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Jackson's GRE Math Course at Udemy

Formula Sheet

This is only a Summary / Map of the course with important formulae. Please make your own detailed notes as you go from lecture to lecture. This will help you build a logical approach rather than memorizing formula / approaches

1. BASICS

-Every Prime number is of the form 6K+/- 1

-HCF of a fractions = (HCF of Numerators) / (LCM of denominators)

(change fractions to simplest form first)

-LCM of fractions = (LCM of Numerators) / (HCF of denominators)

(change fractions to simplest form first)

-Addition / Subtraction of Fractions -> Make denominator the same, can use LCM for this

-> a^1 = 0

-> a^m x a^n = a^(m+n)

-> a^m / a^n = a^(m-n)

-> a^0 = 1

-> a^-n = 1/a^n

-> (a^m)^n = a^(mn)

->a^m x b^m = (ab)^m

->a^m / b^m =(a/b)^m

-> a^(m/n) = nth root of (a^m) = (nth root of a)^m

2. Algebra Basics: Linear Equations

-> a(x+y) = ax + ay

->a(x-y) = ax – ay

->If ax + by + c=0 and dx+ey+f=0 then

No Solution → a/d = b/e != c/f (Read != as Not equal to)

Unique Solution → a/d != b/e

Infinite Solutions → a/d = b/e = c/f

-> (a+b)^2 = a^2 + 2ab + b^2

-> (a-b)^2 = a^2 -2ab + b^2

-> (a+b)^3 = a^3 + b^3 + 3ab(a+b)

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->(a-b)^3 =a^3 – b^3 – 3ab(a-b)

-> a^3 + b^3 =(a+b)(a^2 + b^2 -ab)

-> a^3 – b^3 = (a-b)(a^2 + b^2 +ab)

->(a+b)(a-b) = a^2 – b^2

3. Percentages

->Find X% of Y = (x/100) * Y

->Find what % of X is Y = Y/X *100

->Fraction to Percentage conversion

-> % Change = (Change) / Initial value * 100

-> Increase Y by X % = Y (1+X/100)

-> Decrease Y by X % = Y (1-X/100)

-> To maintain constant product, if one parameter increase by 1/x the other parameter has to decrease by 1/(x+1)

4. Averages and Alligation

-> Simple Average = Arithmetic Mean = Sum / number of values

-> Weighted Average = Sum of product of value and its weight / Sum of weights

->Mixtures and Alligation Trick (Refer video)

-> Initially say you have a Liters of liquid A in a tank. Out of this take out b liters and replace this with b liters of Liquid B. Repeat this n times. Then

→(Liquid A left after N times) / (Initial quantity of A) = (a – b) ^n / a^n

→(Liquid A) / (Liquid B) = [(a-b)^n/a^n] / [1 – (a-b)^n/a^n]

-> Median = Middle value when a set of numbers are arranged in ascending / descending order

-> Mode = Most frequently occurring number in a set of numbers

5. Speed Distance Time

-> Speed = Distance / Time

-> If D = constant S1/S2 = T2/T1

-> If T = constant S1/S2 = D1/D2

-> If S = constant D1/D2 = T1/T2

-> Average Speed = Total Distance / Total Time

-> Meeting based Questions Approach

1. T1/T2 = S1/S2 as D = constant
2. as Time is constant , D1/D2 = S1/S2
3. Then consider only 1 person so S = constant , hence D1/D2 = T1/T2

-> Relative speed when 2 bodies are moving in opposite direction = Sum of Speeds

-> Relative speed when 2 bodies are moving in same direction = Difference of Speeds

->Circular Track Race

→ Time for 1st meeting = Distance of 1 round / Relative Speed

➔ Where will meet -> Check distance travelled in above mentioned time

→Meeting at Starting point ->LCM of time taken to complete 1 round by the runners

->Escalator Problems = Use concept of Visible Steps to solve problems

6. Work

-> If a person takes 10 days to do a job , in 1 day he will complete 10% or 1/10 of the job

->In case of negative work, eg. A pipe that can empty a tank in 10hours, in 1 hour it will empty 10% of the tank or 1/10 of the take. Take this as -10% or -1/10 if the question involves positive and negative work

->If person 1 will take 'a'days more than person 1 & 2 together and Person 2 will take 'b' days more than person 1 & 2 together to do a job, then they will take Squareroot (axb) number of days to do the work together

-> Man days = Number of men * number of days ; This helps to measure work

-> Work as Volume

L1.B1.H1 / L2.B2.H2 = M1.T1.D1 / M2. T2. D2

L -Length, B – Breadth , H – Height, M – Men, T – Hours per day, D – Days

-> P is twice as efficient as H →In same time P does 2 times the work as H

→ To do the same work, P will need half the time H needs

-> P is 2 times more efficient than H →Means P is 1+ 2 = 3 times as efficient as H

-> If you have Men and Children (multiple groups) doing a job, try to find out how many men = 1 child or how many children = 1 man (in terms of work done)

Numbers

7. Numbers: Finding unit digit/power cycle

->Unit digit of the answer of a multiplication only depends on unit digit of numbers multiplied

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->Power cycle of 2 -> 2,4,8,6

-> Power cycle of 3 ->3,9,7,1

-> Power cycle of 4 ->4,6

-> Power cycle of 7 ->7,9,3,1

-> Power cycle of 8 ->8,4,2,6

-> Power cycle of 9 ->9,1

-> Power cycle of 0 ->0 ; 1->1;5->5; 6->6

8. Numbers: Divisibility rules

->2 : last digit to be 0,2,4,6,8 ie, divisible by 2

->4 : last 2 digits to be divisible by 4

->8 : last 3 digits to be divisible by 8

->3 : Sum of digits to be divisible by 3

->9 : Sum of digits to be divisible by 9

->5 : last digit to be 0 or 5

->10 : last digit to be 0

-> Any Coprime number : make it a multiple of coprimes and check

->11: Difference between numbers at even places and odd places to be 0 or a multiple of 11

->7,13: Divide into triplets and give alternatively + and -. Then add up. This to be 0 or divisible by 7 /13 respectively

->37: Divide into triplets and add up. This to be divisible by 37

9. Numbers: Basic Remainder Theorem and Fermat Theorem

-Factorise Numerator and find remainders individually of factors

-Fermat Theorem : x^(Euler Number of N) / N gives a Remainder of 1 if x and N are coprime

-Euler Number of N = Number of coprimes less than N +1

10. Numbers: How to quickly find Square of a Number

-> method for numbers upto 99

-> method for numbers above 99

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11. Find last 2 digits of x^y

->if x is odd

->if x ends in 1 →eg 31^125 ends in 51 (see video)

->if x ends in 3,7,9 → 3^4k, 7^4k and 9^2k end in 1, then apply above method

->if x ends in 5 →even power ends in 25,

→odd power + second last digit of x is even = ends in 25

→odd power + second last digit of x is odd = ends in 75

->if x is even

→(2^10) ^ odd power ends in 24

→(2^10) ^ even power ends in 76

12. Constant Remainder for Arithmetic Progression

-If you divide any term of an arithmetic progression by its common difference or a factor of the common difference then the remainder obtained is the same

13. Successive Division

-Trick explained in Video

14. Chinese Remainder Theorem

-If you have a very big number and you want to find the remainder when you divide it by another number, factorize the denominator to understand the Arithmetic progression whose part the big number is

15. Division Questions

16. Digit Sum based Questions

-Digit sum (upto single digit) = Remainder when you divide by 9

17. Factorial, Number of Zeroes etc.

->1x2x3x4x5x6……xn = n!

->To find highest power of a prime, say p, in n! , do n/p + n/p^2 + ….

-> in case of composite , write it as product of primes and find greatest power of the primes involved. Take the least number of these.

18. Sum of first n numbers

1 + 2+ 3……+ n = n(n+1) / 2

1^2 + 2^2 + 3^2 +…….n^2 =n(n+1)(2n+1)/6

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1^3 + 2^3 + 3^3 +…….n^3 =[n(n+1)/2]^2

19. Number of factors

->Say X = a^p x b^q x c^r where a,b,c are primes Then the number of factors = (p+1)(q+1)(r+1)

-> If a number has exactly 3 factors, then it is a prime square

->If a number has odd number of factors, it is a square number

20. Write a number as Sum of consecutive numbers

-> Number of ways of writing a number as the sum of consecutive natural numbers = Number of odd factors -1

->Powers of 2 can not be written as the sum of consecutive numbers

21. N =x^2 – y^2

->The number of ways you can write N as x^2 – y^2 is the number of ways you can write N as Even x Even or Odd x Odd

->Numbers of the form 4K+2 can not be written as difference of 2 squares

22. Square Root

->See Estimation Trick explained in video

Permutation and Combination

23. P&C Basics

->Use Permutation when order is important. Use Combination when order is not important

->P = Selection + Arrangement

->C=Selection only

->nPr = n! / (n-r)!

->nCr = n! / [r! * (n-r)!]

-> Number of diagonals of a polygon = nC2 – n

-> nPn = n!

24. Relationship between P&C

->nPr = nCr * r!

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25. Fundamental Principle of counting

-> for AND use multiplication

-> for OR use addition

26. Permutation in Depth

->Arrange 'n' things of which 'a' items are identical and 'b' items are identical = n! / a!*b!

->When repetition is allowed and example case 4 Rings - > 5 fingers = 5^4

->Circular Permutation n items

-> (n-1)!

->For Symmetric items from top to bottom [eg.pearls forming necklace] = (n-1)! / 2

-> Restricted Permutation (See Video)

27. Combination in Depth

->Identical things

->Ways to select r things from n identical things = 1 way

->0 or more things from n identical things = n+1 ways

->atleast 1 thing from n identical things = n ways

->Different things

->r things from n different things = nCr

->0 or more things from n different things = 2^n = nC0 +nC1+…….nCn

->atleast 1 from n different things = 2^n - 1 = nC1+nC2…….nCn

28. Grouping Trick (See videos)

29. Dearrangement n items

N! [1 – 1/1! + 1 / 2! – 1/3! ….1/N!]

Probability

30. Probability Basics

-> Probability = number of favourable events / Total number of events

31. Complement of an Event

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-> P(E') = 1 – P(E)

32. Exhaustive Events

->For exhaustive events their probabilities add up to 1

33. Mutually Exclusive Events

->2 events only 1 of which can occur

-> if A and B are mutually exclusive then P(A intersection B) = 0

34. Independent Events

->If A and B are 2 events and B is not affected by A, then they are independent

->P(A intersection B) = P(A) * P(B)

-> if A and B are not independent then

->P(A intersection B) =P(A)*P(B once A occurred)

35. Conditional Probability

->P(A/B) = P(A intersection B) / P(B)

36. R successes in N Trials

->nCr (p)^r * (q)^(n-r)

37. Odds in favour / Odds against

->odds in favour = Number of favourable events / Number of Not favourable events

->odds against = Number of Not favourable events / Number of favourable events

38. Practise probability Qs

Geometry

39. Geometry basics: Points, lines, planes, angles, polygons

-> 2 lines can intersect maximum in 1 point

-> 90 degree = right angle

-> 180 degree = straight angle

-> 360 degree = complete angle

-> For complementary angles , Sum = 90 degree

-> For Supplementary angles, Sum = 180 degrees

-> Conditions to check if 2 angles are adjacent angles

1.common vertex

2.common arm

3.non – common arms are on either side of the common arm

-Linear pair -> adjacent angles with non -common sides as opposite rays

-> Vertically opposite angles are equal

-> Case of Transversal of parallel lines

Corresponding angles are equal

Alternate Interior angles are equal

Alternate Exterior angles are equal

Interior angles on the same side of Transversal are supplementary

40. Triangles

-> Angle opposite greater side is greater

->Equilateral Triangle → all sides are equal, all angles are equal to 60 degrees

Isoceles Triangle → 2 sides are equal, angles opposite equal sides are equal

Scalene Triangle → All sides are different

-> Acute Angled Triangle -> all angles are < 90 degrees

Right angles Triangle -> 1 angle = 90 degree

Obtuse Angled Triangle -> One angle >90 degree

-> Exterior Angle = Sum of Interior opposite angles

-> Sum of angles of a Triangle = 180 degrees

-> Congruence Criterias of Triangles

SSS

SAS

ASA /AAS

RHS

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->Pythagoras Theorem

Hypotenuse^2 = Sum of squares of other 2 sides

-> Area of Triangle = ½ * base * height

-> Conditions to check whether 2 triangles are similar

AA rule

SAS rule

-> Ratio of areas of 2 similar triangles = ratio of squares of corresponding sides

-> Meeting point of altitudes = orthocenter

->Meeting point of Perpendicular bisectors = Circumcenter

->Meeting point of Angle bisectors = Incenter

->Meeting point of Medians = Centroid

Centroid divides a median in the ratio 2:1

-> Midpoint of hypotenuse is the circumcenter for a right angled triangle

-> For an equilateral triangle, Medians, altitudes, Perpendicular bisectors and Angle bisectors coincide

-> Euler Line for a Non – equilateral triangle

Centroid divides line joining orthocenter and circumcenter in 2:1 ratio

-> Heron's Formula for finding area of a Triangle

A = Squareroot [s(s-a)(s-b)(s-c)]

-> Area of Triangle = inradius * semi perimeter

-> Area of Triangle = abc / 4R where R is Circumradius, a,b,c are sides

-> Sum of 2 sides of a triangle has to be greater than third side

->Difference of 2 sides of a triangle < Third side

-> Interior Angle Bisector Theorem (check video)

-> Exterior Angle Bisector Theorem (check video)

-> Midpoint Theorem (check video)

->Proportionality Theorem (check video)

->Apollonius Theorem (check video)

41. Polygons / Quadrilaterals

-> Number of Diagonals = nC2 – n

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-> Sum of angles of a Quadrilateral = 360 degrees

-> Sum of angles of an 'n' sided polygon = (n-2) 180

-> Each internal angle of an 'n' sided regular polygon = (n-2)/n * 180

-> Sum of External Angles of a Polygon = 360 degrees

-> Each Eternal angle of an 'n' sided regular polygon = 360 / n

->External Angle + Internal Angle = 180 degrees

->Area of a general Quadrilateral = ½ Diagonal x (Sum of altitudes to the diagonal from 2 vertices on either side of the diagonal)

->For Parallelogram

1.Opposite sides are equal and parallel

2.Opposite Angles are equal

3.Diagonals bisect each other

4.Sum of adjacent angles = 180 degree

5. Take any quadrilateral and join midpoints of adjacent sides and you get a parallelogram

6. Area = base * height

->Rectangle

Perimeter = 2(l+b)

Area = lb

Diagonals are equal

Rectangle is a Parallelogram

->If Constant Area, To get Max Perimeter →keep 'l' and 'b' as far apart as possible

->If constant Perimeter, To maximise area→ keep 'l' and 'b' as close as possible or if possible make equal

->For rectangle ABCD, let P be an internal point. Then PA^2 + PC^2 =PD^2 + PB^2

->Square

Diagonals are equal

Diagonals are Perpendicular Bisectors of each other

Square is a special type of Rectangle

Square is a parallelogram

-> Trapezium

Has one pair of parallel sides

->If non parallel sides of a trapezium are of equal length its called an isosceles trapezium

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->Area of Trapezium = Height / 2 * (Sum of parallel sides)

-> Kite

1. 2 sets of consecutive sides of equal length
2. diagonals intersect at 90 degree
3. Longer diagonal bisects shorter diagonal
4. Longer diagonal is angle bisector
5. Kites are Not necessarily parallelograms

-> Rhombus

1. Is a parallelogram
2. All sides are equal
3. Rhombus is a kite , but kites are not necessarily rhombuses
4. Diagonals are Perpendicular bisectors of one another
5. area = ½ Product of Diagonals

42. Graphical Division

43. Shape in a Shape

44. Circles

-> You can draw only 1 circle through 3 given non collinear points

->Chord: connects 2 points on a circle

->Arc: portion of a circle

->sector: area enclosed by an arc and a pair or radii

->segment: area enclosed by a chord and an arc

->Circumference: 2*Pi*R

->Area: Pi *R^2

->Tangent: Touches Circle at 1 point

->Tangent and radius at point where tangent touches the circle form a 90 degree angle

->let AB be a chord. P is a point on AB. O is cetre of circle.

If OP Perpendicular to AB then AP = PB

If AP = PB then OP perpendicular to AB

-> 2 equidistant chords from the center are of equal length

-> Length of 2 tangents from an exterior point to a circle are equal

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-> Angles subtended by the same arc are equal

-> Subtended angle is half measure of the arc

->Diameter subtends a 90 degree angle on the circle

-> In a cyclic Quadrilateral , sum of opposite angles = 180 degree

->Secant Tangent Theorem (See video)

->Intersecting Secants (See video)

45. Trignometry

Sin X = Opposite side / hypotenuse

Cos X = Adjacent side / hypotenuse

Tan X = Opposite Side / Adjacent Side = Sin X / Cos X

Sin 0 =0; Sin 30 = ½; Sin 45 = 1/squareroot(2); Sin 60 = Squareroot(3) /2; Sin 90 = 1;

Cos 0 =1; Cos 30 = Squareroot(3) /2; Cos 45 = 1/squareroot(2); Cos 60 = 1/2; Cos 90 = 0;

tan 0 =0; tan 30 =1 / squareroot(3); tan 45 = 1; tan 60 = Squareroot(3); tan 90 = Not defined;

46.Coordinate Geometry

-> Distance between (x1,y1) and (x2,y2) is Squareroot[(x2-x1)^2 +(y2-y1)^2]

-> Straight line

1. ax+by=c=0
2. x/a+y/b=1 , here a =X intercept; b=Y intercept
3. y=mx+c; m =slope of the line
4. (y-y1) / (x-x1) = (y2-y1)/(x2-x1)

->Slope =(y2-y1)/(x2-x1)

-> To find point of intersection of 2 lines solve and find x,y

-> Angle between 2 lines , y=m1 x + C1 and y=m2 x + C2

Tan A = | (m1 – m2) / (1+m1m2) |

-> In case of perpendicular lines m1*m2 = -1

-> Internal Division in ratio m:n

[(mx2 + nx1) / (m+n) , (my2 + ny1) / (m+n)]

-> External Division in ratio m:n

[(mx2 - nx1) / (m-n) , (my2 - ny1) / (m-n)]

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-> Reflection about y=x →interchange x and y

-> Reflection about y=-x →interchange x and y and change signs

-> Reflection about x=0 →keep y the same, x becomes -x

-> Reflection about y=0 →keep x the same, y becomes -y

-> General case (See video)

->Distance between parallel lines

D = | (c1-c2) / Squareroot(a^2+b^2) |

-> Perpendicular distance of a point from a line

D= (ax1 + by1 + c) / squareroot(a^2 + b^2)

->Finding area of Triangle, Quadrilateral if the coordinates of vertices is known (See video)

-> Centroid → [(x1+x2+x3)/3 , (y1+y2+y3)/3]

->Circumcenter Trick (Check Video)

-> Incenter [(ax1 +bx3 +cx2)/(a+b+c), (ay1 +by3 +cy2)/(a+b+c)]

-Altitude Trick (see Videos)

47. Solids

->Cuboid

->Volume of Cuboid = Area of base * height

-> Lateral Surface area = 2lh+ 2bh

->Total Surface area = 2(lb+bh +lh)

->Length of body diagonal = Squareroot (l^2 + b^2 + h^2)

->Cube

->Volume = side ^3

->Cube is a special type of cuboid where l = b = h

->1 m ^3 = 1000L

-> 1 cm^3 = 1 mL

->Right Circular Cylinder

->Lateral Surface Area = 2 *Pi*r*h

->Total Surface Area = 2 *Pi*r*h + 2 *Pi*r^2

->Volume = Area of Base * height = Pi*r^2*h

->Hollow Cylinder

->Volume = Pi*(R^2 – r^2)*h

->Cone

->Slant height = squareroot(h^2 + r^2)

->Curved surface area = Pi*r*l

->Total Surface area = Pi*r^2 + Pi*r*l

->Volume = 1/3 * Pi * r^2 * h

->Sphere

->Total Surface area = 4*Pi*r^2

->Volume = 4/3* Pi*r^3

->Hemisphere

->Curved Surface area = 2*Pi*r^2

->Total Surface area =2*Pi*r^2 + Pi*r^2 = 3 Pi*r^2

->Volume = 2/3 * Pi* r^3

->Spherical Shell

->Volume = 4/3 Pi * (R^3 – r^3)

->Total Surface area = 4Pi (R^2 + r^2)

-> Euler's Formula: F + V = E + 2

F – faces, V – vertices, E – Edges

->Frustrum of a cone

-> Slant height =squareroot (h^2 + (R-r)^2)

->Curved Surface area = Pi*l*(R+r)

->Total Surface area = Pi*l*(R+r) + Pi*r^2 + Pi * R^2

-> Volume = Pi * h /3 * (r^2 + R^2 + Rr)

->Prism has 2 identical bases, the other faces are rectangles

->Pyramid has 1 base, other faces are triangles

Algebra

48. Algebra Equations

-> for ax^2 + bx + c = 0

Sum of roots = -b/a

Product of roots = c/a

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-> You can for a quadratic equation with roots given as

X^2 – (Sum of roots) X + (Product of roots) = 0

-> Solving Quadratic Equation by factorizing (see video)

-> General Solution roots = [-b + / - Squareroot (b^2 – 4ac)]/2a

-> If roots of ax^2 + bx + c = 0 are p and q, then

Equation with roots p+k,q+k → a(x-k)^2 + b(x-k) + c = 0

Equation with roots p-k,q-k → a(x+k)^2 + b(x+k) + c = 0

Equation with roots pk,qk → a(x/k)^2 + b(x/k) + c = 0

Equation with roots p/k,q/k → a(xk)^2 + b(xk) + c = 0

Equation with roots 1/p,1/q → cx^2 + bx + a = 0

->Graphing Quadratic Equations

In ax^2 + bx +c=0

If a > 0, the opens upwards (see video), minimum at x=-b/2a

If a< 0 , opens downwards (see video) , maximum at x=-b/2a

->If Discriminant D >0 → Roots are Real and Different

-> If Discriminant D =0 → Roots are Real and Equal

->If Discriminant D <0 → Roots are Imaginary

->Draw Rough graph to identify range where the Function is >0 or <0

-> if roots of ax^2+bx+c =0 are in the ration m:n then mnb^2 =(m+n)^2 ac

->For Ax^4 + Bx^3 + C x^2+Dx + E = 0

Sum of the roots taken one at a time = Sum of roots = -B/A

Sum of the roots taken 2 at a time = C/A

Sum of the roots taken 3 at a time = -D/A

Sum of the roots taken 4 at a time = Product of roots = E/A