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| **Qn** | **Answer** | **Marks** |
| 1. (a) | (i)   1. The reflected ray, the incident ray, and the normal to the mirror at the point of incidence all lie in the same plane. 2. The angle of incidence is equal to the angle of reflection | 1  1 |
| (i) Regular  (ii) Diffuse  (ii)  In regular reflection the rays in the incident beam are reflected with a particular regular pattern.  In diffuse reflection a regular beam of light gets scattered on reflection by an uneven reflecting surface | 1  1  1 |
| (b) | P  A  2θ  B  M2  M1  O  C  α  θ  (i)  Consider a ray AO incident at O on a plane mirror M1, at a glancing angle α. If OB is the reflected ray, then angle BOC = 2α.  Suppose M1 is now rotated through an angle θ to position M2, the direction of AO remaining constant. Then the glancing angle becomes α + θ and ∠ POC = 2(α + θ). Thus the reflected ray has rotated through an angle POB = ∠POC - ∠BOC  = 2(α + θ) - 2α = 2θ.  Thus the reflected ray moves through twice the angle turned through by the mirror. | 1  1  1  1 |
| *Any one @1*  (ii) - Optical lever in mirror galvanometer  - Sextant | 1 |
| (c) | (i) The glancing angle is the angle between the incident ray and the reflecting surface,  while the angle of incidence is the angle between the incident ray and the normal to the reflecting surface. | 1  1 |
| (ii)  α  α  β  β  A  B  O  C  180o - 2α  180o - 2β  According to the geometry of the figure, (α + β) = 90o  Now, ∠OAB + ∠ABC = 180o - 2α + 180o - 2β  = 360o – 2(α + β)  = 360o – 180o = 180o  So BC is parallel to OC | 1  ½  ½  1 |
| (d) | X  Y  O  A  (i) | 1 |
| (ii) - Used in a mirror **periscope**  A periscope is used to see over obstacles.  K  Object  L  O  Plane mirror  M  I  Plane mirror  The mirrors L and M are inclined at an angle of 45o to the line joining them. So they are parallel to each other. The image, I, of the object, O, can be viewed | 1  1  1  1 |
| ***Total = 20*** | | |
| 2. (a) | (i) ….the radius of a sphere of which the mirror is part. | 1 |
|  | ii)  A  θ  θ  θ  *f*  *r*  C  F  P  X  Consider a ray AX parallel and close to the principal axis of the mirror. It is reflected through F, the principal focus of the mirror.  If C is the centre of curvature, then CX is the normal to the mirror at X.  So ∠AXC = ∠CXF = θ  Also ∠XCF = ∠AXC = θ  Thus CF = FX.  Since AX is close to the principal axis, X is very close to P and FX is approximately equal to FP so that FP = FC or FP =½CP  F I C  O  Therefore **f = r/2** | ½  ½  ½  ½  ½  ½ |
| (b) | (i)  O = object  I = image  F C  I | 1 |
| (ii) | 1 |
| (c) | (i) Real is positive and virtual is negative | 1 |
| Q  θ  θ  X  α γ β  O P I C  N  h  (ii)  Consider a point object O on the principle axis of a convex mirror.  A ray OX from O is reflected along XQ.  A ray OP, incident at the pole P, is reflected back along PO and the point I where the two rays appear to emerge from is the virtual image of O.  The normal at X must be passing through the centre of curvature, C, of the mirror.  From the geometry of the figure  θ = α + β……….……………..(1)  Also θ = γ - β……….………………(2)  Therefore γ ­ β = α + β  ∴ γ - α = 2β …………………………(3)  Now α, β and γ are small angles, and if measured in radians,  α = tanα, β = tanβ and γ = tanγ  So γ =  =  as I is virtual.  α =  =  as O is real  β =  =  as C is virtual  Substituting for α, β and γ in (3)  -  =  So  -  =  ∴  ⇒  (since r =2f) | ½  ½  ½  ½  ½  ½  ½  ½  ½  ½ |
| (d) | (i) In the first case, let the object distance = u  Then in the second case the object distance = u + 7  So  ……………. (1)  and  ………… (2)  From (1) and (2)  =  ∴  =  ∴  =  = 77.4  ∴ u2 + 7u – 541.8 = 0  ∴ u =  = ˉ27.1 or 20.1  We take u = **20.1 cm** | 1  1  1  ½  1  ½  1 |
| (ii) From (1)  ∴ | 1  1 |
| ***Total =20*** | | |
| 3. (a) | (i) ….a surplus or deficit of electrons on a substance. | 1 |
| (ii) …. A region in which an electric force can be detected. | 1 |
| (b) | (i) …. the piling of electrons on one side of a conductor, leaving a positive charge on the opposite side of it, due to presence of a charge nearby. | 1 |
| (ii)  B  Conductor  A negatively charged body, B, is brought near a conductor.  The conductor is then earthed in the presence of B.  Electrostatic induction occurs, and when the conductor is earthed, electrons are repelled to the earth, leaving the conductor positively charged but at zero potential. | 1  ½  ½  1 |
| (iii) An electrophorus consists of a slab of insulating material, e.g polythene, and a brass disc, B, fitted with an insulating handle.  In use, the polythene slab is first given a negative by rubbing it with fur.  \_ \_ \_ \_ \_  + + + + +  \_ \_ \_ \_ \_ \_ \_  B  + + + + +  \_ \_ \_ \_ \_ \_ \_  B  -  \_ \_ \_ \_ \_ \_ \_  + + + + +  Disc is removed and carries charge  (i)  (ii)  (iii)  The metal disc is placed on top and it acquires charge by induction  However perfect the surfaces may look, actual contact occurs only at few points, so that practically negligible negative charge on the polythene is transferred to B.  After momentarily earthing the disc (fig (ii)) the disc is removed and it carries with it positive charge, which can be used to charge other bodies.  The source of electrical energy transferred by B is the work done in removing the positively charged plate against the attraction of the negative charge on the polythene. Therefore the electrophorus converts mechanical energy into electrical energy. | 1  ½  ½  1  ½  ½  1 |
| (c) | A  The conductor, A, is supported on an insulator and given a charge.  Proof planes of the same area, but shaped to fit the various respective parts of the conductor, are prepared.  A proof plane (on an insulating handle) at a time is placed on the part it fits, charged by induction and then transferred to the inside of a hollow can connected to the cap of a neutral electroscope (without making contact with the can), each time noting the divergence of the leaf.  It is observed that proof planes from sharper parts cause greater divergence.  This implies that ***surface density*** (charge per unit area) increases with curvature. | 1  ½  ½  1  1  ½  ½ |
| (d) | Q  R  X  X = Neutral point    *Charge distribution 2*  *Field – pattern 1*  *- direction 1* | 2  2 |
| ***Total = 20*** | | |
| 4. (a) | (i) The electric potential at a point in a field is the work done in moving a positive charge of one coulomb from infinity to the point. | 1 |
|  | (ii) Suppose A is the point whose potential, VA, is required. Then imagine a small point charge q placed at point C, distance x from Q.  +Q ­A  d  δx  B  C  +q  x  Suppose q is now moved a small distance δx to B, δx being so small thatthe field due to Q is not affected.  Over this small distance, the force F may be regarded as constant. So the work done by the external agent over δx against the force of the field is  δW = F(-δx)  The total work done in bringing q from infinity to point A is  The potential VA at point A is the work done per unit positive charge brought from infinity to A. | ½  ½  1  1  1  1 |
| (b) | (i) V1 =  =  = 2.7 x 105 V  V2 =  =  = -3.6 x 105 V  Vp = V1 + V2 = (2.7 - 3.6) x 105  = **-9.0 x 104 V** | 1  1  1  1 |
| (ii) E1 =  =  = 2.7 x 106 NC-1  E2 =  =  = 3.6 x 106 NC-1  120o  E  E1  E2  E2 =  = (2.72 + 3.62 – 2 x 2.7 x 3.6 x 0.5) x 1012  = (7.29 + 12.96 - 9.72) x 1012  = 10.53 x 1012  ∴ E = **3.24 x 106 NC-1** | 1  1  1  1  1 |
| (iii)  Potential energy =  =  = -**1.08 J** | 1  1 |
| (iv) Let A be x cm from Q1  Then  =  ∴  ∴ x2 + 60x – 300 = 0  ∴ x = **4.64 cm** | 1  1  1 |
| ***Total = 20*** | | |