**WINTER– 17 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. | Answer | Marking Scheme |
|---|---|---|---|
| 1. | | Attempt **any nine:** | **18** |
| | a) | **State the Kinematical equations of motion for a freely falling body under gravity. State the meanings of symbols used in it.** | **2** |
| | | **Equation** | 1 |
| | | **Meaning** | 1 |
| | | **Equations:** i) $v = u+gt$<br>ii) $s=ut+1/2\ gt^2$<br>iii) $v^2 = u^2+2gs$ | |
| | | **Meaning:**<br>u = Initial velocity<br>v= final velocity<br>t= time<br>s= distance travelled<br>g = gravitational acceleration. | |
| | b) | **Define impulse and impulsive force.** | **2** |
| | | **Each Definition** | 1 |
| | | **Impulse:** It is defined as change in momentum.<br><br>**Impulsive force:** It is defined as a force which acts on a body for very small time, and produces considerable change in momentum of body. | |

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| 1. | c) | **A load is pulled 40 m along the horizontal by a force of 500 N acting at $60^0$ to the horizontal. Calculate the work done.** | **2** |
| | | **Formula** | 1 |
| | | **Answer with unit** | 1 |
| | | **Given**:<br>s = 40 m<br>F = 500 N<br>$\theta = 60^0$<br>W = ?<br>We have, $W = F \cos\theta \times s = (500 \times \cos 60) \times (40)$<br>**W = 10000 J** | |
| | d) | **State any two applications of centrifugal force.** | **2** |
| | | **Any two application** | 2 |
| | | **Application:**<br>**1. Banking of curved road:** The outer edge of curved road is raised above than the inner edge is called banking of road. This avoids skidding of speedy vehicle along a curved road.<br>**2. Centrifuge machine:** It is machine used to separate heavier particles in a mixture from lighter one.<br>**3. Drive in a washing machine:** Wet clothes are dried by rotating it speedily in a cylindrical porous drum.<br>**4. Centrifugal governor:** Speed of an engine can be controlled by using governor, which makes use of centrifugal force.<br>**5. Centrifugal pump:** To transfer liquid, centrifugal force is used in this process.<br>**6. Centrifugal blower:** To blow air. | |
| | e) | **State any two properties of ultrasonic waves.** | **2** |
| | | **Any two properties**<br>i) Frequency of these sound waves is more than 20kHz.<br>ii) Shorter wavelength.<br>iii) They carry high amount of sound energy.<br>iv) The speed of propagation of ultrasonic waves increases with increase in frequency.<br>v) They show negligible diffraction.<br>vi) Ultrasonic waves travel over long distance without considerable loss.<br>vii) Ultrasonic waves undergo reflection and refraction at the separation of two media.<br>viii) If it passed through fluid, then temperature of the fluid increases.<br>ix) Travel with constant speed through a homogeneous medium.<br>x) Posses certain vibrations which are used as good massage action in case of muscular pain. | 2 |

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| 1. | f) | **State and explain Joule's effect.** | **2** |
| | | **Joule's law** | 1 |
| | | **Explanation** | 1 |
| | | **Joule's law :** It state that the amount of heat generated (H) due to the flow of electric current through a resistance is directly proportional to<br>1) Square of the current ( $I^2$ )<br>2) Resistance ( R )<br>3) Time for which current flows ( t )<br>$H \alpha I^2Rt$<br>$H = \text{Constant} \times I^2Rt$<br>$H = \left(\frac{1}{J}\right) I^2Rt$<br>Where, J = Joule's constant.<br>J = 4200 J / kcal | |
| | g) | **What is thermoelectric series? How are the metals selected from thermoelectric series to form a thermocouple?** | **2** |
| | | Seebeck arranged various metals in a series such that when any two pair of metals is used, the current always flows from the higher end to lower end of the series through the cold junction of the thermocouple. This series is called as thermoelectric series.<br>If the metals used in thermocouple are more apart in the thermoelectric series, then the thermo emf obtained is more. If metals used are closer in series, then emf is less. Depending upon this the metals is selected from thermoelectric series to form a thermocouple. | |
| | h) | **State and explain Planck's Hypothesis.** | **2** |
| | | **Statement** | 1 |
| | | **Explanation** | 1 |
| | | According to this theory energy is not emitted or absorbed continuously but in a discrete units or packets called photon or quanta. The photons are electrically neutral and traveled with speed of light i.e. the radiation considers as shower of photons. The energy E associated with photon is directly proportional to frequency of light.<br>$E \alpha \upsilon$<br>$E = \text{Constant} \times \upsilon$<br>$E = h \upsilon$<br>Where h = Planck's constant<br>$h = 6.63 \times 10^{-34}$ Js | |
| | i) | **The photoelectric work function of a certain metal is 8.28 eV. Calculate its threshold frequency( $h = 6.625 \times 10^{-34}$ J-s)** | **2** |
| | | **Formula** | 1 |
| | | **Answer with unit** | 1 |

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| Q. No. | Sub Q. N. | Answer | Marking Scheme |
|---|---|---|---|
| 1. | i) | Given:<br>$W_0 = 8.28$ eV<br>$W_0 = 8.28 \times (1.6 \times 10^{-19})$<br>$W_0 = 13.248 \times 10^{-19}$ J<br>$h = 6.625 \times 10^{-34}$ J-s<br>$\upsilon_0$ **= ?**<br>We have, $W_0 = h\,\upsilon_0$<br>$\upsilon_0 = W_0 / h$<br>$\upsilon_0 = 13.248 \times 10^{-19} / 6.625 \times 10^{-34}$<br>**$\upsilon_0 = 1.999 \times 10^{15}$ Hz** | |
| | j) | **State any two Engineering applications of X-rays.**<br>**Any two Applications**<br>i. X- rays are used to detect the cracks in the body of aero plane or motor car<br>ii. X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in Quality control.<br>iii. X – rays are used to detect flaws or cracks in metal jobs.<br>iv. X- rays are used to distinguish real diamond from duplicate one<br>v. X- rays are used to detect smuggling gold at airport and docks (ship) yard.<br>vi. X-rays are used to detect cracks in the wall<br>vii. X- ray radiography is used to check the quality of welded joints. | **2**<br>2 |
| | k) | **Define Spontaneous and Stimulated emission.**<br>**Each definition**<br>**Spontaneous emission:** When the electron jumps from higher energy state to lower energy state on its own accord, the emission is known as spontaneous emission.<br><br>**Stimulated emission:** When the electron jumps from higher energy state to lower energy state by triggering,(supplying external energy) the emission is known as spontaneous emission. | **2**<br>1 |
| | l) | **Find minimum wavelength of X rays produced by X ray tube operating at 50 KV.**<br>**Formula**<br>**Answer with unit**<br>Given :<br>$V = 50$ KV $= 50 \times 10^3$ V<br>$\lambda min = ?$<br>We have, $\lambda min = 12400 \text{ X } 10^{-10} / \text{ V}$<br>$\lambda min = 12400 \text{ X } 10^{-10} / 50 \times 10^3$<br>$\lambda min = 0.248 \text{ X } 10^{-10}$ m<br>**$\lambda min = 0.248\ A^0$** | **2**<br>1<br>1 |

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| Q. No. | Sub Q. N. | Answer | Marking Scheme |
|---|---|---|---|
| 2. | | Attempt **any four:** | **16** |
| | a) | **A bullet of mass 50 gm is fired with a muzzle velocity of 600 m/s from a gun of mass 15 kg. Calculate the recoil velocity of gun.** | **4** |
| | | **Given** | 2 |
| | | **Formula with substitution** | 2 |
| | | **Answer with unit** | |
| | | **Given :**<br>$m_1$ = 50 gm = 0.05 kg<br>$v_1$ = 600 m/s<br>$m_2$ = 15 kg<br>$v_2$ =?<br>We have $m_1v_1 = m_2v_2$<br>$v_2 = m_1v_1 / m_2$<br>= ( 0.05 x 600 ) / (15)<br>**$v_2$ = 2 kg.** | |
| | b) | **Define : 1) Angle of projection 2) Range of projectile 3) Time of flight 4) Trajectory** | **4** |
| | | **Each definition** | 1 |
| | | **1) Angle of projection: -** It is defined as angle made by the velocity of projection with the horizontal at the original point.<br>**2) Range of projectile: -** The total horizontal distance covered by a projectile is called as range.<br>**3) Time of flight: -** The total time in which projectile covers the entire trajectory is called as time of flight.<br>**4) Trajectory: -** The path along which projectile moves is called trajectory projectile motion.<br>**OR** It is also defined as the path traced by an object in projectile motion. | |
| | c) | **Explain the piezoelectric method for the production of ultrasonic waves.** | **4** |
| | | **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.<br>  <br> | |

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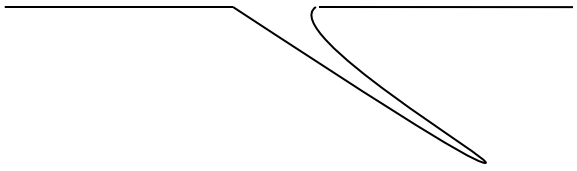
|---|---|---|---|
| 2. | c) | **Working:** A chip of piezo-electric crystal like quartz is placed between two plates as shown in figure. A suitable oscillator is connected across it. The electric oscillations along the electric axis produce mechanical vibrations along the mechanical axis. The frequency 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 advantages of NDT method**.<br>**Any four advantages**<br>**The advantages of non-destructive testing**<br>1. 100 % examination of material or production is possible.<br>2. NDT methods can be automated to lower their costs.<br>3. Testing is possible on shop, floor because of portable equipment; this controls the quality of further production.<br>4. Permanent record of testing can be made during the testing process.<br>5. The destructed parts can be separated in the early stages of manufacturing. This saves the time & production cost.<br>6. Higher accuracy, reliability & repeatability in the test result can be obtained.<br>7. Rapid inspection of each & every component is possible.<br>**Any other relevant advantage may consider.** | **4**<br>4 |
| | e) | **Explain liquid penetrant testing method with neat diagrams.**<br>**Principle**<br>**Diagram**<br>**Procedure**<br>**Principle:** It works on the principle of capillarity<br>**Experimental Procedure:**<br>1. Surface Preparation: Initially the surface of the specimen is cleaned. Because the presence of flakes, dirt, grease etc on the surface of work piece prevents penetrant to be slip into the cracks. This gives wrong information.<br>  | **4**<br>1<br>2<br>1 |

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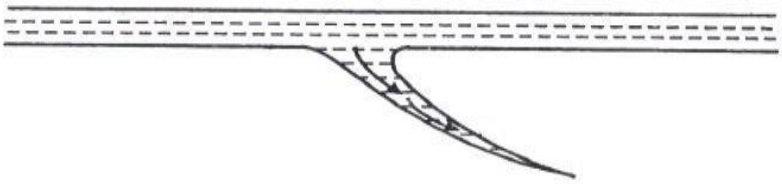
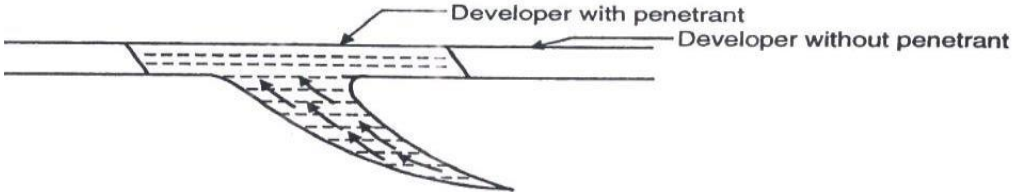
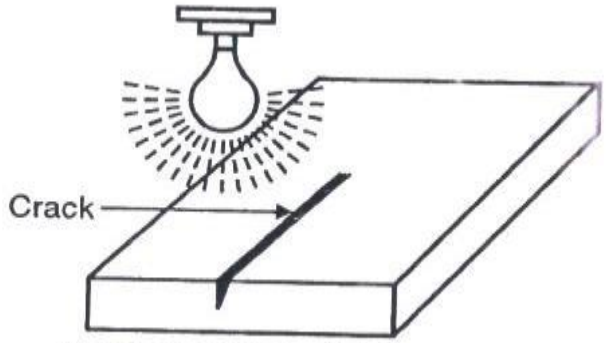
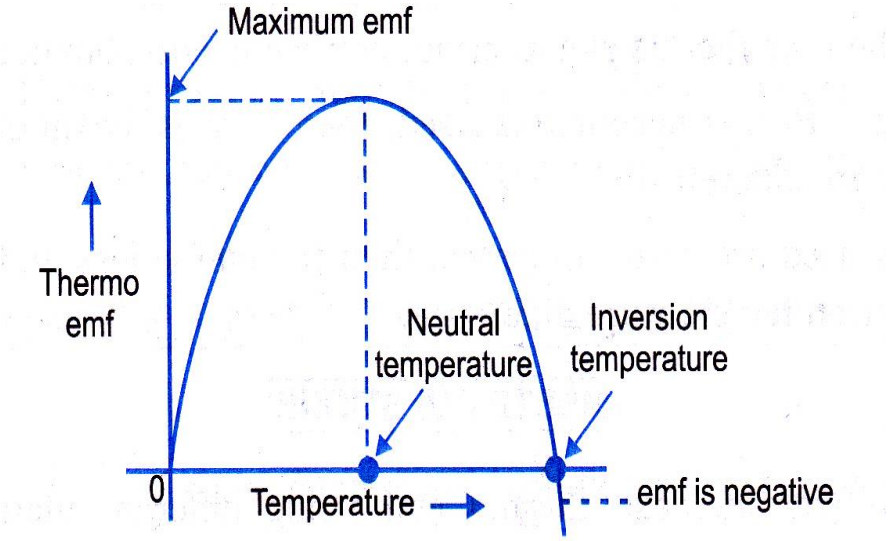
| 2. | e) | 2. Application of Dye penetrant: Suitable fluorescent dye is mixed in penetrant so that its viscosity remains low. This dye penetrant is applied evenly on specimen. Due to capillary action the penetrant goes into the surface open discontinuities. It takes some time. In general case this "dwell time" is 20-30 minutes.  3. Excess penetrant removal: After dwell time is over, the excess penetrant is removed from the surface carefully  4.Application of developer: A thin layer of developer is applied over the surface. The role of developer is to pull the trapped penetrant out of the crack this provides good visibility of crack.   5.Inspection & evalution of defects: Surface of the specimen is seen under white light or ultraviolet or laser light. The crack can be visualized under light.   (Inspection under light) **6. Post cleaning:** After inspection the surface of the specimen is cleaned & the specimen can be used for its intended purpose. | |

| Q. No. | Sub Q. N. | Answer | Marking Scheme |
|---|---|---|---|
| 2. | f) | **A train crosses a tunnel in 30 seconds. At the entry of tunnel, its velocity is 72 km/hr. and at the exit of tunnel it is 36 km/hr. Find length of the tunnel.**<br>**Each formula**<br>**Each answer with unit**<br>**Given,**<br>t = 25 sec.<br>u = 72 km/hr = (72 x 1000) / ( 60 x 60 )<br>**u = 20 m/s.**<br>v = 36 km/hr = (36 x 1000) / ( 60 x 60 )<br>v = **10 m/s.**<br>Length of tunnel = Distance covered = s =?<br>We have,<br>$a = (v - u) / t = (10 - 20) / (30)$<br>**$a = -0.333\ m/s^2$**<br>And<br>$v^2 = u^2 + 2as$<br>$s = (v^2 - u^2) / 2a$<br>$s = (10^2 - 20^2) / (2 \times (-0.333))$<br>**s = 450.45 m** | **4**<br><br>1<br>1 |
| 3. | | Attempt **any four:** | 16 |
| | a) | **Distinguish between Seebeck effect and Peltier effect .( any 4 points)**<br>**Any Four points** | **4**<br>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. |

**Note: Any relevant point may consider.**

| Q. No. | Sub Q. N. | Answer | Marking Scheme |
|---|---|---|---|
| 3. | b) | **Explain variation of thermo e.m.f. with temperature with the help of characteristic curve. Hence define neutral temperature and inversion temperature.** | **4** |
| | | **Diagram** | 1 |
| | | **Explanation** | 1 |
| | | **Each definition** | 1 |
| | |  | |
| | | For a given thermocouple , the temperature of one junction is placed at $0^0$C 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. | |
| | | **Neutral temperature** –The temperature at which the emf is maximum is called inversion temperature | |
| | | **Inversion Temperature:** The temperature at which the emf becomes zero and changes its sign (becomes negative) is called inversion temperature. | |
| | c) | **State Einstein's photoelectric equation and write the meaning of all symbols involved. Calculate the maximum kinetic energy of photoelectron ejected from surface of metal of light of frequency $1.2X10^{15}$Hz is incident upon it.** | **4** |
| | | **(Given Planck's constant, h = 6.625 x $10^{-34}$ J-s; Threshold wavelength of the metal surface = 4000$A^0$)** | |
| | | **Equation** | 1 |
| | | **meaning** | 1 |
| | | **Formula** | 1 |
| | | **Answer with unit** | 1 |

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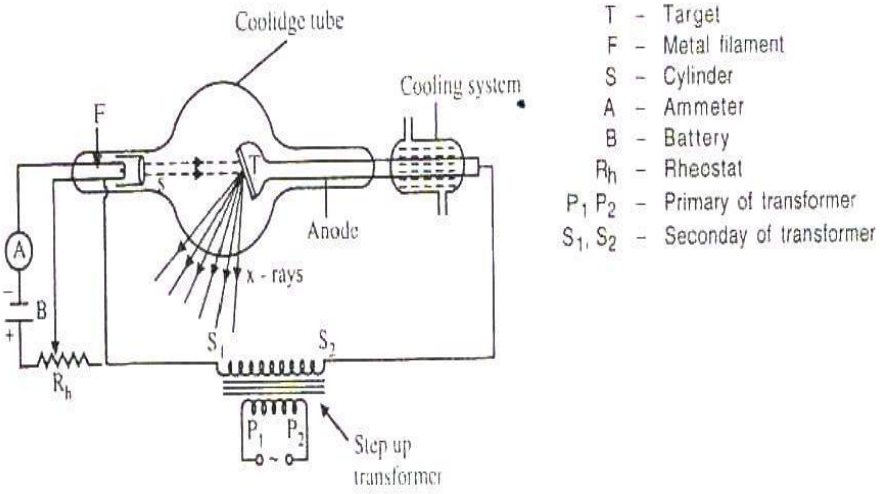
|---|---|---|---|
| 3. | c) | **Einstein's photoelectric equation**<br>$\frac{1}{2}mv^2 = h(\upsilon - \upsilon_0)$<br>**Meaning:** m – mass of electron, v – velocity of electron, h – Planck's constant, $\upsilon$ - frequency of radiation, $\upsilon_0$ - Threshold frequency<br>**Formula:** $KE = h(\upsilon - \upsilon_0)$<br>$KE = h(\upsilon - c/\lambda_0)$<br>$= 6.625 \times 10^{-34} \times (1.2 \times 10^{15} - (3 \times 10^8 / 4000 \times 10^{-10}))$<br>$= 6.625 \times 10^{-34} \times 0.45 \times 10^{15}$<br>**$KE = 2.98 \times 10^{-19}$ J** | |
| | d) | **Explain the production of X-rays using Coolidge tube.**<br>**Labeled diagram**<br>**Principle**<br>**Working**<br>  <br><br>**Principle:**<br>When fast moving electrons are suddenly stopped then X- rays are produced.<br>**Working:**<br>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.<br>By controlling the filament current, the thermionic emission of electron hence intensity of X- rays can be controlled. | **4**<br>2<br>1<br>1 |

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|---|---|---|---|
| 3. | e) | **State any four properties of LASER.**<br>**Any four properties**<br>**Properties**<br>i) **The light is coherent:** The light with waves, all exactly in same phase.<br>ii) **The light is monochromatic:** The light whose waves all have the same frequency or wavelength.<br>iii) **The light is unidirectional:** The light produces sharp focus.<br>iv) **The beam is extremely intense:** The light has extreme brightness. | **4**<br>4 |
| | f) | **A wheel of diameter 3m increases its speed uniformly from 150 r.p.m. to 300 r.p.m. in 30 seconds. Calculate its angular acceleration and linear acceleration.**<br>**Each formula**<br>**Each answer with unit**<br>**Given,**<br>Diameter = 3 m<br>Radius (r) = 1.5 m<br>$\omega_0$ = 150 rpm = (150 x 2π) / 60<br>$\omega_0$ = 15.7 rad/sec.<br>$\omega$ = 300 rpm = (300 x 2π) / 60<br>$\omega_0$ = 31.4 rad/sec.<br>t = 30 sec.<br>α =?<br>a =?<br>We have, $\omega = \omega_0 + \alpha t$<br>$\alpha = (\omega - \omega_0) / t = (31.4 – 15.7) / (30)$<br>**$\alpha = 0.523$ rad/s$^2$**<br>and<br>$a = r \alpha$<br>$a = 1.5 \times 0.523$<br>**$a = 0.785$ m/s$^2$** | **4**<br>1<br>1 |