: Write a chemical equation, showing reaction conditions, for the hydration of ethanol.

Question 329: Write a chemical equation, showing reaction conditions, for the fermentation of glucose to produce ethanol.

Question 330: Draw structural formula for all the possible position isomers of butanol.

Question 331: Draw structural formula for all the possible functional isomers for $C_4H_{10}O$.

Question 332: Draw structural formula for all the possible chain isomers for $C_4H_{10}O$.

Question 333: Compare primary, secondary and tertiary alcohols.

Question 334: Compare the use of anionic, cationic and non-ionic detergents, relating their chemical structure to action.

Question 335: Compare fuels from organic sources with biofuels.

Question 336: Define the term 'renewable' used to describe fuels.

Question 337: Which of the following is true when calculating the pH of a weak diprotic acid?

- (A) The pH of the weak diprotic acid is not dependent on the concentration of the diprotic acid.
- (B) The pH of the weak diprotic acid cannot be calculated using $\text{pH} = -\log[\text{H}^+]$.
- (C) The total $[\text{H}^+]$ released in solution can be calculated from the K_a value of the first degree of dissociation.
- (D) The total $[\text{H}^+]$ released in solution can be calculated from the K_a value of the first and second degree of dissociation.

Question 338: Define the term 'homologous series'.

Question 339: Compare homogenous and heterogenous equilibrium reactions.

Question 340: Describe the three key components of collision theory.

Question 341: Design a procedure to determine the K_{eq} value of a chemical equilibrium system that you have performed as part of the HSC Chemistry course.

Question 342: Explain the role of entropy and enthalpy in governing whether non-equilibrium system will proceed to completion, providing examples of chemical reactions to support your answer.

Question 343: Define the term 'reversible reaction'.

Question 344: Define the term 'irreversible reaction'.

Question 345: Compare open and closed systems.

Question 346: Describe three properties of inorganic acids.

Question 347: Describe three properties of inorganic bases.

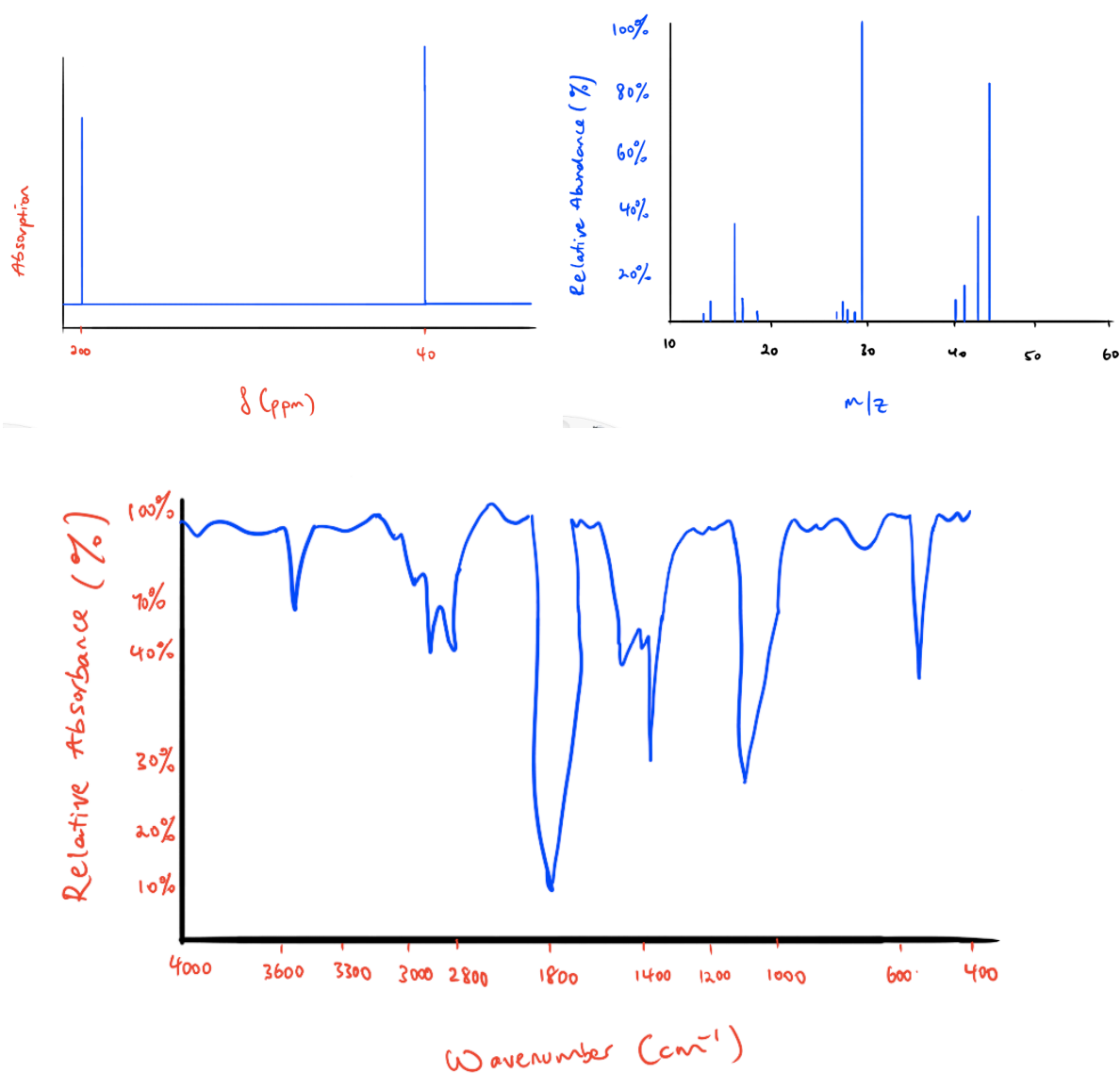
Question 348: Name an inorganic acid and organic acid.

Question 349: Name an inorganic base and an organic base.

Question 350: Which of the following are products of an acid and base reaction?

- (A) Water only
- (B) Salt only
- (C) Water and salt only.
- (D) Water, salt and hydrogen gas.

Question 351: Using the following spectra outputs of the same molecule, draw a possible structure of the molecule.



Disclaimer: The scaled values on the x & y axis of the IR graph are a bit weird. They will be properly scaled in HSC questions.

Question 352 – Random True or False Question – “The collision theory states that reaction rate is directly proportional to the number of effective or successful collisions that occur between reacting species per second.”

Question 353: Describe one property of an organic base that can be used to distinguish itself from an organic base.

Question 354: Describe a property of an organic acid that can be used to distinguish itself from an organic acid.

Question 355: Propose a reaction pathway to produce an amide molecule from a carboxylic acid.

Question 356: Suppose you are given the following ^{13}C NMR data for a molecule with a molecular formula of $\text{C}_7\text{H}_{14}\text{O}$.

^{13}C Chemical Shift Signals (ppm)
22
25
28
58
207

You are also given the following ^1H NMR signals

^1H Chemical Shift Signals (ppm)	Signal Integration Value
1	9
2	3
2.3	2

Using the information above, draw a possible structural formula for the molecule.

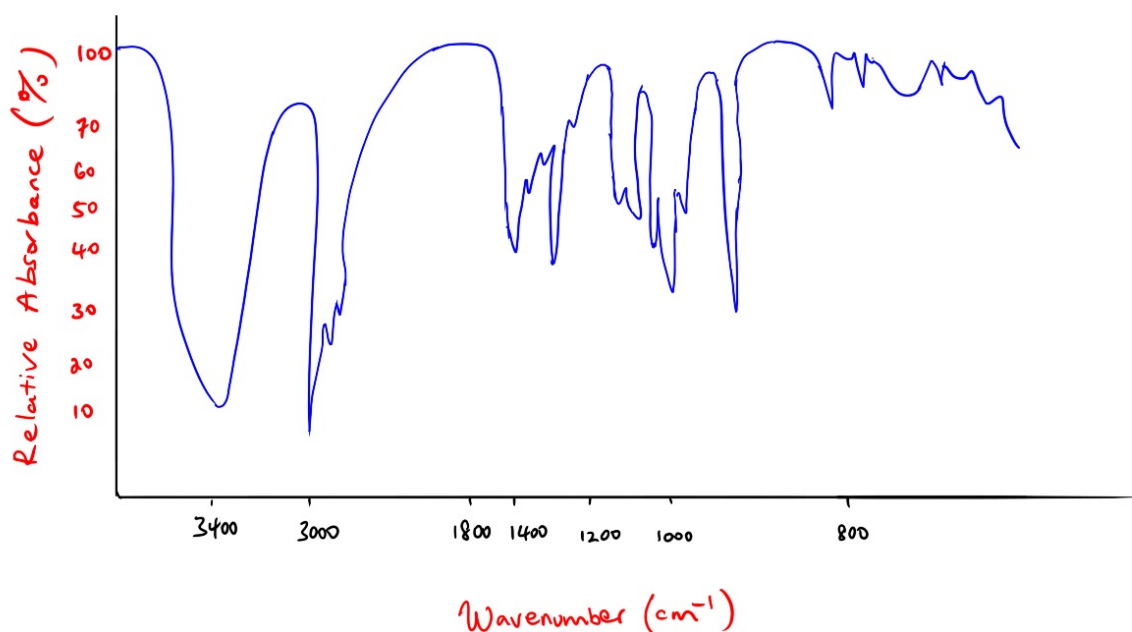
Question 357: Suppose you are given the following ^{13}C NMR data for a molecule with a molecular formula of $\text{C}_4\text{H}_{10}\text{O}$. Draw a possible structure for the molecule.

^{13}C Chemical Shift Signals (ppm)
73
38
23
18

You are also given the following ^1H NMR signals

^1H Chemical Shift Signals (ppm)	Signal Integration Value
1.1	9
3.8	1

The following IR spectra is produced by the same molecule with some significant wavenumbers labelled.



Disclaimer: In HSC Exams, IR spectra data will have properly scaled values on the x-axis.

Question 358: Explain the reason why the signal due to hydroxyl group in carboxylic acids are broader than the signal due to hydroxyl group in alcohols.

Question 359: Colourimeters operate with replaceable colour filters. If a green coloured solution has a λ_{max} of 700nm, effectively absorbing red light in the visible light portion of the EM spectrum. On the other hand, an orange solution has λ_{max} of 450nm, effectively absorbing the blue light. Explain this relationship between colour and maximum wavelength absorbed to help predict the maximum wavelength absorbed for a yellow-coloured solution.

Question 360: Which of the following is true when a molecule absorbs UV-Vis energy?

- (A) Electronic transitions
- (B) Vibrational transitions

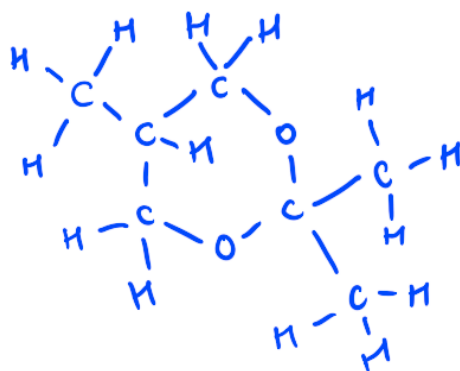
- (C) Nuclear transitions
- (D) Isotopic transitions

Question 361: Explain the reason why the IR spectra of ethylene molecule does not show a signal, indicating IR absorption, in the region of $1620\text{-}1680\text{ cm}^{-1}$.

Question 362: What will be the colour of the solution that absorbs maximum wavelength of light at 700 nm ?

Question 363: Explain the reason why there is no spin-spin coupling or splitting in ^{13}C NMR?

Question 364: How many carbon signals will the following molecule produce in a ^{13}C NMR spectrum?



- (A) 4
- (B) 5
- (C) 6
- (D) 7

Question 365: Which of the following is true regarding the information that can be obtained using mass spectrometry?

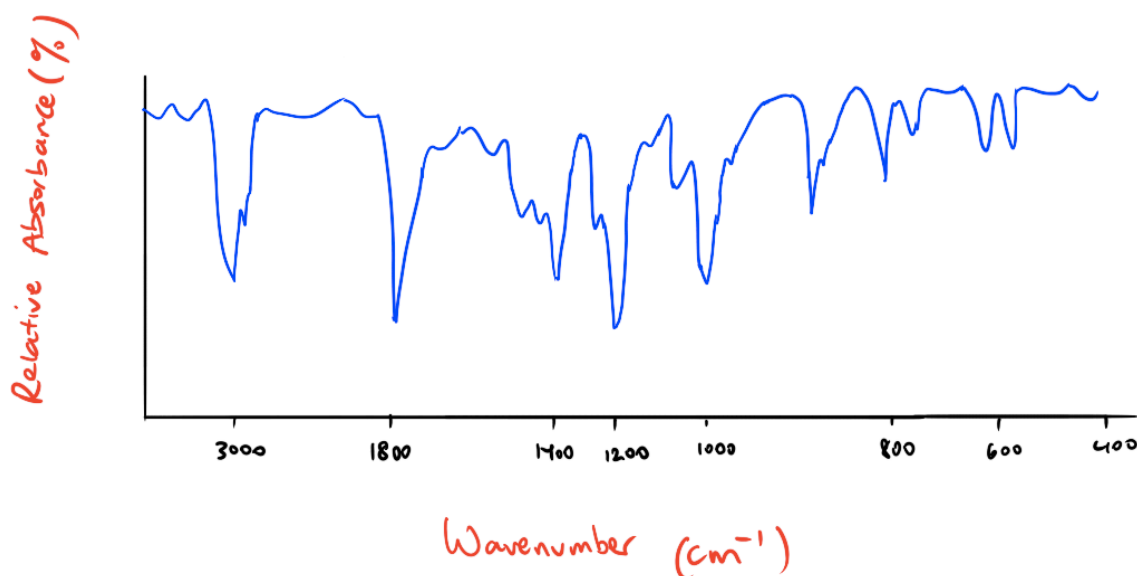
- (A) The number of different hydrogen chemical or electronic environments can be identified.
- (B) The number of different carbon chemical or electronic environments can be identified.
- (C) The molecular mass of the molecule of concern and the molecular mass and its fragments.
- (D) The number of functional groups present in the molecule of concern

Question 366: Which of the following is generally true when a molecule absorbs infrared radiation energy?

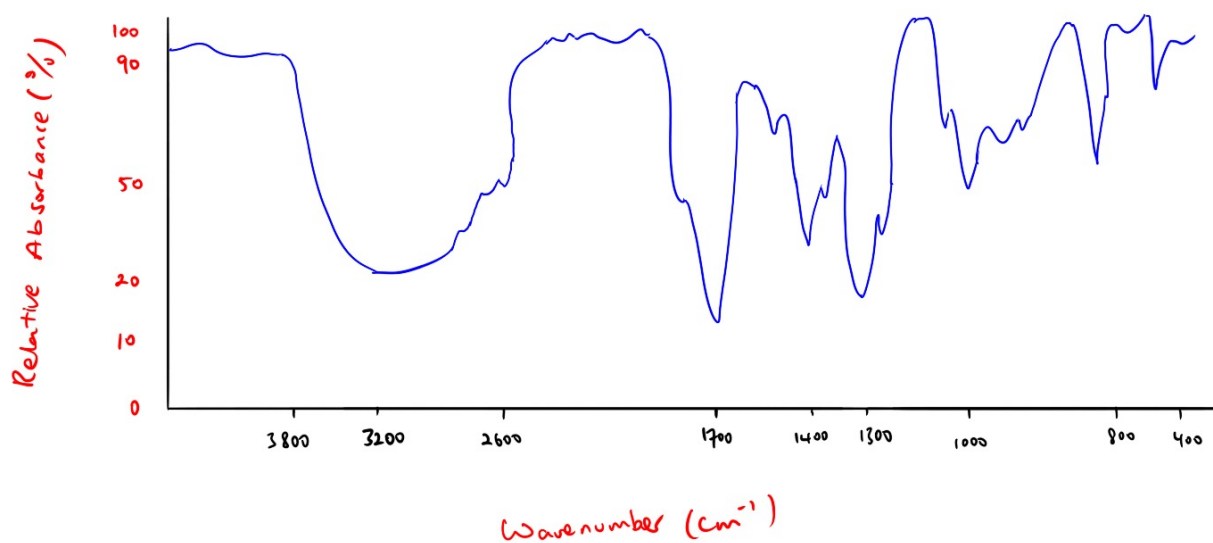
- (A) An electron is knocked off the molecule.
- (B) An electron is absorbed by the molecule.
- (C) The vibration energy of molecule increases.
- (D) An electron is moved to a higher orbital.

Question 367: Assign ethyl ethanoate and ethanoic acid to the following spectra A and B, justifying your assignment.

Spectra A

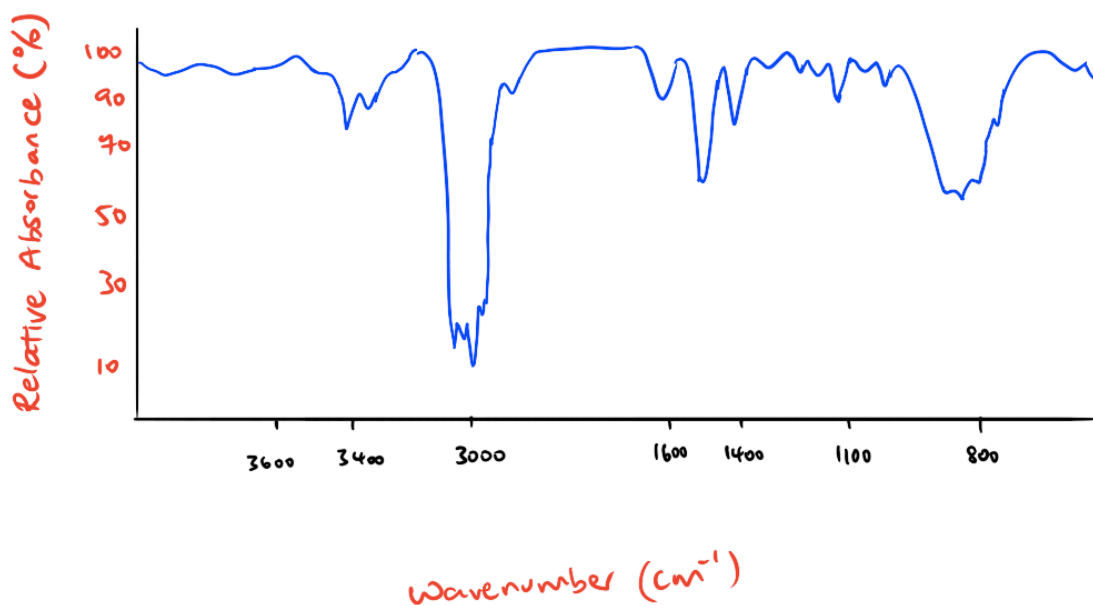


Spectra B

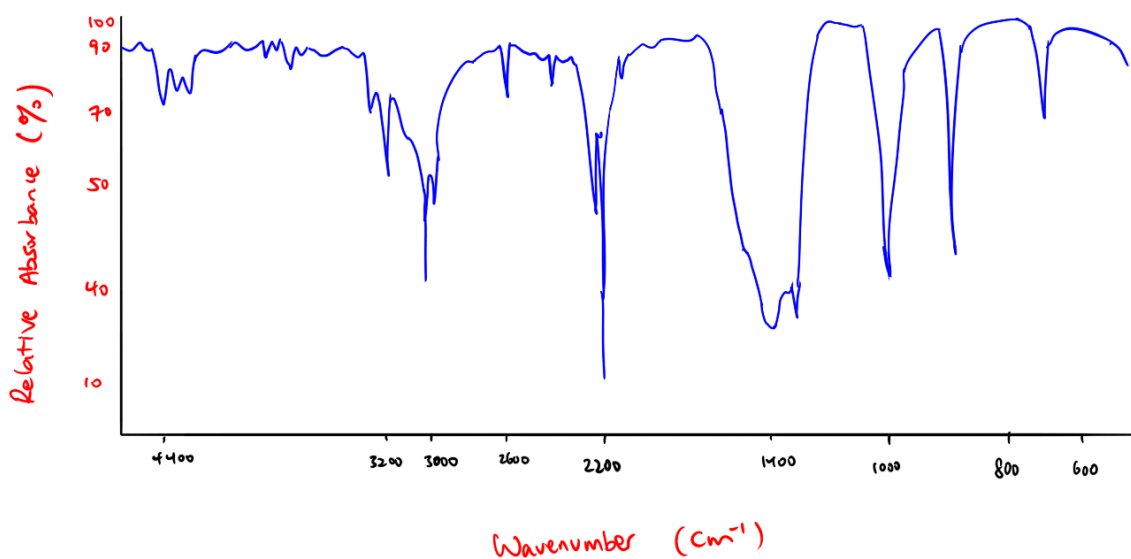


Question 368: Assign butan-1-amine and CH_3CN to the following spectra C and D, justifying your assignment.

Spectra C

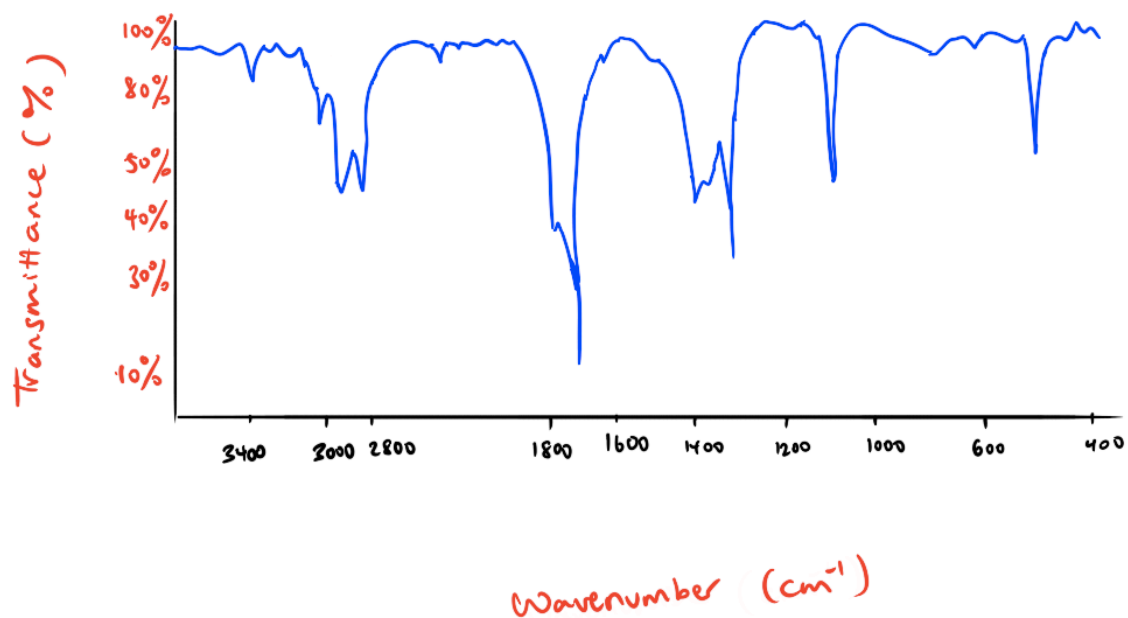


Spectra D

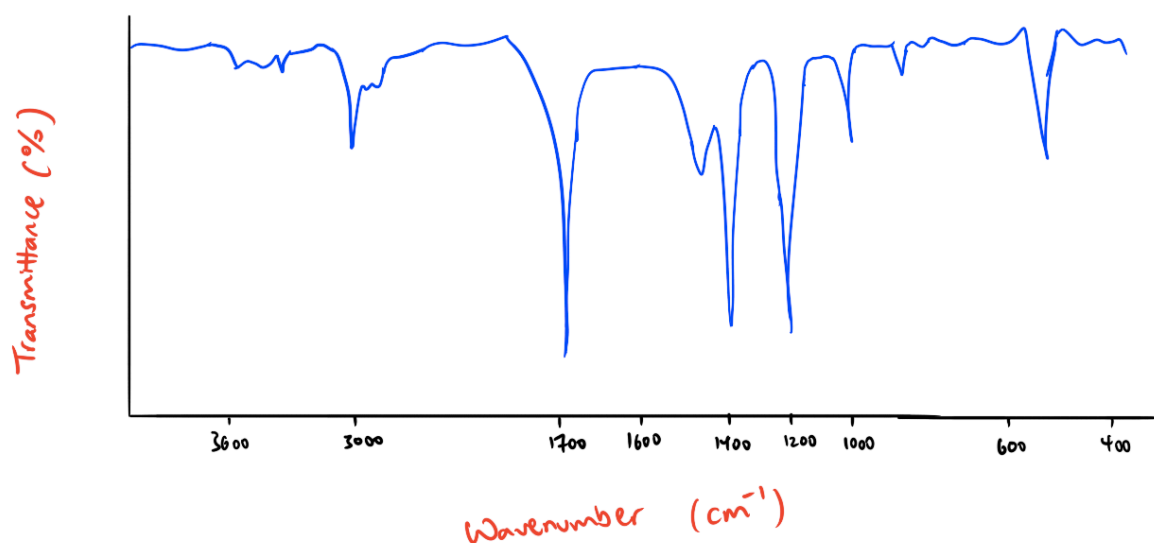


Question 369: Assign ethanal and propanone to the following spectra E and F, justifying your assignment.

Spectra E



Spectra F



Question 370: Describe the reason why C=O bonds have a lower transmittance or percentage absorbance value than C-H bonds in infrared spectroscopy.

Question 371: Describe the relationship between chemical bond strength and vibrational energy and wavenumber.

Question 372: Describe the relationship between the mass of atoms involved in chemical bond to vibrational energy and wavenumber.

Question 373: Describe the relationship between chemical bond length and vibrational energy and wavenumber.

Question 374: Describe the criteria for a molecule to be infrared active, providing an example of an infrared active molecule.

Question 375: Define the term 'complex ion'.

Question 376: Describe an example of a complexation reaction used to test for the presence of a named cation.

Question 377: Describe an example of a complexation reaction used to test for the presence of a named anion.

Question 378: Describe the mechanism to how ionic compounds, such as HCl, can conduct electricity when dissolved in water.

Question 379: Distinguish between intermolecular and intramolecular forces.

Question 380: In your HSC Chemistry, you performed an experiment to calculate the standard enthalpy change of combustion of an alcohol.

- (a) Define what is meant by 'standard enthalpy change of combustion', providing the specific temperature and pressure conditions in your response.
- (b) Write the chemical equation for the combustion of propan-1-ol.
- (c) Suppose that in your experiment, you initially had 50mL of water in the beaker where the heat of combustion raised the water's temperature by 15.7 degrees Celsius. You also measured that 0.3 grams of propanol was used. Calculate the molar enthalpy change of combustion.
- (d) Propose two reasons to account for the error between published and experimental value of enthalpy change due to combustion that was observed. You are told that the published value suggested that the reaction was more exothermic.
- (e) Explain the reason why the enthalpy of combustion is lower when the student repeated the same experiment but with water at a higher initial temperature.
- (f) Explain the reason why students who performed similar experiment with same alcohol with different temperature changes and amount of propanol burnt obtained similar enthalpy change of combustion.

Question 381: Which of the following reactions do you expect to have a negative change in enthalpy of system?

- I. $\text{C}_2\text{H}_5\text{OH (l)} + 3\text{O}_2 \text{ (g)} \rightarrow 2\text{CO}_2 \text{ (g)} + 3\text{H}_2\text{O (l)}$
- II. $\text{HNO}_3 \text{ (aq)} + \text{KOH (aq)} \rightarrow \text{KNO}_3 \text{ (aq)} + \text{H}_2\text{O (l)}$
- III. $\text{H}_2\text{O (g)} \rightarrow \text{H}_2\text{O(l)}$

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) All of the above

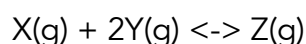
Question 382: Which of the following reactions will not result in an increase in entropy of system?

- (A) A change in the state of two moles of gas reactants to one mole of aqueous product.
- (B) A change in the state of liquid reactants to aqueous products.
- (C) A change in the state of liquid reactants to gaseous products.
- (D) An increase in the system's temperature.

Question 383: Compare the chemical and physical properties of comparable ketone and aldehyde.

Question 384: Explain the difference between the melting and boiling point between comparable alcohol, esters and carboxylic acid.

Question 385: At equilibrium, which of the following is true for the following reaction?



- (A) The equilibrium constant value is less than one.
- (B) $[Y]_{\text{equilibrium}} = 2[X]_{\text{equilibrium}}$
- (C) $[Y]_{\text{equilibrium}} = 2[Z]_{\text{equilibrium}}$
- (D) The rate of reverse reaction is always equal to the rate of the forward rate of reaction, regardless of initial concentration of the reacting species.

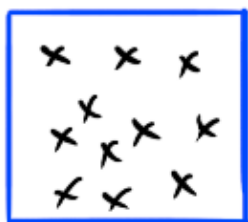
Question 386: At equilibrium, which of the following is true for the following reaction with an equilibrium constant value of 1.5×10^{-5} ?



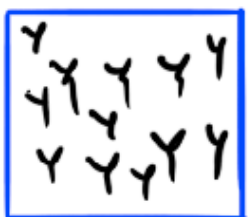
- (A) The equilibrium constant value is greater than one.
- (B) $[C]_{\text{equilibrium}} = [A][B]^2 \times 1.5 \times 10^{-5}$
- (C) $[C]_{\text{equilibrium}} = [A][B] \times 1.5 \times 10^{-5}$
- (D) $[A]_{\text{equilibrium}} = [C]_{\text{equilibrium}}$

Question 387: The equilibrium between X and Y can be expressed $X \rightleftharpoons Y$ with K_{eq} of 1.0×10^{-5} . Which of the following diagram best represents the situation at a molecular level?

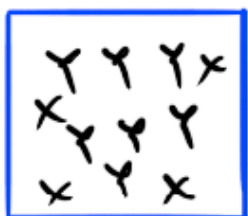
(A)



(B)



(C)

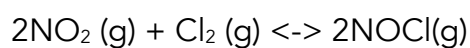


(D)



Question 388: Calculate the volume of water required to be added to 0.5L of 3.0M NaCl to make a sodium chloride solution with a concentration of 1.0M.

Question 389: Using Le Chatelier's Principle, predict which of the following sets of conditions will favour products at equilibrium?



	Temperature of system	Pressure of system
(A)	High	High
(B)	High	Low
(C)	Low	High
(D)	Low	Low

Question 390: Justify whether or not the reaction between butan-1-ol and ethanoic acid is classified as a condensation polymerisation reaction.

Question 391: Calculate the molar solubility of copper (II) hydroxide in a buffer solution at $\text{pH} = 9.20$. Assume that the buffer has a very high buffer capacity.

Question 392: Calculate the molar solubility of calcium phosphate in a solution of calcium nitrate at a concentration of 0.01M .

Question 393: Express the molar solubility of Iron (III) phosphate in terms of 'x', show all your working in your response.

Question 394: Explain how the solubility of silver chloride will when dissolved in a strong acid solution compared to being dissolved in water.

Question 395: Calculate the volume of sodium hydroxide at a concentration of 0.02M that is required to change the pH of a solution containing one litre of HOCl at 0.07M to 7.5 ? You are given that the acid dissociation constant for HOCl to be 4.0×10^{-8} .

Question 396: Calculate the pH of the resulting solution when 25mL of 0.95M of HCl is added to 150mL of 0.31M of KOH after neutralisation?

Question 397: Write the net ionic equation for the reaction between phosphoric acid and potassium hydroxide.

Question 398: Calculate the volume of water required to be added to 100mL of potassium hydroxide with a pH of 13 such that the resulting pH of the solution is 11 ?

Question 398: Calculate the theoretical enthalpy of combustion of methanol using the relevant bond energies from the table below.

Bond	Bond Energy (kJ/mol)
H-H	432
O=O	494
O-H	460
C-H	410
C-O	360
C=O	799
C-C	347
C=C	611

Question 399: The enthalpy of combustion of methanol can also be calculated through a simple experiment that you have performed as part of your HSC Chemistry course.

The results below are from a student who performed the experiment.

Mass of spirit burner and methanol (Before combustion)	50.56 grams
Mass of spirit burner and methanol (After combustion)	49.87 grams
Mass of water in beaker	20.00 grams
Starting temperature of water	32.1 °C
Final temperature of water	37.3 °C

Calculate the heat absorbed by water and the molar enthalpy change of combustion of methanol.

Question 400: Explain the reasons for the published value for the enthalpy of combustion of methanol, being -726 kJ/mol , varies from the values calculated in Question 398 and Question 399.