REPUBLIC OF RWANDA
SOUTHERN PROVINCE
HUYE DISTRICT



THE END OF TERM TWO COMPREHENSIVE ASSESSMENT

ADVANCED LEVEL

SUBJECT: PHYSICS
CLASS: S5

- ❖ MPG (Mathematics-Physics-Geography);
- ❖ PCB (Physics-Chemistry-Biology);
- ❖ PCM (Physics-Chemistry-Mathematics).
- ❖ MPC (Mathematics-Physics-Computer science)

Date: 13-03-2024

Duration: From 8h30-11h30

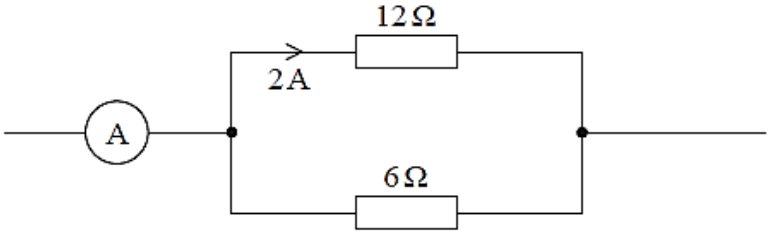
This paper consists of TWO sections: A and B.

- **Section A:** ANSWER **ALL** QUESTIONS **(70 marks)**
- **Section B:** ANSWER **ANY THREE** QUESTIONS **(30 marks)**

SECTION A: ATTEMPT ALL QUESTIONS (70MARKS)

Q1-Q5: Write only the letter of the best answer without deletion or alteration.

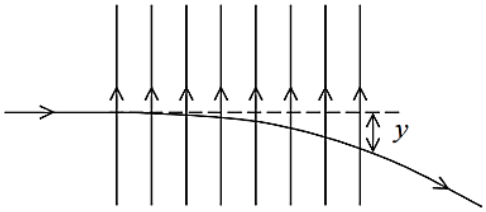
Q1. Part of an electric circuit is shown.



What is the current shown by the ammeter? **(2 marks)**

A 3A **B** 4A **C** 5A **D** 6A

Q2. An electron travels through a uniform electric field of electric field strength $1.3 \times 10^4 N/C$ for a time of $4.3 \times 10^{-9} s$. It is deviated from its original path as shown.



The deflection y of the electron is **(2 marks)**

A $1.21 \times 10^{-2} m$ ***B*** $2.11 \times 10^{-2} m$ **C** $21.1 \times 10^{-2} m$ **D** $12.1 \times 10^{-2} m$

Q3. In the case of forced oscillations, which of the following statements is not true? **(2 marks)**

A frequency equals that of external periodic force

B amplitude depends upon the damping coefficient

C amplitude tends to infinity at resonance

D higher the damping coefficient, lower is the amplitude at resonance

Q4. According to the Bohr's model of hydrogen atom, relation between the principal quantum number n and the radius r of stable orbit is **(2 marks)**

A $r \propto n$ ***B*** $r \propto \frac{1}{n}$ ***C*** $r \propto 1/n^2$ ***D*** $r \propto n^2$

Q5. The equation of motion in the critically damped motion in SI units is given in the form $3\left(\frac{d^2x}{dt^2}\right) + b\left(\frac{dx}{dt}\right) + 48x = 0$. The value of damping coefficient b is given by **(2 marks)**

A $4Nms^{-1}$ ***B*** $24Nm^{-1}s$ ***C*** $16Nms^{-1}$ ***D*** $30Nm^{-1}s$

Q6. Use True (T) or False (F) to answer these sub-questions. **(4 marks)**

(a) Transverse waves are waves in which the displacement of the particles of medium is in the same direction as the direction of propagation of the wave.

(b) Stationary/standing wave is the combination of two progressive waves moving in opposite directions, each having the same amplitude and frequency.

(c) When the particles of a medium are vibrating at right angles to the direction of energy transport, then the wave is longitudinal wave.

(d) Progressive wave is a wave where continuous energy transfer takes place in elastic medium between the crest and trough (transverse wave) or rarefactions and compressions (longitudinal wave.)

Q7. State:

a) Wien's law for black body radiation. **(2 marks)**
b) Two points of Planck's quantum theory. **(2 marks)**
c) Wave particle duality. **(2 marks)**
d) Relation between energy and momentum of a photon. **(1 mark)**

Q8. Simple hamonic motion is a periodic motion, but all periodic motions are not simple harmonic. Evaluate this statement. (**4 marks)**

Q9. a) List and sketch graphs of the types of damped oscillations **(6 marks)**

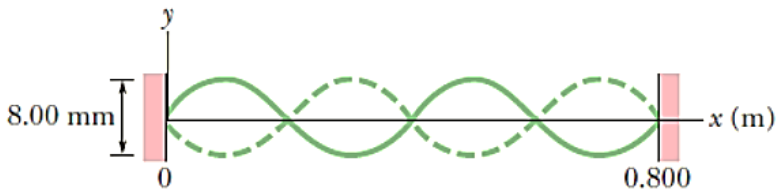
b) (i) How does damping force affect the amplitude of oscillations ? **(2 marks)**

(ii) When does resonance of a system occur? **(2 marks)**

Q10. Distinguish standing waves from progressive waves **(4 marks)**

Q11. A string of length 3 m and mass density 0.0025 kg/m is fixed at both ends. One of its resonance frequencies is 252 Hz. The next higher resonance frequency is 336 Hz. Find the fundamental frequency and the tension in the string. **(5 marks)**

Q12. Figure below shows resonant oscillation of a string of mass and length and that is under tension.

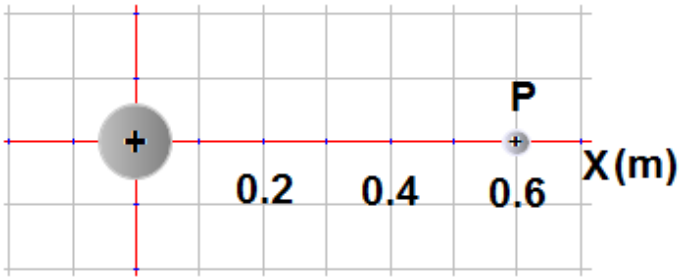


(a) What is the wavelength of the transverse waves producing the standing wave pattern. **(2 marks)**

(b) What is the harmonic number n? **(2 marks)**

(c) What is the frequency f of the transverse waves and of the oscillations of the moving string elements? **(4 marks)**

Q13. A charged sphere A has a charge of +9 μC and is placed at the origin as shown below.



a) What is the electric potential at point P located 0.6 m from the origin? **(2 marks)**

A point charge with a charge of+3 μC and mass of 5 g is brought from infinity to point P.

b) How much work is done to bring the point charge from infinity to point P? **(2 marks)**

c) What is the electric force between two charges? **(2 marks)**

d) What is the net electric field at point 0.3 m from the origin? **(2 marks)**

The sphere stays fixed and point charge is released from rest.

$(Coulomb's\ constant, k = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2/C^2)$

e) What is the speed of the point charge when it is far away from the origin? **(2 marks)**

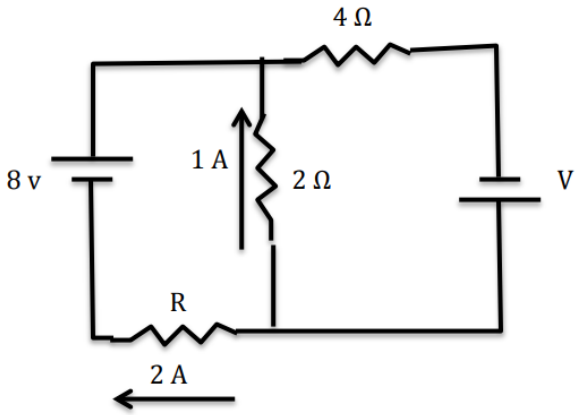
Q14. a) Five cells each with an emf of 2V and internal resistance of 0.5 Ω are connected in parallel. Find

(i)the emf of the resultant battery **(1 mark)**

(ii)the internal resistance of the resultant battery **(2 marks)**

(iii) Calculate the intensity of the current knowing that the external resistance is 1.1 Ω. **(2 marks)**

b) Given the circuit below



Find

i. the voltage V supplied by the battery on the right **(2 marks)**

ii. the current going through the 4ohm resistor **(1 mark)**

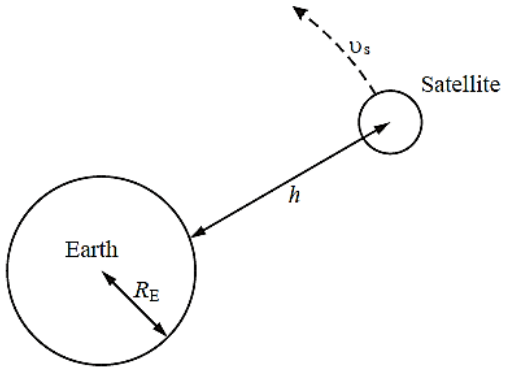
iii. the resistance of the resistor R **(2 marks)**

Q15. a) How does gravitational force depend on distance between two bodies ? **(1 mark)**

b) (i) State any two Kepler's laws of planetary motion **(2 marks)**

(ii) How are Kepler's laws of planetary motion important to Astronomy ? **(2 marks)**

c) A satellite orbits at a height of 700km above the earth's surface. Assume the orbit to be circular.



[Take : Radius of the earth 6400km, Mass of the Earth $6 \times 10^{24} kg$ and Universal gravitational constant $6.67 \times 10^{-11} Nm^2 kg^{-2}$]

Calculate:

(i) the radius of the orbit. **(1 mark)**

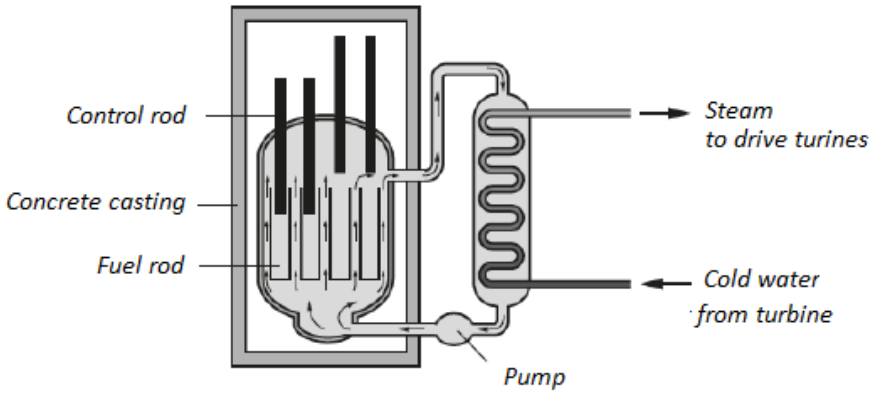
(ii) the speed of the satellite. **(2 marks)**

(iii) Write down an expression for the gravitational field strength in the region of the satellite.

(2 marks)

SECTION B: ANSWER ONLY THREE QUESTIONS (30MARKS)

Q16. A nuclear power station generates electricity. Fig. below shows part of a nuclear reactor.



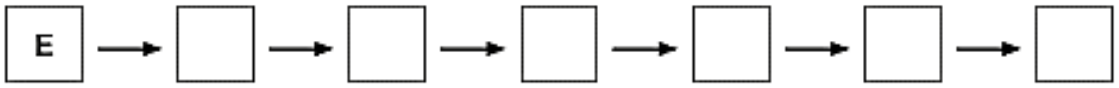
a) State the name of the process that releases energy in the nuclear reactor. ***(1mark)***

b) Suggest a suitable radioactive material used for the fuel rods. ***(1mark)***

c) The main stages in the operation of a nuclear power station are listed below. They are not in the correct order.

A. The turbine turns a generator
B. Fission produces thermal energy
C. Water in the boiler becomes hot
D. Steam turns a turbine
E. Nuclei split apart in the reactor
F. Electromagnetic induction produces the output energy
G. Steam is produced

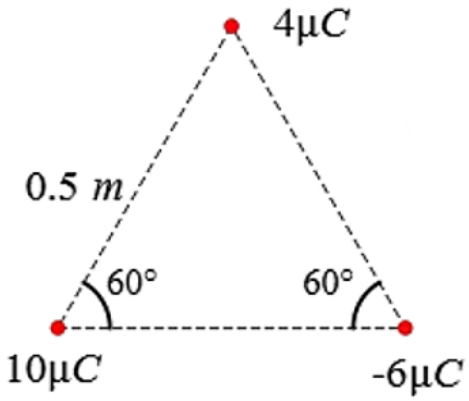
Complete the flow chat to describe how a nuclear power station woks. Insert the missing letters in the empty boxes. ***(6marks)***



d) Some people are opposed to the use of nuclear power stations. Give two disadvantages of using nuclear power stations. ***(1mark)***

e) One use of electricity is to turn an electric motor. The efficiency of an electric motor is always less than 100 %. State the meaning of the term efficiency. ***(1mark)***

Q17. Three point charges are located at the corners of an equilateral triangle, as depicted below.



Find the magnitude and direction of the net electric field at a point midway between the two charges placed on the ***x***-axes. ***(10marks)***

Q18. In Young's experiment, d is the distance between the two slits, D is the distance from the slits to the screen.

(a) What is the path difference for the waves arriving at a point P of the screen? ***(1mark)***

(b) Assuming that the waves arriving at P are $y_1 = a\ sin\ \omega t$ and $y_2 = \text{asin}(\omega t + \emptyset)$

(i) Derive the equation of the resultant wave at P. ***(2marks)***

(ii) What is the relationship between the path difference and the phase difference? ***(1mark)***

(iii) What are the conditions for constructive and destructive interference at point P? ***(2marks)***

(iv) If the distance D is very large compared to the separation distance between the slits d, derive the position of the bright and dark fringes on the screen. ***(2marks)***

(c) If d is equal to 100 times the wavelength of the light used and D=50.0cm, what is the distance between the central maximum and an adjacent maximum? ***(2marks)***

Q19. a) State

(i) Any one factor affecting photoelectric emission **(1 mark)**

(ii) Anyone postulate of bohr model of hydrogen atom **(1 mark)**

b) The following phenomena prove that light can behave like either a particle or a wave:
Reflection of light, refraction of light, interference of light, photoelectric effect, Compton effect.

(i) What phenomena best prove that light is a particle instead of wave? **(2 marks)**

(ii) What phenomena best prove that light is a wave instead of particle? **(2 marks)**

c) When electromagnetic radiation with a wavelength of 350 nm falls on a metal, the maximum kinetic energy of the ejected electrons is 1.20 eV

(i) What is the frequency of this electromagnetic radiation?

The speed of light in vacuum is $3x10^8$ m/s **(2 marks)**

(ii) Determine the work function for this metal in joules then in electron volts

Planck's constant $h=6.626x10^{-34}$ kg m^2/s or $h=6.626x10^{-34}$ J.s **(2 marks)**

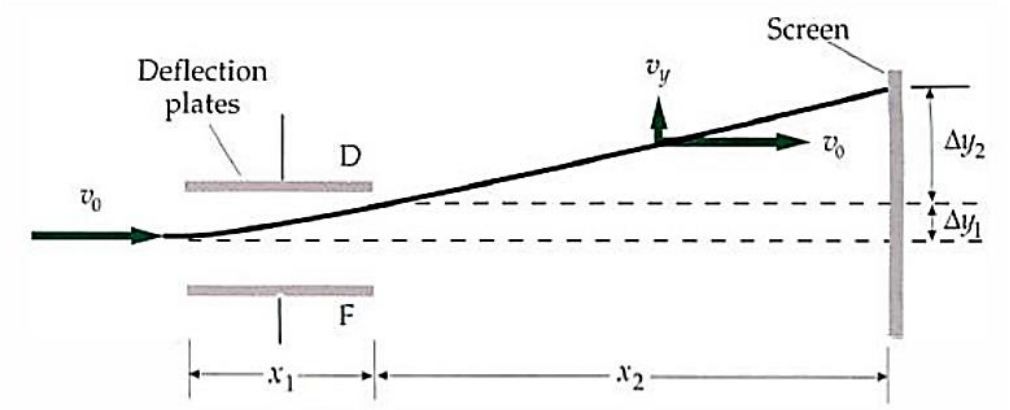
Q20. a) What do you understand by

(i) thermionic emission **(1 mark)**

(ii) cathode rays **(1 mark)**

b) Give any two properties of cathode rays. **(1 mark)**

c) An electron enters the region of a uniform electric field as shown in figure below, with $v_0 = 3.00 \times 10^6 m/s$ and $E = 200N/C$. The horizontal length of the plates is, $x_i = 0.100m$.



(i) Find the acceleration of the electron while it is in the electric field. **(2 marks)**

(ii) Assuming the electron enters the field at time t = 0 ,

find the time at which it leaves the field. **(1 mark)**

(iii) Assuming the vertical position of the electron as it enters the field is $y_i = 0$, what is its vertical position when it leaves the field? **(2 marks)**

(iv) A fluorescent screen is placed 20.0 cm from one of the plates. Find the deflection on the screen when the magnetic field is turned off. **(2 marks)**

END!!!