S.C.H.S

Attempt all items.

Physics 5.5 Holiday work.

Term, 2026.

ITEM 1

A dentist holds a concave mirror of focal length 4cm at a distance of 1.5cm from the tooth. Find the position and magnification of the image which will be formed.

ITEM 2

A concave mirror of radius of curvature 25cm faces a convex mirror of radius of curvature 20cm, with the convex mirror 30cm from a concave mirror, If the object is placed mid way, between two mirrors, find the nature and position of the image formed by reflection

i) By concave mirror
ii) By convex mirror

ITEM 3

Describe how the focal length of a convex mirror can be obtained using a plane mirror and the no parallax method.

ITEM 4

A plane mirror is placed at a distance (d) in front of a convex mirror of focal length (f) such that it covers about half of the mirror surface. A pin placed at a distance (L) in front of the plane mirror gives an image in it, which coincides with that of the pin in the convex mirror. With the aid of an illustration, show that $2df = d^2 - L^2$

ITEM 5

~~A ray of light travelling from a liquid to air hde on~~

A ray of light is incident in water on a plane water-glass boundary. The angle incidence is 30°. Find the angle of ~~reflection~~ refraction. (refractive index of glass and water is 1.5 and 1.33 respectively) Ans(26.4°)

ITEM 6

i) What is meant by the refractive index of a material?

ii) Light of two colours blue and red is incident at an angle $\gamma$ from air to a glass block of thickness t. When blue and red light are refracted through angles of $\theta_b$ and $\theta_r$ respectively, their corresponding speeds in the glass block are $V_b$ and $V_r$. Show that the separation of the two colours at the bottom of the glass block $d = \frac{t}{c}\left(\frac{V_r}{\cos\theta_r} - \frac{V_b}{\cos\theta_b}\right)$ cm. Where $\theta_r > \theta_b$ and C is the speed of light in air.

iii) Light consisting of blue and red is incident at an angle of 60° from air to a glass block of thickness 12cm. If the speeds of blue and red light in the glass block ~~colours at the bottom~~ are $1.86 \times 10^8 ms^{-1}$ and $1.92 \times 10^8 ms^{-1}$ respectively, find the separation of the two colours at the bottom of the glass block. (Answer: 0.54 cm)

ITEM 7

Two point charges of 5μC and 7 μC are placed in liquid of relative permittivity 9 at distance 5cm apart. Calculate the force between them. An (3.992N)

ITEM 8

Two equal point charges at a distance 5Cm apart repel each other with a force of 1.296N. Calculate the size of each charge if they were situated in:

i) A vacuum

ii) A liquid whose dielectric constant is 4 An (i) = 6μC and (ii) = 12μC)

ITEM 9

Two ~~insulta~~ insulating metal spheres each of charge $5 \times 10^{-8}$ C are separated by distance of 6cm. What is the force of repulsion of;

i) The spheres are in air An (0.00625N)

ii) The spheres are in air with the charge in each sphere doubled and their distance apart is halved An (0.1N)

iii) The two spheres are placed in water whose dielectric constant is 81 An ($7.7 \times 10^{-5}$N)

Item 14

Use the method of dimensional analysis to check the validity of the following equations

i) $E = mc^2$, where E is the energy obtainable from a mass m, and c is the velocity of light

ii) Energy stored in a wire $= \frac{1}{2} \frac{EAe^2}{l}$ where E is the youngs modulus, A the cross-sectional area, e the extension and l the original length

iii) Escape velocity from a planet, $V = \sqrt{2Rg}$, where R is the radius of the planet and g is the gravitational intensity at its surface

iv) Period of oscillation of a floating cylinder of density $\rho$ with its axis vertical and length h immersed in a liquid of density is $T = 2\pi \sqrt{\frac{h\rho}{\sigma g}}$

Item 15

At Horizon Secondary School, a chemistry student is studying how real gases behave at high pressure. Instead of using the ideal gas equation, the student uses the modified equation:

$$\left(\frac{P + a}{v^2}\right)(v - b) = RT$$

The student needs to understand what the constants a and b represent, and must find their dimensions before using the equation in calculations.

i) Define dimensions of a physical quantity.

ii) Determine the dimensions of the constants a and b.

ITEM 10

A bulb is used in a torch which is powered by two identical cells in series each of e.m.f 1.5V. The bulb then dissipates power at the rate of 625mW and the p.d across the bulb is 2.5V. Calculate;

i) The internal resistance of each cell.

ii) The energy dissipated in each cell in one minute. An C1Ω. 3.75J)

ITEM 11

A steady uniform current of 5mA flows axially along a metal cylinder of cross-sectional area of 0.2mm², length 5m and resistivity $3 \times 10^{-5}\Omega m$. Find;

~~area 0.2 mm²~~

a) The potential difference between the ends of the cylinder.

b) The rate of production of heat An C3.75V, $1.9 \times 10^{-2}$W)

ITEM 12

a) Explain why the p.d between the terminals of a cell is not always the same as its e.m.f

b) A cell, a resistor and an ammeter of negligible negligible resistance are connected in series and a current of 0.8A is observed to flow when the resistor has a value of 2Ω. When a resistor of 5Ω is connected in parallel with the 2Ω resistor, the ammeter reading is 1A. Calculate the e.m.f of the cell An C2.29V)

ITEM 13

A power supply has an e.m.f of 5000V. When a voltmeter of resistance 20kΩ is connected to the terminals of the power supply a reading of only 40V is obtained.

i) Explain this observation

ii) Calculate the current flowing in the meter and the internal resistance of the power supply. An C$2 \times 10^{-3}$A, 2480Ω)

(6)

item 819

Mulago National Referral Hospital has installed new digital temperature sensors in the neonatal intensive care unit. Since newborn babies are extremely sensitive to temperatures chonges, even an error of 0.2°c could endonger their lives.

To guarantee accuracy, biomedical engineers decide not to use the traditional ice and steam points instead, they employ:

1 A triple point of water cell as a primary temperature reference,

2 A constant-volume gas thermometer connected to a manometer,

3 Atmospheric pressure values of the gas thermomete at several known reference temperatures in order to determine the actual room temperature.

in the ~~quality~~ calibration laboratory.

You are apointed as the quality-control physics consultant for this procedure.

Tasks

i) to train the hospital technicians, you are required to define the following:

a) triple point of water

b) absolute zero temperatures

ii) Hospital management asks why the triple point of water is preferred over ice and steam point. Explain why the triple point of water is adapted as the modern international standard of precise thermometry

(ai) c) Explain what is meant by a thermometric property.

i d) state three qualities that make a physical property suitable for accurate temperature measurements medical instruments.

5

item 36
A particle moving in a straight line with a constant acceleration of $2ms^{-2}$ is initially at rest, find the distance covered by the particle in the 3rd second of its motion.

item 47
A Travelling car A at a constant velocity of 25m/s overtake a stationery Car B. 2s later car B sets off in pursuit, accelerating at a uniform rate of $6ms^{-2}$. How for does B travel before catching up with A

item 518
A train travelling at $72kmh^{-1}$ under goes uniform deceleration of $2ms^{-2}$, when brakes are applied. find the time taken to come to rest and the distance travelled from the place where brakes are applied.

c) Some drug-processing equipment operates at very high temperatures that cannot be measured by contact thermometers. With the aid of a labelled diagram, explain how an optical pyrometer works and why it is suitable for non-contact temperature measurement in this factory.

d) An oxygen tank of volume 50 L is used to supply hospitals. When oxygen is withdrawn, the pressure in the tank drops from $21.4 \times 10^3$ Pa to $7.8 \times 10^5$ Pa. During the process, the temperature of the gas falls from 30°C to 10°C. Calculate the mass of oxygen withdrawn from the tank. (This result used to confirm that the hospital has ~~reached~~ received the correct oxygen supply) Ans (822.8g)

d) i) During calibration, the following pressure readings were recorded at known reference temperatures.

| | length of meraury in inclosed limb (mm Hg) | length of mercury in open limb (mm Hg) |
|---|---|---|
| Bulb in ice | 140 | 130 |
| Bulb in steam | 140 | 330 |
| Bulb at room temperature | 140 | 170 |

Using the supplied pressure - temperature data, calculate the actual room temperature of the calibrated laboratory. This value is used to verify whether the digital incubator sensors are correctly adjusted An (20°c)

ii) The hospital is considering replacing its mercury in-glass thermometers with gas thermometers in the calibration lab. List 3 advantages of the constant-volume gas thermometer over the mercury-in-glass thermometer and advise management wheter the replacement is justified.

e) Ice packs are commonly used in the hospital for emergency cooling. Explain what physically happens when the temperature of a fixed mass of ice is raised from 0°c to 10°c, highlighting how heat energy is absorbed during the process.

Item 2 1

8

3. The ionization energy for a hydrogen atom is 13·6eV, if the atom is in its ground state·It is 3·4eV if the atom is in the first excited state·Calculate the wave length of the photon emitted when a hydrogen atom returns to the ground state from the first excited state·Name the part of the electromagnetic spectrum to which this wavelength belong·($e = -1·6 \times 10^{-19}C$, $h = 6·63 \times 10^{-34}Js$, $c = 3 \times 10^{8} ms^{-1}$)·

End.

Attempt all