Version No.			
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2	2	2	2
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ROLL NUMBER						
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Answer Sheet No.____________

Sign. of Candidate___________

Sign. of Invigilator___________

PHYSICS HSSC–I (2^{nd} Set Solution)

SECTION – A (Marks 17)

Time allowed: 25 Minutes

Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

Q.1 Fill the relevant bubble for each part. Each part carries one mark.

1. In a simple pendulum experiment, percentage errors in length "L" and time "T" are 0.1% and 2% respectively. What is the percentage uncertainty in the value of g?
   A. 4.1% ● B. 3.1% ○
   C. 5% ○ D. 2.1% ○

2. The dimension ratio of power to work is:
   A. $1 : T^2$ ○ B. $1 : T^{-2}$ ○
   C. $1 : T^{-1}$ ● D. $1 : T$ ○

3. The resultant of two forces having magnitude of 5N and 6N is 1N. The angle between them is:
   A. 60° ○ B. 180° ●
   C. 90° ○ D. 30° ○

4. A man carries a bucket of water of 1kg for 10m then work done by gravity will be:
   A. 10J ○ B. 5J ○
   C. 2.5J ○ D. Zero ●

5. A body rotating in a circle of radius 0.5m with an angular speed 10rad/s its tangential velocity is:
   A. 2 m/s ○ B. 5 m/s ●
   C. 10 m/s ○ D. 15 m/s ○

6. Height of the closest orbit of the satellite above the Earth is:
   A. 300 km ○ B. 250 km ●
   C. 500 km ○ D. 400 km ○

7. Entropy of hot reservoir of a heat engine:
   A. Increases ○
   B. Decreases ●
   C. Is zero ○
   D. Remains constant ○

8. Resonance curve is fairly flat for:
   A. Heavily damped system ●
   B. Moderately damped system ○
   C. Lightly damped system ○
   D. Equally flat for all cases ○

9. Fringe width in Young's double slit experiment increases when:
   A. Wavelength increases ●
   B. Distance between source and screen decreases ○
   C. Distance between slits increases ○
   D. The width of the slits increases ○

10. The regular array of atoms in a crystal forms a natural diffraction grating with spacing of:
   A. 10^{-10} m ● B. 10^{-6} m ○
   C. 10^{12} m ○ D. 10^{15} m ○

11. Work done by centripetal force of 10 N moving in a circle of radius 5 m will be:
   A. Zero J ● B. 25 J ○
   C. 50 J ○ D. 75 J ○

12. A particle is falling freely through a viscous medium with terminal velocity. Its acceleration is:
   A. $a = g$ ○ B. $a > g$ ○
   C. $a < g$ ○ D. $a = 0$ ●

13. The fundamental frequency of a closed organ pipe is 50Hz. The frequency of second overtone is:
   A. 100 Hz ○ B. 150 Hz ●
   C. 200 Hz ○ D. 250 Hz ○

14. When a tuning fork of frequency 100Hz is sounded with a tuning fork B, the number of beats per second is 2. After waxing B, the number of beats per second is 1. Frequency of fork B is:
   A. 98 Hz ○ B. 99 Hz ○
   C. 101 Hz ○ D. 102 Hz ●

15. A vector **A** is along positive x-axis. If **B** is another vector such that **A** × **B** = 0 then $\vec{B}$ would be:
   A. 4**j** ○ B. -4**i** ●
   C. -(**i**+**j**) ○ D. (**j**+**k**) ○

16. A man standing on the edge of cliff throws a stone vertically upwards with certain speed. He then throws another stone downwards with same speed. Find the ratio of the speed of two stones when they hit the ground.
   A. 1 : 1 ● B. 1 : 2 ○
   C. 1 : 3 ○ D. 1 : 4 ○

17. Angular speed of hour hand of a clock is:
   A. 1 rev/60min ○ B. 1 rev/12hr ○
   C. 1 rev/24hr ● D. 1 rev/60sec ○

Federal Board HSSC-I Examination
Physics Model Question Paper
(Curriculum 2006)

Time allowed: 2.35 hours   Total Marks: 68

Note: Answer any fourteen parts from Section 'B' and attempt any two questions from Section 'C' on the separately provided answer book. Write your answers neatly and legibly.

SECTION – B (Marks 42)

Q.2 Attempt any **FOURTEEN** parts. All parts carry equal marks. (14× 3 = 42)

i. Find distance travelled by light in one year.

Ans. S=vt

$S=3\times10^8\times365\times24\times60\times60$

$S= 9.4608\times10^{15}$m

ii. Enlist three main causes of errors in measurement.

Ans. Three main causes of errors in measurements are inappropriate technique, faulty apparatus and negligence of user.

1. Personal error due to negligence of user.
2. Systematic error due to faulty apparatus.
3. Random error due to unknown causes that make variations in results of repeated measurements.

iii. Calculate the angle between two vectors for which magnitude of dot and cross product is same.

Ans. $AB\cos\theta = AB\sin\theta$

$1 = \frac{\sin\theta}{\cos\theta}$

$\tan\theta = 1$

$\theta = \tan^{-1} 1$

$\theta = 45^0$

iv. Why tightening of screw with long arm spanner is **NOT** recommended?

Ans. Long arm spanner will produce large torque because of large moment arm. This large torque can deteriorate the threads of screw.

v. Why First law of motion is also called 'law of inertia'?

Ans. First law of motion says that the body will maintain its state of rest or uniform motion in the absence of net force. This state maintaining ability of the body is also known as inertia. That's why First law of motion is also called 'law of inertia'.

vi. A projectile has maximum range at 200 m. What will be the maximum height attained by it?

Ans. $R_{MAX} = \frac{v^2}{g} = 200$ as $\theta = 45^0$ for R_{MAX} and $\sin(2\times45) = 1$

Hence $H = \frac{v^2 \sin^2\theta}{2g} = \frac{v^2}{g}\times\frac{\sin^2\theta}{2} = 200 \times \frac{1}{4} = 50$m

vii. What is meant by conservative field. Give two examples.

Ans. A field in which work done in a closed path is zero and is independent of path followed is called conservative field. Gravitational and electric field are examples of conservative fields.

viii. A proton accelerates from rest to a speed 5×10^7m/s, covers a distance of 10 cm. Find the force required for it.

Ans. $F = ma$

$$a = \frac{v_f^2 - v_i^2}{2S}$$

$$F = m\left(\frac{v_f^2 - v_i^2}{2S}\right)$$

$$F = 20 \times 10^{-12} N$$

ix. How moment of inertia of a ring and a disc can be equal?

Ans. Moment of inertia of ring = MR^2 and Moment of inertia of disc = $\frac{1}{2}MR^2$. Hence modifying the mass and radius of ring $\frac{M}{2}$ and $\frac{R}{\sqrt{2}}$ as compared to mass and radius of disc M and R, moment of inertia of both objects can be equated. Also modifying the mass and radius of disc 2M and $\sqrt{2}$R as compared to mass and radius of ring M and R, moment of inertia of both objects can be equated.

x. Why racing cars and boat are designed oblonged shape?

Ans. Racing cars and boats are designed oblong to reduce the turbulence of fluid (air) by streamlining it. Hence cars and boats move faster due to less resistance offered by air which results into less expenditure of fuel.

xi. What do you understand by Stokes law. Also write its formula?

Ans. Stokes law states that drag force acting upward on the falling spherical objects in resistive medium is $6\pi r\eta v$, where r is the radius of sphere, η is the viscosity of fluid and v is velocity of falling object. Hence drag force $F_D = 6\pi r\eta v$.

xii. The depth of upper hole of a liquid container is h. What will be the depth of lower hole where speed of efflux of liquid become double than the upper hole?

Ans. As $v = \sqrt{2gh}$

So $v' = \sqrt{2gh'}$

Given $v' = 2v$

$\sqrt{2gh'} = 2\sqrt{2gh}$

Squaring both sides give

$2gh' = 8gh$

Hence $h' = 4h$

xiii. What are the practical examples of free and forced oscillations?

Ans. **Free oscillations:** Pendulum, mass spring system, tuning fork, wires of musical system.
Free oscillations: Pushing swing to maintain oscillations, oscillations produced in hanging bridge due to marching troops, oscillations produced in water molecules by microwave oven.

xiv. Why the length of simple pendulum is taken upto centre of bob?

Ans. As vibrations of simple pendulum are carried out under the action of gravitational pull of earth and point of action of earth's gravitational pull is center of gravity of the body. Center of gravity of bob is center point of bob that's why length of pendulum is taken up to center of bob.

xv. Explain frequency and phase change of mechanical wave after reflection from rare to denser.

Ans. When a mechanical wave travelling through rare medium reflects from denser medium, its phase shift by 180^o and frequency remain unchanged after reflection.
When a mechanical wave travelling through denser medium reflects from rare medium, it suffers no phase change and no frequency change.

xvi. In Young's double slit experiment, to measure the wavelength of light, it is desirable to have the screen as far from the slits as possible. Why?

Ans. As fringe width is directly proportional to the distance of screen from slits. Hence far off screen from slits will create wide fringes on the screen whose width can be calculated with more accuracy. This will decrease the uncertainty in the measurement of wavelength of light used which require fringe width.

xvii. How can we obtain coherent source of light?

Ans. Coherent sources of light can be obtained by:
i. Division of wave length as in Young's double slits, Fresnel's byprism and Lioyed's mirror.
ii. Division of amplitude by partial reflection and transmission at a boundary as in Newton's rings.

xviii. Calculate the wavelength of light used when 2000 fringes are observed by moving the mirror of Michelson interferometer by 0.5 mm.

Ans. $\lambda = \frac{2P}{m}$

$\lambda = \frac{2 \times 0.5 \times 10^{-3}}{2000} = 0.5 \times 10^{-6} m$

xix. Calculate work done by thermodynamic system during volume change.

Ans. Consider a gas contained in a cylinder having movable piston, then work will be
W = FΔX
F = PA
W = PAΔX
W = PΔV
So work is product of pressure and change in volume.

xx. Two Carnot engines 'A' and 'B' have their sources at 327°C and 227°C and sinks at 127°C and 27°C respectively. Compare their efficiencies.

Ans. $\eta_A : \eta_B = (1 - \frac{T_{A2}}{T_{A1}}) : (1 - \frac{T_{B2}}{T_{B1}})$

$\eta_A : \eta_B = (1 - \frac{127}{327}) : (1 - \frac{27}{227})$

$\eta_A : \eta_B = (\frac{327-127}{327}) : (\frac{227-27}{227})$

$\eta_A : \eta_B = \frac{200}{327} : \frac{200}{127}$

$\eta_A : \eta_B = \frac{1}{327} : \frac{1}{127}$

$\eta_A : \eta_B = 127 : 327$

SECTION – C(Marks 26)

Note: Attempt any **TWO** questions. All questions carry equal marks. (2 × 13 = 26)

Q.3 a. Derive relation for Bernoulli's equation. **(6)**

Ans. Bernoulli's equation that relates the pressure, flow speed and height for flow of an ideal fluid. Such that mathematically

$P_1 + \frac{1}{2}\rho\, v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$

Bernoulli's equation is simply law of conservation of energy applied to fluids in motion. Consider an ideal fluid flowing through a pipe of non uniform size as illustrated in fig. The work 'W' is due to force other than the conservation force of gravity, so it equals the change in the total mechanical energy (kinetic energy plus gravitational potential energy) associated with the fluid element.

$W = \Delta E$

$W = \Delta K + \Delta U$

The total work done will be sum of all the individual work done.

$W = W_1 + W_2$

For end 1

By definition of work

$W_1 = F_1 . \Delta X_1$

$W_1 = F_1 \Delta X_1 \cos\theta$

Here $\theta=0$ and $\cos 0=1$ therefore $W_1 = F_1 \Delta X_1$

For end 2 by definition of work

$W_2 = F_2 . X_2$ $W_2 = F_2\, \Delta X_2 \cos\theta$

Here $\theta=180$ and $\cos 180=-1$

Therefore $W_2 = -\, F_2\, \Delta X_2$

By definition of pressure $P = \frac{F}{A}$

Or $F = PA$

From equation above equations, we can write

For end 1 $W_2 = P_1 A_1\, \Delta X_1$

For end 2 $W_2 = -P_2 A_2\, \Delta X_2$

Since $\Delta V = A \Delta X$

By definition of density $\rho = \frac{\Delta m}{\Delta v}$

Or $\Delta v = \frac{\Delta m}{\rho}$

Comparing above equations

$\frac{\Delta m}{\rho} = A\Delta x$

Therefore,

$W=P_1\frac{\Delta m1}{\rho}$- $P_2\frac{\Delta m2}{\rho}$

The net change in kinetic energy ΔK is

$\Delta K=\frac{1}{2}\Delta m_2 v_2^2-\frac{1}{2}\Delta m_1 v_1^2$

The net change in potential energy ΔU is

$\Delta U=\Delta m_2 g h_2-\Delta m_1 g h_1$

Using above equations

$P_1\frac{\Delta m1}{\rho}-P_2\frac{\Delta m2}{\rho}=\frac{1}{2}\Delta m_2 v_2^2-\frac{1}{2}\Delta m_1 v_1^2+\Delta m_2 g h_2-\Delta m_1 g h_1$

Since for ideal fluid equal mass should flow across both ends i.e $\Delta m_1=\Delta m_2=\Delta m$

Hence above equation can be written as

$P_1\frac{\Delta m}{\rho}-P_2\frac{\Delta m}{\rho}=\frac{1}{2}\Delta m v_2^2-\frac{1}{2}\Delta m v_1^2+\Delta m g h_2-\Delta m g h_1$

Taking Δm as common

$\frac{\Delta m}{\rho}(P_1-P_2)=\Delta m\,(\frac{1}{2}v_2^2-\frac{1}{2}v_1^2+gh_2-gh_1)$

Multiplying both sides by $\frac{\rho}{\Delta m}$

$P_1-P_2=\frac{1}{2}\rho v_2^2-\frac{1}{2}\rho v_1^2+\rho g h_2-\rho g h_1$

Therefore

$P_1+\frac{1}{2}\rho v_1^2+\rho g h_1=P_2+\frac{1}{2}\rho v_2^2+\rho g h_2$

$P+\frac{1}{2}\rho v^2+\rho g h=\text{constant}$

b. Find the ratio of distance travelled by free falling body in first, second and third second. **(4)**

Ans. $S_1 = S_2 = S_3 = ?$ where

S_1=distance travelled in 1_{st} second

S_2=distance travelled in 2_{nd} second

S_3=distance travelled in 3_{rd} second

Distance travelled in a specific second for a free-falling object is given by

$S_n=\frac{1}{2}g(t_n^2-t_{n-1}^2)$

Where t_n represents specific second. Now required ratio is

$S_1: S_2: S_3 = \frac{1}{2}g\,(1^2-0^2): \frac{1}{2}g(2^2-1^2) : \frac{1}{2}g(3^2-2^2)$

$S_1: S_2: S_3 = (1-0): (4-1): (9-4)$

$S_1: S_2: S_3 = 1: 3: 5$

c. If the force of an engine of automobile is doubled with the velocity remaining constant. What happens to its power? **(3)**

Ans. $P = Fv$

If $F' = 2F$

$P' = F'v = 2Fv = 2P$

$P' = 2P$

Q.4 a. State Doppler effect. Also derive all the solution when apparent frequency of wave decreases than the real frequency. **(7)**

Ans. The apparent change in the frequency of sound, caused by the relative motion of the source of sound and listener is called Doppler Effect. Doppler Effect inter relates the measured frequency of the wave to the relative velocity of the source of sound and receiver. This phenomenon is called Doppler Effect after Christian Johann Doppler who showed in 1842 that frequency shift should be observed for sound and light waves due to relative motion between source and observer.

Apparent frequency of wave decreases when

i. Source move away from stationary listener
ii. Listener move away from stationary sounding source
iii. Source and listener move away from each other.

If the sounding source “S” is moving away from the stationary listener with speed “a” then “f” number of waves are contained in distance (v+a), so the apparent wavelength λ' is

$$\lambda' = \frac{v+a}{f}$$

The apparent frequency f′ is

$$f' = \frac{v}{\lambda'}$$

$$f' = \frac{v}{\lambda+a} f$$

As $f' < f$, so the pitch of sound decreases when the sounding source is moving away from the stationary listener.

When the listener moves away with speed “b” from a stationary sounding source, the speed of sound relative to the listener becomes v-b. As the wavelength remains the same so the observed frequency is

$$f'' = \frac{v-b}{\lambda}$$

where $\lambda'' = \frac{v}{f}$

$$f'' = \frac{v-b}{v} f$$

Here $f''<f$ so the pitch of sound decreases when the listener moves away from the stationary sounding source of sound.

When the source of sound and listener are moving away from each other, then apparent wavelength λ''' is

$$\lambda''' = \frac{v-a}{f}$$

The speed of sound relative to the listener is v-b and the apparent frequency f'''become

$$f''' = \frac{v-b}{v+a} f$$

As $f'''< f$, so the pitch of sound decreases when source and listener are moving away from each other.

b. A heat engine working according to second law of thermodynamics has 50% efficiency. What will be the temperature of its low temperature reservoir if high temperature reservoir is 327°C. **(3)**

Ans. $\eta = (1 - \frac{T_2}{T_1})$ given, $\eta = 50$ and $T_1 = 327$

$$50 = (1 - \frac{T_2}{327})\times 100$$

$$\frac{T_2}{327} = 1 - \frac{50}{100}$$

$T_2 = 163.5°C$

c. What happens to the frequency of the mass spring system if length of the spring is cut into one third. **(3)**

Ans. If length of the spring is cut into one third then its spring constant k becomes three times $k' = 3k$

Hence $f' = \frac{1}{2\pi}\sqrt{\frac{3k}{m}} = \frac{1}{2\pi}\sqrt{\frac{3k}{m}} = \sqrt{3}\frac{1}{2\pi}\sqrt{\frac{k}{m}} = \sqrt{3}\, f$

So, $f' = \sqrt{3}\, f$

Q.5 a. Define centripetal force. Prove that $a_c = \frac{V^2}{r}$. **(6)**

Ans. The force which compels the body to move in circle is called center seeking force or centripetal force. If an object is moving in a circle or along the arc of a circle, it follows that there must be a force acting on it to change its direction.

The change in velocity of body produces acceleration directing towards the center of circle. Such acceleration is known as centripetal acceleration.

Consider a body of mass "m" moving in a circle of radius "r" with uniform speed "v". Point C is center of circle. At point A during time t_1, velocity of body is $v_1$and at point B during time t_2, velocity of body is v_2. Let us now draw a triangle PQR such that PQ is equal and parallel to v_1, and PR is equal and parallel to v_2. As speed is uniform hence $v_1=v_2=v$ in magnitude but they differ in direction. By vector diagram $\Delta v=v_2-v_1$ is the change in velocity of body in time interval $\Delta t=t_2-t_1$. When time Δt is small the change Δv is also small in that case arc AB is approximately equal to AB. So, for similar triangles we can write

$$\frac{s}{r} = \frac{\Delta v}{v}$$

as $s=v\Delta t$ so the above equation becomes

$$\frac{v\Delta t}{r} = \frac{\Delta v}{v}$$

$$\frac{\Delta v}{\Delta t} = \frac{v^2}{r}$$

$$a = \frac{v^2}{r}$$

This acceleration is also called centripetal acceleration.

Thus $a_c = \frac{v^2}{r}$

Using Newton's 2nd law of motion $F_C=ma_C$

Where F_c stands for centripetal force.

Putting $a_c=\frac{v^2}{r}$

We get centripetal force as:

$$F_c=\frac{mv^2}{r}$$

b. If $\vec{A} = 8\hat{\imath} + 6\hat{\jmath}$ makes an angle of 30° with positive *y*-axis then what is the magnitude of its *y*-component. **(3)**

Ans. $A = \sqrt{(8)^2 + (6)^2} = \sqrt{64 + 36} = \sqrt{100} = 10$

$A_y = A \sin\theta = 10 \sin 30^\circ = 10 \times 0.5 = 5$ unit.

c. Explain how can we obtain plain polarized light? **(4)**

Ans. We can achieve plain polarized light by:

i. Selective absorption.
ii. Reflection from surface.
iii. Refraction through crystals.
iv. Scattering by tiny particles.

i. Selective absorption method is the most common method to obtain plane polarized light by using dichoric substances. Ordinary unpolarized light falls on polaroid from source. Light after passing through this has only one plane of vibration and hence we can get plane polarized light.

ii. When unpolarized light falls on glass, water etc. at certain angle of incidence called polarizing angle, at this angle the reflected ray and refracted ray are found to be at right angle to each other. In this way reflected light is partially or completely polarized.

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