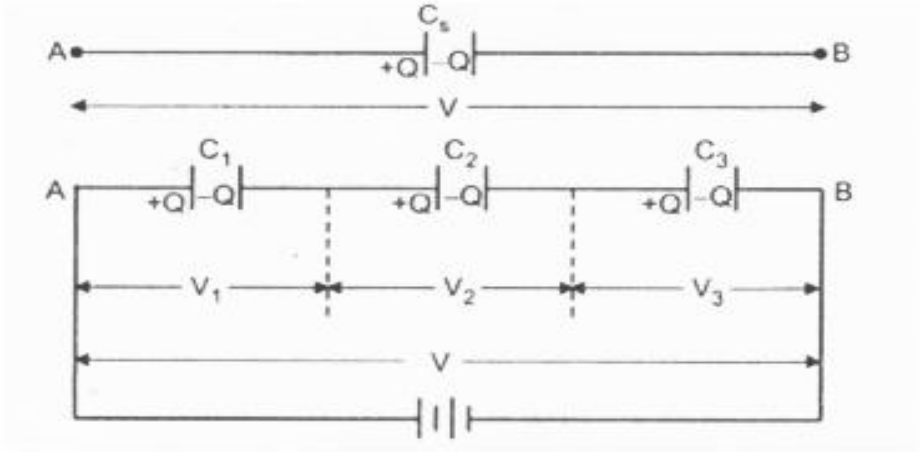
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	a)	**Formula** **Answer with unit** $Q_1 = Q_2 = 1C$ $k = 1$ $d = 1m$ $F = ?$ Formula $F = 9\times10^9 \frac{Q_1 Q_2}{kd^2}$ $F = 9\times10^9 \frac{(1)(1)}{(1)(1)^2}$ $F = 9\times10^9 N$	1 1	2
	b)	**Statement** The force of attraction or repulsion between any two electric charges is directly proportional to the product of the strength of the two charges and inversely proportional to the square of distance between them.	2	2
	c)	**Definition** **Any Two factors** Dielectric Strength: The magnitude of electric field at which dielectric breakdown occurs in an insulating material is called dielectric strength. Dielectric strength depends upon: 1) Nature of material 2) Time for which electric field is applied 3) Temperature 4) Humidity 5) Magnitude of field.	1 1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	d)	**Formula** **Answer with unit** $Abs.Potential(V) = \frac{Work}{Charge}$ $V = \frac{W}{C} = \frac{1600}{25}$ $V = 64$ J/C OR volt	1 1	 2
	e)	**Definition** **Unit** **Capacitance** Capacitance is defined as the ratio of charge on conductor to its potential. **OR** It is also defined as the amount of charge given to a conductor to increase its potential by 1 volt or unity. $C = \frac{Q}{V}$ S. I. unit is Farad (coulomb/volt)	1 1	 2
	f)	**Formula** **Answer** **Given** $\mu_{core} = 1.50$ $\mu_{cladding} = 1.46$ $\therefore N.A. = \sqrt{\mu^2_{core} - \mu^2_{cladding}}$ $= \sqrt{(1.50)^2 - (1.46)^2}$ $= \sqrt{2.25 - 2.13}$ $= \sqrt{0.12}$ $= 0.346$ $= 0.35$	1 1	 2

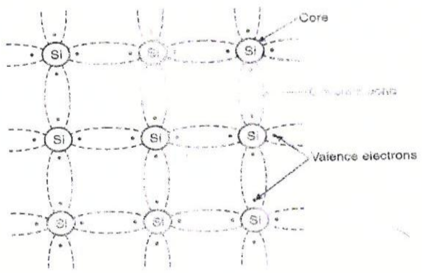
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	g)	**Applications of Optical Fiber (Any Two)** 1. To carry telephone signals. 2. To carry telex signal. 3. To carry fax signal. 4. Used in internet to carry signal. 5. To carry TV cable signal. 6. Fiber sensors are used to measure temperature, pressure. 7. For transmission of digital data. **Note: Any other relevant application to be considered.**	2	2
	h)	**Effect of temperature on resistance of semiconductor:** As temperature of semiconductor increases its resistance decreases.	2	2
	i)	**Definition of conduction band:** The range of energies possessed by conducting electrons is known as conduction band OR The band above the valence band is known as conduction band.	1	
		Definition of valence band: The range of energies possessed by valence electrons is known as valence band OR The band formed by group of energy levels of valence electrons is called valence band.	1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	j)	**Nanotechnology** The design, characterization, production and application structures, devices and systems by controlled manipulation at nanometer scale (atomic, molecular) that produces structures with at least one novel/ superior OR Nanotechnology is the science of engineering matter at the atomic and molecule scale. It is the manipulation precision placement, measurement modeling or manufacture of less than 100 nm scale matter. OR Nanotechnology consists of manipulating matter on atom by atom or molecule by molecule basis to attain the design configuration. OR (Any other Related definition)	2	2
	k)	**Any 2 of the following.** **Advantages of optical fibre over conventional one** 1. In case of optical fibre light is signal carrier and in case of ordinary cable communications electricity is signal carrier. 2. Optical fibre communication is electrically insulated or protected since light carries signal 3. Light has high band width. (10GHz) i.e. many signal carries or can be sending through single optical fibre. 4. Optical fibre due to their light weight and flexibility it can be handled easily. 5. Longer life, easy maintenance, temperature resists. 6. There is no signal leakage and hence cross talk between neighboring fibres is almost absent. 7. Ordinary cables are metallic hence it picks up electromagnetic waves but optical fibres are not metallic do not pick up electromagnetic waves.	2	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	a)	**Formula** **Answer with unit** Given $r = 10cm = 0.1m$ $Q = 1000\mu C = 1000 \times 10^{-6} C$ $d = 12cm = 0.12m$ $k = 1$ $V = ?$ **i) Electrical Potential on the surface of Sphere** $V = 9 \times 10^9 \frac{Q}{kr}$ $V = 9 \times 10^9 \frac{1000 \times 10^{-6}}{(1)(0.1)}$ $V = 90000 \times 10^3$ $V = 9 \times 10^7$ J/C OR volt **Formula** **Answer with unit** **ii) Electrical Potential at point 12cm from the center** $V = 9 \times 10^9 \frac{Q}{kd}$ $V = 9 \times 10^9 \frac{1000 \times 10^{-6}}{(1)(0.12)}$ $V = 75000 \times 10^3$ $V = 7.5 \times 10^7$ J/C OR volt	1 1 1 1	 4
	b)	**Statement** **Well Labeled Diagram** **Explanation & Substitution** **Final Expression** **Statement: -** Reciprocal of equivalent capacitance of the series combination is equal to the sum of reciprocals of capacitances of the condensers in series.	1 1 1 1	 4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	b)	 **Resultant Capacitance when Condensers are Connected in Series:** Consider three condensers C_1, C_2 & C_3 are connected in series between two points A and B with potential difference of V volt. When condensers are connected in series the **total charge on each condenser remains the same and the potential difference across each condenser gets divided** into three parts V_1, V_2 & V_3 which depends on values of capacitor $$V = V_1+V_2+V_3$$ But $C = \frac{Q}{V}$ $$V = \frac{Q}{C}$$ Potential Difference across C_1 is $V_1 = \frac{Q}{C_1}$ Potential Difference across C_2 is $V_2 = \frac{Q}{C_2}$ Potential Difference across C_3 is $V_3 = \frac{Q}{C_3}$ Potential Difference across C_s is $V = \frac{Q}{C_s}$		

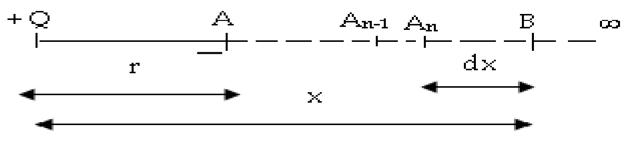
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	b)	$$\therefore \frac{Q}{C_s} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$ $$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$		
	c)	**Each Definition**	1	
		Units	1	4
		i) Electric field: It is defined as the space around the charge in which electric effects such as attraction or repulsion due to a charge can be observed. **OR** Electric field of a charge is the space around the charge where force of attraction or repulsion due to a charge is present. Unit:- No unit **ii) Electric Flux:** The total number of electric lines of force originating from a charged body is called electric flux of that charged body. **Unit:-** coulomb **iii) Electric Flux Density:** The number of electric lines of force crossing unit area held perpendicular to electric lines of force which pass through center of area. **OR** The number of electric lines of force passing normally per unit surface area. **Unit:-** C/m^2		

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	d)	Nanoparticle is a particle having dimensions less than 100 nm.Properties that differentiate Nanoparticles from the bulk material are happening below scale of 100nm. At this nanoscale the colour, melting point, chemical properties, strength, resistance etc. of material changes. Ex. If we take a cube of gold its colour is yellow but if we consider gold particle in nano-size its colour changes. Thus size of particles is the important feature that differentiates nanoparticles from bulk material.	4	4
	e)	**Well Labeled Diagram** **Explanation** A pure semiconductor are called intrinsic semiconductor. An intrinsic semiconductor (like Silicon or Germanium) has four electrons in its outermost orbit of its atoms. In order to fill the valence shell each atom requires four more electrons which is done by sharing one electron from each of the four neighboring atoms as shown fig.  A covalent bond consist of 2 electrons one from each adjacent atom. Both electrons are shared by two atoms. At absolute zero temperature all valance electrons are tightly bound to the parent atoms. Thus there are no free electrons available for electrical conduction. Thus semiconductor behaves as a perfect insulator at absolute zero temperature.	2 2	4
	f)	**Principle:** Total Internal Reflection (TIR) is the principle of optical fibre.	1	4

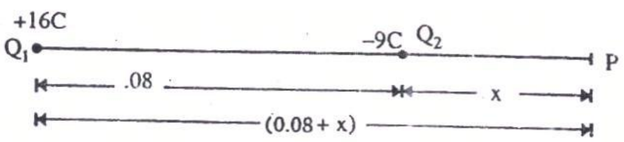
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	f)	**Two Conditions.** **Conditions for TIR** 1) The ray of light must travel from denser medium to rarer medium or source should be kept in a denser medium whose refractive index (R.I.) is high. 2) The angle of incidence in the denser medium should be greater than the critical angle for the pair of media in contact. OR 1) The ray of light must travel from media of high R.I. to lower R.I. 2) i>θ_c (Critical angle)	3	
3)	a)	**Any Four Points**	4	4

Multimode step index fiber	**Multimode graded index fiber**
This type of fiber carries many modes of step index fiber	This type of fiber carries many modes of graded index fiber
More modal dispersion	Less modal dispersion
Refractive index of core is uniform throughout its thickness	Refractive index of core varies with radial distance from axis. The refractive index is maximum at axis of core and decreases gradually towards the older edges
Light propagates in zigzag fashion	Light propagates in curved fashion

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	b)	**Definition** **Types** A semiconductor obtained by doping is called Extrinsic Semiconductor Types of Extrinsic Semiconductor P – Type Semiconductor N – Type Semiconductor **Any two of the following.** **P – Type Semiconductor:** 1) When a small amount of trivalent impurity is added to a pure semiconductor it is called as P-type semiconductor. 2) In p-type majority charge carries are holes. 3) The impurity used is called accepter impurity. 4) The doping give rise to vacancy (Short of electron) in a covalent band 5) e.g. Indium, Boron, Aluminum etc. 6) Diagram of P- type **N – type Semiconductor:** 1) When a small amount of pentavalent impurity is added to a pure semiconductor it is called as N-type semiconductor. 2) In n-type majority charge carries are electrons 3) The impurity used is called doner impurity. 4) The doping give rise to presence of free electrons 5) e.g. Arsenic, Phosphorous, antimony etc 6) Diagram of N- type	1 1 2	 4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	c)	Equivalent capacitance of two identical condensers in series combination $c_s = \frac{c^2}{2c} ------(1)$ [Where, $C_1 = C_2 = C$] Similarly Equivalent capacitance of two identical condensers in parallel combination $c_p = 2c ------(2)$ Four times of equivalent capacitance in series combination, that is $4c_s = 4\left(\frac{c^2}{2c}\right)$ $4c_s = 2c ------(3)$ Comparing eq (2) & eq (3) we get $c_p = 4c_s$ Hence proof.	1 1 1 1	4
	d)	**Diagram** **Derivation**  Consider a point charge Q. 'A' is any point in the electric field of charge Q. Let r = Distance of 'A' from Q. X = Distance of 'B' from Q. ε_0 = Permittivity of free space. Strength of the electric field at point 'A' due to Q is, $E_A = \frac{1}{4\pi\varepsilon_0 k}\frac{Q}{r^2}$ Similarly, intensity at point 'B' due to Q is, $E_B = \frac{1}{4\pi\varepsilon_0 k}\frac{Q}{x^2}$ In order to move a unit positive charge by a very small distance dx	1 3	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	d)	Against the field, some work is required. Let the work done be dw which is given by Work done = Force on unit positive charge x Displacement $dw = -\left(\frac{1}{4\pi\varepsilon_0 k}\frac{Q}{x^2}\right)dx$ Negative sign indicates that work is done against the electric field. Thus if unit positive charge is moved in very small steps from B to A then total work done is $W = dw_1 + dw_2 + dw_3 + ------$ This can be done by integration method. $V = \int dw$ We know that, potential at point 'A' is the total work done in bringing unit positive charge from ∞ to point 'A'. Putting the limits i.e. r to ∞, $V = \int_{\infty}^{r} dw$ $V = \int_{\infty}^{r} -\left(\frac{1}{4\pi\varepsilon_0 k}\frac{Q}{x^2}\right)dx$ $V = -\left(\frac{Q}{4\pi\varepsilon_0 k}\right)\int_{\infty}^{r}\left(\frac{1}{x^2}\right)dx$ $V = -\left(\frac{Q}{4\pi\varepsilon_0 k}\right)\int_{\infty}^{r} x^{-2}dx$ $V = -\left(\frac{Q}{4\pi\varepsilon_0 k}\right)\left[-\frac{1}{x}\right]_{\infty}^{r}$ $V = \frac{Q}{4\pi\varepsilon_0 k}\frac{1}{r} - 0$ $V = \frac{Q}{4\pi\varepsilon_0 k}\frac{1}{r}$ $V = 9\times10^9\frac{Q}{kr}$		

Que. No.	Sub. Que.	Stepwise Solution		Marks	Total Marks
3)	e)	**Formula** **Substitution** **Ans. With unit** $d=10^{-3}m$ $k=7$ $A=3.21m^2$ $\varepsilon_0=8.9\times10^{-12}SI$ $k=?$ $Formula:$ $c=\frac{\varepsilon_0 kA}{d}$ $c=\frac{8.9\times10^{-12}\times7\times3.21}{10^{-3}}$ $c=199.98\times10^{-12}\times10^{3}$ $c=199.98\times10^{-9}F$		**1** **1** **2**	4
	f)	**Formula** **Substitution** **Ans. With unit**  $E_1=9\times10^9\frac{Q_1}{k(0.08+x)^2}$ $E_2=9\times10^9\frac{Q_2}{kx^2}$ Now E1 + E2 = 0 $\frac{9\times10^9}{k}\frac{16}{(0.08+x)^2}+\frac{9\times10^9}{k}\frac{(-9)}{(x^2)}=0$ $\frac{16}{(0.08+x)^2}-\frac{9}{x^2}=0$		1 1 2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
		$\frac{16}{(0.08+x)^2}=\frac{9}{x^2}$ $\frac{4}{(0.08+x)}=\frac{3}{x}$ $4x=0.24+3x$ $x=0.24$ m The point is 0.24 m from a charge of -9C.		

Important Instructions for Examiners

1) The definitions given herein are just sample definition format and not to be treated as standard format. Student may write definition in the other words. Such definitions are to be considered and give appropriate marks.

Wherever labeled diagrams are asked in the question, marks to be given for the neat-labeled diagram. If, in case, student has drawn only the diagram without labeling, appropriate marks to be deducted.