



UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION
MARCH 2025 SEMESTER

COURSE CODE : HRB10303
COURSE TITLE : CHEMISTRY
PROGRAMME NAME : BACHELOR OF OCCUPATIONAL SAFETY & HEALTH (HONOURS)
DATE : 24 JUNE 2025
TIME : 2:00PM - 5:00PM
DURATION : 3 HOURS



INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. *Tick if applicable*
9. Refer to the attached Formula/ Appendies. *Tick if applicable*

THERE ARE 16 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. What happens when HCl is added to an acetic acid buffer ($\text{CH}_3\text{COOH}/\text{CH}_3\text{COO}^-$)?
 - A. pH rises significantly.
 - B. CH_3COOH increases, CH_3COO^- decreases.
 - C. CH_3COOH dissociates more.
 - D. HCl is converted to OH^- .
2. Which of the following combinations can act as an acidic buffer?
 - A. CH_3COOH and CH_3COONa .
 - B. HCl and NaCl.
 - C. NaOH and NaCl.
 - D. NH_3 and NH_4Cl .
3. The functional group of an alcohol is _____.
 - A. $-\text{SH}$
 - B. $-\text{OH}$
 - C. $-\text{NH}_2$
 - D. $-\text{COOH}$
4. According to the Arrhenius theory, a base is a substance that _____.
 - A. accepts electrons
 - B. donates H^+
 - C. accepts H^+
 - D. produces OH^- in water

5. Which of the following defines Lewis acid?
- A. Donates a proton.
 - B. Accepts a pair of electrons.
 - C. Donates OH^- ions.
 - D. Produces H^+ in solution.
6. The pH of a buffer solution can be calculated using _____.
- A. Avogadro's law
 - B. $\text{pK}_a + \log \left(\frac{[\text{A}^-]}{[\text{HA}]} \right)$
 - C. molarity equation
 - D. K_w expression
7. Which of the following is a primary alkyl group?
- A. $-\text{CH}_3$
 - B. $-\text{C}(\text{CH}_3)_3$
 - C. $-\text{CH}_2\text{CH}_3$
 - D. $-\text{CH}_2-$
8. What is the IUPAC name of $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$?
- A. Methane.
 - B. Propane.
 - C. Pentane.
 - D. Butane.

9. Which of the following molecules can act as a Lewis base?
- A. NH_3
 - B. BF_3
 - C. H^+
 - D. AlCl_3
10. How many carbon atoms are there in dodecane?
- A. 12
 - B. 16
 - C. 10
 - D. 14
11. What is the pH of a solution with $[\text{H}^+] = 1.0 \times 10^{-3} \text{ M}$?
- A. 4.0
 - B. 2.0
 - C. 5.0
 - D. 3.0
12. Identify the conjugate base of H_2SO_4 .
- A. H_3O^+
 - B. OH^-
 - C. SO_4^{2-}
 - D. HSO_4^-

13. What type of quantity is specific heat capacity?
- A. Constant.
 - B. Experimental.
 - C. Extensive.
 - D. Intensive.
14. Which of the following is TRUE about Hess's Law?
- A. It states that enthalpy change is path independent.
 - B. It depends on the reaction pathway.
 - C. It applies only to endothermic reactions.
 - D. It only works with gaseous reactants.
15. What does it mean if the equilibrium constant $K \gg 1$?
- A. The reaction is product-favored.
 - B. The reaction barely proceeds.
 - C. Reactants dominate the reaction.
 - D. The system is not at equilibrium.
16. What happens at equilibrium?
- A. The reaction stops completely.
 - B. Concentrations of reactants and products are always equal.
 - C. Reactants are completely converted to products.
 - D. The rate of forward and reverse reactions are equal.

17. When investigating a reaction's mechanism, why is it useful to study the rate?
- A. It tells us the temperature of the solution.
 - B. It helps identify the order of elementary steps.
 - C. It shows which product is most abundant.
 - D. It gives the energy released in joules.
18. Which of the following compounds is correctly named?
- A. 3-methyl-2-butene.
 - B. 2-methyl-2-butene.
 - C. 2-butene-3-methyl.
 - D. methyl-3-butene.
19. Which of the following is a saturated hydrocarbon?
- A. Benzene.
 - B. Butane.
 - C. Ethyne.
 - D. Ethene.
20. A strong acid _____.
- A. has a weak conjugate base.
 - B. dissociates partially in water.
 - C. does not conduct electricity.
 - D. has a low K_a value.

21. If the slope of a concentration vs. time curve becomes less steep over time, it indicates _____.
- A. the reaction has stopped completely
 - B. the reaction is slowing down
 - C. the reaction is accelerating
 - D. the reaction is reaching equilibrium
22. Which species acts as a Bronsted-Lowry base?
- A. NH_4^+
 - B. OH^-
 - C. HCl
 - D. H_3O^+
23. Which equation represents the enthalpy change of a reaction?
- A. $\Delta H = m \times C_p$
 - B. $\Delta H = \Sigma H_f(\text{products}) - \Sigma H_f(\text{reactants})$
 - C. $\Delta H = E + PV$
 - D. $\Delta H = C_p \times \Delta T$
24. During a reaction, the concentration of the reactants halves in 10 minutes. What can be concluded about the rate if the initial concentration was higher?
- A. The rate would be faster.
 - B. The rate would be slower.
 - C. The rate would become zero.
 - D. The rate would be unchanged.

25. How can the effect of concentration on reaction rate be experimentally observed?
- A. By measuring the weight of the reactants.
 - B. By changing the volume of the container.
 - C. By measuring temperature change only.
 - D. By plotting concentration vs. time and analyzing the slope.
26. A tangential line drawn at $t = 5$ hours on a concentration vs. time curve will give the _____.
- A. the average rate over 5 hours.
 - B. the equilibrium constant.
 - C. the final product yield.
 - D. the instantaneous rate at 5 hours.
27. What action would likely make a slow reaction proceed more quickly?
- A. Removing a catalyst.
 - B. Decreasing the temperature.
 - C. Reducing the reactant concentration.
 - D. Increasing the reactant concentration.
28. Which of the following best defines "instantaneous rate"?
- A. The total rate over the reaction.
 - B. The average rate over a long period.
 - C. The rate measured at a specific moment using the tangent slope.
 - D. The final reaction rate after equilibrium.

29. What effect does a decrease in H_2O_2 concentration have on its rate of decomposition?
- A. The rate of decomposition decreases.
 - B. The rate of decomposition increases.
 - C. The rate of decomposition stays constant.
 - D. The reaction stops immediately.
30. The rate of a chemical reaction is important to _____.
- A. predict how long a reaction will take and control the process.
 - B. maximize product purity.
 - C. minimize chemical hazards.
 - D. design colorful experiments.
31. What does the rate of a chemical reaction measure?
- A. The mass of the products formed.
 - B. The energy produced.
 - C. The change in concentration of reactants or products over time.
 - D. The time needed to complete a reaction.
32. If you want a reaction to proceed faster, which of the following should you consider adding?
- A. Catalyst
 - B. Solvent
 - C. Buffer
 - D. Inhibitor

33. According to Le Châtelier's Principle, if the pressure on a gaseous equilibrium system is increased, the system will shift _____.
- A. toward the side with fewer moles of gas
 - B. toward the side with more moles of gas
 - C. in the direction of the reactants only
 - D. in the direction of the products only
34. In the equilibrium reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$, adding more H_2 will _____.
- A. decrease HI concentration
 - B. have no effect
 - C. shift equilibrium to the left
 - D. shift equilibrium to the right
35. What is the general formula for alkenes?
- A. $\text{C}_n\text{H}_{2n+1}\text{OH}$
 - B. $\text{C}_n\text{H}_{2n-2}$
 - C. C_nH_{2n}
 - D. $\text{C}_n\text{H}_{2n+2}$
36. For the endothermic reaction $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$, increasing temperature will _____.
- A. have no effect
 - B. decrease the value of K
 - C. shift equilibrium to the right
 - D. shift equilibrium to the left

37. The term Specific heat capacity referring to _____.
- A. heat required to raise 1 kg of substance by 1°C
 - B. total heat stored in a substance
 - C. heat required to raise 1 mole of substance by 1°C
 - D. heat required to raise the temperature of a substance
38. Which compound is an example of aromatic hydrocarbon?
- A. Butyne.
 - B. Benzene.
 - C. Propane.
 - D. Cyclohexane.
39. In which case a change in pressure DOES NOT affect the position of equilibrium?
- A. When pressure is increased in a system of only solids.
 - B. When the number of moles of gases is the same on both sides.
 - C. When the pressure is decreased in a gas-phase reaction.
 - D. When the number of gas molecules is different on both sides.
40. The reaction quotient (Q) is used to _____.
- A. change the equilibrium constant
 - B. predict temperature effects
 - C. determine if a reaction is at equilibrium
 - D. find the rate constant

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

A chemical manufacturer is planning a large-scale synthesis that involves the decomposition of hydrogen peroxide (H_2O_2). As a chemical engineer, you are required to analyze the kinetics of the reaction and suggest optimizations.

- (a) Explain why understanding reaction rates is crucial in planning and optimizing industrial chemical reactions.

(3 marks)

- (b) Describe the difference between average rate and instantaneous rate of a chemical reaction. Provide one example for each.

(4 marks)

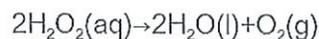
- (c) Identify and explain three factors that can influence the rate of a chemical reaction in an industrial setting.

(3 marks)

- (d) Explain how a catalyst can affect the rate of the reaction and discuss one reason it is advantageous in industrial processes.

(3 marks)

- (e) The decomposition of hydrogen peroxide follows the reaction:



If the concentration of H_2O_2 drops from 1.00 M to 0.60 M in 2 hours, calculate the average rate of decomposition in M/hour.

(2 marks)

- (f) For the same reaction, a student collected the following data:

Initial concentration of $\text{H}_2\text{O}_2 = 0.800 \text{ M}$

After 4 hours, concentration = 0.400 M

Calculate the **average rate** of decomposition over the 4-hour period and compare it with the value obtained in part (e). By analyzing the calculated average rate, what the trend might indicate about the reaction?

(5 marks)

Question 2

A chemist is reviewing several classes of organic compounds and their structural characteristics for a research project involving hydrocarbons and aromatic derivatives. Answer the following based on your understanding of organic chemistry:

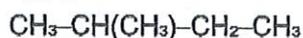
- (a) Differentiate between alkanes, alkenes, and alkynes in terms of bonding and structure. Include definitions of saturation and provide one structural or named example for each.

(4 marks)

- (b) Identify two functional groups that contain a carbon-oxygen double bond (C=O). For each group, name the functional group, describe its general structure, and provide one example (name or structure).

(4 marks)

- (c) Apply the IUPAC rules to name the following compound:



Explain your steps.

(3 marks)

- (d) Describe the nomenclature for benzene compound. Define the terms ortho, meta, and para, and illustrate with a common example such as xylene.

(5 marks)

- (e) Compare the properties of Lewis acids and Lewis bases. In your answer, define each, describe their role in reactions, and provide two examples of each.

(4 marks)

Question 3

A student investigates the heat energy required to change the temperature and phase of water in various forms during an experiment. Using the following data, answer the questions below:

Specific heat capacity of water: **4.18 J/g·°C**

Specific heat capacity of ice: **2.1 J/g·°C**

Heat of fusion of ice: **334 J/g**

Heat of vaporization of water: **2260 J/g**

- (a) Calculate the amount of heat required to raise the temperature of **200 g of water** from **25°C to 75°C**.

(3 marks)

- (b) Calculate the heat needed to melt **100 g of ice** at **0°C**.

(2 marks)

- (c) Calculate the **total heat** required to convert **150 g of ice** at **-10°C** to **steam** at **100°C**, assuming no heat losses.

Break it into:

Heating ice from **-10°C** to **0°C**

Melting ice at **0°C**

Heating water from **0°C** to **100°C**

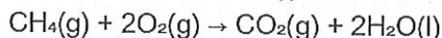
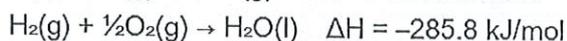
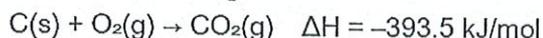
Vaporizing water at **100°C**

(10 marks)

- (d) State Hess's Law and explain how it is used to determine the enthalpy change of a reaction.

(3 marks)

- (e) Given the following reactions:



Use **Hess's Law** to calculate the **enthalpy change** for reaction (3).

(2 marks)

Question 4

Using your understanding of periodic trends and periodic table structure, answer the following questions. Justify your answers with relevant reasoning.

- (a) Apply the concept of effective nuclear charge to determine the order of increasing atomic radius among the following elements: Na, Al, P, Cl. Explain how periodic trends influence your arrangement.

(5 marks)

- (b) Use your knowledge of shielding effect and atomic size to rank the elements Li, Na, K in order of decreasing first ionization energy.

(5 marks)

- (c) Demonstrate the correct order of ionic radii from smallest to largest for the ions Mg^{2+} , Na^+ , and Al^{3+} . Justify your answer by applying knowledge of ionic charge and electron configuration.

(5 marks)

- (d) Apply periodic trends to classify the oxides of the elements Na, P, Cl, Ca as either acidic or basic. Explain how this reflects their metallic or nonmetallic character and position in the periodic table.

(5 marks)

END OF EXAMINATION PAPER

FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent Values
Mass	1 kg = 1000 g = 0.001 metric ton (tonne) = 2.20462 lb _m = 35.27392 oz 1 lb _m = 16 oz = 5 × 10 ⁻⁴ ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10 ⁶ microns (μm) = 10 ¹⁰ angstroms (Å) = 39.37 in = 3.2808 ft = 1.0936 yd = 0.0006214 mile 1 ft = 12 in = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m ³ = 1000 L = 10 ⁶ cm ³ = 10 ⁶ mL = 35.3145 ft ³ = 219.97 imperial gallons = 264.17 gal = 1056.68 qt 1 ft ³ = 1728 in ³ = 7.4805 gal = 29.922 qt = 0.028317 m ³ = 28.317 L
Density	1 g/cm ³ = 1000 kg/m ³ = 62.43 lb _m /ft ³ = density of liquid water at 4°C (reference for specific gravities)
Force	1 N = 1 kg·m/s ² = 10 ⁵ dynes = 10 ⁵ g·cm/s ² = 0.22481 lb _f 1 lb _f = 32.174 lb _m ·ft/s ² = 4.4482 N = 4.4482 × 10 ³ dynes
Pressure	1 atm = 1.01325 × 10 ⁵ N/m ² (Pa) = 101.325 kPa = 1.01325 bar = 1.01325 × 10 ⁶ dynes/cm ² = 14.696 lb _f /in ² (psi) = 760 mm Hg at 0°C (torr) = 10.333 m H ₂ O(l) at 4°C = 29.921 inches Hg at 0°C = 406.8 inches H ₂ O(l) at 4°C
Energy	1 J = 1 N·m = 10 ⁷ ergs = 10 ⁷ dyne·cm = 1 kg·m ² /s ² = 2.778 × 10 ⁻⁷ kW·h = 0.23901 cal = 0.23901 × 10 ⁻³ kcal (food calorie) = 0.7376 ft·lb _f = 9.486 × 10 ⁻⁴ Btu
Power	1 W = 1 J/s = 1 N·m/s = 0.23901 cal/s = 0.7376 ft·lb _f /s = 9.486 × 10 ⁻⁴ Btu/s = 1.341 × 10 ⁻³ hp

Example: The factor to convert grams to lb_m is $\left(\frac{2.20462 \text{ lb}_m}{1000 \text{ g}}\right)$ or $\left(\frac{1 \text{ lb}_m}{453.593 \text{ g}}\right)$.

Specific heat capacity for water (C_p) = 4.18 J/g C

ATOMIC WEIGHTS AND NUMBERS

Atomic weights apply to naturally occurring isotopic compositions and are based on an atomic mass of $^{12}\text{C} = 12$

Element	Symbol	Atomic Number	Atomic Weight	Element	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	—	Iridium	Ir	77	192.2
Aluminum	Al	13	26.9815	Iron	Fe	26	55.847
Americium	Am	95	—	Krypton	Kr	36	83.80
Antimony	Sb	51	121.75	Lanthanum	La	57	138.91
Argon	Ar	18	39.948	Lawrencium	Lr	103	—
Arsenic	As	33	74.9216	Lead	Pb	82	207.19
Astatine	At	85	—	Lithium	Li	3	6.939
Barium	Ba	56	137.34	Lutetium	Lu	71	174.97
Berkelium	Bk	97	—	Magnesium	Mg	12	24.312
Beryllium	Be	4	9.0122	Manganese	Mn	25	54.9380
Bismuth	Bi	83	208.980	Mendelevium	Md	101	—
Boron	B	5	10.811	Mercury	Hg	80	200.59
Bromine	Br	35	79.904	Molybdenum	Mo	42	95.94
Cadmium	Cd	48	112.40	Neodymium	Nd	60	144.24
Calcium	Ca	20	40.08	Neon	Ne	10	20.183
Californium	Cf	98	—	Neptunium	Np	93	—
Carbon	C	6	12.01115	Nickel	Ni	28	58.71
Cerium	Ce	58	140.12	Niobium	Nb	41	92.906
Cesium	Cs	55	132.905	Nitrogen	N	7	14.0067
Chlorine	Cl	17	35.453	Nobelium	No	102	—
Chromium	Cr	24	51.996	Osmium	Os	75	190.2
Cobalt	Co	27	58.9332	Oxygen	O	8	15.9994
Copper	Cu	29	63.546	Palladium	Pd	46	106.4
Curium	Cm	96	—	Phosphorus	P	15	30.9738
Dysprosium	Dy	66	162.50	Platinum	Pt	78	195.09
Einsteinium	Es	99	—	Plutonium	Pu	94	—
Erbium	Er	68	167.26	Polonium	Po	84	—
Europium	Eu	63	151.96	Potassium	K	19	39.102
Fermium	Fm	100	—	Praseodymium	Pr	59	140.907
Fluorine	F	9	18.9984	Promethium	Pm	61	—
Francium	Fr	87	—	Protactinium	Pa	91	—
Gadolinium	Gd	64	157.25	Radium	Ra	88	—
Gallium	Ga	31	69.72	Radon	Rn	86	—
Germanium	Ge	32	72.59	Rhenium	Re	75	186.2
Gold	Au	79	196.967	Rhodium	Rh	45	102.905
Hafnium	Hf	72	178.49	Rubidium	Rb	37	84.57
Helium	He	2	4.0026	Ruthenium	Ru	44	101.07
Holmium	Ho	67	164.930	Samarium	Sm	62	150.35
Hydrogen	H	1	1.00797	Scandium	Sc	21	44.956
Indium	In	49	114.82	Selenium	Se	34	78.96
Iodine	I	53	126.9044	Silicon	Si	14	28.086

Atomic weights apply to naturally occurring isotopic compositions and are based on an atomic mass of $^{12}\text{C} = 12$

Element	Symbol	Atomic Number	Atomic Weight	Element	Symbol	Atomic Number	Atomic Weight
Silver	Ag	47	107.868	Tin	Sn	50	118.69
Sodium	Na	11	22.9898	Titanium	Ti	22	47.90
Strontium	Sr	38	87.62	Tungsten	W	74	183.85
Sulfur	S	16	32.064	Uranium	U	92	238.03
Tantalum	Ta	73	180.948	Vanadium	V	23	50.942
Technetium	Tc	43	—	Xenon	Xe	54	131.30
Tellurium	Te	52	127.60	Ytterbium	Yb	70	173.04
Terbium	Tb	65	158.924	Yttrium	Y	39	88.905
Thallium	Tl	81	204.37	Zinc	Zn	30	65.37
Thorium	Th	90	232.038	Zirconium	Zr	40	91.22
Thulium	Tm	69	168.934				

THE GAS CONSTANT (R)

8.314 $\text{m}^3 \cdot \text{Pa} / (\text{mol} \cdot \text{K})$

0.08314 $\text{L} \cdot \text{bar} / (\text{mol} \cdot \text{K})$

0.08206 $\text{L} \cdot \text{atm} / (\text{mol} \cdot \text{K})$

62.36 $\text{L} \cdot \text{mm Hg} / (\text{mol} \cdot \text{K})$

0.7302 $\text{ft}^3 \cdot \text{atm} / (\text{lb-mole} \cdot ^\circ\text{R})$

10.73 $\text{ft}^3 \cdot \text{psia} / (\text{lb-mole} \cdot ^\circ\text{R})$

8.314 $\text{J} / (\text{mol} \cdot \text{K})$

1.987 $\text{cal} / (\text{mol} \cdot \text{K})$

1.987 $\text{Btu} / (\text{lb-mole} \cdot ^\circ\text{R})$

