CUET 2024 Physics Solution Set B

Ques 1. In an electromagnetic wave, the ratio of energy densities of electric and magnetic fields is

Solu. In an electromagnetic wave, the ratio of energy densities of electric and magnetic fields is 1:1.
Both the electric field (E) and the magnetic field (B) contribute equally to the overall energy density of the wave. This can be derived using the expressions for electric and magnetic field energy densities and a fundamental relationship between the permittivity (ε_0) and permeability (μ_0) of free space.

Ques 3. Of the following, the correct arrangement of electromagnetic spectrum in decreasing order of wavelength is
Fill in the blank with the correct answer from the options given below.
(1) Radio waves, X-rays, Infrared waves, microwaves, visible waves
(2) Infrared waves, microwaves, Radio waves, X-s, visible waves
(3) Radio waves, microwaves, Infrared waves, visible waves, X-rays
(4) X-rays, visible waves, Infrared waves, microwaves, Radio waves

Solu. The correct arrangement of the electromagnetic spectrum in decreasing order of wavelength is:
(3) Radio waves, microwaves, Infrared waves, Visible waves, X-rays
Here's the order from longest wavelength to shortest wavelength:

1. Radio waves
2. Microwaves
3. Infrared waves
4. Visible waves
5. Ultraviolet waves (not included in the options, but falls between visible and X-rays)
6. X-rays

7. Gamma rays

Ques 6. For fixed values of radii of curvature of lens, power of the lens will be Fill in the blank with the correct answer from the options given below.
(1) P ∝ (μ-1)
(2) P ∝ μ^2
(3) P ∝ 1/μ
(4) P ∝ μ^{-2}

Solu. we can solve this for the proportionality of power (P) with a shorter approach:
Given: Fixed radii of curvature (R1 and R2)
We know from the lensmaker's equation:
1/f = (μ - 1) * (constant term) (where constant term depends on R1 and R2)
Since power (P) is the reciprocal of focal length (f):
P = 1/f
Substituting:
P = (μ - 1) * $(\text{constant term})^{-1}$
Key Point: The constant term becomes irrelevant for proportionality because it depends only on the fixed curvature radii.
Therefore, the power (P) is directly proportional (∝) to the difference between the refractive index (μ) and 1 (μ - 1).
In short:
P ∝ (μ - 1)

Ques 8. Using light from a monochromatic source to diffraction in a single slit of width 0.1 mm, the linear width of central maxima is measured to be 5mm on a screen held 50 cm away. The wavelength of light used is___.
Fill in the blank with the correct answer from the options given below.
(1) 2.5 * 10 ^ - 7 * m
(3) 5 * 10 ^ - 7 * m
(2) 4 * 10 ^ - 7 * m
(4) 7.5 * 10 ^ - 7 * m

Solu. The formula for the width of the central maximum in single-slit diffraction is:
$\lambda = wa / (2L)$
Given w = 0.005 m, a = 0.0001 m, and L = 0.5 m, we find:
$\lambda = (0.005 * 0.0001) / (2 * 0.5) = 5 * 10^{-7}$ m
Therefore, the correct answer is:
(3) $5 * 10^{-7}$ m

Ques 9. Radiation of frequency $2v_{0}$ following is is incident on a metal with threshold frequency v_{0} The correct statement of the
Fill in the blank with the correct answer from the options given below.
(1) No photoelectrons will be emitted
(2) All photoelectrons emitted will have kinetic energy equal to $h*v_{0}$
(3) Maximum kinetic energy of photoelectrons emitted can be $h*v_{0}$
(4) Maximum kinetic energy of photoelectrons emifted will be $2h*v_{0}$

Solu. Incident light frequency ($2v_0$) > threshold frequency (v_0):
- Photoelectrons will be emitted.

Maximum kinetic energy:
- Depends on incident photon energy ($h * 2v_0$) minus metal's work function (Φ).
- Limited to $h * v_0$ or less, not $2h * v_0$.

Therefore, option (3) is correct.

Ques 11. A proton accelerated through a potential difference V has a de Broglie wavelength λ. On doubling the accelerating potential, de Broglie wavelength of the proton
Fill in the blank with the correct answer from the options given below.
(1) remains unchanged
(2) becomes double
(3) becomes four times
(4) decreases

Solu. A proton is accelerated through a potential difference V. This gives it a certain de Broglie wavelength (λ). Now imagine we double the accelerating potential (V). What happens to the de Broglie wavelength?
Think about momentum (p):

- We know λ is inversely proportional to p (λ = h / p).
- Doubling V increases the proton's kinetic energy (KE).
- KE is related to p by KE = p^2 / 2m (m = proton mass).

So, p will increase, but not necessarily double.
Impact on λ:
Since λ and p are inversely proportional, any increase in p will cause λ to:
Decrease (because a larger denominator in the fraction λ = h / p means a smaller λ).
Therefore, doubling the accelerating potential leads to a decrease in the de Broglie wavelength of the proton.

Ques 12. The kinetic energy of an electron in ground level in hydrogen atom is K units. The values of its potential energy and total energy respectively are
Fill in the blank with the correct answer from the options given below.
(1) - 2K ; (- K)
(2) +2K; - K
(3) - K, +2K
(4) +K,+ 2K

Solu. Ground state electron in hydrogen: positive kinetic energy (K) to move, but a bigger negative potential energy (-2K) holds it close. Total energy (E) is negative (-K), sum of both. So the answer is (3) -K, +2K.

Ques 13. Two nuclei have mass numbers A and B respectidy. The density ratio of the nuclei is Fill in the blank with the correct answer from the options given below.
(1) A: B
(2) √A: √B
(3) A2: B2
(4) 1:1

Solu. Imagine two atomic nuclei, like tiny, super-dense balls. Surprisingly, no matter how many protons and neutrons they pack in (their mass number), their density stays roughly the same! It's like they're all squished together as tightly as possible.
So, the density of nucleus A is basically the same as the density of nucleus B. That's why the answer is (4) 1:1. Their "squishiness" doesn't depend on their size.

Ques 14. The shortest wavelengths emitted in hydrogen spectrum corresponding to different spectral series are as under:
(A) Pfund series
(C) Brackett series
(B) Balmer series
(D) Lyman series

The wavelengths arranged correctly in decreasing order are Fill in the blank with the correct answer from the options
given below.
(2) (A), (C), (B), (D)
(1) (A), (B), (C), (D)
(3) (B), (A), (D), (C)
(4) (A), (C), (D), (B)

Solu. Higher energy level jumps in hydrogen spectrum lead to shorter wavelengths.

- Electrons fall from farthest levels (Lyman) to closest (Pfund).

Therefore, the order is: (1) (A) Pfund, (B) Balmer, (C) Brackett, (D) Lyman (longest to shortest wavelengths).

Ques 15. Silicon can be doped using one of the following elements as dopant:
(A) Arsenic
(B) Indium
(C) Phosphorus
(D) Boron

To get n-type semiconductor, the dopants that can be used are Fill in the blank with the correct answer from the options given below.
(1) (A) and (C) only
(3) (A), (B), (C) and (D)
(2) (B) and (C) only
(4) (C) and (D) only

Solu. For n-type silicon (more free electrons), we need dopants with 5 valence electrons to donate an extra electron.

- (A) Arsenic (As) - YES (5 valence electrons)
- (B) Indium (In) - NO (3 valence electrons)
- (C) Phosphorus (P) - YES (5 valence electrons)
- (D) Boron (B) - NO (3 valence electrons)

So only Arsenic (A) and Phosphorus (C) work. The answer is (1) (A) and (C) only.

Ques 18. The refractive index of the material of an equilateral prism is sqrt(2) The angle of minimum deviation of that prism is
Fill in the blank with the correct answer from the Options given below.
(1) 60 deg
(2) 75 deg
(3) 30 deg
(4) 90 deg

Solu. Specific equilateral prisms (60° angle) with a refractive index of √2 have a minimum deviation angle of around 30 degrees. So the answer is (3) 30 deg.
Think of it like a special light-bending trick for this particular prism setup.

Ques 19. The transfer of integral numbers of____ is one of the pieces of evidence for quantization of electric charge. Fill in the blank with the correct answer from the options given below.
(1) photons

(2) nuclei
(3) electrons
(4) neutrons

Solu. The transfer of integral numbers of electrons is one of the pieces of evidence for the quantization of electric charge.
Therefore, the correct answer is: (3) electrons

Ques 20. When a slab of insulating material 4 mm thick is introduced between the plates of a parallel plate capacitor of separation 4 mm, it is found that the distance between the plates has to be increased by 3.2 mm to restore the capacity to its original value. The dielectric constant of the material is Fill in the blank with the correct answer from the options given below.
(1) 2
(2) 5
(3) 3
(4) 7

Solu. we can find the dielectric constant of the insulating material using the given information.
Here's how:

1. Initial capacitance (C): We know the capacitance remains the same before and after introducing the slab but with an increased plate separation. Let C represent this initial capacitance.
2. Initial plate separation (d): This is given as 4 mm.
3. Slab thickness (t): This is also given as 4 mm.
4. Increased plate separation (D): This is 4 mm (initial) + 3.2 mm (increase) = 7.2 mm.
5. Dielectric constant (ε): We need to find this value.

Relationship between capacitance and plate separation:
In a parallel plate capacitor, capacitance (C) is directly proportional to the plate area (A) and the permittivity of the material between the plates (ε_0, permittivity of free space) and inversely proportional to the plate separation (d). This relationship can be expressed as:

$C = \varepsilon_0 * A / d$
Relating initial and final capacitance:
Since the capacitance remains the same (C), we can equate the expressions for initial and final configurations:
C (initial) = C (final)
$\varepsilon_0 * A / d$ (initial) = $\varepsilon_0 * A / D$ (final)
Considering the dielectric slab:
In the final configuration, the dielectric slab fills the gap between the plates, and its permittivity (ε) replaces the permittivity of free space (ε_0) for that region. We can represent the effective permittivity considering the slab as:
$\varepsilon\_eff = \varepsilon * (d - t) + \varepsilon_0 * t$
Substituting and solving for ε:

1. Substitute the expressions for initial and final plate separations:

$\varepsilon_0 * A / d = \varepsilon_0 * A / (d + t + 3.2 \text{ mm})$ (Convert mm to meters for consistency: d = 4 mm * (1 m / 1000 mm) = 0.004 m, etc.)

2. Since A cancels out (assuming the plate area remains constant), we can simplify:

$d = (d + t + 3.2 \text{ mm}) * (\varepsilon / \varepsilon_0 + 1)$

3. Now, plug in the known values:

0.004 m = (0.004 m + 0.004 m + 0.0032 m) * (ε / 8.854e-12 F/m + 1)

4. Solve for ε:

ε ≈ 2 * 8.854e-12 F/m (ε ≈ 1.77e-11 F/m)
Converting permittivity to dielectric constant:
The dielectric constant (ε) is the ratio of the material's permittivity (ε) to the permittivity of free space (ε_0). Therefore:
$\varepsilon\_r = \varepsilon / \varepsilon_0 \approx$ (1.77e-11 F/m) / (8.854e-12 F/m) ≈ 2
Answer:
The dielectric constant of the insulating material is approximately (2). So the closest answer choice is (1) 2.

Ques 21. . A copper ball of density 8.0 g/cc and 1 cm in diameteres immersed in oil of density 0.8 g/cc. The charge on the ball if it remains just suspended in oil in an electric field of intensity 600 V/m acting in the upward direction is

Fill in the blank with the correct answer from the options given below. (Take g = 10 m/s²)
(1) 2 * 10 ^ - 6 * C
(2) 2 * 10 ^ - 5 * C
(3) 1 * 10 ^ - 5 * C
(4) 1 * 10 ^ - 6 * c

Solu. Imagine a copper ball suspended in oil due to an upward electric field. To stay balanced, the electric force on the ball (due to its charge) needs to counteract the downward gravity and the upward buoyant force from the oil (think Archimedes' principle).
We can use the densities of copper and oil, along with the electric field strength, to find the charge (Q) that makes this balance work.
After some calculations, the answer is closest to (3) 1 * 10 ^ -5 * C. The electric field provides just enough lift for this amount of charge on the ball.

Ques 22. A metal wire is subjected to a constant potential difference. When the temperature of the metal wire increases, the drift velocity of the electron in it
Fill in the blank with the correct answer from the options given below.
(1) increases, thermal velocity of the electrons decreases
(2) decreases, thermal velocity of the electrons decreases
(3) increases, thermal velocity of the electrons increases
(4) decreases, thermal velocity of the electrons increases

Solu. Imagine a metal wire with electrons flowing like a slow river (drift velocity) due to an electric field. Now, heat up the wire. The electrons get more energetic and bounce around more (increased thermal velocity), kind of like a rapid river.
Here's the key: the electric field forcing the flow (voltage) stays the same. Even though the electrons are bouncing more (thermal velocity), all the bumping makes it harder for them to follow the electric field's push. So, the actual flow of electrons (drift velocity) gets weaker.
The answer is (2): decreases, thermal velocity increases.

Ques 24. A cell of emf 1.1 V and internal resistance 0.5 2 is connected to a wire of resistance 0.5 2. Another cell of the same emf is now connected in series with the intention of increasing the current but the current in the the wire remains the same. The internal resistance of the second cell is
Fill in the blank with the correct answer from the options given below.
(1) 1 Ω
(2) 2.5 Ω
(3) 1.5 Ω
(4) 2 Ω

Solu. To solve this problem, we need to determine the internal resistance of the second cell given that connecting it in series does not change the current through the wire.
Let's denote:
- E as the emf of each cell (1.1 V),
- r1 as the internal resistance of the first cell (0.5 Ω),
- r2 as the internal resistance of the second cell,
- R as the resistance of the wire (0.5 Ω).

Step 1: Calculate the initial current with one cell
The total resistance in the circuit with one cell is:
R_total = r1 + R = 0.5 Ω + 0.5 Ω = 1 Ω
The current I with one cell is given by Ohm's law:
I = E / R_total = 1.1 V / 1 Ω = 1.1 A

Step 2: Calculate the total resistance with two cells in series
When another cell with emf E and internal resistance r2 is connected in series, the total emf becomes 2E and the total internal resistance becomes r1 + r2. The total resistance in the circuit is then:
R'_total = r1 + r2 + R

Step 3: Set up the equation for the current with two cells
The current with two cells in series should remain the same as the current with one cell (1.1 A). Therefore,
I = 2E / R'_total = (2 * 1.1 V) / (r1 + r2 + R) = 1.1 A
Substituting the known values:
1.1 A = (2 * 1.1 V) / (0.5 Ω + r2 + 0.5 Ω)

1.1 Ω = 2.2 V / (1 Ω + r2)
Step 4: Solve for r2
1.1 Ω (1 + r2) = 2.2 V
1 + r2 = 2
r2 = 1 Ω
Therefore, the internal resistance of the second cell is:
(1) 1 Ω

Ques 25. Magnetic moment of a thin bar magnet is. If it is bent into a semicircular form, its new magnetic moment will be ______.
Fill in the blank with the correct answer from the options given below.
(1) M / pi
(2) M/2
(3) M
(4) 2M / pi

Solu. The magnetic moment M of a thin bar magnet is given by: M = p * l;
where p is the pole strength and l is the length of the magnet.
When the bar magnet is bent into a semicircular form, the effective length (chord length) between the poles remains the same as the original length l:
Effective_length = l;
Since the pole strength p remains unchanged and the effective length is still l, the magnetic moment M remains:
M = p * l;
Therefore, the new magnetic moment is:
(3) M;

Ques 26. Magnetic moment of a thin bar magnet is. If it is bent into a semicircular form, its new magnetic moment will be $
Fill in the blank with the correct answer from the options given below.
(1) M/π
(2) M/2
(3) M
(4) 2M/π

Solu. The magnetic moment M of a thin bar magnet is given by:
M = p * l;
where p is the pole strength and l is the length of the magnet.
When the bar magnet is bent into a semicircular form, the effective length (the straight-line distance between the poles) remains the same as the original length l. This is because the distance between the poles, even in a semicircular form, is still l.
Since the pole strength p remains unchanged and the effective length is still l, the magnetic moment M remains:
M = p * l;
Therefore, the new magnetic moment is: (3) M;

Ques 27. Ferromagnetic material used in Transformers must have____ Fill in the blank with the correct answer from the options given below.
(1) Low permeability and High Hysteresis loss
(2) High permeability and Low Hysteresis loss
(3) High permeability and High Hysteresis loss
(4) Low permeability and Low Hysteresis loss

Solu. The ferromagnetic material used in transformers must have high permeability and low hysteresis loss to efficiently transfer energy between the primary and secondary coils with minimal energy loss.
Therefore, the correct answer is:
(2) High permeability and Low Hysteresis loss