PART-1 : PHYSICS

SECTION-I (i) : (Maximum Marks: 24)

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s)
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen.
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen.
Partial Marks	:	+2	If three or more options are correct but ONLY two options are chosen and both of which are correct.
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered).
Negative Marks	:	–2	In all other cases.

- **For Example :** If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

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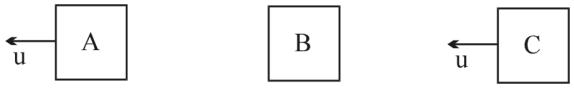
1. Three musicians experiment with the Doppler effect. Musician A rides in a car at a speed u directly away from musician B who is stationary. Musician C rides in a car directly toward B and travels at the same speed as A. Musician A plays a note at frequency f_A on his trumpet. B hears the note, adjusts his trumpet, and plays the same note he heard.



(A) The note heard by C coming from B will be the same pitch as f_A.

(B) The note heard by A coming from B will be higher in pitch than f_A.

(C) The note heard by A coming from B will be lower in pitch than f_A.

(D) The note heard by B coming from A will be lower in pitch than f_A.

2. Following are equations of four waves where x, y, z represent rectangular coordinate system :

(i) $y_1 = a\sin\omega\left(t - \frac{x}{v}\right)$ (ii) $y_2 = a\cos\omega\left(t + \frac{x}{v}\right)$

(iii) $z_1 = a\sin\omega\left(t - \frac{x}{v}\right)$ (iv) $z_2 = a\cos\omega\left(t + \frac{x}{v}\right)$

Which of the following statements is/are correct ?

(A) On superposition of waves (i) and (iii), a travelling wave having amplitude $a\sqrt{2}$ will be formed.

(B) Superposition of waves (ii) and (iii) is not possible.

(C) On superposition of waves (i) and (ii), a transverse stationary wave having maximum amplitude $a\sqrt{2}$ will be formed.

(D) On superposition of waves (iii) and (iv), a transverse stationary wave will be formed.

3. In a series LCR circuit, when an alternating voltage of peak value 500 V and angular frequency 100 rad/s is applied, the peak voltage drops across L, C and R can be respectively

(A) 200 V, 300 V, 0

(B) 800 V, 500 V, 400 V

(C) 600 V, 200 V, 300 V

(D) 1200 V, 1600 V, 0 V

4. The temperature of earth is maintained by a dynamic equilibrium between Sun and Earth. Sun & Earth can be assumed to be black bodies :

(A) If the power output of sun would double with changing the temperature, equilibrium temperature of earth also doubles.

(B) If the radius of sun doubles without changing its' power, its surface temperature would decrease by factor of $\sqrt{2}$.

(C) If the radius of earth doubles without any change in sun, it's equilibrium temperature would increase by factor of $\sqrt{2}$.

(D) If the distance between earth and sun would decrease by a factor of 2, the equilibrium temperature of earth would increase by factor of $\sqrt{2}$.

5. The pitch of screw gauge is 1 mm and its circular scale is divided into 100 divisions. When nothing is put between the studs the zero of main scale is not seen but when circular scale is rotated by 450° the zero of main scale is just visible and the zero of main scale coincides with the zero of circular scale. When a glass plate is placed between the studs, the circular scale lies between 18^{th} and 19^{th} division of main scale and circular scale reads 34 divisions. Then,

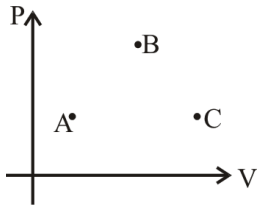
(A) There is positive zero error and its magnitude is 1.25 mm.

(B) There is negative zero error and its magnitude is 1.25 mm.

(C) The thickness of the glass plate is 19.59 mm.

(D) The thickness of the glass plate is 17.09 mm.

6. An ideal gas can expand from state A to C (via state B) through two different process P and Q. In process P, AB and BC are straight lines in P-V diagram. In process Q, states A, B, C are on a circle in P-V diagram. heat supplied and work done by gas in process P and Q are respectively Q_P ; Q_Q and W_P, W_Q :-



(A) $Q_Q > Q_P$

(B) $W_Q < W_P$

(C) $\frac{W_Q}{Q_Q} > \frac{W_P}{Q_P}$

(D) $Q_Q - W_Q = Q_P - W_P$

SECTION-I (ii) : (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each **question has matching lists**. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered)
Negative Marks	:	–1	In all other cases

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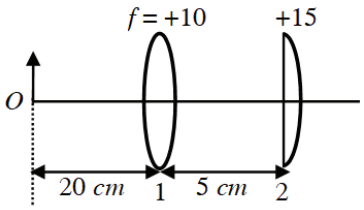
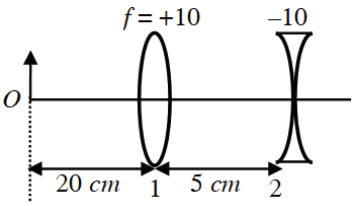
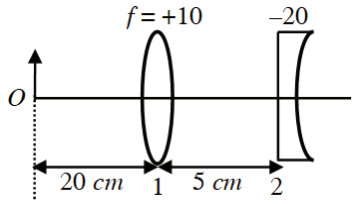
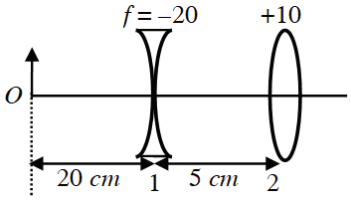
7. List I contains four combinations of two lenses (1 and 2) whose focal lengths (in cm) are indicated in the figures. In all cases, the object is placed 20 *cm* from the first lens on the left, and the distance between the two lenses is 5 *cm*. List II contains the positions of the final images.

List-I		List-II	
(I)		(P)	Final image is formed at 7.5 *cm* on the right side of lens 2.
(II)		(Q)	Final image is formed at 60.0 *cm* on the right side of lens 2.
(III)		(R)	Final image is formed at 30.0 *cm* on the left side of lens 2.
(IV)		(S)	Final image is formed at 6.0 *cm* on the right side of lens 2.
		(T)	Final image is formed at 30.0 *cm* on the right side of lens 2.

Which one of the following options is correct ?

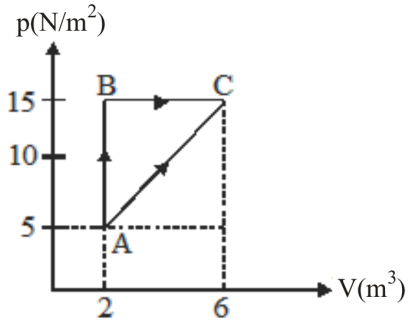
(A) I → P;II → R;III → Q;IV → T

(B) I → Q;II → P;III → T;IV → S

(C) I → P;II → T;III → R;IV → Q

(D) I → T;II → S;III → Q;IV → R

8. An ideal gas is taken along the reversible processes as represented by the adjoining diagram.



List-I		List-II	
(P)	For process B → C	(1)	ΔQ > 0
(Q)	For process A → B	(2)	ΔW > 0
(R)	For cycle A → B → C → A	(3)	ΔU > 0
(S)	For process C → A	(4)	ΔW = 0
		(5)	ΔQ < 0

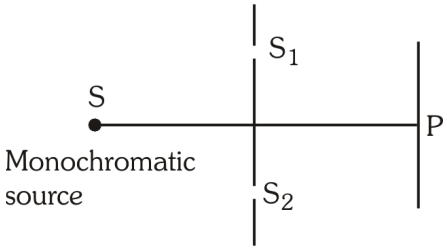
(A) P → 1,2,3;Q → 1,2,5;R → 1,2,3;S → 1,2

(B) P → 1,2;Q → 1,3,4;R → 1,4,5;S → 5

(C) P → 1,2,3;Q → 1,3,4;R → 1,2;S → 5

(D) P → 1,3;Q → 1,3,4;R → 5;S → 4,5

9. A Young's double slit appratus is shown in figure



	List-I		List-II
(P)	Source S move upwards	(1)	Central fringe moves upwards
(Q)	A thin glass slab is placed in front of slit S_2	(2)	Central fringe moves downward
(R)	Whole apparatus is immersed in water	(3)	Fringe width remains constant
(S)	Diameter of slit S_2 is doubled	(4)	Fringe width decreases
		(5)	Intensity of central maxima increases

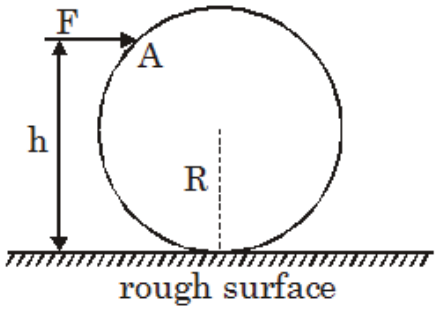
(A) P → 1,2;Q → 3,4;R → 2,5;S → 4

(B) P → 2,3;Q → 2,3;R → 4;S → 3,5

(C) P → 2,3;Q → 3,4;R → 1,4;S → 1,2

(D) P → 1,2;Q → 2,3;R → 2,4;S → 1,3

10. A solid sphere of radius R = 0.5m is placed on a rough surface. A force F = 7 N is applied at point A. Sphere starts to perform pure rolling. Height of point A varies as $h = h_0 + kt$ where $h_0 = 0.1m$, $k = 0.4$ m/sec



	List-I		List-II
(P)	At $t = \frac{5}{4}$ sec frictional force acting on sphere will be	(1)	backward
(Q)	At $t = \frac{3}{2}$sec frictional force acting on sphere will be	(2)	forward
(R)	At $t = \frac{7}{4}$sec frictional force acting on sphere will be	(3)	0
(S)	Work done by friction force from t = 0 to t = 7/4 sec	(4)	1N
		(5)	the magnitude of frictional force is independent of applied force

(A) P → 1,4;Q → 3,5;R → 2,4;S → 3

(B) P → 1,3;Q → 3,5;R → 2,4;S → 4

(C) P → 1,5;Q → 3,5;R → 2,4;S → 3

(D) P → 1,2;Q → 3,5;R → 2,4;S → 3

SECTION-II : (Maximum Marks: 24)

- This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **Two** decimal places; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct)
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct numerical value is entered.
Zero Marks : 0 In all other cases.

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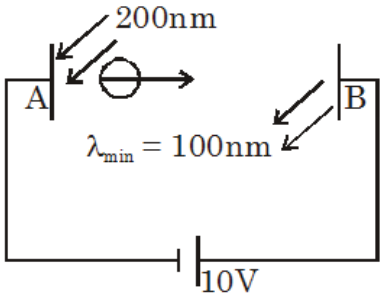
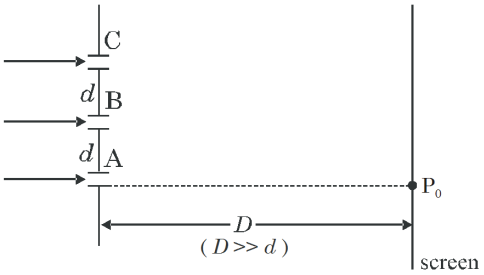
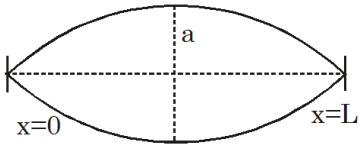
1. In the figure shown electromagnetic radiations of wavelength 200 nm are incident on the metallic plate A. The photo electrons are accelerated by a potential difference 10V. These electrons strike another metal plate B from which electromagnetic radiations are emitted. The minimum wavelength of the emitted photons is 100 nm. Find the work function of the metal 'A' (in eV). Use hc = 12400eVÅ



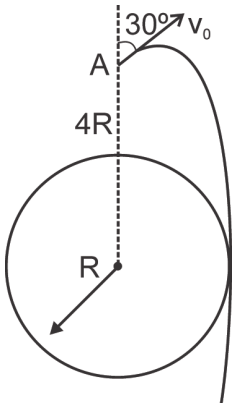
2. Consider superposition of waves coming from three light sources (slits) A, B and C as shown in fig. Given that $BP_0 - AP_0 = \frac{\lambda}{3}$ and $d = \sqrt{\frac{2\lambda D}{3}}$. What is the ratio of intensity at P_0 compared to intensity due to individual slit.



3. A string of mass per unit length μ is clamped at both ends such that one end of the string is at x = 0 and the other end at x = L. When string vibrates in fundamental mode, amplitude of the midpoint of string is a and tension in string is F. Find the total oscillation energy (in J) stored in the string. (Use L = 1m, F = 10 N, $a = \frac{1}{\pi}$ m)



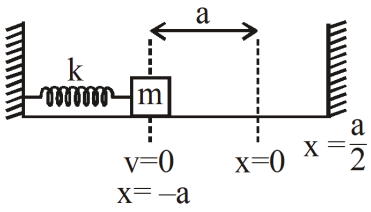
4. A particle is projected from point 'A', that is at a distance 4R from the centre of the earth, with speed v_0 as shown. If the particle passes grazing the earth's surface, then it is found that $v_0 = \sqrt{\frac{GM}{NR}}$. Find the value of N where mass and radius of earth is M and R respectively :



5. Two coherent radio-frequency point sources separated by 2.0 m are radiating in phase with $\lambda = 1.0$m. A detector move in a circular path of large radius around the two sources in a plane containing them. The number of maximas detected by the detector is :-

6. A spring (spring constant k) having one end attached to rigid wall & other end attached to a block of mass m kept on a smooth surface as shown in figure. Initially spring is in its natural length at x = 0, now spring is compressed to x = –a and released. (Coefficient of restitution (e) = $\frac{1}{2}$).

If velocity of block just after first collision is $a\sqrt{\frac{nk}{16m}}$. Find the value of n.



7. A short-sighted person cannot see objects situated beyond 2m from him distinctly. If the power of lens which he should use for seeing distant object clearly is P (in diopter) then the value of 10 |P| is :-

8. Find the distance (in cm) between two images of a point object formed by upper and lower part of the lens when object is placed at 30 cm from given lens.