IUT Admission Test 2015-2016

MATHEMATICS

01. If $i^2 = -1$, and one root of the equation $x^2 + px + q = 0$ is $2 - i3$, then find the value of p and q. (The complex roots of a quadratic equation are conjugate complex numbers.)

Ⓐ $p = 4$ and $q = 9$ Ⓑ $p = 3$ and $q = 13$

Ⓒ $p = -4$ and $q = 13$ Ⓓ $p = 3$ and $q = 9$

Ⓒ Solve $x^2 + px + q = 0$

As, $x^2 - (2 - 3i + 2 + 3i) + (2 + 3i) \times (2 - 3i)$

$= x^2 - 4x + 13$

02. For the following matrix multiplication, find the values of x, y, z and w. $\begin{bmatrix} 5 & 10 \\ 2 & 7 \end{bmatrix} = \begin{bmatrix} x & 0 \\ y & z \end{bmatrix} \times \begin{bmatrix} 1 & w \\ 0 & 1 \end{bmatrix}$

Ⓐ 5, 1, 1, 4   Ⓑ 5, 2, 1, 3 ·

Ⓒ 5, 2, 2, 3   Ⓓ 5, 2, 2, 4

Ⓒ Solve $\begin{bmatrix} x & 0 \\ y & z \end{bmatrix} \times \begin{bmatrix} 1 & w \\ 0 & 1 \end{bmatrix}$

$= \begin{bmatrix} x & wx \\ y & yw + z \end{bmatrix} = \begin{bmatrix} 3 & 10 \\ 2 & 7 \end{bmatrix}$

$\Rightarrow wx = 10$ $yw + x = 7$

$\therefore w = 2$ $\Rightarrow z = 7 - 4 = 3$

$\Rightarrow x = 5, y = 2, w = 2, z = 3$

03. For what value of k the roots of the equation $3x^2 + (k-1)x - 2 = 0$ are equal and opposite?

Ⓐ -2 Ⓑ 1

Ⓒ 2   Ⓓ None of these

Ⓑ Solve By checking option,

$k = 1$,

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

$\therefore x = \frac{\sqrt{6}}{3}, -\frac{\sqrt{6}}{3}$

04. Suppose the cost of produce x toys is $c(x) = 80x + 150$ and the revenue by selling x such toys is $r(x) = -1.5x^2 + 250x$. Determine the number of toys needs to sell to make a positive profit.

Ⓐ $\left(\frac{170 - 20\sqrt{50}}{3}, \frac{170 + 20\sqrt{50}}{3} \right)$

Ⓑ $\left(\frac{170 - 20\sqrt{70}}{3}, \frac{170 + 20\sqrt{70}}{3} \right)$

Ⓒ $\left(\frac{150 - 20\sqrt{70}}{3}, \frac{150 + 20\sqrt{70}}{3} \right)$

Ⓓ $\left(\frac{170 - 15\sqrt{70}}{3}, \frac{170 + 15\sqrt{70}}{3} \right)$

Ⓑ Solve Here, cost $= c(s) = 80x + 150$

revenue $= r(s) = -1.5x^2 + 250x$

For positive profit.

$-1.5x^2 + 250x - 80x - 150 \geq 0$

$\Rightarrow 1.5x^2 - 170x + 150 \leq 0$

solving, $x = \left(\frac{170 - 20\sqrt{70}}{3}, \frac{170 + 20\sqrt{70}}{3} \right)$

05. Suppose 4 Mathematics books are selected from 6 different Mathematics books and 3 English books are chosen from 5 different English books. In how many ways can the seven books be arranged on a self, if a Math book is placed at the beginning and an English book in the middle of the shelf?

Ⓐ 201000   Ⓑ 216000

Ⓒ 215000   Ⓓ 20000

Ⓑ Solve $^5P_3 \times ^4P_2 \times ^6P_1 \times ^5p_1 = 216000$

06. A student has to answer 10 questions out of 13 questions, choosing at least 4 from each of Parts A and B. If there are 6 questions in Part A and 7 in Part B, in how many ways can the student choose 10 questions?

Ⓐ 226   Ⓑ 276

Ⓒ 286   Ⓓ 266

Ⓓ Solve

Part (A)	Part (B)
7	6
4	6
5	5
6	4

Total $^7C_4 \times ^6C_6 + ^7C_5 \times ^6C_5 + ^7C_6 \times ^6C_4 = 266$

07. If a ball rebounds two thirds as for as it falls, how far will it travel before coming to rest if it is dropped from a height of 30 meters? (total distance it travels is the sum of a series)

Ⓐ 155m   Ⓑ 150m

Ⓒ 145m   Ⓓ 160m

Ⓑ Solve 1st time distance travelled = 30 then it rebounds and so covers $\frac{2}{3} \times 30$ and comes down to travel $\frac{2}{3} \times 30$ again,

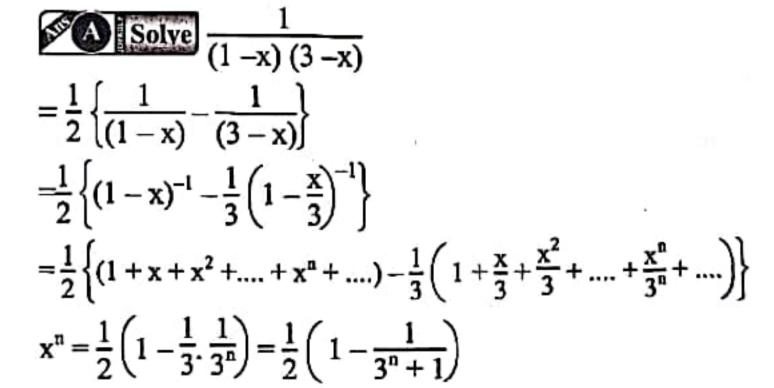So, 2nd time distance travelled $= 2 \times \left(\frac{2}{3} \right) \times 30$

So,

Distance $= 30 + 2 \times \left(\frac{2}{3} \right) \times 30 + 2 \times \left(\frac{2}{3} \right)^2 \times 30 + \dots \dots$

$= 30\left(1 + 2 \times \frac{2}{3} + 2 \times \left(\frac{2}{3} \right)^2 + \dots \dots \right)$

$= 30\left[1 + 2\left\{ \frac{2}{3} + \left(\frac{2}{3} \right)^2 + \left(\frac{2}{3} \right)^3 \right\} + \dots \dots \right]$

$= 30[1 + 2 \times 2] = 30 \times 5 = 150$

08. The coefficient of x^n in the expansion of $\frac{1}{(1-x)(3-x)}$ is :

Ⓐ $\frac{1}{2}\left(1 - \frac{1}{3^n + 1} \right)$ Ⓑ $\frac{1}{2}\left(1 + \frac{1}{33^{n+1}} \right)$

Ⓒ $\frac{1}{2}\left(1 + \frac{1}{3^{1-n}} \right)$ Ⓓ $\frac{1}{2}\left(2 + \frac{1}{3^{n-2}} \right)$

Ⓐ Solve $\frac{1}{(1-x)(3-x)}$

$= \frac{1}{2}\left\{ \frac{1}{(1-x)} - \frac{1}{(3-x)} \right\}$

$= \frac{1}{2}\left\{ (1-x)^{-1} - \frac{1}{3}\left(1 - \frac{x}{3} \right)^{-1} \right\}$

$= \frac{1}{2}\left\{ (1 + x + x^2 + \dots + x^n + \dots) - \frac{1}{3}\left(1 + \frac{x}{3} + \frac{x^2}{3} + \dots + \frac{x^n}{3^n} + \dots \right) \right\}$

$x^n = \frac{1}{2}\left(1 - \frac{1}{3} \cdot \frac{1}{3^n} \right) = \frac{1}{2}\left(1 - \frac{1}{3^n + 1} \right)$

09. The current I in circuit varies directly (i. e., along a straight line) with voltage V. If V = 15 volts when I = 0 ampere and V = 10 volts when I = 150 ampere, then find the equation relating V and I.

Ⓐ $I + 30v - 450 = 0$
Ⓑ $I + 15V - 150 = 0$
Ⓒ $10I + 15V - 150 = 0$
Ⓓ $10I + 30V - 450 = 0$

Ⓐ Solve Checking value
$V = 15, I = 0$
$0 + 30 \times 15 - 450 = 0$

10. Find the equation of a circle if the points P(1, 2) and Q (3, 8) are the endpoints of one of its diameters.

Ⓐ $x^2 + y^2 - 10x - 4y + 19 = 0$
Ⓑ $x^2 + y^2 - 4x - 10y + 9 = 0$
Ⓒ $x^2 + y^2 - 10x - 4y + 9 = 0$
Ⓓ $x^2 + y^2 - 4x - 10y + 19 = 0$

Ⓓ Solve $(x - 1) (x - 3) + (y - 2) (y - 8) = 0$
$\Rightarrow x^2 - 3x - x + 3 + y^2 - 8y - 2y + 16 = 0$
$\Rightarrow x^2 + y^2 - 4x - 10y + 19 = 0$

11. A whispering gallery is an elliptical – shaped room with a dome-shaped ceiling. If two people stand at the foci of the ellipse and whisper, they can hear each other, but others cannot. The maximum length and width of such a hall are 100m and 80m, respectively. Which of the following equations models the shape of the hall?

Ⓐ $\frac{x^2}{9025} + \frac{y^2}{5625} = 1$
Ⓑ $\frac{x^2}{5625} + \frac{y^2}{9025} = 1$
Ⓒ $\frac{x^2}{2500} + \frac{y^2}{1600}$
Ⓓ Both A and B

Ⓒ Solve maximum height, 2a = 100 m
$\therefore a = 50m$
minimum height, 2b = 80 m
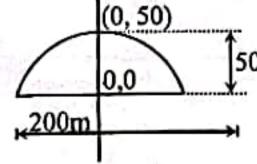$\therefore b = 40m$
$\therefore$ equation $\frac{x^2}{50^2} + \frac{y^2}{40^2} = 1$
$\frac{x^2}{2500} + \frac{y^2}{1600} = 1$

12. When a ball is thrown or kicked, the path it travels is shaped like a parabola, Suppose a football is kicked from ground level, reaches a maximum height of 50m and hits the ground 200m from where it was kicked. Assume that the focus of the parabola is at the origin and is on the ground. Which of the following equations models the flight of the ball?

Ⓐ $y = \frac{1}{200}x^2 + 50$
Ⓑ $y = \frac{1}{200} x^2 + 50$
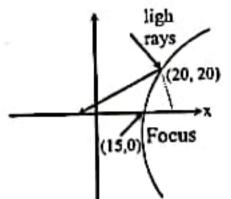Ⓒ $x = \frac{1}{200} y^2 + 50$
Ⓓ $x = -\frac{1}{200} y^2 + 50$

Ⓑ Solve

The equation takes a form of $x^2 = -4ay$
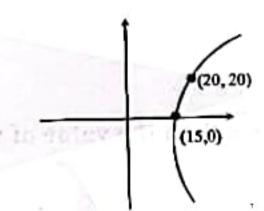So, $x^2 = -4 \times 50 \times (y - 50)$
$\Rightarrow x^2 = -200(y - 50)$
$\therefore y = -\frac{1}{200} x^2 + 50$

13. A hyperbolic mirror is used in some telescopes. Such a mirror has the property that light ray directed at one focus will be reflected to the other focus as shown in the figure will below. Which of the following equations models the hyperbolic mirror's surface?

Ⓐ $\frac{x^2}{9} - \frac{7y^2}{144} = 25$
Ⓑ $\frac{x^2}{15} - \frac{7y^2}{20} = 1$
Ⓒ $\frac{x^2}{15} - \frac{7y^2}{3600} = 1$
Ⓓ None of these

Ⓐ Solve

Here, $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

for point (15,0) → $\frac{(15)^2}{a^2} - \frac{(0)^2}{b^2} = 1 \Rightarrow a^2 = 225$

for point (20, 20) → $\frac{(20)^2}{a^2} - \frac{(20)^2}{b^2} = 1 \Rightarrow b^2 = \frac{3600}{7}$

$\therefore \frac{x^2}{225} - \frac{7y^2}{3600} = 1$
$\Rightarrow \frac{x^2}{9} - \frac{7y^2}{144} = 25$

14. The unit vector normal (perpendicular) to the plane made by two vectors $\vec{A} = 2i - 6j - 3k$ and $\vec{B} = 4i + 3j - k$ is:

Ⓐ $\pm \frac{1}{7} (4i - j + 3k)$
Ⓑ $\pm \frac{1}{7} (i - 4j + 3k)$
Ⓒ $\pm \frac{1}{7} (2i - 3j + 6k)$
Ⓓ $\pm \frac{1}{7} (3i - 2j + 6k)$

Ⓓ Solve $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -6 & 3 \\ 4 & 3 & -1 \end{vmatrix} = 15\hat{i} - 10\hat{j} + 30\hat{k}$

$= \pm \frac{\vec{A} \times \vec{B}}{|A \times B|} = \pm \frac{5(3\hat{i} - 2\hat{j} + 6\hat{k})}{35}$

$= \frac{1}{7} (3\hat{i} - 2\hat{j} + 6\hat{k})$

15. The area bounded by the curves $y = 2 - x^2$ and $y = x$ is:

Ⓐ $\frac{11}{2}$
Ⓑ $\frac{11}{3}$
Ⓒ $\frac{9}{3}$
Ⓓ $\frac{9}{2}$

Ⓓ Solve
$2 - x^2 = x$
$\Rightarrow x + x^2 - 2 = 0$
$\Rightarrow x^2 + x - 2 = 0$
$x = -2, 1$

$\int_{-2}^{1} (2 - x - x^2) \, dx = \frac{9}{2}$

16. $\dfrac{\cos\frac{\theta}{2}-\sqrt{1+\sin\theta}}{\sin\frac{\theta}{2}-\sqrt{1+\sin\theta}} = ?$

  Ⓐ $\cot^2\dfrac{\theta}{2}$ Ⓑ $\tan^2\dfrac{\theta}{2}$

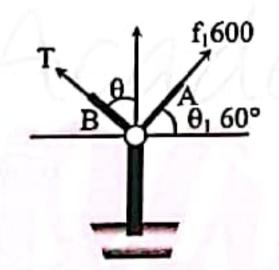 Ⓒ $\dfrac{1-\tan\frac{\theta}{2}}{1+\tan\frac{\theta}{2}}$ Ⓓ $\tan\dfrac{\theta}{2}$

  Ⓓ **Solve** Checking the options using $\theta = 30°$

$$\dfrac{\cos\frac{30}{2}-\sqrt{1+\sin30}}{\sin\frac{30}{2}-\sqrt{1+\sin30}} = 2-\sqrt{3}$$

$$\tan\frac{30}{2} = 2-\sqrt{3}$$

17. If $\sin^{-1}x + \cos^{-1}\dfrac{x}{2} = \dfrac{5\pi}{6}$, then the value of x is:

  Ⓐ $x=1$ Ⓑ $x=\pm1$

  Ⓒ $x=-1$ Ⓓ None of these   **Ans Ⓓ**
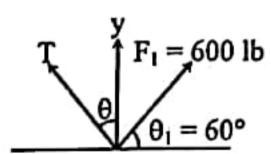
18. The post given in the figure below is to be pulled out of the ground using two ropes A and B. Rope A is subjected to force $F_1 = 600$ lb and is directed at angle $\theta_1 = 60°$ from the horizontal. If the resultant force acting on the post is to be $F_R = 1200$ lb, vertically upward, determine the force T in rope B.

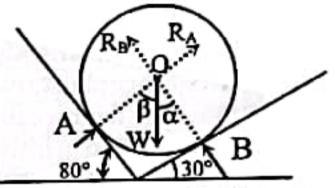 Ⓐ 795.59 lb   Ⓑ 743.59 lb

  Ⓒ 692.82 lb   Ⓓ 843.60 lb

  Ⓑ **Solve**

Here, $\Sigma F_X = 0$

$\Rightarrow 600 \times \cos60° - T\sin\theta = 0$

$\Rightarrow T\sin\theta = 300 \dots\dots\dots$ (i)

and, $\Sigma F_y = F_R$

$\Rightarrow 600 \times \sin60° + T\cos\theta = 1200$

$\Rightarrow T\cos\theta = 680.4 \dots\dots\dots$ (ii)

$\therefore$ (i)^2 + (ii)$^2 \rightarrow T = \sqrt{(300)^2+(680.4)^4} = 743.59$ lb

19. If $\sin^{-1}\dfrac{2a}{1+a^2} - \cos^{-1}\dfrac{1-b^2}{1+b^2} = 2\tan^{-1}x$, then $x = ?$

  Ⓐ $\dfrac{2a}{1-b^2}$ Ⓑ $\dfrac{a+b}{1-ab}$ Ⓒ $\dfrac{a-b}{1+ab}$ Ⓓ $\dfrac{1-b^2}{1-ab}$

  Ⓒ **Solve** If $\sin^{-1}\dfrac{2a}{1+a^2} - \cos^{-1}\dfrac{1-b^2}{1+b^2} = 2\tan^{-1}(x)$

$\Rightarrow 2\tan^{-1}(a) - 2\tan^{-1}(b) = 2\tan^{-1}(x)$

$\Rightarrow \tan^{-1}(a) - \tan^{-1}(b) = \tan^{-1}(x)$

$\Rightarrow \tan^{-1}\dfrac{a-b}{1+ab} = \tan^{-1}(x)$

$\therefore x = \dfrac{a-b}{1+ab}$

20. A sphere with weight W (1020 N) rests in an angled structure one leg of which is at an angle of 30° with the horizontal as shown in the figure given below. Assuming all surfaces smooth, compute the reaction on the sphere at point B.
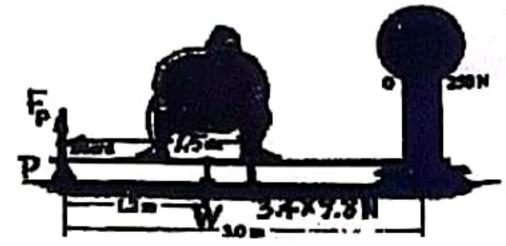

  Ⓐ 510 N.   Ⓑ 721.25 N

  Ⓒ 883.35 N   Ⓓ None of these

  Ⓒ **Solve** $\alpha = 180° - 60° - 90° = 30$

$\therefore W_B = 1020 \times \cos30° = 883.35$ N

21. A person in carrying a weight of W by hanging it from one end of a bar with length l and placing the bar on his shoulder. The person is maintaining the equilibrium by applying a force on the opposite end of the bar by his hand. Assume that the distance between his hand and shoulder is y. Which of the following values of y will produce the minimum force on his shoulder?

  Ⓐ $y = \dfrac{l}{2}$ Ⓑ $y = l$ Ⓒ $y = \dfrac{3}{4}l$ Ⓓ $y = \dfrac{1}{4}l$

  Ⓑ **Solve** If $y = l$, then maximum force will be produced

As, $\dfrac{w \times (y \times l)}{l} = wy$ If $y = l \Rightarrow \dfrac{w \times l^2}{l} = wl$

22. The following figure shows how a scale with a capacity of only 250 N can be used to weight a heavier person. The board is 3m long, has a mass of 3.4 kg, and is of uniform density. It is free to pivot about the end (P) farthest from the scale. What is the weight of a person standing 1.2 m from the pivot end, if the scale reads 210 N? Assume that the board remains nearly horizontal.

  Ⓐ 483.35 N   Ⓑ 520.75 N

  Ⓒ 566.65 N   Ⓓ 529.25 N

  Ⓐ **Solve** Board weight $= 3.4 \times 9.8 = 33.32$ N

$\therefore (w \times 1.2) + (1.5 \times 33.32) = 210 \times 3$

$\Rightarrow w = 483.35$ N

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23. A ball, after having fallen from rest under the influence of gravity for 5s, crashes a horizontal glass plate, thereby losing $\frac{1}{3}$ of its velocity. It then reaches the ground in 3s, find the height of the plate above the ground. (Assume g = 9.8 ms^{-2})

Ⓐ 176.5m

Ⓑ 156.6m

Ⓒ 191.1m

Ⓓ 142.11m

Solve

$v = gt$ $v = u + at$

$= 9.8 \times 5$ $= \dfrac{50}{3} + 9.8 \times 3$

$= 49$ $= 46.06$

$H = \dfrac{v^2 - u^2}{2g} = \dfrac{(46.06)^2 - \left(\dfrac{50}{3}\right)^2}{2 \times 9.8} = 94.06$
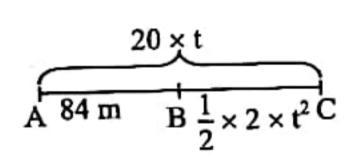
24. A cyclist, from 84m behind of a car, runs at a uniform velocity of 20 ms^{-1} toward the car. The car, at the same time, starts at a uniform acceleration of 2 ms^{-2} in the same direction of the cyclist. After what shortest time, the cyclist will meet the car?

Ⓐ 6s

Ⓑ 20s

Ⓒ 10s

Ⓓ 14s

Ⓐ **Solve**

```
        20 × t
  ┌──────────────┐
  A  84 m   B ½×2×t² C
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$AC - AB = BC$

$\Rightarrow 20t - 84 = t^2$

$\Rightarrow t^2 - 20t + 84 = 0$

$\Rightarrow t = 6, 14$

Because 6 is the shortest time

25. It is claimed that the biggest six hit by a cricket batsman is 160m, (that is the over-boundary covers a distance of 160m). The minimum initial velocity to hit such a six is (assume g = 10 ms^{-2}):

Ⓐ 42.98 ms^{-1}

Ⓑ 40 ms^{-1}

Ⓒ 45 ms^{-1}

Ⓓ 39.6 ms^{-1}

Ⓑ **Solve** $R_{max} = \dfrac{V^2 \sin 90°}{g}$

$\Rightarrow 160 = \dfrac{V^2 \times 1}{10}$

$\Rightarrow V^2 = 1600$

$\therefore V = 40 ms^{-1}$

26. The value of $\displaystyle\lim_{x \to 1} \dfrac{\sin(x-1)}{x^2 + 2x - 3}$ is ?

Ⓐ 0

Ⓑ $\dfrac{1}{4}$

Ⓒ $\dfrac{1}{3}$

Ⓓ Does not exist

Ⓑ **Solve** $\displaystyle\lim_{x \to 1} \dfrac{\cos(x-1)}{2x+2}$

$= \dfrac{1}{4}$ [Using La Hospital]

27. The equation of the tangent line of the function $y = \dfrac{3x^2}{x+5}$ at x = 1 is :

Ⓐ $3x - 8y - 5 = 0$

Ⓑ $8x - 3y - 5 = 0$

Ⓒ $12x - 11y - 5 = 0$

Ⓓ $11x - 12y - 5 = 0$

Ⓓ **Solve** $y = \dfrac{3}{6} = \dfrac{1}{2}, x = 1$

Check which option satisfies x = 1 and y = $\dfrac{1}{2}$ value

$11 \times 1 - 12 \times \dfrac{1}{2} - 5 = 0$

Because the tangent line should intercept

$y = \dfrac{3x^2}{x+5}$ and will go on x = 1

28. If $y = \ln\sqrt{\dfrac{1 - \cos x}{1 + \cos x}}$, then $\dfrac{dy}{dx} = ?$

Ⓐ tan x

Ⓑ sin x

Ⓒ cosec x

Ⓓ $-$ sec x

Ⓒ **Solve** $\dfrac{d}{dx}\left\{\ln\sqrt{\dfrac{1 - \cos x}{1 + \cos x}}\right\}$

$= \dfrac{d}{dx}\left\{\ln\sqrt{\tan^2\dfrac{x}{2}}\right\}$

$= \dfrac{d}{dx}\left\{\ln\tan\dfrac{x}{2}\right\}$

$= \dfrac{1}{\tan\dfrac{x}{2}} \cdot \sec^2\dfrac{x}{2} \cdot \dfrac{1}{2} = \dfrac{1}{2\sin\dfrac{x}{2} \cdot \cos\dfrac{x}{2}} = \dfrac{1}{\sin x} = \text{cosec} x$

29. Air is being pumped into a spherical balloon at a rate of 20 in^{3}min^{-1}. How fast is the radius of the balloon increasing when the radius is 6 in? Volume of a sphere with radius r is $\dfrac{4}{3}\pi r^3$.

Ⓐ 0.0530 in min^{-1}

Ⓑ 0.0442 in min^{-1}

Ⓒ 0.0354 in min^{-1}

Ⓓ 0.0265 in min^{-1}

Ⓑ **Solve** $V = \dfrac{4}{3}\pi r^3$

$\Rightarrow \dfrac{dV}{dt} = 3 \times \dfrac{4}{3} \times r^2\dfrac{dr}{dt}$

$\Rightarrow \dfrac{dV}{dt} = 4\pi \times 6^2 \times \dfrac{dr}{dt}$

$\Rightarrow 20 = 4\pi \times 6^2 \times \dfrac{dr}{dt}$

$\Rightarrow \dfrac{dr}{dt} = \dfrac{20}{4\pi \times 6^2}$

$\therefore \dfrac{dr}{dt} = 0.0442$ in min^{-1} (Ans.)
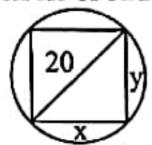
30. Evaluate $\displaystyle\int_3^7 x\sqrt{x-3}\, dx$

Ⓐ $\dfrac{111}{3}$

Ⓑ $\dfrac{189}{4}$

Ⓒ $\dfrac{144}{5}$

Ⓓ $\dfrac{179}{4}$

Ⓒ **Solve** $\displaystyle\int x\sqrt{x-3}\, dx = \dfrac{2}{5}(x-3)^{\frac{3}{2}}(x+2)$

Now, $\displaystyle\int_3^7 x\sqrt{x-3}\, dx = \dfrac{144}{5}$

31. The maximum area of a rectangle (shown in the figure below) inscribed in a circle of radius 10 m is :

Ⓐ 169 m^2 Ⓑ 200 m^2
Ⓒ 225 m^2 Ⓓ 288 m^2

Ⓑ **Solve** Maximum Area can be found if x = y

$x = \sqrt{4r^2 - y^2}$

Suppose, $f(x) = xy = \sqrt{4r^2 - y^2} \times y = 4r^2 y^2 - y^4$

Now, $f'(x) = 0 \Rightarrow y = \sqrt{2}r$

$f'(x) = 8r^2 - 12y^2$

$f''(\sqrt{2}\,r) = 8r^2 - 24r^2 = -16r^2$

So the value of maximum when

$y = \sqrt{2}r$

$\therefore$ So, $xy = (\sqrt{2} \times 10)^2 = 200$

32. Evaluate $\int_{-\frac{3}{4}}^{\frac{3}{4}} \frac{dx}{\sqrt{9 - 4x^2}}$

Ⓐ $\frac{\pi}{6}$ Ⓑ $\frac{\pi}{4}$ Ⓒ $\frac{\pi}{3}$ Ⓓ $\frac{\pi}{2}$

Ⓐ **Solve** $\int \frac{dx}{\sqrt{9 - 4x^2}}\, dx = \frac{1}{2}\sin^{-1}\left(\frac{2x}{3}\right)$

$\int_{-\frac{3}{4}}^{\frac{3}{4}} \frac{dx}{\sqrt{9 - 4x^2}} = \frac{\pi}{6}$

33. The area of the region bounded by x = 0, y = 8 and y = x^3 is:

Ⓐ 4   Ⓑ 12
Ⓒ 16   Ⓓ 24

Ⓑ **Solve** $y = x^3$, $y = 8$, $x = 0$

$\int_0^2 (8 - x^3)\, dx \left[8x - \frac{x^4}{4}\right]_0^2 = 12$

34. In a chess tournament, your probability of winning a game is 0.3 against 50% of the player (say type1), 0.4 against another 25% of the players (say type 2), and 0.5 against the remaining 25% of the players (say type 3). If you play against a randomly selected player and you win, what is the probability that you play against a Type 1 opponent?

Ⓐ 0.375   Ⓑ 0.3
Ⓒ 0.15   Ⓓ 0.4

Ⓐ **Solve** P (winning) = P (T$_1$) P (winning/T$_1$) + P (T$_2$)
P (winning/T$_2$) + P (T$_3$) P (winning/T$_3$)
P (winning) = 50% × 0.3 + 25% × 0.4 + 25% × 0.5
P (winning) = 0.375

35. Five coins are tossed simultaneously. Find the probability of the event that at least 1 head turns up?

Ⓐ $\frac{1}{32}$ Ⓑ $\frac{1}{16}$

Ⓒ $\frac{1}{5}$ Ⓓ $\frac{31}{32}$

Ⓓ **Solve** 5 coins so, $2^5 = 32$
At least one head except this one (TTTTT)
So, probability $= \frac{31}{32}$

PHYSICS

01. The half-life of the radioactive nucleus $^{226}_{88}$ Ra is 1.6 × 10^3 year. If a sample initially contains 3.00 × 10^{16} nuclei, what is the number of nuclei of the material remaining after 4.8 × 10^3 year?

Ⓐ 3.75 × 10^{15} Ⓑ 3.10 × 10^{15}
Ⓒ 3.75 × 10^{18} Ⓓ 3.60 × 10^{20}

Ⓐ **Solve**

$+\frac{1}{2} = \,^{226}_{88}\,Ra$
$= 1.6 \times 10^3\,yr$
$\therefore \lambda = \frac{.693}{1.6 \times 10^3}$
$N_0 = 3 \times 10^{16}$

$N = N_0\, e^{-\lambda t}$
$= 3 \times 10^{16} \times e^{-\frac{.693}{1.6 \times 10^3} \times 4.8 \times 10^3}$
$= 3.75 \times 10^{15}$

02. The total energy of a moving particle is 2.5 times of its energy at rest. What is the speed of the particle?

Ⓐ 2.9 × 10^7 ms^{-1} Ⓑ 2.60 × 10^8 ms^{-1}
Ⓒ 2.75 × 10^8 ms^{-1} Ⓓ 2.25 × 10^8 ms^{-1}

Ⓒ **Solve** E = 2.5 E$_0$
$mc^2 = 2.5\, m_0 c^2$

$\Rightarrow \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = m_0 c^2 \times 2.5$

$\Rightarrow 1 - \frac{v^2}{c^2} = \left(\frac{1}{2.5}\right)^2 \Rightarrow 1 - \frac{v^2}{c^2} = \frac{4}{2.5} \Rightarrow \frac{v^2}{c^2} = \frac{21}{25}$

$\therefore v = 2.75 \times 10^8\,ms^{-1}$

03. An ambulance travels down a highway at a speed of 33.5 ms^{-1}, its siren emitting sound at a frequency of 400 Hz. What frequency is heard by a passenger in a car travelling at 24.6 ms^{-1} in the opposite direction and approaching to the ambulance?

Ⓐ 460 Hz   Ⓑ 475 Hz   Ⓒ 488 Hz   Ⓓ 447 Hz

Ⓒ **Solve** $\underset{33.5}{\overset{\text{Ambulance}}{\longrightarrow}}$ $\underset{24.6}{\overset{\text{car}}{\longleftarrow}}$

$\therefore$ Relative velocity = 33.5 − (− 24.6) = 58.1

If, the source is approaching, $f' = \frac{v}{v - v_{source}} \times f_{source}$

v = velocity of sound = 332 ms^{-1} (say)
f_{source} = 400 Hz

$\therefore f' = \frac{332}{332 - 58.1} \times 400$

$= 484.85$ Hz ≈ 488 Hz

04. Monochromatic light from a helium laser (λ = 632.8 nm) is incident normally on a diffraction grating containing 6.00 × 10^3 lines/cm. What is the angle of the first maximum of the diffraction pattern?

Ⓐ 24.30°   Ⓑ 23.75°
Ⓒ 22.30°   Ⓓ 25.30°

Ⓒ **Solve** λ = 632.8 × 10^{-9} m

$d = \frac{1 \times 10^{-2}}{6 \times 10^3} = 1.66 \times 10^{-6}$

n = 1

$d\sin\theta = n\lambda$

$\therefore \theta = \sin^{-1}\frac{632.8 \times 10^{-9}}{1.667 \times 10^{-6}} = 22.30°$

05. A stove element draws 15 A of current when connected to a 220V DC source. How long does it take to consume 66 KJ?

Ⓐ 25.0 s   Ⓑ 23.5 s
Ⓒ 26.0 s   Ⓓ 20.0 s

Ⓓ Solve $H = I^2RT$

$\Rightarrow H = I^2 \times \dfrac{V}{I} \times T$

$\Rightarrow H = IVT$

$\Rightarrow T = \dfrac{H}{IV} = \dfrac{66 \times 10^3}{15 \times 220} = 20$ sec.

06. An electron is at the origin. What is the potential difference $(V_A - V_B)$? Where point A is at x = 0.25 cm and point B is at x = 0.75 cm.

Ⓐ 3.84×10^{-7} V   Ⓑ 2.84×10^{-7} V
Ⓒ 3.75×10^{-7} V   Ⓓ 3.34×10^{-7} V

Ⓐ Solve $V_A - V_B = \dfrac{1}{4\pi\epsilon_o}\left(\dfrac{q_1}{r_1} - \dfrac{q_2}{r_2}\right) = 3.84 \times 10^{-7}$ V

07. The focal length of a an eyepiece and objective lens of an astronomical telescope are respectively 5 cm and 30 cm. What is the magnification of the telescope for near focusing? Least distance of distinct vision is 25 cm.
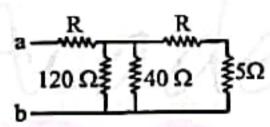
Ⓐ 8.5   Ⓑ 7.6
Ⓒ 7.2   Ⓓ 7.8

Ⓒ Solve

$M = \dfrac{f_o}{f_e}\left(1 + \dfrac{f_e}{D}\right) = 7.2$

$f_o = 30$ cm
$f_e = 5$ cm
$D = 25$ cm

08. The resistance between terminals a and b is 75Ω. If the resistors labeled R have the same value, what is the value of R?

Ⓐ 65 Ω   Ⓑ 46 Ω
Ⓒ 55 Ω   Ⓓ 76 Ω

Ⓓ Solve $\dfrac{1}{Rp} = \dfrac{1}{R+5} + \dfrac{1}{10} = \dfrac{40R + 200}{45 + R}$

$\Rightarrow \dfrac{45 + R}{40R + 200} + \dfrac{1}{120} = \dfrac{160R + 5420}{4800R + 24000}$

$\Rightarrow \dfrac{160R + 5420}{4800R + 24000} + R = 75$

$\Rightarrow \dfrac{160R + 5420 + 4800R^2 + 24000R}{4800R + 24000} = 75$

$\Rightarrow 4800R^2 - 335840R - 1794580 = 0$

$\therefore R = 76\ \Omega$

09. The average distance separating Earth and the Moon is 384000 km. What is the net gravitational force exerted by Earth and the Moon on a 3.00×10^4 kg spaceship located halfway between them? (Mass of earth = 598×10^{24} kg and mass of moon = 7.36×10^{22} kg)

Ⓐ 335 N   Ⓑ 376 N
Ⓒ 321 N   Ⓓ 325 N

Ⓓ Solve $F = G\dfrac{H_1 H_2}{d^2} = 325$ N

10. How much of an iceberg is beneath the surface of the ocean given that the density of ice is 917 kg.m^{-3} and salt water has density of 1025 kg.m^{-3}?

Ⓐ 75.5%   Ⓑ 89.50%
Ⓒ 95.5%   Ⓓ 85.5%

Ⓑ Solve $\dfrac{\rho_{ice}}{\rho_{water}} \times 100 = V_s$

$V_s = \dfrac{917}{1025} \times 100 = 89.50\%$

11. A small ferryboat is 4.00 m wide and 6.00 m long. When a loaded truck pulls onto it, the boat sinks an additional 4.00 cm into the river. What is the weight of the truck?

Ⓐ 9.25 kN   Ⓑ 8.56 kN
Ⓒ 7.41 kN   Ⓓ 9.41 kN

Ⓓ Solve The boat sinks until the weight of the water displaced equals the weight of the truck.

$W_{truck} = \rho_{water}\, \Delta V$
$= 10^3 \times 4 \times 6 \times 4 \times 10^{-2} \times 9.80$
$= 9.41 \times 10^3$ kN

12. A circular copper ring at 20.0°C has a hole with an area of 9.980 cm^2. What minimum temperature must it have so that it can be slipped onto a steel metal rod having a cross-sectional area of 10.00 cm^2? (Coefficient of linear expansion of copper is 17×10^{-6} (°C)$^{-1}$.)

Ⓐ 75.5°C   Ⓑ 79.0°C
Ⓒ 89.0°C   Ⓓ 76.5°C

Ⓑ Solve Here, $A_o = 9.98$; $\beta = 2\alpha = 34 \times 10^{-6}$

$\therefore \Delta A = 10 - 9.8\ cm^2 = 0.02\ cm^2$

We know, $\Delta A = A_o\beta\theta$

$\Rightarrow \Delta\theta = \dfrac{\Delta A}{A_o\beta} = \dfrac{0.02}{9.98 \times 34 \times 10^{-6}} = 58.9 \cong 59$

$\therefore T_2 = T_1 + \Delta\theta = 20° + 59° = 79°$

13. A popular brand of cola contains 6.50 g of carbon dioxide dissolved in 1.00 L of soft drink. If the evaporating carbon dioxide is trapped in a cylinder at 1.00 atm and 20.0°C, what volume does the gas occupy?

Ⓐ 3.55×10^{-3} m^3 Ⓑ 3.75×10^{-3} m
Ⓒ 3.25×10^{-3} m^3 Ⓓ 3.15×10^{-3} m^3

Ⓐ Solve $n_{CO_2} = \dfrac{6.50}{44} = .148$ mol

$T = 293k$
$P = 1.013 \times 10^5$ Pa
$V = \dfrac{nRT}{P} = \dfrac{.148 \times 8.31 \times 293}{1.013 \times 10^5}$ L $= 3.55 \times 10^{-3}$ m^3

14. An aluminium rod is 20.0 cm long at 20°C and has a mass of 350 g. If 10,000 J of energy is added to the rod by heat, what is the change in length of the rod? (Coefficient of linear expansion of aluminium is 24×10^{-6} (°C)$^{-1}$ and specific heat is 900 J. kg^{-1}°C.

Ⓐ 0.18 mm   Ⓑ 0.15 mm   Ⓒ 0.25 mm   Ⓓ 0.33 mm

Ⓑ Solve $W = ms\Delta\theta$

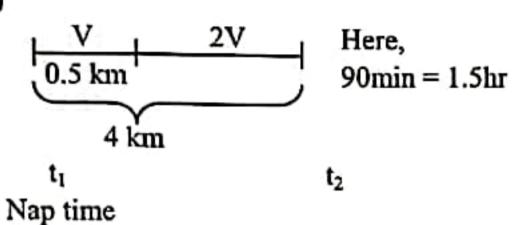$\Rightarrow 10,000 = \dfrac{350}{1000} \times 900 \times \Delta\theta$

$\Rightarrow \Delta\theta = 31.746$

Again, $l_2 = l_1 (1 + \alpha\theta)$

$\Rightarrow l_2 = 20\,(1 + 24 \times 10^{-6} \times 31.746) = 20.0152$

$\therefore \Delta l = 20.0152 - 20 = 0.0152\ cm = 0.15$ mm

15. A turtle and a rabbit engage in a footrace over a distance of 4.00 km. The rabbit runs 0.500 km and the stops for a 90.0 min nap. Upon awakening, he remembers the race and runs twice as fast. Finishing the course in a total time of 1.75 h, the rabbit wins the race. What was his average speed before he stopped for a nap?

Ⓐ 8.5 km^{-1} Ⓑ 9.5 kmh^{-1}
Ⓒ 9.0 kmh^{-1} Ⓓ 8.7 kmh^{-1}

Ⓒ Solve

```
    V       2V
├──────┼──────────┤   Here,
  0.5 km            90min = 1.5hr
 _____/
       4 km
   t₁          t₂
  Nap time
     ↑
```

Here, $t_{total} = t_1 + 1.5 + t_2$

$\Rightarrow 1.75 = \dfrac{0.5}{V} + 1.5 + \dfrac{3.5}{2V}$

$\Rightarrow 0.25 = \dfrac{1 + 3.5}{2V}$

$\Rightarrow V = 9 \text{kmh}^{-1}$

16. An arrow is shot straight up in the air at an initial speed of 15.0 ms^{-1}. After how much time is the arrow heading downward at a speed of 8.0 ms^{-1}?

Ⓐ 2.75 s   Ⓑ 2.35 s
Ⓒ 2.67 s   Ⓓ 2.15 s

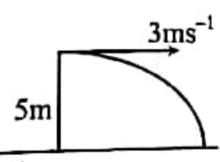Ⓑ Solve $\Delta t = \dfrac{\Delta v}{a} = \dfrac{v_f - v_o}{-g} = \dfrac{-23}{-9.80} = 2.35$

17. A jet plane has takeoff speed of 75 ms^{-1} and can move along the runway at an average acceleration of 1.3 ms^{-2}. What must be the minimum length of the runway?

Ⓐ 2.16 km   Ⓑ 2.76 km
Ⓒ 2.56 km   Ⓓ 2.85 km

Ⓐ Solve $v = at, \ t = \dfrac{v}{a} = \dfrac{75}{1.3} = 57.69 \text{ sec}$

$d = \dfrac{at^2}{2} = \dfrac{1.3 \times (57.69)^2}{2} = 2.16 \text{ km}$

18. An eagle is flying horizontally at a speed of 3.0 ms^{-1} when the fish in her talons (claw) wiggles loose and falls into the lake 5.0 m below. What is the velocity of the fish relative to the water when it hits the water?

Ⓐ 10.67 ms^{-1} Ⓑ 10.34 ms^{-1}
Ⓒ 11.36 ms^{-1} Ⓓ 11.26 ms^{-1}

Ⓑ Solve

```
              3ms⁻¹
         ┌──────→
   5m    │ ╲
         │  ╲
─────────┘───╲──
```

Here, $V_x = V_o = 3 \text{ms}^{-1}$

$y = \dfrac{1}{2} gt^2 \Rightarrow 5 = \dfrac{1}{2} gt^2 \Rightarrow t^2 = \dfrac{10}{g} \Rightarrow t = 1.01 \text{ sec}$

$\therefore V_y = 0 + gt = 9.8 \times 1.01 = 9.899 \text{ ms}^{-1}$
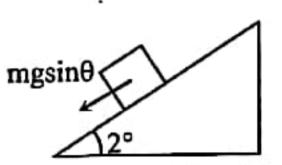
$\therefore V = \sqrt{V_x^2 + V_y^2} = 10.34 \text{ ms}^{-1}$

19. What is the power output needed for a 950 kg car to climb a 2.0° slope at a constant 30.0 ms^{-1} while encountering wind resistance and friction totalling 600 N?

Ⓐ 28.35 kW   Ⓑ 29.35 kW   Ⓒ 27.75 kW   Ⓓ 28.75 kW

Ⓒ Solve

```
       mgsinθ ╲□
            ╲  ╲
           ╲____╲
             2°
```

Total downward force $= 600 + (950 \times 9.8 \times \sin 2°)$
$= 924.91 \text{N}$

We know,
$P = \dfrac{W}{t} = \dfrac{Fs}{t} = Fv = 924.91 \times 30 = 27.75 \text{ kW}$

20. What is the force a 70.0 kg high jumper must exert on the ground to produce an upward acceleration 4.0 times the acceleration due to gravity?

Ⓐ 3476 N   Ⓑ 3430 N   Ⓒ 3576 N   Ⓓ 3486 N

Ⓑ Solve

```
      ↑F
  ⓜ ↑a
      ↓W
```
$a = 4g = 39.2 \text{ ms}^{-2}$
$m = 70 \text{kg}$
$F = mg + ma$
$= m(a + g) = 70(139.2 + 9.8) = 3430 \text{ N}$

21. A truck with 0.42 m radius tires travels at 32.0 ms^{-1}. What is the angular velocity of the rotating tires in rpm?

Ⓐ 728   Ⓑ 738   Ⓒ 708   Ⓓ 725

Blank Solve $\text{Velocity} = 32 \text{ms}^{-1} = 1920 \text{ mm}^{-1}$

$\text{circumference} = 2 \times \pi \times 4.2 = 2.63 \text{ m}$

$\therefore \text{RPM} = \dfrac{\text{speed in meters per minute}}{\text{circumference}} = \dfrac{1920}{2.63} = 730$

22. The driver of a truck slams on the brakes when he sees a tree blocking the road. The truck slows down uniformly with an acceleration of 5.60 ms^{-2} for 4.20 s, making skid marks 62.4 m long that end at the tree. With what speed does the truck then strike the tree?

Ⓐ 3.35 ms^{-1} Ⓑ 3.26 ms^{-1} Ⓒ 3.10 ms^{-1} Ⓓ 3.33 ms^{-1}

Ⓒ Solve

$s = ut - \dfrac{1}{2} at^2$ $\therefore v = u - at$
$= 26.62 - 5.6 \times 4.2$
$\Rightarrow u = \dfrac{s}{t} + \dfrac{1}{2} at$ $= 3.10 \text{ ms}^{-1}$
$\Rightarrow u = 26.62 \text{ ms}^{-1}$

23. The heat sink of a Carnot engine has a temperature of 27°C and efficiency of 50%. In order to increase the efficiency to 60%, how much temperature to be increased at the source?

Ⓐ 250 K   Ⓑ 150 K   Ⓒ 175 K   Ⓓ 235 K

Ⓑ Solve

We, know   Here, $T_2 = (273 + 27)K$
$\eta_1 = 1 - \dfrac{T_2}{T_1}$ $= 300K$
                   $\eta_1 = 50\% = 0.5$
$\Rightarrow T_1 = 600K$ $\eta_2 = 60\% = 0.6$
Again, $\Delta T = ?$

$\eta_2 = 1 - \dfrac{T_2}{T_1'}$

$\Rightarrow T_1' = 750K$

$\therefore \Delta T = T_1' - T_1$
$= 150K$

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24. Using a small pendulum of length 0.71 m a geophysicist counts 72 complete swings in a time of 60.0 s. What is value of g at that location?

Ⓐ 9.67 ms^{-2} Ⓑ 7.98 ms^{-2}
Ⓒ 9.73 ms^{-2} Ⓓ 9.43 ms^{-2}

Ⓒ Solve $T = \dfrac{60}{72} = 0.833\text{s}$

$T = 2\pi \sqrt{\dfrac{L}{g}}$

$\Rightarrow g = \dfrac{14\pi^2 L}{T^2} = \dfrac{4 \times (3.1416)^2 \times 0.171}{(0.833)^2} = 9.73 \text{ ms}^{-2}$

25. A common base n-p-n transistor has $\alpha = 0.98$, $I_E = 1.5$ mA. What is the base current I_B?

Ⓐ $35\mu A$ Ⓑ $28\mu A$
Ⓒ $32\mu A$ Ⓓ $90\mu A$

Blank Solve We know,

$\alpha = \dfrac{I_C}{I_E}$

$\Rightarrow I_C = \alpha I_E = 0.98 \times 1.5 \text{ mA} = 1.47 \text{ mA}$

Again,

$I_E = I_C + I_B$

$\Rightarrow I_B = I_E - I_C$

$\Rightarrow I_B = 1.5 - 1.47$

$\therefore I_B = 30\mu A$

26. An alarm clock is set to sound in 10 h. At t = 0, the clock is placed in a spaceship moving with a speed of 0.75c (relative to Earth). What distance, as determined by an Earth observer, does the spaceship travel before the alarm clock sound?

Ⓐ $1.22 \times 10^{13} \text{ m}$ Ⓑ $1.1 \times 10^{10} \text{ m}$
Ⓒ $1.8 \times 10^{12} \text{ m}$ Ⓓ $1.5 \times 10^{14} \text{ m}$

Ⓐ Solve $t = \dfrac{t_0}{\sqrt{1 - \dfrac{v^2}{c^2}}} = 15.12 \text{ hour} = 54432 \text{ sce}$

$\therefore s = vt = 0.75 \times 3 \times 10^8 \times 54432$

$\therefore s = 1.22 \times 10^{13} \text{ m}$

27. Camera lenses are described in terms of their focal length. A 50.0 mm lens has a focal length of 50.0 mm. A camera with a 50.0 mm lens is focused on an object 3.0 m away. What is the location of the image?

Ⓐ 55 mm Ⓑ 53 mm Ⓒ 51 mm Ⓓ 56 mm

Ⓒ Solve $\left(\dfrac{1}{50 \times 10^{-3}} - \dfrac{1}{3}\right)^{-1} = 50.84 \text{ mm} \cong 51 \text{ mm}$

28. A 6500 kg freight car traveling at 2.5 ms^{-1} collides with an 8000 kg stationary freight car. If they interlock upon collision, what is their velocity?

Ⓐ 1.35 ms^{-1} Ⓑ 1.12 ms^{-1} Ⓒ 1.23 ms^{-1} Ⓓ 1.55 ms^{-1}

Ⓑ Solve $6500 \times 2.5 + 8000 \times 0 = v (6500 + 8000)$

$\Rightarrow v = 1.12 \text{ ms}^{-1}$

29. A 200.0 cm copper wire and a 201.0 cm platinum wire are both at exactly 0°C. At what temperature will they be of equal length? (Coefficient of linear expansion of platinum = $9 \times 10^{-6} \text{ (°C)}^{-1}$)

Ⓐ 628.5°C Ⓑ 675.3°C
Ⓒ 613.5°C Ⓓ 618.5°C

Ⓐ Solve Linear expansion co-efficient of copper = 17×10^{-6} and platinum = 9×10^{-6}

30. What is the size of the current in a 35 cm long wire that is perpendicular to a magnetic field of 0.085 T. If the force on the wire is 125 mN?

Ⓐ 4.76 A Ⓑ 4.55 A
Ⓒ 4.13 A Ⓓ 4.20 A

Ⓓ Solve

$F = NIBl \sin\theta$

Here, N = 1, $\theta = 90°$

$\Rightarrow I = \dfrac{F}{Bl \sin\theta}$

$\Rightarrow I = \dfrac{0.125}{0.085 \times 0.35}$

$\therefore I = 4.2 \text{ A}$

31. A potential difference of 1.0 V is maintained across a 10 Ω resistor for 20 s. What is the total charge pass through the resistor during that time interval?

Ⓐ 3.5 C Ⓑ 2.25 C
Ⓒ 2.00 C Ⓓ 3.25 C

Ⓒ Solve

$C = \dfrac{V}{R} = \dfrac{1}{10} = .1$

$V = \dfrac{Q}{t} . R$

Current $= \dfrac{\text{Charge flow}}{\text{time}}$

$Q = \dfrac{Vt}{R} = \dfrac{20}{10} C = 2C$
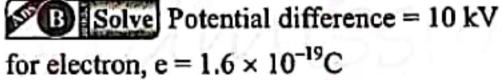
$.1 = \dfrac{Q}{20}$

$Q = 2 \text{ columb}$

32. If an electron is accelerated by a potential difference of 10 kV, What is the speed of the electron?

Ⓐ $5.05 \times 10^7 \text{ ms}^{-1}$ Ⓑ $5.93 \times 10^7 \text{ ms}^{-1}$
Ⓒ $5.56 \times 10^7 \text{ ms}^{-1}$ Ⓓ $5.036 \times 10^7 \text{ ms}^{-1}$

Ⓑ Solve Potential difference = 10 kV

for electron, $e = 1.6 \times 10^{-19} C$

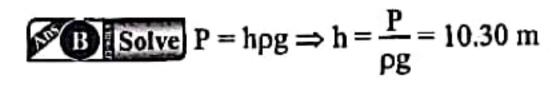$M = 9.1 \times 10^{-19} \text{ kg}$

Potential energy = kinetic energy

$eV = \dfrac{1}{2} mV^2$

$V = \sqrt{\dfrac{2eV}{m}} = \sqrt{\dfrac{1.6 \times 10^{-19} \times 10 \times 1000 \times 2}{9.1 \times 10^{-31}}}$

$= 5.93 \times 10^7 \text{ ms}^{-1}$

33. A heart defibrillator delivers 4.00×10^2 J of energy by discharging a capacitor at 1.00×10^4 V. What is the value of the capacitor?

Ⓐ 8.00 μF Ⓑ 8.67 μF
Ⓒ 8.25 μF Ⓓ 8.75 μF

Ⓐ Solve $U = \dfrac{1}{2} CV^2$

34. What is the depth of water below the surface of a dam where the pressure is 1.00 atm?

Ⓐ 10.55 m Ⓑ 10.30 m
Ⓒ 11.25 m Ⓓ 11.03 m

Ⓑ Solve $P = h\rho g \Rightarrow h = \dfrac{P}{\rho g} = 10.30 \text{ m}$

35. A 60 kg woman floats in the fresh water with 97% of her body volume submerged when her lungs are full of air. What is the average density of the woman?
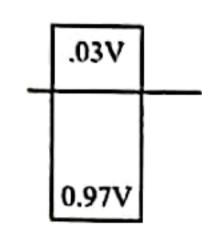
Ⓐ 0.87 gmcm^{-3} Ⓑ 0.97 gmcm^{-3}

Ⓒ 0.93 gmcm^{-3} Ⓓ 0.98 gmcm^{-3}

Ⓑ Solve

```
            ┌──────┐
            │ .03V │
────────────┼──────┼───────
            │      │
            │0.97V │
            └──────┘
```

Here, $W_{Water} = W_{woman}$

$\Rightarrow V'\rho g = mg$

$\Rightarrow 0.97V \times 1000 = 60$

$\therefore V = 0.062 \ m^3$

$\therefore \rho = \dfrac{m}{V} = \dfrac{60}{0.062} = 970 \ kg/m^3 = 0.97 \ gmcm^{-3}$

CHEMISTRY

01. 7.1 g anhydrous Na_2SO_4 is dissolved in water. The amount of Na_2SO_4 obtained on drying the solution very slowly at normal temperature is found to be 9.0 g. The water of crystallization of Na_2SO_4 is ——

Ⓐ 10.0 mol   Ⓑ 5.0 mol

Ⓒ 7.0 mol   Ⓓ 2.0 mol

Ⓓ Solve $Na_2SO_4 . nH_2O$

Here, $\Delta w = 9 - 7.1 = 1.9g$

7.1 g Na_2SO_4 is added with = 1.9g H_2O

$\therefore 14g(Na_2SO_4 = 142g)$ „ „ „ = $\dfrac{1.9 \times 142}{7.1}$ g H_2O

     $= 38g \ H_2O$

     $= \dfrac{38}{18}$ mole H_2O

     $= 2.1$ mole

02. The non-alkaline hardness of water is due to the presence of ——

Ⓐ $Ca(HCO_3)_2$ Ⓑ $M(HCO_3)_2$

Ⓒ $MgCl_2$ Ⓓ $Mg(OH)_2$ **Ans Ⓐ**

03. To separate calcium from the solution of a chalk, which one of the following reagents is to be used?

Ⓐ Hydorzhonic acid   Ⓑ Sulfuric acid

Ⓒ Nitirc acid   Ⓓ Oxalic acid   **Ans Ⓐ**

04. Which of the follows is most reactive cleaning agent for glass apparatus?

Ⓐ Saturated solution of $K_2Cr_2O_7$ in Conc. H_2SO_4

Ⓑ Conc.HCl

Ⓒ Conc.HF

Ⓓ Conc.HNO_3 **Ans Ⓐ**

05. The elements whose neutron number are same but proton number is different consequently the mass number is different is called–

Ⓐ Isobar   Ⓑ Isomar

Ⓒ Isocore   Ⓓ Isotone   **Ans Ⓓ**

06. The name of the reaction by which the –COCl group is directly converted to –CHO group is :

Ⓐ Wolf Kishner Reduction   Ⓑ Clemensen Reduction

Ⓒ Rosenmond Reduction   Ⓓ Pinacol Reduction   **Ans Ⓒ**

07. The reagent that is used in Hofmann degradation reaction is ——.

Ⓐ Sn/HCl   Ⓑ $NaOH/Br_2$

Ⓒ NH_3/Al_2O_3 Ⓓ Zn/Hg   **Ans Ⓑ**

08. The following four analytical reagents are used to identify the presence of carbonyl group in organic compound. Among these which one are inorganic complex compound?

Ⓐ Tolens reagent   Ⓑ Fehling's solution

Ⓒ 2, 4-D.N.P.H   Ⓓ B.D.S   **Ans Ⓒ**

09. Sodium has only one oxidation number. Lead has two oxidation numbers. How many oxidation number may chlorine may have in its different compounds?

Ⓐ 3   Ⓑ 2

Ⓒ 5   Ⓓ 7   **Ans Ⓓ**

10. Which one of following compounds is the main component of synthetic lubricant?

Ⓐ AgO   Ⓑ MgO

Ⓒ Al_2O_3 Ⓓ Si O_2 **Ans Ⓓ**

11. Which of the following element of a compound is used as retarder in cement industry?

Ⓐ C   Ⓑ Mg

Ⓒ Al   Ⓓ Si   **Ans Ⓓ**

12. The idea of dual nature of electron was first given by –

Ⓐ Einstein   Ⓑ Plank

Ⓒ de-Broglie   Ⓓ Bohr   **Ans Ⓒ**

13. 30 mL 12.5 molar HNO_3 is taken to synthesize 20g aniline from benzene. How much (in gram) of HNO_3 will remain unused in this reaction?

Ⓐ 10.075g   Ⓑ 12.125g

Ⓒ 8.625g   Ⓓ 2.25g

Ⓐ Solve 1 mol $HNO_3 \equiv 1$ mol $C_6H_5NH_2$

30 ml 12.5 M $HNO_3 \equiv (0.03 \times 12.5) = 0.375$ mol

20g Aniline $= \dfrac{20}{12 \times 6 + 1 \times 5 + 2 \times 1 + 14}$

     $= 0.215$ mol

$\therefore$ used $HNO_3 = 0.215$ mol

$\therefore$ unused $HNO_3 = (0.375 - 0.215)$ mol

     $= 0.16$ mol

     $= (0.16 \times 63) = 10.08$ g

14. HF is a very week acid. At 410K temperature 35% of HF is being dissociated. The value of Kp of HF at 410K temperature is ——

Ⓐ 0.0512   Ⓑ 0.0623

Ⓒ 0.0415   Ⓓ 0.0725

Ⓒ Solve $Kp = \alpha^2 c$

$\alpha = 0.35$

If volume of flask = 1 L then remaining H^+ amount $= \alpha$ mol

$\therefore$ concentration $= \dfrac{\alpha}{1}$

$Kp = (0.35)^3 = 0.042$

IUT প্রশ্নব্যাংক   ৪৭

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15. At 30°C the concentration of dissolved oxygen in a sample water is 7.54 ppm. The iodine liberated by 1000 mL of this sample water reacts completely with 9.0 mL Na_2SO_3 solution. The concentration of this Na_2SO_3 solution is —

Ⓐ 0.01N   Ⓑ 0.10N

Ⓒ 0.1047N   Ⓓ 0.1085N

Ⓐ Solve 7.54 ppm means,

out of

$$1\,L \cdots\cdots \frac{7.54 \times 10^{-3}\,g}{I_2\text{ এর আণবিক ভর}} = \frac{7.54 \times 10^{-3}}{127 \times 2}\,mol$$

I_2 এর concentration $= 2.97 \times 10^{-5}\,M$

I_2 এর mole $= 1 \times 2.97 \times 10^{-5} \times mol\,L^{-1} \times 2$

$2Na_2SO_3 + I_2 = 9\,NaI + Na_2SO_4$

$1\,mol\,I_2 \equiv 9\,mol\,Na_2S_2O_3$

$\therefore 9.975 \times 10^{-5}\,mol\,I_2 = 9.975 \times 10^{-5} \times 2$

$$= 5.94 \times 10^{-5}\,mol$$

$$= \frac{5.94 \times 10^{-5}\,mol\,L^{-1}}{9 \times 10^{-3}}$$

$$= 6.59 \times 10^{-3}\,M$$

$$= (6.59 \times 10^{-3} \times 2) = 0.01\,N$$

ENGLISH

Refer to the following passage for question no. 1-9 :

When using a metal file, always remember to bear down on the forward stroke only. On the return stroke, lift the clear of the surface to avoid dulling the instrument's teeth. Only when working on very soft metals it is advisable to drag the file's teeth slightly on the return stroke. This helps clear out metal pieces from between the teeth.

It is best to bear down just hard enough to keep the file cutting at all times. Too little pressure uses only the tips of the teeth, while too much pressure can chip the teeth. Move the file in straight lines across the surface. Use a vise to grip the work so that your hands are free to hold the file. Protect your hands by equipping the file with a handle. Buy a wooden handle and install it by inserting the pointed end of the file into the handle hole.

01. These directions show you how to —

Ⓐ Work with a hammer   Ⓑ Use a file

Ⓒ Polish a file   Ⓓ Oil a vise   **Ans Ⓑ**

02. When using a file —

Ⓐ Always bear down on the return stroke

Ⓑ Move it in a circle

Ⓒ Remove the handle

Ⓓ Press down on the forward stroke   **Ans Ⓓ**

03. When working on soft metals, you can —

Ⓐ Remove the handle

Ⓑ Clear metal pieces from the teeth

Ⓒ Bear down very hard on the return stroke

Ⓓ File in circles   **Ans Ⓑ**

04. Protect your hands by —

Ⓐ Dulling the teeth

Ⓑ Dragging the teeth on the backstroke

Ⓒ Using a vise

Ⓓ Installing a handle   **Ans Ⓓ**

05. When having a problem, it is best to dissect the situation, then act. *Dissect* means —

Ⓐ Control   Ⓑ Discuss

Ⓒ Ignore   Ⓓ Analyze   **Ans Ⓓ**

06. The child apprised her father's authority and behaved herself in church. *Apprised* means —

Ⓐ Appreciated   Ⓑ Compromised

Ⓒ Defied   Ⓓ Noted   **Ans Ⓓ**

07. The scientist was able to evoke powerful emotions from her audience. *Evoke* means —

Ⓐ Sell   Ⓑ Calm

Ⓒ Call forth   Ⓓ Exaggerate   **Ans Ⓒ**

08. The official exhibited a heedless attitude when dealing with the dignitaries. *Heedless* means —

Ⓐ Thoughtless   Ⓑ Pleasant

Ⓒ Friendly   Ⓓ Bitter   **Ans Ⓐ**

09. The general tried to *instill* the hope of victory in his troops *instill* means —

Ⓐ Infuse   Ⓑ Delay

Ⓒ Inscribe   Ⓓ Indict   **Ans Ⓐ**

10. The winning team of the World Series often has a jovial attitude. Jovial means —

Ⓐ Merry   Ⓑ Sad

Ⓒ Somber   Ⓓ Laborious

Ⓐ Explanation Jovial- cheerful and friendly

Select the correct words to complete the sentence for questions 11– 15 :

11. The jungle the Tidy City contest, we —

Ⓐ picked an uninterested party   Ⓑ picked an interested party

Ⓒ picked a disinterested party   Ⓓ picked an disinterested party

Ⓒ Explanation Before consonant latter article a is appropriate. Option (C) is more suitable than other options.

12. Arctic trees are — in milder climates.

Ⓐ scrubbiest than trees   Ⓑ scrubbier then trees

Ⓒ scrubbiest than are trees   Ⓓ scrubbier than trees

Ⓓ Explanation Scrubbier is also a comperative form. Than indicates coparative form.

13. The helium-filled balloon —

Ⓐ rose in the air   Ⓑ was rising in the air

Ⓒ was in the air   Ⓓ rose into the air   **Ans Ⓓ**

14. If I —. I would have delivered the package myself.

Ⓐ have the address   Ⓑ have had the address

Ⓒ had the address   Ⓓ had had the address

Ⓒ Explanation If clause + past + perfect = perfect condition (would have).

15. If he — his first draft, he would have received a better grade.

Ⓐ would have revised   Ⓑ had revised

Ⓒ could of revised   Ⓓ had of revised   **Ans Ⓑ**