SUMMER – 2016 EXAMINATION

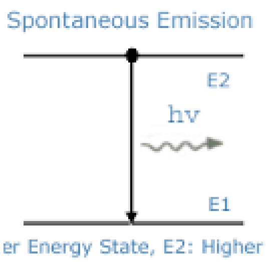
Model Answer Applied Science (Physics)

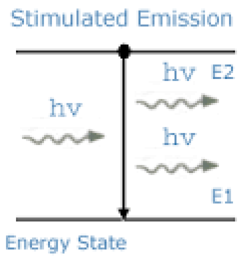
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
		Important Instructions to examiners 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme. 2) The model answer and the answer written by candidate may vary but the examiner may try to assess 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 judgment 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.		

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)		**Attempt any NINE of the following:**		**18**
	(a)	**Define : (i) Angular Displacement** **(ii) Angular acceleration** **Each definition** **i) Angular displacement:** It is the angle through which the radius vector turns when the particle in circular motion moves from one position to Other. **OR** It is defined as the angle subtended by the radius vector when a particle in circular motion moves from one position to other. **ii) Angular acceleration:** The rate of change of angular velocity with respect to time is called as angular acceleration.	1	2
	(b)	**State Newton's first law of motion. Give one example.** **Statement** **Example** **(i)Newton's First Law of motion :** It states that every body continues in its state of rest or of uniform motion in a straight line, unless it is acted upon by some external force. ii)examples (any one) 1) When a bus suddenly starts, the passengers sitting or standing in the bus tend to fall backward e) 2) When a blanket is given a sudden jerk, the dust particles in it fall off due to inertia at rest	1 1	2
	(c)	**Define the terms :** **(i)Projectile motion.** **(ii)Trajectory.** **Each definition** **(i) Projectile Motion :** Projectile motion is the motion of a body thrown in air at an angle θ ($\theta < 90^0$)with the horizontal. **ii) Trajectory :** It is the curved path that an object follows after it has been thrown or shot into the air: **OR** It the path followed by a projectile flying or an object moving under the action of given forces.	1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	(d)	**Find the frequency of a photoelectron of energy 4.2 eV.** **Formula and Substitution** **Answer with Unit** Given: $h = 6.63x10^{-34}$ Js $E = 4.2$ eV $= 4.2 \times 1.6 \times 10^{-19}$ J We have, $E = h\nu$ $\nu = E / h$ $\nu = (4.2 \times 1.6 \times 10^{-19}) / (6.63 \times 10^{-34})$ $\boldsymbol{\nu = 1.01357 \times 10^{15}}$ **Hz**	 1 1	2
	(e)	**Define the terms :** **(i)Audible Range** **(ii)Infrasonic waves** **Each definition** **(i)Audible Range -** A range of frequencies, usually from 20 Hertz to 20,000 Hertz, characteristic of signals audible to the normal human ear. **(ii) Infrasonic waves -** Infrasonic waves are low-frequency sound waves, having frequency less than 20 Hz (hertz)	 1	2
	(f)	**Define impulse and impulsive force.** **Each definition** **i)Impulse-** Impulse is defined as change in momentum of a body or object. **OR** Impulse is defined as a force multiplied by the amount of time it acts over. **ii)Impulsive force** Force that acts for a very short time, causes large change in momentum of the body is called impulsive force.	 1	2
	(g)	**Explain the property of lasers that enables the medical practitioners to use them for cataract operations.** **Explanation** Laser having the property of high brightness with low divergence enable to constitute a high energetic beam, hence used as a sharp cutting tool for cataract surgery.	 2	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	(h)	**A vehicle of mass 2000 kg is moving with a speed of 3000 cm/sec.Calculate the momentum of the car.** **Formula and substitution** **Answer with Unit** **Given:** Mass of vehicle (m) = 2000 kg Speed of vehicle (v) = 3000 cm/sec =30 m/s. Momentum (P) =? We have, Momentum (P) = m v P = 2000 x 30 **P = 60000 kg.m/sec**	 1 1	2
	(i)	**State any two factors affecting thermo emf.** **Each factor** **Factors affecting thermo emf-** 1) Nature of metals forming thermo couple. 2) Temperature difference between two junctions. 3)Materials used for the terminals, contact and contact Connectors.	 1	2
	(j)	**A car moving with an initial velocity 90 km/hr comes to rest in 10 seconds when brakes are applied. Find the retardation value.** **Formula and substitution** **Answer with Unit** **Given :** Initial velocity of a car (u) = 90 km/hr = (90x1000) / 3600 u = 25 m/sec. Final velocity of a car (v) = 0 m/sec. Time (t) =10 sec, a =? **Formula :** Retardation (a) = (v- u) / t Retardation (a) = (0-25) /10 **Retardation (a) = - 2.5 m/sec^2**	 1 1	2
	(k)	**State any two application s of ultrasonic testing.** **Each application** i)To detect flaw: flaws in metal, rubber, tyre, concrete, wood composites, plastics components ii) Rail inspection: Rail tracks are tested on the spot which avoids service failure in track iii) Air-craft inspection: To detect crack iv) Tunnel inspection: To detect crack v) Bridge inspection vi) To detect subsurface discontinuities vii)To test plant component	 1	2

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
1)	(k)	viii)Testing: It is used to test casting, forging, welding fabrication, rolling, heat treatment ix) Monitoring: Monitoring of thermal and atomic power plant, equipment pipe lines and structures x) On line tube testing: Channel ultrasonic flaw detection with thickness measurement of tube and hence corrosion		
	(l)	**State any four methods of non-destructive testing.** **Any four method** **N.D.T:- Non-Destructive Testing Methods.** 1) Liquid penetrant testing (LPT) 2) Ultrasonic testing (UT) 3) Magnetic particle testing (MT) 4) Radiograph testing (RT) 5) Leak testing (LT) 6) Visual testing (VA) 7) Holographic testing (HT) 8) Thermal infra radiography (TR)	2	2
2)		**Attempt any FOUR of the following :**		16
	a)	**Explain the terms** **(i)Spontaneous emission &** **(ii)Stimulated emission with reference to lasers.** **Each explanation** **i) 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. Radiations are in random direction, phase and wavelength. Independent of outside circumstances. No metastable state exist (ordinary exited state). Number of photons emitted is less.  	2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	(a)	**ii) 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. Radiations are coherent, monochromatic and in same direction. Dependent of outside circumstances. Metastable state exists. Number of photons emitted is more.  		
	(b)	**An object projected upwards making an angle of 38^0 with horizontal moves with an initial speed of 60 m/s. Calculate** **i) The distance from the point of projection at which the object strikes.** **ii) The time taken by the object to reach ground**. **Each Formula** **Each Answer with Unit** **Given:** V = 60 m/s, $\theta = 38^0$, R =? ,T =? We have, (i) $R = v^2 \sin 2\theta / g$ $R = (60)^2 \sin 2 \times 38 / 9.8$ **R = 356.43 m** (ii) $T = 2\, v \sin \theta / g$ $T = 2 \times 60 \sin 38 / 9.8$ **T = 7.53 sec**	1 1	4

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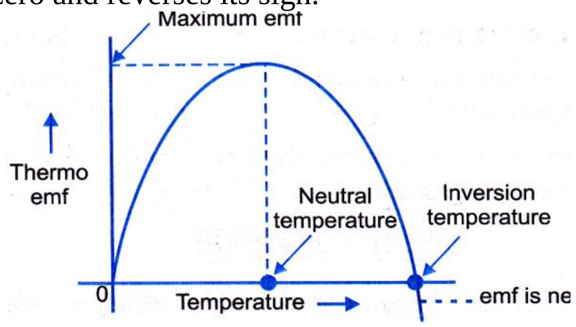
<tr><td>2)</td><td>(c)</td><td>

Explain the variation of thermo emf with temperature with the help of neat graph & hence define the terms:
(i) Neutral temperature (ii)Inversion temperature.
Graph
Explanation of graph
Each definition

The temperature of one junction is placed at 0^0 temperature of other junction is increased by providing heat. The emf generated is measured with the help of mill voltmeter. The graph of thermo emf against temperatures is plotted. It is observed that as the temperature between two junction's increases; emf also increases and reaches to maximum value and thereafter emf decreases, becomes zero and reverses its sign.



i)Neutral temperature – In thermocouple the temperature at which the emf is maximum is called inversion temperature
ii) Inversion Temperature: In thermocouple the temperature at which the emf becomes zero and changes its sign (becomes negative) is called as inversion temperature.

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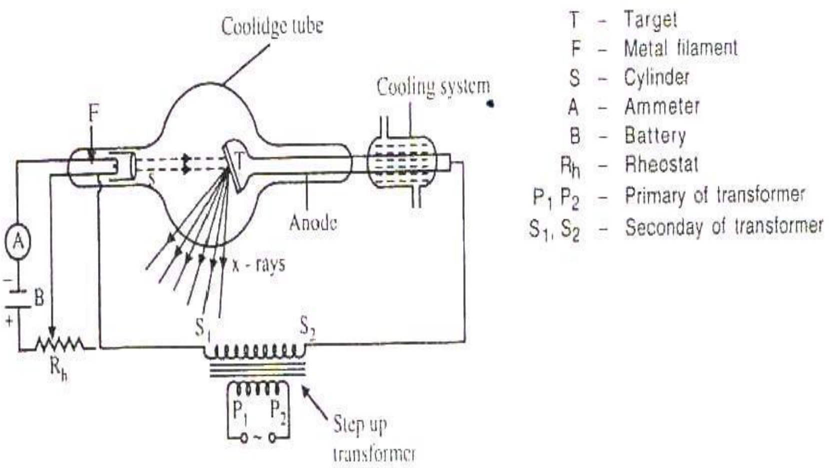
<tr><td></td><td>(d)</td><td>

Describe how of X-rays are produced by using Modern Coolidge tube.
Labeled Diagram
Principle
Working



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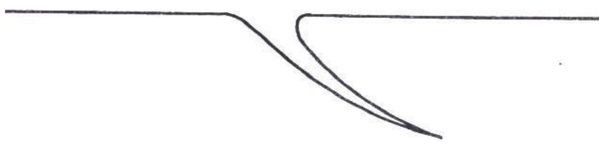
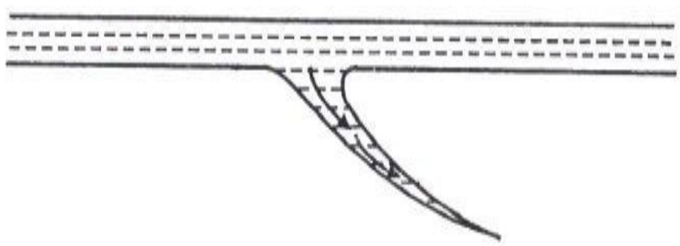
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	(d)	**Principle:** When fast moving electrons are suddenly stopped then X- rays are produced. **Working:** When the cathode is heated by electric current it produce electrons due to thermionic emission. The beam of electrons is then focused on 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)	**Explain liquid penetration testing method to detect surface discontinuities with the help of principle & experimental procedure.** **Principle** **Diagram** **Procedure** **Principle:** It works on the principle of capillarity. **Experimental Procedure:** 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.  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 	 1 1 2	 4

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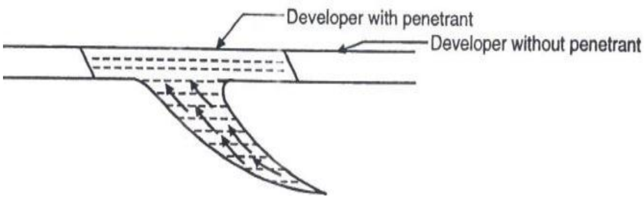
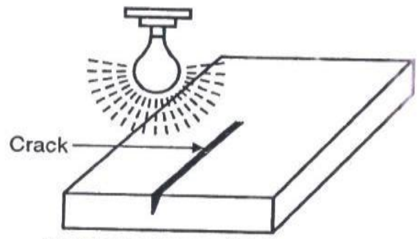
Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
2)	(e)	4. Application of developer: A thin layer of developer is applied over the surface. The role of developer is to pull the trapped penetrant out of the crack this provides good visibility of crack.		



5. Inspection & evaluation 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.

(f) **If light of wavelength 3000 A^0 is incident on metal surface of photoelectric work function 3 eV, will the electrons be ejected from the metal surface or not ? If yes , calculate the maximum kinetic energy of the photoelectrons emitted.(h= 6.63×10^{-34} J-s** — Total Marks: 4

Each Formula and Answer with Unit — 1

Conclusion — 1

Given: **h = 6.63×10^{-34}Js, C = 3×10^8m/s ,**
W_0 =3 eV = $3 \times 1.6\times10^{-19}$ J, υ=? , $\upsilon_{0=?}$

We have,

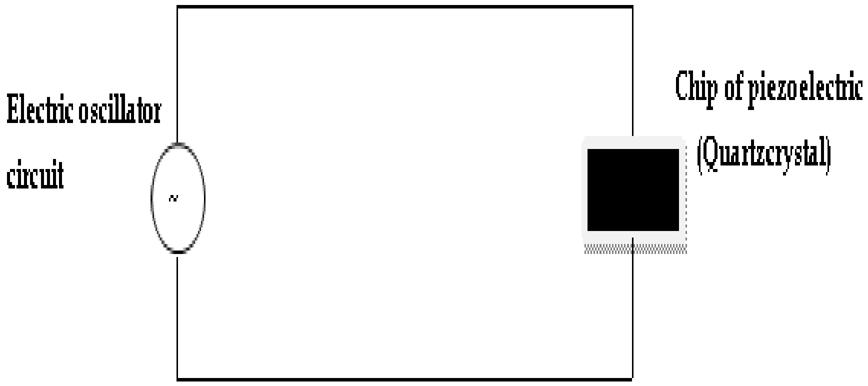
$$\upsilon = c / \lambda$$
$$\upsilon = 3 \times 10^8 / 3000 \times 10^{-10}$$
$$\upsilon = 1 \times 10^{15} \text{ Hz}$$

$$\upsilon_0 = W_0 / h$$
$$\upsilon_0 = 3 \times 1.6\times10^{-19} / 6.63 \times 10^{-34}$$
$$\upsilon_0 = 7.23\times10^{14} \text{ Hz}$$

As $\upsilon > \upsilon_0$ Electrons will be emitted.

$$\text{K.E.} = h(\upsilon - \upsilon_0) = 6.63 \times 10^{-34}(1\times 10^{15} - 7.23\times10^{14})$$
$$\text{K.E} = 1.8 \times 10^{-19} \text{ J}$$

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)		**Attempt any FOUR of the following:**		**16**
	(a)	**A vehicle covers 68 m in 6th second and 92 m in 9th second of its motion. Calculate the acceleration and the distance covered by it in 16th second of its motion.**		4
		Formula and substitution	2	
		Answer with unit	2	
		Given: S^{6th} = 68 m, S^{9th} =92 m, a=? , S^{16th} =?		
		We have,		
		$S^{nth} = u + a/2\,(2n-1)$ -------------------------- (1)		
		$S^{6th} = u + a/2(2 \times 6 - 1)$		
		But $S^{6th} = 68$ m		
		$68 = u + a/2\,(12 - 1)$		
		$68 = u + 11\,a/2$ -------------------------- (2)		
		Putting n =9 in equation (1)		
		$S^{9th} = u + a/2(2 \times 9 - 1)$		
		But $S^{9th} = 92$ m		
		$92 = u + a/2\,(18 - 1)$		
		$92 = u + 17\,a/2$ ---------------------------- (3)		
		Now,Substrating equation (3) from equation (2) we get		
		$92 - 68 = 0 + (17\,a/2) - (11\,a/2)$		
		$24 = a(17/2 - 11/2)$		
		$24 = a(6/2)$		
		$24 = 3a$		
		$a = 24/3$		
		$a = 8\ m/s^2$.		
		Putting the value of a in equation(2)		
		$68 = u + 11\,a/2$		
		$68 = u + (11 \times 8)/2$		
		$68 = u + 44$		
		$u = 68 - 44$		
		$u = 24$ m/s.		
		Now, For S^{16th} putting n = 16 in equation (1)		
		$S^{16th} = u + a/2\,(2n - 1)$		
		$S^{16th} = 24 + 8/2(2 \times 16 - 1)$		
		$S^{16th} = 24 + 124$		
		$S^{16th} = 148$ m.		

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	(b)	**Explain the production of ultrasonic waves by piezoelectric method.** **Diagram** **Principle** **Explanation**	 1 1 2	4
		 **Principle:** When the electric field is applied across the piezoelectric crystal its dimensions changes and when alternating PD is applied across crystal then the crystal sets into elastic vibrations along the perpendicular axis. **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.		

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3)	(c)	**State any four characteristics of photoelectric effect.** **Each characteristics** **Any four characteristics** i) A metal emits electrons only when the incident (light) radiation has frequency greater than critical frequency (ν_0) called threshold frequency. Threshold frequency different for different metals. ii) Photoelectric current is directly proportional to intensity of light and independent of frequency. iii) The velocity of photoelectron is directly proportional to the frequency of light. iv) For a given metal surface, stopping potential is directly proportional to the frequency and is not dependent on intensity light. v) The rate of emission of photoelectrons from the photocathode is independent of its temperature i.e. photoelectric emission is different from thermionic emission. vi) The process is instantaneous.	 1	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	(d)	**Define recoil of gun. Derive the expression for recoil velocity of gun.** **Definition** **Derivation** **Recoil of gun :** If a bullet is fired from a gun then bullet shoots out with a large velocity and at the same time gun moves back with little velocity this backward movement (jerk) is called as recoil of gun. **Expression for recoil velocity of gun:** Consider m_1 is the mass of bullet ,v_1 be the velocity of bullet and m_2 is the mass of gun also v_2 is the velocity of gun **Before firing:** The gun and bullet are at rest i.e. it has zero velocity therefore the total momentum before firing is zero. **After firing:** The bullet moves forward and gun moves backward. Momentum of bullet = m_1v_1 Momentum of gun = $m_2(-v_2)$ Here, Negative sign indicates that the gun moves back. The total momentum of the system after firing = $m_1v_1 - m_2v_2$ According to law of conservation of momentum, Total momentum before firing = Total momentum after firing $0 = m_1v_1 - m_2v_2$ $m_2v_2 = m_1v_1$ $\mathbf{v_2 = m_1v_1 / m_2}$ This gives the recoil velocity of gun.	 1 3	4
	(e)	**(i)State Joule's law and write its mathematical form.** **(ii)Calculate the amount of heat generated when a current of 2 Amp flows through a resistance of 6.4 Ω for 10 minutes.** **Statement** **Mathematical form** **Formula & Answer with unit** **(i)Statement of Joule's Law:** "The amount of heat generated (H) due to flow of electric current through a resistance is directly proportional to square of the current (I^2), the resistance(R), the time for which current flow(t)" Hence, $H \alpha I^2 R t$ $H = \text{Constant} \times I^2 R t$ $H = (1/J) I^2 R t$ $\mathbf{H = I^2 R t / J}$	 1 1 2	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
3)	(e)	Where, J = Joule's Constant or Mechanical equivalent of heat. I =Current, R= Resistance, t = Time & H =Heat generated. **(ii)Given:** I =2 Amp, t= 10 minute = 10 × 60 = 600 Sec. R = 6.4 Ω, J =4200 J/Kcal (Assumed Value), H=? We have, $H = I^2 R\, t / J$ $H = (2)^2 \times 6.4 \times 600 / 4200$ $H = 25.6 / 7$ $\mathbf{H = 3.6571\ Kcal}$		4
	(f)	**Calculate the minimum wavelength and maximum frequency of X-Rays produced by an X-ray tube operating at 60 kV.** **($h = 6.63 \times 10^{-34}$ J-Sec;$e = 1.6 \times 10^{-19}$ C,$c = 3 \times 10^{8}$ m/sec)** **Each Formula and substitution** **Answer with unit** **Given:** $h = 6.63 \times 10^{-34}$ J-Sec, $e = 1.6 \times 10^{-19}$ C, $c = 3 \times 10^{8}$ m/sec $V = 60$ kV $= 60 \times 10^{3}$ v, λ_{min} =?, f_{max} =? We have, $\lambda_{min} = hc / eV$ **OR** $\lambda_{min} = 12400/V$ $\lambda_{min} = 6.63 \times 10^{-34} \times 3 \times 10^{8} / 1.6 \times 10^{-19} \times 60 \times 10^{3}$ $\lambda_{min} = 0.206\ A^{0}$ $\boldsymbol{\lambda_{min} = 0.206 \times 10^{-10}}$ **m** Now, $f_{max} = C / \lambda_{min}$ $f_{max} = 3 \times 10^{8} / 0.206 \times 10^{-10}$ $\mathbf{f_{max} = 14.563 \times 10^{18}}$ **Hz** **OR** $\mathbf{f_{max} = 145.63 \times 10^{17}}$ **Hz**	1 2	