Version No.			

ROLL NUMBER						

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

Answer Sheet No.____________

Sign. of Candidate ___________

Sign. of Invigilator ___________

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PHYSICS HSSC–II

SECTION – A (Marks 17)

Time allowed: 25 Minutes

Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

Q.1 Fill the relevant bubble for each part. Each part carries one mark.

1. How much charge passes in 2 minutes through a junction which has a steady current of 5A?
   - A. 10 coulomb ◯ B. 300 coulomb ◯
   - C. 600 coulomb ◯ D. 50 coulomb ◯

2. The current through a circuit, in which emf of a cell ε = 120V and internal resistance r = 0.01Ω is connected with load R= 1000Ω, is:
   - A. 100 mA ◯ B. 50 mA ◯
   - C. 120 mA ◯ D. 150 mA ◯

3. Find the electric potential (in volts) at the center of line joining the two charges +5μC and -5μC. The charges are placed at a distance of 10cm.
   - A. 9×10^{-3}V ◯ B. 1.8×10^{-2}V ◯
   - C. 0 V ◯ D. Infinite ◯

4. How many electrons on a body will be established by a charge of one coulomb?
   - A. 10 Electrons ◯ B. 1.6×10^{-19} Electrons ◯
   - C. 6.25×10^{18} Electrons ◯ D. 6.25×10^{21} Electrons ◯

5. A capacitor acts like a perfect insulator for:
   - A. Direct current ◯ B. Alternating current ◯
   - C. Magnetic field ◯ D. Electric field ◯

6. The electrical energy converted into heat energy is given by the expression:
   - A. IRt ◯ B. I^2Rt ◯
   - C. VI^2t ◯ D. I^2R ◯

7. A straight current carrying conductor experiences maximum magnetic force in a uniform magnetic field when it is placed ___________ to the field.
   - A. Parallel ◯ B. Perpendicular ◯
   - C. At an angle 180^0 ◯ D. Inclined ◯

8. The S.I unit of Magnetic flux is:

A. NmA^{-1} ◯ B. $NA^{-1}m^{-1}$ ◯

C. Nm^2 ◯ D. Vm ◯

9. The unit "henry" is used for:

A. Self inductance ◯ B. Mutual induction ◯

C. Self induction ◯ D. Induced emf ◯

10. One meter long rod is moving at 30^0 through a magnetic field of 1T. If the velocity of the rod in the magnetic field is $1ms^{-1}$ then induced emf across the rod will be:

A. 0.5 V ◯ B. 0.6 V ◯

C. 1V ◯ D. 0.2 V ◯

11. Phase relationship between alternating voltage (V) and alternating current (I) through an inductor is:

A. 'I' leads 'V' by 90^0 ◯ B. Both 'V' and 'I' are in phase ◯

C. 'I' lags behind 'V' by 90^0 ◯ D. 'V' and 'I' are out of phase by 180^0 ◯

12. The conductivity of good conductors is:

A. 10^4 to $10^7 (\Omega m)^{-1}$ ◯ B. 10^{-8} to $10^{-4} (\Omega m)^{-1}$ ◯

C. 10^{10} to $10^{-20} (\Omega m)^{-1}$ ◯ D. 10^{-6} to $10^6 (\Omega m)^{-1}$ ◯

13. The materials whose resistivity become zero below a certain temperature (critical temperature Tc) are called:

A. Conductors ◯ B. Semi-conductors ◯

C. Super conductors ◯ D. Hybrid conductors ◯

14. Electromagnetic radiations transport energy equal to:

A. $\frac{1}{2} mv^2$ ◯ B. $\frac{P}{c}$ ◯

C. $\frac{hf}{c}$ ◯ D. hf ◯

15. If speed 'v' of an observer is added to the speed of light 'c', the resultant speed will be equal to:

A. v+c ◯ B. v-c ◯

C. c ◯ D. v ◯

16. Strong nuclear force exists between:

A. Hadrons ◯ B. Photons ◯

C. Leptons ◯ D. Muons ◯

17. The amount of energy equivalent to 1 a.m.u. is:

A. 9.315 MeV ◯ B. 93.15 MeV ◯

C. 931.5 MeV ◯ D. 0.931 MeV ◯

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Federal Board HSSC-II Examination
Physics Model Question Paper
(Curriculum 2006)

Time allowed: 2.35 hours Total Marks: 68

Note: Answer any fourteen parts from Section 'B' and attempt any two questions from Section 'C' on the separately provided answer book. Write your answers neatly and legibly.

SECTION – B (Marks 42)

Q.2 Attempt any **FOURTEEN** parts. All parts carry equal marks. $(14 \times 3 = 42)$

i. Why do we not use water as a dielectric material for capacitor even though it has very high value of relative permittivity?

Answer: Water molecules are polar molecules with large value of relative permittivity (80). If the water is used as dielectric between the plates of the capacitors, the water molecules due to polar properties will have a large value of conduction at certain voltage. This large value of conduction turning the dielectric property of a water molecule into a conductor. Thus water cannot be used as dielectric between the plates of the capacitors.

ii. What is the effect of medium on the electrostatic force between two charges?

Answer: The force will decrease with the medium. F_{vac} is greater than in F_{med}

iii. Why does no current pass through the galvanometer in a balanced wheat-stone bridge although the two keys in the circuit are closed?

Answer: When the bridge is in balance condition, no current will flow through the galvanometer because potential difference between the two ends of galvanometer becomes same.

iv. Explain why does the terminal potential difference of a battery decrease, when current drawn from it is increased?

Answer: The terminal potential difference of a battery is

$$IR = E - I.r$$
$$V_t = E - I.r$$

Where E is the emf of the battery, r is the internal resistance of battery, and I.r is the potential difference across internal resistance.
When I increased then I.r becomes larger and terminal potential becomes small. Thus, we can say that when we draw more current from battery then its terminal potential difference will decrease.

v. A rectangular coil of 100 turns and area 500×10^{-4} m^2 carrying 2 A current is placed in a uniform magnetic field of 10T. Find the maximum torque applying on the coil.

Answer: The torque on the rectangular coil due to presence of magnetic field is given,

$$\tau = NIAB\sin\theta$$

where number of turns N=100,
Current in the coil I=2A,
Area of the coil $A = 500 \times 10^{-4} m^2$,

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Magnetic field B=10T,

Angle between area and magnetic field vector is θ

As area vector is always normal to plane and given the plane is parallel to field, so the angle between area and field is 90^o.

So, $\tau=100\times2\times500\times10^{-4}\times10\ \sin90=100Nm$

vi. Why is cyclotron not suitable to accelerate neutron?

Answer: Neutrons are not charged and electrically neutral. The cyclotron accelerates charged particles. Thus, neutrons are not accelerated by cyclotrons. Thus, a cyclotron cannot accelerate neutrons as they are not charged.

vii. How is the mutual inductance of a pair of coils affected when the separation between the coils and the number of turns of each coil is increased?

Answer: (i) When the separation between the two coils is increased, the flux linked with the secondary due to the current in the primary, decreases. Hence the mutual inductance decreases.

(ii) Mutual inductance increases when the number of turns in each coil is increased, because $M \propto N_1N_2$

viii. Calculate the potential difference between the wings of a jet plane induced by its motion normal to the Earth's magnetic field. The total span of wings is 50m and speed is $600ms^{-1}$. (Earth's magnetic field is 0.3 gauss.)

Answer: Induced emf E=Bvl

$= 3\times10^{-5}\times600\times50$

$=0.9V$

ix. Define mutual-inductance and self-inductance and their unit henry.

Answer: Mutual inductance is the belongings of two coils by the virtue of which each opposes any change in the value of current flowing along the other by evolving an induced emf. The **SI unit of mutual inductance is henry**.

Self-inductance of a coil is defined as the phenomenon due to which an emf is induced in a coil when the magnetic flux of coil, linked with the coil changes or current in coil changes. Its S.I. unit is **Henry(H)** .

x. What will be the net power loss through a pure capacitor or inductor?

Answer: In ideal cases, **there are no power losses** in pure inductor and capacitor circuits. Power loss is due to the resistance offered by the linear passive component (Resistor) or the resistance of the conductor and other components. For pure capacitive circuit $\phi=90^\circ$ so P=0.

Average power dissipated is the amount of energy lost due to unwanted means in an electronic device or circuit. This waste occurs because energy gets converted to another form which is an unnecessary by-product, for example heat, sound etc. Thus, the average energy dissipated per cycle in an ideal **inductor is zero**.

xi. High temperature super conductors are required in MRI machines, why?

Answer: Superconductors provide **significantly higher current densities and smaller lighter designs than room temperature equivalents**. Superconductors are also able to conduct direct current without resistance (loss of energy) below a critical temperature and applied field.

xii. The forbidden energy gap of silicon is 1.1eV. What does it mean?

Answer: The forbidden energy gap for silicon is 1.1 eV. This is **the gap between the highest energy electron states in the valence band and the lowest energy states in the conduction band**. The key significance of this gap is that photons with energy less than this value will pass through the solid without interacting.

xiii. Explain why is common emitter configuration widely used in amplifier circuits?

Answer: Common emitter transistors are used most widely, because a common emitter transistor amplifier **provides high current gain, high voltage gain and high power gain**. This type of transistor gives for a small change in input there is small change in output.

xiv. In Photoelectric effect, why do all emitted electrons not possess the K.E of maximum value?

Answer: Each electron energy possessed by an ejected electron can either be the same or different from the other because when a photon energy is absorbed by an electron, part of the energy is used to overcome the binding energy. The extra energy is the one used to release the electron.

xv. When is Compton shift maximum?

Answer: The shift depends only on **the angle of scattering**. It is the scattering of a photon by a charged particle, usually an electron. When a photon collides with an electron at rest, the photon gives its energy to the electron.
The change in wavelength in Compton scattering is given by:

$\Delta\lambda = h/mc(1 - \cos\theta)$

where θ is the scattering angle. $\Delta\lambda$ will be maximum for $\theta = 180^\circ$ in which case.

$\Delta\lambda(max) = 2h/mc = 4c/mc^2$

$= 4\pi \times 197.3$ MeV-fermi/0.511 MeV = 0.0485 Å

xvi. Show that de-Broglie wave length is: $\lambda = \frac{h}{\sqrt{2mVe}}$

Answer: $\lambda = h/mv$

$v = h/m\lambda$

K.E. $= eV = 1/2\ mv^2$

$2eVm = m^2v^2$

xvii. What is population inversion?

Answer: **When the number of rare earth ions in the higher energy excited states are greater than the number in ground or normal state**, population inversion is achieved. Population inversion can be achieved by optical pumping in which the atoms in the ground state are excited to higher states by absorption of pump light.

xviii. If you swallowed an alpha particle and a beta particle which would be more dangerous to you?

Answer: **Alpha particles are the most harmful internal hazard** as compared with gamma rays and beta particles. Radioactive materials that emit alpha and beta particles are most harmful when swallowed, inhaled, absorbed, or injected. Beta particles can partially penetrate skin, causing “beta burns”.

A beta particle is about 8,000 times smaller than an alpha particle and that's what makes them more dangerous. Their **small size allows them to penetrate clothing and skin**.

External exposure can cause burns and tissue damage, along with other symptoms of radiation sickness.

xix. Differentiate between hadrons and leptons.

Answer: Hadrons are particles that feel the strong nuclear force, whereas **leptons are particles that do not**. The proton, neutron, and the pions are examples of hadrons. The electron, positron, muons, and neutrinos are examples of leptons, the name meaning low mass. Leptons feel the weak nuclear force.

Hadrons are particles containing quarks. Baryons are hadrons containing three quarks, and mesons are hadrons containing **a quark and an antiquark**. Baryons have three quarks inside them, while mesons have a quark and an antiquark.

xx. A long straight wire is bent into a circular loop of radius 0.05m. If an ammeter shows 2A current flowing through this closed loop then compute the magnetic field around it**?**

Answer: The equation $B=\mu_0 I/2\pi r$ can be used to find out B, since all other quantities are known.
Solving for B and entering known values gives
$I=2\pi rB/\mu_0=2\pi(5.0\times10^{-2}m)(1.0\times10^{-4}T)/4\pi\times10^{-7}T\cdot$
$=25A$

SECTION – C (Marks 26)

Note: Attempt any **TWO** questions. All questions carry equal marks. (2 × 13 = 26)

Q.3 a. Distinguish between intrinsic and extrinsic semiconductor material? How can P-type and N-type semiconductors be made by using doping? **(2+2+2)**

Answer: The main difference between intrinsic and extrinsic semiconductor is that **intrinsic semiconductors are pure in form**, no form of impurity is added to them while extrinsic semiconductors being impure, contains the doping of trivalent or pentavalent impurities.

In an n-type semiconductor, **pentavalent impurity from the V group is added to the pure semiconductor**. Examples of pentavalent impurities are Arsenic, Antimony, Bismuth etc. The majority of charge carriers in the crystal are negative electrons.

P-type semiconductors are **created by doping an intrinsic semiconductor with an electron acceptor element during manufacture**.

In a p-type semiconductor, trivalent impurity from the III group elements is added as the impurity The term p-type refers to the positive charge of a hole. As opposed to n-type semiconductors, p-type semiconductors have a larger hole concentration than electron concentration.

b. Briefly explain an electric polarization. **(3)**

Answer: **Electric polarization** occurs when a non-polar substance is placed between two parallel plates with an applied electric field. The electric field tends to attract the negatively charged electron towards the positive plate and the positive charge nucleus towards the negative plate. Therefore, in the presence of an electric field or current, there will be observed an electrical distortion or polarized molecule to form an electrical dipole. This type of distortion process in the molecules is called the electric polarization but the polarization disappears as soon as the polarized field is withdrawn and the polarizing molecule comes back to its original state.

c. A heating coil has resistance of 20 Ω. It is designed to operate on 220 V. What electrical energy in joules is supplied to the heater in 10 s? **(4)**

Answer: R=20Ω,
V=220V,
t=10s
Energy dissipated $=V^2 \times t/R$
$=(220)^2 \times 10/20$
$=24200$ J $=24.2$kJ

Q.4 a. How is an AC generator used to produce an alternating current? Explain with the help of graph between instantaneous emf and time. **(6)**

Answer: An A.C. generator is an electronic device used to convert mechanical energy into electrical energy using the principle of electromagnetic induction. Construct the diagram by schematic analyses of its working and thus include all its essential components. The expression for induced emf can be established using the expression for magnetic flux in the coil and Faraday's flux rule.

b. A simple AC generator consists of N=10 turns coil of area $A=1200 cm^2$ which rotates at a constant frequency f = 60Hz in a uniform magnetic field B = 0.40 T. Find the peak e.m.f generated by it. **(3)**

Answer: Number of turns N=10 turns
Area of coil $A=1200\ cm^2=0.012\ m^2$
Frequency f=60Hz
Angular speed $w=2\pi f=2\times\pi\times60=376.8$ rad/s
Magnetic field B=0.40 T
Maximum value of emf induced E_{max}= NBAw
$E_{max}=10\times0.40\times0.012\times376.8=18.08$ volts

c. How fast must a proton move in a magnetic field 2.5×10^{-3} T such that the magnetic force is equal to its weight? **(4)**

Answer:

We know that
Charge of proton $= 1.6 \times 10^{-19}$ C
Mass of proton $= 1.67 \times 10^{-27}$ kg
and Accelration due to gravity $= g = 9.8\ ms^{-2}$
As $F = qvB$ —— (1)
also $F = W = mg$ —— (2)
As magnetic force is equal to its weight
$F = W$
$qvB = mg$
$v = \frac{mg}{qB}$
$= \frac{1.67\times10^{-27}\times9.8}{1.6\times10^{-19}\times2.50\times10^{-3}}$
$= \frac{1.637\times10^{-26}}{4\times10^{-22}}$
$= 4.09\times10^{-5}\ ms^{-1}$

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Q.5 a. i. How is solid state detector better than other radiation detectors? **(4)**

Answer: When talking about radiation detection instruments, there are three types of detectors that are most commonly used, depending on the specific needs of the device.

These are: **Gas-Filled Detectors, Scintillators, and Solid State detectors.**
Solid-state semiconductor detectors are **radiation detectors which employs a semiconductor material as the detecting medium**. These detectors produce pulse of electric current by means of pairs of charge carriers, electrons and holes, generated when the detectors come in contact with ionizing radiation.

ii. How can nuclear reactor initiate a controlled fission reaction? **(3)**

Answer: Most reactors are controlled by means of **control rods** that are made of a strongly neutron-absorbent material such as boron or cadmium. ... Once the fast neutrons have been slowed, they are more likely to produce further nuclear fissions or be absorbed by the control rod.

b. Derive the expression for energy of an electron revolving in the orbit of Hydrogen atom. Show that the total energy of an electron in different orbits is quantized. **(3+3)**

Answer: Bohr's theory explained the atomic spectrum of hydrogen and established new and broadly applicable principles in quantum mechanics.

To get the electron orbital energies, we start by noting that the electron energy is the sum of its kinetic and potential energy: *En* = KE + PE. Kinetic energy is the familiar KE=12mev2KE=12mev2, assuming the electron is not moving at relativistic speeds. Potential energy for the electron is electrical, or $PE = q_e V$, where *V* is the potential due to the nucleus, which looks like a point charge. The nucleus has a positive charge Zq_e ; thus, V=kZqernV=kZqern, recalling an earlier equation for the potential due to a point charge. Since the electron's charge is negative, we see that PE=−kZqernPE=−kZqern. Entering the expressions for *KE* and *PE*, we find

En=12mev2−kZq2ernEn=12mev2−kZqe2rn.

Now we substitute *rn* and *v* from earlier equations into the above expression for energy. Algebraic manipulation yields

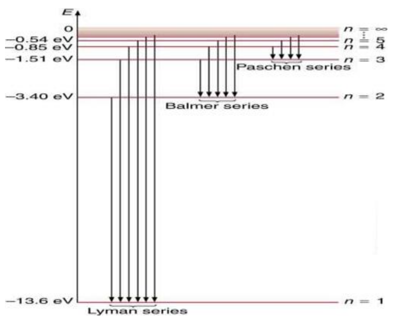
En=−Z2n2E0(n=1,2,3,…)En=−Z2n2E0(n=1,2,3,…)

for the orbital *energies of hydrogen-like atoms*. Here, E_0 is the **ground-state energy** (*n* = 1) for hydrogen (*Z* = 1) and is given by

E0=2πq4emek2h2=13.6 eVE0=2πqe4mek2h2=13.6 eV

Thus, for hydrogen,

En=−13.6 eVn2(n=1,2,3…)



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