Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	NANOSTRUCTURED MATERIALS
COURSE CODE	:	BWC 30903
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND ANSWER ANY **TWO (2)** QUESTIONS IN **SECTION B**

TERBUKA

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

SECTION A

Q1 (a) (i) Describe what happen to the common forces such as gravitational, electric, electromagnetic, thermal and surface tension when materials are scaled down to nanoscale.

(6 marks)

(ii) Elaborate the differences between nanoparticles and bulk properties.

(6 marks)

(b) (i) Outline the differences between crystalline and amorphous solid materials. In your answer, briefly mention the packing, the atoms or elements involved, surface morphology and suggest ONE (1) example that is relevant to each material.

(8 marks)

(ii) Calculate the atomic packing density along [011] direction of aluminum (Al). Express your answer using the unit of atoms, cm^{-1}.

(5 marks)

Q2 (a) Recently, a research group at École Polytechnique Fédérale de Lausanne (3rd March 2015) has fired a laser on metallic nanowires, making charged particles inside the nanowires to vibrate as shown by TEM (Transmission Electron Microscope) image in **Figure 2(a)**. They are the first group to prove the phenomena of "particle-wave dualism" through experiment and imaging tool.

Elaborate the meaning of "particle-wave dualism" and name a famous scientist that discovered the "particle wave duality".

Note on their experiment:

Then comes the novel part - the physicists shot a stream of electrons close to the nanowires. As those electrons interacted with the light source, hitting the confined photons, they either sped up or slowed down, and the microscope allowed the researchers to image the position where the change in speed and therefore the standing wave.

(10 marks)

(b) What is the most important fact about "particle-wave dualism"? Explain the standing wave and relates it to how it is used to describe quantum phenomena. Use **Figure 2(b)** given to help you answer the question

(10 marks)

(c) Calculate the Bohr radius for hydrogen states from $n = 1$ to $n = 3$ using **Equation 2(c)** and sketch the standing wave in **Figure 2(b).**

(5 marks)

SECTION B

Q3 (a) Outline and elaborate the process to fabricate nanoparticles using the photolithography or electron beam lithography (EBL) technique.

(9 marks)

(b) Point out 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) A water droplet beads up on a lotus leaf due to the hydrophobic nanostructures.What kind of surface properties is needed to obtain a superhydrophobic surface?

(9 marks)

(b) Elaborate the uniqueness of carbon and its materials

(8 marks)

(c) Propose a technique to fabricate carbon nanotube (CNT).

(8 marks)

Q5 (a) Outline and elaborate the basic operation of Fourier transform infrared spectroscopy (FTIR) machine.

(9 marks)

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

(8 marks)

(c) Evaluate the FTIR spectrum shown in **Figure 5(c).** What type of information can you obtain from such results?

(8 marks)

– **END OF QUESTIONS** –

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II / 2016/2017	PROGRAMME	: BWC
COURSE	: NANOSTRUCTURED MATERIALS	COURSE CODE	: BWC 30903

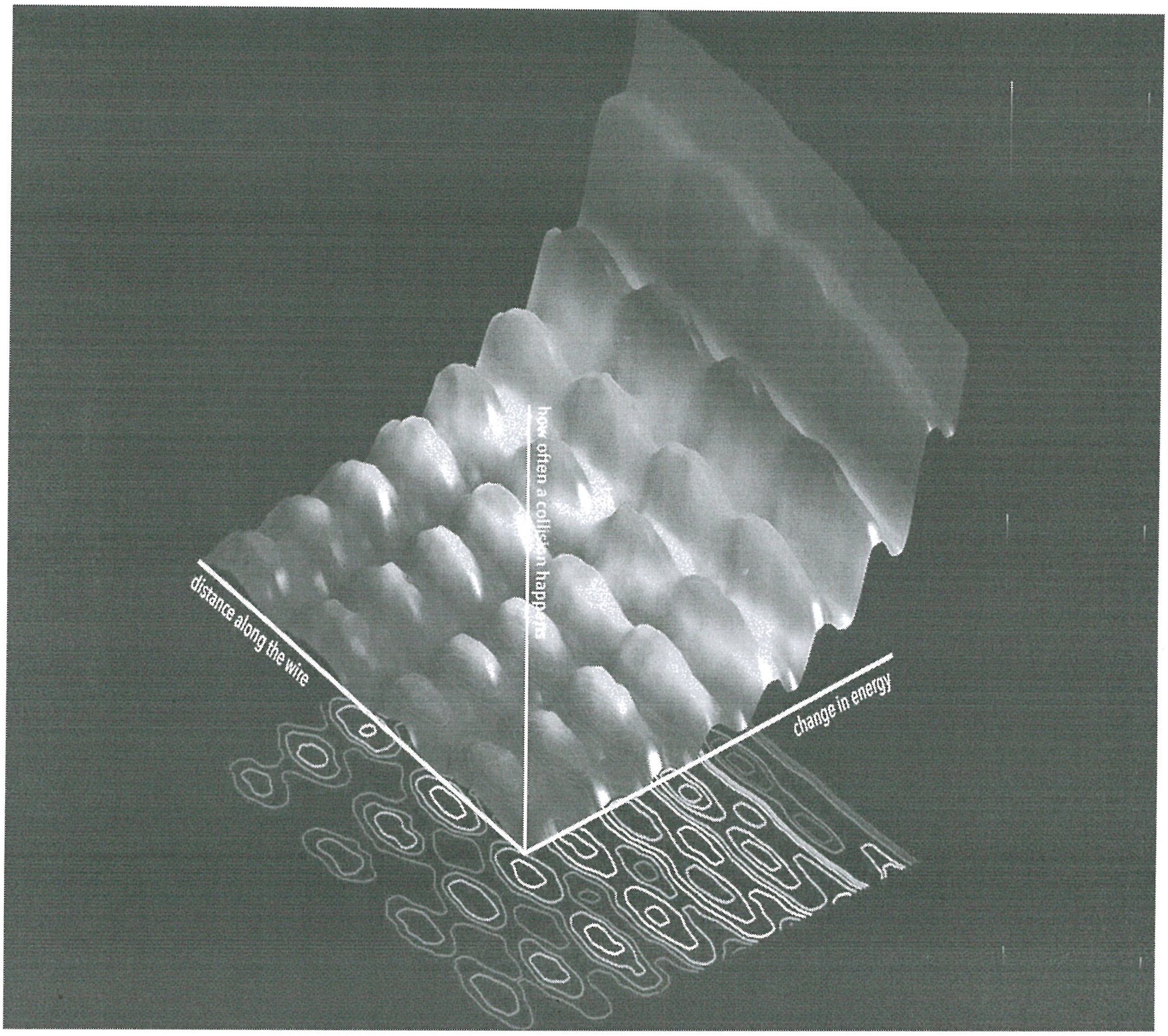


Figure Q2 (a)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2016/2017 PROGRAMME : BWC
COURSE : NANOSTRUCTURED MATERIALS COURSE CODE : BWC 30903

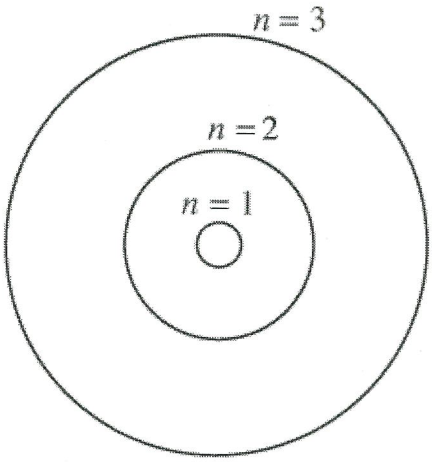


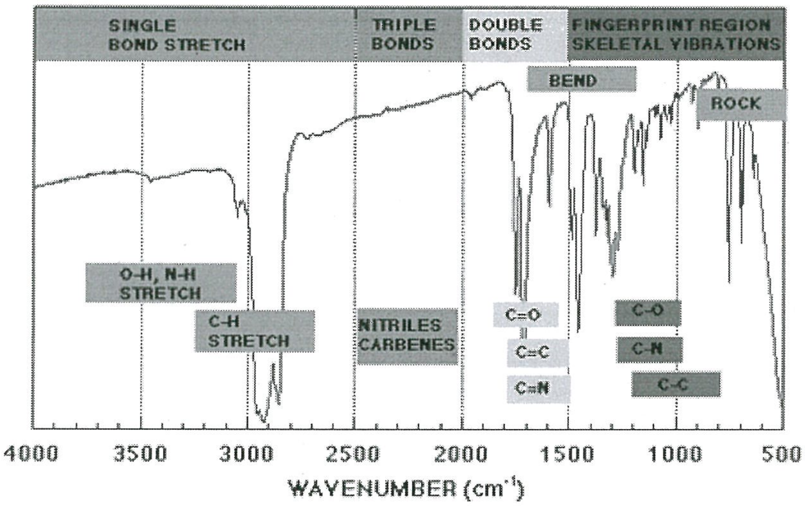
Figure Q2 (b)

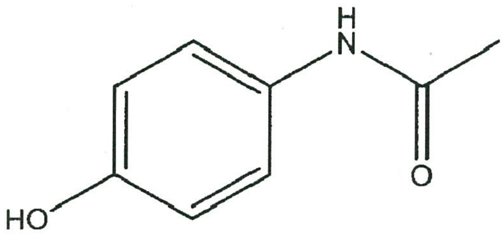
$$r_n = \frac{\hbar^2 n^2}{m_e k e^2 Z} = \frac{a_0 n^2}{Z} = \frac{52.9 n^2}{Z} \text{ pm}$$

Equation 2 (c)

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II / 2016/2017	PROGRAMME	: BWC
COURSE	: NANOSTRUCTURED MATERIALS	COURSE CODE	: BWC 30903





Paracetamol

Figure Q5 (c)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2016/2017 PROGRAMME : BWC
COURSE : NANOSTRUCTURED MATERIALS COURSE CODE : BWC 30903

List of Constant

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 = 1.381×10^{-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 = 1.602×10^{-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