

## Exam Solutions Shift-02

### Physics

27 JANUARY 2024

IIT JEE

Time- 03 Hrs

M.Marks : 300

#### Topic Covered

Physics : Full Syllabus

Chemistry : Full Syllabus

Maths : Full Syllabus

#### GENERAL INSTRUCTION

1. Immediately fill in the particulars on this page of the test booklet.
2. The test is of 3 hours duration.
3. The test booklet consists of 90 questions. The maximum marks are 300.
4. There are Three Sections in the question paper, Section I, II & III consisting of Section-I (Physics), Section-II (Chemistry), Section-III (Mathematics) and having 30 questions in each part in which first 20 questions are compulsory and are of Objective Type and Last 10 questions are integers type in which you have to attempt 5 questions only.
5. There is only one correct response for each question.
6. Each correct answer will give 4 marks while 1 Mark will be deducted.
7. No student is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
8. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.





### PHYSICS

1. An equation of real gas  $\left(p - \frac{a}{V^2}\right)(V - b) = RT$

then dimension of  $\left(\frac{a}{b^2}\right)$  is

P : Pressure

V = Volume

R = Gas constant

T = Temperature

- (1)  $[ML^{-1}T^{-2}]$                       (2)  $[MLT^{-2}]$                       (3)  $[ML^2T^{-2}]$                       (4)  $[MLT^{-1}]$

Ans. (1)

Sol. Basic theory

2. **Assertion:** There can be positive zero error in vernier calliper.

**Reason:** Due to mishandling or rough handling of instrument

- (1) Assertion true, reason true and reason is correct explanation of assertion  
(2) Assertion true, reason true and reason is not correct explanation of assertion  
(3) Assertion true, reason false  
(4) Assertion false, reason true

Ans. (1)

3. In a RLC series circuit  $R = 10\Omega$ ,  $L = \frac{100}{\pi}mH$ ,  $C = \frac{10^{-3}}{\pi}F$  and frequency is 50 Hz. Find power factor.

Ans. 1

Sol.  $X_L = \frac{100}{\pi} \times 2\pi \times 50 \times 10^{-3} = 10\Omega$

$$X_C = \frac{1}{2\pi \times 50 \times \frac{10^{-3}}{\pi}} = 10\Omega$$

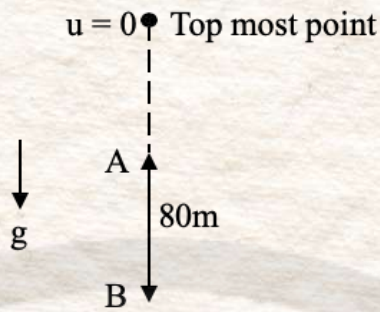
$$X_L = X_C$$

$$\cos\phi = 1$$



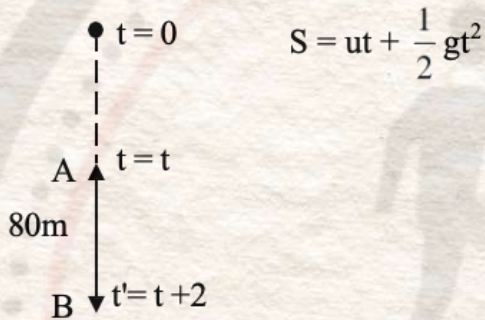


4. A stone is released and while free-fall stone covers 80 m distance in last 2 sec. Find distance of point A from top most point.



Ans. 45

Sol.



$$5(t+2)^2 - 5t^2 = 80 \Rightarrow t = 3\text{sec}$$

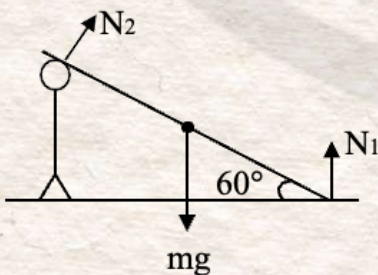
$$S_A = 0 + \frac{1}{2} \times 10 \times 3^2 = 45\text{m}$$

5. A person is standing on horizontal ground. A rod of mass 12 kg is touching a shoulder of person and other end is resting on ground. Angle made by rod with horizontal is  $60^\circ$ . Reaction force applied by person on rod is

- (1) 60 N                      (2) 30 N                      (3) 90 N                      (4) 120 N

Ans. (2)

Sol.





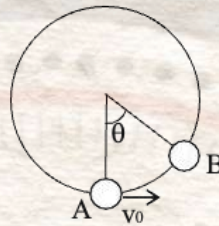


Taking torque about  $N_1$ .

$$mg \cdot \frac{\ell}{2} \cos 60^\circ = N_2 \ell$$

$$N_2 = 30 \text{ N}$$

6. Point 'B' is at highest point of trajectory of object. Magnitude of acceleration at 'A' and 'B' is equal. Find the angle ' $\theta$ ' as shown.



(1)  $2 \tan^{-1}(1/2)$

(2)  $\tan^{-1}(1/2)$

(3)  $\tan^{-1}(1/4)$

(4)  $\tan^{-1}(2)$

Ans. (1)

Sol. Apply work energy theorem

$$mg(1 - \cos\theta) = \frac{1}{2} m v_0^2$$

$$\frac{v_0^2}{\ell} = 4g \sin^2\left(\frac{\theta}{2}\right) \quad \dots(1)$$

$$g \sin\theta = \frac{v_0^2}{\ell} \quad \dots(2)$$

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

$$\theta = 2 \tan^{-1}\left(\frac{1}{2}\right)$$

7. In an adiabatic process, pressure is proportional to cube of temperature. Find the ratio  $C_p/C_v$ .

Ans.  $3/2$

Sol.  $PT^{\gamma/1-\gamma} = \text{constant}$

$$P \propto T^3$$

$$PT^{-3} = C$$

$$\frac{\gamma}{1-\gamma} = -3$$

$$\gamma = -3 + 3\gamma$$

$$2\gamma = 3$$

$$\gamma = 3/2$$





8. **Assertion:** Angular velocity of earth around sun is lesser than the angular velocity of moon about earth

**Reason:** Time taken by moon revolve around earth is less than time taken by earth to revolve around sun

(1) Both Assertion (A) and Reason (R) are true & correct explanation of Assertion 'A'

(2) Both 'A' and 'R' are correct but 'R' is not correct explanation of 'A'

(3) 'A' is correct and 'R' is false

(4) 'A' is false and 'R' is correct

**Ans.** (1)

**Sol.** 
$$T = \frac{2\pi}{\omega} \quad T_{\text{earth}} = 365 \text{ days}$$

$$T_{\text{moon}} = 27 \text{ days}$$

9. If wave function of a metal is 6.68eV. Find threshold frequency.

(1)  $8 \times 10^{15} \text{ Hz}$

(2)  $1.6 \times 10^{15} \text{ Hz}$

(3)  $10 \times 10^{15} \text{ Hz}$

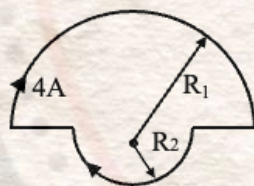
(4)  $4 \times 10^{15} \text{ Hz}$

**Ans.** (2)

**Sol.**  $6.68 \times 1.6 \times 10^{-19} = 6.626 \times 10^{-34} \nu_0$

$$1.6 \times 10^{15} \text{ Hz} = \nu_0$$

10. Find magnetic field strength at the centre of loop.



$$R_1 = \frac{\pi}{2}$$

$$R_2 = \frac{\pi}{4}$$

**Ans.**  $24 \times 10^{-7} \text{ Tesla}$

**Sol.** 
$$B_{\text{centre}} = \frac{\mu_0 (i)}{4R_1} + \frac{\mu_0 i}{4R_2}$$

$$= \frac{\mu_0 \times 4}{4} \left[ \frac{1}{R_1} + \frac{1}{R_2} \right]$$

$$= \mu_0 \left[ \frac{2}{\pi} + \frac{4}{\pi} \right]$$

$$= 4\pi \times 10^{-7} \left[ \frac{6}{\pi} \right]$$

$$= 24 \times 10^{-7} \text{ Tesla}$$





11. **Assertion:** If external force is removed, then body will try to regain its actual shape, this is called elasticity.

**Reason:** Due to intermolecular force, this happens

- (1) Assertion True, Reason True & Reason is correct explanation of assertion
- (2) Assertion True, Reason True & Reason is not correct explanation of assertion
- (3) Assertion True, Reason false
- (4) Assertion false, Reason True

**Ans. (1)**

12. A bullet gets embedded in a fixed target. It is found that bullet losses  $1/3^{\text{rd}}$  of its velocity in traveling 4 cm into target and losses remaining kinetic energy while traveling further  $d \times 10^{-3}$  m. Find d.

**Ans. 32**

**Sol.**  $v^2 = u^2 + 2ax$

$$\left(\frac{2u}{3}\right)^2 = u^2 + 2(-a)(4\text{cm}) \quad \dots(1)$$

for next

$$0 = \left(\frac{2u}{3}\right)^2 + 2(-a)(x) \quad \dots(2)$$

using equation (i) &(ii)

$$x = 32 \times 10^{-3} \text{ m}$$

So  $d = 32$

13. 1 mole of an ideal  $\text{O}_2$  gas is at  $27^\circ\text{C}$ . Find its total kinetic energy?

- (1) 1250 J
- (2) 6250 J
- (3) 645 J
- (4) 1025 J

**Ans. (2)**

**Sol.** Kinetic Energy =  $\frac{n}{2} fRT$

$$\text{KE} = \frac{1}{2} \times 5 \times \frac{25}{3} \times 300$$

$$= 6250 \text{ J}$$





14. Light of intensity  $I = 6 \times 10^8 \frac{W}{m^2}$  is incident on an object kept in medium of refractive index,  $\mu = 3$  assuming 100% absorption. Find radiation pressure ( $N/m^2$ )?

Ans. 6

Sol. Radiation =  $\frac{IA}{\left(\frac{h\nu}{\lambda}\right)} \left(\frac{h}{\lambda}\right) \frac{1}{A} = \frac{I}{v} = \frac{I}{C\mu} = \frac{6 \times 10^8 \times 3}{3 \times 10^8} = 6$

15. A ring and a solid sphere of same mass and radius are released from same point of inclined plane. Find the ratio of their KE when they reach to bottom without slipping

- (1) 1 : 7                      (2) 1 : 3                      (3) 1 : 5                      (4) 1 : 1

Ans. (4)

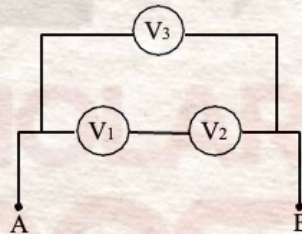
Sol. EC

$$mgh = k_f - k_i$$

$$k_f = mgh$$

$$\text{so } KE_{\text{Ring}} = K.E._{\text{solid sphere}}$$

16. Three voltmeters of different internal resistances are connected as shown in figure and a certain voltage is applied across AB. State which is true?



- (1)  $V_1 + V_2 > V_3$                       (2)  $V_1 + V_2 \neq V_3$                       (3)  $V_1 + V_2 = V_3$                       (4)  $V_1 + V_2 < V_3$

Ans. (3)

Sol. By series and parallel combination

$$V_1 + V_2 = V_3$$

17. Specific resistance  $S$  is given as  $S = \frac{RA}{\ell}$ . If length is doubled, find corresponding change in  $S$ .

- (1)  $S$  is halved  
(2)  $S$  is doubled  
(3)  $S$  is quadrupled  
(4) No change in  $S$

Ans. (4)





18. **Assertion :** Static friction depends on area of contact but independent of material.

**Reason :** Kinetic friction is independent of area of contact but depends on material.

- (1) Assertion true, reason true and reason is correct explanation of assertion.
- (2) Assertion true, reason true and reason is not correct explanation of assertion.
- (3) Assertion true, reason false.
- (4) Assertion false, reason true.

**Ans. (4)**

19. **Assertion :** Work done by electrostatics force on an object when moved on equipotential surface is always zero.

**Reason :** Electric field lines falls perpendicular to the equipotential surface

- (1) Assertion true, reason true and reason is correct explanation of assertion.
- (2) Assertion true, reason true and reason is not correct explanation of assertion.
- (3) Assertion true, reason false.
- (4) Assertion false, reason true.

**Ans. (1)**

**Sol. Assertion is true and reason is true and correct explanation.**

20. A nucleus of  $C^{13}$  breaks into  $C^{12}$  and neutron. Find energy released.

Atomic mass of  $C^{12} = 12.000 \text{ u}$

$C^{13} = 13.013975 \text{ u}$

$n = 1.008665 \text{ u}$

- (1) 3.04 MeV                      (2) 4.1 MeV                      (3) 4.94 MeV                      (4) 6 MeV

**Ans. (3)**

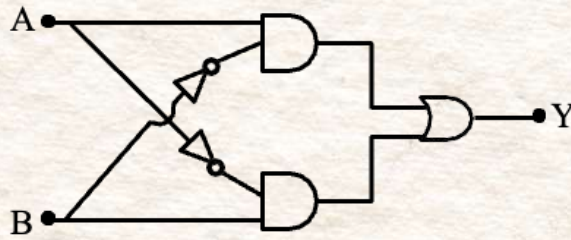
**Sol.** Mass defect =  $13.013975 - (12 + 1.008665) = 0.00531 \text{ U}$

Energy released =  $0.00531 \times 931 = 4.94 \text{ MeV}$





21. For given logic circuit. The truth table will be



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

Ans. (4)

Sol. Using Boolean algebra

$$Y = A\bar{B} + \bar{A}B$$

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

22. In a transformer, ratio of turns in primary to secondary coil is 10 : 1. If primary side voltage is 230 volt and frequency is 50 Hz and resistance of secondary side is  $46 \Omega$  then find power output.

- (1) 11.5 W                      (2) 12 W                      (3) 12.5 W                      (4) 23 W

Ans. (1)

Sol. 
$$\frac{N_1}{N_2} = \frac{V_1}{V_2}$$

$$\frac{10}{1} = \frac{230}{V_2}$$

$$V_2 = 23 \text{ V}$$

$$P_2 = \frac{V_2^2}{R_2} = \frac{23 \times 23}{46} = \frac{23}{2} = 11.5 \text{ W}$$

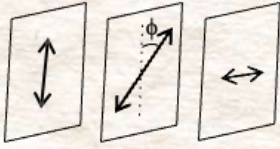




23. Between two polaroid placed in crossed position, a third polaroid is introduced. By what angle (in degree) the introduced polaroid placed should be rotated to get maximum intensity of the out coming light.

Ans. 45

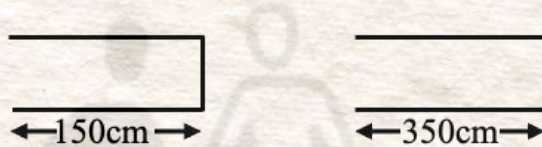
Sol.



$$I = I_0 \cos^2 \phi \sin^2 \phi$$

$$I_{\max} \text{ at } \phi = 45^\circ$$

24. If their fundamental frequencies are sounded together, beat frequency is 7 Hz. Find velocity (in m/s) of sound in air?



Ans. 24

Sol.  $f_1 = \frac{v}{4\ell_1}$        $f_2 = \frac{v}{2\ell_2}$

$$f_1 = \frac{v \times 100}{4 \times 150} \quad f_2 = \frac{v \times 100}{2 \times 350}$$

$$f_1 = \frac{v}{6} \quad f_2 = \frac{v}{7}$$

$$\frac{v}{6} - \frac{v}{7} = 7$$

$$\frac{v}{42} = 7, \quad v = 42 \times 7$$

$$v = 294 \text{ m/sec}$$

25. For 200  $\mu\text{A}$  current galvanometer deflects by  $\pi/3$  radians. For what value of current, it will deflect by  $\pi/10$  radians ?

Ans. 60

Sol.  $i \propto \theta$  (angle of deflection)

$$\frac{i_1}{i_2} = \frac{\theta_1}{\theta_2}$$

$$\frac{200 \mu\text{A}}{i_2} = \frac{\pi/3}{\pi/10} = \frac{10}{3}$$

$$60 \mu\text{A} = i_2$$





26. Two charges of magnitude  $-4 \mu\text{C}$  kept at  $(1, 0, 4)$  and another charge of  $+4 \mu\text{C}$  kept at  $(2, -1, 5)$  in the presence of external electric field  $E = 0.2 \hat{i} \text{ V/cm}$ . The torque on the system of charges is  $8\sqrt{\alpha} \times 10^{-5} \text{ N-m}$ . Find  $\alpha$ .

Ans. 2

Sol.  $\vec{\tau} = \mathbf{P} \times \mathbf{E}$

$$\vec{P} = \mathbf{Pr} = 4 \times 10^{-6} \times \sqrt{3} \frac{(\hat{i} - \hat{j} + \hat{k})}{\sqrt{3}}$$

$$\mathbf{P} = 4 \times 10^{-6} (\hat{i} - \hat{j} + \hat{k})$$

$$\mathbf{E} = 0.2 \times 10^2 \hat{i} = 20 \hat{i} \text{ V/m}$$

$$\vec{\tau} = 4 \times 10^{-6} \times 20 [(\hat{i} - \hat{j} + \hat{k}) \times \hat{i}]$$

$$\vec{\tau} = 8 \times 10^{-5} (\hat{k} + \hat{j})$$

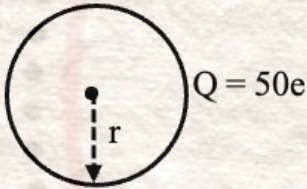
$$|\vec{\tau}| = 8\sqrt{2} \times 10^{-5} \text{ Nm}$$

$$\alpha = 2$$

27. A nucleus with atomic number '50' and having radius of nucleus is  $9 \times 10^{-13} \text{ cm}$ . Calculate the potential (in MV) at the surface of the nucleus.

Ans. 8

Sol.



$$V_{\text{surface}} = \frac{kQ}{r} = \frac{9 \times 10^9 \times 50 \times 1.6 \times 10^{-19}}{9 \times 10^{-15}}$$

$$= 80 \times 10^5 \text{ volt}$$

$$V_{\text{surface}} = 8 \text{ MV}$$

28. A pressure inside wall pipe before hole is  $4.5 \times 10^4 \text{ N/m}^2$ . When a small hole is made in pipe, pressure is changed to  $2.0 \times 10^4 \text{ N/m}^2$ . If speed of water flux after hole is  $\sqrt{v} \text{ m/s}$ . Find out  $v$  :

Ans. 50

Sol.  $\Delta P = \frac{1}{2} \rho v^2$

$$2.5 \times 10^4 = \frac{1}{2} \times 10^3 v_0^2$$

$$v_0 = \sqrt{50} \text{ m/s}$$

$$v = 50$$





**Rough Work**



**THE END**