UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	SOLID STATE PHYSICS
COURSE CODE	:	BWC 21003
PROGRAMME	:	2 BWC
EXAMINATION DATE	:	JUNE/JULY 2015
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Define the following terms in relation to crystal structure,

(i) lattice points
(ii) basis
(iii) unit cell

(6 marks)

(b) What are the differences between crystalline and non-crystalline materials?

(6 marks)

(c) Obtain the Miller indices of a plane which intercepts at ***a***, ***b/2***, ***3c*** in a simple cubic unit cell. Draw a neat diagram showing the plane (where ***a***, ***b***, and ***c*** are lattice parameters).

(8 marks)

Q2 (a) **Figure Q2(a)** shows the first five peaks of the x-ray diffraction pattern for tungsten, which has a BCC crystal structure; monochromatic x-radiation having a wavelength of 0.1542 nm was used.

(i) Determine the index (i.e., give *h*, *k*, and *l* indices) for each of these peaks.
(ii) Determine the interplanar spacing for each of the peaks
(iii) For each peak, determine the atomic radius for W and compare these with the value presented in **Table Q2(a)(iii)**.

(14 marks)

(b) The lattice parameter for iron, Fe is 0.2866 nm. Assume that monochromatic radiation with wavelength of 0.1790 nm is used, and the order of reflection is 1. For BCC iron, compute

(i) The interplanar spacing,
(ii) The diffraction angle for the (220) set of planes.

(6 marks)

Q3 Most of the insulator crystals and pure alkali halide crystals are transparent to visible light. When they are irradiated, these crystals appear to be coloured due to the selective absorption of some components of the visible spectrum by certain imperfection. Colour centres may be produced by the following methods; colouration by ionizing radiation and electrolytic colouration. Outline both of the methods mentioned.

(20 marks)

Q4 (a) The extrinsic semiconductors are those in which impurities of large quantity are present. In general, the impurities can be either III group elements or V group elements. Based on the impurities present in the extrinsic semiconductors, they are classified into two categories; n-type semiconductors and p-type semiconductors. Differentiate both types of the extrinsic semiconductor.

(16 marks)

(b) The following data are given for intrinsic Ge at 300K, $\boldsymbol{n_i} = 2.4 \times 10^{19}$ m^{-3}; $\boldsymbol{\mu_e} = 0.39$ m^{2}v^{-1}s^{-1}; and $\boldsymbol{\mu_p} = 0.19$ m^{2}v^{-1}s^{-1}, calculate the resistivity of the sample.

(4 marks)

Q5 (a) (i) How does the energy-band model can be used to explain the poor electrical conductivity of an insulator such as pure diamond?

(ii) Construct an explanation for the good electrical conductivity of magnesium and aluminum even though these metals have filled outer 3*s* energy bands.

(8 marks)

(b) Define the following quantities pertaining to the flow of electrons in a metal conductor.

(i) drift velocity,
(ii) relaxation time,
(iii) electron mobility.

(9 marks)

(c) If a semiconductor is transparent to light with a wavelength longer than 0.87 μm, what is its band-gap energy?

(3 marks)

- END OF QUESTION –

FINAL EXAMINATION

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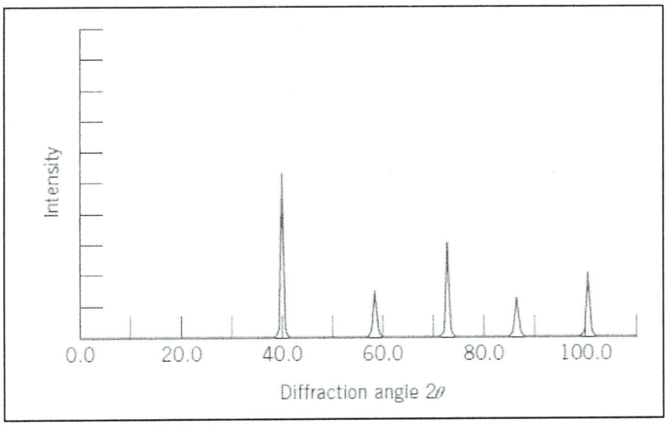

Figure Q2(a): Diffraction pattern for powdered tungsten.

Table Q2(a)(iii): Atomic Radii and Crystal Structures for 16 Metals

Metal	*Crystal Structure*[a]	*Atomic Radius*[b] *(nm)*	*Metal*	*Crystal Structure*	*Atomic Radius (nm)*
Aluminum	FCC	0.1431	Molybdenum	BCC	0.1363
Cadmium	HCP	0.1490	Nickel	FCC	0.1246
Chromium	BCC	0.1249	Platinum	FCC	0.1387
Cobalt	HCP	0.1253	Silver	FCC	0.1445
Copper	FCC	0.1278	Tantalum	BCC	0.1430
Gold	FCC	0.1442	Titanium (α)	HCP	0.1445
Iron (α)	BCC	0.1241	Tungsten	BCC	0.1371
Lead	FCC	0.1750	Zinc	HCP	0.1332

[a] FCC = face-centered cubic; HCP = hexagonal close-packed; BCC = body-centered cubic.
[b] A nanometer (nm) equals 10^{-9} m; to convert from nanometers to angstrom units (Å), multiply the nanometer value by 10.