2019

PHYSICS (Honours)

Paper Code : IV-A & B

[New Syllabus]

Full Marks : 70 Time : Four Hours

Important Instructions for Multiple Choice Question (MCQ)

- Write Subject Name and Code, Registration number, Session and Roll number in the space provided on the Answer Script.

  Example : Such as for Paper III-A (MCQ) and III-B (Descriptive).

  Subject Code : | III | A | & | B |

  Subject Name : [ ]

- Candidates are required to attempt all questions (MCQ). Below each question, four alternatives are given [i.e. (A), (B), (C), (D)]. Only one of these alternatives is 'CORRECT' answer. The candidate has to write the Correct Alternative [i.e. (A)/(B)/(C)/(D)] against each Question No. in the Answer Script.

  Example — If alternative A of 1 is correct, then write :

  1. — A

- There is no negative marking for wrong answer.
- No student will be allowed to leave the examination hall before completion of the examination.
- Using abusive language or employing any other unfair means, he/she will render himself/herself liable to disqualify.
- Use of any mobile phone, calculator or log table etc. in the examination hall is prohibited, except specially instructed in the question paper.

মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী

- উত্তরপত্রে নির্দেশিত স্থানে বিষয়ের (Subject) নাম এবং কোড, রেজিস্ট্রেশন নম্বর, সেশন এবং রোল নম্বর লিখতে হবে।

  উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

  Subject Code : | III | A | & | B |

  Subject Name : [ ]

- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A) / (B) / (C) / (D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

  উদাহরণ — যদি **1** নম্বর প্রশ্নের সঠিক উত্তর **A** হয় তবে লিখতে হবে :

  1. — A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।
- কোন অবস্থাতেই পরীক্ষার্থীকে পরীক্ষাচলাকালীন পরীক্ষাকেন্দ্রের বাইরে যাওয়ার অনুমতি দেওয়া যাবে না।
- অবাঞ্ছিত কোন শব্দ ব্যবহার করা অথবা অবৈধ কোনো কাজকর্মে লিপ্ত থাকলে ছাত্র/ছাত্রী তার পরীক্ষা বাতিলের জন্য নিজেই দায়ী থাকবে।
- প্রশ্নপত্রে নির্দেশিত বিশেষ নির্দেশ ছাড়া পরীক্ষাকক্ষে মোবাইল ফোন, ক্যালকুলেটর অথবা লগ-টেবিল ইত্যাদি ব্যবহার নিষিদ্ধ।

Paper Code : IV-A

Full Marks : 15 Time : Thirty Minutes

Choose the correct answer.

Each question carries $1\frac{1}{2}$ marks.

1. A telescope with an objective of focal length 50 cm is used to bring into view an object 150 cm distant. When the eyepiece is adjusted to form the image at infinity, the magnifying power is 5. The focal length of the eyepiece is —

   (A) + 15 cm

   (B) – 15 cm

   (C) + 75 cm

   (D) – 75 cm

2. A parallel beam of light of wavelength 589 nm is incident on a thin plate of glass of refractive index 1.5 such that the angle of refraction is 60°. Calculate the smallest thickness of the plate for which dark fringe appears by reflection —

   (A) 340 nm

   (B) 366.66 nm

   (C) 392.66 nm

   (D) 240.25 nm

3. In a Huygens' eyepiece lenses of focal lengths 15.0 mm and 5.0 mm respectively are used. The equivalent focal length of the eyepiece is —

   (A) 10.0 mm

   (B) 7.5 mm

   (C) 3.75 mm

   (D) 75.0 mm

Turn Over

4. In a double slit experiment the width of each slit is 0.1 mm and that of the opaque space is 0.3 mm. The missing orders of interference fringes would be —

   (A) 2, 4, 6 etc.

   (B) 3, 6, 9 etc.

   (C) 4, 8, 12 etc.

   (D) None of the above

5. Two coherent sources of the same frequency have intensities I_0 and $2I_0$. Then the ratio of maximum intensity to minimum intensity in their interference pattern would be —

   (A) 3 : 1

   (B) 4 : 1

   (C) 20 : 3

   (D) 34 : 1

6. At a given point in space the total light wave is composed of three phases $P_1 = a$, $P_2 = \frac{a}{2}e^{i\theta}$ and $P_3 = \frac{a}{2}e^{-i\theta}$, the intensity of light at this point is —

   (A) $4a^2\cos^2\left(\frac{\theta}{2}\right)$

   (B) $4a^2\cos^4\left(\frac{\theta}{2}\right)$

   (C) $a^2\cos^2\theta$

   (D) $4a^2\cos^2(2\theta)$

7. A plane diffraction grating, having 80 lines per mm, just resolves the sodium D-lines (having wavelengths 589.0 mm and 589.6 mm) in the second order. The least width of the grating must be —

(A) 6.15 mm

(B) 6.20 mm

(C) 6.25 mm

(D) 6.30 mm

8. A Zener diode acts as a perfect voltage regulator when the percentage regulation has a value —

(A) 100%

(B) Not less than 50%

(C) Above 90%

(D) 0%

9. A transistor operates under fixed bias condition. If $V_{CC} = 9.0$ V, $R_B = 300$ kΩ, $\beta = 50$ and V_{BE} is negligible, the collector current will be —

(A) 4.5 mA

(B) 30.0 μA

(C) 1.5 mA

(D) 1.53 mA

Turn Over

10. A truth-table is given below for the two inputs A and B and the output Y :

A	*B*	*Y*
0	0	1
0	1	0
1	0	0
1	1	0

The gate which corresponds to the above truth-table is —

(A) OR gate

(B) NOR gate

(C) XOR gate

(D) NAND gate

P-II (1+1+1) H / 19 (N)

2019

PHYSICS (Honours)

Paper Code : IV-B

[New Syllabus]

Full Marks : 55 Time : Three Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer *five* questions taking at least *one* from each group.

Any kind of calculator may be used.

Group - A

[Geometrical Optics]

1. (a) State Fermat's principle in optics and with its help deduce Snell's law of refraction of light in a curved surface. 1+3

(b) Obtain the translation and refraction matrices as are used in geometrical optics. Hence, derive the system matrix for a thick lens. 2+2+3

2. (a) Explain briefly 'coma' and 'astigmatism'. 2

(b) Find the condition of achromatism of two thin co-axial lenses of the same material separated by a distance. 3

(c) When seen normally through the flat surface, the greatest thickness of a hemispherical glass block appears to be 2.4 cm, but when seen normally through the curved surface, it appears to be 3.0 cm thick. The actual thickness is 3.6 cm. Find (i) the refractive index of glass and (ii) the radius of curvature of the curved surface. 3

(d) Show that Linear magnification of a lens is equal to the product of angular magnification and longitudinal magnification. 3

Turn Over

Group - B

[Physical Optics]

3. (a) What will happen if the acute angles of a biprism are increased ? Explain with reasons. 2

(b) What is a zone plate ? Prove that a zone plate has multiple foci. 1+2

(c) A zone plate is found to give a series of images of a point source on its axis. If the strongest and the second strongest images are at distances of 30.0 cm and 6.0 cm respectively from the zone plate, both on the same side remote from the source, prove that the principal focal length and the radius of the first zone are respectively 0.15 m and 2.74×10^{-4} m, Wavelength of light used = 5×10^{-7} m. 4

(d) For the star Betelgeuse the mirror separation for the first disappearance of fringes in a Michelson's stellar interferometer was 3.0 metre. If the distance of the star from the earth is 1.7×10^{15} km, calculate its linear diameter. The mean wavelength of hight emitted by the star is 5750 Å. 2

4. (a) What is the nature of the fringes formed by a Fabry-Perot interferometer ? 1

(b) Derive an expression for the intensity distribution of the Fabry-Perot interferometer fringes in terms of the intensity of the incident light, coefficient of finesse, etc. show that in a Fabry-Perot interferometer the visibility of fringes is given by $V = \frac{2R}{1+R^2}$, terms having usual significance. 5+2

(c) A thin film of soap solution is illuminated by white light at an angle of incidence $\sin^{-1}\left(\frac{4}{5}\right)$. In refelcted light, two dark consecutive overlapping fringes are observed corresponding to wavelengths 610 nm and 600 nm. The refractive index of the soap film is $\frac{4}{3}$. Calculate the thickness of the film. 3

5. (a) A monochromatic beam of parallel light rays is incident normally on a plane diffraction grating with N lines per unit length. Obtain expressions for angular positions of the maxima and the minima of the transmitted spectra. Discuss the formation of principal and secondary maxima. Indicate why the secondary maxima are not usually visible. 6+2

(b) In whcih ways is a concave grating superior to a plane transmission grating ? 2

(c) What is meant by 'normal spectrum' ? 1

6. (a) State Rayleigh's criterion for the resolution of spectral lines. Find an expression for the chromatic resolving power of a prism. 1+4

(b) Light is incident at 70° on a plane reflection grating which has 6000 lines per cm ruled over a width of 3.0 cm. What is the maximum resolving power available at a wavelength of 5000Å ? 3

(c) A plane grating which has 4000 lines per cm is used at normal incidence. Show that the dispersive power of the grating in the third order spectrum in the wavelength region of 500 nm is 15000 radian/cm. 3

Group - C

[Electronics - I]

7. (a) State Thevenin's theorem for an electrical network. 1

(b) A voltage source V_S having internal resistance R_S is connected to a variable load R_L such that $R_L \geq 100\, R_S$. Show that when the load is varied, the percentage change in the load voltage is only 1%. 2

(c) How is the depletion region formed in a p-n junction diode ? Mention the order of its width with biasing. 2+1

Turn Over

(d) Draw the current-voltage characteristic curve of a Zener diode for forward and reverse bias. Indicate clearly the 'breakdown region'. Choose a point in the breakdown region and estimate the dynamic or a.c. resistance at that point. 1+1+1

(e) Discuss clearly the mechanism of 'Zener breakdown'. 2

8. (a) Define α and β of a bipolar transistor and obtain a relation between them. 2+2

(b) What is Early effect ? 2

(c) Draw the circuit diagram of a positive diode logic AND gate and explain its operation. Give the relevant truth table. 4+1

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2019

PHYSICS (Honours)

Paper Code : V-A & B

[New Syllabus]

Full Marks : 70 Time : Four Hours

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  Subject Name : [ ]

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  উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

  Subject Code : | III | A | & | B |

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- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A) / (B) / (C) / (D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

  উদাহরণ — যদি **1** নম্বর প্রশ্নের সঠিক উত্তর **A** হয় তবে লিখতে হবে :

  1. — A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।
- কোন অবস্থাতেই পরীক্ষার্থীকে পরীক্ষাচলাকালীন পরীক্ষাকেন্দ্রের বাইরে যাওয়ার অনুমতি দেওয়া যাবে না।
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Paper Code : V-A

Full Marks : 15 Time : Thirty Minutes

Choose the correct answer.

Each question carries $1\frac{1}{2}$ marks.

1. The thermodynamic function which remains constant in an isothermal isobaric process is —

   (A) Helmholtz's free energy

   (B) Gibbs' free energy

   (C) Enthalpy

   (D) Internal energy

2. The efficiency of a carnot engine is 40%. The sink temperature is 15°C. The corresponding source temperature is —

   (A) 207°C

   (B) 200°C

   (C) 480°C

   (D) None of the above

Turn Over

3. Starting from Maxwell's thermodynamical relation; $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$, one can obtain the relation —

   (A) $\left(\frac{\partial Q}{\partial P}\right)_T = -\frac{T\beta}{V}$, where $\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$

   (B) $\left(\frac{\partial Q}{\partial P}\right)_T = +\frac{T\beta}{V}$

   (C) $\left(\frac{\partial Q}{\partial P}\right)_T = +TV\beta$

   (D) $\left(\frac{\partial Q}{\partial P}\right)_T = -TV\beta$

4. A familiar process by which heat is completely converted into work, is —

   (A) A reversible cyclic process of any system;

   (B) A reversible cyclic process of an ideal gas;

   (C) A quasistatic isothermal expansion of an ideal gas;

   (D) Not, at all, available

5. The change in temperature of an ideal gas due to Joule-Thomson effect is —

   (A) PR/V

   (B) TR/V

   (C) $\left(2a/RT - b\right)/RT$

   (D) Zero

6. A coil of self inductance 100 mH is connected in series with another coil of self inductance 169 mH. The effective inductance of the combination is found to be 70 mH. The mutual inductance between the coils is —

(A) 100 mH

(B) 99.5 mH

(C) 99.0 mH

(D) 69.0 mH

7. The metals M_1 and M_2 form a thermocouple each with a standard metal S. For the $M_1 - S$ couple, the thermoelectric power is $P_1 = (-0.04t + 16)$ $\mu v/°C$, while for the $M_2 - S$ couple it is $P_2 = (0.01t + 2)\mu v/°C$. The neutral temperature for the $M_1 - M_2$ couple is —

(A) 280°C

(B) 200°C

(C) 400°C

(D) 300°C

8. A charged particle moves with a uniform velocity $\vec{u} = 5\hat{i}\ ms^{-1}$ in a region where $\vec{E} = 30\hat{j}\ Vm^{-1}$ and $\vec{B} = B_0\hat{k}$ tesla. The value of B_0 is —

(A) 5.0 tesla

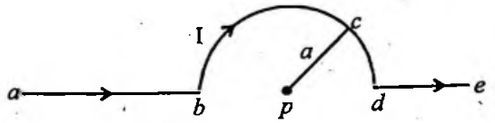
(B) 0.167 tesla

(C) 6.0 tesla

(D) 150.0 tesla

Turn Over

9. A current I is passing through the wire shaped as shown in the figure. The magnetic field at the point P is :



(A) $(\mu_0 I)/4a$

(B) $(\mu_0 I)/4\pi a$

(C) $(\mu_0 I)/2a$

(D) $(\mu_0 I)/a$

10. A cylindrical bar magnet is kept along the axis of a circular coil. On rotating the magnet about its axis, the coil will experience in it —

(A) alternating current

(B) direct current

(C) only e.m.f

(D) No current

2019

PHYSICS (Honours)

Paper Code : V-B

[New Syllabus]

Full Marks : 55 Time : Three Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer *five* questions, taking at least *two* from each group.

(Any kind of Calculator may be used.)

Group - A

[Thermodynamics]

1. (a) Is temperature of a body an extensive or an intensive variable? Explain. 1

(b) What is meant by thermodynamic equilibrium? What is a quasistatic process? 1+1

(c) One mole of an ideal gas undergoes an adiabatic free expansion so that its volume is doubled. Compute the change in entropy in the process, if any. 2

(d) Represent the various strokes of a diesel cycle in an indicator diagram and obtain an expression for the efficiency of the cycle. 2+4

2. (a) Deduce the following relation :

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P,$$ terms being usual.

Turn Over

Show that for a van der Waals' gas, $\left(\frac{\partial U}{\partial V}\right)_T = \frac{a}{V^2}$.

Hence, prove that the temperature change during a free expansion of a van der Waals' gas from a volume V_i to a final volume V_f is

$$\Delta T = \frac{a}{c_V}\cdot\frac{V_i - V_f}{V_i V_f}$$ 3+1+3

(b) Using the third law of thermodynamics, prove that the absolute zero of temperature cannot be attained. 3

(c) State Le Chatelier's principle. 1

3. (a) How is the order of a phase transition defined? Deduce the following latent heat equations :

(i) $\left(\frac{dP}{dT}\right)_{sat} = \frac{L}{T(v_2 - v_1)}$ and

(ii) $\frac{dL}{dT} - \frac{L}{T} = C_2 - C_1$, where L is the latent heat of the system at a temperature T and other symbols are usual. 1+3+3

(b) The density of iodine at the boiling point (185.3°C) is 3.71 gm/cc and latent heat of vaporisation is 40.9 cal/gm. If the boiling point changes by 1°C for a change of pressure of 17 mm of Hg, calculate the specific volume of the vapour.

Take $J = 4.18$ joule/cal. 4

4. (a) What is J.T. effect? Show that J.T. coefficient 'μ' is given by

$$\mu = \frac{1}{C_P}\left[T\left(\frac{\partial V}{\partial T}\right)_P - V\right]$$ 2+3

(b) What is adiabatic demagnetisation? Describe briefly how it has been used to produce very low temperatures. 1+3

(c) The phase equilibrium carve of solid and vapour ammonia is given by

$ln\ P = 23.03 - \frac{3754}{T}$, and that of liquid and vapour ammonia is given by

$ln\ P = 19.49 - \frac{3063}{T}$

Estimate the triple point of ammonia. 2

Group - B

[Electricity - II]

5. (a) Using Biot-Savart law, deduce an expression for the magnetic field at an axial point of a circular coil carrying a steady current.

How could you produce a uniform magnetic field in the laboratory by using two identical circular coils? Justify your answer by mathematical reasons. 4+3

(b) A circular coil of radius 'a' carrying a current I is lying on the x-y plane with its centre at the origin. There is an external uniform magnetic field :

$$\vec{B} = \frac{B_0}{\sqrt{2}}(\hat{i} + \hat{j})$$

Find the force and the torque acting on the coil. 2

(c) What is a Bohr magneton? Give its value in SI units. 1+1

6. (a) Write down the differential form of Ampere's circuital theorem. Hence, convert it into the usual integral form. 2

Turn Over

(b) A metal disc of radius 'a' rotates with a constant angular velocity $\vec{\omega}$ about its axis in a magnetic field of induction $\vec{B}$ normal to the plane of the disc and parallel to $\vec{\omega}$. Show that the potential difference between the centre and the rim of the disc would be $\frac{\omega B a^2}{2}$. 3

(c) What do you understand by free and bound currents? For non-uniform magnetisation of a material, establish the relation : $\vec{\nabla} \times \vec{M} = \vec{J}_M$, terms being usual. 2+4

7. (a) With necessary theory discuss the method of measurement of a high resistance by the leakage of charge of a charged capacitor. 5

(b) A railway track 1.2m wide runs along the earth's magnetic meridian. The vertical component of the earth's magnetic field is 5×10^{-5} tesla. Calculate the e.m.f. in mV that will exist between the rails when a train runs on the line at a speed of 60 km/hr. 2

(c) For a thermoelectric circuit comprised by two metals A and B, deduce the relation : 4

$\pi = T\frac{dE}{dT}$, symbols being usual.

8. (a) A series LCR circuit is driven by an alternating e.m.f $V = V_0 \sin wt$, terms being usual. Show graphically the variation of current (I) with the frequency $\left(f = \frac{\omega}{2\pi}\right)$ of the supply e.m.f. Explain the term 'resonance' in this connection and indicate the resonant frequency (f_0) in your graph. Define Q-factor for the circuit. 1+2+1

(b) A 60 Volt-10W lamp is to be lit in an a.c. supply of 100V – 50Hz. in series with a suitable capacitor. Find the capacity of the capacitor that would be needed for the purpose. 3

(c) If two coils of self inductances L_1 and L_2 are coupled by a mutual inductance M, show that the magnetic energy of the system is,

$U = \frac{1}{2}\left(L_1 I_1^2 + L_2 I_2^2 + M I_1 I_2\right)$, where I_1 and I_2 are the currents in the two coils. 4
