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**END-OF-YEAR EXAMINATIONS**

**November 2015**

**S5 PHYSICS**

**Paper 2**

***2 hours 30 minutes***

*Attempt* ***FIVE*** *questions only*

*Assume where necessary:*

*Acceleration due to gravity, g = 9.81 ms-2*

*Speed of light in vacuum, c = 3.0 x 108 ms-1*

*Electron charge, e = 1.6 x 10-19 C*

*Electron mass, me = 9.11 x 10-31 kg*

*Permittivity of free space, ε0 = 8.85 x 10-12 Fm-1*

Fill the table below to indicate the questions you have attempted, in the order you answered them.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Question |  |  |  |  |  | Total |
| Marks scored |  |  |  |  |  |  |

1. (a) (i) Distinguish between **a shadow** and **an image** (2)

(ii) Using a ray diagram show that the image formed by a plane mirror is as far behind the mirror as its object is in front of the mirror. (3)

(b) Derive the mirror formula for a spherical mirror. (5)

(c) Describe an experiment to determine the focal length of a convex mirror using a converging lens. (5)

(d) A rod, 80cm long, is laid along the principal axis of a diverging mirror of focal length 30 cm. If the nearest end of the rod is 40 cm from the mirror, find the length of the image of the rod. (5)

2. (a) What is meant by

(i) ***refractive index*** of a medium? (1)

(ii) ***total internal reflection*** of light? (1)

(b) (i) Explain why a pool of water looks shallower. (3)

(ii) Describe an experiment to determine the refractive index of liquid using an air-cell. (5)

(c) A ray of light is incident at a small angle if incidence on a prism of small angle, A. If the refractive index of the prism material is n, derive an expression for the deviation produced. (4)

(d) A ray of light is incident on a prism of refractive index 1.5 and refracting angle 60o. The ray emerges from the prism at an angle of 65o.

Find

(i) the angle of incidence (4)

(ii) the deviation of the ray (2)

3. (a) For a converging lens, what is meant by

(i) **principal axis** (1)

(ii) **principal focus** (1)

(b) A lens of focal length f forms an image on a screen of an object which is at a distance y from the screen. Derive an expression for the distance y for the image to always be real. (4)

(c) Describe an experiment to determine the focal length of a diverging lens with the help of a converging mirror. (5)

(d) What is meant by the following?

(i) **Visual angle** (1)

(ii) **Angular magnification** of an instrument (1)

(e) (i) Draw a ray diagram to illustrate how a Galilean telescope forms a final virtual image 30 cm from the eyepiece. (2)

(ii) Derive an expression for the angular magnification of the arrangement in (d) (i). (3)

(iii) State two advantages of this telescope over a terrestrial telescope.

(2)

4. (a) (i) State Ohm’s law (1)

(ii) Give anexample of a non-Ohmic conductor and sketch its current-voltage characteristic. (2)

(b) (i) Define potential difference. (1)

(ii) Derive an expression for the electrical energy dissipated in a resistor of resistance **R**, carrying a current **I** for time **t**. (3)

(c) A network of resistors of 2Ω, 3Ω, 4Ω and 6Ω are connected to a 6V d.c supply of negligible internal resistance as shown in figure 1

6V

4Ω

3Ω

6Ω

2Ω

**Fig. 1**

Calculate the power dissipated in the 6Ω resistor. (4)

(d) (i) Define **temperature coefficient of resistance**. (1)

(ii) Explain why a conductor heats up when a current flows through it.

(2)

(e) An electric heater consists of 4.0 m of wire of diameter 0.60 mm. When connected to a 240 V supply, the heater dissipates 2.4 kW and the temperature of the heater is found to be 1020oC. If the resistivity of the material of the wire at 10oC is 10.2 x 10-7Ωm, calculate:

(i) the resistance of the wire at 10oC. (2)

(ii) the mean temperature coefficient of resistance of the material of the wire between 10oC and 1020oC. (4)

5. (a) (i) Define **electric potential**. (1)

(ii) Derive an expression for the electric potential at a point d metres from an isolated point charge Q in a medium of permittivity ε. (5)

(b) A neutral conductor, A, is placed adjacent to a positively charged sphere, B, as shown in figure 2.

A

B

**Fig. 2**

Sketch a graph to show how the electric potential varies with the horizontal distance from the left of A to a point on the right of B. (2)

(c) (i) Describe an experiment to investigate the charge distribution over the surface of an irregularly shaped conductor. (5)

(ii) Explain why a charged spherical conductor loses charge faster when a pin is attached to it. (2)

(d) Two charges of magnitudes 5μC and -9μC are placed at the corners of a square ABCD of side 5 cm, as shown in figure 3

A

B

C

D

**Fig. 3**

5μC

-9μC

Find the work done in taking a point charge of 2μC from A to the centre of the square. (5)

6. (a) (i) Define the term **dielectric constant**. (1)

(ii) State **two** uses of a dielectric in a capacitor (2)

(iii) Explain the action of a dielectric (5)

(b) (i) Using the same axes sketch graphs of p.d across a capacitor against time and of charging current against time. (1)

(ii) Derive an expression for the energy stored in a capacitor of capacitance C charged to a p.d V. (5)

(c) Four capacitors of capacitances 29μF, 30μF, 50μF and 70μF are connected to a 20V d.c. supply as shown in figure 4.

20V

50μF

29μF

30μF

70μF

**Fig. 4**

Calculate the energy stored in the 30μF capacitor when fully charged. (6)

7. (a) (i) State Kirchhoff’s circuit laws. (2)

(ii) In the circuit shown in figure 5, all the sources have negligible internal resistance.

4Ω

5Ω

5Ω

3V

2V

4V

**Fig. 5**

Find the current flowing in the 4Ω resistor. (4)

(b) Explain why a potentiometer may be preferred to a voltmeter for measuring emf of a cell. (2)

(c) Describe an experiment to measure the emf of a cell using a potentiometer. (6)

(d) In the circuit shown in figure 6 the sources P and Q have negligible internal resistance and emfs 3V and 2.1V respectively. The wire AB is uniform and has resistance of 12Ω.

3V

3Ω

S2

4Ω

A

B

P

C

Q

2.1V

S1

3Ω

**Fig. 6**

Find the balance length AC when

(i) switch S1 closed and S2 open. (3)

(ii) switch S1 open and S2 closed (3)