Physics II

030

14/11/ 2016   8.30 am – 11.30 am

REB

Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2016

SUBJECT: PHYSICS

PAPER II: THEORY

COMBINATIONS:	- Physics-Chemistry-Maths	(PCM)
	- Maths-Physics-Computer science	(MPC)
	- Physics-Chemistry-Biology	(PCB)
	- Maths-Physics-Geography	(MPG)
	- Physics-Economics-Maths	(PEM)

DURATION: 3 HOURS

1. Do not open this question paper until you are told to do so.
2. Write your name and index number on the answer booklet as written on your registration form.
3. This paper consists of **two** sections: **A** and **B**.

   Section A: Attempt **all** questions.   **(55 marks)**
   Section B: Attempt **only three** questions.   **(45 marks)**

4. Non-programmable scientific calculator and mathematical set may be used.
5. **Useful constants**
   Permittivity of vacuum (free space) $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
   Acceleration due to gravity $g = 9.81$ m/s^2
   Energy of the ground level of the hydrogen atom $E_1 = -13.6$ eV
   Magnitude of the charge of electron $e = 1.6 \times 10^{-19}$ C
   Permeability of vacuum (free space) $\mu_0 = 4\pi \times 10^{-7}$ H/m
   Refractive index of air $n \cong 1$
6. Use **blue** or **black** pen and **pencil** for drawing.

SECTION A: ATTEMPT ALL QUESTIONS (55 MARKS)

1) With the aid of a ray diagram, give the nature and size of the image formed by a concave mirror when an object is placed between focus and pole of the mirror. **(4marks)**

2 a) Mention any two differences between astronomical telescope and compound microscope. **(2marks)**

b) Explain myopia and suggest how it can be corrected. **(2marks)**

3 a) Copy the following table and complete each space provided.

Physical quantity	Dimension	SI Unit	Equivalent units
Force			Newton(N)

(2marks)

b) A ball is thrown horizontally at a speed of 10 m/s from the top of a building and takes 4 s to reach the ground.
The air resistance is negligible.
Find the horizontal distance covered by the ball. **(2marks)**

4) A light ray falls perpendicular to one of the faces of a glass prism of angle of 60° and refractive index 1.5. Find:

a) the angle of incidence on the second face inside the prism by using a ray diagram. **(2marks)**

b) the angle of emergence. What do you conclude? **(2marks)**

5) Two point electric charges q and $-q$ are separated by a distance d. Consider a point p located between the charges at a distance $\dfrac{d}{2}$ from each charge.

a) What is the electric potential due to q at p ? **(1mark)**

b) Determine the electric potential created by $-q$ at the

above mentioned point. **(1mark)**

c) Find the resultant electric potential at p . **(1mark)**

6 a) What do you understand by the term radiation as defined in thermal effect? **(1mark)**

b) (i) Name the predominant method of heat transfer that causes a pot of water to boil. **(1mark)**

(ii)Assuming heat capacity of 10 g of water to be 42 J/K, what is the heat required to raise its temperature from 30°C to 40°C ? **(2marks)**

7 a) Use kinetic theory of matter to explain why solids are not heated by convection. **(1mark)**

b) From your knowledge on adhesion and cohesion, explain why the free surface of water in capillary tube is concave but that of mercury is convex. **(2marks)**

8 a) Name any one property of a liquid to satisfy Bernoulli's theorem. **(1mark)**

b) What is the upward force on a skydiver with mass 70 kg when he/she reaches terminal velocity? **(2marks)**

9) A mixture of 0.5 moles of hydrogen (H_2) and 0.3 moles of chlorine gas (Cl_2) in a container at 300 K has a total gas pressure of 100 kPa.

(a) Convert the temperature of 300 K to degrees Celsius. **(1mark)**

(b)What is the partial pressure of hydrogen in the mixture? **(2marks)**

10 a) An inventor claims to have developed an engine that takes in 1000 J of heat and produces 1500 J of work during each cycle. On the basis of efficiency of heat engine, comment on the validity of this claim. **(1mark)**

b) Calculate the efficiency of a Carnot engine operating between temperatures of 400° C and 100°C. **(2marks)**

11 a) An object of mass 10 kg is moving with a uniform velocity of 10 m/s. Find the linear momentum of this object. **(2marks)**

b) The torque acting on a body is 2000 Nm with an angular acceleration of 2 rad/s². What is the moment of inertia of this body? **(2marks)**

12) A 0.5 H inductor is connected to the terminals of a 60 Hz alternating current source whose root mean square(r.m.s) voltage is 110 V . Find:

a) the inductive reactance of the circuit. **(2marks)**

b) the r.m.s current in the circuit. **(2marks)**

13 a)What are the necessary conditions for the phenomenon of interference of light to occur ? **(2marks)**

b) In terms of path difference and wavelength, state the conditions necessary to produce:

(i) constructive interference at point P on the screen. **(1mark)**

(ii) destructive interference at point Q on the screen. **(1mark)**

14) a)Imagine an electron of a hydrogen atom absorbed enough energy to jump from the ground level to the top energy level.

(i) What happens to the electron if it absorbs much more energy? **(1mark)**

(ii) What happens to the atom? **(1mark)**

b) The electron in a hydrogen atom jumps from the 1th energy level to the 2nd energy level.

Calculate the energy of the electron at the 2nd energy level in electron volt. **(2marks)**

15) A bipolar junction transistor has emitter current of 16mA and a base current of 250μA.

a) What is its collector current? **(2marks)**

b) Find the current gain for this device. **(2marks)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (45 MARKS)

16) A potential difference V of a dry cell drives a direct current through

three resistors R_1, R_2 and R_3 joined in series. The resistance are

$2\Omega, 3\Omega, 4\Omega$ respectively.

a) Draw a complete electrical circuit according to the above information
including four voltmeters and three ammeters to read electric current
passing through every component. **(4marks)**

b) Differentiate between the terms "resistor" and "resistance". **(2marks)**

c) If the voltmeter across R_1 reads 4 volts, what are the currents in R_1? **(2marks)**

d)What do the voltmeters across R_2 and R_3 read? **(3marks)**

e)What is the value of V? **(2marks)**

f)Find the resistance of the single equivalent resistor which can
replace the resistors R_1, R_2 and R_3 in series. **(2marks)**

17 a) State in words the following ideal gas laws:

(i)Boyle's law **(2marks)**

(ii)Charles' law **(2marks)**

(iii) Pressure law **(2marks)**

b) (i) A container of an ideal gas has a volume of 0.10 m³ at a pressure
of 2.0×10^5 N/m² and a temperature of 27°C.

Find the new pressure if the gas is heated at constant volume to

57°C. **(2marks)**

(ii) A sample of oxygen has a volume of 30 ml and a pressure
of 4 atm. If the pressure of the gas is reduced to 2 atm and the
temperature is kept constant, what is the new volume of the gas? **(2marks)**

(iii) A 600 ml sample of nitrogen is warmed from 77 °C to 87°C.

Find its new volume if the pressure remains constant. **(2marks)**

c) Using a vertical y -axis to represent pressure, P, and a horizontal
x- axis to represent volume, V, illustrate by rough sketches the
changes which take place in question17(b)(i),(ii) and (iii). **(3marks)**

18 a) (i) Copy and complete the following table related to radioactive decay. **(6marks)**

Type of radiation	Description	Electrical charge
Alpha (α) radiation		
Beta (β) radiation		
Gamma (γ) radiation		

(ii) Which of the above radiations is most dangerous and damaging when the radioactive source is outside the human body? Justify your answer

(2marks)

b) Suggest three precautions you must take for safety against radioactive materials. **(3marks)**

c) (i) Explain the term half-life of a radioactive nuclide. **(1mark)**

(ii) A radioactive substance has a half-life of 1 day.

Calculate the decay constant for this substance? **(3marks)**

19 a) (i) What do you understand by the term "simple harmonic motion"? **(2marks)**

(ii)State any one example of simple harmonic oscillator. **(1mark)**

(iii)What factors affect the frequency of simple harmonic motion

for a mass-spring system ? **(2marks)**

b) A 0.500 kg mass is vibrating in simple harmonic motion (SHM) in a system in which the restoring constant is 100 N/m; the amplitude of vibration is 0.200 m. Find:

(i) the total energy of the system **(2marks)**

(ii) the maximum kinetic energy **(1mark)**

(iii) the potential energy and kinetic energy when the displacement
X = 0.100 m. **(4marks)**

(iv) the equation of this SHM   if X = 0.2 00 m at t =0 s. **(2marks)**

c) What condition for the system performing simple harmonic motion is necessary if your calculation in 19(b)(iii) above is to be valid. **(1mark)**

20 a) (i) What is meant by the term "electromagnetism"? **(1mark)**

(ii) State any two practical applications of electromagnetism. **(2marks)**

b) With the aid of a diagram, show the direction and write the expression for the magnetic flux density at :

(i) a perpendicular distance r from a long straight wire carrying a current I in a vacuum, **(2marks)**

(ii) the centre of a circular coil of N turns each of radius R and carrying a current I in a vacuum, **(2marks)**

(iii) the centre of an air cored solenoid of n turns per metre each carrying a current I . **(2marks)**

c) Two long upward straight wires A and B of the same length L separated by a distance d are parallel to each other and carry the same currents I in the same upward direction.

(i) Draw a diagram to show the direction of electromagnetic force on each wire. **(2marks)**

(ii) Do they attract or repel each other? Explain your answer. **(2marks)**

(iii) How do the magnitudes of these forces on each wire compare? Justify your answer. **(2marks)**

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