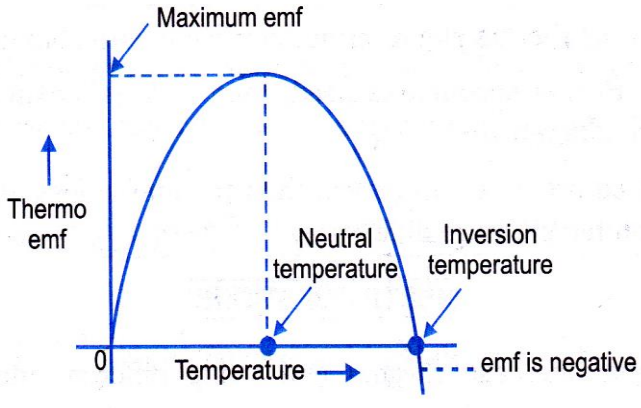
WINTER– 19 EXAMINATION

Subject Name: Applied Physics **Model Answer** Subject Code: 17202

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)	**State relation between linear velocity and angular velocity.** Relation between linear velocity and angular velocity is **$v = r \omega$**	**2**
	b)	**Determine the quantity of water raised in 15 min. to height of 24 m by using pump of 12 kW.** **Formula with substitution** **Answer with unit** Given:- t = 15 min.= 15 x 60 = 900 sec. h = 24 m, power = 12 kW = 12000 watt Power = Work / time = mgh / t m = (power x t) / gh m = (12000 x 900) / (9.81 x 24) m = 45871.56 kg **m = 45871.56 liters** **(** for water 1 kg = 1 liter)	**2** 1 1
	c)	**Porter lifts a suitcase weighting 20 kg from the platform and put it on his head 2 m above the platform. Calculate the work done by porter on the suitcase.** **Formula with substitution** **Answer with unit** Given:- m = 20 kg, h = 2 m, w = ? Work done = mgh = 20 x 9.8 x 2 **Work done = 392 J**	**2** 1 1

Q. No.	Sub Q. N.	Answers	Marking Scheme
1.	d)	**Define centripetal force and centrifugal force** **Each Definition** **Centripetal force –** It is defined as the force acting along the radius towards the center of the circular path, which keeps the particle in uniform circular motion. **OR** Centripetal force is the force acting on a particle performing uniform circular motion which is along the radius and towards the center of circular path. **Centrifugal force –** It is defined as the force acting on a particle performing uniform circular motion which is directed away from center and along the radius of the circular path. **OR** A particle performing uniform circular motion experiences force which is along the radius and away from the center is called Centrifugal force.	**2** 1
	e)	**State any two properties of ultrasonic waves.** **Each Property** i) Frequency of these sound waves is more than 20kHz ii) Shorter wavelength iii) They carry high amount of sound energy iv) The speed of propagation of ultrasonic waves increases with increase in frequency v) They show negligible diffraction vi) Ultrasonic waves travel over long distance without considerable loss vii) Ultrasonic waves undergo reflection and refraction at the separation of two media viii) If it passed through fluid, then temperature of the fluid increases. ix) Travel with constant speed through a homogeneous medium. x) Posses certain vibrations which are used as good massage action in case of muscular pain.	**2** 1
	f)	**Explain variation of thermo e.m.f. with temperature.** **Diagram** **Explanation**  	**2** 1 1

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1.	f)	For a given thermocouple , the temperature of one junction is placed at 0^0C and temperature of other junction is increased by providing heat. The emf generated is measured with the help of millivoltmeter. Emfs e_1, e_2, e_3,……for different temperatures t_1, t_2, t_3,…… are recorded and the graph is plotted. It is observed that as the temperature difference between two junctions increases, emf also increases and reaches to maximum value and thereafter emf decreases, becomes zero and reverses its sign.	
	g)	**State Joules law of heating.** **Statement** **Joules law :** It state that the amount of heat generated (H) due to the flow of electric current through a resistance is directly proportional to 1) Square of the current (I^2) 2) Resistance (R) 3) Time for which current flows (t)	**2** 2
	h)	**Define Work function and Stopping potential.** **Each Definition** **Work Function:** It is the minimum energy required just to emit or detach or knock the electron from the metal surface. **Stopping potential:** It is the negative potential of photoelectric cell at which photoelectric current becomes zero.	**2** 1
	i)	**The photoelectric work function of a metal is 5 eV. Calculate threshold wavelength.** **Formula with substitution** **Answer with unit** Given:- Wo = 5 eV = 5 x (1.6 x 10^{-19}) J λo = ? We have υ_o = Wo / h = (5 x 1.6 x 10^{-19}) / (6.63 x 10^{-34}) υ_o = 1.212 x 10^{15} Hz λo = c / υ_o = 3 x 10^8 / 1.212 x 10^{15} **λo = 2475 A^0**	**2** 1 1
	j)	**State formula for cut-off wavelength of X-rays and explain meanings of symbols used in it.** **Formula** **Meaning of symbol**	**2** 1 1

Q. No.	Sub Q. N.	Answers	Marking Scheme
1.	j)	$\lambda_{min} = \frac{hc}{eV}$ λ_{min} = minimum wavelength of X - ray h = Planck's constant C = Velocity of light e= Charge of electron V = Applied voltage	
	k)	**State any two applications of X-rays.** **Any two applications** 1. X- rays are used to detect the cracks in the body of aero plane or motor car. 2. X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in quality control. 3. X – rays are used to detect flaws or cracks in metal jobs. 4. X- rays are used to distinguish real diamond from duplicate one. 5. X- rays are used to detect smuggling gold at airport and docks (ship) yard. 6. X-rays are used to detect cracks in the wall. 7. X- ray radiography is used to check the quality of welded joints. 8. X – Rays are used in surgery to detect bone fractured. 9. X- Rays are used to cure skin diseases and destroy tumours. 10. X – Rays are used to cure diseases like cancer. 11. X – Rays are used to detect bullets position inside the body.	**2** 2
	l)	**Distinguish between stimulated emission and spontaneous emission.** **Two points**	**2** 2

Spontaneous emission	**Stimulated emission**
Excited atoms comes to ground state on its own accord	Excited atoms comes to ground state after interaction with incident photon.
Radiations are in random direction , phase and wavelength	Radiations are coherent , monochromatic and in same direction.
Independent of outside circumstances	Dependent of outside circumstances
No metastable state exist (ordinary exited state)	Metastable state exist
Number of photons emitted are less	Number of photons emitted are more

Q. No.	Sub Q. N.	Answers	Marking Scheme
2.		**Attempt any Four of the following:**	**16**
	a)	**A railway wagon of mass 200 kg moving with a velocity of 18 km/hr has a head on collision with a stationary wagon of 3000 kg. If wagon move together after collision. Calculate their common velocity and loss of kinetic energy due to collision.**	**4**
		Each formula with substitution	2
		Each answer with unit	2
		Given:- $m_1 = 200$ kg, $v_1 = 18$ km/hr $= 18 \times 1000 / 60 \times 60 = 5$ m /s $m_2 = 3000$ kg $v_2 = ?$ K.E. = ? We have $m_1 \times v_1 = m_2 \times v_2$ $v_2 = m_1 \times v_1 / m_2 = 200 \times 5 / 3000$ **$v_2 = 0.333$ m / s** i.e. common velocity = 0.333 m/s^2 K.E. before collision = ½ $m_1v_1^2$ = ½ (200 x 5^2) = 2500 kg.m/s^2 K.E. after collision = ½ $m_1v_1^2$ = ½ (3000 x 0.333^2) = 332.67 kg.m/s^2 Therefore loss of K.E. = 2500 – 332.67 = 2167.33 kg.m/s^2	
	b)	**A bullet is fired with a velocity of 490 m/s at an angle of 30^0 with the horizontal. How high will it rise? How long will it takes to reach to this height?**	**4**
		Each formula	2
		Answer with unit	2
		Given : v = 490 m/s $\theta = 30^0$ g = 9.81 m/s^2 H = ? R = ? Maximum height $H = (v \sin\theta)^2 / 2g$ $H = (490 \times \sin 30^0)^2 / 2 \times 9.81$ **H = 3059.37 m** Range $R = v^2 \sin 2\theta / g$ $R = (490)^2 \times \sin 2(30) / 9.81$ **R = 21195.99 m**	
	c)	**Explain production of ultrasonic wave by using piezoelectric method.**	**2**
		Diagram with label	2
		Principle	1
		Working	1
		Principle: When the electric field is applied across the crystal its dimensions changes and when alternating PD is applied across crystal then the crystal sets into elastic vibrations  	

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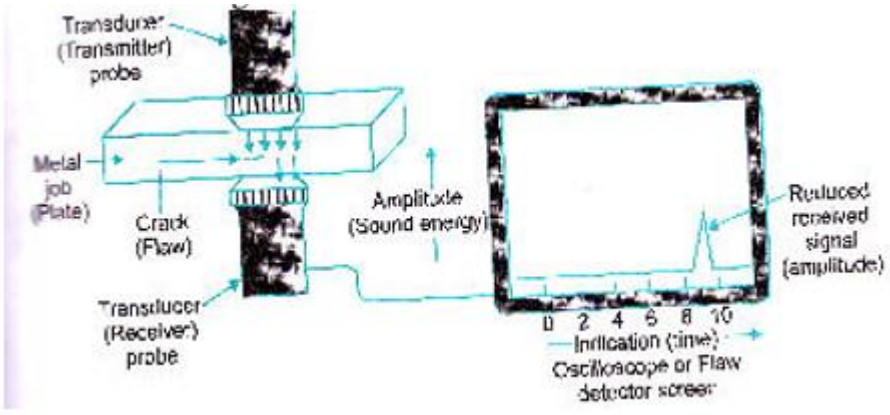
2.	c)	**Working:** A chip of piezo-electric crystal like quartz is placed between two plates as shown in figure. A suitable oscillator is connected across it. The electric oscillations along the electric axis produce mechanical vibrations along the mechanical axis. The frequency of oscillator is increased. At a particular frequency of oscillator, the oscillator frequency becomes equal to natural frequency of vibration of crystal. Then the crystal sets into resonance vibration and ultrasonic waves are produced.	
	d)	**State four factors on which NDT method can be selected.** **Any four factors** i) Codes or standard requirement ii) Specification of material to be tested, for example, nature of material, its size and shape iii) Type of disorders to be detected, also depend on nature of disorders. iv) Testing also depends on manufacturing process of material to be tested v) It is also depending on the equipments available for testing vi) Total cost required to test the material.	**4** 4
	e)	**Explain process of transmission ultrasonic testing and pulse echo UT testing.** **Each Diagram** **Each Explanation** **Transmission UT method:-** In this method two different tranducers are used, one acting as a transmitter and other acting as a receiver. The transmitter convers electrical pulse into sound signal. This sound pulse travels through the material. the receiver on opposite side receives these sound signals and converted into electrical pulse. This signal pulse sent to CRT screen. This screen displays amplitude on Y axis and time on X axis. If the signals are not received by receiver it indicates that there is crack in the material, complete lack of signal indicates that flow or crack is very large enough to reflect completely. If the received signal is 100% the the material is flowless.  **Pulse Echo UT method:-** In this case only one transducer is used. This transducer acts as transmitter as well as receiver. Initially transducer acts as transmitter. It converts electrical energy into sound energy. This sound pulse travels through the material and reflected by crack or opposite wall and return back.	**4** 1 1

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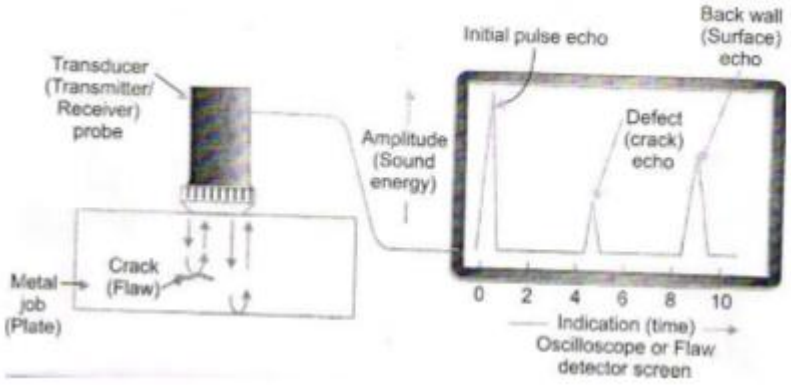
2.	e)	Now the transducer acts as receiver. The received sound energy is converted into electrical pulse. This signal pulse sent to CRT screen. This screen displays amplitude on Y axis and time on X axis. Some sound is transmitted through material and some sound is reflected from the first surfaces and gives a pulse which indicates the initial pulse. The electrical transmission pulse triggers a sound pulse at the probe crystal. At the same time this voltage pulse is fed to the input of CRT is called initial pulse as shown in following diagram.  	
	f)	**A car starting from rest, is given a uniform acceleration of 2 m/s^2 for 5 seconds. It then moves with constant velocity for one minute. The breaks are then applied and the car is brought to rest in 5 seconds. Determine the total distance covered by a car.** **Three parts of solution** **Total distance i.e. Final answer** **Let us divide the journey into three parts** **Part I** **Given :-** u = 0 ; a = 2 m/s^2 , t = 5 second v = u + at = 0 + (2 x 5) = 10 m/s. s_1 = ut + ½ at^2 = 0 + ½ (2x10) = 25 meter. **Part II** Given v = 10 m/s; t = 60 seconds. v = s_2 /t s_2 = vt = 10 x 60 = 600 m Part III **Given :-** u = 10 ; v = 0, t = 5 second a= v – u / t = 0 – 10 / 5 = - 2 m/s^2 v = u + at = 0 + (2 x 5) = 10 m/s. s_3 = ut + ½ at^2 = 10 x 5 - ½ (2x25) = 25 meter. Therefore total distance travelled = $s_1 + s_2 + s_3$ = 25 + 600 + 25 = 650 m	**4** 1 each 1

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3.		**Attempt any four of the following:**	**16**
	a)	**Distinguish between Seebeck and Peltier effect .**	**4**
		Any Four points	4

Seebeck's effect	**Peltier effect**
When two dissimilar metals are joined together so that two junctions are formed and if one junction is heated and other is cooled then electric current flows through it.	When electric current flows through a junction of two metals of thermocouple, then heat is generated at one junction and heat is absorbed at the other junction.
emf is developed across the two junction.	One junction gets heated and other get cooled.
emf generated is small in mV.	Heat generated or absorbed is small.
Amount of heat generated depends on pair of metals and temperature difference.	Amount of heat generated depends on pair of metals and current through it.

	b)	**Find ratio of heat evolved in a conductor of 1 watt and 2 watt respectively connected across a battery.**	**4**
		formula and Substitution	2
		Answer with unit	2

$P_1 = 1$ W
Heat evolved H_1

$$J = \frac{P_1 t}{H_1} \quad \text{---------- Equation 1}$$

$P_1 = 2$ W
Heat evolved H_2

$$J = \frac{P_2 t}{H_2} \quad \text{---------- Equation 2}$$

Equating equation 1 and 2 we get

$$P_1 t / H_1 = P_2 t / H_2$$

$$P_1 / P_2 = H_1 / H_2$$

$1 / 2 = H_1 / H_2$; Therefore ratio of hat volved i.e. $H_1 : H_2$ is 1 : 2

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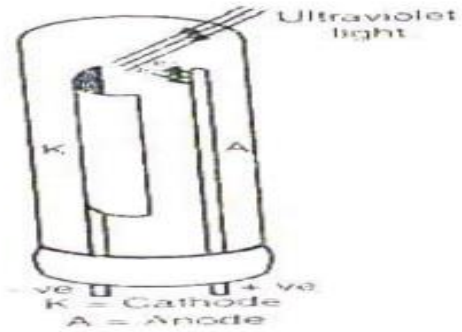
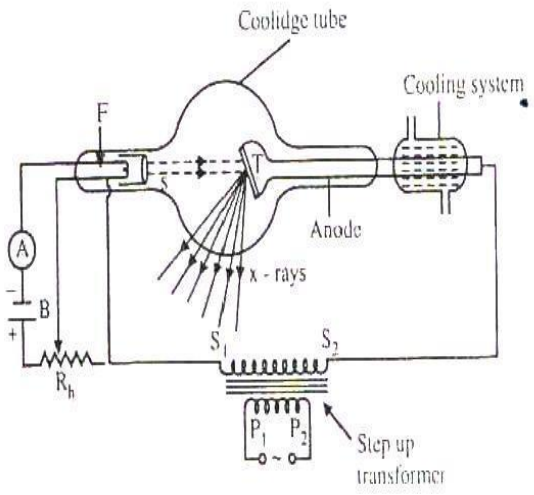
3.	c)	**Explain the construction and working of a photocell. State its any two applications.** **Diagram** **Construction** **Working** **Application**  **Construction:** 1. It consists of evacuated glass bulb having cathode (K) and anode (A). 2. The semi cylindrical cathode coated with photosensitive material from inner side. 3. The anode is platinum rod. 4. The cathode is connected to negative terminal of battery and anode is connected to positive terminal of battery. **Working:** Photoelectric cell is a device which converts light energy into electrical energy. When light of a suitable frequency is allowed to fall on cathode, it emits Photoelectrons. These photoelectrons are attracted by anode. The photoelectric current flows through the circuit & millimeter Shows the deflection. **Applications:-** 1) It is used for automatic control of traffic signals. 2) It is used to switch on and off automatically the street light. 3) It is used in Burglar alarm. 4) It is used in TV set. 5) It is used in fire alarms.	**4** 1 1 1 1
	d)	**Explain construction and working of Coolidge tube for production of X-ray.** **Labeled diagram** **Construction** **Working**	**4** 2 1 1

Q. No.	Sub Q. N.	Answers	Marking Scheme
3.	d)	 T – Target F – Metal filament S – Cylinder A – Ammeter B – Battery R_h – Rheostat P_1 P_2 – Primary of transformer S_1, S_2 – Seconday of transformer **Construction:-** It consist of hard glass bulb with cathode and anode as shown in fig. Cathode is a metal filament kept at negative potential to the filament. Target T consist of copper block in which a piece of tungsten is fitted. **Working:** When the cathode is heated by electric current it produce electrons due to thermionic emission. The beam of electrons is then focused on the anode (target). The electrons from cathode are accelerated by applying high voltage between cathode & anode using step up transformer. When these fast moving electrons are suddenly stopped by tungsten anode, they lose their kinetic energy and x rays are produced from the target. Some amount of Kinetic energy is converted to large amount of heat. By controlling the filament current, the thermionic emission of electron hence intensity of X- rays can be controlled.	
	e)	**Define population inversion and explain optical pumping by using three level systems.** **Definition** **Explanation** **Population inversion:** Making population of excited state more than that of ground state is called population inversion.i.e. $N_2 >> N_1$	**4** 1 3

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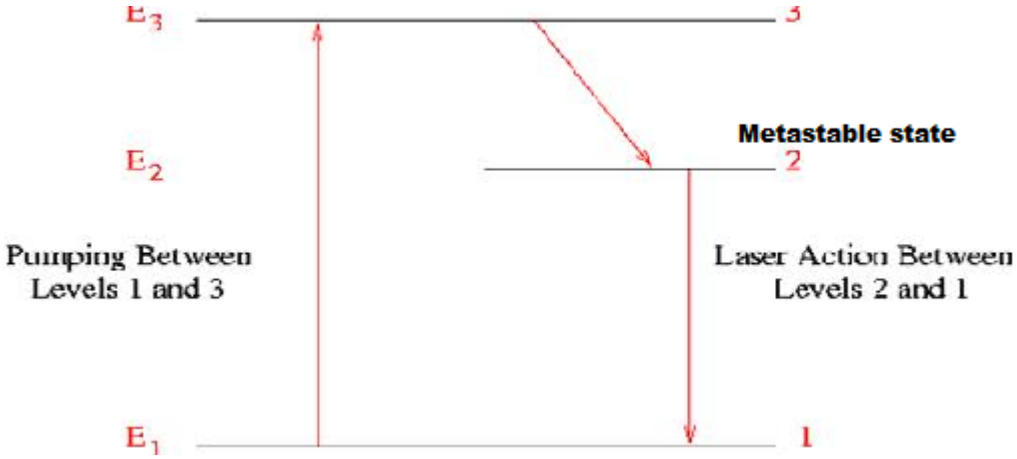
3.	d)	 Let E_1, E_2 And E_3 are energy levels. Atoms in energy level E_1 excited to E_3 by optical pumping. They lose some energy and return to energy state E_2. This is metastable state. Since E_2 is metastable state the no. of atoms in E_2 increases and when it is greater than state E_1 i.e. $N_2 >> N_1$ population inversion takes place. If atom is triggered due to action of an incident photon of energy hv12 then stimulated emission takes place. Atom emits photons of same direction, intense, monochromatic and coherent laser radiations.	
	f)	**A flywheel starting from rest is subjected to an acceleration of 0.7 rad/s^2.Calculate its angular displacement in 5th second.** **formula and Substitution** **Answer with unit** Given:- $\omega_0 = 0$ $\alpha = 0.7$ rad/s^2 $\theta^{5th} = ?$ $\theta^{nth} = \omega_0 + \alpha / 2 (2n-1)$ $\theta^{5th} = 0 + 0.7 / 2 (2 \times 5 - 1)$ **$\theta^{5th} = 3.15$ radians**	**4** 2 2