QUESTIONS & SOLUTIONS OF

AIPMT 2012 (MAINS)

Date : 13-05-2012 | **Duration : 3 Hours** | **Max. Marks : 480**

IMPORTANT INSTRUCTIONS

1. The Answer Sheet is inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars on **Side-1** and **Side-2** carefully with **blue/black** ball point pen only.
2. The test is of **3 hours** duration and Test Booklet contains 120 questions. Each question carries 4 marks. For each correct response, the candidate will get **4 marks**. For each incorrect response, **one mark** will be deducted from the total scores. The maximum marks are **480**.
3. Use **Blue/Black Ball Point Pen** only for writing particulars on this page/marking responses.
4. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
5. **On completion of the test, the candidate must havdover the Answer Sheet to the invigilator in the Room/Hall. The candidates are allowed to take away this Test Booklet with them.**
6. The CODE for this Booklet is A. Make sure that the CODE printed on **Side-2** of the Answer Sheet is the same as that on this Booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklets and the Answer Sheets.
7. The Candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your roll no. anywhere else except in the specified space in the Test Booklet/Answer Sheet.
8. Use of white fluid for correction is **NOT** permissible on the Answer Sheet.

Name of the Candidate (in Capitals): ____________________

Roll Number : in figures ____________________

Centre of Examination (in Capitals) : ____________________

Candidate's Signature: ____________________ Invigilator's Signature: ____________________

Fascimile signature stamp of
Centre Superintendent : ____________________

PART - A (PHYSICS)

1. The dimensions of $(\mu_0 \varepsilon_0)^{-1/2}$ are :

(1) $[L^{1/2}T^{-1/2}]$ (2) $[L^{-1}T]$ (3) $[LT^{-1}]$ (4) $[L^{1/2}T^{1/2}]$

Ans. (3)

Sol. $(\mu_0 \varepsilon_0)^{-1/2} = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$ = C : speed of light

So dimension LT^{-1}

2. A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by :

(1) 68% (2) 41% (3) 200% (4) 100%

Ans. (2)

Sol. When stone hits the ground momentum $P = m\sqrt{2gh}$

when some stone dropped from 2h (100% of initial) then momentum $P' = m\sqrt{2g(2h)} = \sqrt{2}P$

Which is is changed by 41% of initial.

3. A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by :

(1) $\sqrt{\mu_S mRg}$ (2) $\sqrt{Rg / \mu_S}$ (3) $\sqrt{mRg / \mu_S}$ (4) $\sqrt{\mu_S Rg}$

Ans. (4)

Sol. For smooth driving maximum speed of car v then

$$\frac{mv^2}{R} = \mu_s mg$$

$$v = \sqrt{\mu_S Rg}$$

4. A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to :

(1) t^2P_0 (2) $t^{1/2}$ (3) $t^{-1/2}$ (4) $\frac{t}{\sqrt{m}}$

Ans. (2)

Sol. Constant power of car P_0 = F.V. = ma.v

$$P_0 = m\frac{dv}{dt}.v$$

$$P_0\, dt = mvdv$$

$$P_0.t = \frac{mv^2}{2}$$

$$v = \sqrt{\frac{2P_0t}{m}}$$

$$v \propto \sqrt{t}$$

5. A circular platform is mounted on a frictionless vertical axle. Its radius R = 2m and its moment of inertia about the axle is 200 kgm^2. it is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of $1ms^{-1}$ relative to the ground. Time taken by the man to complete one revolution is :

(1) πs (2) $\frac{3\pi}{2}s$ (3) $2\pi s$ (4) $\frac{\pi}{2}s$

Ans. (3)

Sol. using angular momentum conservation

$L_i = 0$

$L_t = mvR -$

$I\omega$ $mvR = I.\omega$

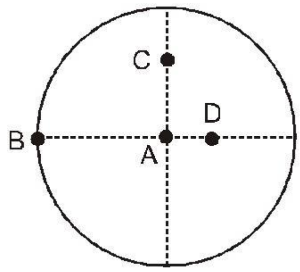
$\omega = \left(\frac{1}{2}\right)$

$(v + \omega R)t = 2\pi R$

$\left(1 + \frac{1}{2} \times 2\right) = 2\pi \times 2$

$t = 2\pi$ sec.

6. The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through :



(1) B (2) C (3) D (4) A

Ans. (1)

Sol. $I = I_{cm} + md^2$

d is maximum for point B

so I_{max} about B

7. Three masses are placed on the x-axis : 300 g at origin, 500g at x = 40 cm and 400g at x = 70 cm. The distance of the centre of mass from the origin is :

(1) 40 cm (2) 45 cm (3) 50 cm (4) 30 cm

Ans.(1)

Sol. $X_{cm} = \frac{300 \times (0) + 500(40) + 400 \times 70}{300 + 500 + 400}$

$X_{cm} = \frac{500 \times 40 + 400 \times 70}{1200}$

$X_{cm} = \frac{50 + 70}{3} = \frac{120}{3} = 40$ cm

8. If v_e is escape velocity and v_0 is orbital velocity of a satellite for orbit close to the earth's surface, then these are related by :

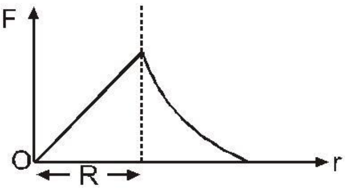
(1) $v_0 = \sqrt{2}v_e$ (2) $v_0 = v_e$ (3) $v_e = \sqrt{2v_0}$ (4) $v_e = \sqrt{2}v_0$

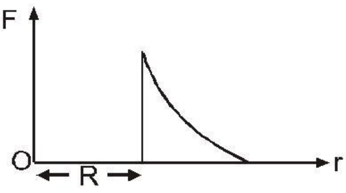
Ans. (4)

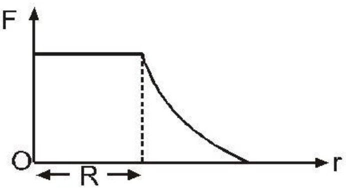
Sol. $v_e = \sqrt{\dfrac{2GM}{R}} \Rightarrow v_0 = \sqrt{\dfrac{GM}{R}}$

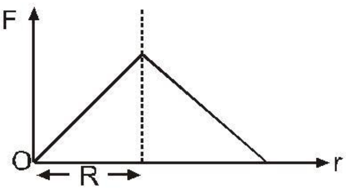
$$v_e = \sqrt{2}v_0$$

9. Which one of the following plots represents the variation of gravitational field on a particle with distance r due to a thin spherical shell of radius R ? (r is measured from the centre of the spherical shell)

(1)


(2)


(3)


(4)


Ans. (2)

Sol. For $r > R$

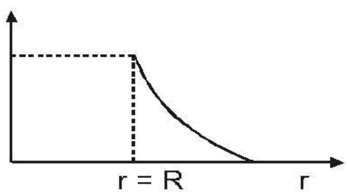
$$F = \frac{GM}{r^2}$$

For $r = R$

$$F = \frac{GM}{R^2}$$

For $r < R$

$F = 0$



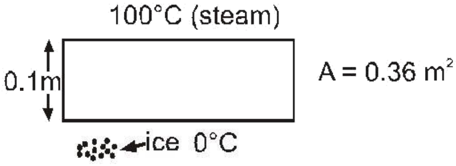
10. A slab of stone of area 0.36 m^2 and thickness 0.1 m is exposed on the lower surface to steam at 100°C. A block of ice at 0°C rests on the upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is :

(Given latent heat of fusion of ice = 3.36×10^5 J kg^{-1}) :

(1) 1.24 J/m/s/°C (2) 1.29 J/m/s/°C (3) 2.05 J/m/s/°C (4) 1.02 J/m/s/°C

Ans. (1)

Sol.



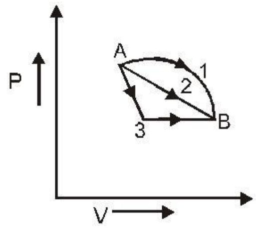
Rate of heat given by steam = Rate of heat taken by ice

$$\frac{dQ}{dt} = \frac{KA(100-0)}{} = m\frac{dL}{dt}$$

$$\frac{K \times 100 \times 0.36}{0.1} = \frac{4.8 \times 3.36 \times 10^5}{60 \times 60}$$

$$K = 1.24 \text{ J/m/s/°C}$$

11. An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram :



If Q_1, Q_2, Q_3 indicate the heat a absorbed by the gas along the three processes and ΔU_1, ΔU_2, ΔU_3 indicate the change in internal energy along the three processes respectively , then

(1) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

(2) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

(3) $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

(4) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

Ans. (1)

Sol. Intial and final condition is same for all process

$$\Delta U_1 = \Delta U_2 = \Delta U_3$$

$$\Delta Q = \Delta U + \Delta W$$

Work done $\Delta w_1 > \Delta w_2 > \Delta w_2$ (Area of P.V. graph)

So $\Delta Q_1 > \Delta Q_2 > \Delta Q_3$

12. The equation of a simple harmonic wave is given by

$$y = 3\sin\frac{\pi}{2}(50t - x)$$

Where x and y are in meters and t is in seconds. The ratio of maximum particle velocity to the wave velocity is

(1) 2π (2) $\frac{3}{2}\pi$ (3) 3π (4) $\frac{2}{3}\pi$

Ans. (2)

Sol. $y = 3\sin\frac{\pi}{2}(50t - x)$

$$y = 3\sin\left(25\pi t - \frac{\pi}{2}x\right)$$

Wave velocity $v = \frac{\omega}{k} = \frac{25\pi}{\pi/2} = 50$ m/sec.

$$v_P = \frac{\partial y}{\partial t} = 75\pi\cos\left(25\pi t - \frac{\pi}{2}x\right)$$

$v_{p\,max} = 75\pi$

then $\frac{v_{pmax}}{v} = \frac{75\pi}{50} = \frac{3\pi}{2}$

13. A train moving at a speed of $220 ms^{-1}$ towards a stationary object, emits a sound of frequency 1000 Hz . Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the of the train is :

(speed of sound in air is $330\ ms^{-1}$)

(1) 3500 Hz (2) 4000 Hz (3) 5000 Hz (4) 3000 Hz

Ans. (3)

Sol. Fequency of the echo detected by the driver of the train is

$$f' = \left(\frac{v+u}{v-u}\right)f$$

$$f' = \left(\frac{330+220}{330-220}\right)1000$$

= 5000 Hz

14. A parallel plate capacitor has a uniform electric field E in the space between the plates. If the distance between the plates is d and area of each plate is A,the energy stored in the capacitor is :

(1) $\frac{1}{2}\varepsilon_0 E^2$ (2) $E^2 Ad/\varepsilon_0$ (3) $\frac{1}{2}\varepsilon_0 E^2 Ad$ (4) $\varepsilon_0 EAd$

Ans. (3)

Sol. $U = \frac{1}{2}CV^2$

V = E.d.

$$C = \frac{A\varepsilon_0}{d}$$

$$U = \frac{1}{2}\frac{A\varepsilon_0}{d}(Ed)^2$$

$$= \frac{1}{2}\frac{A\varepsilon_0 E^2 d}{d}$$

15. Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C, respectively . If these are connected by a conducting wire, the final charge on the bigger sphere is :

(1) 2×10^{-2} C (2) 3×10^{-2} C (3) 4×10^{-2} C (4) 1×10^{-2} C

Ans. (2)

Sol. At equilibrium potential of both sphere becomes same if charge of sphere one x and other sphere Q – x then where $Q = 4 \times 10^{-2}$ C

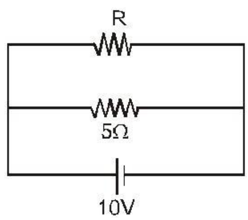
$$\frac{kx}{1\text{ cm}} = \frac{k(Q-x)}{3\text{ cm}}$$

$$3x = Q - x$$
$$4x = Q$$

$$x = \frac{Q}{4} = \frac{4\times10^{-2}}{4}\text{ C} = 1\times10^{-2}$$

$$Q' = Q - x = 3\times10^{-2}\text{ C}$$

16. The power dissipated in the circuit shown in the figure is 30 Watts. The value of R is :



(1) 20 Ω (2) 15 Ω (3) 10 Ω (4) 30 Ω

Ans. (3)

Sol. $P = \dfrac{v^2}{R_{eq}}$ $v = 10\text{volt}$

$$R_{eq} = \left(\frac{5R}{5+R}\right)$$

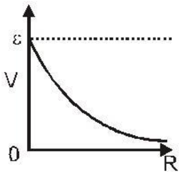
P = 30W

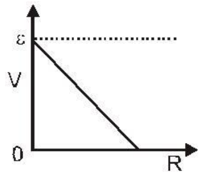
$$30 = \frac{(10)^2}{\left(\frac{5R}{5+R}\right)}$$

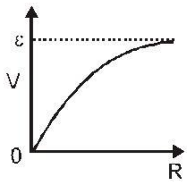
$$\frac{15R}{5+R} = 10$$

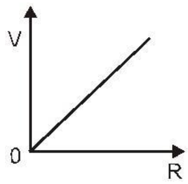
$$15R = 50 + 10R$$
$$5R = 50$$
$$R = 10\Omega$$

17. Cell having an emf ε and internal resistance r is connected across a variable external resistance R .As the resistance R is increased, the plot of potential difference V across R is given by :

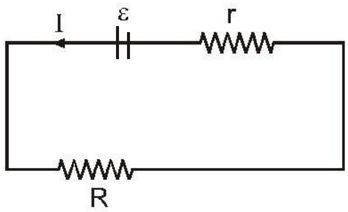
(1) 

(2) 

(3) 

(4) 

Ans. (3)



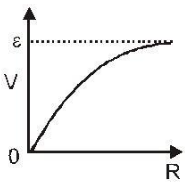
Sol. $I = \left(\frac{\varepsilon}{R + r}\right)$

$V = IR = \left(\frac{\varepsilon}{R + r}\right)R$

$V = \frac{\varepsilon}{\left(1 + \frac{r}{R}\right)}$

when R = 0, V = 0,

R = ∞ , v = ε



18. A proton carrying 1 MeV kinetic energy is moving in a circular path of radius R in uniform magnetic field. What should be the energy of an α - particle to describe a circle of same radius in the same field ?

(1) 2 MeV (2) 1 MeV (3) 0.5 MeV (4) 4 MeV

Ans. (2)

Sol. $R = \frac{\sqrt{2mK}}{qB}$

$q_\alpha = 2q$, $m_\alpha = 4m$

$R_\alpha = \frac{\sqrt{2(4m)K'}}{2qB}$

$\frac{R}{R_\alpha} = \sqrt{\frac{K}{K'}}$, but $R = R_\alpha$

then K = K'= 1 MeV

19. A magnetic needle suspended parallel to a magnetic field requires $\sqrt{3}$ J of work to turn it through 60° . The torque needed to maintain the needle in this position will be :

(1) $2\sqrt{3}$J (2) 3J (3) $\sqrt{3}$J (4) $\frac{3}{2}$J

Ans. (2)

Sol. $W = U_{final} - U_{initial} = MB (\cos 0 - \cos 60^o)$

$W = \frac{MB}{2} = \sqrt{3}J$ ..... (i)

$\tau = M \times B = MB \sin 60^o = \left(\frac{MB\sqrt{3}}{2}\right)$ .....(ii)

From eq. (i) and (ii)

$\tau = 2\sqrt{3} \times \frac{\sqrt{3}}{2} = 3J$

20. The instantaneous values of alternating current and voltages in a circuit are given as

$i = \frac{1}{\sqrt{2}}\sin(100\,\pi t)$amper

$e = \frac{1}{\sqrt{2}}\sin(100\,\pi t + \pi / 3)$ Volt

The average power in Watts consumed in the circuit is :

(1) $\frac{1}{4}$ (2) $\frac{\sqrt{3}}{4}$ (3) $\frac{1}{2}$ (4) $\frac{1}{8}$

Ans.(4)

Sol. $< P > = V_{Rms}.\, I_{Rms} \cos \phi$

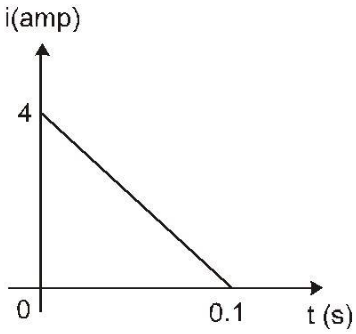
$V_{Rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \frac{1}{2}$ volt

$I_{Rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \left(\frac{1}{2}\right)$A

$\cos \phi = \cos \frac{\pi}{3} = \frac{1}{2}$

$< P > = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$ W

21. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is :



(1) 8 (2) 2 (3) 6 (4) 4

Ans. **(2)**

Sol. Area of i – t graph = q = $\frac{1}{2} \times 0.1 \times 4$

$q = 0.2$ C

$q = \frac{\Delta\phi}{R}$

$q = 0.2 = \frac{\Delta\phi}{10}$

$\Delta\phi = 2$ weber

22. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to :

(1) the speed of light in vacuum

(2) reciprocal of speed of light in vacuum

(3) the ratio of magnetic permeability to the electric susceptibility of vacuum

(4) unity

Ans. **(2)**

Sol. $U = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\frac{B^2}{\mu_0}$

$\varepsilon_0 \mu_0 = \frac{B^2}{E^2}$

$\frac{B}{E} = \sqrt{\varepsilon_0 \mu_0} = \frac{1}{C}$

23. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index :

(1) lies between $\sqrt{2}$ and 1 (2) lies between 2 and $\sqrt{2}$
(3) is less than 1 (4) is greater than 2

Ans (2)

Sol. $\delta_{min} = i + e - A$

$\delta_{min} = A$ then

$2A = i + e$ in case of δ_{min} $i = e$

$2A = 2i$ $r_1 = r_2 = \frac{A}{2}$

$i = A = 90°$

then $1 \sin i = n \sin r_1$

$\sin A = n \sin \frac{A}{2}$

$2 \sin \frac{A}{2} \cos \frac{A}{2} = n \sin \frac{A}{2}$

$2 \cos \frac{A}{2} = n$

when $A = 90° = i_{min}$

then $n_{min} = \sqrt{2}$

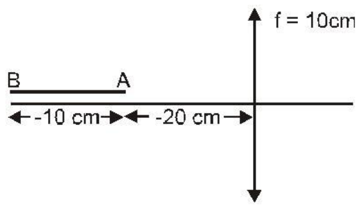
$i = A = 0$ $n_{max} = 2$

24. A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is :

(1) 10 cm (2) 15 cm (3) 2.5 cm (4) 5 cm

Ans. (4)

Sol. When $u_1 = -20$ cm



$\frac{1}{v_1} + \frac{1}{20} = \frac{1}{10}$

$\frac{1}{v_1} + \frac{1}{10} = \frac{1}{20} = \frac{1}{20}$

$v_1 = 20$ cm When

$u_2 = -30$ cm

$\frac{1}{v_2} + \frac{1}{30} = \frac{1}{10}$

$\frac{1}{v_2} = \frac{1}{10} - \frac{1}{30} = \frac{1}{15}$

$v_2 = 15$ cm .

$L = v_1 - v_2 = 5$cm

25. If the momentum of electron is changed by P, then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be :

(1) 200 P (2) 400 P (3) $\frac{P}{200}$ (4) 100 P

Ans. (1)

Sol. $\lambda = \frac{h}{P}$

$$\frac{d\lambda}{\lambda} = -\frac{dp}{P}$$

$$\frac{0.5}{100} = \frac{P}{P'}$$

$$P' = 200P$$

26. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is :

(1) 1 : 4 (2) 1 : 2 (3) 1 : 1 (4) 1 : 5

Ans. (2)

Sol. $K.E_{max} = E - W$

$$\frac{1}{2}mv_1^2 = (1 - 0.5)\text{ eV} = 0.5\text{ eV}$$

$$\frac{1}{2}mv_2^2 = (2.5 - 0.5)\text{ eV} = 2\text{ eV}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{0.5}{2}} = = \frac{1}{\sqrt{4}} = 2$$

27. The transition from the state n = 3 to n = 1 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from :

(1) $2 \rightarrow 1$ (2) $3 \rightarrow 2$ (3) $4 \rightarrow 2$ (4) $4 \rightarrow 3$

Ans. (4)

28. The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed is :

(1) 30 days (2) 50 days (3) 60 days (4) 15 days

Ans.(2)

Sol. $N_1 = N_0 e^{-\lambda t}$ $\quad N_1 = \frac{1}{3} N_0$

$$\frac{N_0}{3} = N_0 e^{-\lambda t_2} \qquad \text{...........(i)}$$

$$N_2 = \frac{2}{3} N_0$$

$$\frac{2}{3} N_0 = N_0 e^{-\lambda t_1} \qquad \text{........(ii)}$$

From eq. (i) and (ii)

$$\frac{1}{2} = e^{-\lambda(t_2 - t_1)}$$

$\lambda (t_2 - t_1) = n2$

$t_2 - t_1 = \frac{n2}{\lambda} = t_{1/2}$ = 50 days

29. The input resistance of a silicon transistor is 100 W. Base current is changed by 40 μA which results in a change in collector current by 2mA. This transistor is used as a common emitter amplifier with a load resistance of 4 KΩ. The voltage gain of the amplifier is :

(1) 2000 (2) 3000 (3) 4000 (4) 1000

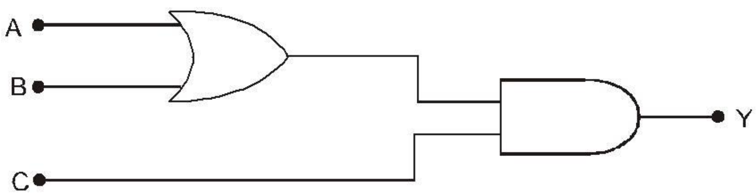
Ans. (1)

Sol. Voltage gain $= \frac{V_{out}}{V_{in}} = \frac{I_{out}}{I_{in}} \times \frac{R_{out}}{R_{in}}$

$$= \frac{2 \times 10^{-3}}{40 \times 10^{-6}} \times \frac{4 \times 10^{3}}{100}$$

= 2 × 1000 = 2000

30. To get an output Y = 1 in given circuit which of the following input will be correct :



	A	B	C
(1)	1	0	0
(2)	1	0	1
(3)	1	1	0
(4)	0	1	0

Ans. (2)

Sol. when A = 1, B = 0, C = 1 then Y = 1