PC-2019
PHYSIC

Unless otherwise specified in the question, the following value should be used:

Mechanical equivalent of heat, J = 4.2 J cal^{-1}
Acceleration due to gravity, g = 9.8 m s^{-2}
Absolute zero temperature = – 273 °C
Speed of light in vacuum = 3×10^8 ms^{-1}

The following symbols usually carry meaning as given below:

ε_0 : electric permittivity of free space
μ_0 : magnetic permeability of free space
R : universal gas constant

Category – I (Q.1 to Q. 30)

Category – I : Carry 1 mark each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ¼ mark will be deducted.

1. A point object is placed on the axis of a thin convex lens of focal length 0.05 m at a distance of 0.2 m from the lens and its image is formed on the axis. If the object is now made to oscillate along the axis with a small amplitude of A cm, then what is the amplitude of oscillation of the image?

$$\left[\text{you may assume, } \frac{1}{1+x} \approx 1 - x, \text{ where } x << 1\right]$$

(A) $\frac{4A}{9} \times 10^{-2} m$ (B) $\frac{5A}{9} \times 10^{-2} m$ (C) $\frac{A}{3} \times 10^{-2} m$ (D) $\frac{A}{9} \times 10^{-2} m$

Ans: (D)

2. In Young's experiment for the interference of light, the separation between the slits is d and the distance of the screen from the slits is D. If D is increased by 0.5% and d is decreased by 0.3%, then for the light of a given wavelength, which one of the following is true?

"The fringe width......."

(A) increases by 0.8% (B) decreases by 0.8%
(C) increases by 0.2% (D) decreases by 0.2%

Ans: (A)

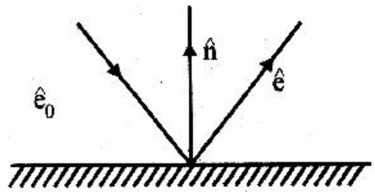
3. When the frequency of the light used is changed form $4 \times 10^{14} s^{-1}$ to $5 \times 10^{14} s^{-1}$, the angular width of the principal (central) maximum in a single slit Fraunhoffer diffraction pattern changes by 0.6 radian. What is the width of the slit (assume that the experiment is performed in vacuum)?

(A) 1.5×10^{-7} m (B) 3×10^{-7} m (C) 5×10^{-7} m (D) 6×10^{-7}m

Ans: (C)

4. A ray of light is reflected by a plane mirror. $\hat{e}_0$, $\hat{e}$ and $\hat{n}$ be the unit vectors along the incident ray, reflected ray and the normal to the reflecting surface respectively.

Which of the following gives an expression for $\hat{e}$?



(A) $\hat{e}_0 + 2(\hat{e}_0.\hat{n})\hat{n}$ (B) $\hat{e}_0 - 2(\hat{e}_0.\hat{n})\hat{n}$ (C) $\hat{e}_0 - (\hat{e}_0.\hat{n})\hat{n}$ (D) $\hat{e}_0 + (\hat{e}_0.\hat{n})\hat{n}$

Ans: (A)

5. A parent uncleus X undergoes α-decay with a half-life of 75000 years. The daughter nucleus Y undergoes β-decay with a half-life of 9 months. In a particular sample, it is found that the rate of emission of β-particles is nearly constant (over several months) at 10^7/hour. What will be the number of α-particles emitted in an hour?

(A) 10^2 (B) 10^7 (C) 10^{12} (D) 10^{14}

Ans: (B)

6. A proton and an electron initially at rest are accelerated by the same potential difference. Assuming that a proton is 2000 times heavier than an electron, what will be the relation between the de Broglie wavelength of the proton (λ_p) and that of electron (λ_e)?

(A) $\lambda_p = 2000\lambda_e$ (B) $\lambda_p = \frac{\lambda_e}{2000}$ (C) $\lambda_p = 20\sqrt{5}\lambda_e$ (D) $\lambda_p = \frac{\lambda_e}{20\sqrt{5}}$

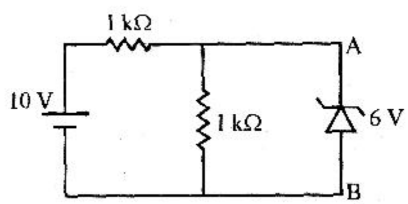
Ans: (D)

7. Two which of the following the angular velocity of the electron in the n-th Bohr orbit is proportional?

(A) n_2 (B) $\frac{1}{n^2}$ (C) $\frac{1}{n^{3/2}}$ (D) $\frac{1}{n^3}$

Ans: (D)

8. In the circuit shown, what will be the current through the 6V zener?



(A) 6 mA, from A to B (B) 2 mA, from A to B

(C) 2 mA, from B to A (C) Zero

Ans: (D)

9. Each of the two inputs A and B can assume value either 0 or 1. Then which of the following will be equal to $\bar{A}\cdot\bar{B}$?

(A) A + B (B) $\overline{A+B}$

(C) $\overline{A\cdot B}$ (D) $\bar{A}+\bar{B}$

Ans: (B)

10. The correct dimensional formula for impulse is given by

(A) ML^2T^{-2} (B) MLT^{-1} (C) ML^2T^{-1} (D) MLT^{-2}

Ans: (B)

11. The density of the material of a cube can be estimated by measuring its mass and the length of one of its sides. If the maximum error in the measurement of mass and length 0.3% and 0.2% respectively, the maximum error in the estimation of the density of the cube is approximately

(A) 1.1% (B) 0.5% (C) 0.9% (D) 0.7%

Ans: (C)

12. Two weights of the mass m_1 and m_2 ($> m_1$) are joined by an inextensible string of negligible mass passing over a fixed frictionless pulley. The magnitude of the acceleration of the loades is

(A) g (B) $\frac{m_2-m_1}{m_2}g$ (C) $\frac{m_1}{m_2+m_1}g$ (D) $\frac{m_2-m_1}{m_2+m_1}g$

Ans: (D)

13. A body starts from rest, under the action of an engine working at a constant power and moves along a straight line. The displacement S is given as a function of time (t) as

(A) $S = at + bt^2$, a, b are constants

(B) $S = bt^2$, b is a constant

(C) $S = a\,t^{3/2}$, a is a constant

(D) $S = at$, a is a constant

Ans: (C)

14. Two particles are simultaneously projected in the horizontal direction from a point P at a certain height. The initial velocities of the particles are oppositely directed to each other and have magnitude v each. The separation between the particles at a time when their position vectors (drawn form the point P) are mutually perpendicular, is

(A) $\frac{v^2}{2g}$ (B) $\frac{v^2}{g}$ (C) $\frac{4v^2}{g}$ (D) $\frac{2v^2}{g}$

Ans: (C)

15. Assume that the earth moves around the sun in a circular orbit of radius R and there exists a planet which also moves around the sun in a circular orbit with an angular speed twice as large as that of the earth. The radius of the orbit of the planet is

(A) $2^{-2/3}R$ (B) $2^{2/3}R$ (C) $2^{-1/3}R$ (D) $\frac{R}{\sqrt{2}}$

Ans: (A)

16. A compressive force is applied to a uniform rod of rectangular cross-section so that its length decreases by 1%. If the Poisson's ratio for the material of the rod be 0.2, which of the following statements is correct?

"The volume approximately ...."

(A) decreases by 1% (B) decreases by 0.8%

(C) decreases by 0.6% (D) increases by 0.2%

Ans: (C)

17. A small spherical body of radius r and density ρ moves with the terminal velocity v in a fluid of coefficient of viscosity η and density σ. What will be the net force on the body?

(A) $\frac{4\pi}{3}r^3(\rho-\sigma)g$ (B) $6\pi\eta rv$

(C) Zero (D) Infinity

Ans: (C)

18. Two black bodies A and B have equal surface areas and are maintained at temperatures 27°C and 177° C respectively. What will be the ratio of the thermal energy radiated per second by A to that by B?

(A) 4:9 (B) 2:3 (C) 16:81 (D) 27:177

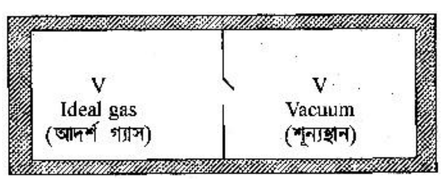
Ans: (C)

19. What will be the molar specific heat at constant volume of an ideal gas consisting of rigid diatomic molecules?

(A) $\frac{3}{2}R$ (C) $\frac{5}{2}R$ (C) R (D) 3R

Ans: (B)

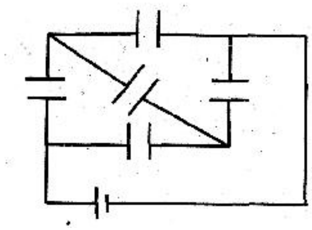
20. Consider the given diagram. An ideal gas is contained in a chamber (left) of volume V and is at an absolute temperature T. It is allowed to rush freely into the right chamber of volume V which is initially vacuum. The whole system is thermally isolated. Waht will be the final temperature of the system after the equilibrium has been attained?



(A) T (B) $\frac{T}{2}$ (C) 2T (D) $\frac{T}{4}$

Ans: (A)

21. Five identical capacitors, of capacitance $20\ \mu F$ each, are connected to a battery of 150V, in a combinbation as shown in the diagram.What is the total amount of charge stored?



(A) $15 \times 10^{-3}C$ (B) $12 \times 10^{-3}C$ (C) $10 \times 10^{-3}C$ (D) $3 \times 10^{-3}C$

Ans: (D)

22. Elevan equal point chartges , all ofthe, having a charge +Q, are placed at all the hour positions of a cirtcular clock of radius r, except at the 10hour positiom. What is the electric field strength at ther centre of the clock?

(A) $\frac{Q}{4®£_o r^2}$ from the centre towards the mark 10

(B) $\frac{Q}{4®£_o r^2}$ from the mark 10 towards centre

(C) $\frac{Q}{4®£_o r^2}$ from the centre towards the mark 6

(D) Zero

Ans: (A)

23. A negative charge is placed at the midpoint between two fixed equal positive charges, separated by distance 2d. If the negative charge is given a small displancement $x\ (x << d)$ perpendicular to the line joining the positive charges, how that force (F) developed on it will apporoximately depend on x?

(A) $F \propto x$ (B) $F \propto \frac{1}{x}$ (C) $F \propto x^2$ (D) $F \propto \frac{1}{x^2}$

Ans: (A)

24. To which of the following, the radius of the circular path of a charged particle moving at right angles to a uniform magnetic field is directly proportional ?

(A) energy of the particle. (B) magnetic field.

(C) charge of the particle. (D) momentum of the particle.

Ans: (D)

25. An electric current ‘I’ enters and leaves a uniform circular wire of radius r through diametrically opposite point. A particle carrying a charge q moves along the axis of the circular wire with speed v. What is the magnetic force experienced by the particle when it passes through the centre of the circle ?

(A) $qv\frac{«_0 i}{a}$ (B) $qv\frac{«_0 i}{2a}$ (C) $qv\frac{«_0 i}{2\pi a}$ (D) Zero

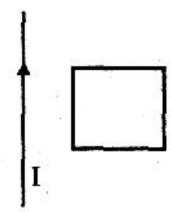
Ans: (D)

26. A current 'I' is flowing along an infinite, straight wire, in the positive Z-direction and the same current is flowing along a similar parallel wire 5 m apart, in the negative Z-direction. A point P is at a perpendicualr distance 3 m from the first wire and 4 m from the second. What will be magnitude of the magnetic field $\vec{B}$ at P?

(A) $\frac{5}{12}(\mu_0 I)$ (B) $\frac{5}{24}(\mu_0 I)$ (C) $\frac{5}{24}(\mu_0 I)$ (D) $\frac{25}{288}(\mu_0 I)$

Ans: $\frac{5\mu_0 I}{24\text{®}}$ **(No option Matching)**

27. A square conducting loop is placed near an infinitely long current carring wire with one edge parallel to the wire as shown in the figure. If the current in the straight wire is suddenly halved, which of the following statements will be true ?



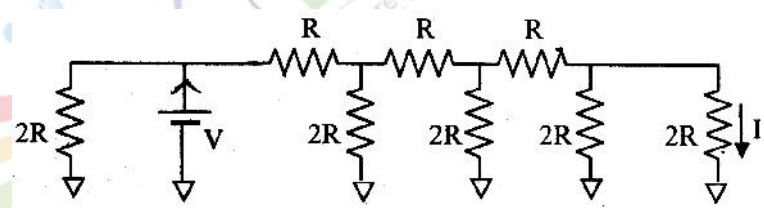
"The loop will ...."

(A) stay stationary. (B) move towards the wire.

(C) move away from the wire. (D) move parallel to the wire.

Ans: (B)

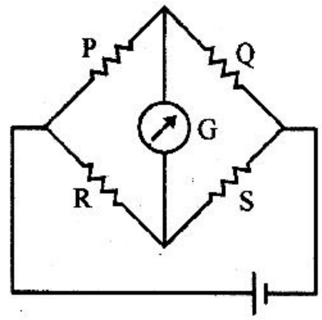
28. What is the current I shown in the given circuit?



(A) $\frac{V}{2R}$ (B) $\frac{V}{R}$ (C) $\frac{V}{16R}$ (D) $\frac{V}{8R}$

Ans: (C)

29. When the value of R in the balanced Wheatstone bridge, shown in the figure, is increased from 5 Ω to 7 Ω, the value of s has to be increased by 3 Ω in order to maintain the balance. what is the initial value of S?



(A) 2.5 Ω (B) 3 Ω (C) 5 Ω (D) 7.5 Ω

Ans: (D)

30. When a 60 mH inductor and a resistor are connected in series with an AC voltage source, the voltage leads the current by 60°. If the inductor is replaced by a 0.5 μF capacitor, the voltage lages behind the current by 30°. What is the frequency of the AC supply?

(A) $\frac{1}{2\pi}\times10^4\,Hz$ (B) $\frac{1}{\pi}\times10^4\,Hz$ (C) $\frac{3}{2\pi}\times10^4\,Hz$ (D) $\frac{1}{2\pi}\times10^8\,Hz$

Ans: (A)

Category – II (Q. 31 to Q. 35)

Carry 2 marks each and only one option is correct. In case of incorect answer or any combination of more than one answer, ½ mark will be deducted.

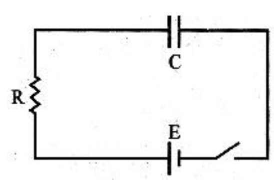
31. A parallel plate capacitor in series with a resistance of 100 Ω, an inductor of 20 mH and an AC voltage source of variable frequency shows resonance at a frequency of $\frac{1250}{\pi}\,Hz$.

If this capacitor is charged by a DC voltage source to a voltage 25 V, what amount of charge will be stored in each plate of the capacitor?

(A) 0.2 μC (B) 2mC (C) 0.2 mC (D) 0.2 C

Ans: (C)

32. A capacitor of capacitance C is connected in series with a resistance R and DC source of emf E through a key. The capacitor starts charging when the key is closed. By the time the capacitor has been fully charged, what amount of energy is dissipated in the resistance R?



(A) $\frac{1}{2}CE^2$ (B) 0

(C) CE^2 (D) $\frac{E^2}{R}$

Ans: (A)

33. A horizontal fire hose with a nozzle of cross-sectional area $\frac{5}{\sqrt{21}}\times10^{-3}\,m^2$ delivers a cubic metre of water in 10s. What will be the maximum possible increase in the temperature of water while it hits a rigid wall (neglecting the effect of gravity)?

(A) 1°C (B) 0.1°C (C) 10°C (D) 0.01°C

Ans: (A)

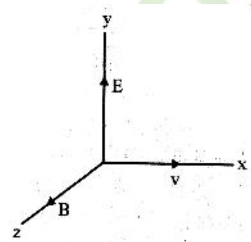
34. Two identical blocks of ice move in opposite directions with equal speed and collide with each other. What will be the minimum speed required to make both the block melt completely, if the initial temperatures of the blocks were –8°C each?

(Specific heat of ice is 2100 $Jkg^{-1}\,K^{-1}$ and Latent heat of fusion of ice is $3.36\times10^5\,Jkg^{-1}$)

(A) 840 ms^{-1} (B) 420 ms^{-1} (C) 8.4 ms^{-1} (D) 84 ms^{-1}

Ans: (A)

35. A particle with charge q moves with a velocity v in a direction perpendicular to the directions of uniform electric and magnetic fields, E and B respectively, which are mutually perpendicular to each other. Which one of the following gives the condition for which the particle moves undeflected in its original trajectory?



(A) $v=\frac{E}{B}$ (B) $v=\frac{B}{E}$ (C) $v=\sqrt{\frac{E}{B}}$ (D) $v=q\frac{B}{E}$

Ans: (A)

Catagory – III (Q. 36 to Q. 40)

Carry 2 marks each and one or more option(s) is/are correct. If all correct answers are not marked and also no incorrect answer is marked then secore = 2×number of correct answers marked ÷ actual number of correct answers. If any wrong option is marked or if any combination including a wrong option is marked, the answer will be considered wrong, but there is no negative marking for the same and zero mark will be awarded.

36. A metallic loop is placed in a uniform magnetic field $\vec{B}$ with the plane of the loop perpendicular to $\vec{B}$. Under which condition (s) given below an emf will be induced in the loop?

"If the loop is ...."

(A) moved along the direction of $\vec{B}$ (B) squeezed to a smaller area.

(C) rotated about its axis (D) roated about one of its diameters.

Ans: (B) & (D)

37. Electrons are emitted with kinetic energy T from a metal plate by an irradiation of light of intensity J and frequency v. Then which of the following will be true?

(A) T α J
(B) T linerarly increasing with v
(C) T α time of irradiation
(D) Number of electrons emitted α J

Ans: (B) & (D)

38. The initial pressure and volume of a given mass of an ideal gas $(\text{with } \frac{C_p}{C_v} = \gamma)$, taken in a cylinder fitted with a piston, are P_0 and V_0 respectively. At this stage the gas has the same temperature as that of surrounding medium which is T_0. It is adiabatically compressed to a volume equal to $\frac{V_0}{2}$. Subsequently the gas is allowed to come to thermal equilibrium with the surroundings. What is the heat released to the surroundings?

(A) 0
(B) $(2^{\gamma-1}-1)\frac{P_0V_0}{\gamma-1}$
(C) $\gamma P_0V_0 \ln 2$
(D) $\frac{P_0V_0}{2(\gamma-1)}$

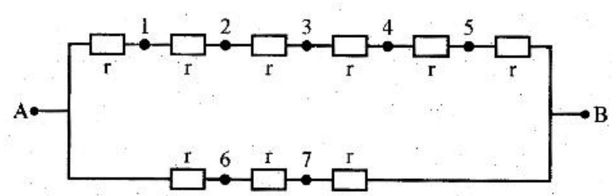
Ans: (B)

39. A projectile thrown with an intial velocity of 10 ms^{-1} at an angle α with the horizontal, has a range of 5m. Taking g = 10 ms^{-2} and neglecting air resistance, wht will be the estimated value of α?

(A) 15°
(B) 30°
(C) 45°
(D) 75°

Ans: (A) (D)

40. In the circuit shown in the figure all the resistances are identical and each has the value r Ω. The equivalent resistance of the combination between the points a and B will remain unchanged even when the following pairs of point marked in the figure are connected through a resistance R.



(A) 2 and 6
(B) 3 and 6
(C) 4 and 7
(D) 4 and 6

Ans: (A) (C)