MATRIX HIGH SCHOOL

NTSE STAGE II
CODE: 13 – 15 (2019 – 2020)
SCHOLASTIC APTITUDE TEST
Held on: February 14, 2021
HINTS & SOLUTIONS

BIOLOGY

1.	**4**	2.	**4**	3.	**3**	4.	**2**
5.	**4**	6.	**4**	7.	**1**	8.	**3**
9.	**1**	10.	**1**	11.	**2**	12.	**1**
13.	**2**						

CHEMISTRY

14.	**4**	15.	**3**	16.	**1**	17.	**2**
18.	**1**	19.	**1**	20.	**2**	21.	**2**
22.	**1**	23.	**4**	24.	**4**	25.	**1**
26.	**3**						

PHYSICS

27.	**4**	28.	**4**	29.	**3**	30.	**3**
31.	**2**	32.	**3**	33.	**3**	34.	**1**
35.	**2**	36.	**1**	37.	**4**	38.	**3**
39.	**4**	40.	**2**				

MATHEMATICS

41.	**3**	42.	**1**	43.	**4**	44.	**1**
45.	**3**	46.	**2**	47.	**2**	48.	**3**
49.	**2**	50.	**2**	51.	**4**	52.	**2**
53.	**4**	54.	**No Option Correct**			55.	**2**
56.	**1**	57.	**1**	58.	**1**	59.	**2**
60.	**4**						

SOCIAL SCIENCE

61.	**3**	62.	**1**	63.	**2**	64.	**4**
65.	**2**	66.	**1**	67.	**1**	68.	**2**
69.	**1**	70.	**1**	71.	**4**	72.	**3**
73.	**3**	74.	**1**	75.	**3**	76.	**2**
77.	**3**	78.	**4**	79.	**3**	80.	**1**
81.	**2**	82.	**4**	83.	**1**	84	**3**
85.	**1**	86.	**3**	87	**2**	88.	**4**
89.	**2**	90.	**4**	91.	**4**	92.	**2**
93.	**1**	94	**4**	95.	**2**	96.	**4**
97.	**2**	98.	**3**	99.	**1**	100.	**2**

BIOLOGY

1. 4

Sol. Specimen belongs to echinodermata phylum.

2. 4

Sol. AaBbCcddEe × AabbCcDdEe

(1) Aa × Aa

AA Aa Aa (aa)

$Aa = \frac{1}{4}$

(2) Bb × bb

Bb Bb (bb) bb

$bb = \frac{2}{4}$

(3) Cc × Cc

CC Cc Cc (cc)

$cc = \frac{1}{4}$

(4) dd × Dd

Dd (dd) Dd (dd)

$dd = \frac{2}{4}$

(5) Ee × Ee

EE Ee Ee (ee)

$ee = \frac{1}{4}$

$\therefore \quad \frac{1}{4} \times \frac{1}{2} \times \frac{1}{4} \times \frac{1}{2} \times \frac{1}{4} = \frac{2}{1024} \Rightarrow \frac{1}{256}$

3. 3

Sol. Sexual reproduction leads maximum variation in DNA sequence through generation.

4. 2

Sol. M = 1 mg, → Grass hopper

N = 0.2 mg, → Grass

O = 3mg → Adipose tissues of birds

MNO

Grasshopper, Grass, adipose tissue of bird

5. 4

Sol. Pyramid of energy for every ecosystem is upright.

6. 4

Sol. Human arm, seal forelimb and wings of a bird are homologous organs and they show divergent evolution.

7. 1

Sol. Farmer B performed the practice of mixed cropping. Mixed cropping reduces risk and gives some insurance against failure of one of the crops.

8. 3

Sol. Egg shell is made up of calcium carbonate when it kept in HCl it reacts with $CaCO_3$ and dissolves the shell.

9. 1

Sol. Iodine helps to produce thyroxine, which is important for metamorphosis.

10. 1

Sol.

Test tube – A	**Test tube – B**	**Test tube – C**
Saliva + Iodine ↓ incubation	Starch + Saliva ↓ incubation	Starch + Saliva + Enzyme Inhibitor ↓ Incubation + Iodine
Yellow colour	No colour	Blue black colour

* iodine is camel brown in colour

* When iodine reacts with starch gives blue black colour

11. 2

Sol. Test tube A – Mitochondria
Test tube B – Rough Endoplasmic Reticulum (RER)
Test tube C – Lysosome

12. 1

Sol.

Column 1		**Column 2**	
A.	Ovary	I.	Progesterone
B.	Pancreas	II.	Insulin
C.	Adrenal gland	VIII.	Aldosterone
D.	Parathyroid	III.	Parathyroid hormone
E.	Pituitary gland	V.	Follicle stimulating hormone

13. 2

Sol. Antibiotics helped in the selection for bacterium with mutations in the DNA conferring drug resistance which were already present in the population.

14. 4

Sol. Number of moles of glucose = $\frac{1.80}{180} = 10^{-2}$ moles

Number of molecules of glucose = $10^{-2} \times 6.022 \times 10^{23} = 6.022 \times 10^{21}$ molecules of glucose

Total number of O – atom present in glucose = $6 \times 6.022 \times 10^{21}$

Number of moles of water = $\frac{36}{18}$ = 2 moles

Number of H_2O molecule = $2 \times 6.022 \times 10^{23}$ molecule

$\therefore$ No. of O atom in water = 12.044×10^{23}

Total number of O – atom present in solution = $12.044 \times 10^{23} + 36.138 \times 10^{21}$

= 12.40×10^{23} oxygen atom

15. 3

Sol. F, Cl, N & O are electronegative element. In second period of periodic table the tendency of forming anion increase upto fluorine.

16. 1

Sol. Rate of evaporation α Temperature & wind speed

Rate of evaporation $\alpha \frac{1}{\text{Humidity}}$

17. 2

Sol. $NaOH + H_2SO_4 \longrightarrow NaSO_4 + H_2O$

0.1 M 0.04 M

0.01 mole 0.004 mol

Mole of NaOH left = 0.006

$\therefore$ Amount of NaOH = $0.006 \times 40 = 0.24$

18. 1

Sol. $CH_3CH_2CH_2 - OH \xrightarrow{[O]} CH_3CH_2COOH$

$CH_3 - CH_2 - COOH$

$CH_3 - COO - CH_3$

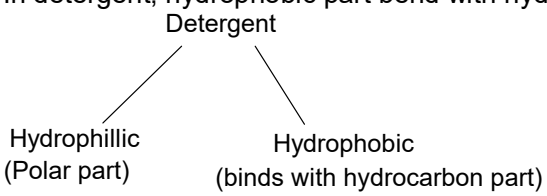
$H - \overset{\overset{O}{\|}}{C} - OC_2H_5$

19. 1

Sol. $\text{Average atomic mass} = \frac{\sum(\%\ \text{Abundance} \times \text{Isotopic mass})}{100}$

20. 2

Sol. In detergent, hydrophobic part bend with hydrocarbon part and hydrophilic part



21. 2

Sol.

$$\underset{A}{CH_3COOH} + \underset{B}{C_2H_5OH} \longrightarrow CH_3 - \underset{\underset{C}{\|}}{\overset{O}{C}} - O - C_2H_5$$

$$\underset{B}{C_2H_5OH} + [O] \xrightarrow{KMnO_4} \underset{A}{CH_3COOH}$$

$$CH_3 - \overset{\overset{O}{\|}}{C} - O - C_2H_5 + H_2O \xrightarrow{NaOH} \underset{B}{CH_3CH_2OH} + CH_3COOH$$

22. 1

Sol. The solution of $\underset{S.B}{NaOH} + \underset{W.A}{CH_3COOH}$ have pH more than 7.

23. 4

Sol. As we go in periodic table from left to right in period, atomic size decrease, so size of B is not smaller than K

24. 4

Sol. When current is applied to electrochemical cell Cu(II) was in solution and reduced to Cu-atom at the cathode Cu-atom on the anode are oxidized in Cu(II) ions. The cathode gain mass, the anode looses mass

25. 1

Sol. The order of reactivity of metal is
Z > Zn > Fe > Y > Cu > X

26. 3

Sol.

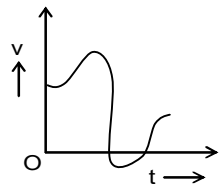
$$\underset{X}{CaCO_3} + H_2O + CO_2 \longrightarrow \underset{Y}{Ca(HCO_3)_2}$$

$$CaCO_3 + H_2SO_4 \longrightarrow \underset{Z}{CaSO_4} + H_2O + CO_2$$

PHYSICS

27. 4

Sol.



28. 4

Sol. Loss of PE = Gain in K.E.

$$\Rightarrow \quad v = \sqrt{2gh}$$

$$\therefore \quad \frac{v_A}{v_B} = \sqrt{\frac{h_A}{h_B}} = \sqrt{\frac{18}{8}} = \frac{3}{2}$$

29. 3

Sol. When two bodies of equal masses undergo elastic collision in one dimension, their velocities gets interchanged.

30. 3

Sol. Buoyant force = Weight of body (flotation)

$V \times \rho_\ell \times g = M_b \times g$

$V \times \rho_\ell = M_b$

Fraction remains same.

31. 2

Sol. Given, $mg_1 = 0.25\ mg$

$$g_1 = \frac{g}{4}$$

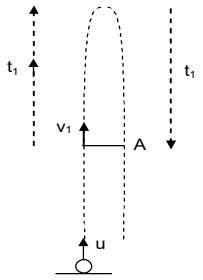
& $$T = 2\pi\sqrt{\frac{L}{g}}$$

32. 3

Sol. $$KE = PE = \frac{KE_{max}}{2}$$

$$\frac{1}{2}mv_1^2 = \frac{1}{2}mu^2$$

$$v_1 = \frac{u}{\sqrt{2}}$$



$$t_1 = \frac{u}{\sqrt{2}g}$$

Body will reach back to point A from maximum height in time t_1.

Total time internal = $2t_1 = 2 \times \frac{u}{g} = \sqrt{2}\frac{u}{g}$

33. 3

Sol. $$\frac{1}{2}mv^2 + mgx = \frac{1}{2}kx^2$$

$$\frac{1}{2} \times 10 \times (10)^2 + 10 \times 10 \times \frac{5}{100} = \frac{1}{2} \times k \times \left(\frac{5}{100}\right)^2$$

$k = 4 \times 10^5$ N/m

34. 1

Sol. Sound will be produced when ball hit ground

Time taken by ball to return is

$$t_A = \frac{u}{g} = \frac{20}{10} = 2s$$

Distance of cliff $d = \frac{v \times t}{2}$ = 350 m.

35. 2

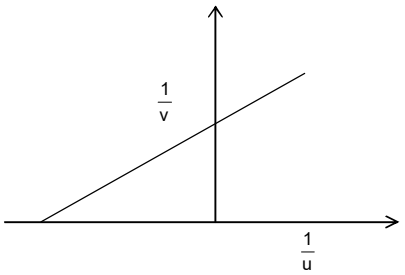
Sol. By sign conversion, for convex mirror

v = +ve u = –ve f = +ve

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

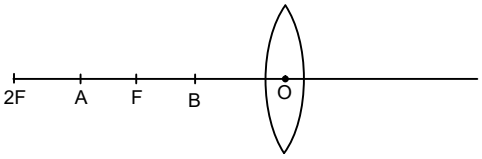
$$\frac{1}{v}=\frac{1}{u}+\frac{1}{f}$$

y = mx + c



36. 1

Sol.



$$m=\frac{f}{f+u}$$

For u = –AO m = –ve

U = –BO m = +ve

$$-m=\frac{f}{f-AO} \quad \& \quad m=\frac{f}{f-BO}$$

$$\frac{f}{f-AO}=-\frac{f}{f-BO}$$

f – BO = AO – f

2f = AO + BO

2f = (AF + OF) + (OF – BF)

2f = 2f + AF – BF

$\Rightarrow$ AF = BF

37. 4

Sol. I. She suffers from myopia where the far point is nearer than the blackboard.

II. A concave lens with a suitable power an help correct her vision.

III. Her eye is defective and is forming images in front of the retina.

Statements I, II & III are correct.

38. 3

Sol. For I_{max}

R_{eq} should be minimum (V = IR)

To get minimum resistance least value resistor should be connected in series.

39. 4

Sol. $I_{Bulb}=\frac{110}{220}A \quad I_{fan}=\frac{70}{220}A \quad I_{Heater}=\frac{1200}{220}A$

$I_{fuse} = I_{Bulb} + I_{fan} + I_{Heater}$

= 6.27 A

Fuse wire should be 10 A.

40. 2

Sol. $|^{+} \quad -\blacktriangleleft- e^{-} \quad |^{-}$

When observed from –ve plate current is towards observer. Thus by RHTR magnetic field is anti-clockwise.

41. 3

Sol. $x = \dfrac{\sqrt{5}-\sqrt{2}}{2\sqrt{3+\sqrt{5}-\sqrt{2}}}$

$\Rightarrow x = \dfrac{\sqrt{5}-\sqrt{2}}{2\left(\dfrac{\sqrt{5}+1}{\sqrt{2}}\right)-\sqrt{2}}$ (Since $\sqrt{3+\sqrt{5}} = \dfrac{\sqrt{5}+1}{\sqrt{2}}$)

$\Rightarrow x = \dfrac{\sqrt{5}-\sqrt{2}}{\sqrt{10}} \Rightarrow x\sqrt{10} = \sqrt{5}-\sqrt{2}$

So, $\dfrac{x\sqrt{10}+\sqrt{2}}{x\sqrt{10}+2\sqrt{5}} = \dfrac{\sqrt{5}}{3\sqrt{5}-\sqrt{2}} = \dfrac{15+\sqrt{10}}{43}$

42. 1

Sol. $x = 17q_1 + 9 = 11q_1 + 6q_1 + 9$

$x-3$ must be divisible by 11

$\Rightarrow 11q_1 + 6q_1 + 6$ is divisible by 11

$\Rightarrow 6q_1 + 6$ is divisible by 11

$\Rightarrow q_1 = 10, 21, 32, ...$

For $q_1 = 21$, x lies between 300 and 400

So, $x = 17 \times 21 + 9$

= 366

Remainder where 366 is divided by 21 is 9.

43. 4

Sol. By long division

$(ax+b)(x^5+1)-(5x+1) = (x^2+1)(ax^4+bx^3-ax^2-bx+a)$

$+(a+b-5)x+(b-a-1)$

Taking remainder = 0

We get $a+b=5$ and $-a+b=1$

On solving we get a = 2, b = 3

So, $2a+3b=13$

44. 1

Sol. Intersection point of $15x+20y=-2$ and $x-y=-2$ is $x=\dfrac{-6}{5}, y=\dfrac{4}{5}$

Now $2\left(-\dfrac{6}{5}\right)+3\left(\dfrac{4}{5}\right)=k^2$

$\Rightarrow k^2 = 0 \Rightarrow k = 0$

So, k is an integer

45. 3

Sol. $(a_{13}-a_3)^2 = a_{13}^2 + a_3{}^2 - 2a_{13}a_3$

$\Rightarrow (10d)^2 = 5 - 2a_{13}a_3$

$\Rightarrow d^2 = \dfrac{5 - 2a_{13}a_3}{100}$

Now $a_4 \times a_{12} = (a_3 + d) \times (a_{13} - d)$

$\Rightarrow R = a_3a_{13} + d(a_{13} - a_3) - d^2$

$\Rightarrow R = a_3a_{13} + 9d^2$

$\Rightarrow R = a_3a_{13} + 9\left[\dfrac{5 - 2a_{13}a_3}{100}\right]$

$\Rightarrow a_{13}a_3 = \dfrac{100R - 45}{82}$

46. 2

Sol. α, β are roots of $2x^2 - 5x - 6 = 0$

$\Rightarrow 2\alpha^2 - 5\alpha - 6 = 0 \Rightarrow \alpha^2 - 3 = \dfrac{5\alpha}{2}$

Similarly, $\beta^2 - 3 = \dfrac{5\beta}{2}$

Now, $\dfrac{P_9 - 3P_7}{4P_8} = \dfrac{(\alpha^8 - \beta^8) - 3(\alpha^6 - \beta^6)}{4(\alpha^7 - \beta^7)}$

$= \dfrac{\alpha^6(\alpha^2 - 3) - \beta^6(\beta^2 - 3)}{4(\alpha^7 - \beta^7)}$

$= \dfrac{\frac{5}{2}[\alpha^7 - \beta^7]}{4[\alpha^7 - \beta^7]} = \dfrac{5}{8}$

47. 2

Sol. Total numbers = 1000

Now numbers of form m^n are either perfect square or perfect cube or of form m^5 or m^7

Now, for n = 2, m can take 30 values

for n = 3, m can take 7 values (excluding 64 and 729 as these are counted in perfect square)

for n = 5, m can take 2 values

for n = 7, m can take 1 value

Total $\overline{\quad 40}$

Probability $= \dfrac{40}{1000} = \overline{\dfrac{1}{25}}$

48. 3

Sol. A (–5, 5), B (4, –5), C (4, 5)

By distance formula

$AB = \sqrt{181}$

BC = 10

AC = 9

Since $AB^2 = BC^2 + AC^2$

$\Rightarrow$ ABC is right angled triangle and $\angle C = 90^\circ$, hypotenuse $= \sqrt{181}$

Radius of circum circle $= \dfrac{\sqrt{181}}{2}$

So, required area

$= \pi\left(\dfrac{\sqrt{181}}{2}\right)^2 - \dfrac{1}{2}\times 10\times 9$

$= \dfrac{181}{4}\pi - 45$

49. 2

Sol. B' (–3, 1) is image of B (3, 1) in y – axis

Now $\Delta CB'D \cong \Delta CBD$

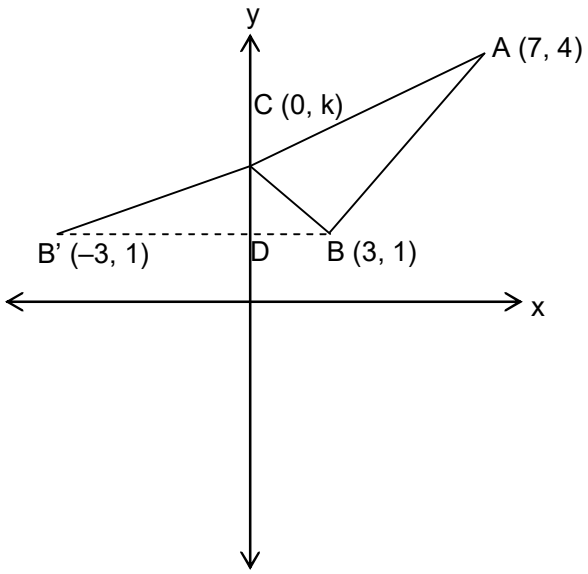
$\Rightarrow CB = CB' \left(CPCT\right)$

Since CB + CA is minimum

$\Rightarrow CB' + CA$ is also minimum which is possible when B', C and A are collinear

$\Rightarrow$ Slope of B' C = Slope of AB'

$\Rightarrow \dfrac{k-1}{3} = \dfrac{3}{10} \Rightarrow k = \dfrac{19}{10}$



50. 2

Sol. $\Delta OQA \sim \Delta OAP$

$\Rightarrow \dfrac{OQ}{OA} = \dfrac{OA}{OP} \Rightarrow OA^2 = OQ\times OP$

$\Rightarrow r^2 = OQ\times OP$

51. 4

Sol. $\Delta PXQ \sim \Delta CXB$

$\therefore \dfrac{XM}{XN} = \dfrac{PQ}{BC} = \dfrac{1}{4}$

$XM + XN = 9$

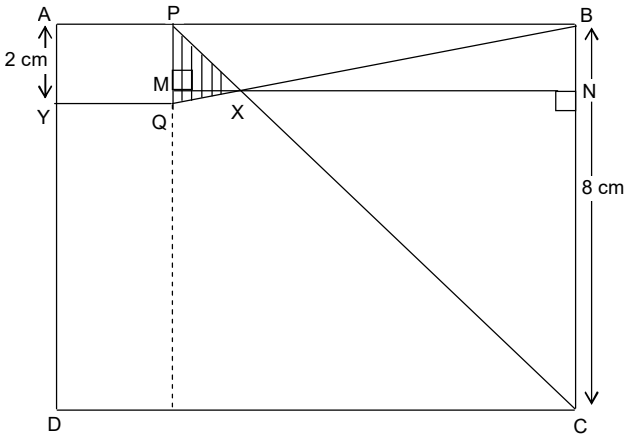
$\Rightarrow 5\times XM = 9$

$\Rightarrow XM = \dfrac{9}{5}cm$

$\text{area}\left(\Delta PXQ\right) = \dfrac{1}{2}\times PQ\times XM$

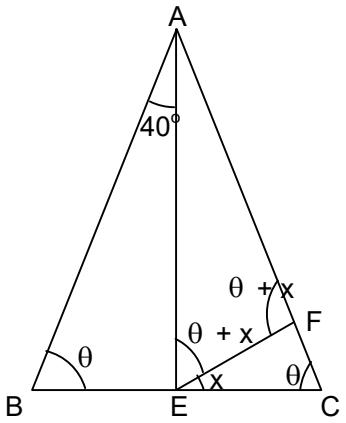
$= \dfrac{1}{2}\times 2\times \dfrac{9}{5}$

$= 1.8\ cm^2$



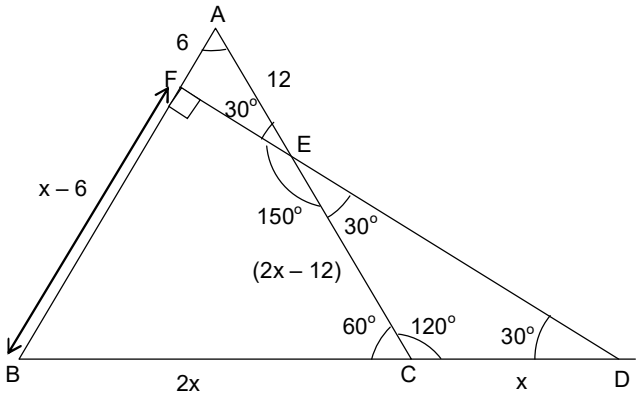
52. 2

Sol. Let $\angle ABC = \angle ACB = \theta$ and $\angle CEF = X$
then $\angle AFE = \angle AEF = \theta + X$
Now by exterior angle property
$\angle AEC = \angle ABE + \angle BAE$
$\Rightarrow \theta + 2x = 40 + \theta \Rightarrow x = 20^o$



53. 4

Sol. AF = 6 $\Rightarrow$ AE = 6 $\cos ec\,30^o = 12$
$\Rightarrow AC = 2x - 12$ and
$\angle CDE = \angle CED \Rightarrow CE = CD$
$\Rightarrow 2x - 12 = x \Rightarrow x = 12$
$BF = 2x - 6 = 18$



54. **No Option Correct**

Sol. When water level rise 15 cm then radius of top surface of water level $= \frac{20+10}{2} = 15\,cm$

Required time $= \frac{\frac{1}{3}\pi\left[15^2 + 10^2 + 15\times 10\right]\times 15}{\pi\times 5\times 5\times 10}$

= 9.5 minutes

55. 2

Sol. $S = 6$

$$\Delta = \sqrt{6\times(1)(6-a)(a-1)}$$

$$= \sqrt{6\left(6a+a-a^2-6\right)}$$

$$= \sqrt{-6a^2+42a-36}$$

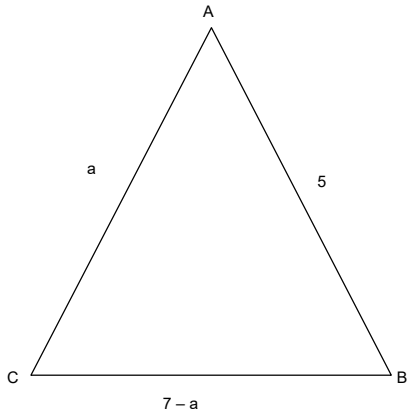
$$\Delta^2_{max} = \frac{-D}{4a}$$

$$= \frac{75}{2}$$

$$\Delta_{max} = \sqrt{\frac{75}{2}}$$

$$= 5\frac{\sqrt{3}}{\sqrt{2}}$$

$$= \frac{5}{2}\sqrt{6}$$



56. 1

Sol. $u = \cos\theta\left(\sin\theta+\sqrt{\sin^2\theta+\sin^2\alpha}\right)\ u\in R$

$$u\sec\theta = \sin\theta+\sqrt{\sin^2\theta+\sin^2\alpha}$$

$$\left(u\sec\theta-\sin\theta\right)^2 = \sin^2\theta+\sin^2\alpha$$

$$u^2\sec^2\theta-2u\tan\theta = \sin^2\alpha$$

$$u^2\tan^2\theta-2u\tan\theta+u^2-\sin^2\alpha = 0$$

$\tan\theta\in R,\ D\geq 0$

$$4u^2-4\left(u^2\right)\left(u^2-\sin^2\alpha\right)\geq 0$$

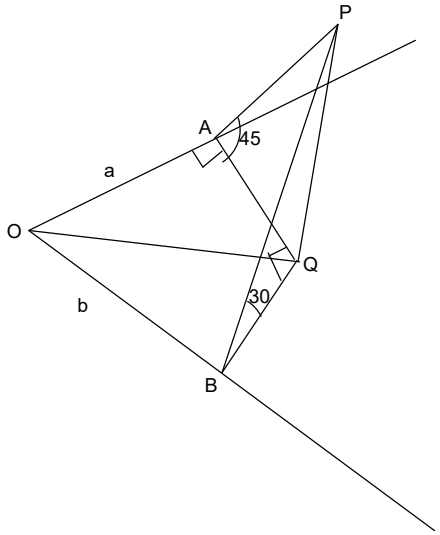
$$4u^2\left(1-u^2+\sin^2\alpha\right)\geq 0$$

$$u^2\leq 1+\sin^2\alpha$$

$$-\sqrt{1+\sin^2\alpha}\leq u\leq\sqrt{1+\sin^2\alpha}$$

57. 1

Sol. Let PQ be the tower.



$$\tan 45 = \frac{PQ}{AQ}$$

$$\Rightarrow PQ = AQ = x \text{ (say)}$$

$$\tan 30 \Rightarrow \frac{PQ}{BQ} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow BQ = \sqrt{3}\,x$$

Now, $OA^2 + AQ^2 = BQ^2 + DB^2$

$$a^2 + x^2 = 3x^2 + b^2$$

$$2x^2 = a^2 - b^2$$

$$x^2 = \frac{a^2 - b^2}{2}$$

$$PQ^2 = x^2 = \frac{a^2 - b^2}{2}$$

$$PQ = \sqrt{\frac{a^2 - b^2}{2}}$$

58. 1

Sol. $PB = \sqrt{4^2 + 8^2} = \sqrt{80} = 4\sqrt{5}\,cm$

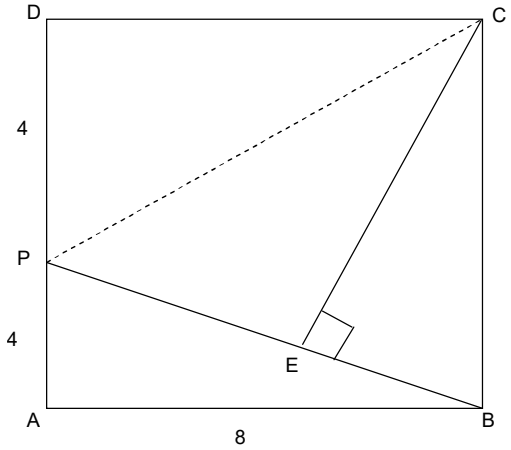
$$ar(\Delta PCB) = \frac{1}{2} ar(\square ABCD)$$

$$= \frac{1}{2} \times 64 = 32\,sq.cm$$

$$\therefore \frac{1}{2} \times PB \times CE = 32$$

$$\frac{1}{2} \times 4\sqrt{5} \times CE = 32$$

$$CE = \frac{16}{\sqrt{5}}$$



Also, $\Delta PAB \sim \Delta BEC$

$$\Rightarrow \frac{PA}{BE} = \frac{AB}{EC} = \frac{PB}{BC}$$

$$\Rightarrow \frac{4}{BE} = \frac{8 \times \sqrt{5}}{16} = \frac{4\sqrt{5}}{8}$$

$$\Rightarrow BE = \frac{8}{\sqrt{5}}$$

$$\therefore ar(\Delta BEC) = \frac{1}{2} \times CE \times BE$$

$$= \frac{1}{2} \times \frac{16}{\sqrt{5}} \times \frac{8}{\sqrt{5}}$$

$$= \frac{64}{5} cm^2$$

59. 2

Sol. Let numbers are a, b and c

a is smallest and c is largest then median = 5 $\Rightarrow b = 5$

also, $\frac{a+b+c}{3} = a+10 = c-15$

$\Rightarrow a = 0$ and $c = 25$

So, $a^2 + b^2 + c^2 = 650$

60. 4

Sol. Let radius of sphere A is a

radius of sphere B is b

then $4\pi b^2 = 4\pi a^2 + 8 \times 4\pi a^2$

$\Rightarrow \frac{a}{b} = \frac{1}{3} = \frac{k}{3k}$ (let)

$V_B - V_A = \frac{4}{3}\pi\left[(3k)^3 - (k)^3\right] = \frac{4}{3}\pi(26k)$

$$\text{Required percentage} = \frac{\frac{4}{3}\pi(26k)}{\frac{4}{3}\pi(3k)^3} \times 100$$

$$= 96.3\% \text{ (Approx)}$$