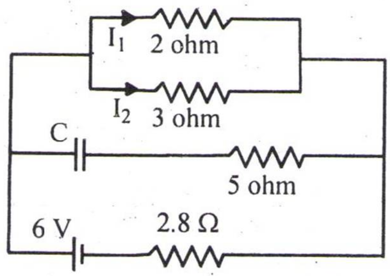
PHYSICS

1. Calculate the steady current in the 2 Ω resistor shown in the figure. The battery has negligible resistance and C = 0.2μF.
A) 1.5 A B) 0.9 A C) 0.44 A D) 0.6 A



2. The temperature at which the resistance of an iron wire would be 20% more than the resistance at 0°C is ($\alpha = 5 \times 10^{-3}/{}^\circ C$)
A) 40° C B) 65° C C) 50° C D) 25° C

3. Two resistances are connected in the two gaps of a meter bridge. The balance point is 20 cm from the zero end. A resistance of 15 Ω is connected in series with the smaller of the two resistances when the null point shifts to 40 cm. The smaller of the two resistances has the value
A) 8 Ω B) 10 Ω C) 9 Ω D) 12 Ω

4. Two concentric coplanar circular loops of radii 7 cm and 10 cm carry currents such that the net magnetic field at their common centre is zero. If the current in the outer loop is 7 A clockwise, the current in the inner loop is
A) 1 A clockwise B) 4.9 A anticlockwise
C) 10 A clockwise D) 49 A anticlockwise

5. A voltmeter of range 3 V and resistance 200 Ω cannot be converted to an ammeter of range
A) 10 mA B) 100 mA C) 1 A D) 10 A

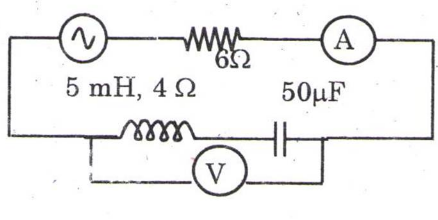
6. A proton and a deuteron of equal momenta enter a uniform magnetic field normally. The ratio of their radii orbits is
A) 1 : 2 B) 1 : 1 C) 2 : 1 D) 1 : 4

7. A solenoid carrying current is oscillating in a horizontal plane about its centre in a uniform magnetic field with a period T. If the current is increased to 4 I the period of oscillation will be
A) 4T B) 2T C) T/2 D) T/4

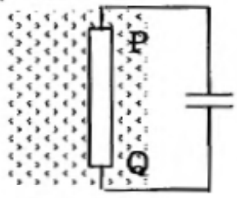
8. The magnetic field lines inside a bar magnet
A) converge at N pole and diverge at S pole
B) are from N pole to S pole
C) are from S pole to N pole
D) do not exist

9. If the temperature of a block of aluminium at 300 K is decreased by 20%, its magnetic susceptibility increases by
A) 25% B) 8% C) 20% D) 15%

10. In the circuit shown in the figure, the AC source V = 20 cos(2000t). Neglecting source resistance, the voltmeter and ammeter readings will be
A) 0 V, 0.47 A
B) 1.68 V, 0.47 A
C) 0 V, 1.4 A
D) $2\sqrt{2}$ V, $\sqrt{2}$ A



11. PQ is a straight conductor of length 1 m connected to a capacitor of capacitance 10 μF as shown in the figure. The velocity with which the conductor has to be moved across the magnetic field of 2T, so that the capacitor acquires a charge of 10 μC is



A) 1 ms^{-1}

B) 0.5 ms^{-1}

C) 10 ms^{-1}

D) 5 ms^{-1}

12. Which of the following in electrodynamics is analogous to the momentum in mechanical dynamics?

A) VI B) qV C) LI D) $L\frac{dI}{dt}$

13. In a series LCR circuit at resonance, the applied AC voltage is 220 V. If the potential drop across the inductance and capacitor is 110 V, the potential drop across the resistance is

A) 110 V B) $110\sqrt{2}$ V C) 220 V D) $220\sqrt{2}$ V

14. In a series LCR circuit R is 100 Ω and the applied voltage is 200 V. When the capacitance alone is removed, the voltage leads the current by 30° and when the inductance alone is removed the current leads the voltage by 30°. The current in the circuit is

A) 2 A B) 1 A C) 0.5 A D) 4 A

15. In a transformer, the core is made up of soft iron insulated strips to reduce

A) eddy currents B) heat energy loss

C) hystersis loss D) Both A and C

16. An electromagnetic wave of frequency f = 3 MHz passes from vacuum into a dielectric medium with K = 4.0. Then,

A) wavelength is doubled and frequency (f) is unchanged

B) wavelength is doubled and frequency (f) becomes half

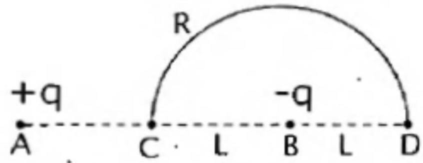
C) wavelength is halved and frequency (f) is unchanged

D) wavelength and frequency (f) remain unchanged

17. Charges +q and –q are placed at corners A and B respectively which are at a distance 2L apart. C is the midpoint between A and B. The work done in moving a charge +Q along the semicircle CRD is

A) $\frac{qQ}{2\pi\varepsilon_0 L}$ B) $\frac{qQ}{6\pi\varepsilon_0 L}$

C) $-\frac{qQ}{6\pi\varepsilon_0 L}$ D) $\frac{qQ}{4\pi\varepsilon_0 L}$



18. Two charges q_1 and q_2 are distributed over two spheres of radii R_1 and R_2 such that their electrical potential V is equal. What is the ratio of the surface density of charges of the spheres? ($\sigma_1 : \sigma_2$)

A) R_2/R_1 B) R_2^2/R_1^2 C) R_2^3/R_1^3 D) R_1^2/R_2^2

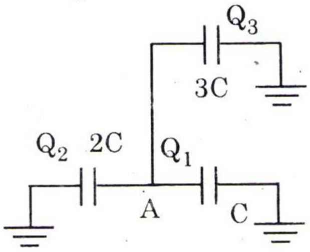
19. Two spherical conductors B and C having equal radii and carrying equal charges on them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is

A) 3 F/8 B) 3 F/4 C) F/4 D) F/8

20. An electric dipole has the magnitude of its charge as q and its dipole moment is p. It is placed in a uniform electric field E. If its dipole is placed along the direction of the field, the force on it and its potential energy are

A) qE and PE B) zero and minimum C) qE and maximum D) 2qE and minimum

21. A charge of 6 μC is given to the capacitor at A. The ratio of charge distributed on each capacitor is



A) 1 : 2 : 3

B) 2 : 4 : 6

C) 3 : 2 : 1

D) both A and B

22. The ionization energy of hydrogen atom is 13.6 eV. The ionization energy of He^+ ion is

A) 3.4 eV B) 13.6 eV C) 54.4 eV D) 108.8 eV

23. In a hydrogen atom, two electrons move around the nucleus in a circular orbit of radii 4 r and 25 r. The ratio of time taken by them to complete one revolution is

A) 8:125 B)125:8 C) 2:5 D) None of these

24. Blue light can cause photoelectric emission from a metal, but yellow light cannot. If red light is incident on the metal, then

A) photoelectric current will increase

B) rate of emission of photoelectrons will decrease

C) no photoelectric emission will occur

D) energy of photoelectrons will increase

25. Light of frequency 6.4×10^{15} Hz is incident on a material having work function of 6.5 eV. The maximum kinetic energy of the emitted electron is

A) 17 eV B) 37 eV C) 20 eV D) 22.7 eV

26. If 75% of a radioactive sample disintegrates in 16 days, the half-life of the radioactive sample is

A) 6 days B) 4 days C) 8 days D) 12 days

27. A sample of radioactive element has a mass of 10 g at an instant t = 0. The approximate mass of this element in the sample after two mean lives is

A) 3.70 g B) 6.3 g C) 1.35 g D) 2.5 g

28. A nucleus at rest splits into two nuclear parts having radii in the ratio 1 : 2. Their velocities are in the ratio

A) 8 : 1 B) 1 : 8 C) 4 : 1 D) 2 : 1

29. The decay of an electron into two γ ray photons is not possible since this violates the law of conservation of

A) energy B) charge

C) linear momentum D) angular momentum and charge

30. In Rutherford's α rays scattering experiment, for a given impact parameter 'b', as the energy of α particles increases scattering angle θ

A) increases B) decreases

C) cannot be predicted D) none of these

31. In a Fraunhofer diffraction experiment, at a single slit using light of wavelength 400 nm, the first minimum is formed at an angle of 30°. Then the direction of the first secondary maximum is given by

A) $\tan^{-1}\left(\frac{1}{3}\right)$ B) $\tan^{-1}\left(\frac{3}{4}\right)$ C) 60° D) $\sin^{-1}\left(\frac{3}{4}\right)$

32. An interference experiment is performed with green light of wavelength 5500 Å in air. The fringe width was found to be 0.40 mm. If the whole set up is immersed in water of refractive index $\frac{4}{3}$, then fringe width is

A) 0.30 mm B) 0.40 mm C) 0.53 mm D) 0.2 mm

33. Choose the correct statement:

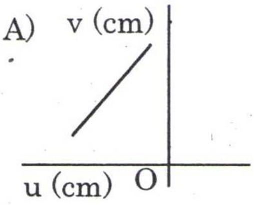
A) The Brewster's angle is independent of wavelength of light.

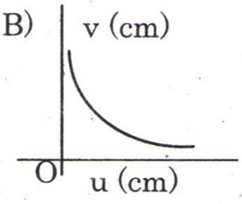
B) The Brewster's angle is independent of the nature of reflecting surface.

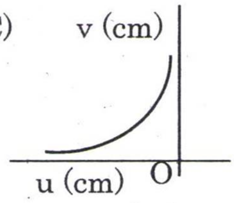
C) The Brewster's angle is different for different wavelengths.

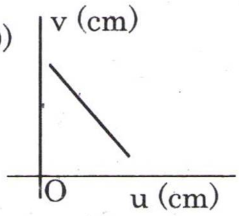
D) Brewster's angle depends on wavelength but not on the nature of reflecting surface.

34. A student measures the focal length of a convex lens by putting an object pin at a distance 'u' from the lens and measuring the distance 'v' of the image pin. The graph between 'u' and 'v' plotted by the student should look like

A) 

B) 

C) 

D) 

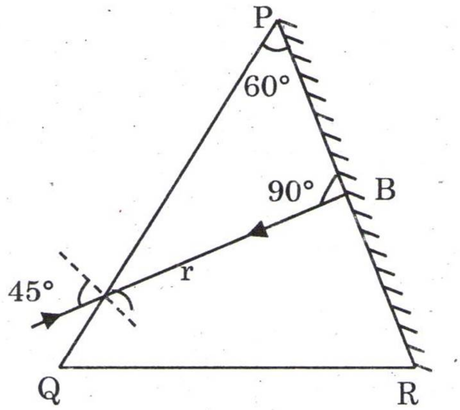
35. While reading a man keeps the book at a distance of 2.5 cm from his eye. He wants to read the book by holding the book at 25 cm. What is the nature of spectacles one should advise him?

A) convex lens of f = 25 cm
B) convex lens of f = 2.5 cm
C) concave lens of f = 25 cm
D) concave lens of f = 2.5 cm

36. A convex lens of focal length 15 cm is made of material having refractive index 1.2. When placed in water (n =1.3), it will behave as

A) converging lens of focal length 15 cm
B) converging lens of focal length different than 15 cm
C) diverging lens of focal length 15 cm
D) diverging lens of focal length different than 15 cm

37. The face PR of a prism PQR of angle 60° is silvered. A ray is incident on face PQ at an angle of 45° as shown in the figure. The refracted ray undergoes reflection on face PR and retraces its path. The refractive index of the prism is



A) $\sqrt{\frac{2}{3}}$

B) $\frac{3}{\sqrt{2}}$

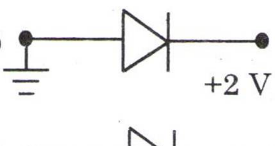
C) 1.5

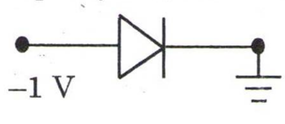
D) 1.33

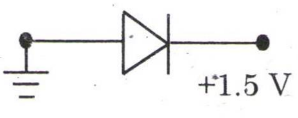
38. A light source placed at the bottom of a water beaker 10 cm deep forms an illuminated circle of radius 11.2 cm at its surface. If the depth of the water in the beaker is increased to 20 cm, the radius of the illuminated circle will be

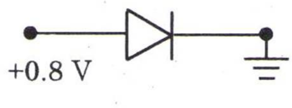
A) 16.8 cm
B) 30.6 cm
C) 22.4 cm
D) None of these

39. In which one of the following diagrams is the *p–n* junction forward biased?

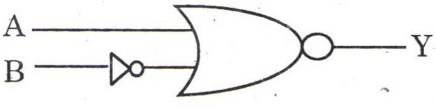
A) 

B) 

C) 

D) 

40. The Boolean expression for the logic circuit shown below is



A) $Y = A + \overline{B}$
B) $Y = A \times \overline{B}$
C) $Y = \overline{A + \overline{B}}$
D) $Y = \overline{A \times B}$

41. The range of frequency allotted for FM radio is

A) 88 – 108 kHz
B) 88 – 108 MHz
C) 470 – 960 kHz
D) 47 – 230 kHz

42. If x is the displacement of the particle from the mean position while executing SHM, then the total energy of the particle executing SHM is

A) directly proportional to x
B) directly proportional to x^2
C) independent of x
D) directly proportional to $\sqrt{x}$

43. A pipe closed at one end produces a fundamental note of 412 Hz. It is cut into two pieces of equal length. The fundamental notes produced by the two pieces are

A) 206 Hz, 212 Hz
B) 206 Hz, 824 Hz
C) 412 Hz, 824 Hz
D) 824 Hz, 1648 Hz

44. The value of 'g' decreases by 0.1% on a mountain as compared to that at sea level. To maintain the same period, the length must be

A) increased by 0.1%
B) decreased by 0.1%
C) increased by 0.05%
D) decreased by 0.05%

45. A wave of frequency 600 Hz has a velocity 360 ms^{-1}. The distance between two nearest points 60° out of phase will be approximately

A) 10 cm
B) 12 cm
C) 6 cm
D) 1 cm

46. A body travelling with uniform acceleration crosses two points A and B with velocities 20 m/sec. and 30 m/sec. respectively. The speed of the body at the midpoint of A and B is

A) 25 m/sec
B) 25.5 m/sec
C) 24 m/sec
D) $10\sqrt{6}$ m/sec

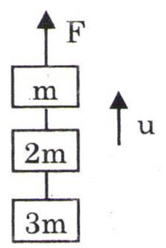
47. A projectile is thrown into space so as to have a maximum possible horizontal range equal to 400 m. Taking the point of projection as the origin, the co-ordinates of the point where the velocity of the particles is minimum are

A) (400, 100)
B) (200, 100)
C) (400, 200)
D) (200, 200)

48. A motor boat is travelling with a speed of 3.0 m/sec. If the force on it due to water flow is 500 N, the power of the boat is

A) 150 kW
B) 15 kW
C) 1.5 kW
D) 150 W

49. Three blocks with masses 'm', '2m' and '3m' are connected by strings as shown in the figure. 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'?



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

50. If the distance between the sun and the earth reduces to one-fourth of the present value, the length of the year on the earth will be

A) half of the present year
B) one-fourth of the present year
C) one-sixth of the present year
D) one-eighth of the present year

51. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied? (L is length; d is diameter)

A) L = 50 cm, d = 0.5 mm
B) L = 100 cm, d = 1 mm
C) L = 200 cm, d = 2 mm
D) L = 300 cm, d = 3 mm

52. In an experiment, four quantities a, b, c and d are measured with percentage errors 1%, 2%, 3% and 4% respectively. Quantity 'P' is calculated as follows: $P = \frac{a^3b^2}{cd}$.

% error in P is

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

53. A thin uniform circular ring is rolling down on an inclined plane of inclination 30° without slipping. Its acceleration along the inclination will be

A) g/2
B) g/3
C) g/4
D) 2g/3

54. A man walks 8 km. north and then 5 km. in a direction 60° east of north. His resultant displacement from his starting point is

A) 11 km
B) 12 km
C) 13 km
D) 14 km

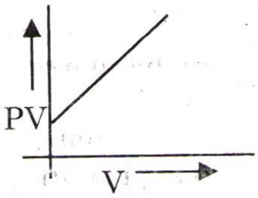
55. When liquid flows through a capillary tube satisfying Poiseuille's formula, the velocity of the liquid layer is zero

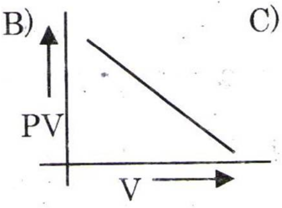
A) for the layer along the axis of the tube.
B) for the layer in contact with the wall of the capillary tube.
C) for the layer mid-way between the axis and the wall of the capillary tube.
D) for none of the layers.

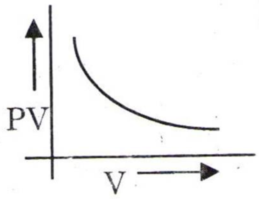
56. Bernoulli's equation is given by $P + 1/2\ \rho v^2 + \rho g h$ = Constant. The quantity $\rho v^2/2$ has the same units as that of

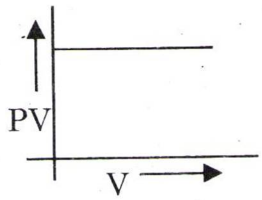
A) force
B) impulse
C) strain
D) pressure

57. Which of the following graphs represents the behaviour of an ideal gas?

A)


B)


C)


D)


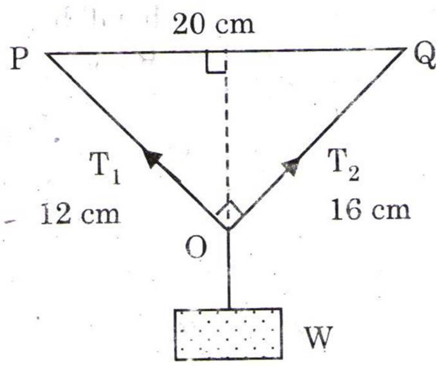
58. The amount of heat energy required to raise the temperature of 1 gm of helium at NTP from T_1 K to T_2 K is

A) $3/8\ N_a\ k_B\ (T_2 - T_1)$
B) $3/2\ N_a\ k_B\ (T_2 - T_1)$
C) $3/4\ N_a\ k_B\ (T_2 - T_1)$
D) $3/8\ N_a\ k_B\ (T_2 / T_1)$

59. A black body emits 100 W/cm^2 at 327°C. The sun radiates 10^5 W/cm^2. Then, what is the temperature of the sun?

A) 5000 K
B) 2000 K
C) 8000 K
D) 6000 K

60. Three forces acting on a body and keeping it in equilibrium are as shown in the diagram. If T_1 and T_2 are the tensions in the strings in OP and OQ and W is the weight of the body, we have



A) $W = T_1 + T_2$
B) $W = \sqrt{T_1^2 + T_2^2}$
C) $W = \sqrt{T_1 \times T_2}$
D) $W = T_1 T_2 / T_1 + T_2$

Answer Key

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1.	B	2.	A	3.	C
4.	B	5.	A	6.	B
7.	C	8.	C	9.	A
10.	C	11.	B	12.	C
13.	C	14.	A	15.	A
16.	C	17.	C	18.	A
19.	A	20.	B	21.	D
22.	C	23.	A	24.	C
25.	C	26.	C	27.	C
28.	A	29.	D	30.	B
31.	D	32.	A	33.	C
34.	C	35.	B	36.	D
37.	A	38.	C	39.	D
40.	C	41.	B	42.	C
43.	D	44.	B	45.	A
46.	C	47.	B	48.	C
49.	A	50.	D	51.	A
52.	C	53.	C	54.	A
55.	B	56.	D	57.	D
58.	A	59.	D	60.	B

Answers:

1. Capacitor blocks D.C. Hence current flows only through 2Ω and 3Ω resistors.
   $R_p = 2 \times 3/5 = 1.2$ ohm, $R_{eff} = 1.2 + 2.8 = 4$ ohm, $I = V/R = 6/4 = 1.5$ A,
   $I_1 = 0.9$ A, $I_2 = 0.6$ A

2. $R_2 = R_0 + 20\%R_0 \quad R_1 = R_0;\ t_1 = 0°C,\ t_2 = ?$
   $(R_2 = R_1(1 + \alpha\Delta t)); \quad 1.2\,R_0 = R_0(1+\alpha\Delta t);\ 1.2 = (1+\alpha\Delta t)$
   $\therefore (\alpha\Delta t) = 1.2$ or $\Delta t = 40°C$. $\Delta t = t_2 - t_1 \quad \therefore t_2 = 40 - 0 = 40°C$

3. $\dfrac{X}{S} = \dfrac{20}{80} \therefore S = 4X \rightarrow (1)$
   $\Rightarrow \dfrac{X+15}{S} = \dfrac{40}{60} = \dfrac{2}{3} \Rightarrow \dfrac{X+15}{4X} = \dfrac{40}{60} = \dfrac{2}{3} \therefore X = 9\,\Omega.$

4. $B_1 = B_2$
   Magnetic field due to inner loop = Magnetic field due to outer loop
   $\dfrac{I_1}{R_1} = \dfrac{I_2}{R_2};\ \dfrac{I_1}{7} = \dfrac{7}{10} \quad \therefore I_1 = 4.9$ A anticlockwise.

5. Ammeter range can be increased but cannot be decreased.
   $I = V/G = 3/200 = 1.5 \times 10^{-2} = 15$ mA. So range must be more than 15 mA.

6. Using the equation $R = \dfrac{P}{Bq}$, since momentum and charge are same, radii of proton and deuteron are same.

7. Solenoid behaves as a bar magnet of magnetic moment M. $M \propto I$. Hence
   $M_1 = M$ and $M_2 = 4M_1$; $\dfrac{T_2}{T_1} = \sqrt{\dfrac{M_1}{M_2}} = \dfrac{1}{2}$ or $T_2 = T_1/2 = T/2$.

9. Change in temperature = 2%(300) = 60, $T_2 = 300 - 60 = 240$ K

$\chi \propto 1/T$ change in susceptibility =

$$\frac{\chi_2 - \chi_1}{\chi_1} = \frac{\frac{1}{T_2} - \frac{1}{T_1}}{T_1} = \frac{T_1 - T_2}{T_2} = \frac{300 - 240}{240} = 0.25 = 25\% .$$

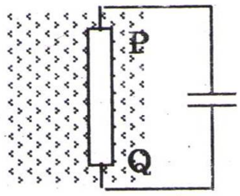
10. $R = 6 + 4 = 10$ ohm, $X_L = 10$ ohm, $X_c = 10$ ohm

Since $X_L = X_c$ $\therefore$ $Z = R$ $I_0 = V_0/R = 20/10 = 2A$

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2} = 1.414A$$

Voltmeter reading $V_{rms} = 0$ because it is resonance circuit.

11. The emf to be induced in the conductor PQ is given by



$V=Q/C = 10 \times 10^{-6}/10 \times 10^{-6} = 1V$

If v be the velocity of the conductor, the emf induced is given by $e = BLv$.

$v = e/BL = V/BL = 1/(2 \times 1) = 0.5\ ms^{-1}$.

12. $F = \frac{d}{dt}(mV)$. Similarly, in electrodynamics, $E = L\left(\frac{dI}{dt}\right) = \frac{d}{dt}(LI)$.

13. At resonance $V_L = V_C$; $V = \sqrt{(V_L - V_C)^2 + V_R^2}$ then $V = V_R$.

14. When L and R are present, voltage leads the current by 30°.

$\tan 30 = X_L / R$ or

When C and R are present, current leads the voltage by 30°.

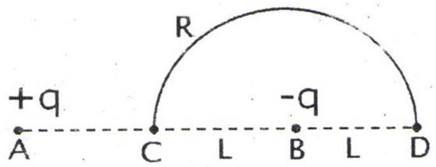
$\tan 30 = X_C / R$.

Thus $X_L/R = X_C/R$ or $X_L = X_C$; $Z = \sqrt{R^2 + 0} = R$.

$I = V/Z = 200 / 100 = 2$ A.

16. $f = 2$ MHz; $K = 4$; $V = \sqrt{\frac{C}{K}} = \frac{C}{2}$; $V = f\lambda$ $\therefore$ $\lambda = \frac{V}{f}$; $\lambda = \frac{\lambda}{2}$.

17.



AC = BC = L; CD = 2L Potential at C; $V_C = 0$

Potential at D ; $V_D = K(-q/L) + (Kq/3L) = -2/3(Kq/L)$

Potential difference $V_D - V_C = -\frac{2}{3}\frac{Kq}{L} \times Q = \frac{1}{4\pi\varepsilon_o}\left(-\frac{2qQ}{3L}\right) = \frac{-1}{6\pi\varepsilon_o}\left(\frac{qQ}{L}\right)$

18. $V = \sigma R$ = constant since $V_1 = V_2$ $\therefore \frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$.

19. Let charge on B and C be q. $F = \frac{1}{4\pi\varepsilon_0}\frac{q \times q}{d^2} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{d^2}$

When third conductor and B are in contact, charge on each is q/2.
When third conductor and C are in contact, charge on each is

$$\frac{\frac{q}{2} + q}{2} = \frac{3q}{4}$$ Force on B and C is

$$F^1 = \frac{1}{4\pi\varepsilon_0}\left(\frac{q/2 \times 3q/4}{d^2}\right) = \frac{1}{4\pi\varepsilon_0}\left(\frac{q^2}{d^2}\right)\left(\frac{3}{8}\right) = \frac{3F}{8}$$

20. When dipole moment is along the direction of the field the net force on the dipole is zero. So potential energy is minimum, because
P.E.= –PE cos θ if θ = 0, W = – PE (negative, so it is minimum)

21. Since all capacitors are connected between two common points A and earth, it is a parallel combination. $C_1 : C_2 : C_3 = Q_1 : Q_2 : Q_3 : = 1 : 2 : 3 = 2 : 4 : 6$

22. $E_n \propto 13.6\left(\frac{Z^2}{n^2}\right)$ n = 1; Z = 2 $\Rightarrow E_n = 13.6 \times 4 = 54.4$ eV.

23. $r_1 : r_2 = 4r : 25r;$ $r \propto n^2;$ $r_1 : r_2 = 2 : 5;$ $n_1 = 2$ and $n_2 = 5$
$T \propto n^3$ $T_1 : T_2 = 8 : 125.$

24. If $\lambda > \lambda_0$ no photoelectric effect takes place. Since $\lambda_R > \lambda_Y$, when photoelectric effect is not possible for yellow, certainly it is not possible for red colour.

25. Incident energy $h\gamma = \frac{6.625 \times 10^{-34} \times 6.4 \times 10^{15}}{1.602 \times 10^{-19}} = 26.5$ eV
K.E = Incident energy – Work function ⇒ 26.5 – 6.5 = 20 eV.

26. Disintegration of sample = 75%. The sample left undecayed after 16 days = 25%.
$\frac{N}{N_0} = \frac{25}{100} = \frac{1}{4}$ and $\frac{N}{N_0} = \frac{1}{2^n}$ $2^n = 4$ or n = 2 $T = \frac{t}{n} = \frac{16}{2} = 8$ days

27. $t = 2T_m = \frac{2}{\lambda};$ $N = N_0 e^{-\lambda t} \Rightarrow N = N_0 e^{-\lambda \frac{2}{\lambda}}$

$N = \frac{N_0}{e^2} = \frac{10}{2.718 \times 2.718} = 1.35$ g OR

Since mean life > half-life, in two half-lives sample reduces to 2.5 g.
Hence in two mean-lives sample must be < 2.5 g.

28. $R \propto A^{1/3}$ $\frac{R_1}{R_2} = \frac{A_1^{1/3}}{A_2^{1/3}}$ or $\frac{A_1}{A_2} = \frac{R_1^3}{R_2^3} = \frac{1}{8}$

Since $A \propto m$, $\frac{A_1}{A_2} = \frac{m_1}{m_2} = \frac{1}{8} \rightarrow (1).$

According to law of conservation of linear momentum
$m_1v_1 = m_2v_2$ $\therefore \frac{v_1}{v_2} = \frac{m_2}{m_1}$. From equation (1), $\frac{v_1}{v_2} = \frac{8}{1}$

29. Electron is negatively charged and fermion. But γ ray photon is electrically neutral and has zero spin. Hence charge and angular momentum are both not conserved.

30. Decreases. $b = \frac{1}{4\pi\varepsilon_0}\left(\frac{Ze^2}{E}\right)\cot\frac{\theta}{2}$ Since 'b' is constant, as energy increases, cot value increases and hence tan θ decreases. As tan θ↓, θ↓.

31. For first minimum d sin 30 = nλ = λ ------(1)
For first maximum d sin θ = (2n+1)λ/2 = 3/2 λ ------(2)
Using equations 1 and 2, $\frac{\sin\theta}{\sin 30} = \frac{3}{2} \therefore \sin\theta = \frac{3}{2} \times \frac{1}{2} = \frac{3}{4} \therefore \theta = \sin^{-1}\left(\frac{3}{4}\right)$

32. $\beta' = \frac{\beta}{n} = \frac{40 \times 10^{-5}}{4/3} = 30 \times 10^{-5} = 0.30$ mm.

33. Angle depends on R.I. (n) and (n) depends on wavelength (λ).

34. When the object is moved farther away from the lens 'v' decreases but remains positive. (Answer C is correct)

35. v = D = 25 cm; u = d = 2.5 cm; $f = \frac{D \times d}{D - d} \approx 2.5$ cm

36. $n_g = 1.2,\ n_w = 1.3;$

$$\frac{f_w}{f_a} = \frac{(n_g - 1)n_w}{(n_g - n_w)} = \frac{0.2 \times 1.3}{-0.1} = -2.6\ ;\ f_w = -2.6 \times 15 = -39 \text{ cm.}$$

37. $A = 60°,\ i = 45°,\ r = 60°$

$$n = \frac{\sin i}{\sin r} = \frac{\sin 45°}{\sin 60°} = \frac{1 \times 2}{\sqrt{2 \times 3}} = \sqrt{\frac{2}{3}}$$

38. $h = r\sqrt{n^2 - 1}\quad \frac{r_2}{r_1} = \frac{h_2}{h_1}\ \therefore\ r_2 = r_1 \cdot \frac{h_2}{h_1} = 11.2 \times \frac{20}{10} = 22.4 \text{ cm}$

39. For forward bias P should be of higher potential and N should be of lower potential.

42. Total energy remains constant at any instant.

43. Fundamental frequency of the given pipe, $f_1 = V / 4l = 412$ Hz.

If length $= l/2$ then frequency of closed pipe,

$f_2 = V / (4l/2) = 2V / 4l = 2 \times 412 = 824$ Hz

Frequency of open pipe when $l = l/2$,

$f_3 = V / (2l/2) = V / l = 4(V / 4l) = 4 \times 412 = 1648$ Hz.

When pipe is in water it behaves as closed pipe.

44. $T = 2\pi\sqrt{\frac{L}{g}}$.

For 'T' to be the same, (L /g) must remain constant; if 'g' decreases by 0.1%, 'L' must be decreased by 0.1%.

45. $\lambda = \frac{v}{f} = \frac{360}{600} = \frac{3}{5} \text{m}$; phase difference $= \pi/3$; $\Delta x = \frac{\lambda}{2\pi} \times \Delta\phi$

The distance between two nearest points is path difference,

$$\Delta x = \left(\frac{\lambda}{2\pi}\right) \times \text{phase difference} = \left(\frac{3/5}{2\pi}\right) \times \frac{\pi}{3} = \frac{1}{10} \text{ m} = 10 \text{ cm.}$$

46. For equal distances with different velocity

$V_{average} = (2V_1V_2)/V_1 + V_2$; $(2 \times 20 \times 30)/50 = 24$ m/s.

47. R is maximum if $\theta = 45°$ and $H = R/4 = 400/4 = 100$ m.

X – coordinate $X = \frac{R_{max}}{2} = 200$ m.

48. Power $= F \times v$; $500 \times 3 = 1500 = 1.5$ kW.

49. F = 0 because all the blocks are moving with constant velocity (a = 0) and hence net force on the blocks is zero.

50. $\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2} \Rightarrow \left(\frac{\frac{1}{4}r_1}{r_1}\right)^{3/2} = \frac{1}{8}$. Hence $T_2 = T_1 / 8$.

51. $y = \frac{F \times L}{A \times \Delta L}\ \therefore\ \Delta L = \frac{F \times L}{A \times y}$ or $\Delta L \propto \frac{L}{A}$

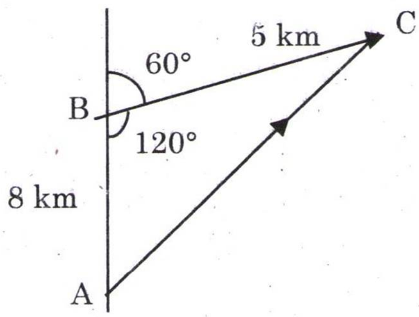
where extension is maximum for option (A).

52. $$\frac{\Delta P}{P} \times 100 = 3\left(\frac{\Delta a}{a} \times 100\right) + 2\left(\frac{\Delta b}{b} \times 100\right) + \left(\frac{\Delta c}{c} \times 100\right) + \left(\frac{\Delta d}{d} \times 100\right)$$

$$= 3 \times 1 + 2 \times 2 + 3 + 4 = 14\%.$$

53. $a = \dfrac{g \sin\theta}{1 + \frac{K^2}{R^2}} = \dfrac{g \cdot x\frac{1}{2}}{1 + 1} = \dfrac{g}{4}\ \because K = R$ for circular ring.

54.



AC = displacement

By triangle of vector addition

$AC = \sqrt{AB^2 + BC^2 + 2AB \times BC \times \cos\theta}$

$AC = \sqrt{64 + 25 - 2 \times 8 \times 5 \times (1/2)} = 11$ km

56. According to the principle of homogeneity, only like-terms can be added.

57. According to Boyle's law, for a given mass of an ideal gas, PV = constant, for any value of volume.

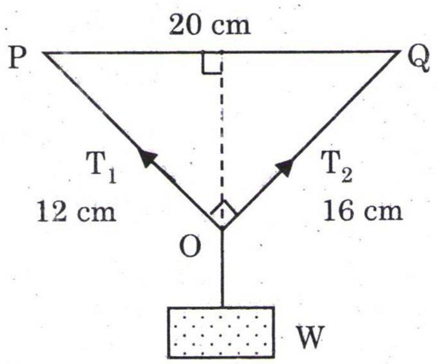
58. Degrees of freedom f = 3 for helium.
Number of moles n = m/M = 1/4; $R = k_B N_a$

$$Q = \frac{f}{2} nR\Delta T = \frac{3}{2} \times \frac{1}{4} k_B N_a (T_2 - T_1).$$

59. $E \propto T^4$ OR $T \propto E^{1/4}$

$$\frac{T_{blackbody}}{T_{sun}} = \left[\frac{E_{blackbody}}{E_{sun}}\right]^{1/4}; \quad \frac{600}{T_{sun}} = \left(\frac{10}{10^5}\right)^{1/4}; \quad T_{sun} = 6000 \text{ K}$$

60. In the right angled triangle OPQ, W is perpendicular to PQ. OP is perpendicular to T_2. OQ is perpendicular to T_1.



$$\frac{T_1}{OQ} = \frac{W}{PQ} = \frac{T_2}{OP} \Rightarrow \frac{T_1}{16} = \frac{W}{20} = \frac{T_2}{12} \quad \therefore T_1 = \frac{4}{5} W \text{ and } T_2 = \frac{3}{5} W$$

$$W = \sqrt{T_1^2 + T_2^2 + 2T_1T_2\cos(90)} = \sqrt{\frac{16}{25}W^2 + \frac{9}{25}W^2} = \sqrt{\frac{25}{25}W^2} = W.$$