Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	NANOSTRUCTURED MATERIALS
COURSE CODE	:	BWC 30903
PROGRAMME	:	BWC
EXAMINATION DATE	:	JUNE/JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND SELECT **TWO** QUESTIONS IN **SECTION B**.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

SECTION A

Q1 (a) Briefly explain the energy band gap and how catalyst is fabricated by exploiting the energy band gap of materials chemical reaction.

(8 marks)

(b) Metal such as iron is solid and mercury is in liquid phase at room temperature. Explain how mercury naturally forms liquid phase at room temperature.

(9 marks)

(c) Calculate the atomic packing density along [000] direction of aluminum (Al). Express your answer in units of atoms cm^{-1}.

(8 marks)

Q2 (a) Explain on how to achieve vacuum condition of outer space in a Field Emission Scanning Electron Microscope (FESEM) machine.

(9 marks)

(b) What is the collision condition of electrons during FESEM operation? How can these electrons be used to create patterning of materials on polymer resist used to covered substrate surface?

(8 marks)

(c) Calculate the Bohr radius for hydrogen states from n=1 to n= 3. The formula to calculate Bohr orbital is as below, and later schetch the standing wave in the given **Figure 2(c).**

$$r_n = \frac{\hbar^2 n^2}{m_e k e^2 Z} = \frac{a_0 n^2}{Z} = \frac{52.9 n^2}{Z} \text{ pm}$$

(8 marks)

SECTION B

Q3 (a) Elaborate the process to fabricate nanoparticles either from the photolithography or Electron Beam Lithography (EBL) technique.
(9 marks)

(b) Describe the limitations in today's photolithography when it comes to decreasing the feature size.
(8 marks)

(c) What are the advantages and the disadvantages of EBL versus photolithography?
(8 marks)

Q4 (a) What kind of surface properties is needed to obtain a super hydrophobic surface?
(9 marks)

(b) Elaborate the uniqueness of Carbon and its materials.
(8 marks)

(c) Describe a technique to fabricate Carbon Nanotube.
(8 marks)

Q5 (a) Describe the operation of Fourier Transform Infrared Spectroscopy (FTIR).
(9 marks)

(b) What are the advantages and the disadvantages of FTIR?
(8 marks)

(c) What can you explain from the FTIR spectrum shown in **Figure 5(c).**
(8 marks)

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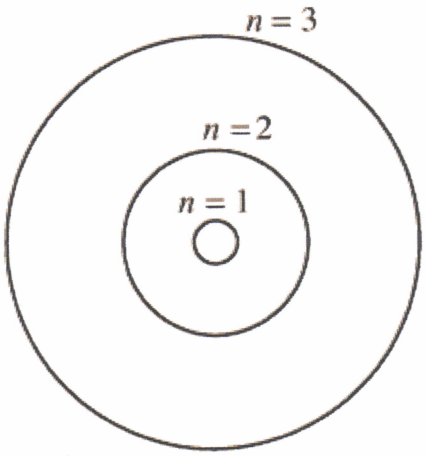
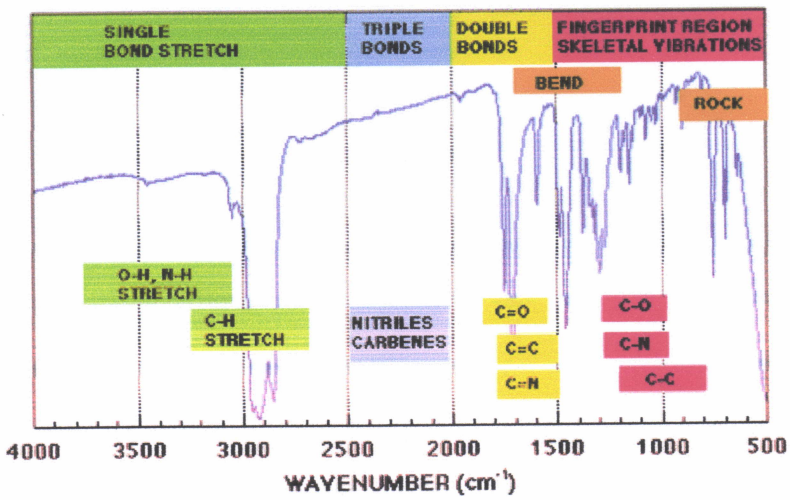
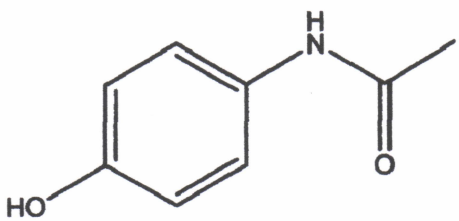


FIGURES Q2(c)





Paracetamol

FIGURE Q5(c): IR Spectrum of Paracetemol and its molecule.

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Constants

Quantity	Symbol	Value
Angstrom unit	Å	$1\ Å = 10^{-8}$ cm $= 10^{-10}$ m
Avogadro number	N	6.023×10^{23}/mol
Boltzmann constant	k	8.620×10^{-5} eV/K $= 1.381 \times 10^{-23}$ J/K
Electronic charge	q	1.602×10^{-19} C
Electron rest mass	m_o	9.109×10^{-31} kg
Electron volt	eV	$1\ eV = 1.602 \times 10^{-19}$ J
Gas constant	R	1.987 cal/mole-K
Permeability of free space	μ_o	1.257×10^{-6} H/m
Permittivity of free space	ε_o	8.850×10^{-12} F/m
Planck constant	h	6.626×10^{-34} J-s
Proton rest mass	m_p	1.673×10^{-27} kg
$h/2\pi$	$\hbar$	1.054×10^{-34} J-s
Thermal voltage at 300 K	V_T	0.02586 V
Velocity of light in vacuum	c	2.998×10^{10} cm/s
Wavelength of 1-eV quantum	λ	1.24 μm

- END OF QUESTION –

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