INDIAN SCHOOL MUSCAT
FINAL EXAMINATION 2022
PHYSICS (SUB CODE: 042)

CLASS: XII   TIME ALLOTED: 3 HRS.

DATE: 19.11.2022   MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

(1) There are 35 questions in all. All questions are compulsory

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.

(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

(6) You may use the following values for the constants wherever necessary.

$$e = 1.6 \ x \ 10^{-19} \ C \ ; \ \mu_0 = 4 \ \pi \ x \ 10^{-7} \ TmA^{-1} \ ; \ \frac{1}{4\pi\varepsilon_0} = 9 \ x \ 10^9 \ Nm^2C^{-2} \ ; \ \varepsilon_0 = 8.854 \ x10^{-12} \ C^2N^{-1}m^{-2}$$

SECTION A

1.   Figure shows electric field lines in which an electric dipole **p** is placed as shown. Which of the   1
following statements is correct?
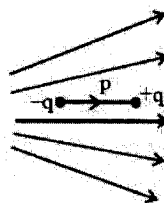
(a)The dipole will not experience any net force

(b)The dipole will experience a net force towards right

(c)The dipole will experience a net force towards left

(d)The dipole will experience a net force upwards

2. A charge of q μC is placed at the centre of a cube of side 0.1 m. Then the electric flux diverging from each face of this cube is   1

(a) $\dfrac{q \times 10^{-6}}{\varepsilon_0}$ Vm   (b) $\dfrac{q \times 10^{-4}}{\varepsilon_0}$ Vm   (c) $\dfrac{q \times 10^{-6}}{6\,\varepsilon_0}$ Vm   (d) $\dfrac{q \times 10^{-4}}{6\,\varepsilon_0}$ Vm

3. According to Coulomb's law, which is the correct relation for the following figure?   1
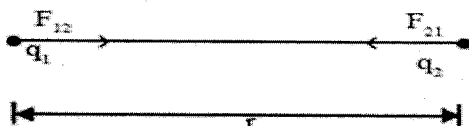
(a) $q_1 q_2 > 0$ (b) $q_1 q_2 < 0$ (c) $q_1 q_2 = 0$ (d) $1 > q_1 q_2 > 0$

4. The electric potential on the axis of an electric dipole at a distance 'r from its centre is V. Then the potential at a point at the same distance on its equatorial line will be   1

(a) 2V   (b) -V   (c) V/2   (d) Zero

5. Two capacitors 0.3 μF and 0.6 μF are connected in series across 6 V. The ratio of energies stored will be   1

(a) ½   (b) 2   (c) ¼   (d) 4

6. The capacitance of a parallel plate capacitor in air is 2 μF. If a dielectric medium is placed between the plates, then the potential difference reduces to 1/6th of the original value. The dielectric constant of the medium is   1

(a) 6   (b) 3   (c) 2.2   (d) 4.4

7. In a Wheatstone bridge all the four arms have equal resistance R. If the resistance of the galvanometer arm is also R, the equivalent resistance of the combination across the battery is   1

(a) $\dfrac{R}{2}$ (b) R   (c) 2R   (d) $\dfrac{R}{4}$

8. A piece of Copper and another of Germanium are cooled from room temperature to 80 K. The resistance of   1

(a)   Each of them increases

(b)   Each of them decreases

(c)   Copper increases and Germanium decreases

(d)   Copper decreases and Germanium increases

9. Lenz's law is in accordance with the law of conservation of   1
(a) energy   (b) charge   (c) momentum   (d) mass

10. When a ray of light enters a glass slab from air   1
(a) its wavelength decreases   (b) its wavelength increases

(c) its frequency increases   (d) neither its wavelength nor its frequency changes

11. Which of the following graphs represent the variation of current (I) with frequency (f) in an AC circuit   1
     containing a pure inductor?

        (a)   (b)   (c)   (d)
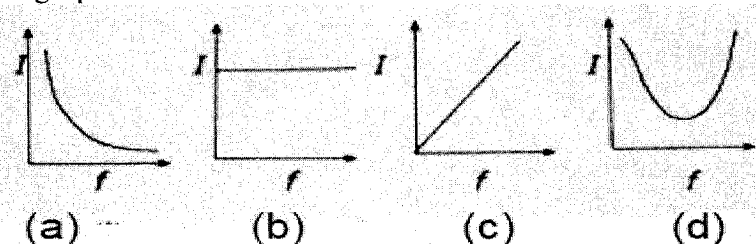
12. An iron cored coil is connected in series with an electric bulb with an AC source as shown in   1

     figure. When iron piece is taken out of the coil, the brightness of the bulb will
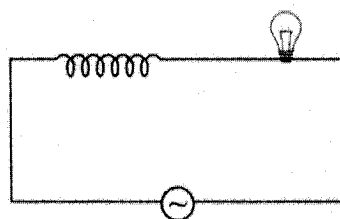
     (a) decrease   (b) increase   (c) remain unaffected   (d) fluctuate

13. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes   1

     from 0 to 20A in 0.5s, what is the change of flux linkage with the other coil?

     (a) 30 Wb   (b) 15 Wb   (c) 60 Wb   (d) 25 Wb

14. In order to increase the angular magnification of a simple microscope, one should increase   1

     (a) the object size   (b) the aperture of the lens

     (c) the focal length of the lens   (d) the power of the lens

15. If the magnetizing field on a ferromagnetic material is increased, its permeability

     (i) decreases   (ii) increases   (iii) remains unchanged   (iv) first decreases and then increases

16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).**   1
     Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
     below.
     a) Both A and R are true, and R is the correct explanation of A
     b) Both A and R are true, and R is NOT the correct explanation of A
     c) A is true but R is false
     d) A is false and R is also false
     Assertion (A): X-rays cannot be deflected by electric or magnetic fields.

     Reason(R): These are electromagnetic waves.

17. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).**   1
     Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
     below.

a) Both A and R are true, and R is the correct explanation of A
b) Both A and R are true, and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

Assertion (A): The drift velocity of electron in a metallic wire will decrease, if the temperature of the wire is increased.

Reason(R): On increasing temperature conductance increases.

18. Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.   1
a) Both A and R are true, and R is the correct explanation of A
b) Both A and R are true, and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

Assertion (A): Acceleration of a magnet falling through a long solenoid decreases.

Reason(R): The induced current produced in a circuit always flow in such direction that it opposes the change to the cause that produced it.

SECTION B

19. Derive the expression for the electric field strength at a distant point situated along the axis of an electric dipole.   2

OR

Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

20. (a) Define electrostatic potential at a point. Write its SI unit.   2

(b) Three charges q_1, q_2 and q_3 are kept respectively at points A, B and C as shown in figure. Write the expression for electrostatic potential energy of the system.
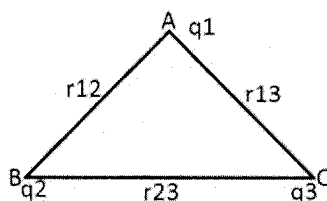

21. Derive the expression for drift velocity of free electron in terms of relaxation time and electric field applied across a conductor.   2

OR

State the two Kirchhoff' laws. Explain briefly how these laws are justified.

22. A narrow beam of protons and alpha particles, each having the same momentum, enters a region   2
of uniform magnetic field directed perpendicular to their direction of momentum. What would be the ratio of the radii of the circular paths described by them?

23. A uniform magnetic field gets modified as shown in figure when two specimens (a) and (b) are placed in it.   2
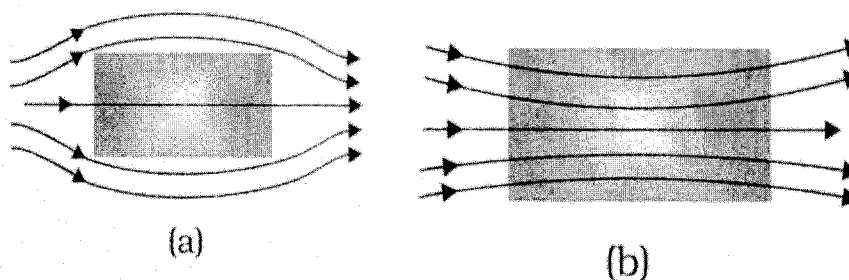
(a)   (b)

(i) Identify the specimen (a) and (b)

(ii) How is the magnetic susceptibility of specimen (a) different from that of specimen (b)?

24. Draw the graph showing the variation of reactance of (i) a capacitor (ii) an inductor with a frequency of an a.c. circuit.   2

25. Figure shows a series LCR circuit with L= 5 H , C = 80 μF and R = 40 Ω, connected to a variable frequency 240 V source .   2
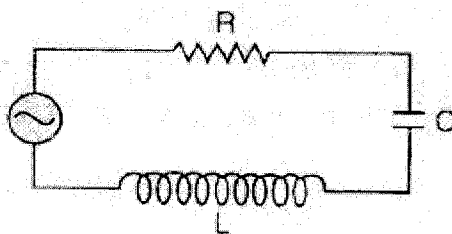
Calculate (a) angular frequency of the source which drives the circuit at resonance

(b) the current at the resonating frequency.

SECTION C

26. Draw a schematic ray diagram of reflecting telescope showing how rays coming from a distant object are received at the eye piece. Write its two important advantages over refracting telescope.   3

27. A parallel plate capacitor is charged by a battery. When the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain what changes if any, occur in the values of (i) charge (ii) electric field strength between the plates (iii) capacitance.   3

28. Apply Gauss theorem to obtain the expression for the electric field at a point due to an infinitely long thin, uniformly charged straight wire of linear charge density λ C/m.   3

29. Name the electromagnetic wave which is suitable for   3
(a) radar systems used in aircraft navigation.
(b) taking photographs of the sky during night and foggy conditions.
(c) diagnostic tools in medicine

OR

How does an oscillating charge produce electromagnetic wave?

Sketch schematic diagram depicting oscillating electric field and magnetic field of an em wave propagating along + x direction.

30. (a) On the basis of electron drift, derive the expression for resistivity of a conductor in terms of 3 number density of free electrons and relaxation time(b) On what factors does resistivity of a conductor depend?

OR

Calculate the steady current through 2-ohm resistor in the circuit shown below.
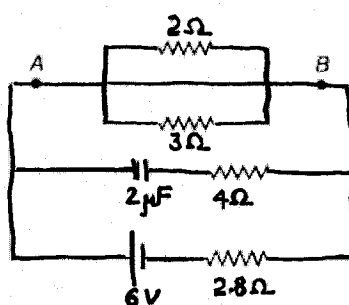
SECTION D

31. (a) Describe briefly with the help of a labelled diagram, the principle and working of a step up 5 transformer (b) Write any two sources of energy loss in a transformer (c) A step up transformer converts a low voltage into a high voltage. Does it violate the principle of conservation of energy? Explain.

OR

(a) Explain the working principle of ac generator with the help of labelled diagram.

(b) The coil of an ac generator having N turns, each of area A is rotated with a constant angular velocity ω. Deduce the expression for alternating emf generated in the coil.

(c) Can the current produced by ac generator be measured with a moving coil galvanometer? Give reason.

32. (a) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in 5 normal adjustment position. Define its magnifying power.

(b) You are given three lenses of power 0.5 D ,4 D and 10 D to design a telescope. Which lenses should be used as objective and eyepiece? Justify your answer.

OR

With the help of a ray diagram show the formation of image of a point object due to refraction of light at a spherical surface separating two media of refractive indices n_1 and n_2 ($n_1 < n_2$)

respectively. Derive the relation for refractive index and radius of curvature. Write the sign convention used. What happens to the focal length of convex lens when it is immersed in water?

33. (a) State Biot-Savart law giving the mathematical expression for it. 5

(b) Use Biot-Savart law to derive the expression for the magnetic field due to a circular coil carrying current at a point along its axis.

OR

(a) Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field.

(b) A straight wire of mass 200 g and length 1.5 m carries a current of 2A. It is suspended in midair by a uniform magnetic field **B**. What is the magnitude of the magnetic field?
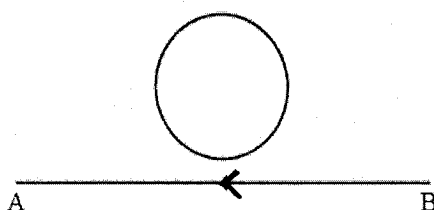
SECTION E

34. **Case Study:**
Read the following paragraph and answer the questions.
In year 1820 Oersted discovered the magnetic effect of current. Faraday gave the thought that reverse of this phenomenon is also possible i.e., current can also be produced by magnetic field. Whenever relative motion between coil and magnet takes place an emf induced in coil. If coil is in closed circuit then current is also induced in the circuit. This phenomenon is called electromagnetic induction. Lenz's law states that the direction of current in a circuit is such that it opposes the change which produces it.

(i) State Faraday's laws of electromagnetic induction. 1

(ii) Write S.I. unit of magnetic flux. Is it a scalar or a vector quantity? 1

(iii) The electric current flowing in a wire in the direction from B to A is decreasing. Find out the direction of the induced current in the metallic loop kept above the wire as shown. 2

OR

(iii) A small piece of metal wire is dragged across the gap between the pole piece of a magnet in 0.5s. The magnetic flux between the pole pieces is known to be 8 x 10⁻⁴ Wb. Estimate the induced emf in the wire.

35. **Case Study:**
Read the following paragraph and answer the questions.

Optical fibres are thin tubes of transparent material that allows light to pass through, without being refracted into the air or another external medium. These fibres are fabricated in such a way that light reflected at one side of the inner surface strikes the other at an angle larger than critical angle. Even, if fibre is bent, light can easily travel along the length.

(i) Write the conditions for total internal reflection.   1

(ii) Write any two uses of optical fibre.   1

(iii) Define critical angle and write the relation between critical angle and refractive index.

                                                                                                            2

OR

(iii) What is the critical angle for a material of refractive index $\sqrt{2}$.

****END OF THE QUESTION PAPER****

INDIAN SCHOOL MUSCAT
FINAL EXAMINATION 2022
PHYSICS (SUB CODE:042)

CLASS: XII
DATE: 19.11.2022

TIME ALLOTED: 3 HRS.
MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

(1) There are 35 questions in all. All questions are compulsory

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.

(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

(6) You may use the following values for the constants wherever necessary.

$$e = 1.6 \times 10^{-19} \, C \; ; \; \mu_0 = 4\pi \times 10^{-7} \, TmA^{-1} \; ; \; \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \, Nm^2C^{-2} \; ; \; \varepsilon_0 = 8.854 \times 10^{-12} \, C^2N^{-1}m^{-2}$$

## SECTION A

1. Two charges are at a distance d apart in air. Coulomb force between them is F. If a dielectric material of dielectric constant K is placed between them, the Coulomb force now becomes   1

   (a) F/K   (b) K F   (c) F/K^2 (d) $K^2 F$

2. A negatively charged object X is repelled by another charged object Y. However, an object Z is attracted to object Y. Which of the following is the most possibility for the object Z?   1

   (a) positively charged only   (b) negatively charged only

   (c) neutral or positively charged   (d) neutral or negatively charged

3. A point charge +q, is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is   1

(a) directed perpendicular to the plane and away from the plane.

(b) directed perpendicular to the plane but towards the plane.

(c) directed radially away from the point charge.

(d) directed radially towards the point charge.

4. In bringing an electron towards another electron, the electrostatic potential energy of the system   1

    (a) increases   (b) decreases   (c) remains unchanged   (d) becomes zero

5. A parallel plate air capacitor has a capacitance 18 μF. If the distance between plates is tripled and   1 a dielectric medium is introduced between the plates, the capacitance becomes 72 μF. The dielectric constant of the medium is

    (a) 4   (b) 9   (c) 12   (d) 2

6. The electric potential on the axis of an electric dipole at a distance 'r from its centre is V. Then the   1 potential at a point at the same distance on its equatorial line will be

    (a) 2V   (b) -V   (c) V/2   (d) Zero

7. When a cell of emf E is connected with an external resistance R, the pd across the cell becomes V.   1 The expression for the internal resistance of the cell is

    (a) $\dfrac{E-V}{V}R$ (b) $\dfrac{V-E}{V}R$ (c) $\dfrac{E}{V}R$ (d) $\dfrac{V}{E}R$

8. In a Wheatstone bridge all the four arms have equal resistance R. If the resistance of the   1 galvanometer arm is also R, the equivalent resistance of the combination across the battery is

    (a) $\dfrac{R}{2}$ (b) R   (c) 2R   (d) $\dfrac{R}{4}$

9. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0   1 to 20A in 0.5s, what is the change of flux linkage with the other coil?

    (a) 30 Wb   (b) 15 Wb   (c) 60 Wb   (d) 25 Wb

10. The induced charge in an electromagnetic induction independent of which of the following factors?   1

    (a) time   (b) resistance of the coil   (c) change of flux   (d) none of the above

11. Which of the following graphs represent the variation of current (I) with frequency (f) in an AC   1 circuit containing a pure inductor?
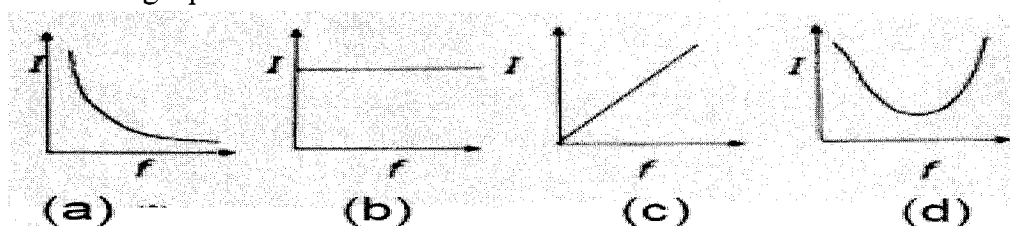
(a)   (b)   (c)   (d)

12. An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. 1
When iron piece is taken out of the coil, the brightness of the bulb will
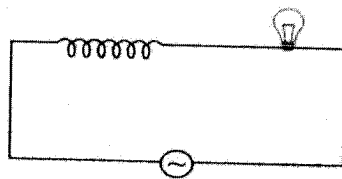
(a) decrease   (b) increase   (c) remain unaffected   (d) fluctuate

13. When a ray of light enters a glass slab from air   1

(a) its wavelength decreases   (b) its wavelength increases

(c) its frequency increases   (d) neither its wavelength nor its frequency changes

14. In order to increase the angular magnification of a simple microscope, one should increase   1

(a) the object size   (b) the aperture of the lens

(c) the focal length of the lens   (d) the power of the lens

15. If the magnetizing field on a ferromagnetic material is increased, its permeability   1

(i) decreases   (ii) increases   (iii) remains unchanged   (iv) first decreases and then increases

16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).** 1
Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
a) Both A and R are true, and R is the correct explanation of A
b) Both A and R are true, and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false
Assertion (A): Acceleration of a magnet falling through a long solenoid decreases.

Reason(R): The induced current produced in a circuit always flow in such direction that it opposes the change to the cause that produced it.

17. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).** 1
Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
a) Both A and R are true, and R is the correct explanation of A
b) Both A and R are true, and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false
Assertion (A): The drift velocity of electron in a metallic wire will decrease, if the temperature of the wire is increased.

Reason(R): On increasing temperature conductance increases.

18. Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).   1
Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
below.

a) Both A and R are true, and R is the correct explanation of A

b) Both A and R are true, and R is NOT the correct explanation of A

c) A is true but R is false

d) A is false and R is also false

Assertion (A): X-rays cannot be deflected by electric or magnetic fields.

Reason(R): These are electromagnetic waves.
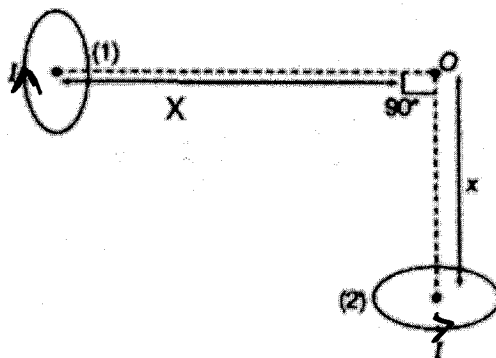
SECTION B

19. (a) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction.   2

(b) Why do the equipotential surfaces due to a uniform electric field not intersect each other?

20. (a) Draw the pattern of electric field lines when a point charge $-Q$ is kept near an uncharged   2
conducting plate.

(b) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks.
Why is it so?

### OR

A hollow cylindrical box of length 1m and area of cross-section 25 cm^2 is placed in a three
dimensional coordinate system as shown in the figure. The electric field in the region is given by
$E = 50x \, \hat{\imath}$, where E is in N/C and x is in metres. Find the net flux through the cylinder.
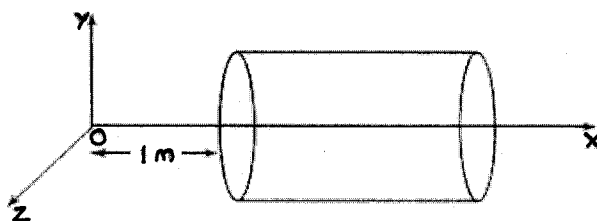
21. Establish a relation between electric current and drift velocity in a conductor.   2

22. Two small identical circular loops, marked (1) and (2), carrying equal currents, are placed with the   2
geometrical axes perpendicular each other as shown on figure. Find the magnitude and direction of
the net magnetic field produced at the point O.

23. A uniform magnetic field gets modified as shown in figure when two specimens (a) and (b) are   2
placed in it.

(a)   (b)
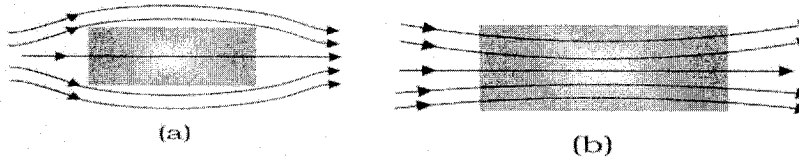
(i) Identify the specimen (a) and (b)

(ii) How is the magnetic susceptibility of specimen (a) different from that of specimen (b)?

24. (a) Define self-inductance of a coil in terms of induced emf.   2

(b) Current in a circuit falls from 5 A to 0A in 0.1 s. If an average emf of 200 V is induced, calculate

the self-induction of the coil.

OR

Derive the expression for self-inductance of a long air -cored solenoid of length *l*, cross-sectional
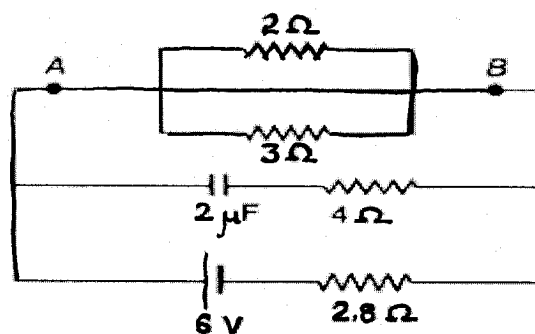
area A and having number of turns N.

25. Draw the graph showing the variation of reactance of (a) a capacitor (b) an inductor with a frequency   2

of an ac circuit.

SECTION C

26. Apply Gauss theorem to obtain the expression for the electric field at a point due to an infinitely   3

long thin, uniformly charged straight wire of linear charge density λ C/m.

27. A parallel plate capacitor is charged by a battery. The battery is disconnected and a dielectric slab   3

is inserted in the space between the plates. Explain what changes if any, occur in the values of

(i) capacitance (ii) electric field strength between the plates (iii) energy stored in the capacitor.

28. (a) On the basis of electron drift, derive the expression for resistivity of a conductor in terms of   3

number density of free electrons and relaxation time.

(b) On what factors does resistivity of a conductor depend?

OR

Calculate the steady current through 2-ohm resistor in the circuit shown below.

29. Name the electromagnetic wave which is suitable for 3

(a) radar systems used in aircraft navigation.

(b) taking photographs of the sky during night and foggy conditions.

(c) diagnostic tool in medicine

OR

(a) How does an oscillating charge produce electromagnetic wave?

(b) Sketch a schematic diagram depicting oscillating electric and magnetic field of an electromagnetic wave propagating along + x direction.

30. With the help of a suitable ray diagram, derive the expression for the refractive index of the material 3 of the prism in terms of angle of the prism and angle of minimum deviation.

SECTION D

31. (a) State Biot-Savart law giving the mathematical expression for it. 5

(b) Use Biot-Savart law to derive the expression for the magnetic field due to a circular coil carrying current at a point along its axis.

OR

(a) Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field.

(b) A straight wire of mass 200 g and length 1.5 m carries a current of 2A. It is suspended in midair by a uniform magnetic field **B**. What is the magnitude of the magnetic field?

32. (a) Describe briefly with the help of a labelled diagram the principle and working of a step up transformer. 5

(b) Write any two sources of energy loss in a transformer.

(c) A step up transformer converts a low voltage into a high voltage. Does it violate the principle of conservation of energy? Explain.

OR

(a) Explain the working principle of ac generator with the help of labelled diagram.

(b) The coil of an ac generator having N turns, each of area A is rotated with a constant angular velocity ω. Deduce the expression for alternating emf generated in the coil.

(c) Can the current produced by ac generator be measured with a moving coil galvanometer?

33. (a) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power. 5

(b) You are given three lenses of power 0.5 D ,4 D and 10 D to design a telescope. Which lenses should be used as objective and eyepiece? Justify your answer.
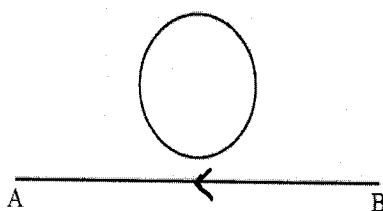
OR

With the help of a ray diagram show the formation of image of a point object due to refraction of light at a spherical surface separating two media of refractive indices n_1 and n_2 ($n_1 < n_2$) respectively. Derive the relation for refractive index and radius of curvature. Write the sign convention used. What happens to the focal length of convex lens when it is immersed in water?

SECTION E

34. **Case Study:**
Read the following paragraph and answer the questions.

In year 1820 Oersted discovered the magnetic effect of current. Faraday gave the thought that reverse of this phenomenon is also possible i.e., current can also be produced by magnetic field. Whenever relative motion between coil and magnet takes place an emf induced in coil. If coil is in closed circuit then current is also induced in the circuit. This phenomenon is called electromagnetic induction. Lenz's law states that the direction of current in a circuit is such that it opposes the change which produces it.

(i) State Faraday's laws of electromagnetic induction. 1

(ii) Write S.I. unit of magnetic flux. Is it a scalar or a vector quantity? 1

(iii) The electric current flowing in a wire in the direction from B to A is decreasing. Find out the direction of the induced current in the metallic loop kept above the wire as shown. 2

OR

(iii) A small piece of metal wire is dragged across the gap between the pole piece of a magnet in 0.5s. The magnetic flux between the pole pieces is known to be 8×10^{-4} Wb. Estimate the induced emf in the wire.

35. **Case Study:**
Read the following paragraph and answer the questions.

Optical fibres are thin tubes of transparent material that allows light to pass through, without being refracted into the air or another external medium. These fibres are fabricated in such a way that light reflected at one side of the inner surface strikes the other at an angle larger than critical angle. Even, if fibre is bent, light can easily travel along the length.

(i) Write the conditions for total internal reflection.   1

(ii) Write any two uses of optical fibre.   1

(iii) Define critical angle and write the relation between critical angle and refractive index.   2

OR

(iii) What is the critical angle for a material of refractive index $\sqrt{2}$.

****END OF THE QUESTION PAPER****

INDIAN SCHOOL MUSCAT
FINAL EXAMINATION 2022
PHYSICS (SUB CODE: 042)

CLASS: XII
DATE: 19.11.2022

TIME ALLOTED: 3 HRS.
MAXIMUM MARKS: 70

<u>*GENERAL INSTRUCTIONS:*</u>

(1) There are 35 questions in all. All questions are compulsory

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.

(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

(6) You may use the following values for the constants wherever necessary.

$e = 1.6 \times 10^{-19} C$; $\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$; $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2C^{-2}$; $\varepsilon_0 = 8.854 \times 10^{-12} C^2N^{-1}m^{-2}$

SECTION A

1. When a cell of emf E is connected with an external resistance R, the pd across the cell becomes V. The expression for the internal resistance of the cell is   1

(a) $\frac{E-V}{V}R$ (b) $\frac{V-E}{V}R$ (c) $\frac{E}{V}R$ (d) $\frac{V}{E}R$

2. A negatively charged object X is repelled by another charged object Y. However, an object Z is attracted to object Y. Which of the following is the most possibility for the object Z?   1

(a) positively charged only

(b) negatively charged only

(c) neutral or positively charged

(d) neutral or negatively charged

3. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20A in 0.5s, what is the change of flux linkage with the other coil?   1

(a)   30 Wb   (b)   15 Wb   (c)   60 Wb   (d)   25 Wb

4. An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure.   1
    When iron piece is taken out of the coil, the brightness of the bulb will
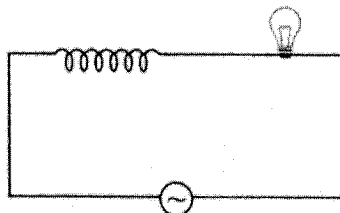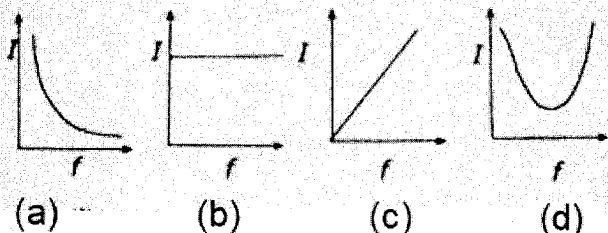

    (a) decrease   (b) increase   (c) remain unaffected   (d) fluctuate

5. In bringing an electron towards another electron, the electrostatic potential energy of the system   1

    (a) increases   (b) decreases   (c) remains unchanged   (d) becomes zero

6. Two charges are at a distance d apart in air. Coulomb force between them is F. If a dielectric material   1
    of dielectric constant K is placed between them, the Coulomb force now becomes

    (a) F/K   (b) K F   (c) F/K^2 (d) $K^2 F$

7. According to Coulomb's law, which is the correct relation for the following figure?   1
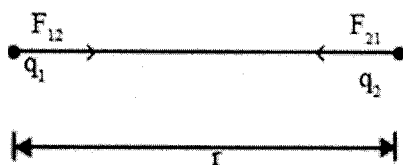
    (a) $q_1 q_2 > 0$ (b) $q_1 q_2 < 0$ (c) $q_1 q_2 = 0$ (d) $1 > q_1 q_2 > 0$

8. In a Wheatstone bridge all the four arms have equal resistance R. If the resistance of the   1
    galvanometer arm is also R, the equivalent resistance of the combination across the battery is

    (a) $\frac{R}{2}$ (b) R   (c) 2R   (d) $\frac{R}{4}$

9. The capacitance of a parallel plate capacitor in air is 2 μF. If a dielectric medium is placed between   1
    the plates, then the potential difference reduces to $1/6^{th}$ of the original value. The dielectric constant
    of the medium is

    (a) 6   (b) 3   (c) 2.2   (d) 4.4

10. The induced charge in an electromagnetic induction independent of which of the following factor?   1

    (a) time   (b) resistance of the coil   (c) change of flux   (d) none of the above

11. A piece of Copper and another of Germanium are cooled from room temperature to 80 K. The   1
    resistance of

    (a)   Each of them increases   (b)   Each of them decreases

(c)   Copper increases and Germanium decreases

(d)   Copper decreases and Germanium increases

12.   In order to increase the angular magnification of a simple microscope, one should increase   1
       (a) the object size   (b) the aperture of the lens
       (c) the focal length of the lens   (d) the power of the lens

13.   When a ray of light enters a glass slab from air   1
       (a) its wavelength decreases   (b) its wavelength increases
       (c) its frequency increases   (d) neither its wavelength nor its frequency changes

14.   Which of the following graphs represent the variation of current (I) with frequency (f) in an AC circuit   1
       containing a pure inductor?

15.   If the magnetizing field on a ferromagnetic material is increased, its permeability   1

       (i) decreases   (ii) increases   (iii) remains unchanged   (iv) first decreases and then increases

16.   **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).**   1
       Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
       below.
       a) Both A and R are true, and R is the correct explanation of A
       b) Both A and R are true, and R is NOT the correct explanation of A
       c) A is true but R is false
       d) A is false and R is also false
       Assertion (A): Acceleration of a magnet falling through a long solenoid decreases.

       Reason(R): The induced current produced in a circuit always flow in such direction that it

                opposes the change to the cause that produced it.

17.   **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R).**   1
       Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
       below.
       a) Both A and R are true, and R is the correct explanation of A
       b) Both A and R are true, and R is NOT the correct explanation of A
       c) A is true but R is false
       d) A is false and R is also false
       Assertion (A): The drift velocity of electron in a metallic wire will decrease, if the temperature of

                the wire is increased.

       Reason(R): On increasing temperature conductance increases.

18. Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). 1
Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given
below.

a) Both A and R are true, and R is the correct explanation of A

b) Both A and R are true, and R is NOT the correct explanation of A

c) A is true but R is false

d) A is false and R is also false

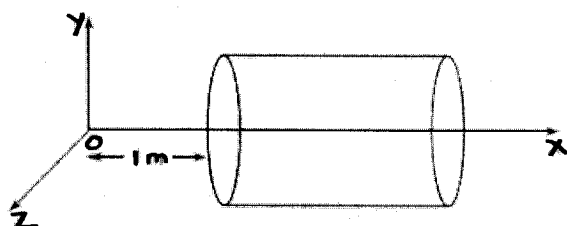**Assertion (A):** X-rays cannot be deflected by electric or magnetic fields.

**Reason(R):** These are electromagnetic waves.

SECTION B

19. A narrow beam of protons and alpha particles, each having the same momentum, enters a region 2
of uniform magnetic field directed perpendicular to their direction of momentum. What would be
the ratio of the radii of the circular paths described by them?

20. (a) Draw the pattern of electric field lines when a point charge $-Q$ is kept near an uncharged 2
conducting plate.

(b) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks.
Why is it so?

OR

A hollow cylindrical box of length 1m and area of cross-section 25 cm^2 is placed in a three
dimensional coordinate system as shown in the figure. The electric field in the region is given by
$= 50x\ \hat{\imath}$, where E is in N/C and x is in metres. Find the net flux through the cylinder.

21. A uniform magnetic field gets modified as shown in figure when two specimens (a) and (b) are 2
placed in it.

(a)

(b)
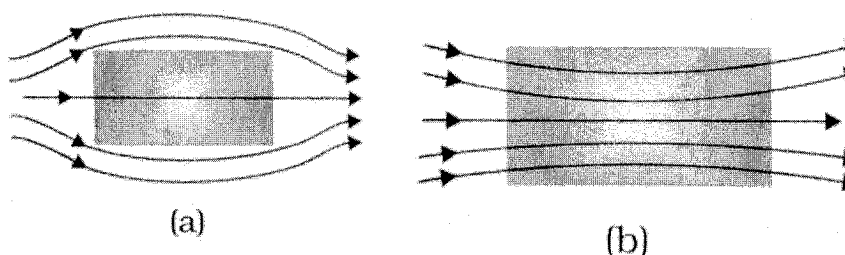
(i) Identify the specimen (a) and (b)

(ii) How is the magnetic susceptibility of specimen (a) different from that of specimen (b)?

22. (a) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction.   2

(b) Why do the equipotential surfaces due to a uniform electric field not intersect each other?

23. Draw the graph showing the variation of reactance of (a) a capacitor (b) an inductor with a frequency   2 of an ac circuit.

24. (a) Define self-inductance of a coil in terms of induced emf.   2

(b) Current in a circuit falls from 5 A to 0A in 0.1 s. If an average emf of 200 V is induced, calculate the self-induction of the coil.

OR

Derive the expression for self-inductance of a long air -cored solenoid of length l, cross-sectional area A and having number of turns N.

25. Derive the relation between electric current and drift velocity.   2

SECTION C

26. Name the electromagnetic wave which is suitable for   3

(a) radar systems used in aircraft navigation.

(b) taking photographs of the sky during night and foggy conditions.
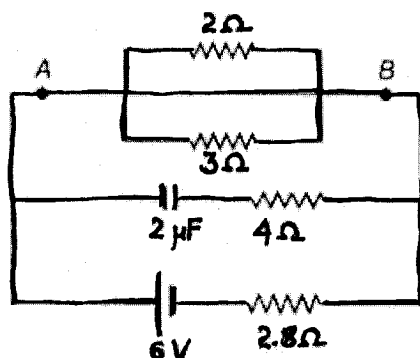
(c) diagnostic tool in medicine

OR

(a) How does an oscillating charge produce electromagnetic wave?

(b) Sketch a schematic diagram depicting oscillating electric and magnetic field of an electromagnetic wave propagating along + x direction.

27. A parallel plate capacitor is charged by a battery. The battery is disconnected and a dielectric slab   3 is inserted in the space between the plates. Explain what changes if any, occur in the values of

(i) charge   (ii) electric field strength between the plates   (iii) capacitance.

28. Draw a schematic ray diagram of reflecting telescope showing how rays coming from a distant   3 object are received at the eye piece. Write its two important advantages over refracting telescope.

29. Apply Gauss theorem to obtain the expression for the electric field at a point due to an infinitely   3 long thin, uniformly charged straight wire of linear charge density λ C/m.

30. (a) On the basis of electron drift, derive the expression for resistivity of a conductor in terms of   3
number density of free electrons and relaxation time.

(b) On what factors does resistivity of a conductor depend?

OR

Calculate the steady current through 2-ohm resistor in the circuit shown below.

SECTION D

31. a) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in
normal adjustment position. Define its magnifying power.   5

(b) You are given three lenses of power 0.5 D ,4 D and 10 D to design a telescope. Which lenses
should be used as objective and eyepiece? Justify your answer.

OR

With the help of a ray diagram show the formation of image of a point object due to refraction of
light at a spherical surface separating two media of refractive indices n_1 and n_2 ($n_1 < n_2$) respectively.
Derive the relation for refractive index and radius of curvature. Write the sign convention used.
What happens to the focal length of convex lens when it is immersed in water.

32. (a) Describe briefly, with the help of a labelled diagram the working of a step up transformer.

(b) Write any two sources of energy loss in a transformer.   5

(c) A step up transformer converts a low voltage into a high voltage. Does it violate the principle
of conservation of energy? Explain.

OR

(a) Explain the working principle of ac generator with the help of labelled diagram.

(b) The coil of an ac generator having N turns, each of area A is rotated with a constant angular velocity ω. Deduce the expression for alternating emf generated in the coil.

(c) Can the current produced by ac generator be measured with a moving coil galvanometer?

33. (a) State Biot-Savart law giving the mathematical expression for it.

(b) Use Biot-Savart law to derive the expression for the magnetic field due to a circular coil carrying current at a point along its axis. 5

OR

(a) Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field.

(b) A straight wire of mass 200 g and length 1.5 m carries a current of 2A. It is suspended in midair by a uniform magnetic field **B**. What is the magnitude of the magnetic field?

SECTION E

34. **Case Study:**
Read the following paragraph and answer the questions.

Optical fibres are thin tubes of transparent material that allows light to pass through, without being refracted into the air or another external medium. These fibres are fabricated in such a way that light reflected at one side of the inner surface strikes the other at an angle larger than critical angle. Even, if fibre is bent, light can easily travel along the length.

(i) Write the conditions for total internal reflection.

1

(ii) Write any two uses of optical fibre.

1

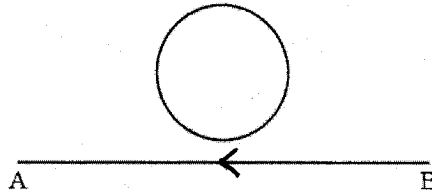(iii) Define critical angle and write the relation between critical angle and refractive index.

2

OR

What is the critical angle for a material of refractive index $\sqrt{2}$.

35. **Case Study:**
Read the following paragraph and answer the questions.

In year 1820 Oersted discovered the magnetic effect of current. Faraday gave the thought that reverse of this phenomenon is also possible i.e., current can also be produced by magnetic field. Whenever relative motion between coil and magnet takes place an emf induced in coil. If coil is in closed circuit then current is also induced in the circuit. This phenomenon is called electromagnetic induction. Lenz's law states that the direction of current in a circuit is such that it opposes the change which produces it.

(i) State Faraday's laws of electromagnetic induction. 1

(ii) Write S.I. unit of magnetic flux. Is it a scalar or a vector quantity? 1

(iii) The electric current flowing in a wire in the direction from B to A is decreasing. Find out the direction of the induced current in the metallic loop kept above the wire as shown. 2

OR

(iii) A small piece of metal wire is dragged across the gap between the pole piece of a magnet in 0.5s. The magnetic flux between the pole pieces is known to be 8 x 10⁻⁴ Wb. Estimate the induced emf in the wire.

****END OF THE QUESTION PAPER****