PRACTICE MCQs

CLASS 12 PHYSICS (TERM - I)

MAGNETISM AND MATTER

BY

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learning simplified

Question 1:
A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', the ratio (T'/T) is
(a) $1/(2\sqrt{2})$
(b) 1/2
(c) 2
(d) 1/4

Answer: (b) 1/2
For an oscillating magnet, $T = 2\pi\sqrt{(I/MB)}$
Where $I = ml^2/12$, $M = xl$, x = pole strength
When magnet is divided into 2 equal parts, the magnetic dipole moment
M'= Pole strength x Length
$= (xl)/(2)$
$= (M/2)$ ....(1)
$I' = \text{Mass} \times (\text{length})^2/(12)$
$= (m/2)\,(l/2)^2/12$
$= ml^2/(12 \times 8)$
$= (I/8)$ ....(2)
Therefore, time period $T = 2\pi\sqrt{(I'/M'B)}$
Or $(T'/T) = \sqrt{[(I'/M') \times (M/I)]}$
$= \sqrt{[(I'/I) \times (M'/M)]}$ ....(3)
Therefore, $(T'/T) = \sqrt{[(1/8) \times (2/1)]}$
$= \sqrt{(1/4)}$
$= 1/2$

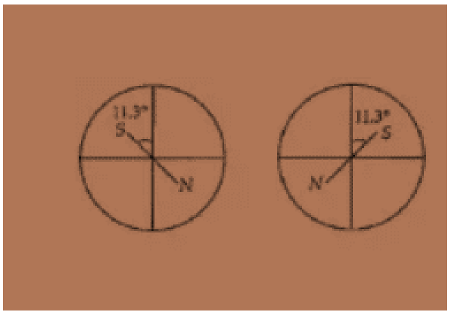
Question 2:
North pole of a magnet is brought near a stationary negatively charged conductor. Will the pole experience any force?
(a) Force acting on the pole will be 0
(b) Force acting on the pole will be maximum
(c) Depends on the magnitude of pole strength
(d) None

Answer: (a) Force acting on the pole will be 0

The pole experiences force only if it is placed in some external magnetic field. As the stationary charge doesn't produce any magnetic field, the force acting on the pole will be zero.

Question 3:
The magnetic field of Earth can be modelled by that of a point dipole placed at the centre of the earth. The dipole axis makes an angle of 11.3° with the axis of earth. At Mumbai, declination is nearly zero. Then
(a) the declination varies between 11.3° West to 11.3° East
(b) the least declination is 0°
(c) the plane defined by dipole axis and the earth axis passes through Greenwich
(d) declination averaged over Earth must be always negative

Answer: (a) the declination varies between 11.3° West to 11.3° East
The angle between magnetic meridian and geographic meridian is called magnetic declination.
This axis of dipole makes an angle of 11.3° to the axis of rotation of earth. As a result, two possibilities arise as shown in the figure below.



Question 4:
If a magnet is suspended at an angle 30° to the magnetic meridian, the dip needle makes angle of 45° with the horizontal. The real dip is
(a) $\tan^{-1}(\sqrt{3}/2)$
(b) $\tan^{-1}(\sqrt{3})$
(c) $\tan^{-1}(3/\sqrt{2})$
(d) $\tan^{-1}(\sqrt{2}/3)$

Answer: (a) $\tan^{-1}(\sqrt{3}/2)$
Let the real dip be θ, then
$\tan \delta = (B_V/B_H)$
For apparent dip,
$\tan \delta' = (B_V)/(B_H \cos \theta)$
$= (2B_V)/(\sqrt{}B_H)$
Or $\tan 45^0 = (2/\sqrt{3}) \times \tan \theta$

Or $\theta = \tan^{-1}(\sqrt{3}/2)$

Question 5:
In a permanent magnet at room temperature
(a) magnetic moment of each molecule is zero.
(b) the individual molecules have non-zero magnetic moment which are all perfectly aligned.
(c) domains are partially aligned.
(d) domains are all perfectly aligned.

Answer: (c) domains are partially aligned.
At room temperature, the permanent magnet retains ferromagnetic property for a long period of time.

Question 6:
A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60°. The torque needed to maintain the needle in this position will be
(a) $\sqrt{3}$ W
(b) W
(c) ($\sqrt{3}/2$) W
(d) 2 W

Answer: (a) $\sqrt{3}$ W
$W = MB(\cos\theta_2 - \cos\theta_1)$
$= MB(\cos 60^\circ - \cos 0^0)$
$= (MB)/(2)$
Therefore,
$\tau = MB \sin\theta$
$= MB \sin 60^\circ$
$= \sqrt{3}(MB/2)$
$= (2W \times \sqrt{3})/2$
$= \sqrt{3}$ W

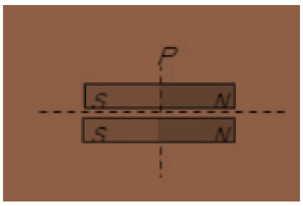
Question 7:
Which of the following is not considered as an element of the earth's magnetic field?

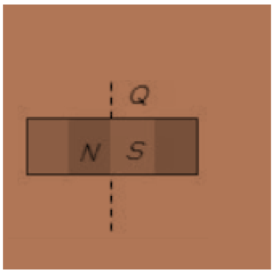
(a) The declination D
(b) The inclination I
(c) The horizontal component of the earth's field H_E
(d) Magnetic susceptibility

Answer: (d) magnetic susceptibility
To describe the magnetic field of the earth at a point on its surface, we need to specify three quantities, viz., the declination D, the angle of dip or the inclination I and the horizontal component of the earth's field H_E. These are known as the elements of the earth's magnetic field.

Question 8:
Two similar bar magnets P and Q each of magnetic moment M, are taken, If P is cut along its axial line and Q is cut along its equatorial line, all the four pieces obtained have
(a) equal pole strength
(b) magnetic moment (M/4)
(c) magnetic moment (M/2)
(d) magnetic moment M

Answer: (c) magnetic moment (M/2)
If the pole strength, magnetic moment and length of each part are m', M' and L' respectively, then
m' = (m/2), L' = L and M' = (M/2)
m' = m
and L'= (L/2)
Therefore, M' = (M/2)





Question 9:
The horizontal component of the earth's magnetic field is 0.22 gauss and total magnetic field is 0.4 gauss. The angle of dip is:
(a) $\tan^{-1}(1)$
(b) $\tan^{-1}(\infty)$
(c) $\tan^{-1}(1.518)$
(d) $\tan^{-1}(\pi)$

Answer: (c) $\tan^{-1}(1.518)$

By using $B_H = B \cos \phi$

Or $\cos \phi = (B_H)/(B)$

$= (0.22)/ (0.4)$

Or $\tan \phi = \sqrt{(0.4)^2 - (0.22)^2}/(0.22)$

Or $\phi = \tan^{-1}(1.518)$

Question 10:

A current carrying coil is placed with its axis perpendicular to N-S direction. Let horizontal component of earth's magnetic field be Ho and magnetic field inside the loop is H. If a magnet is suspended inside the loop, it makes angle θ with H. Then θ =

(a) $\tan^{-1}(H_0/H)$

(b) $\tan^{-1}(H/H_0)$

(c) $\text{cosec}^{-1}(H/H_0)$

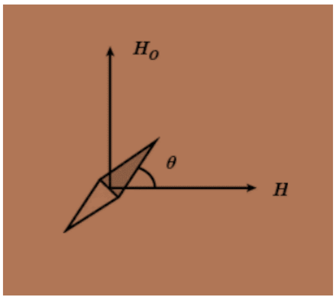
(d) $\cot^{-1}(H_0/H)$

Answer: (a) $\tan^{-1}(H_0/H)$

In given case H and H_0 are perpendicular to each other.

From figure $\tan \theta = (H_0)/(H)$

$\theta = \tan^{-1}(H_0/H)$



Question 11:

The Earth's magnetic field at some place on magnetic equator of earth is 0.5×10^{-4} T. Consider the radius of earth at that place as 6400 km. Then, the magnetic dipole moment of the Earth in Am^2 is

(a) 1.05×10^{23}

(b) 1.15×10^{23}

(c) 1.31×10^{23}

(d) 1.62×10^{23}

Answer: (d) 1.62×10^{23}

$R_e = 6400 \text{ km} = 6.4 \times 10^6$ m

$B_e = 0.5 \times 10^{-4}$ T

$\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}

The magnetic field at the equator $B = (\mu_0/4\pi) (I/R_e)$

$M = IA$

$M = (4\pi R_e B)/(\mu_0) \times (\pi R_e)^2$

$= (4 \pi \times 64 \times 10^5 \times 5 \times 10^{-5} \times 3.14 \times 4096 \times 10^{10})/(4\pi \times 10^{-7})$
$= 130 \times 10^7 \times 3.14 \times 4096 \times 10^{10}$
$= 1.67 \times 10^{23}$ Am^2

Question 12:
A magnet of dipole moment M is aligned in equilibrium position in a magnetic field of intensity B. The work done to rotate it through an angle θ with the magnetic field is
(a) MB sin θ
(b) MB cos θ
(c) MB (1 – cos θ)
(d) MB(l – sin θ)

Answer: (c) MB (1 – cos θ)
At equilibrium position θ = 0,
Work done, $W = \int_0^{\theta} MB \sin\theta \, d\theta$
$= MB (1 - \sin\theta)$

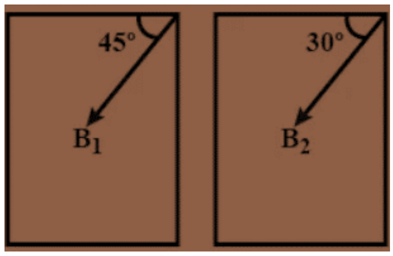
Question 13:
The primary origin of magnetism lies in
(a) Atomic current and intrinsic spin of electrons.
(b) Faraday's law of Magnetism.
(c) Pauli exclusion principle.
(d) Electronegative nature of materials.

Answer: (a) Atomic current and intrinsic spin of electrons.
The primary origin of magnetism lies in the fact that the electrons are revolving and spinning about nucleus of an atom, which gives rise to currents and hence to magnetism.

Question 14:
A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40times per minute where the dip is 30°. If B_1 and B_2 are respectively the total magnetic field due to theearth at the two places, then the ratio B_1 / B_2 is best given by
(a) 0.7
(b) 3.6
(c) 1.8

(d) 2.2

Answer: (a) 0.7



Frequency of oscillation
$f_1 = (1/2\pi)\ \sqrt{\mu B_1 \cos 45^\circ)/(I)}$
$f_2 = (1/2\pi)\ \sqrt{\mu B_2 \cos 30^\circ)/(I)}$
$(f_1/f_2) = \sqrt{B_1 \cos 45^\circ / B_2 \cos 30^\circ}$
Therefore, $(B_1/B_2) = 0.7$

Question 15:
Where on the surface of the earth the angle dip equals zer0?
(a) The poles
(b) The equator
(c) Everywhere
(d) Angle dip can never zero

Answer: (b) The equator
At the equator angle dip is the lowest and at the poles angle dip is 90^0.
The magnetic equator is the only place where the needle of a magnetic compass will be truly parallel to the surface of the Earth.Elsewhere, the lines of force are not parallel to the surface and gradually become oriented 90^0 to the surface at the north and south magnetic poles.

Question 16:
The incorrect statement regarding the lines of force of the magnetic field B is:
(a) magnetic lines of force for a closed curve
(b) due to magnet the magnetic force of the magnetic lines of force never cut each other
(c) magnetic intensity is a measure of lines of force passing through a unit area held normal to it
(d) inside a magnet its magnetic lines of force move from north pole of the magnet towards the south pole:

Answer: (d) inside a magnet its magnetic lines of force move from north pole of the magnet towards the south pole
Magnetic intensity is proportional to the number of magnetic field lines.
Magnetic field lines of forces are closed curves.

Inside the magnet, field lines move from the South Pole to the North Pole.
Magnetic lines of force never cut each other.

Question 17:
The horizontal component of earth's magnetic field at a place is √3 times the vertical component. The angle of dip at that place is
(a) π/6
(b) π/3
(c) π/4
(d) 0

Answer: (a) π/6
$\tan \delta = (B_V/B_H)$
Given $B_H = \sqrt{3}\, B_V$
$= (B_V)/(\sqrt{3}B_V)$
$= (1/\sqrt{3})$
$\delta = 30^0$ or $(\pi/6)$ radians

Question 18:
The small angle between magnetic axis and geographic axis at a place is-
(a) Magnetic meridian
(b) Geographic meridian
(c) Magnetic inclination
(d) Magnetic Declination

Answer: (d) Magnetic Declination
Magnetic declination or Angle of declination is the small angle between geographic axis & magnetic axis.

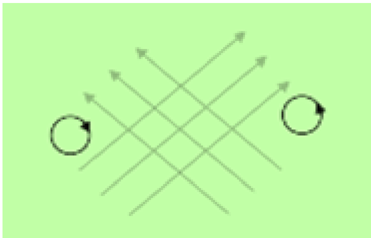
Assertion Reason Based Questions

In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) Both assertion and reason are true and the reason is the correct explanation of assertion.
(b) Both assertion and reason are true but the reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Question 19:
Assertion (A): There exists isolated magnetic north and south poles known as magnetic monopoles.
Reason (R): When a bar magnet is broken into two halves, two similar bar magnets with somewhat weaker properties are obtained.

Answer: (d) Assertion is false but reason is true.
North and South Pole of a magnet cannot be isolated. When a bar magnet is broken into two halves, two similar bar magnets with somewhat weaker properties are obtained. Unlike electric charges, isolated magnetic north and south poles known as magnetic monopoles do not exist.

Question 20:
Assertion (A): In the figure given below the magnetic field lines are wrongly marked.



Reason (R): Magnetic field lines (like electric field lines) can never cross each other, because otherwise the direction of the field at the point of intersection is ambiguous.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.
Magnetic field lines (like electric field lines) can never cross each other, because otherwise the direction of the field at the point of intersection is ambiguous. There is further error in the figure. Magneto static field lines can never form closed loops around empty space. A closed loop of static magnetic field line must enclose a region across which a current is passing. By contrast, electrostatic field lines can never form closed loops, neither in empty space, nor when the loop encloses charges.

Question 21:
Assertion (A): The magnetic field lines do not intersect

Reason (R): If the magnetic field lines intersected then at the point of intersection, the direction of the magnetic field would not be unique.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.

The magnetic field lines do not intersect, for if they did, the direction of the magnetic field would not be unique at the point of intersection. That is at the point of intersection, the magnetic field would have two directions.

Question 22:

Assertion (A): Magnetic Resonance Imaging (MRI) is a useful diagnostic tool for producing images of various parts of human body.

Reason (R): Protons of various tissues of the human body play a role in MRI.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.

MRI is useful diagnostic tool for producing images of various parts of human body because it makes use of magnetic property of spinning proton inside the nucleus.

Question 23:

Assertion (A): A magnetic needle free to rotate in a vertical plane, orients itself (with its axis) vertical at the poles of the earth.

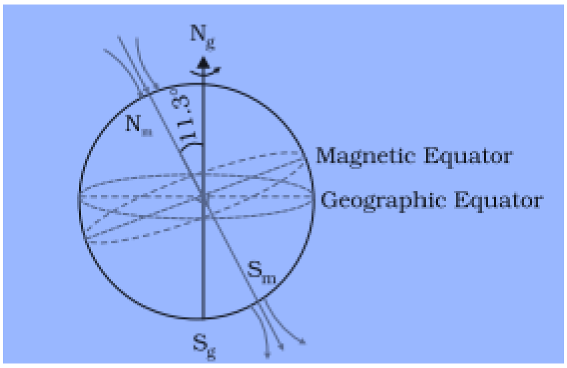
Reason (R): At the poles of the earth the horizontal component of earth’s magnetic field will be zero.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion

The given statement is correct and reason is the correct explanation of the above statement. At poles, magnetic needle orients itself vertically because horizontal components of earth’s field are zero there.

Case Study Based Questions

Question 24:
The direction of the longitude circle determines the geographic north-south direction, the line of longitude towards the North Pole being the direction of true north. The vertical plane containing the longitude circle and the axis of rotation of the earth is called the geographic meridian. In a similar way, one can define the magnetic meridian of a place as the vertical plane which passes through the imaginary line joining the magnetic north and the south poles. This plane would intersect the surface of the earth in a longitude-like circle. A magnetic needle, which is free to swing horizontally, would then lie in the magnetic meridian and the north pole of the needle would point towards the magnetic north pole. Since the line joining the magnetic poles is titled with respect to the geographic axis of the earth, the magnetic meridian at a point makes an angle with the geographic meridian.



1) The angle between the true geographic north and the north shown by a compass needle. This angle is called the ______.
(a) Inclination
(b) Magnetic declination
(c) Angle of dip
(d) None of the above

2) If a magnetic needle is perfectly balanced about a horizontal axis so that it can swing in a plane of the magnetic meridian; the needle would make an angle with the horizontal. This is known as the ____.
(a) Inclination
(b) Magnetic declination
(c) Angle of dip
(d) ‘a’ and ‘c’

3) The declination is greater at ___________ and smaller near the _________.
(a) Equator, higher latitudes
(b) Higher latitudes, equator
(c) South pole, north pole
(d) Equator, poles

4) At a certain place when horizontal component and vertical components of earth's magnetic field are equal; the angle of dip equals ________.
(a) 30 degrees
(b) 45 degrees
(c) 60 degrees
(d) 90 degrees

5) Check whether the following statement is true or false:
A dip needle is used at the magnetic pole instead of normal compass as the horizontal component is almost negligible and normal compass does not show proper direction at magnetic pole.
(a) The above statement is true
(b) The above statement is false
(c) The above statement would be true if the vertical component is negligible instead of horizontal component
(d) The above statement would be true if it was equator instead of magnetic poles

Answer:

1) (b) Magnetic declination

2) (d) 'a' and 'c'

3) (b) higher latitudes, equator

4) (b) 45 degrees

$\tan I = \frac{Z_E}{H_E} = 1$

$I = \tan^{-1} 1$

$I = 45°$

5) (a) the above statement is true

At the poles, the magnetic field lines are converging or diverging vertically so that the horizontal component is negligible. The normal compass needle is only capable of moving in a horizontal plane, it can point along any direction, rendering it useless as a direction finder.

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