u v

O M P I

I΄

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| **Qn** | **Answer** | **Marks** |
| 1. (a) | A pin O is placed to form an image I in the convex mirror.  Then a small plane mirror, M, facing O is moved between O and P until the image, I΄, of the lower part of O coincides with I.  The distances OP and MP are measured.  Due to the plane mirror, OM = MI  **∴** v = OM – MP (virtual) and u = OP (real)  The procedure is repeated for several positions of O each time working out u and v.  A graph of 1/v against 1/u is plotted.  The intercept on each axis gives 1/f | 1  ½  1  1  ½  ½  ½  1 |
| (b) | Let the ends be A and B, with A at 40 cm from the mirror        ∴ Length of the image = 21.2 – 15.4 = **5.8 cm** | ½  1  ½  1  2 |
| (c) | 15cm  20cm  10cm  10cm  h  h1  (i) | 2 |
| (ii) v = 30 cm | 1  1  2 |
| (iii)  ∴ h1 = **6 cm** | 2  1 |
| ***Total = 20*** | | |
| 2. (a) | (i) Refraction is the change of direction of travel of light resulting from change of speed when light crosses from one medium to another of different optical density.  O  I  Water  Air | 1 |
| (ii)  Let O be a point at the bottom of the pond.  Rays of light coming from O are refracted away from their respective normal as they cross the water-air boundary.  This makes them appear to come from I as they enter the observer’s eye.  So the bottom of the pond appears raised to I | 1  1  1 |
| (iii) An air cell is formed by cementing together two thin plane-parallel glass plates so as to contain a thin film of air of constant thickness.  Angular scale  Liquid  A  *i*1  air  glass  liquid  E  Air cell  M            The liquid is poured in a glass vessel having thin plane-parallel sides. The air cell A is placed in the liquid.  Bright light from a source, M is directed to one side of A in a constant direction MO, and is observed at E on the other side.  A is first positioned so that the incident light from M strikes it normally and goes through undeviated.  A is now rotated (slowly) until the light is suddenly cut off from E.  The angle, *i*1, turned through is noted. It is the angle of incidence in the liquid when light just grazes the glass-air boundary.  Since the boundaries are parallel nsin i =constant  **∴** n1sin*i*1 = ngsin i2 =1 x sin90°, where n1 is the refractive index of the liquid  **∴** nlsin*i*1 = 1 | 1  1  ½  ½  ½  ½  ½  ½  ½  ½ |
| (b) | Let the respective positions of the lens be A and B  O A B I        Let h = height of the object  m1 = magnification when the lens is in position A  m2 = magnification when the lens is in position B  then m1 = h1/h = AI/AO…………………….(1)  and m2 = h2/h = BI/BO…………………….(2)  But AI = BO and AO =BI (since O and I are conjugate points)  h/h1= h2/h | ½  1  1  ½  ½  ½ |
| (c) | O  L1  L2  M  N  I  600  20  For lens L1: u = 600 cm, f = 30 cm  (i)      For lens L2, I is a virtual object. Thus, u′ = ‾(31.6 – 20) = ‾ 11.6 cm  So the image is **virtual** and is **8.8 cm** to the left of L2 | 1  1  1  1 |
| (ii) Overall magnification, m = m1 x m­2 | 2 |
| ***Total = 20*** | | |
| 3. (a) | This is the resistance per unit cross-sectional area per unit length of a material | 1 |
| (b) | (i)  Thick copper strips  Uniform resistance wire 1 m long  G | ½  1  ½ |
| (ii)  R  *l*1 *l*2  G  *x*   * A length x of the wire is connected in one gap of the metre bridge while a standard resistor, R, is connected in the other gap and so chosen as to bring the balance points in the middle third during the experiment. * The circuit is connected as shown, and the balance point is found. Balance lengths *l*1 and *l*2 are noted. * The experiment is repeated for several different lengths x, each time noting the corresponding balance lengths *l*1 and *l*2. * A graph of  against x is plotted * The diameter, d, of the wire is measured and noted.   Let β = resistivity of the wire    ∴ β = πd2Rs | 1  1  ½  1  ½  ½  1  ½ |
| (iii) Ro = x 5 = 4.09 Ω  and R100 = x 5 = 5.59 Ω | 1  1  1  2 |
| (c) | (i)  G  2V  1Ω  2Ω  1.5V  A  I  D  B  I =  = 0.2 A  VAD = 1.5 V | ½  ½  1 |
| (ii) Terminal p.d = x 0.2 x 9 = 1.26 V  ∴ 3 = 2.56 + 1.26r  ∴ r =  = **0.35 Ω** | ½  1  ½  1 |
| ***Total = 20*** | | |
| 4.(a) | (i) An electric field is a region in which an electric force is detected. | 1 |
| (ii) 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 |
| (b) | **E1**  **E2**  **Ep**  Ep2 = E12 + E22 + 2E1E2 cos 60o  = [2.72 + 1.82 + 2 x 2.7 x 1.8 x 0.5] x 1012  = 15.37 x 1012  ∴ Ep = **3.92 x 106 NC-1** | 1  1  1  1  1 |
| (ii) At point Y the magnitudes of the intensities are equal.  So E1 = E2  Let x = distance of point Y from Q1.    ∴ *x*2 – 60*x* + 300 = 0  Since x must be less than 10 cm, x must be **5.5 cm** | ½  1  ½  1 |
| (c) | (i) C2 is in series with (C1 + C3) = C′  C′ = 40 + 20 = 60 μF  90V  C2  C′  Equivalent capacitance of the whole circuit,    ∴ Energy stored in the circuit, E = CV2 = x 20 x 10-6 x 902  = **8.1 x 10-2 J** | 1  1  1  1  1 |
| (ii) The capacitance of C2 becomes 3 x 30 = 90 μF  This is in series with (C1 + C3) = 60 μF  The equivalent capacitance for the whole circuit is  Energy stored, E′ = x 36 x 10-6 x 902 = 1.46 x 10-1 J  Change in energy = E′ - E = 0.146 – 0.081  = **0.055 J** | 1  1  1  1  1 |
| ***Total = 20*** | | |
| 5. (a) | (i) ***Hysteresis*** is the lagging of the flux density behind the magnetising intensity.  This is because once iron has been magnetized, some domains remain aligned even when the magnetizing force is removed. | 1  1 |
| (ii) ***Remanance***, is the retained magnetic flux density in an originally magnetised material when the magnetising force has been removed.  It is due to the tendency of the domains to stay put once they have been aligned. | 1  1 |
| (iii) The ***coersive force*** is the minimum opposing magnetising force required to bring the residual flux density to zero.  It is the measure of the difficulty of breaking up the alignment of the domains.  X  X = neutral point | 1  1 |
| (b) | (i)  ***Neutral point***  ***Pattern and direction*** | ½  ½ |
| X = neutral point  X  X  OR  ***Neutral point***  ***Pattern and direction***  (ii) | ½  ½ |
| (c) | (i) Two equal but opposite magnetic forces act at the point  Flux density  Distance | 1 |
| (ii)  ***Award only if the axes are labeled*** | 1 |
| (iii) Length of the conductor in the field  Strength of the magnetic field  Magnitude of current  Angle between the conductor and the field | ½  ½  ½  ½ |
| (d) | x  12-x  I1  I2  P  I1 = 2A and I2 = 4A  At the neutral point P, B1 = B2  ∴ 2x = 12 – x  ∴ x = **4 cm** from I1 | 1  1  1  1 |
| (e) | HE = HC cotθ  θ  HE  HC  = **167.8 A m-1** | 2  1  1 |
| ***Total = 20*** | | |