



UNIVERSITY OF KELANIYA - SRI LANKA
FACULTY OF SCIENCE

Bachelor of Science General Degree Examination – December 2022

Academic Year 2020/2021 – Semester I

CHEM 11601 and CHEM 11511 (Repeat) - Calculations in Chemistry

Number of Questions: Four (04)

Time: Two (02) hours

Number of pages: Four (04)

Answer all four (04) questions

1.

a) Factorize completely $x^4 - y^4$.

(05 marks)

b) Simplify $\frac{5\sqrt{2}}{\sqrt{8}-\sqrt{7}}$

(10 marks)

c) Given that $y = \frac{1}{64}x^3$ express each of the following in the form of kx^n , where k and n are constants.

i. $y^{\frac{1}{3}}$

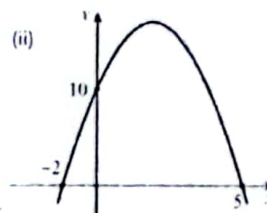
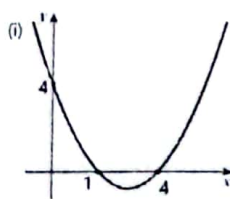
ii. $4y^{-1}$

(10 marks)

d) Solve the equation $5^{2x} + 7(5^x) - 30 = 0$, giving your answer to 2 decimal places.

(10 marks)

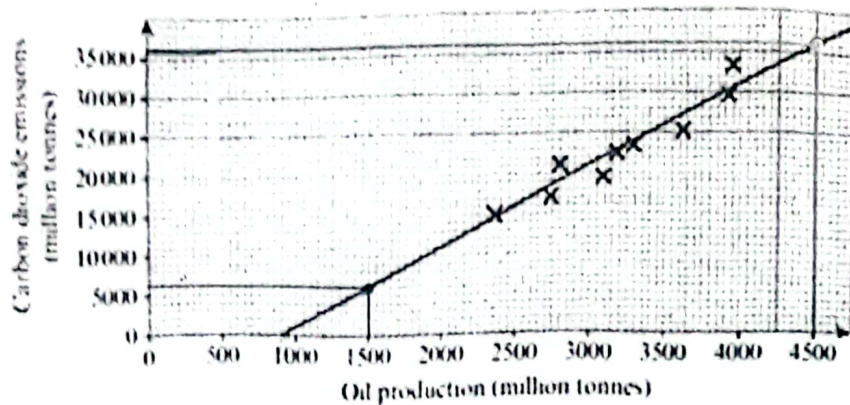
e) Two sketches below are graphs of quadratic functions in the form of $y = ax^2 + bx + c$. Find the values of a , b and c of each.



(20 marks)

f) The scatter graph shows the oil production (P) and carbon dioxide emissions (E) for various years since 1970. A line of the best fit has been added to the scatter graph.

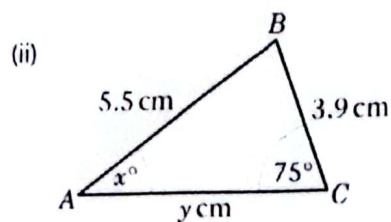
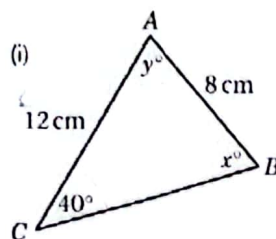
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- Find the gradient of the best fit line.
- Formulate a linear expression linking P and E given the relationship in the form of $y = mx + C$.
- Interpret the value of m in your expression.
- With reference to your value of C , comment on the validity of the expression for small values of P.

(25 marks)

g) Find the values of x and y of the accompanying triangles.



(20 marks)

2.

- Given that $3 + 2 \log_2 x = \log_2 y$, show that $y = 8x^2$.
 - Express $\log_p 12 - (\frac{1}{2} \log_p 9 + \frac{1}{3} \log_p 8)$ as a single logarithm to base p .

(25 marks)

b)

- Sketch the graph of $y = \sin \theta^\circ$ in the interval $0 \leq \theta \leq 2\pi$.
- Sketch the $y = 3 \sin \theta^\circ$ on the graph (i).

(20 marks)

c) Given that x is an angle measured in radians, express the below trigonometric functions in terms of $\sin x$.

- $\sin(2\pi - x)$

ii. $\cos\left(\frac{\pi}{2} + x\right)$

(12 marks)

d) The speed of light is 299 792 458 m/s. Write this speed correct to

- 3 significant figures
- 6 significant figures

(08 marks)

e) Expand the function $\sum_{n=0}^{\infty} \left(\frac{(-1)^n x^{2n+1}}{(2n+1)!} \right)$.

(10 marks)

f) If a 10.00 L flask at 500 K is filled with a 0.30 mole of hydrogen and 0.30 mole of iodine, what are the equilibrium concentrations of the three gases? The equilibrium constant $K_C = 45.0$. The relevant reaction is



Note: use the knowledge of roots of a quadratic function to solve this problem.

(25 marks)

3. ✓

a) Differentiate the following functions with respect to x.

- $y = e^x - 2x$
- $y = \ln(x^2 - 2)$
- $y = 2x^3 - 3x^2 + 18$
- $y = (x^3 + 4)(x^2 + 8)$
- $y = (5x + 1)/(3x - 4)$

(25 marks)

b) Find the second order derivatives with respect to x for the following functions.

- $y = 2x^2 - 3x^5$
- $y = 3x^5 + 6x^4 + 5$

(20 marks)

c) According to the van der Waals equation for a real gas, the pressure P of gas is related to its volume V and temperature T by the equation,

$$P = \frac{nRT}{(V - nb)} - \frac{an^2}{V^2}$$

in which R is the gas constant and a and b are constants that depend upon the gas being considered. Treating T and n as constants, write expressions for,

- dP/dV
- d^2P/dV^2

(25 marks)

d) Find the following higher order partial derivatives for the function:

$$z = 2x^4 - 5x^3y^3 - y^4$$

- i. f_{xx}
- ii. f_{xy}
- iii. f_{yy}

(30 marks)

✓ 4.

a) Integrate the following functions with respect to x.

- i. $(x^5 + x^7)$
- ii. xe^x
- iii. $4x^3(x^4 + 2)^6$
- iv. $\frac{\ln x}{x^3}$
- v. $\sin x \cos x$

(25 marks)

b) Evaluate $\int_0^1 f(x) dx$ for the following functions.

- i. $f(x) = x^3$
- ii. $f(x) = 2x$

(20 marks)

c) Use the Ideal gas equation $PV=nRT$ to verify the triple product rule (cycle rule).
(Hint: $P=nRT/V$; $V=nRT/P$; $T=PV/nR$; $-PV/nRT=-1$)

(30 marks)

d) When a liquid is in equilibrium with its vapor, the vapor pressure P is related to the temperature T by the Clausius-Clapeyron equation;

$$\frac{d(\ln P)}{dT} = \frac{\Delta H_e}{RT^2}$$

In which ΔH_e is the enthalpy of vaporization and R is the gas constant. If the vapor pressure is P_0 when the temperature is T_0 , show that,

$$P = P_0 \exp \left\{ \frac{\Delta H_e}{R} \left[\frac{1}{T_0} - \frac{1}{T} \right] \right\}$$

(25 marks)