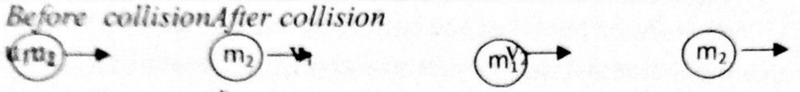
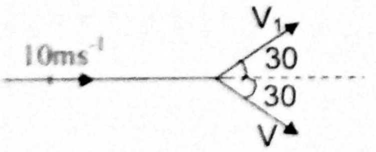
JINJA JOINT EXAMINATION BOARD 2019

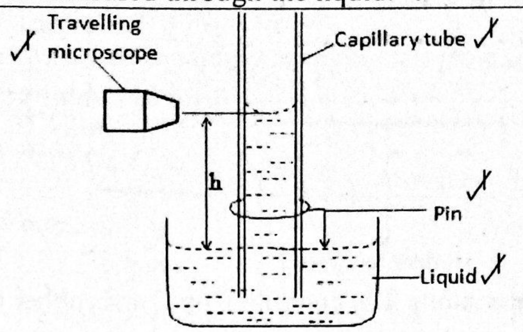
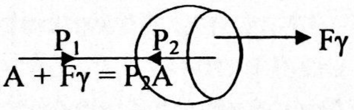
MOCK EXAMINATIONS P510/1 PHYSICS

MARKING GUIDE

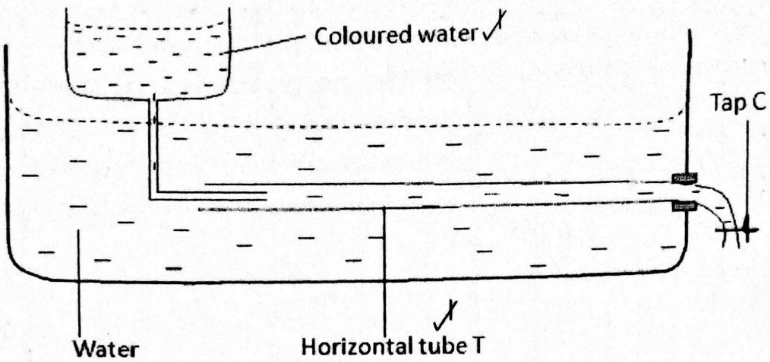
No.	*Solutions*	*Marks*
1 (a)	-Everybody continues in its state of rest or in uniform motion unless acted upon by an external force - The rate of change of momentum of a body is proportional to the applied force and takes place in the direction of the force. - To every action, there is an equal and opposite reaction	01 01 01
(b)(i)	If no external forces act on a system of colliding objects, then their total momentum remains constant.	01
(ii)	*Before collisionAfter collision*  $F = m(v - u)/t$ ....second Law $F_{21} = \frac{m_1(v_1-u_1)}{t}$ $F_{12} = \frac{m_2(v_2-u_2)}{t}$ $F_{21} = -F_{12}$ ....third Law $\frac{m_1(v_1-u_1)}{t} = \frac{-m_2(v_2-u_2)}{t}$ $\Leftrightarrow m_1(v_1-u_1) + m_2(v_2-u_2) = m_1(v_1-u_1) + m_2(v_2-u_2)$	01 01 01 ½ ½
(c)(i)	 Resolving momentum vertically $0 = 0.1v_1\sin30 - 0.1v_2\sin30$ $0.1\ v_2\sin30 = 0.1v_1\sin30 \Leftrightarrow v_2 = v_1$ Resolving momentum horizontally $0.1\times 10 = 0.1v_1\cos30 + 0.1v_2\cos30$ $1 = 0.2v1\cos30$ $\therefore v_1 = \frac{1}{0.2\cos30}$ $= 5.77ms^{-1}$ k.e before collision $= ½mu^2 = ½\times0.1\times10^2 = 5J$ k.e after collision $= 2[½\times0.1(5.77)^2] = 3.33J$ The collision is not elastic since the kinetic energy is not conserved.	01 01 01 ½ ½ 1 1 ½ 1½ ½
(d)	Weightlessness is a condition of a body where the weight of a body equals the reaction of the support on which the body is. This implies that the resultant force on the body is zero. There the body will have no tendency to rise up or sink down.	½ ½ 01 01 **20**

		01
2(a) (i)	A planet is an astronomical body orbiting the sun	01
(ii)	The planets describe ellipses about the sun as one focus. The line joining the sun and the planet sweeps out equal areas in equal times. The squares of the periods of revolution of the planets are proportional to the cubes of their mean distances from the sun	01 01
(b)(i)	$\frac{mv^2}{r_o} = \frac{GM_m}{r_o^2}$ ∴ k.e = ½ mv^2 = $\frac{GM_m}{2r_o}$ ....(i) $v = \int_{\infty}^{r_o} \frac{GMm\partial r}{r^2} = \frac{-GM_m}{r_o r_o}$ => p.e of m = $-\frac{GM_m}{\quad}$ Total energy in orbit = $\frac{GM_m}{r_o} + \frac{GM_m}{2r_o r_o} = -\frac{GM_m}{\quad}$	01 1½ 1½
(ii)	$\frac{GM_m}{2r} > \frac{GM_m}{2r_o}$ these two quantities are the kinetic energy values in the respective orbits of radius rand r_o. Hence the kinetic energy of the satellite increases. But the potential energy decreases by twice as much as the kinetic energy. Therefore there is loss of energy in form of heat. From the law of conservation of energy; The total energy = p.e + k.e. + heat energy. Since heat loss is very small, a decrease in p.e. results in a net increase in k.e. Hence the speed of the satellite progressively increases as it comes closer and closer to the earth.	½ 1 1½ ½ ½ 01
c)	$r = (R+h) = (6.4\times10^6 + 0.5\times10^6) = 6.9\times10^6$ $\frac{mv^2}{r} = \frac{GM_m}{r^2}$ ∴ k.e = ½ mv^2 = $\frac{GM_m}{2r} = \frac{GM_m}{2(R+h)}$ => k.e = $\frac{6.67\times10^{-11}\times300\times5.97\times10^{24}}{2\times6.9\times10^6} = 8.657\times10^9$ J p.e. = $-\frac{GM_m}{r} = \frac{6.67\times10^{-11}\times300\times5.97\times10^{24}}{6.9\times10^6} = -1.7313\times10^{10}$J Total energy = k.e + p.e = 8.657 – 1.7313 = -8.657×10^9J	½ 1½ 02 01
d)	Because of the very small value of the gravitational constant G, the gravitational force between bodies of ordinary mass is extremely small. Hence their acceleration is too small to cause any noticeable motion.	01 01 01 20

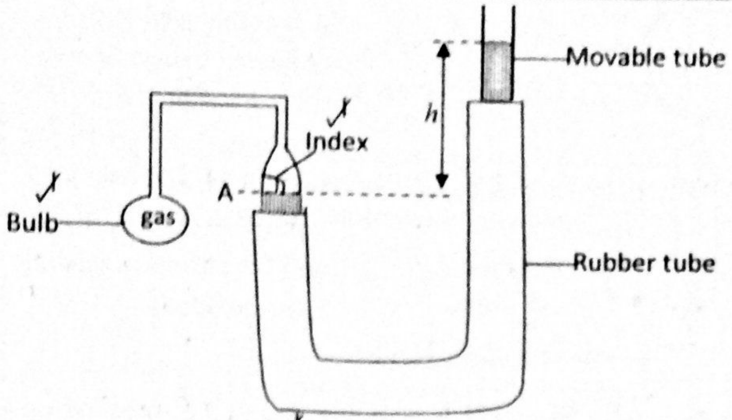
3.(a)(i)	The surface tension is the work done in increasing the surface area by $1m^2$ under isothermal conditions	01
(ii)	Surface tension decreases with increase in temperature. Therefore the surface tension of the hot soap solution is less than that of the cold soap solution. Consequently, the hot soap solution penetrates more into the pores of the fabric, thus increasingcleansing action of soap.	½ 01 01 ½

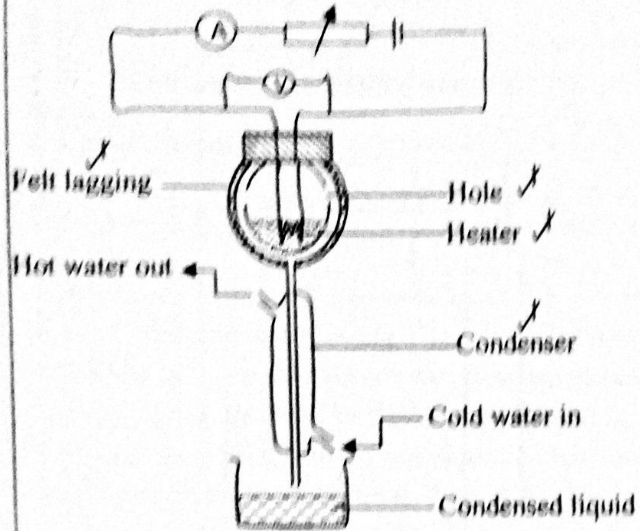
(b)(i)	Angle of contact is the angle between the solid surface and the tangent to the liquid meniscus measured through the liquid. ✓	01
(ii)		02
	A clean capillary tube is supported vertically ✓with its lower end dipping in the liquid. A pin bent at right angles ✓in two places is attached to the capillary tube using a rubber band and is adjusted so that its tip just touches ✓ the liquid surface. The travelling microscope is ✓first focused on the bottom of the meniscus ✓in the tube ✓and then on the tip ✓of the pin when the beaker is removed. Column ✓length h ✓is obtained. The diameter of the capillary is measured at three ✓different places, and the average radius r obtained. If the angle of contact θ is known, then the surface tension is given by $\gamma = \frac{hr\rho g}{2\cos\theta}$ ✓ Where g is the acceleration due to gravity and ρ is the density of the liquid	½ ½ ½ 01 ½ ½ ½
(c)	 $P_1A + F\gamma = P_2A$ At equilibrium; ✓ $P_1\pi r^2 + 2\pi r\gamma + P_2\pi r^2$ $(P_2-P_1)\pi r^2 = 2\pi r\gamma$ ✓ $\therefore \quad P_2-P_1 = \frac{2\gamma}{r}$ ✓	01 01 01
d)	$h\rho g - \frac{2\gamma}{r} = \frac{4\gamma}{r}$ ✓ $\Rightarrow h\times10^3\times9.81 - \frac{2\times7\times10^{-2}}{0.5\times10^{-2}} = \frac{4\times3\times10^{-2}}{0.5\times10^{-2}}$ ✓ $9.81\times10^3h - 280 = 24$ ✓ $\therefore \quad h = \frac{24+280}{9.81\times10^3}$ ✓ $= 3.06\times10^{-2}$m ✓ Assuming zero angle of contact. ✓	02 01 02 01 20

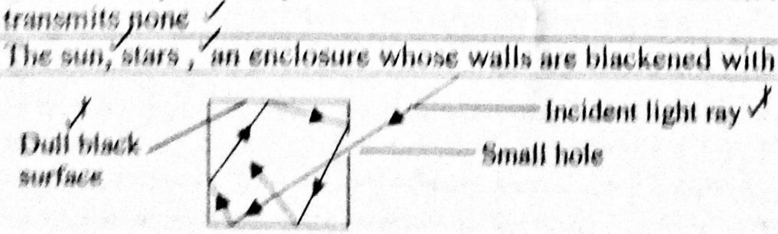
4.(a)(i)	Streamline flow is the flow in where equidistant layers from axis of flow have the same velocity, flow lines are parallel and the flow is orderly. ✓ Turbulent flow is the flow in where equidistant layers from axis of flow have varied velocities, flow lines are not parallel and the flow is disorderly. ✓	01 01

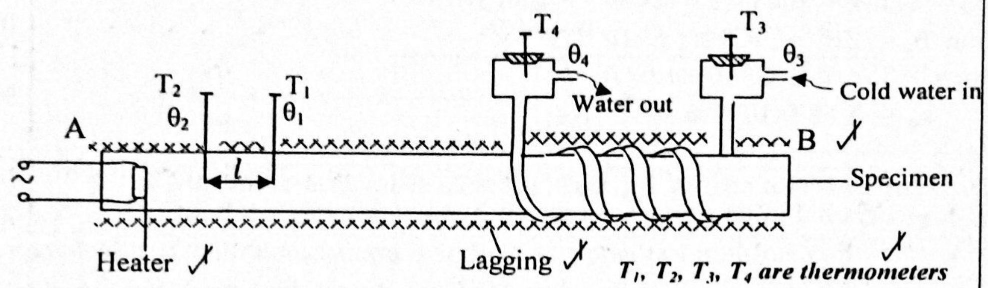
(ii)		½ ½
	Flow of coloured water along T is controlled by C and rubber tubing connected to T. At low velocity of flow when tap is open slightly, a thin coloured steam of water is seen along the middle of T. This shows laminar flow. Tap is opened fully to increase the flow rate through T. The coloured water spreads all over the tube. This shows turbulent flow.	½ ½ 01 01
(b) (i)	Coefficient of viscosity is the frictional force per unit area of fluid in a region of unit velocity gradient.	01
	$[\eta] = \frac{[\text{force}]}{[\text{area}]} \times \frac{1}{[\text{velocity gradient}]}$	½
	$= \frac{MLT^{-2}}{L^2} \times \frac{1}{T^{-1}} = ML^{-1}T^{-1}$	02
(ii)	$A_1V_1 = A_2V_2 \Rightarrow (10\times10^{-2})0.2 = V_B\times2.5\times10^{-4} \therefore V_B = 0.8\ ms^{-1}$ Pressure difference $= \frac{1}{2}\rho(V_B^2 - V_A^2)$ $= \frac{1}{2}\times10^{-3}(0.8^2-0.2^2) = 3\times10^2\ Nm^{-2}$	1½ 01 1½
c)(i)	It states that for astreamline flow of a non-viscus incompressible fluid, the sum of the pressure, kinetic energy and potential energy per unit volume is constant	01
(ii)	If we blow over a piece of paper, the velocity of air moving along the upper surface of the paper is higher than that along the lower surface. Therefore, from bernoulis principle, the air pressure on the upper surface decreases below the atmospheric pressure, whereas that on the lower surface increases above the atmospheric pressure. Hence an upward thrust is exerted on the paper which keeps it horizontal	01 01 01 01 20

5.(a)(i)	A thermometric property is a physical quantity that varies uniformly and continuously with temperature.	01
(ii)	A fixed point is a temperature at which water changes from one state to another.	01
(b)(i)	Determine the resistance of a platinum wire at the ice point R_o, steam point R_{100} and at the unknown temperature θ, $R_θ$;	01 02

	Calculate θ from; $\theta = \dfrac{R_\theta - R_o}{R_{100} - R_o} \times 100\ ^\circ C$ ✓	01
(ii)	Advantages: wide range, sensitive, accurate, Disadvantage: cannot measure rapidly changing temperature, cannot measure temperature at a junction. ✓	01 ½ ½
(c)	 The bulb is placed in contact with the body whose temperature is to be measured. The gas in the bulb expands and forces mercury up the movable tube. The height of this tube is then adjusted to bring the mercury in the left hand tube to back to its original position at the fixed mark A. The head of the mercury h is measured and the pressure P_θ at the unknown temperature θ is calculated from; $P_\theta = H + h$, ✓ where H is the prevailing atmospheric pressure. If P_o and P_{100} are the pressures at 0°C and 100°C respectively, the temperature of the body is calculated from $\theta = \dfrac{P_\theta - P_o}{P_{100} - P_o} \times 100\ ^\circ C$ ✓	½ ½ ½ ½ ½ ½ ½ 01 ½
d)	273.16 K = 273.16 – 273.15 = 0.01°C ✓ 600.5 K = 600.5 – 273.15 = 327.35 °C ✓ From $R = R_o(1 + \alpha t)$ $101.6 = R_o(1 + 0.01\alpha)$ ....(i) ✓ $165.5 = Ro(1 + 327.35\alpha)$ ....(ii) ✓ $\Rightarrow \dfrac{106.6}{165.5} = \dfrac{R_o(1 + 0.01\alpha)}{Ro(1 + 327.35\alpha)}$ ✓ <=> $0.6139 = \dfrac{(1 + 0.01\,\alpha)}{(1 + 327.35\alpha)}$ $\Rightarrow 0.6139(1 + 327.35\alpha) = (1 + 0.01\alpha)$ ✓ $0.6139 + 200.96\alpha = 1 + 0.01\alpha \therefore \alpha = 1.921\times10^{-3}$ From (i) $101.6 = R_o(1 + 0.01\times1.921\times10^{-3})$ $\therefore R_o = 101.598\ \Omega$ ✓ $\Rightarrow 123.4 = 101.598\,(1 + 1.921\times10^{-3}t)$ $1.215 = 1 + 1.921\times10^{-3}t$ $\therefore t = 111.9\ ^\circ C$ ✓	½ ½ 01 01 01 01 01 01 20

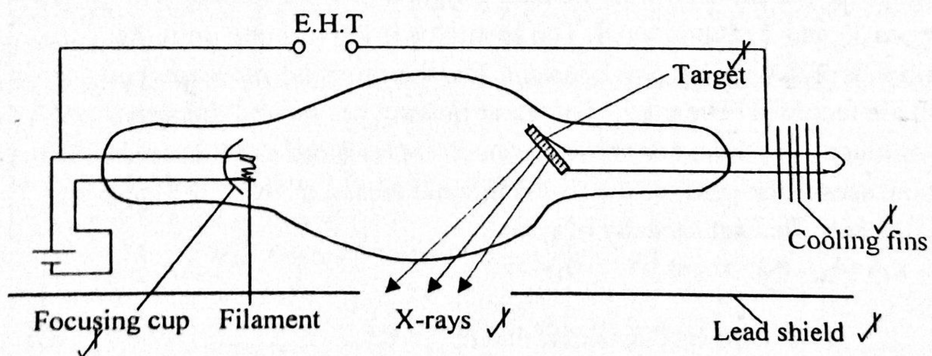
6.(a)(i)	Latent heat of vaporization of a liquid is the amount of heat required to convert one kilogram mass of a liquid into vapour at the same temperature ✓	01
(ii)		
	The liquid is heated to its boiling point. ✓ Vapour passes through the holes to the condenser where it is condensed and ✓ collected over a known ✓ time, t. ✓ The mass condensed per second m is determined. ✓ The voltmeter reading V_1 ✓ and the ammeter reading I_1 are recoded.	½ 1½ 01 ½ 01 ½ ½
	=> $V_1I_1 = m_1l + h$ ....(i) where h is power loss to the surrounding and specific latent heat of vaporization. The experiment is repeated for different values of current, I_2 and voltage V_2. If m_2 is mass collected per second, $V_2I_2 = m_2l + h$, ...(ii) From (i) and (ii), $l = \frac{V_2I_2 - V_1I_1}{m_2 - m_1}$ ✓	½ ½ 01
c)	A saturated vapour is a vapour which is in a dynamic equilibrium with its own liquid. ✓ Unsaturated vapour is a vapour which is not in a dynamic equilibrium with its own liquid. ✓	01 01
d) (i)	It is the pressure of a vapour which is in a dynamic equilibrium with its own liquid ✓	01
(ii)	At the boiling point, s.v.p = atmospheric pressure ✓ => $P_2 = (1.14 - 1.01)10^5 = 1.3\times10^4$, $T_2 = 273 + 78 = 351$, ✓ $P_1 = ?$, $T_1 = 273 + 20 = 293$ ✓ From $\frac{P_1}{T_1} = \frac{P_1}{T_1}$ => $P1 = \frac{1.3\times10^4\times293}{351} = 1.09\times10^4$ ✓ ∴ s.v.p at 20°C $= 1.7\times10^4 - 1.09\times10^4 = 6.15\times10^3\ Nm^{-2}$ ✓	01 ½ ½ 2½ 1½ **20**

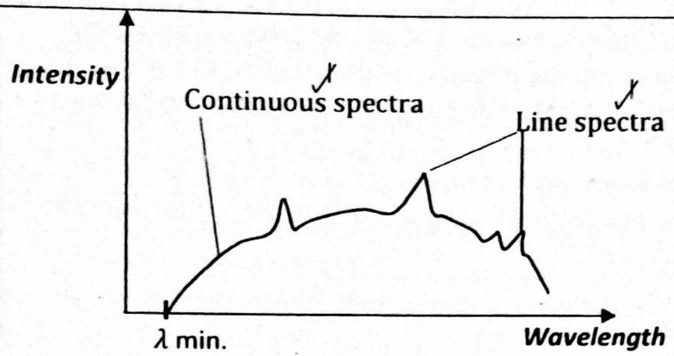
7.(a)(i)	A black body is a body that absorbs all radiation incident on it, reflects and transmits none ✓	01
(ii)	The sun, ✓ stars, ✓ an enclosure whose walls are blackened with a small hole	02
(iii)		01

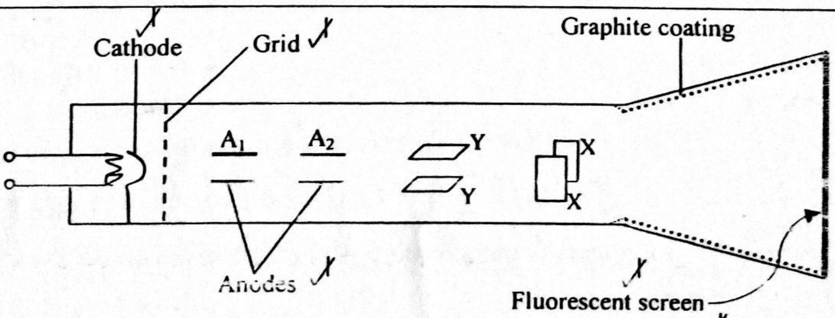
	Punch a small hole on the lid of an empty tin blackened with soot inside. Light which enters the tin through the small hole is reflected many times inside the tin. At each reflection, energy is absorbed. Eventually all the light is absorbed. The hole and the enclosure thus act as a black body.	01 01 01
(iii)	Volume of the sun = $\frac{2.0\times10^{30}}{1.4\times10^{3}} = 1.429\times10^{27}$ $\frac{4}{3}\pi r^3 = 1.429\times10^{27}$ ∴ $r = 6.987\times10^{8}$m $\rho = \sigma 4T^4 \Rightarrow 5.67\times10^{-8}\times4\pi(6.987\times10^{8})^3\ T^4 = 4.4\times10^{26}$ ∴ $T = 5.96\therefore10^{3}$K	01 02 02 01
c) (i)	The coefficient of thermal conductivity is the rate of heat transfer per unit cross-sectional area per unit temperature gradient.  The specimen AB is heated electrically at end A and cooled at end B by circulating water which runs through the copper foil soldered to the specimen. Two thermometers T_1 and T_2 are inserted in holes drilled in the bar and the holes are smeared with mercury for good thermal contact. The length $l$between T_1 and T_2 is measured. The apparatus is left running until the thermometer readings become constant. The thermometer readings θ_1, θ_2, θ_3 and θ_4 are recorded. The mass m of water flowing per second through the foil is determined. The diameter of the specimen is measured and the cross-sectional area A, calculated. If K is the thermal conductivity of the specimen and C the specific heat capacity of water, $$\frac{KA(\theta_2-\theta_1)}{l} = mC(\theta_4-\theta_3)$$ Hence K is calculated.	01 ½ 1½ 01 ½ 01 ½ 01 20

8. (a)	Electron in a hydrogen atom is moves in circular orbit while in this orbit it does not radiate energy. Angular momentum of the electron is an integral multiple of $h/2\pi$	01 01
(b)	When a gas is heated to a high temperature, electron transitions occur from low to high energy levels. As electrons return to lower energy levels, radiation of wave lengths such hc/λ equals energy difference between the initial and final levels is given off. The radiation consists of a series of lines when viewed through the diffraction grating.	1½ ½ 02

c)	Most alpha particles passed through undeflected. A few are deflected through small angles less than 90°. Very few are scattered through large angles greater than 90°. Most pass through because most space in the atom is empty. Small angle scattering is because a few alpha particles are incident on atom at large distances from the nucleus. Large angle scattering is because the chance of a head on collision between an alpha particle and the nucleus is very small. This implies the nucleus occupies a small portion of the available space.	01 01 01 01 01 01
d)	The experiment is carried out in a vacuum because the range of alpha particles in air is very limited, so the vacuum allows the particles to reach the foil and the detector beyond the foil.	01 02
e)(i)	k.e. = $\frac{1}{2}mv^2 = meV$ $\Rightarrow mv^2 = 8meV$ from $b_o = \frac{Ze^2}{\pi\epsilon mv^2} = \frac{79(1.6\times10^{-19})2}{8.85\times10^{-12}\times8\times10^{6}\times1.6\times10^{-19}}$ $b_o = 5.683\times10^{-14}$ m	01 02 01
(ii)	The significance of nearest approach gives an estimation of the size of the nucleus.	01 20

9. a)(i)	X-rays are electromagnetic radiation of short wavelengthproduced when fast moving electrons are stopped by matter; While cathode rays are streams of fast moving electrons.	01 01
(ii)	 The filament is heated and emits electrons by thermionic emission. The electrons arefocused by the cup and accelerated by the high p.d between cathode and anode. The electrons strike the target embedded in the anode. A small percentage of the kinetic energy of the electrons is converted to X-rays. Much of the kinetic energy of the electrons is converted to heat which is carried away by the cooling fins.	½ ½ 1½ 01 01 01 01 ½

b)	Soft x-rays are produced using a low accelerating p.d which results into electrons of low kinetic energy giving x-rays of long wavelength and low penetrating power. Hard x-rays are produced using a high p.d which results into electrons of high kinetic energy giving x-rays of short wavelength and high penetrating power.	01 01 01 ½ 1½
c) (i)		01
(ii)	Minimum wavelength, λ min. depends on the tube voltage. $\lambda min = {hc}/{ev}$, the higher the voltage, the smaller the value of cut off wavelength. Continuousspectra is formed as a result of multiple collisions of energetic electrons with target atoms. At each collision x-rays of different wavelengthare emitted. Line spectrum is formed when a highly energetic electron knocks out an electron out of the inner most shells. Electron transitions to the vacancies left result in emission of x-rays of definite wavelength	½ ½ 01 ½ 01 ½
(d)(i)	$5.0\times10^4\times I\times\frac{99.6}{100} = 600$ $\quad\therefore I = 0.0121A$	02
(ii)	$I = n e \Rightarrow n = \frac{0.0121}{1.6\times10^{-19}}$ $\quad\therefore n = 7.563\times10^{16}$	02 **20**

10. a)(i)	 X, X are X-plates, Y,Y are Y-plates. The cathode is heatedand it emits electrons. A_1 and A_2 focus and accelerate the electrons onto the screen. Grid controls number of electrons in the beam. X and Y plates deflect electrons horizontally and vertically respectively. Graphite coatings conduct stray electrons to the earth. The screen displays the signal.	01 01 01 01 1½ ½

(ii)	Used as a voltmeter, displays wave forms, comparing frequencies, measuring phase relationships.	01
b) (i)	The leaf gradually diverges. ✓	01
(ii)	This is because when zinc loses electrons, charge flows from leaf and plate to the zinc plate to replace electrons lost. This leaves the leaf and plate positively charged. The repulsion between the leaf and the plate makes the leaf to diverge ✓	01 01 01 ½
c)(i)	1. the time between irradiation and emission of the electrons is negligible ✓ 2. photocurrent is proportional to the intensity of the incident radiation ✓ 3. maximum kinetic energy of emitted electrons depends on the frequency of incident radiation. ✓ 4. for a given metal, there is minimum frequency below which no photoelectric emission can occur irrespective of the intensity of the incident radiation. ✓	01 01 01 01
d)(i)	$\frac{1}{2} mV^2_{max} = {}^{hc}/_{\lambda} - \phi$ ✓ $\Rightarrow \frac{1}{2} \times 9.11 \times 10^{-34} V^2_{max} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{150 \times 10^{-9}} - 2 \times 1.6 \times 10^{-19}$ ✓ $\therefore V_{max} = 1.482 \times 10^6 \text{ ms}^{-1}$ ✓	01 01 01
(ii)	$hf_o = \phi$ ✓ $\Rightarrow f_o = \frac{2 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}}$ ✓ $= 4.85 \times 10^{14} \text{ s}^{-1}$ ✓	02 20

END