

Physics II

030

14/07/2025 08:30 AM – 11:30 AM

Names:
Index number:

SUBJECT: PHYSICS II PAPER II: THEORY

COMBINATIONS:

- PHYSICS - CHEMISTRY - MATHEMATICS (**PCM**)
- PHYSICS - CHEMISTRY- BIOLOGY (**PCB**)
- MATHEMATICS - PHYSICS - GEOGRAPHY (**MPG**)
- MATHEMATICS - PHYSICS - COMPUTER SCIENCE (**MPC**)

DURATION: 3 HOURS

S6 QUESTIONS and ANSWERS BOOKLET

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2024-2025

Instructions to candidates:

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

Section A: Attempt **ALL** questions. **(70 marks)**

Section B: Attempt any **THREE** questions. **(30 marks)**

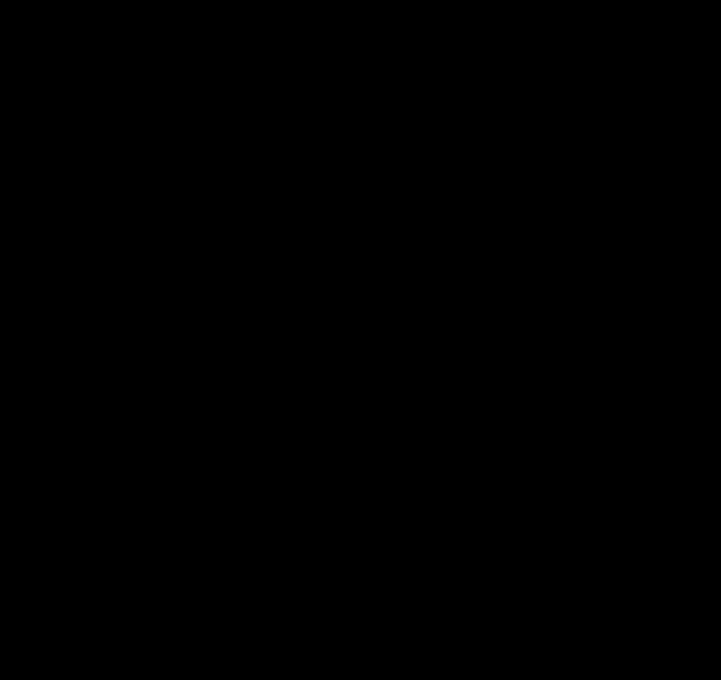
- 4) Scientific calculator and mathematical set may be used.
- 5) Answer multiple choice questions by circling the letter corresponding to the option that answers the question or completes the statement.
- 6) **Useful constants**

Refractive index of vacuum $n_v=1$	Coulomb's constant $k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$
Permittivity of free space $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{Nm}^2$	Acceleration due to gravity $g = 9.81 \text{ m/s}^2$
Speed of light in air/vacuum $c = 3 \times 10^8 \frac{\text{m}}{\text{s}}$	Mass of an electron $m_e = 9.1 \times 10^{-31} \text{ kg}$
Plank's constant $h = 6.63 \times 10^{-34} \text{ J.s}$	Electron's charge $e = 1.6 \times 10^{-19} \text{ C}$

FOR EXAMINER'S USE ONLY

Questions	Marks	Questions	Marks
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

TOTAL MARKS...../100



Section A: Attempt all questions (70 marks)

- 1) State whether each of the following statements is **true** or **false**
- a) In simple harmonic motion (SHM), the restoring force is directly proportional to the displacement of the body. **(1 mark)**
 - b) In SHM, the displacement is maximum when the velocity is maximum. **(1 mark)**
 - c) In a simple pendulum, the period of oscillation depends on the mass of the bob. **(1mark)**
 - d) The total mechanical energy in SHM depends on the frequency of oscillation. **(1mark)**
- 2) Select and circle the letter of the correct alternative that best completes the statement.
- I) Quarks are the constituents of.....
- a) all particles
 - b) all leptons
 - c) all hadrons
 - d) only strange particles
- (1 mark)**
- II) Which was the first particle discovered that is till today believed to be elementary, that is to say not made up of further constituents?
- a) Gluon
 - b) Electron
 - c) Proton
 - d) Photon
- (1 mark)**
- III) Any baryon is a combination of.....
- a) three quarks
 - b) two quarks and an antiquark
 - c) one quark and two antiquarks
 - d) one quark and one antiquark
- (1mark)**
- IV) What is the force that bind protons and neutrons in a nucleus?
- a) Electromagnetic force
 - b) Gravitational force
 - c) Strong nuclear force
 - d) Weak nuclear force
- (1mark)**

V) Which is an exchange particle for the weak nuclear force?

- a) Gluon
- b) Photon
- c) Graviton
- d) W bosons

(1 mark)

3) With regards to electric field and gravitational field, use an arrow and match the terms in the table below with their descriptions.

Term	Description
a) Gravitational potential	i) Electric force per unit electric charge at a point.
b) Electric field strength	ii) Surface where electric potential is constant.
c) Electric potential	iii) Work done to bring a unit mass to a point from infinity.
d) Equipotential surface	iv) Work done to bring a unit electric charge to a point from infinity.

(4 marks)

4) Choose the option that best answers the question or completes the statement. The following is a simplified diagram of double slit experiment (*figure 1*) used to demonstrate the interference of light.

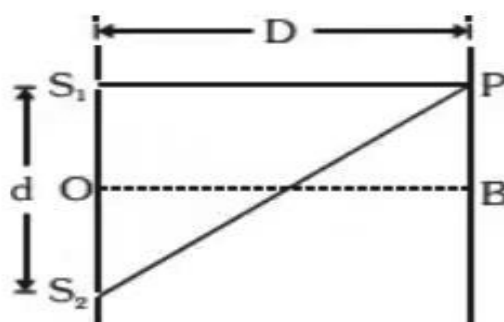


Figure 1

- I) Which of the following phenomena is evidence of the particle nature of light?
- a) Diffraction
 - b) Compton Effect
 - c) Interference
 - d) Polarization

(1 mark)

II) Which statement is true about electromagnetic waves?

- a) The velocity is parallel to electric field
- b) They are transverse waves
- c) They require medium for propagation
- d) They have the same wavelength

(1 mark)

III) For constructive interference to occur at a point, the phase difference between two coherent light waves must be

- a) 0 rad
- b) $\frac{\pi}{2}$ rad
- c) π rad
- d) 2π rad

(1 mark)

IV) For destructive interference to occur at point P, the path difference Δ between two interfering waves must be

- a) $n\lambda$ where n is an integer
- b) $n\frac{\lambda}{2}$
- c) $(2n + 1)\frac{\lambda}{2}$
- d) $(2n + 1)\lambda$

(1 mark)

V) In Young double-slit experiment, when light passes through two narrow slits and creates an interference pattern on a screen. What happens when the slit separation is decreased?

- a) The fringe width decreases
- b) The fringe width remains the same
- c) The fringe width increases
- d) The fringes disappear.

(1 mark)

5) Identify the correct alternative that best answers the question or completes the statement below.

I) A ray of light after refraction through a lens emerges parallel to the principal axis of the lens. The incident ray passes through

- a) its optical centre
- b) its first focus
- c) its second focus
- d) its centre of curvature of the first surface.

(1 mark)

II) Where must an object be placed in front of a converging lens in order to obtain a virtual image?

- a) At the focal point
- b) Between the focal point and the centre of curvature
- c) Between infinity and focal point
- d) Between the focal point and the lens

(1 mark)

III) A diverging lens produces an image of a real object. The image is

- a) virtual, larger than the object and upright
- b) virtual, smaller than the object and upright
- c) virtual, smaller than the object and inverted
- d) real, smaller than the object and inverted

(1 mark)

IV) What is the condition for minimum deviation of light ray in a prism?

- a) The angle of incidence is equal to the prism angle
- b) The angle of incidence is greater than the angle of emergence
- c) The angle of incidence is equal to the angle of emergence
- d) The angle of incidence is less than the angle of emergence

(1 mark)

6) Choose the correct answer from the proposed alternatives.

I) Which of the following best describes the term “energy degradation”?

- a) Energy that is lost to the surroundings as useful work
- b) Energy that is transformed into a less useful form, usually heat
- c) Energy that is conserved and remains in its original form
- d) Energy that remains 100% efficient in all conversion

(1 mark)

II) A device that converts heat energy into work in a cyclic process is

- a) Refrigerator
- b) Turbine
- c) Electric motor
- d) Heat engine

(1 mark)

III) What is the function of a turbine in a power plant?

- a) Convert mechanical energy of moving fluid into heat energy
- b) Convert kinetic energy of moving fluid into mechanical energy
- c) Convert mechanical energy of moving fluid into electrical energy
- d) Convert electrical energy into mechanical energy

(1 mark)

IV) Which energy source is primarily used in thermal power plant?

- a) Water
- b) Sunlight
- c) Fossil fuels
- d) Wind

(1 mark)

7) Match the elements in column **A** with the ones in column **B**, according to their meanings.

(5 marks)

Column A	Column B
a) Base transceiver station (BTS)	i) The amplitude and the frequency of the carrier signal remains constant
b) Frequency Modulation	ii) Used for relaying signals between mobile phones and network
c) Satellite Communication	iii) Routes calls and connects mobile devices to the network
d) Mobile Switching Center	iv) Transmits radio signals for long-distance communication
e) Phase Modulation	v) The frequency of the carrier signal is altered at a rate equal to the frequency of the audio frequency but the amplitude remains constant

- 8) Fill in the blank space with an appropriate term from the list below. Four terms are distractors.

Redshift	Elliptical	Universe	Relativity
Blue shift	Spiral	Sun	Big bang

- a) Milky way galaxy is large barred galaxy that includes the solar system. **(1 mark)**
- b) The of light from most galaxies, is evidence that the universe is expanding, supporting the theory. **(2 marks)**
- c) The reciprocal of the Hubble's constant gives the age of the **(1 mark)**
- 9) State whether each of the following statement is **True** or **False**:
- a) Energy distribution of black body radiation states that when wavelength increases, the energy emitted from black body radiation will increase first and then decreases. **(1 mark)**
- b) All objects emit radiation if they have a temperature greater than 0K. **(1 mark)**
- c) Climate change refers only on the Earth's rising surface temperature. **(1 mark)**
- d) Increasing carbon dioxide will cause sea ice to reduce in spatial coverage. In turn, the reduced ice extent is a positive feedback on Earth's surface temperature because it has a greater albedo than ocean. **(1 mark)**
- 10) Choose the option that best answers the question or completes the statement.
- l) If the distance between two masses is doubled, the gravitational force between them
- a) is doubled
- b) is reduced to half
- c) becomes four times
- d) is reduced to a quarter
- (1 mark)**

II) The time period of a satellite orbiting Earth in a circular orbit is

INDEPENDENT of:

- a) Radius of the orbit
- b) The mass of the satellite
- c) Both the mass and radius of the orbit
- d) Neither the mass nor the radius of its orbit

(1 mark)

III) A satellite travels around the Sun in an elliptical orbit as shown in *figure 2*. As the satellite travels from X to Y, which of the following is true about its speed and angular momentum?

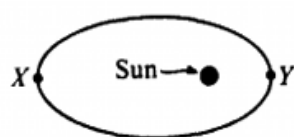


Figure 2

Option	Speed	Angular momentum
a)	Increases	Increases
b)	Decreases	Decreases
c)	Increases	Remains constant
d)	Decreases	Remains constant

(1 mark)

IV) Which of the following is true regarding gravitational potential energy and gravitational potential?

(1 mark)

- a) Gravitational potential energy depends on the mass of the object and the gravitational potential, while the gravitational potential depends only on the mass of the source.
- b) Gravitational potential energy is independent of the mass of the object whereas the gravitational potential depends on the object's mass.
- c) Both gravitational potential energy and the gravitational potential depend on the distance from the centre of the object.
- d) Gravitational potential energy is independent of distance from the centre of the object whereas the gravitational potential depends on the distance from the centre of the object.

V) If F_1 is the magnitude of the force exerted by the Earth on a satellite in orbit above the Earth and F_2 is the magnitude of the force exerted by the satellite on the Earth, then which of the following is true?

- A) F_1 is much greater than F_2
- B) F_1 is equal to F_2
- C) F_1 is slightly greater than F_2
- D) F_2 is much greater than F_1

(1 mark)

11) Choose the option that best answers the question.

I) The critical angle for total internal reflection from a medium to vacuum is 30° .

- A) The refractive index of the medium is
- a) 1
 - b) 1.5
 - c) 1.6
 - d) 2

(2 marks)

B) Use your result from A) to find the speed of light in the medium.

- a) 1.5×10^8 m/s
- b) 2×10^8 m/s
- c) 3×10^8 m/s
- d) 6×10^8 m/s

(1 mark)

II) An optical fiber has a refractive index of $n_1 = 1.45$ for the core and $n_2 = 1.42$ for the cladding. What is the critical angle at the core-cladding interface?

- a) 45°
- b) 57.4°
- c) 78.3°
- d) 84.5°

(2 marks)

III) You are comparing the use of multimode fiber and single mode fiber for a long distance communication link. Based on performance, which would you recommend for a system requiring minimal signal distortion over long distance?

- a) Multimode graded index optical fiber
- b) Single mode fiber
- c) Multimode step index optical fiber
- d) Special purpose optical fiber

(1 mark)

12) Choose the option that answers the question.

I) State whether each of the following statements is **True** or **False**.

- a) Work is a vector quantity because it depends on both the force and the displacement directions **(1 mark)**
- b) According to the work energy theorem, the work done by all forces acting on a body is equal to the kinetic energy of the body. **(1 mark)**

II) A 77 kg diver drops from a board 10 m above the water surface taken as the reference level of gravitational potential energy. Assume that there is no air friction.

A) Its potential energy before dropping is

- a) zero
- b) 770 J
- c) 3776.85 J
- d) 7553.7 J

(1 mark)

B) Its kinetic energy at the water surface is

- a) zero
- b) 770 J
- c) 7553.7 J
- d) 3776.85 J

(1 mark)

C) The velocity at the water surface is:

- a) zero
- b) 10 m/s
- c) 7.1 m/s
- d) 14.0 m/s

(1 mark)

13) Choose the option that answers the question or completes the statement.

I) Calculate the following:

A) The electric potential due to an electric charge of $4 \times 10^{-7} \text{C}$ at a point P located 0.09 m away from it.

- a) $0.292 \times 10^2 \text{ V}$
- b) $3.24 \times 10^2 \text{ V}$
- c) $4 \times 10^4 \text{ V}$
- d) $44.4 \times 10^4 \text{ V}$

(1 mark)

B) The magnitude of the electric field created by an electric charge of $4 \times 10^{-7} \text{ C}$ at a point P located 0.09 m away from it.

- a) $3.6 \times 10^{-8} \text{ N/C}$
- b) $4 \times 10^{-7} \text{ N/C}$
- c) $3.24 \times 10^2 \text{ N/C}$
- d) $4.4 \times 10^5 \text{ N/C}$

(2 marks)

II) A point electric charge causes an electric flux of $6 \times 10^3 \text{ Nm}^2\text{C}^{-1}$ to pass through a spherical Gaussian surface of 9 cm radius centered on the electric charge.

A) If the radius of the Gaussian surface increases, what will happen to the electric flux through the surface?

- a) It will increase
- b) It will remain the same
- c) It will decrease
- d) It will be zero

(1 mark)

B) What is the value of electric charge enclosed by the above Gaussian surface?

- a) $1.48 \times 10^{-15} \text{ C}$
- b) $4.78 \times 10^{-9} \text{ C}$
- c) $5.31 \times 10^{-8} \text{ C}$
- d) $6.78 \times 10^{14} \text{ C}$

(1 mark)

14) State whether each of the following statements is **True** or **False**

- a) Rain fall, steepness of slope, earthquake, arrangement of the rock layers are some causes of landslide. **(1 mark)**
- b) Epicenter of an Earthquake is the point inside the Earth where the Earthquake begins. **(1 mark)**
- c) In flood prone areas, a creative solution might involve designing homes with elevated foundations or floating houses that can withstand rising water..... **(1 mark)**
- d) Establishing an early warning system and evacuation routes is the disaster management plans that you would propose for a coastal city prone to tsunami. **(1 mark)**
- e) A city vulnerable to cyclones would benefit more from building underground bunkers in every home than developing a public alert system and clear evacuation routes..... **(1 mark)**

15) An electron is accelerated from rest through an electric potential difference of 200 V. Choose the option that answers the question or completes the statement.

I) Calculate the kinetic energy E_k of this electron

- a) 8×10^{-22} J
- b) 1.8×10^{-28} J
- c) 32×10^{-18} J
- d) 1.14×10^{-15} J

(2 marks)

II) Use the relation between the linear momentum and the kinetic energy of a moving body to calculate the momentum P of the electron.

- a) 1.46×10^{-29} kgm/s
- b) 7.63×10^{-24} kgm/s
- c) 3.82×10^{-23} kgm/s
- d) 4.55×10^{-23} kgm/s

(2 marks)

III) Calculate the Broglie wavelength λ of the electron

- a) 1.46×10^{-11} m
- b) 1.74×10^{-11} m
- c) 8.69×10^{-11} m
- d) 3.68×10^{-5} m

(1 mark)

Section B: Attempt any three questions (30 marks)

Space in which to answer the three questions is provided at the end of this section.

- 16) An X-ray tube (figure 3) is operating with an anode potential of 10 kV and a current of 15.0 mA.

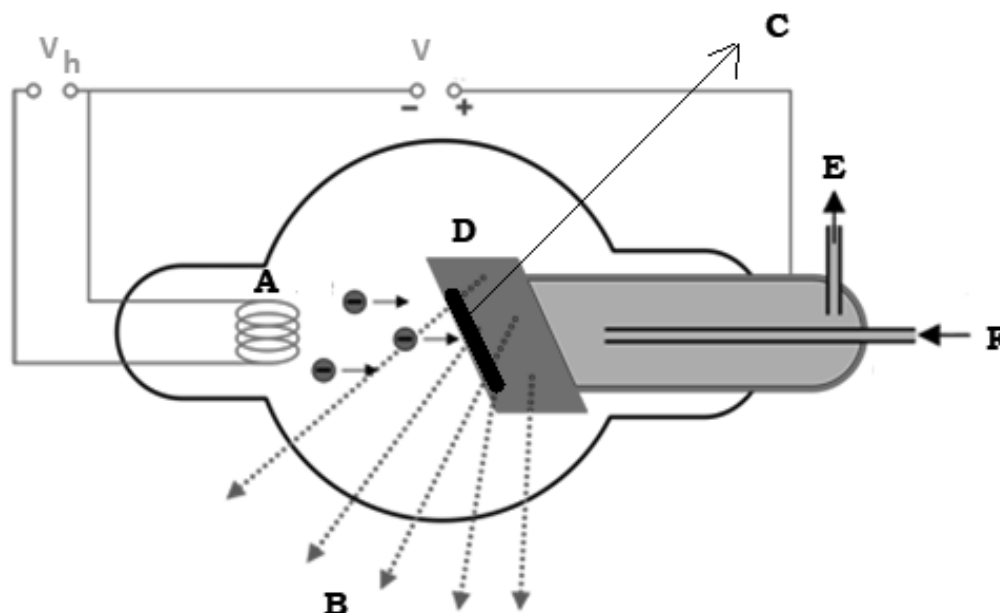


Figure 3

I) Explain

- a) How the intensity of X-rays from such a tube may be increased?

(1 mark)

- b) How the penetrating power of X-rays from such a tube may be increased?

(1 mark)

II) a) Estimate the electric charge transferred to the anode per second.

(2 marks)

- b) Calculate the number of electrons hitting the anode per second.

(2 marks)

III) Determine the velocity at which the electrons strike the target.

(2 marks)

IV) State two real life applications of X-rays.

(2 marks)

- 17) A fixed mass of an ideal gas is used as the working substance in an engine. The graph, not to scale (*figure 4*) shows the variation with the volume V of the pressure P of the fluid.

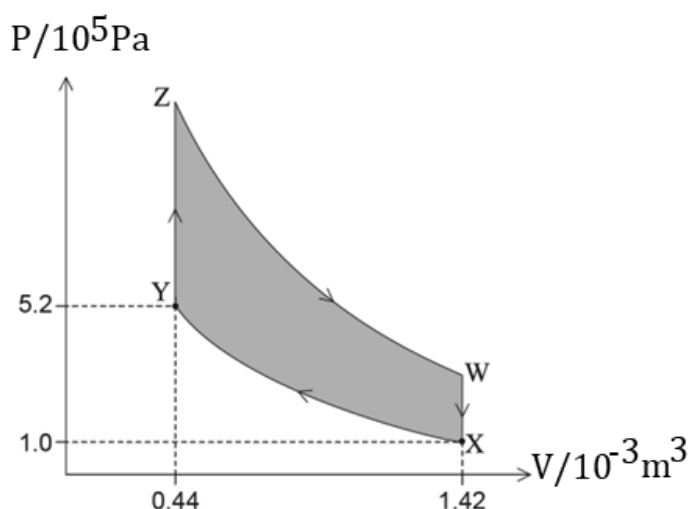


Figure 4

- For the cycle, identify an isochoric (isovolumetric) changes. **(2 marks)**
- The temperature at point X is 310 K. Calculate the temperature at point Y **(2 marks)**
- The shaded area WXYZ is 610 J. The total thermal energy transferred out of the gas in one cycle is 1.3 kJ.
 - State what is represented by the shaded area WXYZ. Justify your answer. **(2 marks)**
 - Determine the efficiency of cycle WXYZ. **(2 marks)**
- The work done on the gas during the adiabatic compression XY is 210J. Determine the change in internal energy during the change from X to Y. **(2 marks)**

18) Choose the correct option that best answers the question for multiple choice question.

I) *Figure 5* represents the waveform of a sound wave. The wave is travelling at a constant speed

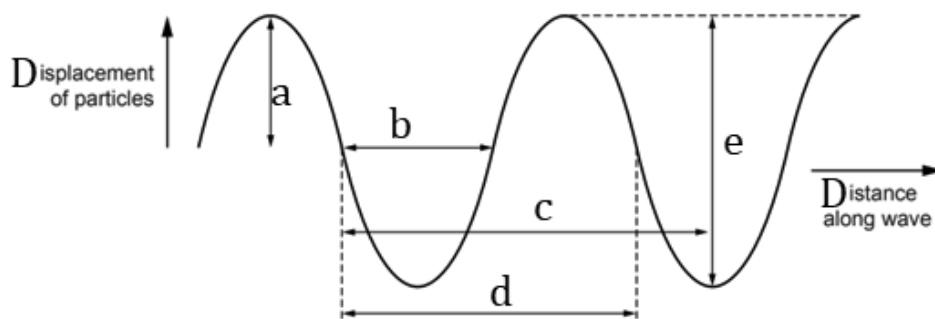


Figure 5

A) State:

a) the letter corresponding to the amplitude of the sound wave.

(1 mark)

b) the letter corresponding to the wavelength of the sound wave.

(1 mark)

B) State what happens to the amplitude and the wavelength of the sound wave if the loudness of the sound is increased at a constant pitch.

Amplitude: **(1 mark)**

Wavelength: **(1 mark)**

II) A sound wave resonates in a pipe closed on one end as shown in *figure 6*.

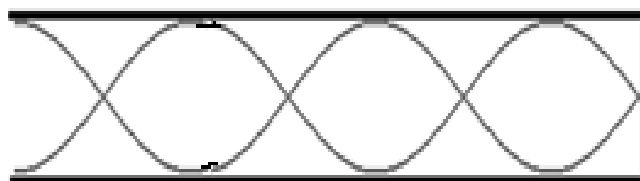


Figure 6

The length of the pipe is 2.1 m and the speed of sound in air is 340 m/s

A) What is the wavelength of the sound wave?

- a) 0.6 m
- b) 1.05m
- c) 1.2 m
- d) 161.9 m

(1 mark)

B) What is the fundamental frequency?

- a) 4.289 Hz
- b) 40.476 Hz
- c) 80.95 Hz
- d) 283.3 Hz

(1 mark)

III) Design an experiment to measure how sound waves travel through different materials. What materials would you choose and why?

(4 marks)

19) Consider the following figure and answer related questions.

I) A cell, a resistor, a key and an ammeter are arranged as shown in the circuit diagrams A, B and C of figure 7.

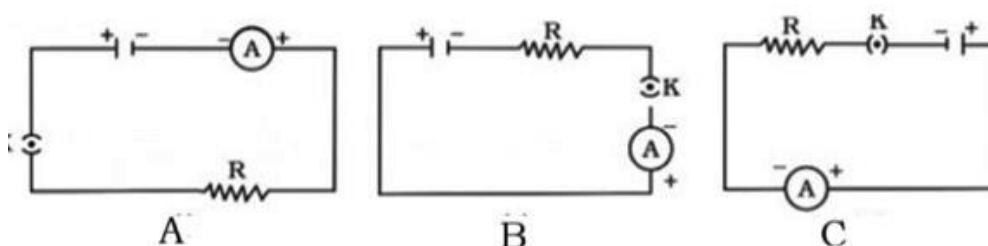


Figure 7

The current recorded in the ammeter will be

- a) maximum in A
- b) maximum in B
- c) maximum in C
- d) the same in all the cases.

(1 mark)

II) Three electric circuits A, B and C are given below (figure 8).

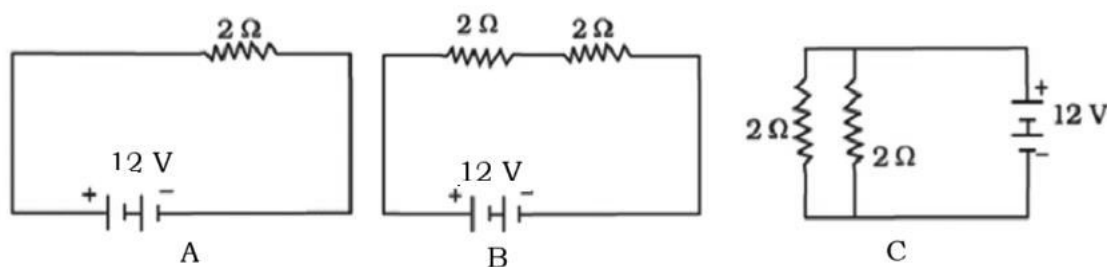


Figure 8

In the above circuits, heat produced per second in the resistor or combination of resistors connected to a 12 V battery will be

- a) maximum in case A
- b) maximum in case B
- c) maximum in case C
- d) same in all the cases

(2 marks)

- III) The factors that influence the resistance of a metallic conductor are
- a) the material of which the conductor is made
 - b) the length of the conductor
 - c) the thickness of the conductor

Choose the option that best answers the question.

- A) a) and b) B) b) and c) C) a) and c) D) a), b) and c)

(1 mark)

- IV) Use Kirchhoff's laws to find the three electric currents flowing through the electric circuit shown in *figure 9*.

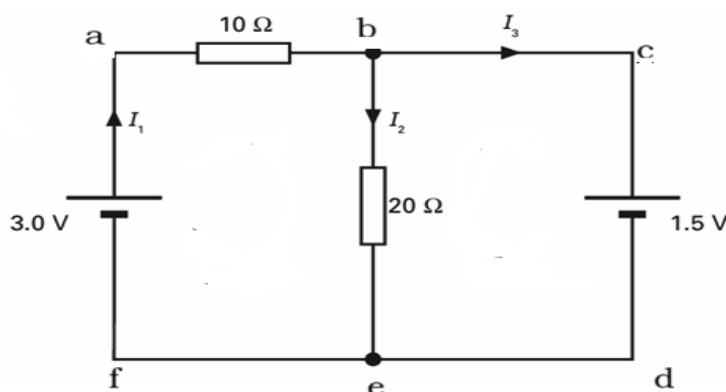


Figure 9

(6 marks)

- 20) A) Select the correct option that answers the following questions:

- I) If the number of protons and neutrons of an element is 13 and 14 respectively, what is the atomic number (Z) and mass number (A)?

- a) 13;13
- b) 13;27
- c) 14;13
- d) 27;14

(1 mark)

- II) Which of the following is true for the atomic model of Rutherford?

- a) Electrons orbit the nucleus in discrete, quantized energy levels.
- b) Electrons are randomly distributed in the atom.
- c) The nucleus of an atom is positively charged and occupies most of the atom's mass.
- d) The atom consists of a uniform cloud of positive charge.

(1 mark)

III) An electron in the hydrogen atom is in the $n = 4$ energy level.
When this electron makes a transition to a lower energy level $n = 2$
the wavelength of the photon emitted belongs to:

- a) Lyman series.
- b) Balmer series
- c) Paschen series
- d) Lyman and Balmer series

(1 mark)

IV) What does Bohr's assumption that electrons can only occupy
specific quantized orbits imply for the atom?

- a) Electrons can lose any amount of energy
- b) The atom emits a continuous spectrum of radiation
- c) Electrons can jump between arbitrary orbits
- d) The atom emits a discrete spectrum of radiation

(1 mark)

B) Some quantum numbers and energy levels in a hydrogen atom are given
in *figure 10*.

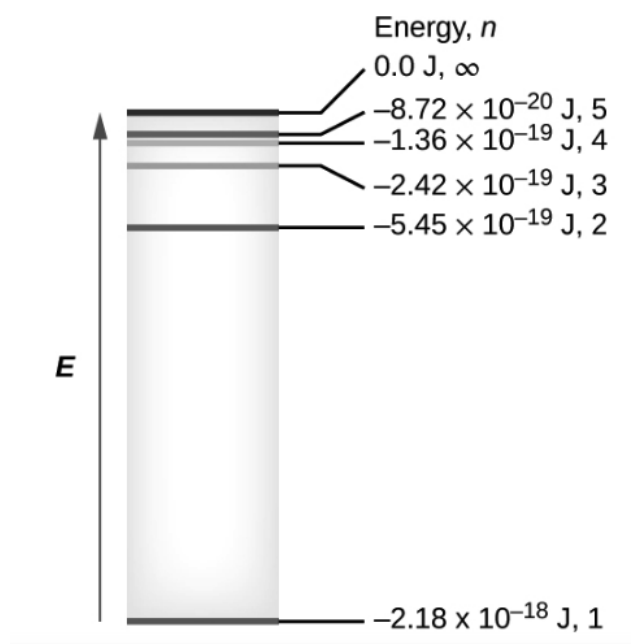


Figure 10

- a) If a spark promotes the electron in a hydrogen atom into an orbit with $n = 6$,
calculate its energy in joules.

(2 marks)

- c) Find the radius of the electron's orbit when the atom is in its 6th energy level of a hydrogen atom. The radius of the first orbit ($n = 1$) of hydrogen atom is $a_0 = 5.29 \times 10^{-11}m$ (Bohr's radius).

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This image shows a full page of blank white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for writing or drawing. There are no margins, text, or other markings present.

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