AIEEE- 2012 Physics

PART A - PHYSICS

1. Two electric bulbs marked 25 W – 220 V and 100 W – 220 V are connected in series to a 440 V supply.
(1) 100 W (2) 25 W (3) neither (4) both

1. **(2)** $R_1 = \frac{(220)^2}{25}$ $R_2 = \frac{(220)^2}{100}$ $i = \frac{440}{(220)^2\left(\frac{1}{25}+\frac{1}{100}\right)} = \frac{2}{220}.\frac{100}{5} = \frac{2}{11}A$

$\therefore$ $P_1 = \left(\frac{2}{11}\right)^2.\frac{(220)^2}{25} = 64\ W > 25\ W$ $P_2 = \left(\frac{2}{11}\right)^2.\frac{(220)^2}{100} = 16W$

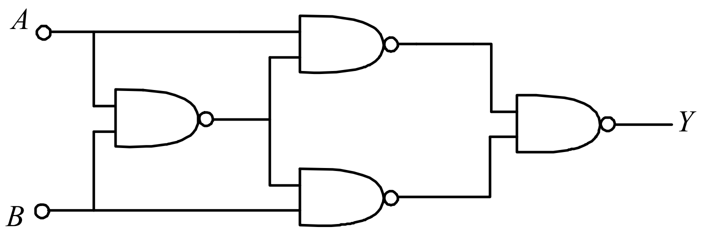
$\therefore$ Bulb of 25 W – 220 V will fuse.

2. A boy can throw a stone up to a maximum height of 10 m. The maximum horizontal distance that the boy can throw the same stone up to will be :
(1) 10 m (2) $10\sqrt{2}$ m (3) 20 m (4) $20\sqrt{2}$ m

2. **(3)** $u^2 = 2.10\,.10$ $\Rightarrow u = 10\sqrt{2}$

$\therefore$ $R = \frac{u^2 \sin(2\times 45^\circ)}{g} = \frac{100\times 2}{10} = 20\text{m}$

3. Truth table for system of four NAND gates as shown in figure is :



(1)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

(2)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(3)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(4)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

3. **(3)** $Y = \overline{\overline{\{\overline{A}.(A+B)\}} + \overline{\{\overline{B}.(A+B)\}}} = A.B + \overline{A}.\overline{B}$

A	B	$\overline{A}$	$\overline{B}$	Y
0	0	1	1	1
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1

4. This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.
Statement – 1 : Davisson – Germer experiment established the wave nature of electrons.
Statement – 2 : If electrons have wave nature, they can interfere and show diffraction.
(1) Statement 1 is true, Statement 2 is false.
(2) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation for Statement 1.
(3) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.
(4) Statement 1 is false, Statement 2 is true.

4. **(2)** C. J. Davisson and L. H. Germer tested the wave nature of electron. If it is wave then it should show diffraction and interference.

5. In Young's double slit experiment, one of the slit is wider than other, so that the amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I wahen they interefere at phase difference ϕ is given by:

(1) $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$ (2) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$

(3) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$ (3) $\frac{I_m}{9}(4+5\cos\phi)$

5. **(2)** $I \propto A^2$, $I_1 = I_0$, $I_2 = 4I_0$
$I = I_0 + 4I_0 + 2.\sqrt{I_0}\ \sqrt{(4I_0)}\cos\phi$
$= I_0[1 + 4\cos^2(\phi/2)]$ $= (I_m/5)[1 + 4\cos^2(\phi/2)]$

6. If a simple pendulum has significant amplitude (up to a factor of 1/e of original) only in the period between t = 0s to $t = \tau$s, then τ may be called the average life of the pendulum. When the spherical bob of the pendulum suffers a retardation (due to viscous drag) proportional to its velocity, with 'b' as the constant of proportionality, the average life time of the pendulum is (assuming damping is small) in seconds:
(1) b (2) $(1/b)$ (3) $(2/b)$ (4) $(0.693/b)$

6. **(2)** $m(dv/dt) = -Kx - bv$, $\Rightarrow A = A_0 e^{-bt}$ ...(1)
In case of damping.
Given, $A = A_0 e^{-t/\tau}$ ...(2)
Comparing (1) & (2)
Average Life = $(1/b)$

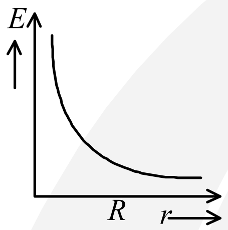
7. This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.
If two springs S_1 and S_2 of force constants k_1 and k_2, respectively, are streched by the same force, it is found that more work is done on spring S_1 and on spring S_2.
Statement – 1 : If stretched by the same amount, work done on S_1, will be more than that on S_2.
Statement – 2 : $k_1 < k_2$.
(1) Statement 1 is true, Statement 2 is false.
(2) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation for Statement 1.
(3) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.
(4) Statement 1 is false, Statement 2 is true.

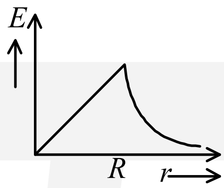
7. **(4)** $x_1 = (F/K_1)$, $x_2 = (F/K_2)$ $W_1 = (1/2)K_1x_1^2 = (F^2/2K_1)$
$W_2 = [F^2/2K_2]$
$\Rightarrow$ Statement - 1 :- $W_1 = (1/2)K_1x^2$
$W_2 = (1/2)K_2x^2$ (False)
Statement - 2 : - True $\because$ $W_1 > W_2$ $\Rightarrow K_1 < K_2$

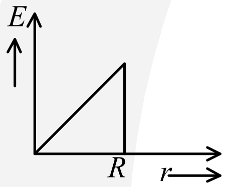
8. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object be shifted to be in sharp focus on film?
(1) 2.4 m (2) 3.2 m (3) 5.6 m (4) 7.2 m

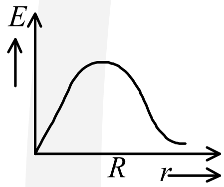
8. **(3)** $\Delta t = [1 - (1/15)] \times 1 = (1/3)$ cm $(1/v) - (1/u) = (1/f) \Rightarrow (1/12) - (1/-240) = (1/f)$
$\Rightarrow f = (240/21)$ cm Again $(1/v) - (1/u) = (1/f)$ $\Rightarrow (3/35) - (1/-u) = (21/240)$
$(1/u) = (3/35) - (21/240)$
$u = [(35 \times 240)/(3 \times 240 - 21 \times 35)] = [8400/(720 - 735)] = (8400/-15)$
$= -560$ cm $= -5.6$ m.

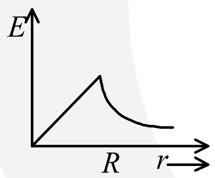
9. In a uniformly chared sphere of total charge Q and radius R, the electric field E is plotted as a function of distance from the centre. The graph which would correspond to the above will be:

(1) 

(2) 

(3) 

(4) 

9. **(2)** 

$E = (KQr/R^3)$ $(r \le R)$
$E = (KQ/r^2)$ $(r \ge R)$

10. A coil is suspended in a uniform magnetic field, with the plane of the coil parallel to the magnetic lines of force. When a current is passed through the coil it starts oscillating; it is very difficult to stop. But if an aluminium plate is placed near to the coil, it stops. This is due to:
(1) Induction of electrical charge on the plate.
(2) Shielding of magnetic lines of force as aluminium is a paramagnetic material.
(3) Electromagnetic induction in the aluminium plate giving rise to electromagnetic damping.
(4) Development of air current when the plate is placed.

10. **(3)** According to Lenz's Law, eddy current is developed on plate.

11. A spectrometer gives the following reading when used to measure the angle of prism.

Main scale read : 58.5 degree

Vernier scale reading : 09 divisions

Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data :

(1) 58.77 degree (2) 58.65 degree (3) 59 degree (4) 58.59 degree

11. **(2)** $1VSD = \frac{29 \times 0.5°}{30}$, 1 MSD = 0.5°

L.C. = 1 MSD – 1 VSD = (0.5° / 30) = (1 / 60)°

$\therefore$ reading MSR + n × L.C = [58.5 + (9 ×1 / 60)] = 58.65

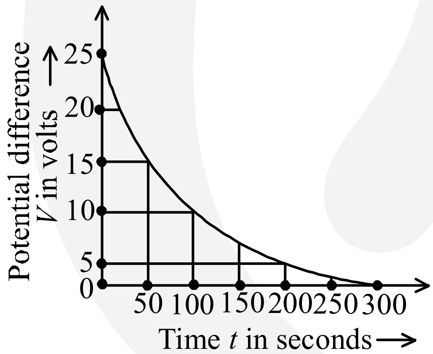
12. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r. If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization, its energy will be given by: (n is an integer)

(1) $\frac{n^2h^2}{2(m_1+m_2)r^2}$ (2) $\frac{2n^2h^2}{(m_1+m_2)r^2}$ (3) $\frac{(m_1+m_2)n^2h^2}{2m_1m_2r^2}$ (4) $\frac{(m_1+m_2)^2n^2h^2}{2m_1^2m_2^2r^2}$

12. **(3)** $E = (1/2)\,\mu r^2 . \omega^2$ ..... (1)

and $L = \mu\omega r^2 = nh$ ..... (2) where $\mu = [m_1m_2 / (m_1+m_2)]$

using (1) & (2) $E = \frac{(m_1+m_2)n^2h^2}{2m_1m_2r^2}$ where $\boldsymbol{h}$ stands for ($\boldsymbol{h}$ **/ 2**π)

13. 

The figure shows an experimental plot for discharging of a capacitor in an R–C circuit. The time constant τ of this circuit lies between :

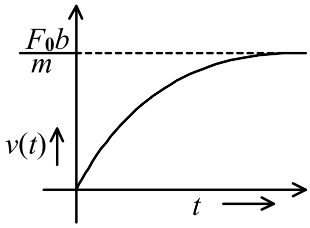
(1) 0 and 50 sec (2) 50 sec and 100 sec

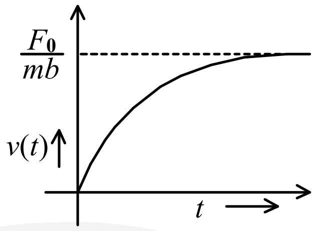
(3) 100 sec and 150 sec (4) 150 sec and 200 sec

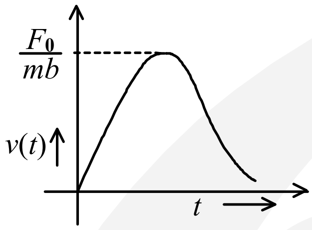
13. **(3)** $V = V_0e^{-t/\tau} = 25\,e^{-t/\tau}$ for $v = 12.5$, $t = 75$

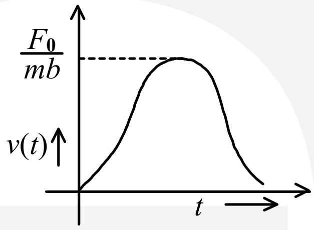
$\Rightarrow (t/\tau) = \ln 2 \quad \Rightarrow t = (t/\ln 2) = (75/0.693) \approx 110$

14. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves ?

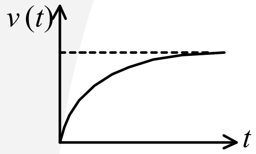
(1) 

(2) 

(3) 

(4) 

14. **(2)** $a(t) = [F(t) / m] = [F_0 / m)\, e^{-bt}$
$\Rightarrow \quad V(t) = V_0 + \int_0^t a(t)\, dt \;=\; (F_0 / m) \int_0^t e^{-bt} = (F_0 / mb)\,(1 - e^{-bt})$
where F_0 / mb is the peak value.



15. Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2, respecitively. Their speeds are such that they make complete circles in the same time t. The ratio of their centripetal acceleration is
(1) $m_1 : m_2$ (2) $r_1 : r_2$ (3) 1 : 1 (4) $m_1 r_1 : m_2 r_2$

15. **(2)** $(a_1 / a_2) = (\omega^2 r_1 / \omega^2 r_2)$
$\because \quad \omega = (2\pi / t)$ (same for both)

16. A radar has a power of 1 kW and is operating at a fequency of 10 GHz. It is located on a mountain top of height 500 m. The maximum distance upto which it can detect object located on the surface of the earth (Radius of earth = 6.4×10^6 m) is:
(1) 16 km (2) 40 km (3) 64 km (4) 80 km

16. **(4)** $OA = \sqrt{(OO_1)^2 - (O_1A)^2}$
$= \sqrt{(R+h)^2 - R^2}$
$= 8 \times 10^4$ m = 80 km

17. Assume that neutron breaks into a proton and an electron. The energy released during this process is:
(Mass of neutron = 1.6725×10^{-27} kg
Mass of proton = 1.6725×10^{-27} kg
Mass of electron = 9×10^{-31} kg)
(1) 7.10 MeV (2) 6.30 MeV (3) 5.4 MeV (4) 0.73 MeV

17. **(No Option is correct)**
From data $m_n = m_p$. So reaction $\boldsymbol{n \to p + e}$ is not possible without energy input.

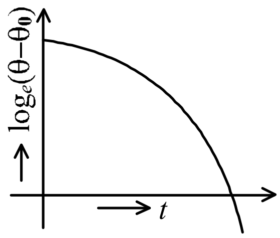
18. This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.
An insulating solid sphere of radius R has a uniformly positive charge density ρ. As a result of this uniform charge distribution there is a finite value of electric potential at the centre of the sphere, at the surface of the sphere and also at a point out side the sphere. The electric potential at infinity is zero.
Statement – 1 : When a charge 'q' is taken from the centre to the surface of the sphere, its potential energy charges by $(q\rho / 3\varepsilon_0)$.
Statement – 2 : The electric field at a distance r ($r < R$) from the centre of the sphere is $(qr / 3\varepsilon_0)$.
(1) Statement 1 is true, Statement 2 is false.
(2) Statement 1 is false, Statement 2 is true.
(3) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation for Statement 1.
(4) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

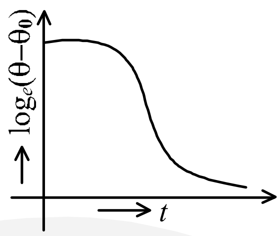
18. **(2)** $\Delta V = (q\rho / 3\varepsilon_0)$ (dimensionally wrong)

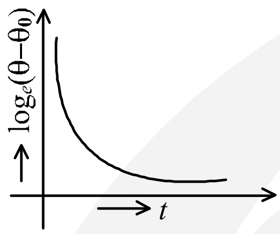
from gauss therom $E\,(4\,\pi r') = \dfrac{\rho(\frac{4}{3}\pi r^3)}{\varepsilon_0}$

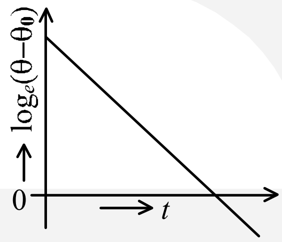
$$\Rightarrow \quad E = (\rho r / 3\varepsilon_0)$$

19. A liquid in a breaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between loge$(\theta - \theta_0)$ and t is:

(1) 

(2) 

(3) 

(4) 

19. **(4)** $-(d\theta / dt) = k(\theta - \theta_0)$

$$\Rightarrow \quad \int \frac{d\theta}{\theta - \theta_0} = \int - kdt$$

$$\Rightarrow \quad \log_e (\theta - \theta_0) = -kt + C$$

20. Resistance of given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is:
(1) Zero (2) 1% (3) 3% (4) 6%

20. **(4)** $R = (V / I) \Rightarrow (dR / R) = [(dV / V) + (dI / I)] = (3 + 3)\% = 6\%$

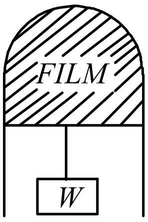
21. The mass of a spaceship is 100 kg. It is to be launched from the earth's surface out into free space. The value of 'g' and 'R' (radius of earth) are 10 ms^{-2} and 6400 km respectively. The required energy for this work will be:
(1) 6.4×10^{8} Joules (2) 6.4×10^{9} Joules
(3) 6.4×10^{10} Joules (4) 6.4×10^{11} Joules

21. **(3)** $E = mgR = 6.4 \times 10^{10}$ Joules

22. A cylindrical tube, open at both ends, has a fundamental frequency, f, in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air-column is now
(1) $(f/2)$ (2) $(3f/4)$ (3) $2f$ (4) f

22. **(4)** Tube open at both ends : $(\lambda / 2) = L$, $\lambda = 2L = (C / f)$
Tube portion dipped in water : $(\lambda' / 4) = L / 2$, $\lambda' = 2L = (C / f')$
$\therefore \quad f' = f$

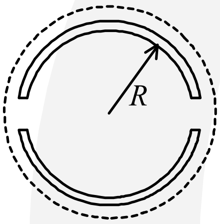
23. A thin liquid film formed between *U*–shaped wire and a light slide supports a weight of 1.5×10^{-2} N (see figure). The length of the slider is 30 cm and its weight negligible. The surface tension of the liquid film is:



(1) $0.1\ \text{Nm}^{-1}$ (2) $0.05\ \text{Nm}^{-1}$ (3) $0.025\ \text{Nm}^{-1}$ (4) $0.0125\ \text{Nm}^{-1}$

23. **(3)** $2.S.L = W$
$S = (W/2L) = [(1.5 \times 10^{-2}\text{N}) / (2 \times 0.3\ \text{m})] = 0.025\ \text{Nm}^{-1}$

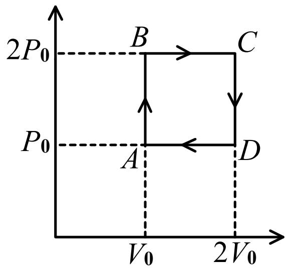
24. A wooden wheel of radius *R* is made of two semicircular parts (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area *S* and length *L*. *L* is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α, and its Youngs' modulus is *Y*, the force that one part of the wheel applies on the other part is:



(1) $SY\alpha\Delta T$ (2) $\pi\ SY\alpha\Delta T$ (3) $2SY\alpha\Delta T$ (4) $2\ \pi\ SY\alpha\Delta T$

24. **(1)** Thermal stress = $Y\,.\,(\Delta L / L) = Y\,\alpha\,\Delta\theta$
Force = $Y\alpha\Delta\theta\ .\ S$

25. Helium gas goes through a cycle *ABCDA* (consisting of two isochoric and two isobaric lines) as shown in figure. Efficiency of this cycle is nearly:
(Assume the gas to be close to ideal gas)



(1) 9.1% (2) 10.5% (3) 12.5% (4) 15.4%

25. **(4)** efficiency, $\eta = (\Delta W / \Delta Q_{+ve})$
$= [\text{Area under pv–diagram} / (\Delta Q_{AB} + \Delta Q_{BC})]$

$$\eta = \frac{P_0V_0}{\frac{3}{2}nR(T_B - T_A) + 4P_0V_0} = \frac{P_0V_0}{\frac{3}{2}P_0V + 4P_0V_0}$$

$= (1 / 6.5) \approx 15.4\%$

26. Hydrogen atom is excited from ground state to another state with principal quantum number equal to 4. Then the number of spectral lines in the emission spectra will be:
(1) 3 (2) 5 (3) 6 (4) 2

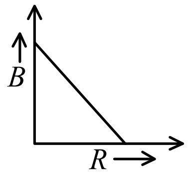
26. **(3)** No. of spectral line in emission spectra = $[n(n-1)/2] = 6$

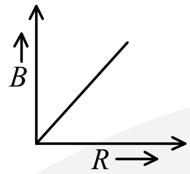
27. Proton, Deuteron and alpha particle of the same kinetic energy are moving in circular trajectories in a constant magnetic field. The radii of proton, deuteron and alpha particle are respectively r_p, r_d and r_α. Which one of the following relations is correct ?
(1) $r_\alpha = r_p < r_d$ (2) $r_\alpha > r_d > r_p$ (3) $r_\alpha = r_d > r_p$ (4) $r_\alpha = r_p = r_d$

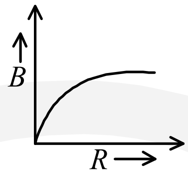
27. **(1)** $r = (mv / qB) = \dfrac{\sqrt{2km}}{qB}$

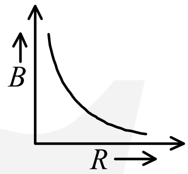
$\therefore \quad r \propto (\sqrt{m} / q)$
$m_\alpha = 4\, m_p \qquad q_\alpha = 2\, q_p$
$m_d = 2\, m_p \qquad q_d = q_p$
$\Rightarrow \quad r_\alpha = r_p < r_d$

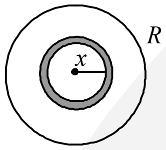
28. A charge Q is uniformly distributed over the surface of non-conducting disc of radius R. The disc rotates about an axis perpendicular to its plane and passing through its centre with an angular velocity ω. As a result of this rotatioin a magnetic field of induction B is obtained at the centre of the disc. If we keep both the amount of charge placed on the disc and its angular velocity to be constant and vary the radius of the disc then the variation of the magnetic induction at the centre of the disc will be represented by the figure.

(1) 

(2) 

(3) 

(4) 

28. **(4)** 

$$B = \int_0^R \frac{\mu_0}{2x} \cdot \frac{\frac{Q}{\pi R^2} . 2\pi x dx}{T} \quad = \quad \frac{\mu_0 Q}{R^2} \cdot \frac{R}{T} = \frac{\mu_0 Q}{RT} \quad = \quad \frac{\mu_0 Q \omega}{2\pi R}$$

29. An electromagnetic wave in vacuum has the electric and magnetic field $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarizatioin is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then :

(1) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$ (2) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

(3) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$ (4) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

29. **(1)** e.m. wave are polarized along $\vec{E}$ – vector
and, wave velocity is along $\vec{E} \times \vec{B}$ vector.

30. A Carnot engine, whose efficiency is 40%, takes in heat from a source maintained at a temperature of 500 K. It is desired to have an engine of efficiency 60%. Then, the intake temperature for the same exhaust (sink) temperature must be :
(1) 1200 K
(2) 750 K
(3) 600 K
(4) Efficiency of Carnot engine cannot be made larger than 50%

30. **(2)** $\eta = [1 - (T_{sink} / T_{source})]$
$\therefore \quad 0.4 = [1 - (T_{sink} / 500)] \quad \Rightarrow \quad T_{sink} = 300\ k$
Also, $0.6 = [1 - (300 / T_{source})] \quad \Rightarrow \quad T_{source} = 750\ k$