INTERIM JOINT MATRICULATION BOARD
AHMADU BELLO UNIVERSITY
ZARIA

INTERIM JOINT MATRICULATION BOARD EXAMINATION 2016

SUBJECT: PHYSICS PAPER II
DATE SCHEDULED: FRIDAY 19TH FEBRUARY, 2016
TIME ALLOWED: THREE HOURS (3 HRS)

INSTRUCTIONS:

i. Answer **ALL** the questions in Section A and **ONE (1)** question from each of Section B and D, and **TWO (2)** questions from Section C.

ii. Non-Programmable electronic calculators can be used.

Useful constant:

Charge on the electron	e	=	$-1.6 \times 10^{-19}C$
Electron volt	eV	=	$1.6 \times 10^{-19}J$
Mass of electron	M_e	=	$9.0 \times 10^{-31}Kg$
Permeability of free space	μ_0	=	$4\pi \times 10^{-7}NA^{-2}$
Permittivity of free space	ε_0	=	$8.85 \times 10^{-12}Fm^{-1}$
Electrical constant of proportionality	K	=	$9 \times 10^{9}Nm^2C^{-2}$
Plank's constant	h	=	$6.6 \times 10^{-34}Js$
Velocity of light in free space	c	=	$3.0 \times 10^{8}ms^{-1}$
Avogadro's number	N	=	$6 \times 10^{23}mol^{-1}$
Atomic mass unit	1u	=	931Mev
Universal gravitational constant,	G	=	$6.67 \times 10^{-11}\ Nm^2\ Kg^{-2}$

SECTION A

Answer All the questions in this section

1(a). Write down one difference and one similarities of real and virtual images. Mention any two uses each of *plane mirror, concave and convex mirror.*

2. A ray of light travelling on a medium at an angle of $\cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$ and refracted at an angle of $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ in the medium. Calculate the velocity of light in the medium.

3. A concave mirror has a focal length of 25.3 cm. An object, of height 1.45 cm is placed 46 cm in front of the mirror. Determine the: *the radius of curvature of the mirror, the image position, size and nature of the image.*

4. A charge of $1\mu C$ on a small sphere of mass $1\mu g$ is placed in a uniform electric field of $3NC^{-1}$. Calculate the acceleration produced by this filed.

5(a). Define the term Coulomb. Calculate the Coulombic force between two electrons situated at 1.6Å apart in vacuum.

6. A 2.5μF capacitor is connected in series with a non-inductive resistor of 300Ω across a mains of *rms* value 50 V, 1000/2πHz. .Calculate: the thermal values of the current in the circuit and the p.d across the capacitor.

7. Ten 1.5 V cells, each having an internal resistance of 0.2Ω, are connected in series to a load of 58 Ω. Determine the current flowing in the circuit and the p.d at the battery terminals.

8. Light is directed onto a metal surface for which the work function is 2eV. If the light's frequency is *f* such that $hf = 5eV$. What is the maximum speed of the emitted electrons?

9. State the Heisenberg Uncertainty Principle involving energy. What is the minimum uncertainty in the energy state of an atom if an electron remains in this state for 10^{-8}s?

10. Briefly explain the concepts of "insulators, semiconductors and conductors in terms of the forbidden energy gap. What is N-type semiconductor?

Premicah

SECTION B: GEOMETRIC OPTICS

Answer ONE question only from this section

11a (i). Explain how to differentiate between a plane mirror, a concave and a convex mirror, without touching them in terms of image formed.

(ii) Explain the following rules for ray diagram:

(A) A ray of light parallel to the principal axis.

(B) A ray of light passing through Centre of curvature of a mirror.

(C) A ray of light passing through the principal focus of a mirror.

(iii). Complete the table for the image formation by a concave mirror for different positions of the object. (1 to 8) in Table 1.

Position of object	Position of image	Size of image	Nature of image
At infinity	(1)	(2)	Real and inverted
At C	(3)	(4)	(5)
Between C and F	Beyond C	(6)	Real and inverted
At F	(7)	Highly enlarged	(8)

Table 1.

b(i). State the necessary conditions for the total internal reflection to occur. What are the factors on which the refractive index of a medium depends?

(ii) A 1.2 cm long pin is placed perpendicular to the principal axis of a convex mirror of focal length 12 cm, at a distance of 8 cm from it. Sketch the ray diagram and find the location, height and the nature of the image.

(iii) An astronomical telescope in normal use has an angular magnification of 8 and the lenses are at a distance of 45cm apart. What is the focal length of the lenses?

12a(i). State and give the geometrical interpretations of the laws of refraction using a rectangular glass prism. Hence, show that, $n_1 v_1 = n_2 v_2$ where v_1, v_2 velocities of light in medium 1 and 2 of refractive indices n_1 *and* n_2 respectively.

(ii) A ray of light making an angle of 30^0 with the normal, enters a glass plate 4 cm thick. Calculate the distance the light ray travels in the glass before it leaves the plate. What angles does the emergent ray make with the normal?

b. An object 4cm high is placed at a distance of 40cm from a converging lens of focal length 15cm. A diverging lens of focal length 10cm is placed a distance 30cm from the first lens. Find the position, size and the nature of the final image.

SECTION C : ELECTRICITY AND MAGNETISM

Answer TWO questions only from this section

13a(i). Explain in **details** the term "*capacitor*".

(ii). You are provided with three identical capacitors each of capacitances $2\mu F$. what are the maximum and minimum capacitance could you obtain with these capacitors? What arrangement of these capacitors would give a resultant capacitance of $3\mu F$? Sketch its diagram.

13b(i). Define the terms inductor and inductance of inductor.

(ii). Four inductors each of inductance 2mH, are connected in parallel across a 10A a.c

supply. Calculate the equivalent inductance and the energy stored.

14a(i). Define magnetic flux and magnetic flux density. State their possible units.

(ii). Assume the maximum working flux of a lifting magnet is 1.8T and the effective area of a pole face is circular in cross section. If the total magnetic flux produced is 0.353Wb. Calculate the radius of the pole.

14b(i). State the mathematical form of Gauss's law of electrostatic and state the meaning of each symbol in the equation.

(ii). Distinguish between resistance and reluctance. Calculate the permeance of reluctance $\frac{5}{9}$ *per* Hery.

(iii). Two wires of same material and length have resistances 5 Ω and 10 Ω respectively. Find the ratio of radii of the two wires.

15a (i). State the law of electromagnetic induction and derive its mathematical relations.

(ii). Calculate the mutual inductance between two coils when a current changing at $200As^{-1}$ in one coil induces an emf of 1.5V in the other.

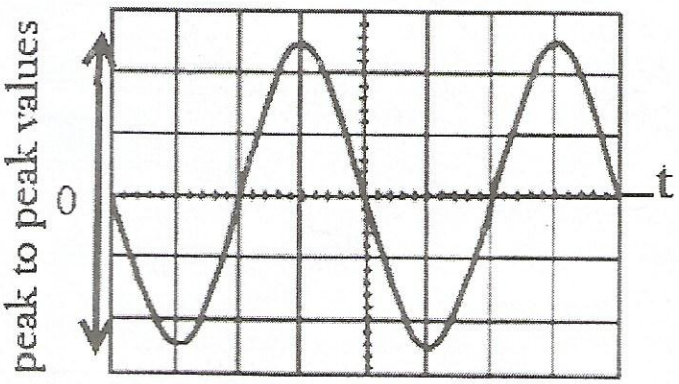

fig. 15.1

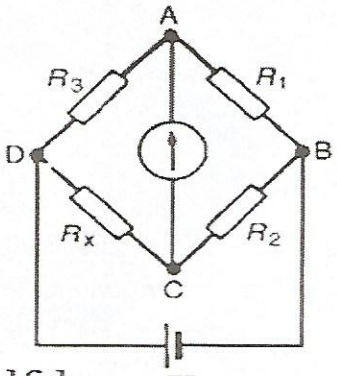

fig. 16.1

15.b(i). What do you understand by a cathode ray oscilloscope (c.r.o.)? A sinusoidal voltage trace displayed by a (c.r.o). is shown in Figure 15.1. If the 'time/cm' switch is on 500μs/cm and the 'volts/cm' switch is on 5 V/cm. Find, for the waveform: the frequency, the peak-to-peak voltage, the amplitude and the r.m.s value of voltage. Given that the width of one complete cycle is 4 cm.

16a(i). The arms of a Wheatstone bridge ABCD (fig. 16.1), have the following resistances: $AB: R_1 = 100\Omega \pm 1.0\%$, $BC: R_2 = 100\Omega \pm 0.5\%$, $CD: unkown\ resis\tan ce\ R_x$, $DA: R_3 = 432.5\Omega \pm 0.2\%$. Determine the value of the unknown resistance and its relative error.

16a(ii). A coil of copper wire has a resistance of 100Ω when its temperature is 0°C. Determine its resistance at 70 ^{0}C if the temperature coefficient of resistance of copper at 0°C is $0.0043°C^{-1}$.

16b(i). Calculate the effective resistance between points A and B in figure 16.2.

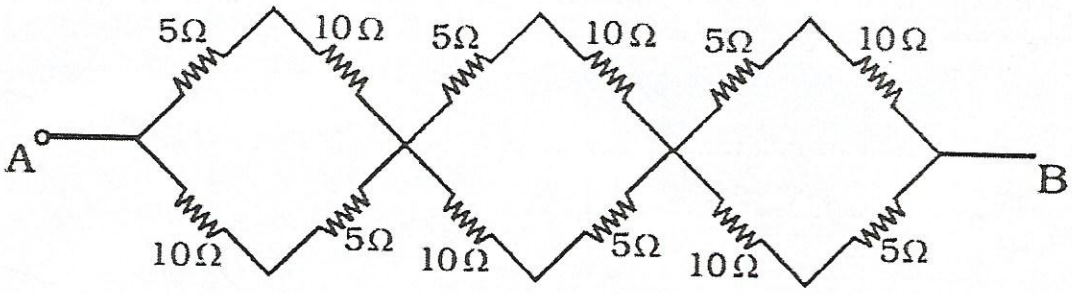

fig. 16.2

(ii). Briefly define the following terms*: ammeter, voltmeter, ohmmeter moving coil galvanometer, and current sensitivity of a galvanometer.*

(iii). Draw a circuit diagram to show, how the alternating voltmeter and ammeter connected in a circuit of load resistance 12.72kΩ with 210Va.c mains?

SECTION D: MODERN PHYSICS

Answer ONE question only from this section

17a(i). Explain in details the modes of production and action of a modern x-rays tube. (Labeled diagram is needed) and mention any two good characteristics of the target material in the productions of x- rays and one good characteristics of the anode.

(ii). Briefly explain the terms *hard and soft x-rays*. State five properties of x-rays.

(iii). A Coolidge tube operates at 24800 V. Determine the maximum frequency the radiation emitted from tube.

17(b)(i). State five Shortcomings of Bohr's theory?

(ii) If the Wavelength of Balmer first line is 6563Å. Calculate the wavelength of second line.

18a(i). State any four properties each of α, β, *and* γ, rays emitted by radioactive atoms.
(ii) State and derive the radioactive law of disintegration.
(iii) Calculate the time required for 60% of a sample of radon to completely decay. Given $T_{½}$ of radon = 3.8 days.

18(b). Show labeled sketches of PNP and NPN junction transistor and diode valves. Illustrate your answer with their respective circuit symbols.