

NEET 2013 — Physics Question Paper with Solutions

36 Physics questions as set in the paper · answers checked by RankUp

NEET 2013

1. In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as follows: $P = a^3b^2/(cd)$. % error in P is

- (A) 14%
- (B) 10%
- (C) 7%
- (D) 4%

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2. The velocity of a projectile at the initial point A is $(2\hat{i} + 3\hat{j})$ m/s. Its velocity (in m/s) at point B (the point where it returns to the same horizontal level as A) is

- (A) $-2\hat{i} - 3\hat{j}$
- (B) $-2\hat{i} + 3\hat{j}$
- (C) $2\hat{i} - 3\hat{j}$
- (D) $2\hat{i} + 3\hat{j}$

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3. A stone falls freely under gravity. It covers distances h_1 , h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1 , h_2 and h_3 is

- (A) $h_1 = 2h_2 = 3h_3$
- (B) $h_1 = h_2/3 = h_3/5$
- (C) $h_2 = 3h_1$ and $h_3 = 3h_2$
- (D) $h_1 = h_2 = h_3$

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4. Three blocks with masses m, 2m and 3m are connected by strings (m at the top, 2m below it and 3m at the bottom). After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m? (g is the acceleration due to gravity)

- (A) zero
- (B) 2mg
- (C) 3mg
- (D) 6mg

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5. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

- (A) $\mu = 1/\tan \theta$
- (B) $\mu = 2/\tan \theta$
- (C) $\mu = 2 \tan \theta$
- (D) $\mu = \tan \theta$

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6. A uniform force of $(3\hat{i} + \hat{j})$ newton acts on a particle of mass 2 kg. Hence the particle is displaced from position $(2\hat{i} + \hat{k})$ metre to position $(4\hat{i} + 3\hat{j} - \hat{k})$ metre. The work done by the force on the particle is

- (A) 9 J
- (B) 6 J
- (C) 13 J
- (D) 15 J

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7. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 m s^{-1} and the second part of mass 2 kg moves with 8 m s^{-1} speed. If the third part flies off with 4 m s^{-1} speed, then its mass is

- (A) 3 kg
- (B) 5 kg
- (C) 7 kg
- (D) 17 kg

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8. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q (the string is vertical). When the string is cut, the initial angular acceleration of the rod is

- (A) $3g/(2L)$
- (B) g/L
- (C) $2g/L$
- (D) $2g/(3L)$

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9. A small object of uniform density rolls up a curved surface with an initial velocity v . It reaches up to a maximum height of $3v^2/(4g)$ with respect to the initial position. The object is

- (A) Ring
- (B) Solid sphere
- (C) Hollow sphere
- (D) Disc

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10. A body of mass m is taken from the earth's surface to the height equal to twice the radius (R) of the earth. The change in potential energy of body will be

- (A) $2mgR$
- (B) $(2/3)mgR$
- (C) $3mgR$
- (D) $(1/3)mgR$

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11. Infinite number of bodies, each of mass 2 kg, are situated on x-axis at distances 1 m, 2 m, 4 m, 8 m, ... respectively, from the origin. The resulting gravitational potential due to this system at the origin will be

- (A) $-G$
- (B) $-(8/3)G$
- (C) $-(4/3)G$
- (D) $-4G$

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12. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied ?

- (A) length = 50 cm, diameter = 0.5 mm
- (B) length = 100 cm, diameter = 1 mm
- (C) length = 200 cm, diameter = 2 mm
- (D) length = 300 cm, diameter = 3 mm

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13. The wettability of a surface by a liquid depends primarily on -

- (A) viscosity
- (B) surface tension
- (C) density
- (D) angle of contact between the surface and the liquid

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14. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v , respectively. If $\gamma = C_p/C_v$ and R is the universal gas constant, then C_v is equal to

- (A) $(1 + \gamma)/(1 - \gamma)$
- (B) $R/(\gamma - 1)$
- (C) $(\gamma - 1)/R$
- (D) γR

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15. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using -

- (A) Stefan's law
- (B) Wien's displacement law
- (C) Kirchhoff's law
- (D) Newton's law of cooling

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16. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of C_p/C_v for the gas is

- (A) $4/3$
- (B) 2
- (C) $5/3$
- (D) $3/2$

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17. A wave travelling in the +ve x-direction having displacement along y-direction as 1 m, wavelength 2π m and frequency of $1/\pi$ Hz is represented by

- (A) $y = \sin(x - 2t)$
- (B) $y = \sin(2\pi x - 2\pi t)$
- (C) $y = \sin(10\pi x - 20\pi t)$
- (D) $y = \sin(2\pi x + 2\pi t)$

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18. A source of unknown frequency gives 4 beats/s when sounded with a source of known frequency 250 Hz. The second harmonic of the source of unknown frequency gives five beats per second when sounded with a source of frequency 513 Hz. The unknown frequency is

- (A) 254 Hz
- (B) 246 Hz
- (C) 240 Hz
- (D) 260 Hz

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19. Two pith balls carrying equal charges are suspended from a common point by strings of equal length; the equilibrium separation between them is r . Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now becomes

- (A) $(1/\sqrt{2})^2$
- (B) $r/\sqrt[3]{2}$
- (C) $2r/\sqrt{3}$
- (D) $2r/3$

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20. A wire of resistance 4Ω is stretched to twice its original length. The resistance of stretched wire would be -

- (A) 2Ω
- (B) 4Ω
- (C) 8Ω
- (D) 16Ω

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21. The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10Ω is

- (A) 0.2Ω
- (B) 0.5Ω
- (C) 0.8Ω
- (D) 1.0Ω

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22. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are

- (A) ma_0/e west, $2ma_0/(ev_0)$ up
- (B) ma_0/e west, $2ma_0/(ev_0)$ down
- (C) ma_0/e east, $3ma_0/(ev_0)$ up
- (D) ma_0/e east, $3ma_0/(ev_0)$ down

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23. A current loop in a magnetic field -

- (A) experiences a torque whether the field is uniform or non-uniform in all orientations
- (B) can be in equilibrium in one orientation
- (C) can be in equilibrium in two orientations, both the equilibrium states are unstable
- (D) can be in equilibrium in two orientations, one stable while the other is unstable

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24. A bar magnet of length l and magnetic dipole moment M is bent in the form of an arc of a circle of radius r subtending an angle of 60° at the centre. The new magnetic dipole moment will be

- (A) M
- (B) $(3/\pi)M$
- (C) $(2/\pi)M$
- (D) $M/2$

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25. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is -

- (A) once per revolution
- (B) twice per revolution
- (C) four times per revolution
- (D) six times per revolution

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26. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when -

- (A) frequency of the AC source is decreased
- (B) number of turns in the coil is reduced
- (C) a capacitance of reactance $X_C = X_L$ is included in the same circuit
- (D) an iron rod is inserted in the coil

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27. Ratio of longest wavelengths corresponding to Lyman and Balmer series in hydrogen spectrum is

- (A) $5/27$
- (B) $3/23$
- (C) $7/29$
- (D) $9/31$

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28. The half-life of a radioactive isotope 'X' is 20 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio 1 : 7 in a sample of a given rock. The age of the rock is estimated to be -

- (A) 40 years
- (B) 60 years
- (C) 80 years
- (D) 100 years

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29. For photoelectric emission from certain metal the cutoff frequency is ν . If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass)

- (A) $\sqrt{(h\nu/(2m))}$
- (B) $\sqrt{(h\nu/m)}$
- (C) $\sqrt{(2h\nu/m)}$
- (D) $2\sqrt{(h\nu/m)}$

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30. The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by

- (A) $\lambda_p \propto \lambda_e^2$
- (B) $\lambda_p \propto \lambda_e$
- (C) $\lambda_p \propto \sqrt{\lambda_e}$
- (D) $\lambda_p \propto 1/\sqrt{\lambda_e}$

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31. A plano convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then the focal length of the combination is

- (A) $R/(2(\mu_1 + \mu_2))$
- (B) $R/(2(\mu_1 - \mu_2))$
- (C) $R/(\mu_1 - \mu_2)$
- (D) $2R/(\mu_2 - \mu_1)$

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32. For a normal eye, the cornea of eye provides a converging power of 40 D and the least converging power of the eye lens behind the cornea is 20 D. Using this information, the distance between the retina and the cornea-eye lens can be estimated to be

- (A) 5 cm
- (B) 2.5 cm
- (C) 1.67 cm
- (D) 1.5 cm

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33. In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000 \text{ \AA}$ and $\lambda_2 = 10000 \text{ \AA}$. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other?

- (A) 8 mm
- (B) 6 mm
- (C) 4 mm
- (D) 3 mm

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34. A parallel beam of fast moving electrons is incident normally on a narrow slit. A fluorescent screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statements is correct ?

- (A) Diffraction pattern is not observed on the screen in the case of electrons
- (B) The angular width of the central maximum of the diffraction pattern will increase
- (C) The angular width of the central maximum will decrease
- (D) The angular width of the central maximum will be unaffected

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35. In an n-type semiconductor, which of the following statements is true?

- (A) Electrons are majority carriers and trivalent atoms are dopants
- (B) Electrons are minority carriers and pentavalent atoms are dopants
- (C) Holes are minority carriers and pentavalent atoms are dopants
- (D) Holes are majority carriers and trivalent atoms are dopants

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36. In a common emitter (CE) amplifier having a voltage gain G , the transistor used has transconductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with transconductance 0.02 mho and current gain 20, the voltage gain will be

- (A) $(2/3)G$
- (B) $1.5G$
- (C) $(1/3)G$
- (D) $(5/4)G$

Answer key and explanations

1. Answer: (A) 14%

Maximum fractional errors add with powers as weights: $\Delta P/P = 3(1\%) + 2(2\%) + 3\% + 4\% = 3 + 4 + 3 + 4 = 14\%$. Getting 10% comes from ignoring the powers and just adding the four errors.

2. Answer: (C) $2\hat{i} - 3\hat{j}$

With no horizontal force the horizontal component stays $2\hat{i}$, while at the same level the vertical component has the same size but reverses, becoming $-3\hat{j}$. So the velocity at B is $2\hat{i} - 3\hat{j}$; reversing both components would wrongly reverse the horizontal motion too.

3. Answer: (B) $h_1 = h_2/3 = h_3/5$

Starting from rest, distances covered in successive equal time intervals are in the ratio 1 : 3 : 5 (Galileo's law of odd numbers). So $h_2 = 3h_1$ and $h_3 = 5h_1$, i.e. $h_1 = h_2/3 = h_3/5$. Equal distances would hold only for uniform velocity.

4. Answer: (A) zero

All three blocks move at constant velocity, so their acceleration is zero and by Newton's second law the net force on each block, including $2m$, is zero. $2mg$ is only the weight of that block, which is balanced by the string tensions.

5. Answer: (C) $\mu = 2 \tan \theta$

Let the plane length be L . Gain in KE from gravity over the full length, $mg \sin \theta \cdot L$, must equal the friction work on the rough lower half, $\mu mg \cos \theta \cdot (L/2)$. This gives $\mu = 2 \tan \theta$. $\mu = \tan \theta$ would only stop the acceleration on the rough part, not bring the block to rest.

6. Answer: (A) 9 J

Displacement $d = (4\hat{i} + 3\hat{j} - \hat{k}) - (2\hat{i} + \hat{k}) = 2\hat{i} + 3\hat{j} - 2\hat{k}$. $W = F \cdot d = 3 \times 2 + 1 \times 3 + 0 \times (-2) = 9$ J. The mass of the particle is not needed for the work done by a given force.

7. Answer: (B) 5 kg

Initial momentum is zero. The first two momenta are $1 \times 12 = 12$ and $2 \times 8 = 16$ kg m s⁻¹ at right angles, giving a resultant $\sqrt{(12^2 + 16^2)} = 20$ kg m s⁻¹. The third part must carry 20 kg m s⁻¹ in the opposite direction, so $m = 20/4 = 5$ kg.

8. Answer: (A) $3g/(2L)$

About the hinge P, the weight acts at $L/2$: torque = $Mg(L/2)$. Moment of inertia of a rod about its end = $ML^2/3$. $\alpha = Mg(L/2)/(ML^2/3) = 3g/(2L)$. Using g/L treats the rod as a point mass at the end.

9. Answer: (D) Disc

Rolling KE = $(1/2)mv^2(1 + k^2/R^2)$ is converted to $mgh = mg \times 3v^2/(4g) = (3/4)mv^2$. So $1 + k^2/R^2 = 3/2$, $k^2/R^2 = 1/2$, which is the value for a disc. A solid sphere ($k^2/R^2 = 2/5$) or a ring ($k^2/R^2 = 1$) would rise to different heights.

10. Answer: (B) $(2/3)mgR$

$\Delta U = GMm/R - GMm/3R = (2/3)GMm/R = (2/3)mgR$, using $GM = gR^2$. The answer $2mgR$ comes from wrongly using mgh with $h = 2R$, which is valid only for heights much smaller than R .

11. Answer: (D) $-4G$

$V = -Gm(1/1 + 1/2 + 1/4 + 1/8 + \dots) = -G \times 2 \times [1/(1 - 1/2)] = -G \times 2 \times 2 = -4G$. Forgetting the 2 kg mass gives $-2G$ -type answers; the sum of the geometric series is 2.

12. Answer: (A) length = 50 cm, diameter = 0.5 mm

Extension $\Delta L = FL/(AY) \propto L/d^2$ for the same material and tension. $L/d^2 = 50/0.25 = 200$, $100/1 = 100$, $200/4 = 50$ and $300/9 \approx 33$ (cm/mm²), so the 50 cm, 0.5 mm wire stretches most. The longest wire is not the answer because its larger area wins.

13. Answer: (D) angle of contact between the surface and the liquid

Whether a liquid wets a surface is decided by the angle of contact: an acute angle means wetting, an obtuse angle means non-wetting. Surface tension alone does not decide this, since the contact angle depends on the balance of adhesive and cohesive forces.

14. Answer: (B) $R/(\gamma - 1)$

Mayer's relation $C_p - C_v = R$ with $C_p = \gamma C_v$ gives $\gamma C_v - C_v = R$, so $C_v = R/(\gamma - 1)$. The expression $\gamma R/(\gamma - 1)$ would be C_p , and $(\gamma - 1)/R$ is the inverse of the correct result.

15. Answer: (B) Wien's displacement law

Wien's displacement law, $\lambda_m T = \text{constant}$, says that the wavelength of maximum emission shifts to shorter values as temperature rises, so the colour changes from red towards yellow and white. Stefan's law gives only the total power radiated, not the colour.

16. Answer: (D) 3/2

For an adiabatic process $PV^\gamma = \text{constant}$ combined with $PV = nRT$ gives $P \propto T^{\gamma/(\gamma-1)}$. Setting $\gamma/(\gamma-1) = 3$ gives $\gamma = 3\gamma - 3$, so $\gamma = 3/2$. 5/3 is the monatomic value and does not satisfy the given relation.

17. Answer: (A) $y = \sin(x - 2t)$

$k = 2\pi/\lambda = 2\pi/2\pi = 1 \text{ m}^{-1}$ and $\omega = 2\pi f = 2\pi \times (1/\pi) = 2 \text{ rad s}^{-1}$, amplitude 1 m. A wave along +x is $y = A \sin(kx - \omega t) = \sin(x - 2t)$. A plus sign between the terms would describe a wave moving along -x.

18. Answer: (A) 254 Hz

4 beats with 250 Hz means $f = 254 \text{ Hz}$ or 246 Hz. Second harmonics are 508 Hz or 492 Hz; only 508 Hz gives $513 - 508 = 5$ beats per second. So $f = 254 \text{ Hz}$; 246 Hz would give 21 beats.

19. Answer: (B) $r^{3/2}$

For a ball at equilibrium, $\tan \theta = F/mg$; with small angles $\tan \theta \approx (r/2)/L$, so $(r/2)/L = kq^2/(r^2mg)$, giving $r^3 \propto L$. Clamping at half the height halves the effective length, so $r'^3 = r^3/2$ and $r' = r/\sqrt[3]{2}$.

20. Answer: (D) 16 Ω

Stretching keeps the volume constant, so doubling the length halves the cross-section. $R = \rho l/A$ becomes $\rho(2l)/(A/2) = 4R = 4 \times 4 = 16 \Omega$. 8Ω only accounts for the change in length.

21. Answer: (B) 0.5 Ω

$I = E/(R + r)$: $0.2 = 2.1/(10 + r)$, so $10 + r = 10.5$ and $r = 0.5 \Omega$.

22. Answer: (B) ma_0/e west, $2ma_0/(ev_0)$ down

At rest only the electric force acts: $eE = ma_0$ westward, so $E = ma_0/e$ towards west. Moving north, the extra $2ma_0$ westward comes from the magnetic force: $ev_0B = 2ma_0$, $B = 2ma_0/(ev_0)$. For a positive charge, $\mathbf{v}$ (north) $\times \mathbf{B}$ must point west, which happens when $\mathbf{B}$ points down.

23. Answer: (D) can be in equilibrium in two orientations, one stable while the other is unstable

Torque on a loop is $\tau = m \times B$, which is zero when the magnetic moment is parallel or antiparallel to $\mathbf{B}$. The parallel position (minimum energy) is stable and the antiparallel position (maximum energy) is unstable. A loop does not feel a torque in every orientation.

24. Answer: (B) $(3/\pi)M$

Pole strength stays m with $M = ml$. The arc length $l = r(\pi/3)$, so $r = 3l/\pi$. The poles are now joined by a chord subtending 60° , whose length equals r , so $M' = m \times 3l/\pi = 3M/\pi$.

25. Answer: (B) twice per revolution

The induced emf in a rotating loop is $e = NBA\omega \sin \omega t$, which changes sign twice in each full rotation (at 0 and π). So the direction reverses twice per revolution.

26. Answer: (D) an iron rod is inserted in the coil

An iron rod increases the inductance L , raising $X_L = \omega L$ and the impedance, so the current and the bulb's brightness drop. Lowering the frequency, reducing the turns or adding a capacitor with $X_C = X_L$ all reduce the net reactance and make the bulb brighter.

27. Answer: (A) 5/27

Longest wavelengths: Lyman ($2 \rightarrow 1$): $1/\lambda = R(1 - 1/4) = 3R/4$, $\lambda = 4/(3R)$. Balmer ($3 \rightarrow 2$): $1/\lambda = R(1/4 - 1/9) = 5R/36$, $\lambda = 36/(5R)$. Ratio = $(4/3)/(36/5) = 20/108 = 5/27$.

28. Answer: (B) 60 years

$X : Y = 1 : 7$ means $1/8$ of the original X remains. $1/8 = (1/2)^3$, so three half-lives have passed: $3 \times 20 = 60$ years. 80 years would leave $1/16$.

29. Answer: (C) $\sqrt{(2h\nu/m)}$

Work function = $h\nu$ (cutoff). $KE_{\text{max}} = h(2\nu) - h\nu = h\nu = (1/2)mv^2$, so $v = \sqrt{(2h\nu/m)}$. Using $\sqrt{(h\nu/m)}$ drops the factor 2 from the kinetic energy formula.

30. Answer: (A) $\lambda p \propto \lambda e^2$

Electron: $\lambda e = h/\sqrt{(2mE)}$, so $\lambda e^2 \propto 1/E$. Photon: $\lambda p = hc/E \propto 1/E$. Therefore $\lambda p \propto \lambda e^2$. A direct proportion would be true only if both depended on E in the same way.

31. Answer: (C) $R/(\mu_1 - \mu_2)$

Plano-convex: $1/f_1 = (\mu_1 - 1)/R$; plano-concave of the same curvature: $1/f_2 = -(\mu_2 - 1)/R$. In contact: $1/f = (\mu_1 - \mu_2)/R$, so $f = R/(\mu_1 - \mu_2)$. A factor of 2 would appear only for double-curved lenses.

32. Answer: (C) 1.67 cm

For a relaxed normal eye viewing a distant object, the total power $40 + 20 = 60 \text{ D}$ must focus the image on the retina. $f = 1/60 \text{ m} = 100/60 \text{ cm} \approx 1.67 \text{ cm}$, which is the cornea-retina distance. Using only the cornea power (40 D) gives 2.5 cm.

33. Answer: (B) 6 mm

Fringe width $\beta = \lambda D/d$: $\beta_1 = (12000 \times 10^{-10} \times 2)/(2 \times 10^{-3}) = 1.2 \text{ mm}$ and $\beta_2 = 1.0 \text{ mm}$. Bright fringes coincide when $n_1(1.2) = n_2(1.0)$, first at $n_1 = 5$, $n_2 = 6$, i.e. 6 mm from the centre.

34. Answer: (C) The angular width of the central maximum will decrease

Faster electrons have a smaller de Broglie wavelength $\lambda = h/(mv)$. The angular width of the central maximum is about $2\lambda/a$, so it decreases. Electrons do show diffraction because of their wave nature.

35. Answer: (C) Holes are minority carriers and pentavalent atoms are dopants

An n-type semiconductor is made by doping with pentavalent atoms (e.g. P, As), which donate electrons. Electrons become the majority carriers and holes the minority carriers. Trivalent dopants would give p-type material.

36. Answer: (A) $(2/3)G$

Voltage gain of a CE amplifier $A_v = g_m \times R_L$. With the same load resistance, $G'/G = 0.02/0.03$, so $G' = (2/3)G$. The current gain does not enter this relation, so using 20/25 gives a wrong answer.

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