UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF INDUSTRIAL TECHNOLOGY

FINAL EXAMINATION

JANUARY 2016 SEMESTER

COURSE CODE	:	JCB 40104
COURSE TITLE	:	CHEMICAL AND BIOPROCESS INSTRUMENTATION
PROGRAMME LEVEL	:	BACHELOR
DATE	:	19 MAY 2016
TIME	:	2.30 PM – 5.30 PM
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 consists of TWO (2) sections.

4. Answer ALL questions in Section A. Choose ONE (1) question in Section B.

5. Please write your answers on the answer booklet provided.

6. Please answer all questions in English only.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 80 Marks)

INSTRUCTION: Answer ALL Questions
Please use the answer booklet provided.

Question 1

(a)   Measurement is important in our daily life especially in chemical and bioprocess industry.

　　i.   Define the meaning of measurement and give TWO (2) examples.

(4 marks)

　　ii.   There are two predetermined standards that are usually used in chemical and bioprocess, which is IUPAC and SI units. Explain SI units and list TWO (2) examples.

(3 marks)

(b)   Measurements have to be reported in a correct number of significant figures. List the significant figures for those number :

　　i.   0.00068 m
　　ii.   306500 km
　　iii. 1.05×10^6 L
　　iv.   4.0900 cm
　　v.   33.2005 M

(5 marks)

No. of	Confidence Level		
Observations	Q_{90}	Q_{95}	Q_{99}
3	0.941	0.970	0.994
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568
15	0.338	0.384	0.475
20	0.300	0.342	0.425
25	0.277	0.317	0.393
30	0.260	0.298	0.372

Table 1: Rejection Quotient, Q, at Different Confidence Limits

(c)   In a chemical and bioprocess instrumentation usually there is questionable data. Evaluate the sets of data received below using Q-test at confidence of 95 % and 90%. Evaluate the data by using **mean, standard deviation** and discuss whether the data should be rejected or not using **Q test**. Refer Table 1 for 90% and 95% confidence level.

   i.   Data obtained for the measurement of Hg^{2+} ions in waste water sample are 5.3 ppm, 5.0 ppm, 4.7 ppm, 4.4 ppm, 5.5 ppm and 3.2 ppm. Evaluate the given set of data in table form.

(5 marks)

   ii.   Data obtained for the measurement of Cd^{2+} in electroplating industry are 7.5ppm, 7.2ppm, 6.8ppm, 7.9 ppm and 5.8ppm.

(5 marks)

(d)   Pressure gauges A and B have a full scale (FS) accuracy of ± 2.5%. Sensor C has a range of 0 - 1 bar and sensor D is 0 - 10 bar. Explain which gauge is more suitable to be used if the reading is 0.89 bars.

(3 marks)

Question 2

(a)   Electroanalytical methods are a class of techniques in analytical chemistry which study an analyte by measuring the potential (volts) and/or current (amperes) in an electrochemical cell containing the analyte. List and explain the **THREE (3)** main category of electroanalytical method.
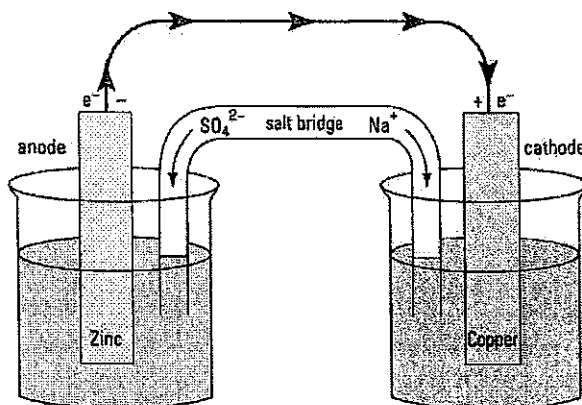
(6 marks)

Figure 1: A galvanic electrochemical cell

(b)   Figure 1 shows a galvanic electrochemical cell which consists of two solutions connected by a salt bridge and electrodes to form electrical circle.

   i.   Identify **TWO (2)** ways on how the electrodes contacts

(2 marks)

   ii.   Interpret the half equation that occur at the left and right electrode. Finally, write the overall equation to combine both half equation

(4 marks)

   iii.   State the differences between electrolytes and non-electrolytes in and give **ONE (1)** example.

(3 marks)

Question 3

(a) Electromagnetic radiation or radiant energy comes from the sun. The different types of radiation are called electromagnetic spectrum EMS.

    i. Electromagnetic Spectrum (EMS) can be divided into **SEVEN (7)** categories. List them.

        (2 marks)

    ii. Types of spectroscopy usually comes from their energy source. Give **TWO (2)** types of spectroscopy and their applications

        (3 marks)

(b) Electromagnetic radiation consists of an oscillating electric and magnetic field that carries energy through space at the speed of light, c .The wavelength of radiation, λ is related to its frequency, v. $c = \lambda v$

(Planck constant, $h = 6.626 \times 10^{-34}\ J\ s^{-1}$ $c = 3 \times 10^{10}\ cm\ s^{-1}$)

    i. Analysed the energy and frequencies of radiation at wavelength 2000 Å and 6000 Å.

        (4 marks)

    ii. Convert the wavelength $\lambda = 300$ Å into frequency and wavenumber.

        (3 marks)

(c) In chemical and bioprocess industry, spectroscopy is considered as a great analytical technique for identification of organic and inorganic compound. The analytical technique of spectroscopy is based on the absorption or emission of electromagnetic radiation.

    i. Briefly explain the spectroscopy and spectrum.

        (3 marks)

    ii. Explain the five major instrumentation unit in spectroscopy.

        (5 marks)

Question 4

(a)   Chromatography is the laboratory techniques used for the separation of mixtures. In chromatography a mobile phase carrying a mixture is caused to move in contact with a selectively absorbent stationary phase. There are numbers of different kinds of chromatography, which differ in the mobile and the stationary phase used. Analyse and explain the **FIVE (5)** basic components of gas chromatography.

(10 marks)

(b)   Gas chromatography is a type of chromatography used in chemistry for analyzing and separating compounds that can be convert to gas without decomposition.

    i.   Define retention time in gas chromatography.

(2 marks)

    ii.   Describes **FOUR (4)** factors that influence retention time.

(4 marks)

(c)   Gas chromatography is similar to fractional distillation. Identify **TWO (2)** advantages of Gas Chromatography (GC).

(4 marks)

SECTION B (Total: 20 Marks)

INSTRUCTION: Answer ONE (1) Question only

Please use the answer booklet provided.

Question 1

a.

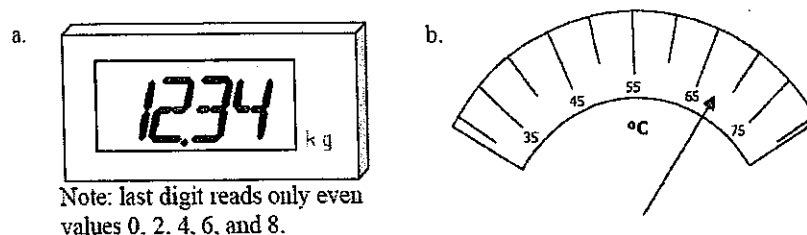Note: last digit reads only even values 0, 2, 4, 6, and 8.

b.

Figure 2

(a) Write the nominal value, resolution, reading error, and units for the following instruments.

(8 marks)

(b) A temperature measurement is reported as 25.3 ± 0.000034 °C. Does the measurement make sense? Explain.

(6 marks)

(c) Round the value 1257.469575 to each successive decimal place, one at a time.

(6 marks)

Question 2

(a) Calculate the energy of a mole of photons corresponding to a wavelength of 300 nm.

(3 marks)

(b) Write the Beer's Law

(2 marks)

(c) Calculate the absorbance of an organic dye C =7×10-4 mol L^{-1}, knowing that the molar absorptivity ε = 650 mol L^{-1} cm^{-1} and that the length of the optical path of the cell used is 2×10^{-2} m. Evaluate the absorbance if the cell used was of double its present thickness.

(6 marks)

(d)   A 1.28×10^{-4} M solution of potassium permanganate has a transmittance of 0.5 when measured in a 1 cm cell at 525 nm.

  i.   Calculate the molar absorptivity coefficient for the permanganate at this wavelength.

(4 marks)

  ii.   If the concentration is doubled what would be the absorbance and the percentage transmittance of the new solution?

(5 marks)

END OF EXAMINATION PAPER