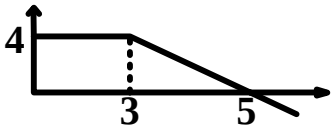
PHYSICS

1. Two stones are projected with the same speed of 25 ms^{-1} from the same point and have the same range of 60 m. Find the difference in their time of flight. Note that if sin x = 0.6, then sin 2x = 0.96.
(A) 2 s (B) 1 s (C) $\sqrt{2}$ s (D) $\sqrt{3}$ s

1. **(B)** ***Based on Projectile Motion Q. 29***
sin 2θ = gR / u^2 = 600 / 625 = 0.96. ∴ sin θ = 0.6 or 0.8.
As $t = (2u / g)$ sin θ, t = 3 s or 4 s. ∴ Δt = 1 s.

2. The acceleration (in ms^{-2}) vs. time (in s) graph for a particle is shown. The particle starts from rest and comes to rest again at time t =



(A) 9 s (B) 8 s (C) 8.5 s (D) 7.5 s

2. **(A)** ***Based on One Dimensional Motion Q. 128***
Line slope, m = – 4 / (5 – 3) = – 2.
For area = 0 (as $v_{ini} = v_{fin}$), 4 × 3 + ½ × 4 (5 – 3) = ½ (2) $(t – 5)^2$ i.e.
$(t – 5)^2$ = 16 or t = 9 s.

3. For a particle in one-dimensional motion, the displacement s and velocity v are related as $vs = c$, a constant. If acceleration $a = bs^n$ where b is a constant, then n =
(A) 3 (B) 1.5 (C) – 1.5 (D) – 3

3. **(D)** ***Based on One Dimensional Motion Q. 118***
$v = c\,s^{-1}$, $a = v\,(dv / ds) = (c\,s^{-1})\,(– c\,s^{-2}) = – c^2\,s^{-3}$. ∴ n = – 3.

4. For a projectile, the horizontal range is six times the greatest height. If the angle of projection is θ, then tan θ =
(A) 3 / 4 (B) 4 / 3 (C) 2 / 3 (D) 3 / 2

4. **(C)** ***Based on Projectile Motion Q. 18***
tan θ = 4H / R = 4H / 6H = 2 / 3.

5. A balloon starts rising from the earth's surface and has a constant vertical component of velocity as u. Due to wind, it has a horizontal velocity component $v_x = ky^2$, where k is a constant and y is the height. Assuming it started from the origin, the equation of its trajectory is
(A) $3ux = ky^3$ (B) $2ux = ky^2$ (C) $uy = kx^2$ (D) $u^2x^2 = ky$

5. **(A)** ***Based on Projectile Motion Q. 8***
$y = ut$, $dx / dt = v_x = k\,u^2t^2$, $x = (ku^2 / 3)\,t^3 = (k / 3u)\,y^3$ or $3ux = ky^3$.

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6. The displacement (s) - time (t) relationship for a particle is $x = c\,(T\,t^2 + t^3)$ where c, T are constants. Its average acceleration between $t = T$ to $t = 2T$ is
(A) $5cT$ (B) $8cT$ (C) $11cT$ (D) $13cT$

6. **(C)** ***Based on One Dimensional Motion Q. 107***
$v_t = (2Tt + 3t^2)\,c$, $v_T = 5T^2c$, $v_{2T} = 16T^2c$. $\therefore\ a_{avg} = (v_{2T} - v_T) / T = 11cT$.

7. A particle is at rest at position (0 m, 0 m). From $t = 0$, it has constant acceleration 2 ms^{-2} towards positive x-axis. From $t = 2$ s, it has an additional acceleration of 4 ms^{-2} along positive y-axis. At $t = 5$ s, the particle is at position
(A) (13 m, 8 m) (B) (13 m, 18 m) (C) (25 m, 8 m) (D) (25 m, 18 m)

7. **(D)** ***Based on Projectile Motion Q. 17***
$x = ½\ a_x\ t^2 = 25$ m, $y = ½\ a_y\ (t - t_1)^2 = 18$ m. $\therefore$ (25 m, 18 m).

8. A bus starts from a bus stand and moves with constant acceleration 1 ms^{-2}. A man, at a distance D behind the bus when it starts, runs with a constant speed of 6 ms^{-1} and manages to catch the bus. The maximum D for which this is possible is
(A) 25 m (B) 18 m (C) 13 m (D) 9 m

8. **(B)** ***Based on One Dimensional Motion Q. 176***
To just catch, $v_{bus} = v_{man} = 6\ ms^{-1}$. $\therefore\ t = v_{man} / a_{bus} = 6$ s. As $s_{man} = v_{man}\ t = 36$ m, $s_{bus} = ½\ a_{bus}\ t^2 = 18$ m, $D_{max} = s_{man} - s_{bus} = 18$ m.

9. The equation of a curve is $ky = x^2$ where k is a positive constant. Find the area between the curve and the x-axis between the lines $x = 0$ and $x = 3k$.
(A) $27k^2$ (B) $27k^3$ (C) $9k^2$ (D) $9k^3$

9. **(C)** ***Based on One Dimensional Motion Q. 56***
$A = \int_0^{3k} (x^2 / k)\,dx = [x^3 / 3k]_0^{3k} = 9k^2$.

10. For the curve $y = 3x^2 + 2$, $z = x^4 - 2x^3 + 2$, find (dz / dy) at $x = 3$.
(A) 3 (B) 8 (C) 6 (D) 4

10. **(A)** ***Based on One Dimensional Motion Q. 36***
$dz / dy = (dz / dx) / (dy / dx) = (4x^3 - 6x^2) / 6x$. At $x = 3$, $dz / dy = (108 - 54) / 18 = 3$.

11. A lift starts from rest and goes up with uniform acceleration a. After some time, it has uniform retardation $3a$ till it comes to rest. If the retardation time is t, the total height ascended is
(A) $12at^2$ (B) $6at^2$ (C) $3at^2$ (D) $8at^2$

11. **(B)** ***Based on One Dimensional Motion Q. 165***
$v_{max} = 3a\ t = a\ t_{acc}$ giving $t_{acc} = 3t$. $\therefore\ H = ½\ a\ t_{acc}^2 + ½\ (3a)\ t^2 = 6at^2$.

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12. Ball B is dropped from a height at $t = 0$. After 2 s, ball C is thrown down from the same point with a speed v. After another 4 s, the balls collide. $g = 10\ \text{ms}^{-2}$. Then v (in ms^{-1}) =
(A) 45 (B) 40 (C) 35 (D) 25

12. **(D)** ***Based on One Dimensional Motion Q. 184***
$\frac{1}{2} \cdot 10 \cdot (2 + 4)^2 = v \cdot 4 + \frac{1}{2} \cdot 10 \cdot 4^2$ giving $v = 25\ \text{ms}^{-1}$.

13. The acceleration a of a particle P at time t is $a = bT - bt$ where b & T are constants. P starts with initial velocity bT^2. The distance travelled till time T is
(A) $(3 / 2)\ bT^3$ (B) $(1 / 2)\ bT^3$ (C) $(4 / 3)\ bT^3$ (D) $(1 / 3)\ bT^3$

13. **(C)** ***Based on One Dimensional Motion Q. 124***
As $dv / dt = bT - bt$, $ds / dt = v = bTt - \frac{1}{2}\ bt^2 + bT^2$, $s = \frac{1}{2}\ bTt^2 - (bt^3 / 6) + bT^2t$.
At $t = T$, $s = (4 / 3)\ bT^3$.

14. Two stones are thrown simultaneously at $t = 0$ from a height of 15 m with speed 20 ms^{-1} at 30º to the horizontal. They hit the ground at times $t = t_1$ & $t = t_2$ ($> t_1$).
Take $g = 10\ \text{ms}^{-2}$. Then $t_2 : t_1$ =
(A) 3 : 1 (B) 2 : 1 (C) 3 : 2 (D) 4 : 3

14. **(A)** ***Based on Projectile Motion Q. 44***
$u_y = \pm 20 \sin 30° = \pm 10\ \text{ms}^{-1}$. As $5t_1^2 + 10t_1 = 15$ & $5t_2^2 - 10t_2 = 15$, $t_1 = 1$ s & $t_2 = 3$ s.

15. A man can throw a stone vertically up to a height h. The maximum distance to which he can throw it on a horizontal level ground is
(A) h (B) $2h$ (C) $3h$ (D) $4h$

15. **(B)** ***Based on Projectile Motion Q. 24***
$h = u^2 / 2g$, $R_{max} = u^2 / g = 2h$.

16. An object thrown vertically up from the ground is 25 m above the ground at two instants that are 4 s apart. Take $g = 10\ \text{ms}^{-2}$. The time of flight of the object is
(A) 8 s (B) $3\sqrt{6}$ s (C) $5\sqrt{2}$ s (D) 6 s

16. **(D)** ***Based on One Dimensional Motion Q. 193***
$H - 25 = \frac{1}{2}\ g\ (4 / 2)^2 = 20$. $\therefore\ H = 45$ m. $\therefore\ T = 2\ \sqrt{(2H / g)} = 6$ s.

17. Car C starts from rest with acceleration 6 ms^{-2} which decreases to zero linearly with time in 10 s. After this, C moves at constant speed. The time needed for C to travel 500 m is
(A) 22 s (B) 20 s (C) 18 s (D) 16 s

17. **(B)** ***Based on One Dimensional Motion Q. 143***
For $0 \le t \le 10$, $a = 0.6\ (10 - t)$, $v = 0.3\ (20t - t^2)$, $s = 0.1\ (30t^2 - t^3)$.
$\therefore\ v_{10} = 30\ \text{ms}^{-1}$, $s_{10} = 200$ m. $\therefore\ T = 10 + ((500 - s_{10}) / v_{10}) = 20$ s.

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18. For the curve $y = x^2 + 2x + 3$, the slope of the tangent to the curve at point P is 6. Then P lies on the line $3x + y =$
(A) 24 (B) 20 (C) 17 (D) 15

18. **(C)** ***Based on One Dimensional Motion Q. 43***
$dy / dx = 2x + 2 = 6$ at $x = 2$, $y = 11$, $3x + y = 17$.

19. Find the vector to be added to the vectors $(5\mathbf{i} + 3\mathbf{j} + \mathbf{k})$ and $(-7\mathbf{i} - 4\mathbf{j} - 2\mathbf{k})$ to get the resultant vector as a unit vector along positive z-axis.
(A) $-2\mathbf{i} - \mathbf{j} - 2\mathbf{k}$ (B) $-2\mathbf{i} - \mathbf{j} - \mathbf{k}$ (C) $2\mathbf{i} + \mathbf{j} + \mathbf{k}$ (D) $2\mathbf{i} + \mathbf{j} + 2\mathbf{k}$

19. **(D)** ***Based on One Dimensional Motion Q. 13***
$\mathbf{c} = \mathbf{r} - \mathbf{a} - \mathbf{b} = \mathbf{k} - (5\mathbf{i} + 3\mathbf{j} + \mathbf{k}) + (7\mathbf{i} + 4\mathbf{j} + 2\mathbf{k}) = 2\mathbf{i} + \mathbf{j} + 2\mathbf{k}$.

20. Water drops fall at regular intervals from a tap 7.2 m above the ground. The third drop is leaving the tap at the instant the first drop touches the ground. Take $g = 10\ \text{ms}^2$. Find the height above the ground of the second drop at that instant.
(A) 5.4 m (B) 4.8 m (C) 2.4 m (D) 1.8 m

20. **(A)** ***Based on One Dimensional Motion Q. 192***
$7.2 = \frac{1}{2} g (2\,\Delta t)^2$ and $7.2 - H = \frac{1}{2} g (\Delta t)^2 = 1.8$. $\therefore H = 5.4$ m.

21. A particle starts almost from rest from the origin and has acceleration a related to displacement s as $a = k^2 s$, k being a positive constant. Its velocity v is related to s as
(A) $v = ks$ (B) $v^2 = 2ks$ (C) $2v = k^2 s$ (D) $v^2 = ks^2$

21. **(A)** ***Based on One Dimensional Motion Q. 132***
$v\,dv / ds = a = k^2 s$ or $v\,dv = k^2 s\,ds$. $\therefore v = ks$.

22. Vectors **A**, **B**, **C** are related as $\mathbf{C} = \mathbf{A} + \mathbf{B}$ and have magnitudes a, b, c respectively. If $a = 5$, $b = 12$; then
(A) $5 \le c \le 13$ (B) $7 \le c \le 17$ (C) $5 \le c \le 12$ (D) $13 \le c \le 17$

22. **(B)** ***Based on One Dimensional Motion Q. 2***
c lies between $|b - a|$ (when **A** & **B** are oppositely directed) and $(b + a)$ (when **A** & **B** are in same direction). $\therefore 7 \le c \le 17$.

23. A driver takes 0.25 s to apply the brakes after he sees an obstacle on the road. If he is driving at $20\ \text{ms}^{-1}$ and the brakes cause a deceleration of $8\ \text{ms}^{-2}$, the stopping distance after seeing an obstacle is
(A) 25 m (B) 22.5 m (C) 30 m (D) 27.5 m

23. **(C)** ***Based on One Dimensional Motion Q. 181***
$d_1 = u\,t_{react} = 5$ m, $d_2 = u^2 / 2a = 25$ m, $d_{total} = d_1 + d_2 = 30$ m.

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24. The displacement s of an object moving along a straight line is directly proportional to the cube of the time t of motion. Its acceleration a is directly proportional to
(A) $s^{1/3}$ (B) $s^{1/2}$ (C) s (D) s^2

24. **(A)** ***Based on One Dimensional Motion Q. 121***
$s = bt^3$, $v = 3bt^2$, $a = 6bt \propto s^{1/3}$.

25. For a particle moving along a straight line, the displacement s (in m) at time t (in s) is $s = (t^3 - 6t^2 + 18t - 13)$. When its acceleration is zero, the velocity (in ms^{-1}) is
(A) 7 (B) 3.5 (C) 9 (D) 6

25. **(D)** ***Based on One Dimensional Motion Q. 160***
$v = 3t^2 - 12t + 18$, $a = 6t - 12$. As $a = 0$ when $t = 2$, $v = 6\ ms^{-1}$.

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26. If p, q, r are non-zero, real numbers such that $p^2 + q^2 + r^2 = pq + qr + rp$, then the roots of $px^2 + qx + r = 0$ are

(A) real & distinct (B) real & equal

(C) non-real & distinct (D) non-real & equal

26. **(C)** ***Based on Basic of Algebra Q. 30***

As $(p - q)^2 + (q - r)^2 + (r - p)^2 = 0$, $p = q = r$. $\therefore x^2 + x + 1 = 0$ which has non-real, distinct roots.

27. $3x^2 + 2ax + 4 = 0$ and $x^2 + bx + 2 = 0$ have a common root. Then $2a^2 + 3b^2 =$

(A) $5ab + 1$ (B) $5ab - 1$ (C) $ab + 5$ (D) $ab - 5$

27. **(B)** ***Based on Basic of Algebra Q. 100***

$E_1 - 3E_2$ and $E_1 - 2E_2$ give $x = 2 / (2a - 3b) = 2 (b - a)$. $\therefore (2a - 3b)(b - a) = 1$ or $5ab - 2a^2 - 3b^2 = 1$ i.e. $2a^2 + 3b^2 = 5ab - 1$.

28. The number of solutions of $| x - 4 | + | x + 4 | = 10 + | x |$ is

(A) 1 (B) 2 (C) 0 (D) infinite

28. **(B)** ***Based on Basic of Algebra Q. 180***

When $-4 \le x \le 4$, LHS = 8 while RHS ≥ 10 i.e. no solution.

When $x > 4$, $2x = 10 + x$ or $x = 10$. When $x < -4$, $-2x = 10 - x$ or $x = -10$.

$\therefore$ 2 solutions.

29. $| 2x + 8 | / | x + 8 | > 2$ & $| x | < 10$. The number of integer solutions for x is

(A) 1 (B) 2 (C) 3 (D) more than 3

29. **(B)** ***Based on Basic of Algebra Q. 190***

$| x + 4 | > | x + 8 |$, $x \ne -8$, $| x | < 10$. $\therefore x + 6 < 0$, $x \ne -8$, $-10 < x < 10$.

$\therefore$ Integer $x = -9, -7$ i.e. 2 solutions.

30. $k (6x^2 + 3rx) + rx + 2k^2 - 1 = 0$ and $6k (2x^2 + px) + px + 4k^2 - 2 = 0$ have both roots common, then $(2r - p) : (r - p) =$

(A) 0 (B) k (C) $3k$ (D) $-6k$

30. **(D)** ***Based on Basic of Algebra Q. 111***

As $(4k^2 - 2) : (2k^2 - 1) = 12k : 6k = 2$, $(6k + 1) p = 2 (3k + 1) r$.

$\therefore (2r - p) : (r - p) = -6k$.

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31. The sum of all the solutions of $[x] + 2\{x\} = 12.4$, where $[\cdot]$ & $\{\cdot\}$ are integer part & fractional part respectively, is

(A) 12.2 (B) 16.4 (C) 19.8 (D) 23.9

31. **(D)** ***Based on Basic of Algebra Q. 201***

$\{x\} = 0.2$ or 0.7 giving $[x] = 12$ or 11. $\therefore x = 12.2$ or 11.7.

32. $x^3 - 12x + 16 = 0$ has roots p, q, r. The equation with roots $2(q + r)^2 / p^3$, $2(r + p)^2 / q^3$, $2(p + q)^2 / r^3$ is

(A) $2x^3 - 3x^2 + 1 = 0$ (B) $2x^3 - 3x + 1 = 0$

(C) $2x^3 + 3x - 1 = 0$ (D) $2x^3 + 3x^2 - 1 = 0$

32. **(A)** ***Based on Basic of Algebra Q. 131***

As $p + q + r = 0$, $2(q + r)^2 / p^3 = 2(-p)^2 / p^3 = 2 / p$.

Equation is $(2 / x)^3 - 12 (2 / x) + 16 = 0$ or $2x^3 - 3x^2 + 1 = 0$.

33. If $(1 + p)$ is a root of $x^2 + px + (2 + 2p) = 0$, then difference of roots is

(A) 0 (B) 1 (C) 3.5 (D) 2.5

33. **(D)** ***Based on Basic of Algebra Q. 63***

$(2 + 2p) / (1 + p) = 2$ is a root. $\therefore 4 + 2p + 2 + 2p = 0$ or $1 + p = -½$.

$\therefore$ Difference of roots = 2.5.

34. If the roots of $2x^2 - 3x + 5 = 0$ are reciprocals of the roots of $ax^2 + bx + 4 = 0$, then $(2a + b) =$

(A) 14 (B) 11 (C) 8 (D) 0

34. **(A)** ***Based on Basic of Algebra Q. 83***

Reciprocals are roots of $5x^2 - 3x + 2 = 0$ or $a = 10$, $b = -6$.

35. The sum of all the solutions of $(3x - 1) = |2x - 4|$ is

(A) 1 (B) – 2 (C) 4 (D) 0

35. **(A)** ***Based on Basic of Algebra Q. 173***

$(3x - 1) = \pm (2x - 4)$ for $x = 1$ or -3. Only $x = 1$ satisfies.

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36. The number of integers x satisfying $|x^2 - 2x| - 8 \le 0$ is

(A) 3 (B) 5 (C) 7 (D) 9

36. **(C)** ***Based on Basic of Algebra Q. 193***

$|(x-1)^2 - 1| \le 8$, $(x-1)^2 \le 9$. $\therefore (x-1) = 0, \pm 1, \pm 2, \pm 3$ i.e. 7 solutions.

37. The numbers of integers x for which $(\sqrt{(x-3)} + \sqrt{(21-4x)})$ is real is

(A) 0 (B) 2 (C) 3 (D) 5

37. **(C)** ***Based on Basic of Algebra Q. 163***

$\sqrt{(x-3)}$ is real for $x \ge 3$, $\sqrt{(21-4x)}$ is real for $x \le 5.25$.

Integers satisfying both are **{**3, 4, 5**}** i.e. 3 integers.

38. $x^3 + 3x^2 - x - 3 = 0$ has roots p, q, r. Then $p^2 + q^2 + r^2 + 2pqr =$

(A) 5 (B) 17 (C) – 3 (D) 11

38. **(B)** ***Based on Basic of Algebra Q. 124***

$p^2 + q^2 + r^2 + 2pqr = (p + q + r)^2 - 2(pq + qr + rp) + 2pqr$

$= (-3)^2 - 2(-1) + 2(3) = 17$.

39. If the least value of $f(x) = 4x^2 - 20x + k$ is 32, then $k =$

(A) 64 (B) 57 (C) 32 (D) 7

39. **(B)** ***Based on Basic of Algebra Q. 274***

$f(x) = (2x-5)^2 + (k - 25)$. $\therefore k = 25 + 32 = 57$.

40. The sum of all the solutions of $4\{x\} = [x] - 1$, where $[\cdot]$ & $\{\cdot\}$ are integer part & fractional part respectively, is

(A) 11.5 (B) 10.5 (C) 7.0 (D) 4.5

40. **(A)** ***Based on Basic of Algebra Q. 205***

$\{x\} = 0, ¼, ½, ¾$. Corresponding $[x] = 1, 2, 3, 4$. $\therefore x = 1, 2.25, 3.5, 4.75$

with $S = 11.5$.

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41. Let $\log_2 x + \log_2 y + \log_4 z = 2$, $\log_9 x + \log_3 y + \log_3 z = 2$, $\log_4 x + \log_2 y + \log_4 z = 2$. Then $(yz / x) =$

(A) 27 (B) 16 (C) 9 (D) 54

41. **(C)** ***Based on Basic of Algebra Q. 245***

$x^2y^2z = 16$, $xy^2z^2 = 81$, $xy^2z = 16$. $\therefore x = 1$, $yz = 9$.

42. If $a(x-1)^2 + b(x^2 - 3x + 2) + x - a^2 = 0$ has more than two roots, then $(a + 3b) =$

(A) 0 (B) 1 (C) 2 (D) – 1

42. **(C)** ***Based on Basic of Algebra Q. 86***

$(a + b)x^2 + (1 - 2a - 3b)x + (a + 2b - a^2) = 0$ is an identity.

$\therefore a + b = 1 - 2a - 3b = a + 2b - a^2 = 0$. $\therefore a = -1$, $b = 1$.

43. $x^2 + kx - 13 = 0$ and $x^2 - 3kx + 35 = 0$ have a common root. The smallest possible value of k is

(A) 10 (B) 3 (C) 0 (D) – 12

43. **(D)** ***Based on Basic of Algebra Q. 97***

$0 = 3(x^2 + kx - 13) + (x^2 - 3kx + 35) = 4(x^2 - 1)$. $\therefore x = \pm 1$, $k = \pm 12$.

44. If $x^2 - 2x + 5 = 0$ has roots p & q, then $(p-2)^2 (q-2)^2 =$

(A) 125 (B) 25 (C) 5 (D) 1

44. **(B)** ***Based on Basic of Algebra Q. 48***

As $p^2 - 2p + 5 = 0$, $p - 2 = -5 / p$. Similarly, $q - 2 = -5 / q$ and

$(p-2)^2 (q-2)^2 = 5^4 / (pq)^2 = 5^4 / 5^2 = 25$.

45. The numbers of integers x satisfying $|x| < 7$ and $(x^2 + 3x + 4) / (1 - x) > 1$ is

(A) 3 (B) 4 (C) 6 (D) 7

45. **(B)** ***Based on Basic of Algebra Q. 148***

$(x^2 + 4x + 3) / (1 - x) > 0$. $(x + 3)(x + 1)(x - 1) < 0$. $\therefore x < -3$ or $-1 < x < 1$.

$\therefore x = -6, -5, -4, 0$ i.e. 4 values.

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46. If both roots of $x^2 + 2x + b = 0$ are greater than b, then complete set of values of b is
(A) $1 < b < 3$ (B) $-1 < b < 1$ (C) $-3 < b < -1$ (D) $b < -3$

46. **(D)** ***Based on Basic of Algebra Q. 318***
$s > 2b$, $D \geq 0$, $f(b) > 0$ i.e. $-2 > 2b$, $4 - 4a \geq 0$, $b(b + 3) > 0$.
$\therefore b < -1$, $b \leq 1$, $b < -3$ or $b > 0$ i.e. $b < -3$.

47. The roots of $x^2 + 3kx + (3k + 2) = 0$ are in ratio 2 : 1. Then largest possible value of k is
(A) -2 (B) $1/2$ (C) 2 (D) $-1/2$

47. **(C)** ***Based on Basic of Algebra Q. 59***
$p + 2p = -3k$ and $p \cdot 2p = 3k + 2$ i.e. $2k^2 - 3k - 2 = 0$ i.e. $k = 2, -½$.

48. The roots of $x^2 + 3x + 2 = 0$ are also the roots of $x^4 - px^2 + q = 0$. The largest root of $x^4 - px^2 + q = 0$ is
(A) 2 (B) 3 (C) 4 (D) 5

48. **(A)** ***Based on Basic of Algebra Q. 139***
$-1, -2$ satisfy $x^4 - px^2 + q = 0$. $\therefore p = 1 + q$ & $4p = 16 + q$. $\therefore p = 5$, $q = 4$.
$\therefore x^4 - 5x^2 + 4 = 0$ or $(x^2 - 1)(x^2 - 4) = 0$ i.e. $x = \pm 1, \pm 2$. $\therefore$ Largest root is 2.

49. If $\log_{49} 2 = x$, then $\log_7 56 =$
(A) $2 + x$ (B) $1 + 6x$ (C) $3 - 8x$ (D) $7x - 4$

49. **(B)** ***Based on Basic of Algebra Q. 229***
$\log_7 56 = 1 + 3 \log_7 2 = 1 + 6 \log_{49} 2 = 1 + 6x$.

50. Both roots of $x^2 - 2kx + k^2 - 9 = 0$ are less than $\sqrt{26}$. The greatest integral value of k is
(A) 2 (B) 5 (C) 10 (D) 26

50. **(A)** ***Based on Basic of Algebra Q. 309***
$(x - k)^2 = 9$. $\therefore x = k \pm 3$. As $k + 3 < \sqrt{26}$, $k_{max} = 2$.

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CHEMISTRY

51. How many g of KCl would have to be dissolved in 60 H_2O to give 20% by weight of solution ?
(A) 15 g (B) 1.5 g (C) 11.5 g (D) 31.5 g

51. **(A)** % by weight = $\frac{\text{weight of solute}}{\text{weight of solution}} \times 100$ or $20 = \frac{w}{(w+60)} \times 100$ or w = 15 g

52. What volume of H_2 at 273 K and 1 atm will be consumed in obtaining 21.6 g of elemental boron (at. mass 10.8) from the reduction of boron trichloride with H_2 ?
(A) 44.8 L (B) 22.4 L (C) 89.6 L (D) 67.2 L

52. **(D)** $2BCl_3 + 3H_2 \longrightarrow 2B + 3HCl$
2×10.8 g $B = 3 \times 22.4$ L H_2

$\therefore \quad 21.6 \text{ g } B \equiv \frac{3 \times 22.4 \times 21.6}{2 \times 10.8} = 67.2$ L H_2

53. In a gaseous reaction of the type $aA + bB \longrightarrow cC + dD$, which is wrong ?
(A) a litre of A combines with b litre of B to give C and D
(B) a mole of A combines with b mole of B to give C and D
(C) a g of A combines with b g of B to give C and D
(D) a molecules of A combines with b molecules of B to give C and D

53. **(C)** Stoichiometry represents mole ratio or volume ratio of reactants and products.

54. A metal oxide has the formula Z_2O_3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of the metal oxide requires 6 mg of hydrogen for complete reduction. The atomic weight of the metal is :
(A) 27.90 (B) 159.60 (C) 79.80 (D) 55.80

54. **(D)** Meq. of oxide = Meq. of H ;

$\frac{0.1596}{E+8} = \frac{6 \times 10^{-3}}{1} \quad \therefore E = 18.6$

$\therefore$ atomic wt. = $18.6 \times 3 = 55.8$ ($\because$ valence = 3)

55. A mixture of 10 cm³ of oxygen and 50 cm³ of hydrogen is sparked continuously. What is the maximum theoretical decrease in volume ?
(All gas volumes measured at 298 K and standard atmospheric pressure)
(A) 10 cm³ (B) 15 cm³ (C) 20 cm³ (D) 30 cm³

55. **(D)** $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$
O_2 is the limiting reagent
Volume of H_2 used = $2 \times 10 = 20$ cm³
Therefore, maximum decrease in volume
= Volume of gases reacted = 10 + 20 = 30 cm³

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56. For complete oxidation, 1 mole of an organic compound requires 3 mol of oxygen gas. What could be the formula of the compound ?

(A) CH_3CHO (B) CH_3CH_2OH (C) CH_3CH_3 (D) CH_3COOH

56. **(B)** $CH_3CH_2OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

57. What percent of free SO_3 can be obtained from 100 g oleum, that is labelled with "113.5% H_2SO_4"?

(A) 13.5% (B) 40% (C) 60% (D) 80%

57. **(C)** 113.5% suggests total mass of pure H_2SO_4 present in 100 g.
When 13.5 g of H_2O is added to oleum, that combines with free SO_3 and 113.5 g H_2SO_4.

$$\underset{13.5\,g}{H_2O} + SO_3 \longrightarrow H_2SO_4$$

0.75 mol of H_2O will combine with 0.75 mol ≡ 60 g of SO_3

58. 0.8 mole of a mixture of CO and CO_2 requires exactly 40 gram of $NaOH$ in solution for complete conversion of all the CO_2 into Na_2CO_3. How many moles more of $NaOH$ would it require for conversion into Na_2CO_3, if the mixture (0.8 mole) is completely oxidised to CO_2 ?

(A) 0.2 (B) 0.6 (C) 1 (D) 1.5

58. **(B)**

59. Ratio of moles of Fe (II) oxidised by equal volumes of equimolar $KMnO_4$ and $K_2Cr_2O_7$ solution in acidic medium will be :

(A) 5 : 3 (B) 1 : 1 (C) 1 : 2 (D) 5 : 6

59. **(D)**

60. Arrange the following in order of increasing masses

(i) 1 Molecule of oxygen (ii) 1 atom of Nitrogen
(iii) 1 mole of water (iv) 1×10^{-10} g of iron
(A) $ii < i < iii < iv$ (B) $i < ii < iv < iii$
(C) $ii < i < iv < iii$ (D) $i < ii < iii < iv$

60. **(C)** ***Based on Mole concept : Q. 8***

(i) Molecules = mole × 6×10^{23}
1 = (Given weight / 32) × 6×10^{23}
Given weight = $(32 / 6) \times 10^{-23} = 5.3 \times 10^{-23}$ g
(ii) 1 atom of $N = (14 / 6) \times 10^{-23} = 2.3 \times 10^{-23}$ g
(iii) 1 mole of H_2O = 18 g
(iv) weight of $Fe = 10^{-10}$ g

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61. Which of the following contains maximum number of atoms
(A) 4 g of H_2 (B) 16 g of O_2 (C) 28 g of N_2 (D) 18 g of H_2O

61. **(A)** ***Based on Mole concept : Q. 9***
For $H_2 = (4 / 2) \times N_A \times 2 = 1\ N_A$
For $O_2 = (16 / 32) \times N_A \times 2 = 1\ N_A$
For $N_2 = (28 / 28) \times N_A \times 2 = 1\ N_A$
For $H_2O = (18 / 18) \times N_A \times 3 = 3\ N_A$

62. How many moles of O are present in 4.9 g of H_3PO_4?
(A) 0.4 mole (B) 0.8 mole (C) 1 mole (D) 0.2 mole

62. **(D)** ***Based on Mole concept : Q. 13***
$H_3PO_4 = 1 \times 3 + 31 + 16 \times 4 = 98$ g
98 g = 1 mole of H_3PO_4 = 4 mole of O
4.9 g of $H_3PO_4 = (4.9 / 98) \times 4 = 0.2$ mole of O

63. What is the molecular mass of a compound X, if its 3.0115×10^9 molecules weigh 1.0×10^{-12} g?
(A) 300 g (B) 200 g (C) 5×10^{-2} g (D) 700 g

63. **(B)** ***Based on Mole concept : Q. 15***
3.0115×10^9 molecules of $X = 10^{-12}$ g
6.023×10^{23} molecules of $X = (10^{-12} \times 6.023 \times 10^{23}) / (3.0115 \times 10^9) = 200$ g

64. At STP, 5.6 litre of a gas weighs 60 g. The vapour density of gas is :
(A) 240 (B) 120 (C) 30 (D) 60

64. **(B)** ***Based on Mole concept : Q. 30***

$$\text{Mole} = \frac{\text{Given volume}}{22.4}$$

$$\frac{\text{Given weight}}{\text{Molecular weight}} = \frac{5.6}{22.4} \qquad \frac{60}{M} = \frac{5.6}{22.4}$$

$$M = \frac{22.4 \times 60}{5.6} \quad M = 240 \text{ g.}$$

V.D = Mol. mass / 2 = 240 / 2 = 120.

65. 10 g of a metal gives 14 g of its oxide. The equivalent mass of its oxide and hydroxide will be respectively.
(A) 28 and 37 (B) 20 and 37 (C) 56 and 74 (D) None of these

65. **(A)** ***Based on Mole concept : Q. 33***

$$\text{Equivalent mass of metal} = \frac{10}{(14-10)} \times 8 = 20g$$

$\therefore$ Equivalent mass of metal oxide = Equivalent mass of metal + Equivalent mass of oxygen = 20 + 8 = 28.
Equivalent mass of metal hydrooxide = Equivalent mass of metal + Equivalent mass of OH^- = 20 + 17 = 37.

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66. 0.32 g of metal gave on treatment with an acid 112 ml of hydrogen at NTP. Calculate the equivalent weight of the metal :
(A) 58 (B) 11.2 (C) 24 (D) 32

66. **(D)** ***Based on Mole concept : Q. 35***

$$\text{Eq.wt} = \frac{\text{mass of metal} \times 11200 \text{ ml}}{\text{Volume in ml of Hydrogen}} = \frac{0.32 \times 11200}{112 \times 100} = 32$$

67. Vapour density of a metal chloride is 118.5. The equivalent mass of the metal is 4. Its atomic mass would be
(A) 3 (B) 6 (C) 9 (D) 12

67. **(B)** ***Based on Mole concept : Q. 35***
Molecular weight of matal chloride = 118.5 × 2 = 237
Let valency of metal = x

Formula = MCl_x Molecular weight = 237
$(4 \times x) + (35.5 \times x) = 237$ $39.5\,x = 237$ $x = (237 / 39.5) = 6$

68. The oxidation number of Al in $LiAlH_4$ is :
(A) + 3 (B) –3 (C) + 1 (D) + 4

68. **(A)** ***Based on Redox Q. 15***
Let oxidation number of $Al = a$
$1 + a + 4 \times (-1) = 0$
$1 + a - 4 = 0$
$a - 3 = 0$
$a = + 3$

69. Change of hydrogen into proton is :
(A) Oxidation of hydrogen (B) Acid - base reaction
(C) Reduction of hydrogen (D) Displacement reaction

69. **(A)** ***Based on Redox Q. 24***
$H^\circ \rightarrow H^{1+} + e^-$
[loss of e^- = oxidation]

70. In which reaction H_2O_2 acts as reducing agent ?
(A) $Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$ (B) $2KI + H_2O_2 \rightarrow 2KOH + I_2$
(C) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$ (D) $H_2O_2 + SO_2 \rightarrow H_2SO_4$

70. **(A)** ***Based on Redox Q. 25***
Ag^+ is reduced to Ag

71. What is the molarity of 22.4 V of H_2O_2?
(A) 4 (B) 2 (C) 1 (D) 6

71. **(B)** ***Based on Redox Q. 27***
For H_2O_2 : Normality = volume strength / 5.6 = 22.4 / 5.6 = 4 N
Since H_2O_2 is dibasic $\therefore$ M = (4 / 2) = 2

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72. Calculate the equivalent mass of potassium permanganate ($KMnO_4$) in neutral medium

(A) $EW = (M / 5)$ (B) $EW = (M / 3)$ (C) $EW = (M / 1)$ (D) $EW = (M / 7)$

72. **(B)** ***Based on Redox Q. 47***

In neutral medium

$Mn^{7+} + 3e^- \rightarrow Mn^{4+}$

$\therefore EW = \frac{M}{3}$.

73. Which of the following is a redox reaction ?

(A) $NaCl + KNO_3 \rightarrow NaNO_3 + KCl$

(B) $CaC_2O_4 + 2HCl \rightarrow CaCl_2 + H_2C_2O_4$

(C) $Mg(OH)_2 + 2NH_4Cl \rightarrow MgCl_2 + 2NH_4OH$

(D) $Zn + 2AgCN \rightarrow 2Ag + Zn(CN)_2$

73. **(D)** ***Based on Redox Q. 22***

$Zn \rightarrow Zn^{2+} + 2e^-$

$Ag^+ + e^- \rightarrow Ag$

In *A*, *B* and *C*, O.N does not change

74. The oxidation states of sulphur in the anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ follow the order

(A) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$ (B) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$

(C) $S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$ (D) $S_2O_6^{2-} < S_2O_4^{2-} < SO_3^{2-}$

74. **(A)** ***Based on Redox Q. 33***

$S_2O_6^{2-}$: $2x - 12 = -2 \Rightarrow x = 5$

SO_3^{2-} : $x - 6 = -2 \Rightarrow x = 4$

$S_2O_4^{2-}$: $2x - 8 = -2 \Rightarrow x = 3$

75. The number of electrons lost in the following change is

$Fe + H_2O \rightarrow Fe_3O_4 + H_2$

(A) 2 (B) 4 (C) 6 (D) 8

75. **(D)** ***Based on Redox Q. 34***

$3Fe^\circ \rightarrow (Fe^{+(8/3)})_3 + 8e^-$

$2H^+ + 2e^- \rightarrow H_2^\circ$ [× 4]

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

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