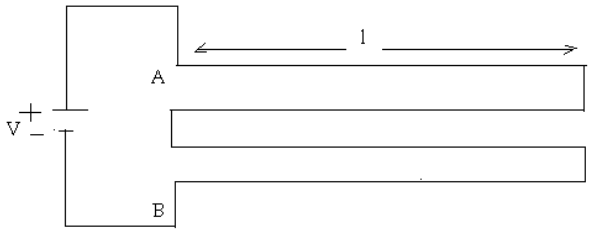
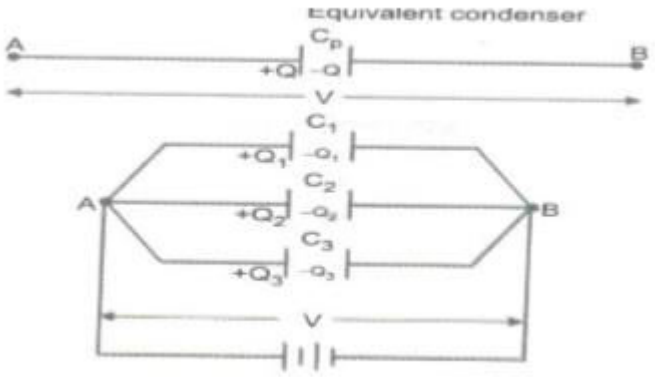
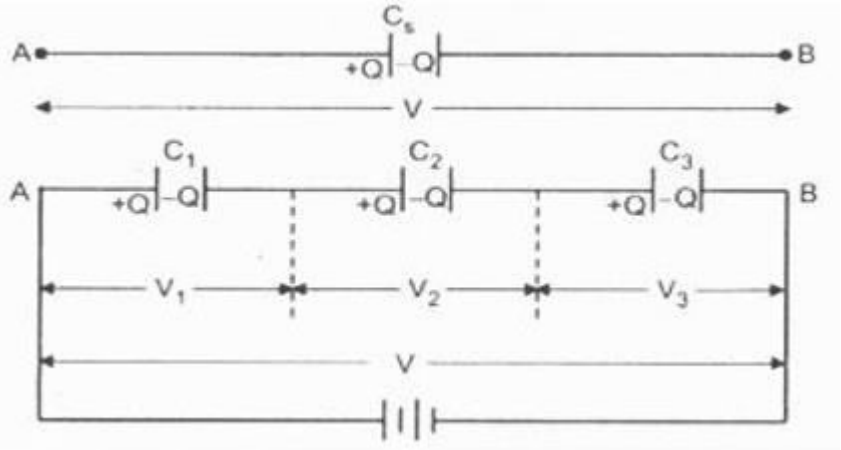
WINTER– 18 EXAMINATION

Subject Name: Applied Physics **Model Answer** Subject Code: 17210

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1.		**Attempt any NINE of the following:**	**18**
	a)	**Define conductivity and state its unit.**	**2**
		Definition	1
		Unit	1
		Conductivity:- It is defined as the reciprocal of resistivity. **OR** It is defined as the reciprocal of specific resistance.	
		Unit:- siemens/meter or S/m	
	b)	**Draw a neat labeled circuit diagram of a potentiometer.**	**2**
		Labeled diagram	2
		 Potentiometer	
	c)	**Define potential gradient. State its S.I. unit.**	**2**
		Definition	1
		S.I.Unit	1

Q. No.	Sub Q. N.	Answers	Marking Scheme
1.	c)	**Definition**: - Potential gradient is defined as the fall of potential per unit length of potentiometer wire. **OR** P.G. = Potential / Length **S.I. Unit :-** V/m.	
	d)	**Draw the symbols when i) Condensers are in parallel ii) Condensers are in series.** **Each symbol** **i) Condensers in parallel**  **ii)Condensers in series:-**  	**2** 1
	e)	**Define conduction band & forbidden energy gap.** **Each definition** **Conduction band :**Range of energy possesed by conduction electrons is called **conduction band.** **Forbidden energy gap :** The energy difference between conduction band and valance band is called forbidden energy gap.	**2** 1

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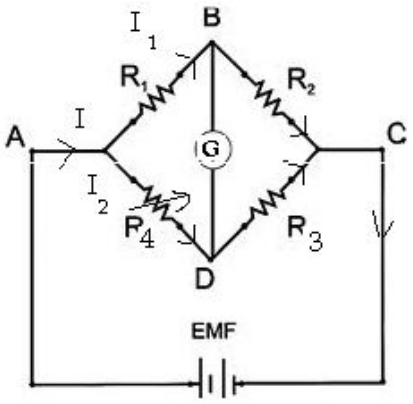
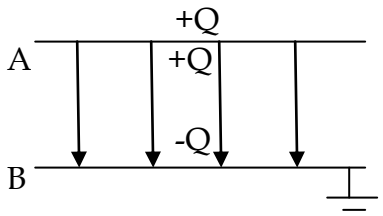
Q. No.	Sub Q. N.	Answers	Marking Scheme
1.	f)	**Write any two applications of photodiode.**	**2**
		Any two applications	2
		Application of photodiode 1. It is used as light sensor in remote controlled television set. 2. It is used as light sensor in remote controlled air conditioner 3. It is used as object counter to count object, cards etc. 4. It is used as smoke detector. 5. It is used as encoder. 6. It is used as position sensor.	
	g)	**An X-ray tube is operated at 80kV. Calculate minimum wavelength of X-rays emitted by it.**	**2**
		Formula with substitution	1
		Answer with unit	1
		Given V = 80 kV = 80 x 10^3 V We have, $\lambda_{min} = \frac{hc}{eV}$ $\lambda_{min} = \frac{6.634\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times80\times10^{3}}$ $\lambda_{min} = \frac{19.90\times10^{-26}}{92.8\times10^{-16}}$ $\lambda_{min} = 0.155\times10^{-10}\,m$ *OR* $\lambda_{min} = \frac{12400}{V}$ $\lambda_{min} = \frac{12400}{80\times10^{3}}$ $\lambda_{min} = 0.155\times10^{-10}\,m$	
	h)	**State two properties of X-rays**	**2**
		Any two Properties i. They are electromagnetic waves of very short wavelength ii. They travel with speed of light. iii. They affect photographic plates. iv. They produce fluorescence in many substances. v. They can be reflected or refracted under certain conditions. vi. They are not deflected by magnetic or electric field. vii. They have high penetrating power. **viii.** They produce photoelectric effect.	2

Q. No.	Sub Q. N.	Answers	Marking Scheme
1.	h)	ix. They are invisible to eyes. x. X-ray kill some form of animal cell.	
	i)	**Give the full form of LASER.** **Full form** Light Amplification by Stimulated Emission of Radiation.	**2** 2
	j)	**Give any two applications of LASER.** **Each Application** i) Lasers are used for engraving and embossing of printing plates For example- number plate, name plate etc., ii) Lasers are used in cutting, drilling and welding metals. iii) Lasers are used in holography iv) Lasers are used in computer printers v) Lasers are used for 3D, Laser scanners vi) Lasers are used in controlled heat treatment vii) Lasers are used for data transfer through optical fiber from one computer to other viii) Lasers are used to find flaws or defect in material.	**2** 1
	k)	**What is Nano-technology? Define nano scale.** **Each definition** **Nanotechnology:-**The branch of engineering that deals with things having the dimensions smaller than 100 nm is called nanotechnology. **Nanoscale:-**The scale range from 1nm to 100 nm is called nanoscale. **Any relevant answer may be considered.**	**2** 1
	l)	**State two properties of nano material.** **Any two properties** i. Mechanical property. ii. Structural property. iii. Thermal property. iv. Electric property. v. Magnetic property. **vi.** Optical property.	**2** 2

Q. No.	Sub Q. N.	Answers	Marking Scheme
2.		**Attempt any FOUR of the following:**	16
	a)	**Calculate the resistivity and conductivity of a wire having diameter 0.3 mm, length 4m and its resistance is 30Ω.**	**4**
		Each formula with substitution	1
		Each answer with unit	1
		Given dia = 0.3 mm = 0.3 x 10^{-3} m radius r = 0.15 x 10^{-3} m, L = 4 m, R = 30Ω Resistivity (ρ) = RA / L = R π r^2 / L ρ = 30 x 3.14 x (0.15 x 10^{-3})^2 / 4 **ρ = 0.529 x 10^{-6} Ωm** Conductivity (σ) = 1 / ρ = 1 / 0.529 x 10^{-6} **σ = 1.890 x 10^6 S / m.**	
	b)	**State and explain the balancing condition of Wheatstones network with neat diagram.**	**4**
		Diagram	2
		Explanation	2
			
		In this network R_1,R_2,R_3 are kept constant and R_4 is so adjusted that galvanometer shows zero deflection. When galvanometer shows zero deflection, network is said to be balanced. Network is balanced means points B and D are at equal potential. This is possible if , (P.D. across AB) =(P.D. across AD) and (P.D. across BC)= (P.D. across DC) Using Ohm's law, $I_1R_1 = I_2R_4$ ……..(1) $I_1R_2 = I_2R_3$ ……..(2) Dividing equation (1) by (2) we get $$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_4}{I_2R_3}$$	

Q. No.	Sub Q. N.	Answers	Marking Scheme
2.	b)	$\frac{R_1}{R_2} = \frac{R_4}{R_3}$ This is the balancing condition of Wheatstone's network.	
	c)	**Derive an expression for the capacitance of a parallel plate capacitor.** **Diagram** **Equation with symbol meaning** **Final equation of capacity**	**4** 1 2 1



Consider two metal plates A and B as shown above,
Let
A = Area of each plate
d= Distance between two plate
+Q = Charge given to A
-Q= Charge induce to inner side of B
V=P. D. between two electrode
k = Dielectric constant of the medium
Then,
The electric flux density D between the two plate is given by,

$D = \varepsilon_0 k.E$

Where,
E = Electric Intensity
ε_0 = Permittivity of free space
But,

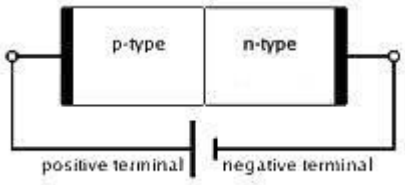
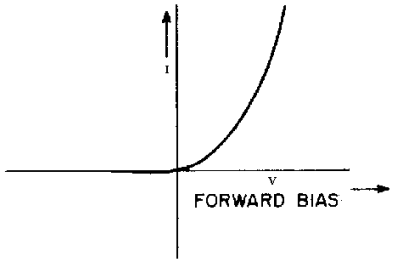
$$D = \frac{\Psi}{A} = \frac{Q}{A} \qquad \text{(Where, } \Psi \text{ is electric flux)}$$

$$\therefore \frac{Q}{A} = \varepsilon_0 kE$$

$$\therefore \frac{Q}{A} = \varepsilon_0 k \frac{V}{d}$$

$$\therefore \frac{Q}{V} = \varepsilon_0 k \frac{A}{d}$$

Q. No.	Sub Q. N.	Answers	Marking Scheme
2.	c)	$\because \frac{Q}{V} = C$ $\therefore C = \varepsilon_0 k \frac{A}{d}$	
	d)	**Two condensers of capacitance 15μF and 10 μF are connected in parallel across a battery of 12 volt. Find the resultant capacitance and charge on each condenser.** **Formula with substitution** **Answer with unit** **Given** $C_1 = 15\mu F = 15 \times 10^{-6} F$ $C_2 = 10\mu F = 10 \times 10^{-6} F$ $V = 12 V$ Resultant capacitance $Cp = C_1 + C_2 = 15 + 10$ **$Cp = 25\ \mu F$** Voltage across $C_1 = C_2 = V$ $Q_1 = C_1V = 15 \times 10^{-6} \times 12$ **$Q_1 = 180 \times 10^{-6}$ C or 180 μC** $Q_2 = C_2V = 10 \times 10^{-6} \times 12$ **$Q_2 = 120 \times 10^{-6}$ C or 120 μC**	**4** 2 2
	e)	**Classify the solids into conductors, semiconductors and insulators on the basis of band theory of solids.** **In conductors** there is no energy gap between valance band and conduction band, they are overlapped on each other. So electrons can jump from valance band to conduction band easily and material conducts the current. **In semiconductors** the energy gap between valance band and conduction band is very small i.e. 1eV. So electrons can jump from valance band to conduction band when small amount of energy is supplied to it. Therefore conductivity of semiconductors is in between conductors and insulators. **In insulators** the energy gap between valance band and conduction band is very large i.e. 5.5eV. So electrons cannot jump from valance band to conduction band when some amount of energy is supplied to it. Therefore insulators cannot conduct the current.	**4**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2.	f)	**With I-V curve, explain the forward biased characteristics of a PN junction diode.** **Each Diagram** 1 **Explanation** 2  **Explanation:** Above circuit diagram shows PN junction diode in forward bias mode. In forward bias mode P-type of semiconductor is connected to positive terminal and N-type of semiconductor is connected to negative terminal of battery. As voltage increases current starts flowing through diode. When the voltage applied across PN junction reaches to 0.7V (Si) the current flows through the diode i.e. the diode start conducting current. Following graph shows current voltage characteristics of PN junction forward bias.  *Voltage-current characteristic for a p-n junction.*	**4**

Q. No.	Sub Q. N.	Answers	Marking Scheme
3.		**Attempt any FOUR of the following:**	**16**
	a)	**Distinguish between intrinsic and extrinsic semiconductor.(Any four points)**	**4**
		Each point	1

Intrinsic Semiconductor	**Extrinsic Semiconductor**
It is a pure semiconductor.	It is a impure semiconductor.
No. of electrons is always equals to No. of holes.	No. of electrons are not equals to No. of holes.
Conductivity is poor.	Conductivity is higher.
Current conduction is due to electrons and holes.	to electrons and holes. Current conduction is due to electrons and holes depending upon types of semiconductor.

	b)	**The photoelectric work function of a metal is 5 eV. Calculate the threshold frequency. (Given 1eV=1.6 x 10^{-19} J and h = 6.63 x 10^{-34} Js.)**	**4**
		Formula with substitution	2
		Answer with unit	2

Given : $W_0 = 5$ eV $= 5 \times 10^{-19}$ J

$1eV = 1.6 \times 10^{-19}$ J

$h = 6.63 \times 10^{-34}$ Js

Required : ν_0 = ?

$W_0 = h\nu_0$

$\nu_0 = W_0 / h$

$\nu_0 = 5 \times 1.6 \times 10^{-19} / 6.63 \times 10^{-34}$

ν_0 = 1.2 x 10^{15} Hz

	c)	**State four applications of X-ray's.**	**4**
		Each application.	4

Application of X-rays:

i)X- rays are used to detect the cracks in the body of aero plane

ii) X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in quality control.

iii) X – rays are used to detect flows or cracks in metal jobs

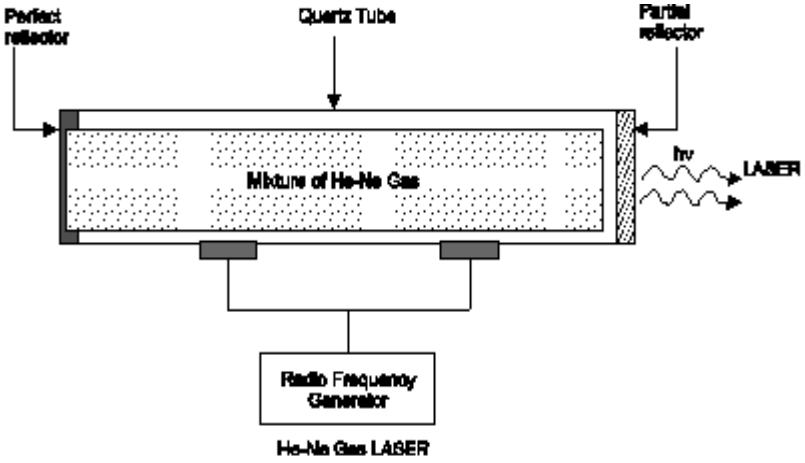
iv) X- rays are used to distinguish real diamond from duplicate one.

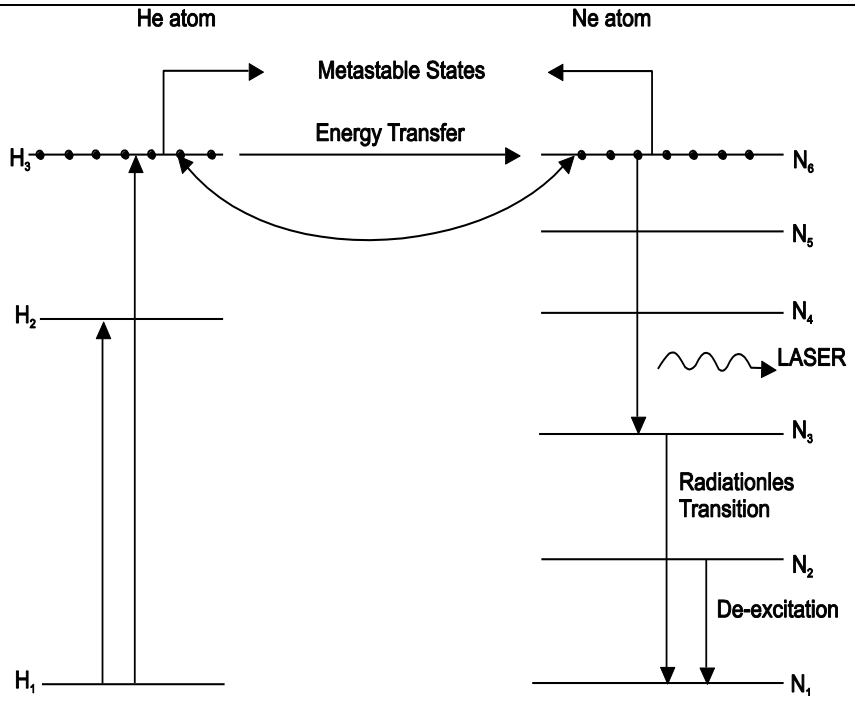
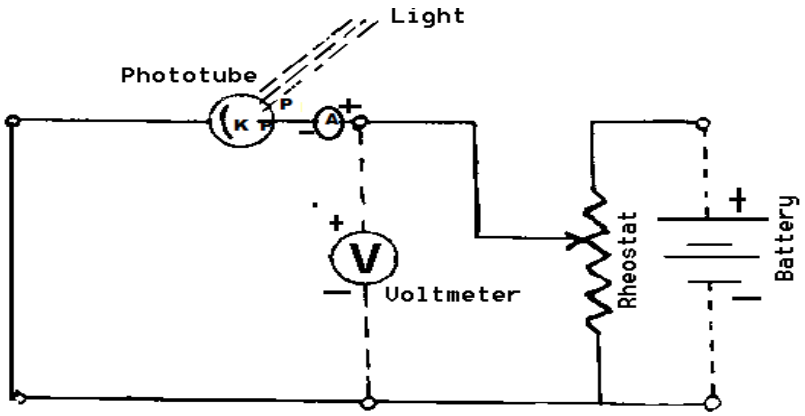
v) X- rays are used to detect smuggling gold at airport and docks (ship) yard.

vi) X-rays are used to detect cracks in the wall.

vii) X- ray radiography is used to check the quality of welded joints.

Any other relevant application may consider.

Q. No.	Sub Q. N.	Answers	Marking Scheme
3.	d)	**Explain with help of neat labeled diagram the working of He-Ne Laser.** **Each diagram** **construction** **working** **Construction :** 1. It consists of a quartz tube of about 80 cm length and 1.5 cm diameter. 2. The tube is filled with mixture of helium (He) and neon (Ne) gas. 3. The mixture consists of 90% helium atoms and 10% neon atoms. 4. At one end perfect reflector is fixed and at the other end partial reflector is fixed.  He-Ne Gas LASER **Working :** (1)When electric discharge is produced in the tube, He and Ne gas atoms are excited. Some excited levels of helium are close to some excited levels of neon. Therefore these excited helium atoms collide with excited atoms of neon and transfer the energy to neon atoms. (2) The actual lasing action is done by neon atoms. The neon atoms with extra energy from helium atom are forced to jump in ground state by emitting a photon. This produces the LASER light. The newly emitted photon triggers the next neon atom and increases the radiations. (3) Thus coherent, monochromatic, unidirectional LASER is produced by He-Ne gas LASER The energy level diagram of He-Ne LASER is shown below.	**4** 1 1 1

Q. No.	Sub Q. N.	Answers	Marking Scheme
3.	d)		
	e)	**Explain photoelectric effect with suitable diagram.** **Diagram** **Explanation** 	**4** 2 2

Q. No.	Sub Q. N.	Answers	Marking Scheme
3.		**Explanation:-** An evacuated quartz bulb contains two plates P and K. Plate K connected to negative terminal of battery and Plate P connected to positive terminal of battery through ammeter. When light is fall on plate K, photoelectrons are emitted from plate K. these electrons get attracted towards plate P since it is at positive potential. Thus circuit gets completed and current starts flowing. This current is called as photoelectric current.	
	f)	**State any four applications of nano-technology in field of engineering.** **Any four application** **Applications of nano-material in engineering field.** 1. **Data storage system –** Semiconductor material in the form of film can be deposited on substrate to form the chip. 2. **Use of nanomaterial in energy sector** – The conventional energy sources like coal, fuel are depleting day by day, thus use of alternative energy source is inevitable. 3. **Application in automobiles-** High mechanical strength material but light in weight can be produced by using nanotechnology. Nanopainting materials can be used to get uniform layer of coating on the vehicle body. 4. **Application in consumer goods –** Nanotechnology has wide applications in cosmetics, domestics products and textiles. Using nanomaterial fiber, one can get comfort of cotton clothes. **Any other relevant application**	**4** 4