PACE-IIT & MEDICAL

(SOLUTION)

Physics

1. Soln.: (2)

Case (i) $_{W}\mu_{g} = \dfrac{\mu_g}{\mu_W} = \dfrac{3/2}{4/3} = \dfrac{9}{8}$

Critical angle at this surface is given by

$C_1 = \sin^{-1}(8/9)$ or $C_1 = 60^{\circ}45'$

Case (II) Similarly,

$_{a}\mu_{W} = \dfrac{\mu_W}{\mu_a} = \dfrac{4}{3}$

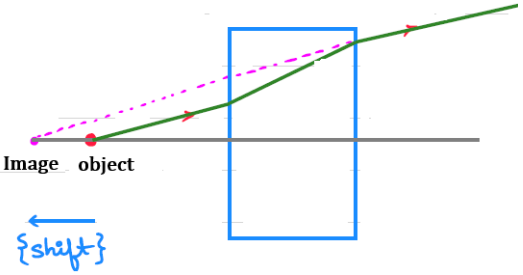
$C_2 = \sin^{-1}(3/4)$ or $C_2 = 48^{\circ}36'$

$C_2 < C_1$

$\therefore$ TIR occurs at upper surface, i.e. air – water interface

2 Soln.: (2)

Since μ slab < μ medium $\therefore$ it will appear farther from him.



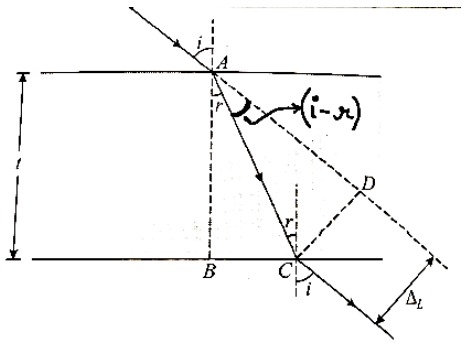
(observe that Rays bend away from normal as it enters the slab as Denser to Rarer medium)

3. Soln.: (3)

$AC = \dfrac{t}{\cos r}$

$\Delta_L = AC \times \sin(i - r)$

$= \dfrac{t}{\cos r}\sin(i - r)$



4. Soln.: (1)

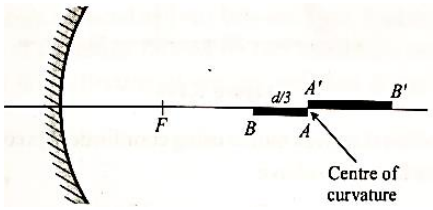
Given that image is touching the object that means this point must be at the center of curvature of the mirror as shown in figure-. The image of A is formed at the same position (since is at Center of curvature). For image of B we will use mirror formula.

Applying mirror formula for image of B, according to cartesian coordinate sign convention,
we use u = + 5d/3 and f = +d

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

$$\Rightarrow \quad \frac{1}{v}+\frac{1}{\frac{5d}{3}}=\frac{1}{d}$$

$$\Rightarrow \quad v=\frac{5d}{2}$$



Hence length of image obtained is

$$A'B'=\frac{5d}{2}-2d=\frac{d}{2}$$

5. Soln.: (4)

For image produced by concave mirror, by coordinate sign convention for mirror formula, we use u = + 35 cm, f = + 25 cm

Now by mirror formula we have

$$v=\frac{uf}{u-f}=\frac{35\times 25}{10}=+87.5\text{cm}$$

Thus image produced by concave mirror *I* is located at a distance 87.5 cm from P which is at 87.5 – 35 = 52.5 cm from the object O.

Separation between *O* & *I* is

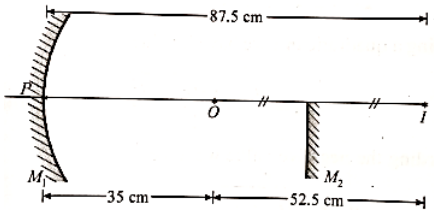
= 87.5 – 35 = 52.5 cm

Position of M_2, from object is at *O* distance

$$=\frac{52.5}{2}=26.25\,\text{cm}$$

Distance of M_2 from pole of mirror is

P = 35 + 26.25 = 61.25 cm.



6. Soln.: (1)

$$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{(\mu_2-\mu_1)}{R}$$

$$\frac{\mu}{2R}-\frac{1}{\infty}=\frac{(\mu-1)}{R}$$

$$\frac{\mu}{2R}-\frac{\mu-1}{R}$$

$$2\mu-2=\mu$$

$$\mu=2$$

7. Soln.: (1)

Her first refraction at flat surface image is produced of a is distance given by

$$\mu h = \frac{3}{2} \times 20 = 30$$

For second refraction at spherical surface, for refraction formula we use

u = +40 cm; R = + 10 cm; $\mu_1 = \frac{3}{2}$; $\mu_2 = 1$

Substituting values in refraction formula, we get

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \quad \frac{1}{v} = \frac{3}{2 \times 40} = \frac{1 - \frac{3}{2}}{10} \Rightarrow \quad \frac{1}{v} = \frac{3}{90} - \frac{1}{20} = -\frac{1}{80} \Rightarrow \text{ v = -80 cm}$$

Thus final image is seen by observer at a distance 80 cm from the pole p\ of curved surface and it is a real image

8. Soln.: (4)

Resultant of two equal forces:

$$R = \sqrt{F^2 + F^2 + 2F^2 \cos\theta}$$

Given R = F, substitute

$$F = \sqrt{2F^2(1 + \cos\theta)}$$

Square both sides:

$$F^2 = 2F^2(1 + \cos\theta)$$

Divide by F^2

$$1 = 2(1 + \cos\theta)$$

$$1 = 2 + 2\cos\theta$$

$$2\cos\theta = -1$$

$$\cos\theta = -\frac{1}{2}$$

$$\theta = 120^o$$

9. Soln.: (2)

Understand that the resultant force of two vectors depends on the angle between them

Recall that the formula for the magnitude of the resultant force is given by

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

Where θ is the angle between the forces.

As the angle θ increases, the value of cos θ

decreases, leading to a decrease in the magnitude of the resultant force.

10. Soln.: (3)

For two vectors $\vec{F}_1$ and $\vec{F}_2$ of equal magnitude, the resultant vector splits the angle between them equally due to symmetry.

Thus, direction of resultant = **angle bisector** of the included angle.

11. Soln.: (2)

According to the **Triangle Law of Vector Addition**, if two vectors are represented in magnitude and direction by two sides of a triangle taken in the same order (tip-to-tail arrangement), their resultant is represented in magnitude and direction by the third side **of the triangle taken in the opposite order** (from the tail of the first vector to the head of the second).

12. Soln.: (3)
Friction does negative work on the block because it acts in the direction opposite to the block's displacement. The block is sliding, so it has a non-zero displacement, and the force of friction constantly opposes this motion, converting the block's kinetic energy into heat until it comes to rest.

13. Soln.: (2)
Work done

$$W = \int_0^a F\,dx = \int_0^a kx\,dx$$

Integrate: $W = k\left[\frac{x^2}{2}\right]_0^a = \frac{ka^2}{2}$

14. Soln.: (1)
When a ball is thrown vertically upward, the total mechanical energy (ME) is conserved (neglecting air resistance) meaning ME = KE + PE = constant.

- Kinetic energy (KE) : This energy is dependent on the velocity (v) of the object, given by the formula $KE = \frac{1}{2}mv^2$. At the very peak of its flight path, the ball momentarily stop, so it instantaneous velocity is zero (v =0) . Consequently, the kinetic energy is zero
- Potential Energy (PE): This energy is dependent on the height (h) of the object relative to a reference point, given by the formula PE = mgh . Since the ball reaches its maximum height at the highest point, its potential energy is maximum

Therefore, at the peak, all the initial kinetic energy has been converted entirely into potential energy.

15. Soln.: (1)
Force: $\vec{F} = 3\hat{i} + 4\hat{j}\ N$
Displacement: $\vec{s} = 2\hat{i} - \hat{j}\ m$
Work done $W = \vec{F} \cdot \vec{s}$
Dot product $W = (3)(2) + (4)(-1) = 6 - 4 = 2\ J$

Chemistry

16. Soln.: (2)
Very large jump from I_2 to I_3 indicates removal of the third electron from a stable noble-gas core; hence two valence electrons → Group 2.

17. Soln.: (1)
All are in period 3. Across a period, atomic radius decreases with increasing atomic number; so Na(11) largest, then S(16), then Ar(18) smallest.

18. Soln.: (1)
Electronegativity increases left to right across a period; in period 3 sequence is Na, Mg, Al, Si with increasing electronegativity.

19. Soln.: (3)
Al forms amphoteric $Al_2O_3 AlO(OH)$ and salts like $Al(ClO_4)_3$; other listed metals form mainly basic oxides

20. Soln.: (3)
Na (highly metallic) is on extreme left of period 3, Cl is a non-metal on the right; difference in tendency to lose electrons is largest.

21. Soln.: (3)
Once all valence electrons are removed, next ionisation removes an inner-shell electron requiring a big jump in energy; this is used to infer valence electron count.

22. Soln.: (2)
P (group 15) is left of Q (group 17) in the same period, so it is more metallic, less electronegative, and has lower I_1 than Q.

23. Soln.: (2)
Fe^{3+} in Fe_2O_3 goes to Fe(0) (gain of electrons → reduction); Al(0) goes to Al^{3+} in Al_2O_3 (loss of electrons → oxidation).

24. Soln.: (1)
Increase in oxidation state from +2 to +3 occurs by loss of one electron, so Fe^{2+} is oxidised.

25. Soln.: (2)
Zn + HCl gives H_2 (does not decolourise acidified $KMnO_4$), while Na_2SO_3 + HCl gives SO_2 which bleaches/decolourises acidified $KMnO_4$ due to its reducing nature.

26. Soln.: (3)
Burning Mg mainly forms MgO by combination with oxygen; oxidation is gain of oxygen. Minor formation of Mg_3N_2 does occur but the key reason for calling it combination is union of Mg and O only; the given R is not correct as stated.

27. Soln.: (2)
Na_2CO_3 + HCl gives CO_2 effervescence → P; Na_2SO_4 + $BaCl_2$ gives $BaSO_4$ white ppt → Q; NaCl shows neither effervescence with HCl nor ppt with Ba^{2+} → R.

28. Soln.: (2)
Zn is more reactive than Fe in electrochemical series and acts as a sacrificial anode, getting oxidised preferentially and protecting iron from rusting.

29. Soln.: (1)
"S" is an acid (turns blue litmus red); Zn displaces H from acid: $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ Acid is reduced to H_2 while Zn is oxidised; this is a displacement accompanied by reduction of acid.

30. Soln.: (4)
Balance C: y = 3 (3 carbons). Balance H: z = 4 (8 H atoms). O atoms on RHS = 3×2 + 4 = 10, so O_2 moles x = 5 To keep coefficients integral without fractions, multiply by 2: $2C_3H_8 + 7O_2 \rightarrow 6CO_2 + 8H_2O \rightarrow x = 7, y = 6, z = 8$

Biology

31. Soln.: (4)
Respiration is majorly catabolic & photosynthesis is anabolic.

32. Soln.: (3)
LOH is U – shaped or hair -pin like

33. Soln.: (4)
Mammals & Birds show double circulation due to 4 – chambered heart

34. Soln.: (2)
More the number of alveoli, more is the surface area for gaseous exchange

35. Soln.: (1)
Increasing cranial capacity & Bipedalism were the most – significant trends of human evolution

36. Soln.: (2)
AB blood group is universal recipient as it lacks blood group antibodies

37. Soln.: (4)
Genotype codes for phenotype of an organism that get selected via natural selection

38. Soln.: (1)
Darwin said evolution is slow due to accumulation of favourable variation generation after generation

39. Soln.: (1)
Paleontology

40. Soln.: (3)
Menstrual cycle stops during pregnancy i.e. no ovulation occurs.

41. Soln.: (2)
Fragmentation does not involve fertilization & hence asexual reproduction

42. Soln.: (3)
Pollen grain are stored in anther of flower.

43. Soln.: (3)
Grafting is a method of vegetative propagation to improve plant breed

44. Soln.: (2)
Endocrine glands are ductless. Mammary & salivary glands are exocrine

45. Soln.: (4)
Sympathetic – emergency neural system parasympathetic maintain homeostasis

46. Soln.: (4)
only animal have neural system

47. Soln.: (3)
Dwarfism resulting in stunted physical growth is due to lack of GH

48. Soln.: (4)
Walking is a mode of locomotion. Reflex – quick, spontaneous involuntary action

49. Soln.: (1)
Roots grows deep in soil towards force of gravity

50. Soln.: (4)
Thyroxine – Animal hormone