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Hi,Im just beginner and I m trying to learn integrals.I m just in starting phase,but still in few tences,not details...How or why we get logarithm in gibbs free energy equation?Because of integration of this equation or due to probability and statistics laws? Thanks Maybe you could provide the equation you are referring too? deltaG=-RTlnK But I mean in general,why there is a ln.And how we get this.By integrating(for now,I don t need why we use integrating)or due to probability(Boltzmann and etc...) Thanks This term can be traced back to entropy. In its easiest form the entropy for a system is some function of ##\Omega## where ##\Omega## is the numer of states available to a system. Now if you are combining two sub systems, with possible number of states ##\Omega_1## and ##\Omega_2##, as any state of one system can be combined with any state of the other, ##\Omega=\Omega_1\Omega_2##. But we know that entropy is an extensive quantity, i.e. doubling a system should double the entropy. To achieve this, entropy has to depend on the logarithm of ##\Omega## as the logarithm of a product becomes the sum of the logarithms. This carries over to ##\Delta G=\Delta H-T\Delta S## due to the second term. Thanks,so it has nothing to do with integration...Right? In your equation is ΔG the standard change in gibbs free energy for a reaction and K the equilibrium constant for the reaction? Is that what your symbols refer to? In your equation is ΔG the standard change in gibbs free energy for a reaction and K the equilibrium constant for the reaction? Is that what your symbols refer to? Yes,so am I right?Nothing to do with integration? Thanks,so it has nothing to do with integration...Right? Depends on what you are integrating. Depends on what you are integrating. Thanks,but what do you mean with this? In the easiest case of ideal gasses ##\Delta G=\sum_i u_i \mu_i=\sum_i u_i \mu_i^0+RT \sum_i \ln (p_i/p_i^0)=\Delta G_0+RT (\ln \Pi_i p_i /p_i^0)##. Here ##\mu_i## is the chemical potential of compound i, ##u_i## the stochiometric coefficient of compound i in the reaction considered and ##p_i## its pressure (##p_i^0## the normal pressure, 1 Atm). Now this relation can be obtained by integrating e.g. ## d\mu_i=V_i dp_i ## from ##p_i^0## to ##p_i## with ##V_i=RT/p_i## being the molar volume. So you can derive this formula using steps which include integration if you want. However I would not say that integration is the "reason" for the appearance of the logarithm. Last edited: Feb 26, 2013 In the easiest case of ideal gasses ##\Delta G=\sum_i u_i \mu_i=\sum_i u_i \mu_i^0-RT \sum_i \ln (p_i/p_i^0)=\Delta G_0-RT (\ln \Pi_i p_i /p_i^0)##. Here ##\mu_i## is the chemical potential of compound i, ##u_i## the stochiometric coefficient of compound i in the reaction considered and ##p_i## its pressure (##p_i^0## the normal pressure, 1 Atm). Now this relation can be obtained by integrating e.g. ## d\mu_i=V_i dp_i ## from ##p_i^0## to ##p_i## with ##V_i=RT/p_i## being the molar volume. So you can derive this formula using steps which include integration if you want. However I would not say that integration is the "reason" for the appearance of the logarithm. OK,so what is the actual reason of this logarithm be in this equation?What inspired physicists? I always thought the log was used because it has the property: ln(x*y) = ln(x) + ln(y) There are different ways of looking at this. One is from the standpoint of statistical thermodynamics, and the other is from the standpoint of classical thermodynamics. From the standpoint of classical thermodynamics, if G0 is the free energy of formation of a substance in a standard state p0, T0, and G is the free energy of the substance at the same temperature and pressure p, then [tex]G(p,T_0)=G_0+\int_{p_0}^pVdp[/tex] This comes directly from the thermodynamic relationship dG=-SdT+VdP If the gas is an ideal gas, [tex]G(p,T_0)=G_0+RT_0\ln{\frac{p}{p_0}}[/tex] If the pressure is expressed in atmospheres, and, if the reference state is p0= 1atm, then [tex]G(p,T_0)=G_0+RT_0\ln p[/tex] If you are dealing with a mixture of ideal gases, such that G in the above equation is the partial molar free energy (aka the chemical potential), then the pressure in the above equation is the partial pressure of a species. In obtaining the equation for the equilibrium constant in terms of the molar free energies of formation of the reactants and products, you add the free energies stoichiometrically. But at equalibrium, the overall change in the free energy is zero. So this leaves you with the equation: [tex]RT_0\ln K_p=-\Delta G_0[/tex] From all this you can see that an integration step was indeed involved in obtaining the final equation for an ideal gas (at least in the classical development). Incidentally, in your equation, you left out a minus sign in front of the change in standard free energy for the reaction. OK,thanks to all for answers...:) In the early days of chemistry, chemists used the term "affinity" to describe the force responsible for chemical reactions. In the modern era, affinity is called Gibbs free energy. Gibbs free energy is a measure of the potential for reversible or maximum work that may be done by a system at constant temperature and pressure. It is a thermodynamic property that was defined in 1876 by Josiah Willard Gibbs to predict whether a process will occur spontaneously at constant temperature and pressure. Gibbs free energy G is defined as G = H - TS where H, T, and S are the enthalpy, temperature, and entropy. The SI unit for Gibbs energy is the kilojoule. Changes in the Gibbs free energy G correspond to changes in free energy for processes at constant temperature and pressure. The change in Gibbs free energy change is the maximum non-expansion work obtainable under these conditions in a closed system; ΔG is negative for spontaneous processes, positive for nonspontaneous processes, and zero for processes at equilibrium. Gibbs free energy is also known as (G), Gibbs' free energy, Gibbs energy, or Gibbs function. Sometimes the term "free enthalpy" is used to distinguish it from Helmholtz free energy. The terminology recommended by the International Union of Pure and Applied Chemistry (IUPAC) is Gibbs energy or Gibbs function. The sign of a Gibbs energy value may be used to determine whether or not a chemical reaction proceeds spontaneously. If the sign for ΔG is positive, additional energy must be input for the reaction to occur. If the sign for ΔG is negative, the reaction is thermodynamically favorable and will occur spontaneously. However, just because a reaction occurs spontaneously doesn't mean it occurs quickly. The formation of rust (iron oxide) from iron is spontaneous, yet occurs too slowly to observe. The reaction: C(s)diamond → C(s)graphite also has a negative ΔG at 25 C and 1 atmosphere, yet diamonds do not appear to spontaneously change into graphite. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. 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The LibreTexts approach is highly collaborative where an Open Access textbook environment is under constant revision by students, faculty, and outside experts to supplant conventional paper-based books. Campus BookshelvesBookshelvesLearning Objects Home is shared under a not declared license and was authored, remixed, and/or curated by LibreTexts. We have a Gibbs Free Energy function G=G(P, T, N1, N2) I am not writing the whole function because I just want a push in the right direction. Find expressions for the entropy, volume, internal energy, enthalpy and chemical potential. Homework Equations Maxwell Relations T=(dU/dS) V and Ni constant -P=(dU/dV) S and Ni constant T=(dH/dS) P and Ni constant V=(dH/dP) S and Ni constant The Attempt at a Solution I have found entropy, volume and chemical potential (partial molar gibbs free energy) functions using related equations. But I'm not sure on how to derive internal energy and enthalpy expressions. If I try to make use of above equations, for an example first equation dU=TdS so U=T.dS but also from second equation dU=-PdV so U=-PdV Can both be correct at the same time? I think they would yield different equations. If I am going absolutely wrong, do you have any idea on how to find U and H expressions. What other relations could be used? Homework Statement I have a question which asks: What does it mean that deltaG_zero = 0? Relevant Equations . At equilibrium, we know that deltaG = 0. But what about deltaG_zero, i.e. the standard Gibbs free energy? When is deltaG_zero = 0? In the solution manual it says that it means that K = 1, but by calculating an equilibrium constant you are already stating that we are at equilibrium? I.e. that deltaG = 0, and K = 1 implies deltaG_zero = 0. A bit confused by this. stevendaryl Problem Statement: I have a question which asks: What does it mean that deltaG_zero = 0? Relevant Equations: . At equilibrium, we know that deltaG = 0. But what about deltaG_zero, i.e. the standard Gibbs free energy? When is deltaG_zero = 0? In the solution manual it says that it means that K = 1, but by calculating an equilibrium constant you are already stating that we are at equilibrium? I.e. that deltaG = 0, and K = 1 implies deltaG_zero = 0. A bit confused by this. You haven't said which textbook you're using, so it's not clear what the quantity ##K## is. But also, when people use ##\Delta#, they usually mean the change in some quantity. So ##\Delta G_0 = 0## means no change in the value of ##G_0##. You're talking about change under what circumstances? At equilibrium, we know that deltaG = 0. But what about deltaG_zero, i.e. the standard Gibbs free energy? When is deltaG_zero = 0? I'm assuming that by ##\Delta G^0 ## you mean the standard Gibbs free energy of a reaction (since it is that that is related to the equilibrium constant ##K##). ##\Delta G^0 = 0## when the Gibbs free energy of the products is the same as the Gibbs free energy of the reactants. For a reaction of the kind A + B ##\rightleftharpoons## C + D ##\Delta G^0 = 0## means that the Gibbs free energy of A + B is the same as C + D, so no side of the equation is favored, and at equilibrium there will be as much A and B as C and D (hence ##K=1##). In the solution manual it says that it means that K = 1, but by calculating an equilibrium constant you are already stating that we are at equilibrium? I.e. that deltaG = 0, and K = 1 implies deltaG_zero = 0. A bit confused by this. ##K## and ##\Delta G^0## are constants for a given reaction. They give information about what will happen at equilibrium. ##\Delta G## tells you about a particular system, and can tell you if it is at equilibrium or not. Last edited: May 9, 2019 Likes stevendaryl For a reaction of the kind A + B ##\rightleftharpoons## C + D ##\Delta G^0 = 0## means that the Gibbs free energy of A + B is the same as C + D, and at equilibrium there will be as much A and B as C and D (hence ##K=1##). I don't think you really mean this. This will be the case only if you start out with equal amounts of A and B. For an ideal gas reaction, it means that the product of the partial pressures of A and B will be equal to the product of the partial pressures of C and D at equilibrium. I don't think you really mean this. This will be the case only if you start out with equal amounts of A and B. For an ideal gas reaction, it means that the product of the partial pressures of A and B will be equal to the product of the partial pressures of C and D at equilibrium. You are of course correct. I had something in mind that I tried to express simply and it came out wrong With K I mean the equilibrium constant. I got a bit confused here. what exactly does it mean that ##\Delta G^0 = 0##? Apart from it meaning that the Gibbs free energy of the products are the same as the Gibbs free energy of the reactants. Is there something more we can deduce from it? With K I mean the equilibrium constant. I got a bit confused here. what exactly does it mean that ##\Delta G^0 = 0##? Apart from it meaning that the Gibbs free energy of the products are the same as the Gibbs free energy of the reactants. Is there something more we can deduce from it? Are you asking for a physical interpretation (in terms of physical processing of the materials) for the standard change in free energy? Are you asking for a physical interpretation (in terms of physical processing of the materials) for the standard change in free energy? No, I was wondering what other "results" one could take from ##\Delta G^0 = 0## Science, Tech, Math All Science, Tech, Math Humanities All Humanities Languages All Languages Resources All Resources sorry we can't understand the question. is the force 30o towards X or Z axis. well i can tell you that write eqns in form of x(i) + y(j) + z(k) and the vector opposite the resultant of vectors given in question is the answer sorry, it's hard to understand you. Let me show you a picture of the problem, and the exact text I was given: Three forces are applied to an object, as indicated in the drawing. Force 1 has a magnitude of 33.0 Newtons (33.0 N) and is directed 30.0° to the left of the +y axis. Force 2 has a magnitude of 26.0 N and points along the +x axis. What must be the magnitude and direction (specified by the angle θ in the drawing) of the third force 3 such that the vector sum of the three forces is 0 N? [URL] /URL] I tried the problem again and got this: For ease, we will say Force 1 = A, Force 2 = B and Force 3 = C Ax = A cos (theta) Ax = 33 cos (30) = 29, but we make it negative because the drawing shows that Force 1 extends left along the x-axis, so Ax = -29 Ay = 33 sin 30 = 17 From the drawing, we can conclude that Bx = 26 and By = 0, because Force 2 only goes along the x-axis and does not move vertically. The resultant vector components of those two forces is Rx = -3 and Ry = 17. Is this right so far? Now, in order to make the magnitude zero, wouldn't the x and y components of C (force 3) simply be the same as the components of the resultant vector, but with opposite signs?) What I mean is, wouldn't Cx = 3 and Cy = -17? I think this logically makes sense, but, according to the drawing Force 3 is negative along the x- and y-axis. Also, when I used Pythagoras (sqrt(rx^2+ry^2) t find the magnitude, I apparently got the wrong answer. So, how much of this did I get wrong, and what do I do to fix it? Last edited by a moderator: Apr 25, 2017 Two tiny objects with equal charge of 85.0 µC are placed at two corners of a square with sides of 0.295 m, as shown. How far above and to the left of the corner of the square labeled A would you place a third small object with the same charge so that the electric field is zero at A? Here is a drawing: Homework Equations Coulomb's Law: F = (k * q1 * q2) / r^2 Electric Field: = k*q / r^2The Attempt at a Solution One of the force vectors (call it F1) is pure y. I decomposed the other force vector (call it F2) into it's x and y components. Vector F1 = < 0, F1 > Vector F2 = < F2*cos(a), F2*sin(a) > Last edited: Aug 24, 2007 so you know now, the net force acting due to F1 and F2 but the system is in equilibrium so find F3 so you know now, the net force acting due to F1 and F2 but the system is in equilibrium so find F3 Thanks for the response. I can find F3: F3 = F1 + F3 = < F2 cos (a) + F1, sin (a) > Now, I know can find F1 and F2 using Coulomb's law: F2 = (k * 85 uC) / r2^2 F1 = (k * 85 uC) / r1^2 And I also know that the F3 = I'm stuck here because I'm not sure what the setup should be. Thanks for the response. I can find F3: F3 = F1 + F3 = < F2 cos (a) + F1, sin (a) > Now, I know can find F1 and F2 using Coulomb's law: F2 = (k * 85 uC) / r2^2 F1 = (k * 85 uC) / r1^2 And I also know that the F3 = no, you don't know that! It's the net force that =0 F3 != and as k and 85 uC would cancel out, you can find x and y distance of F3 I know: F3 = F1 + F3 = < F2 cos (a) + F1, sin (a) > and F2 = (k * 85 uC) / r2^2 F1 = (k * 85 uC) / r1^2 so for x component: F2 * cos(a) + F1 = (k * 85 uC) / r2^2 y component: F1 * sin(a) = (k * 85 uC) / r1^2 Is this reasonable? Where do I go from here? yea, that's reasonable enough. you know r1 and r2 and you also know sin(a) and cos(a) amd so F3x=that total x-comp F3y = that total y-comp and you know it's charge so you would left with r3x and r3y yea, that's reasonable enough. you know r1 and r2 and you also know sin(a) and cos(a) amd so F3x=that total x-comp F3y = that total y-comp and you know it's charge so you would left with r3x and r3y I'm not following you entirely: r1, r2, and the angle a is unknown to me. If I am not mistaken, don't these 3 values depend on the position of where I place A? Ultimately I want to the electric field to zero wherever I place A. I'm not following you entirely: r1, r2, and the angle a is unknown to me. If I am not mistaken, don't these 3 values depend on the position of where I place A? Ultimately I want to the electric field to zero wherever I place A. "are placed at two corners of a square with sides of 0.295 m, as shown. " A is at one corner of the square. And reread the question: I think it's like E should be zero at A. So, you are calculating the force acting at point A due to other three charges so, A is fixed and you cannot move it Last edited: Aug 24, 2007 Oh you're absolutely right. So I'll just determine vector F3 by summing vector F1 and F2: I have all the ingredients. r1 = .295 r2 = .42 angle a = 45 degrees Am I doing the following correctly: Force F2 = (85E-6 C * K) / (.42 m)^2 Force F1 = (85E-6 C * K) / (.295 m)^2 so the vectors: F2 = < F2 cos(45), F2 sin(45) > F1 = < 0, F1 > Oh you're absolutely right. So I'll just determine vector F3 by summing vector F1 and F2: I have all the ingredients. r1 = .295 r2 = .42 angle a = 45 degrees Am I doing the following correctly: Force F2 = (85E-6 C * K) / (.42 m)^2 Force F1 = (85E-6 C * K) / (.295 m)^2 so the vectors: F2 = < F2 cos(45), F2 sin(45) > F1 = < 0, F1 > yep seems correct, now find f3-x and f3-y Here's what I'm doing. Using Coulomb's law: Force F2 = (85E-6^2 C * K) / (.42 m)^2 = 369 Newtons Force F1 = (85E-6^2 C * K) / (.295 m)^2 = 474 Newtons F1 = < 0, 474 > F2 = < cos(45)*F2, sin(45)*F2 > = < 261, 261 > F3 = These figures don't seem right. learningphysics You're mixing up electric field, and electrical force... For this problem, you need to use electric field... Electric field strength= kq/r^2 Electric force between to charges = kq1q2/r^2 F3 = These figures don't seem right. If you have added correctly, and all that, here's what you should do now. F3[x] = (85E-6^2 C * K) / x^2 F3[y] = (85E-6^2 C * K) / y^2 so find x and y, and it would be the answer. P.S. you have used the wrong method but nevertheless, you can use it to get the answer "Force F2 = (85E-6 C * K) / (.42 m)^2 Force F1 = (85E-6 C * K) / (.295 m)^2" why did you squared it[85E-6 C * K] in the post after this one? oops.. I just ignored what you were using, but rather was looking at the way.. It should have been E2 and E1 instead of F1 and F2 sorry, my mistake If you have added correctly, and all that, here's what you should do now. F3[x] = (85E-6^2 C * K) / x^2 F3[y] = (85E-6^2 C * K) / y^2 so find x and y, and it would be the answer. P.S. you have used the wrong method but nevertheless, you can use it to get the answer I solved those equations and here's what I got: x = +/- 5 y= +/- 3 The problem states that A is in the top left region relative to the square should I use ? learningphysics I think a lot of careless mistakes are propping up... first find the field due to those first two charges at A... not the force... Then the field due to the third charge must cancel the field due to the first two charges... ie: it's the negative of the above field... Using the magnitude of this field, you can find the distance the third charge is from A... using the direction of the field, you can find the angle from the third charge to A... then using this angle you can get the x value (distance to the left of A) and y value(distance above A). learningphysics If you have added correctly, and all that, here's what you should do now. F3[x] = (85E-6^2 C * K) / x^2 F3[y] = (85E-6^2 C * K) / y^2 so find x and y, and it would be the answer. P.S. you have used the wrong method but nevertheless, you can use it to get the answer This isn't right... the x component and y component don't work out like that... so F3 = and thus (85E-6^2 C * K) / x^2 = 261 hence x= 0.4991 and (85E-6^2 C * K) / y^2 = 753 y=0.2938 and I used other method, and got the same answer! so don't they work? I think a lot of careless mistakes are propping up... first find the field due to those first two charges at A... not the force... Then the field due to the third charge must cancel the field due to the first two charges... ie: it's the negative of the above field... Using the magnitude of this field, you can find the distance the third charge is from A... using the direction of the field, you can find the angle from the third charge to A... then using this angle you can get the x value (distance to the left of A) and y value(distance above A). The vector that cancels the first two charges I found to be The magnitude is 3.7E6. How do I this is to find the distance the third charge is from A? so F3 = and thus (85E-6^2 C * K) / x^2 = 261 hence x= 0.4991 and (85E-6^2 C * K) / y^2 = 753 y=0.2938 and I used other method, and got the same answer! so don't they work? For the answer, I do think that the x component is negative and the y component is positive since the third large is located somewhere to the left and to the top relative to A. Does that make sense? again use Ex=kq/x^2 Ey=kq/y^2 and thus solve for x and y. learningphysics If a charge q is at some point (x, y)... then the magnitude of the field at the (0,0) is: [tex]\frac{kq}{x^2+y^2}[/tex] The x-component of the field is [tex]\frac{kq}{x^2+y^2} * cos(\theta) = \frac{kq}{(x^2+y^2)}\frac{-x}{\sqrt{x^2+y^2}}=\frac{-kq * x}{(x^2+y^2)^{\frac{3}{2}}}[/tex] ie: the x-component is NOT [tex]-\frac{kq}{x^2}[/tex] Last edited: Aug 24, 2007 oops, sorry again, I would try them tomorrow morning. P.S. need a sleep.yea, I got it now! :D I think I had been thinking wrong through out my last year physics course >< P.S. somehow I got more than 100% on my static electricity unit test lol Last edited: Aug 24, 2007 learningphysics oops, sorry again, I would try them tomorrow morning. P.S. need a sleep. yea, I got it now! :D I think I had been thinking wrong through out my last year physics course >< For the answer, I do think that the x component is negative and the y component is positive since the third large is located somewhere to the left and to the top relative to A. Does that make sense? yea, though I can't think any good know, but I guess it's located "a" distance left, and less than "a" distance above A. just don't care about signs much, that makes the job a lot easier. And always try using symmetries and other geometrical tools while solving these problems P.S. don't sub in values right away, chances of getting a wrong answer become high. learningphysics The vector that cancels the first two charges I found to be The magnitude is 3.7E6. How do I this is to find the distance the third charge is from A? Oops... sorry, I didn't notice this till now. Just use kq/r^2 = 3.7E6 to calculate r. Draw a picture... Are you sure your vector is right? I'm getting this for the field due to the first two charges: For the first charge this comes from (9E9)(85E-6)/(0.295^2) For the second charge this comes from (9E9)(85E-6)/(0.295^2 + 0.295^2)cos(45) So the total I'm getting is: so with a magnitude of 12.3E6 Last edited: Aug 25, 2007 Oops... sorry, I didn't notice this till now. Just use kq/r^2 = 3.7E6 to calculate r. Draw a picture... Are you sure your vector is right? I'm getting this for the field due to the first two charges: For the first charge this comes from (9E9)(85E-6)/(0.295^2) For the second charge this comes from (9E9)(85E-6)/(0.295^2 + 0.295^2)cos(45) So the total I'm getting is: so with a magnitude of 12.3E6 This is how I proceeded. I decompose E2. The .42 (the r from the second charge to A) is just the hypotenuse of a right triangle: sqrt(.295^2 + .295^2) = .42 I am saying that the angle 135 degrees is the angle of E2 relative to the positive x-axis. E1 = (same thing you did) E2 = (9E9)(85E-6)/.42^2 * = 4.3E7 * < cos(135), sin (135) > = < -3E7, 3E7 > Enet = E1 + E2 = < -3E7, 3.9E7 > ||Enet|| = 4.7E7 So it seems our only disagreement is E2. Where am I going wrong? Last edited: Aug 25, 2007 learningphysics Check your exponent when you calculate E2... I think it should be 4.3E6. Check your exponent when you calculate E2... I think it should be 4.3E6. Whoops. Ok: E1 = E2 = (9E9)(85E-6)/.42^2 * = 4.3E6 * < cos(135), sin (135) > = < -3E6, 3E6 > Enet = E1 + E2 = < -3E6, 1.2E7 > ||Enet|| = 1.2E7 Looks good now right? Could you explain where I go from here? Last edited: Aug 25, 2007 learningphysics Whoops. Ok: E1 = E2 = (9E9)(85E-6)/.42^2 * = 4.3E6 * < cos(135), sin (135) > = < -3E6, 3E6 > Enet = E1 + E2 = < -3E7, 3.9E7 > ||Enet|| = 4.7E7 Looks good now right? Could you explain where I go from here? You should fix Enet. Yeah. Posted too hastily...Fixed learningphysics Cool. So you want the field created by the 3rd charge to cancel this one... so it has the same magnitude and opposite direction... I recommend first calculating r using: kq/r^2 = 1.2E7 The field created by the third charge is then -Enet = < 3E6, -1.2E7 > (9E9)(85E-6)/r^2 = 1.2E7 ==> r = .25 Looks good? learningphysics The field created by the third charge is then -Enet = < 3E6, -1.2E7 > (9E9)(85E-6)/r^2 = 1.2E7 ==> r = .25 Looks good? Yeah... looks good. I'm a little worried about the number of decimal places we're keeping... I think more would be better, but no big deal... Do you have an idea about where the third charge should be (the angle)? you can get the angle from the field... Yeah... looks good. I'm a little worried about the number of decimal places we're keeping... I think more would be better, but no big deal... Do you have an idea about where the third charge should be (the angle)? you can get the angle from the field... Regarding decimal places, I will go through the problem again with more accuracy no worries at this point. How about getting the angle using inverse tangent: I know < 3E6, -1.2E7 >. tan(a) = (1.27E7/ 3E6) ==> a = 76 degrees For a reaction to be feasible, the value of ΔG has to be less than 0. In mathematical terms, it is feasible if: ΔG < 0 Because ΔG = ΔH - TΔS, that means that for a feasible reaction: ΔH - TΔS < 0 If you know values for ΔH and ΔS, then you can work out a value for T which makes this expression less than 0. In the case we are looking at ΔH = +178 kJ mol-1, and ΔS = +0.1604 kJ K-1 mol-1 Putting those values into the expression ΔH - TΔS < 0 gives 178 - T x 0.1604 < 0 You can treat the "less than" sign just like an equals sign, and so rearranging this gives: 178 < T x 0.1604 178 / 0.1604 < T 1110 < T That's a strange way of looking at it, of course ("1110 is less than T."). But that is just the same as saying that T has to be greater than 1110 K. Working out the effect of temperature without doing calculations Look again at the equation: ΔG = ΔH - TΔS Remember that for a reaction to be feasible, ΔG has to be negative. ΔH could be negative (an exothermic reaction) or positive (an endothermic reaction). Similarly ΔS could be either positive or negative. There are four possible combinations of the signs of ΔH and ΔS. I want to look at those in turn. Where ΔH is negative and ΔS is positive In the equation ΔG = ΔH - TΔS: ΔH is negative. TΔS is positive, and so -TΔS is negative. Both terms are negative irrespective of the temperature, and so ΔG is also bound to be negative. The reaction will be feasible at all temperatures. Where ΔH is positive and ΔS is negative In the equation ΔG = ΔH - TΔS: ΔH is positive. TΔS is negative, and so -TΔS is positive. Both terms are positive irrespective of the temperature, and so ΔG is also bound to be positive. The reaction will not be feasible at any temperature. Where ΔH is positive and ΔS is positive In the equation ΔG = ΔH - TΔS: ΔH is positive. TΔS is positive, and so -TΔS is negative. Now increasing the temperature will change things. At higher temperatures, -TΔS will become more and more negative, and will eventually outweigh the effect of ΔH. The reaction won't be feasible at low temperatures, but if you heat it, there will be a temperature at which it becomes feasible, because ΔG becomes negative. The decomposition of calcium carbonate is a case like this, and we have done three calculations around it. Where ΔH is negative and ΔS is negative In the equation ΔG = ΔH - TΔS: ΔH is negative. TΔS is negative, and so -TΔS is positive. Again there will be a temperature effect. As temperature increases, -TΔS will become more and more positive, and will eventually outweigh the effect of ΔH. At low temperatures, ΔG will be negative because of the effect of the negative ΔH, but as you increase the temperature, the effect of the positive -TΔS will eventually outweigh that. The value of ΔG will then become positive, and the reaction will no longer be feasible. In summary I really wouldn't suggest you tried to learn this - it is too confusing. Make sure that you understand it, so that when a question comes up you can work it out at the time. You should where possible practise by finding questions from past papers from your examiners, checking them carefully against the mark schemes and examiner's reports if they are available. That way you will get a feel for what they think is important. But it isn't too difficult to make up questions for yourself which would help you through the whole topic. Choose a simple reaction where you can find entropy values for everything involved. Use a data book if you have one, or find the equivalent information online, and avoid anything which involves solutions. Use enthalpies of formation to work out the enthalpy change for the reaction. (If you use combustion reactions, for example, then you can just look up the enthalpy of combustion to save you the bother!) Then work out the entropy change during the reaction. Decide what the effect of temperature will be on the feasibility of the reaction, and then work out values of ΔG at some widely different temperatures to see if you are right. (When you are doing those calculations, don't forget to correct the entropy change value from joules to kJ!) , the free encyclopedia that anyone can edit. 117,922 active editors 6,999,488 articles in English The first UK Phantom on a test flight in 1968 From 1968 to 1992, the United Kingdom used the McDonnell Douglas F-4 Phantom II as one of its principal combat aircraft. The Phantom was procured to serve in both the Royal Navy's Fleet Air Arm and the Royal Air Force (RAF) in several different roles. Most Phantoms operated by the UK were built as a special batch containing a significant amount of British technology. Two variants were initially built: the F-4K was a carrier-based air-defence interceptor for the Fleet Air Arm, while the F-4M was initially used by the RAF for tactical strike and reconnaissance, before transitioning to an air defence role in the 1970s. In the mid-1980s, a third Phantom variant was obtained when fifteen former US Navy F-4J aircraft were purchased to augment the UK's air defences. Although the Fleet Air Arm ceased using the Phantom in 1978, the RAF retained it until 1992, when it was withdrawn as part of a series of post-Cold War defence cuts. (Full article...) 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Magoffin made pilots in his group sprint around an airfield for not saluting him? Archive Start a new article Nominate an article Nicuşor Dan Author Banu Mushtaq and translator Deepa Bhasthi win the International Booker Prize for Heart Lamp: Selected Stories. Nicuşor Dan (pictured) is elected as president of Romania. In the Portuguese legislative election, the Democratic Alliance wins the most seats in parliament. Austria, represented by JJ with the song "Wasted Love", wins the Eurovision Song Contest. A tornado outbreak leaves at least 27 people dead in the Midwestern and Southeastern United States. Ongoing: Gaza war M23 campaign Russian invasion of Ukraine timeline Sudanese civil war timeline Recent deaths: Jim Irsay Yury Grigorovich Yuri Vladimirov Colton Ford Werenoi Benjamin Ritchie Nominate an article May 27 Manchu Prince Dorgon 1644 – Manchu regent Dorgon (depicted) defeated rebel leader Li Zicheng of the Shun dynasty at the Battle of Shanhai Pass, allowing the Manchus to enter and conquer the capital city of Beijing. 1799 – War of the Second Coalition: Austrian forces defeated the French Army of the Danube, capturing the strategically important Swiss town of Winterthur. 1954 – The security clearance of American nuclear physicist J. Robert Oppenheimer, head of Project Y, was revoked. 1967 – Australians voted overwhelmingly to include Indigenous Australians in population counts for constitutional purposes and to allow the federal government to make special laws affecting them in states. 1997 – A destructive F5-rated tornado tracked through a subdivision of homes northwest of Jarrell, Texas, killing 27 people. Diego Ramírez de Arellano (d. 1624)Julia Ward Howe (b. 1819)Cilla Black (b. 1943)Gérard Jean-Juste (d. 2009) More anniversaries: May 26 May 27 May 28 Archive By email List of days of the year About Anemonoides blanda, the Balkan anemone, Grecian windflower, or winter windflower, is a species of flowering plant in the family Ranunculaceae. The species is native to southeast Europe and the Middle East. It grows up to 10 to 15 centimetres (4 to 6 inches) tall and is valued for its daisy-like flowers, which appear in early spring, a time when little else is in flower. The flowers are found in various colors and are radially symmetrical, containing seven or more sepals and petals. This purple A. blanda flower was photographed in Bamberg, Germany. Photograph credit: Reinhold Möller Recently featured: Bluespotted ribbontail ray Black Lives Matter art Germanicus Archive More featured pictures Community portal – The central hub for editors, with resources, links, tasks, and announcements. Village pump – Forum for discussions about Wikipedia itself, including policies and technical issues. Site news – Sources of news about Wikipedia and the broader Wikimedia movement. Teahouse – Ask basic questions about using or editing Wikipedia. Help desk – Ask questions about using or editing Wikipedia. Reference desk – Ask research questions about encyclopedic topics. Content portals – A unique way to navigate the encyclopedia. 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Unsourced material may be challenged and removed.Find sources: "1644" – news · newspapers · books · scholar · JSTOR (August 2016) (Learn how and when to remove this message) Calendar year Years Millennium 2nd millennium Centuries 16th century 17th century 18th century Decades 1620s 1630s 1640s 1650s 1660s Years 1641 1642 1643 1644 1645 1646 1647 vte July 1: The Battle of Colberger Heide is fought between Sweden and Denmark-Norway off of the German coast. July 2: Parliament wins control of northern England from King Charles in the Battle of Marston Moor. 1644 by topic Arts and science Architecture Art Literature Music Science Leaders State leaders Colonial governors Religious leaders Birth and death categories Births – Deaths Establishments and disestablishments categories Establishments – Disestablishments Works category Works vte 1644 in various calendarsGregorian calendar1644MDCXLIVAb urbe condita2397Armenian calendar1093ԹՎ ՌՂԳAssyrian calendar6394Balinese saka calendar1565–1566Bengali calendar1050–1051Berber calendar2594English Regnal year19 Cha. 1 – 20 Cha. 1Buddhist calendar2188Burmese calendar1006Byzantine calendar7152–7153Chinese calendar癸未年 (Water Goat)4341 or 4134 — to —甲申年 (Wood Monkey)4342 or 4135Coptic calendar1360–1361Discordian calendar2810Ethiopian calendar1636–1637Hebrew calendar5404–5405Hindu calendars - Vikram Samvat1700–1701 - Shaka Samvat1565–1566 - Kali Yuga4744–4745Holocene calendar11644Igbo calendar644–645Iranian calendar1022–1023Islamic calendar1053–1054Japanese calendarKan'ei 21 / Shōhō 1(正保元年)Javanese calendar1565–1566Julian calendarGregorian minus 10 daysKorean calendar3977Minguo calendar268 before ROC民前268年Nanakshahi calendar176Thai solar calendar2186–2187Tibetan calendar阴水羊年(female Water-Goat)1770 or 1389 or 617 — to —阳木猴年(male Wood-Monkey)1771 or 1390 or 618 1644 (MDCXLIV) was a leap year starting on Friday of the Gregorian calendar and a leap year starting on Monday of the Julian calendar, the 1644th year of the Common Era (CE) and Anno Domini (AD) designations, the 644th year of the 2nd millennium, the 44th year of the 17th century, and the 5th year of the 1640s decade. As of the start of 1644, the Gregorian calendar was 10 days ahead of the Julian calendar, which remained in localized use until 1923. Calendar year It is one of eight years (CE) to contain each Roman numeral once (1000(M)+500(D)+100(C)+(-10(X)+50(L))+(-1(I)+5(V)) = 1644). Kolumna Zygmunta erected. January 22 – The Royalist Oxford Parliament is first assembled by King Charles I of England.[1] January 26 – First English Civil War: Battle of Nantwich – The Parliamentarians defeat the Royalists, allowing them to end the 6-week siege of the Cheshire town.[2] January 30 Dutch explorer Abel Tasman departs from Batavia in the Dutch East Indies (modern-day Jakarta in Indonesia) on his second major expedition for the Dutch East India Company, to map the north coast of Australia. Tasman commands three ships, Limmen, Zeemeeuw and Braek, and returns to Batavia at the beginning of August with no

becomes the Queen. 1504: Foundation of the Sultanate of Sennar by Amara Dunqas, in what is modern Sudan 1505: Zhengde Emperor ascends the throne of Ming dynasty. 1505: Martin Luther enters St. Augustine's Monastery at Erfurt, Germany, on 17 July and begins his journey to instigating the Reformation. 1505: Sultan Trenggono builds the first Muslim kingdom in Java, called Demak, in Indonesia. Many other small kingdoms were established in other islands to fight against Portuguese. Each kingdom introduced local language as a way of communication and unity. 1506: Leonardo da Vinci completes the Mona Lisa. 1506: King Afonso I of Kongo wins the battle of Mbanza Kongo, resulting in Catholicism becoming Kongo's state religion.Battle of Cerignola: El Gran Capitan finds the corpse of Louis d'Armagnac, Duke of Nemours 1506: At least two thousand converted Jews are massacred in a Lisbon riot, Portugal. 1506: Christopher Columbus dies in Valladolid, Spain. 1506: Poland is invaded by Tatars from the Crimean Khanate. 1507: The first recorded epidemic of smallpox in the New World on the island of Hispaniola. It devastates the native Taíno population.[6] 1507: Afonso de Albuquerque conquered Hormuz and Muscat, among other bases in the Persian Gulf, taking control of the region at the entrance of the Gulf. 1508: The Christian-Islamic power struggle in Europe and West Asia spills over into the Indian Ocean as Battle of Chaul during the Portuguese-Mamluk War 1508–1512: Michelangelo paints the Sistine Chapel ceiling. 1509: The defeat of joint fleet of the Sultan of Gujarat, the Mamlûk Burji Sultanate of Egypt, and the Zamorin of Calicut with support of the Republic of Venice and the Ottoman Empire in Battle of Diu marks the beginning of Portuguese dominance of the Spice trade and the Indian Ocean. 1509: The Portuguese king sends Diogo Lopes de Sequeira to find Malacca, the eastern terminus of Asian trade. After initially receiving Sequeira, Sultan Mahmud Shah captures and/or kills several of his men and attempts an assault on the four Portuguese ships, which escape.[7] The Javanese fleet is also destroyed in Malacca. 1509: Krishnadevaraya ascends the throne of Vijayanagara Empire. Afonso de Albuquerque 1509–1510: The 'great plague' in various parts of Tudor England.[8] 1510: Afonso de Albuquerque of Portugal conquers Goa in India. 1511: Afonso de Albuquerque of Portugal conquers Malacca, the capital of the Sultanate of Malacca in present-day Malaysia. 1512: Copernicus writes Commentariolus, and proclaims the Sun the center of the Solar System. 1512: The southern part (historical core) of the Kingdom of Navarre is invaded by Castile and Aragon. 1512: Qutb Shahi dynasty, founded by Quli Qutb Mulk, rules Golconda Sultanate until 1687. 1512: The first Portuguese exploratory expedition was sent eastward from Malacca (in present-day Malaysia) to search for the 'Spice Islands' (Maluku) led by Francisco Serrão. Serrão is shipwrecked but struggles on to Hitu (northern Ambon) and wins the favour of the local rulers.[9] 1513: Machiavelli writes The Prince, a treatise about political philosophy 1513: The Portuguese mariner Jorge Álvares lands at Macau, China, during the Ming dynasty. 1513: Henry VIII defeats the French at the Battle of the Spurs. 1513: The Battle of Flodden Field in which invading Scots are defeated by Henry VIII's forces. 1513: Sultan Selim I ("The Grim") orders the massacre of Shia Muslims in Anatolia (present-day Turkey). 1513: Vasco Núñez de Balboa, in service of Spain arrives at the Pacific Ocean (which he called Mar del Sur) across the Isthmus of Panama. He was the first European to do so. 1514: The Battle of Orsha halts Muscovy's expansion into Eastern Europe. 1514: Dózsa rebellion (peasant revolt) in Hungary.Martin Luther initiated the Reformation with his Ninety-five Theses in 1517. 1514: The Battle of Chaldiran, the Ottoman Empire gains decisive victory against Safavid dynasty. 1515: Ascension of Francis I of France as King of France following the death of Louis XII. 1515: The Ottoman Empire wrests Eastern Anatolia from the Safavids after the Battle of Chaldiran. 1515: The Ottomans conquer the last beyliks of Anatolia, the Dulkadirs and the Ramadanids. 1516–1517: The Ottomans defeat the Mamluks and gain control of Egypt, Arabia, and the Levant. 1517: The Sweating sickness epidemic in Tudor England.[10] 1517: The Reformation begins when Martin Luther posts his Ninety-five Theses in Saxony. 1518: The Treaty of London was a non-aggression pact between the major European nations. The signatories were Burgundy, France, England, the Holy Roman Empire, the Netherlands, the Papal States and Spain, all of whom agreed not to attack one another and to come to the aid of any that were under attack. 1518: Mir Chakar Khan Rind leaves Baluchistan and settles in Punjab. 1518: Leo Africanus, also known as al-Hasan ibn Muhammad al-Wazzan al-Fasi, an Andalusian Berber diplomat who is best known for his book Descrittione dell'Africa (Description of Africa), is captured by Spanish pirates; he is taken to Rome and presented to Pope Leo X. 1518: The dancing plague of 1518 begins in Strasbourg, lasting for about one month. 1519: Leonardo da Vinci dies of natural causes on May 2.Europe at the time of the accession of Charles V in 1519 1519: Wang Yangming, the Chinese philosopher and governor of Jiangxi province, describes his intent to use the firepower of the fo-lang-ji, a breech-loading Portuguese culverin, in order to suppress the rebellion of Prince Zhu Chenhao. 1519: Barbary pirates led by Hayreddin Barbarossa, a Turk appointed to ruling position in Algiers by the Ottoman Empire, raid Provence and Toulon in southern France. 1519: Death of Emperor Maximilian; Charles I of Austria, Spain, and the Low Countries becomes Emperor of Holy Roman Empire as Charles V, Holy Roman Emperor (ruled until 1556). 1519–1522: Spanish expedition commanded by Magellan and Elcano are the first to Circumnavigate the Earth. 1519–1521: Hernán Cortés leads the Spanish conquest of the Aztec Empire. Ferdinand Magellan led the first expedition that circumnavigated the globe in 1519–1522. 1520–1566: The reign of Suleiman the Magnificent marks the zenith of the Ottoman Empire. 1520: The first European diplomatic mission to Ethiopia, sent by the Portuguese, arrives at Massawa 9 April, and reaches the imperial encampment of Emperor Dawit II in Shewa 9 October. 1520: Vijayanagara Empire forces under Krishnadevaraya defeat the Adil Shahi under at the Battle of Raichur 1520: Sultan Ali Mughayat Shah of Aceh begins an expansionist campaign capturing Daya on the west Sumatran coast (in present-day Indonesia), and the pepper and gold producing lands on the east coast. 1520: The Portuguese established a trading post in the village of Lamakera on the eastern side of Solor (in present-day Indonesia) as a transit harbour between Maluku and Malacca. 1521: Belgrade (in present-day Serbia) is captured by the Ottoman Empire. 1521: After building fortifications at Tuen Mun, the Portuguese attempt to invade Ming dynasty China, but are expelled by Chinese naval forces. 1521: Philippines encountered by Ferdinand Magellan. He was later killed in the Battle of Mactan in central Philippines in the same year. 1521: Jiajing Emperor ascended the throne of Ming dynasty, China. 1521: November, Ferdinand Magellan's expedition reaches Maluku (in present-day Indonesia) and after trade with Ternate returns to Europe with a load of cloves. 1521: Pati Unus leads the invasion of Malacca (in present-day Malaysia) against the Portuguese occupation. Pati Unus was killed in this battle, and was succeeded by his brother, sultan Trenggana. 1522: Rhodes falls to the Ottomans of Suleiman the Magnificent.[11]Sack of Rome of 1527 by Charles V's forces (painting by Johannes Lingelbach) 1522: The Portuguese ally themselves with the rulers of Ternate (in present-day Indonesia) and begin construction of a fort.[9] 1522: August, Luso-Sundanese Treaty signed between Portugal and Sunda Kingdom granted Portuguese permit to build fortress in Sunda Kelapa. 1523: Sweden gains independence from the Kalmar Union. 1523: The Cacao bean is introduced to Spain by Hernán Cortés 1524–1525: German Peasants' War in the Holy Roman Empire. 1524: Giovanni da Verrazzano is the first European to explore the Atlantic coast of North America between South Carolina and Newfoundland. 1524: Ismail I, the founder of Safavid dynasty, dies and Tahmasp I becomes king.Gun-wielding Ottoman Janissaries and defending Knights of Saint John at the siege of Rhodes in 1522, from an Ottoman manuscript 1525: Timurid Empire forces under Babur defeat the Lodi dynasty at the First Battle of Panipat, end of the Delhi Sultanate. 1525: German and Spanish forces defeat France at the Battle of Pavia, Francis I of France is captured. 1526: The Ottomans defeat the Kingdom of Hungary at the Battle of Mohács. 1526: Mughal Empire, founded by Babur. 1527: Sack of Rome with Pope Clement VII escaping and the Swiss Guards defending the Vatican being killed. The sack of the city of Rome considered the end of the Italian Renaissance. 1527: Protestant Reformation begins in Sweden. 1527: The last ruler of Majapahit falls from power. This state (located in present-day Indonesia) was finally extinguished at the hands of the Demak. A large number of courtiers, artisans, priests, and members of the royalty moved east to the island of Bali; however, the power and the seat of government transferred to Demak under the leadership of Pangeran, later Sultan Fatah. 1527: June 22, The Javanese Prince Fatahillah of the Cirebon Sultanate successfully defeated the Portuguese armed forces at the site of the Sunda Kelapa Harbor. The city was then renamed Jayakarta, meaning "a glorious victory." This eventful day came to be acknowledged as Jakarta's Founding Anniversary. 1527: Mughal Empire forces defeat the Rajput led by Rana Sanga of Mewar at the Battle of Khanwa 1529: The Austrians defeat the Ottoman Empire at the siege of Vienna. 1529: Treaty of Zaragoza defined the antimeridian of Tordesillas attributing the Moluccas to Portugal and Philippines to Spain. 1529: Imam Ahmad Gurey defeats the Ethiopian Emperor Dawit II in the Battle of Shimbra Kure, the opening clash of the Ethiopian–Adal War. Spanish conquistadors with their Tlaxcallan allies fighting against the Otomies of Metztitlan in present-day Mexico, a 16th-century codex 1531–1532: The Church of England breaks away from the Catholic Church and recognizes King Henry VIII as the head of the Church. 1531: The Inca Civil War is fought between the two brothers, Atahualpa and Huáscar. 1532: Francisco Pizarro leads the Spanish conquest of the Inca Empire. 1532: Foundation of São Vicente, the first permanent Portuguese settlement in the Americas. 1533: Anne Boleyn becomes Queen of England. 1533: Elizabeth Tudor is born. 1534: Jacques Cartier claims Canada for France. 1534: The Ottomans capture Baghdad from the Safavids. 1534: Affair of the Placards, where King Francis I becomes more active in repression of French Protestants. 1535: The Münster Rebellion, an attempt of radical, millennialist, Anabaptists to establish a theocracy, ends in bloodshed. 1535: The Portuguese in Ternate depose Sultan Tabariji (or Tabarija) and send him to Portuguese Goa where he converts to Christianity and bequeaths his Portuguese godfather Jordao de Freitas the island of Ambon.[12] Hairun becomes the next sultan. 1536: Catherine of Aragon dies in Kimbolton Castle, in England.Territorial expansion of the Ottoman Empire under Suleiman (in red and orange) 1536: In England, Anne Boleyn is beheaded for adultery and treason. 1536: Establishment of the Inquisition in Portugal. 1536: Foundation of Buenos Aires (in present-day Argentina) by Pedro de Mendoza. 1537: The Portuguese establish Recife in Pernambuco, north-east of Brazil. 1537: William Tyndale's partial translation of the Bible into English is published, which would eventually be incorporated into the King James Bible. 1538: Gonzalo Jiménez de Quesada founds Bogotá. 1538: Spanish–Venetian fleet is defeated by the Ottoman Turks at the Battle of Preveza. 1539: Hernando de Soto explores inland North America. Nicolaus Copernicus 1540: The Society of Jesus, or the Jesuits, is founded by Ignatius of Loyola and six companions with the approval of Pope Paul III. 1540: Sher Shah Suri founds the Suri dynasty in South Asia, an ethnic Pashtun (Pathan) of the house of Sur, who supplanted the Mughal dynasty as rulers of North India during the reign of the relatively ineffectual second Mughal emperor Humayun. Sher Shah Suri decisively defeats Humayun in the Battle of Bilgram (May 17, 1540). 1541: Pedro de Valdivia founds Santiago in Chile. 1541: An Algerian military campaign by Charles V of Spain (Habsburg) is unsuccessful. 1541: Amazon River is encountered and explored by Francisco de Orellana. 1541: Capture of Buda and the absorption of the major part of Hungary by the Ottoman Empire. 1541: Sahib I Giray of Crimea invades Russia. 1542: The Italian War of 1542–1546 War resumes between Francis I of France and Emperor Charles V. This time Henry VIII is allied with the Emperor, while James V of Scotland and Sultan Suleiman I are allied with the French. 1542: Akbar The Great is born in the Rajput Umarkot Fort 1542: Spanish explorer Ruy López de Villalobos named the island of Samar and Leyte Las Islas Filipinas honoring Philip II of Spain and became the official name of the archipelago. 1543: Ethiopian/Portuguese troops defeat the Adal army led by Imam Ahmad Gurey at the Battle of Wayna Daga; Imam Ahmad Gurey is killed at this battle. 1543: Copernicus publishes his theory that the Earth and the other planets revolve around the Sun 1543: The Nanban trade period begins after Portuguese traders make contact with Japan. 1544: The French defeat an Imperial–Spanish army at the Battle of Ceresole.Scenes of everyday life in Ming China, by Qiu Ying 1544: Battle of the Shirts in Scotland. The Frasers and Macdonalds of Clan Ranald fight over a disputed chiefship; reportedly, 5 Frasers and 8 Macdonalds survive. 1545: Songhai forces sack the Malian capital of Niani 1545: The Council of Trent meets for the first time in Trent (in northern Italy). 1546: Michelangelo Buonarroti is made chief architect of St. Peter's Basilica. 1546: Francis Xavier works among the peoples of Ambon, Ternate and Morotai (Moro) laying the foundations for a permanent mission. (to 1547) 1547: Henry VIII dies in the Palace of Whitehall on 28 January at the age of 55. 1547: Francis I dies in the Château de Rambouillet on 31 March at the age of 52. 1547: Edward VI becomes King of England and Ireland on 28 January and is crowned on 20 February at the age of 9. 1547: Emperor Charles V decisively dismantles the Schmalkaldic League at the Battle of Mühlberg. 1547: Grand Prince Ivan the Terrible is crowned tsar of (All) Russia, thenceforth becoming the first Russian tsar. 1548: Battle of Uedahara: Firearms are used for the first time on the battlefield in Japan, and Takeda Shingen is defeated by Murakami Yoshikiyo. 1548: Askia Daoud, who reigned from 1548 to 1583, establishes public libraries in Timbuktu (in present-day Mali). 1548: The Ming dynasty government of China issues a decree banning all foreign trade and closes down all seaports along the coast; these Hai jin laws came during the Wokou wars with Japanese pirates. 1549: Tomé de Sousa establishes Salvador in Bahia, north-east of Brazil. 1549: Arya Penangsang with the support of his teacher, Sunan Kudus, avenges the death of Raden Kikin by sending an envoy named Rangkud to kill Sunan Prawoto by Keris Kyai Satan Kober (in present-day Indonesia). The Islamic gunpowder empires: Mughal Army artillerymen during the reign of Jalaluddin Akbar 1550: The architect Mimar Sinan builds the Süleymaniye Mosque in Istanbul. 1550: Mongols led by Altan Khan invade China and besiege Beijing. 1550–1551: Valladolid debate concerning the human rights of the Indigenous people of the Americas. 1551: Fifth outbreak of sweating sickness in England. John Caius of Shrewsbury writes the first full contemporary account of the symptoms of the disease. 1551: North African pirates enslave the entire population of the Maltese island Gozo, between 5,000 and 6,000, sending them to Libya. 1552: Russia conquers the Khanate of Kazan in central Asia. 1552: Jesuit China Mission, Francis Xavier dies. 1553: Mary Tudor becomes the first queen regnant of England and restores the Church of England under Papal authority. 1553: The Portuguese found a settlement at Macau. 1554: Missionaries José de Anchieta and Manuel da Nóbrega establishes São Paulo, southeast Brazil. 1554: Princess Elizabeth is imprisoned in the Tower of London upon the orders of Mary I for suspicion of being involved in the Wyatt rebellion. 1555: The Muscovy Company is the first major English joint stock trading company. 1556: Publication in Venice of Delle Navigationi et Viaggi (terzo volume) by Giovanni Battista Ramusio, secretary of Council of Ten, with plan La Terra de Hochelaga, an illustration of the Hochelaga.[13] 1556: The Shaanxi earthquake in China is history's deadliest known earthquake during the Ming dynasty. 1556: Georgius Agricola, the "Father of Mineralogy", publishes his De re metallica. 1556: Akbar defeats Hemu at the Second battle of Panipat. 1556: Russia conquers the Astrakhan Khanate. 1556–1605: During his reign, Akbar expands the Mughal Empire in a series of conquests (in the Indian subcontinent).Political map of the world in 1556 1556: Mir Chakar Khan Rind captures Delhi with Humayun. 1556: Pomponio Algerio, radical theologian, is executed by boiling in oil as part of the Roman Inquisition. 1557: Habsburg Spain declares bankruptcy. Philip II of Spain had to declare four state bankruptcies in 1557, 1560, 1575 and 1596. 1557: The Portuguese settle in Macau (on the western side of the Pearl River Delta across from present-day Hong Kong). 1557: The Ottomans capture Massawa, all but isolating Ethiopia from the rest of the world. 1558: Elizabeth Tudor becomes Queen Elizabeth I at age 25. 1558–1603: The Elizabethan era is considered the height of the English Renaissance. 1558–1583: Livonian War between Poland, Grand Principality of Lithuania, Sweden, Denmark and Russia. 1558: After 200 years, the Kingdom of England loses Calais to France. 1559: With the Peace of Cateau Cambrésis, the Italian Wars conclude. 1559: Sultan Hairun of Ternate (in present-day Indonesia) protests the Portuguese's Christianisation activities in his lands. Hostilities between Ternate and the Portuguese. The Mughal Emperor Akbar shoots the Rajput warrior Jaimal during the Siege of Chittorgarh in 1567 1560: Ottoman navy defeats the Spanish fleet at the Battle of Djerba. 1560: Elizabeth Bathory is born in Nyirbator, Hungary. 1560: By winning the Battle of Okehazama, Oda Nobunaga becomes one of the pre-eminent warlords of Japan. 1560: Jeanne d'Albret declares Calvinism the official religion of Navarre. 1560: Lazarus Church, Macau 1561: Sir Francis Bacon is born in London. 1561: The fourth battle of Kawanakajima between the Uesugi and Takeda at Hachimanbara takes place. 1561: Guido de Bres draws up the Belgic Confession of Protestant faith. 1562: Mughal emperor Akbar reconciles the Muslim and Hindu factions by marrying into the powerful Rajput Hindu caste. 1562–1598: French Wars of Religion between Catholics and Huguenots. 1562: Massacre of Wassy and Battle of Dreux in the French Wars of Religion. 1562: Portuguese Dominican priests build a palm-trunk fortress which Javanese Muslims burned down the following year. The fort was rebuilt from more durable materials and the Dominicans commenced the Christianisation of the local population.[12] 1563: Plague outbreak claimed 80,000 people in Elizabethan England. In London alone, over 20,000 people died of the disease. 1564: Galileo Galilei born on February 15 1564: William Shakespeare baptized 26 April 1565: Deccan sultanates defeat the Vijayanagara Empire at the Battle of Talikota. 1565: Mir Chakar Khan Rind dies at aged 97. 1565: Estácio de Sá establishes Rio de Janeiro in Brazil. 1565: The Hospitallers, a Crusading Order, defeat the Ottoman Empire at the siege of Malta (1565). 1565: Miguel López de Legazpi establishes in Cebu the first Spanish settlement in the Philippines starting a period of Spanish colonization that would last over three hundred years. 1565: Spanish navigator Andres de Urdaneta discovers the maritime route from Asia to the Americas across the Pacific Ocean, also known as the tornaviaje. 1565: Royal Exchange is founded by Thomas Gresham. 1566: Suleiman the Magnificent, ruler of the Ottoman Empire, dies on September 7, during the battle of Szigetvar.Siege of Valenciennes during the Dutch War of Independence in 1567 1566–1648: Eighty Years' War between Spain and the Netherlands. 1566: Da le Balle Contrade d'Oriente, composed by Cipriano de Rore. 1567: After 45 years' reign, Jiajing Emperor died in the Forbidden City, Longqing Emperor ascended the throne of Ming dynasty. 1567: Mary, Queen of Scots, is imprisoned by Elizabeth I. 1568: The Transylvanian Diet, under the patronage of the prince John Sigismund Zápolya, the former king of Hungary, inspired by the teachings of Ferenc Dávid, the founder of the Unitarian Church of Transylvania, promulgates the Edict of Torda, the first law of freedom of religion and of conscience in the World. 1568–1571: Morisco Revolt in Spain. 1568–1600: The Azuchi-Momoyama period in Japan. 1568: Hadiwijaya sent his adopted son and son in-law Sutawijaya, who would later become the first ruler of the Mataram dynasty of Indonesia, to kill Arya Penangsang. 1569: Rising of the North in England. 1569: Mercator 1569 world map published by Gerardus Mercator. 1569: The Polish–Lithuanian Commonwealth is created with the Union of Lublin which lasts until 1795. 1569: Peace treaty signed by Sultan Hairun of Ternate and Governor Lopez De Mesquita of Portugal. The Battle of Lepanto 1570: Ivan the Terrible, tsar of Russia, orders the massacre of inhabitants of Novgorod. 1570: Pope Pius V issues Regnans in Excelsis, a papal bull excommunicating all who obeyed Elizabeth I and calling on all Catholics to rebel against her. 1570: Sultan Hairun of Ternate (in present-day Indonesia) is killed by the Portuguese.[12] Babullah becomes the next Sultan. 1570: 20,000 inhabitants of Nicosia in Cyprus were massacred and every church, public building, and palace was looted. Cyprus fell to the Ottoman Turks the following year. 1571: Pope Pius V completes the Holy League as a united front against the Ottoman Turks, responding to the fall of Cyprus to the Ottomans. 1571: The Spanish-led Holy League navy destroys the Ottoman Empire navy at the Battle of Lepanto. 1571: Crimean Tatars attack and sack Moscow, burning everything but the Kremlin. 1571: American Indians kill Spanish missionaries in what would later be Jamestown, Virginia. 1571: Spanish conquistador Miguel López de Legazpi establishes Manila, Philippines as the capital of the Spanish East Indies. 1572: Brielle is taken from Habsburg Spain by Protestant Watergeuzen in the Capture of Brielle, in the Eighty Years' War. 1572: Spanish conquistadores apprehend the last Inca leader Tupak Amaru at Vilcabamba, Peru, and execute him in Cuzco. 1572: Jeanne d'Albret dies aged 43 and is succeeded by Henry of Navarre. 1572: Catherine de' Medici instigates the St. Bartholomew's Day massacre which takes the lives of Protestant leader Gaspard de Coligny and thousands of Huguenots. The violence spreads from Paris to other cities and the countryside. 1572: First edition of the epic The Lusiads of Luís Vaz de Camões, three years after the author returned from the East.[14] 1572: The 9 years old Taizi, Zhu Yijun ascended the throne of Ming dynasty, known as Wanli Emperor. 1573: After heavy losses on both sides the siege of Haarlem ends in a Spanish victory.St. Bartholomew's Day massacre of French Protestants 1574: in the Eighty Years' War the capital of Zeeland, Middelburg declares for the Protestants. 1574: After a siege of 4 months the siege of Leiden ends in a comprehensive Dutch rebel victory. 1575: Oda Nobunaga finally captures Nagashima fortress. 1575: Following a five-year war, the Ternateans under Sultan Babullah defeated the Portuguese. 1576: Tahmasp I, Safavid shah, dies. 1576: The Battle of Haldighati is fought between the ruler of Mewar, Maharana Pratap and the Mughal Empire's forces under Emperor Akbar led by Raja Man Singh. 1576: Sack of Antwerp by badly paid Spanish soldiers. 1577–1580: Francis Drake circles the world. 1577: Ki Ageng Pemanahan built his palace in Pasargede or Kotagede. 1578: King Sebastian of Portugal is killed at the Battle of Alcazarquivir. 1578: The Portuguese establish a fort on Tidore but the main centre for Portuguese activities in Maluku becomes Ambon.[12] 1578: Sonam Gyatso is conferred the title of Dalai Lama by Tumed Mongol ruler, Altan Khan. Recognised as the reincarnation of two previous Lamas, Sonam Gyatso becomes the third Dalai Lama in the lineage.[15] 1578: Governor-General Francisco de Sande officially declared war against Brunei in 1578, starting the Castilian War of 1578. 1579: The Union of Utrecht unifies the northern Netherlands, a foundation for the later Dutch Republic. 1579: The Union of Arras unifies the southern Netherlands, a foundation for the later states of the Spanish Netherlands, the Austrian Netherlands and Belgium.The Irish Gaelic chieftain's feast, from The Image of Ireland 1579: The British navigator Sir Francis Drake passes through Maluku and transit in Ternate on his circumnavigation of the world. The Portuguese establish a fort on Tidore but the main centre for Portuguese activities in Maluku becomes Ambon.[16] The fall of Spanish Armada 1580: Drake's royal reception after his attacks on Spanish possessions influences Philip II of Spain to build up the Spanish Armada. English ships in Spanish harbours are impounded. 1580: Spain unifies with Portugal under Philip II. The struggle for the throne of Portugal ends the Portuguese Empire. The Spanish and Portuguese crowns are united for 60 years, i.e. until 1640. 1580–1587: Nagasaki comes under control of the Jesuits. 1581: Dutch Act of Abjuration, declaring abjuring allegiance to Philip II of Spain. 1581: Bayinnaung dies at the age of 65. 1582: Oda Nobunaga commits seppuku during the Honnō-ji Incident coup by his general, Akechi Mitsuhide. 1582: Pope Gregory XIII issues the Gregorian calendar. The last day of the Julian calendar was Thursday, 4 October 1582 and this was followed by the first day of the Gregorian calendar, Friday, 15 October 1582 1582: Yermak Timofeyevich conquers the Siberia Khanate on behalf of the Stroganovs. 1583: Denmark builds the world's first theme park, Bakken. 1583: Death of Sultan Babullah of Ternate. 1584–1585: After the siege of Antwerp, many of its merchants flee to Amsterdam. According to Luc-Normand Tellier, "At its peak, between 1510 and 1557, Antwerp concentrated about 40% of the world trade...It is estimated that the port of Antwerp was earning the Spanish crown seven times more revenues than the Americas."[17] 1584: Ki Ageng Pemanahan died. Sultan Pajang raised Sutawijaya, son of Ki Ageng Pemanahan as the new ruler in Mataram, titled "Loring Ngabehi Market" (because of his home in the north of the market). 1585: Akbar annexes Kashmir and adds it to the Kabul SubahPortuguese fusta in India from a book by Jan Huygen van Linschoten 1585: Colony at Roanoke founded in North America. 1585–1604: The Anglo-Spanish War is fought on both sides of the Atlantic. 1587: Mary, Queen of Scots is executed by Elizabeth I. 1587: The reign of Abbas I marks the zenith of the Safavid dynasty. 1587: Troops that would invade Pajang Mataram Sultanate storm ravaged the eruption of Mount Merapi. Sutawijaya and his men survived. 1588: Mataram into the kingdom with Sutawijaya as Sultan, titled "Senapati Ingalaga Sayidin Panatagama" means the warlord and cleric Manager Religious Life. 1588: England repulses the Spanish Armada. 1589: Spain repulses the English Armada. 1589: Catherine de' Medici dies at aged 69. Abu'l-Fazl ibn Mubarak presenting Akbarnama to Mughal Azam Akbar, Mughal miniature 1590: Siege of Odawara: the Go-Hojo clan surrender to Toyotomi Hideyoshi, and Japan is unified. 1591: Gazi Giray leads a huge Tatar expedition against Moscow. 1591: In Mali, Moroccan forces of the Sultan Ahmad al-Mansur led by Judar Pasha defeat the Songhai Empire at the Battle of Tondibi. 1592–1593: John Stow reports 10,675 plague deaths in London, a city of approximately 200,000 people. 1592–1598: Korea, with the help of Ming dynasty China, repels two Japanese invasions. 1593–1606: The Long War between the Habsburg monarchy and the Ottoman Turks. 1594: St. Paul's College, Macau, founded by Alessandro Valignano. 1595: First Dutch expedition to Indonesia sets sail for the East Indies with two hundred and forty-nine men and sixty-four cannons led by Cornelis de Houtman.[18] 1596: Birth of René Descartes. 1596: June, de Houtman's expedition reaches Banten the main pepper port of West Java where they clash with both the Portuguese and Indonesians. It then sails east along the north coast of Java losing twelve crew to a Javanese attack at Sidayu and killing a local ruler in Madura.[18] 1597: Romeo and Juliet is published. 1597: Cornelis de Houtman's expedition returns to the Netherlands with enough spices to make a considerable profit.[18] 1598: The Edict of Nantes ends the French Wars of Religion. 1598: Abbas I moves Safavids capital from Qazvin to Isfahan in 1598. 1598–1613: Russia descends into anarchy during the Time of Troubles. 1598: The Portuguese require an armada of 90 ships to put down a Solorese uprising.[12] (to 1599) 1598: More Dutch fleets leave for Indonesia and most are profitable.[18]Edo period screen depicting the Battle of Sekigahara 1598: The province of Santa Fe de Nuevo México is established in Northern New Spain. The region would later become a territory of Mexico, the New Mexico Territory in the United States, and the US State of New Mexico. 1598: Death of Toyotomi Hideyoshi, known as the unifier of Japan. 1599: The Mali Empire is defeated at the Battle of Jenné. 1599: The van Neck expedition returns to Europe. The expedition makes a 400 per cent profit.[18] (to 1600) 1599: March, Leaving Europe the previous year, a fleet of eight ships under Jacob van Neck was the first Dutch fleet to reach the 'Spice Islands' of Maluku.[18] 1600: Giordano Bruno is burned at the stake for heresy in Rome.Siege of Filakovo castle during the Long Turkish War 1600: Battle of Sekigahara in Japan. End of the Warring States period and beginning of the Edo period. 1600: The Portuguese win a major naval battle in the bay of Ambon.[19] Later in the year, the Dutch join forces with the local Hituese in an anti-Portuguese alliance, in return for which the Dutch would have the sole right to purchase spices from Hitu.[19] 1600: Elizabeth I grants a charter to the British East India Company beginning the English advance in Asia. 1600: Michael the Brave unifies the three principalities: Wallachia, Moldavia and Transylvania after the Battle of Şelimbăr from 1599. For later events, see Timeline of the 17th century. Polybius' The Histories translated into Italian, English, German and French.[20] Mississippian culture disappears. Medallion rug, variant Star Ushak style, Anatolia (modern Turkey), is made. It is now kept at the Saint Louis Art Museum. Hernan Cortes (1485–1547) Henry VIII, (1491–1547) King of England and Ireland Don Fernando Álvarez de Toledo (1507–1582) Suleiman the Magnificent, Sultan of the Ottoman Empire (1520–1566) Ivan IV the Terrible (1530–1584) Oda Nobunaga (1534–1582) Sir Francis Drake (c. 1540 – 1596) Alberico Gentili, (1552–1608) the Father of international law Philip II of Spain, King of Spain (1556–1598) Akbar the Great, Mughal emperor (1556–1605) Related article: List of 16th century inventions. The Columbian Exchange introduces many plants, animals and diseases to the Old and New Worlds. Introduction of the spinning wheel revolutionizes textile production in Europe. The letter J is introduced into the English alphabet. 1500: First portable watch is created by Peter Henlein of Germany.The Iberian Union in 1598, under Philip II, King of Spain and Portugal 1513: Juan Ponce de León sights Florida and Vasco Núñez de Balboa sights the eastern edge of the Pacific Ocean. 1519–1522: Ferdinand Magellan and Juan Sebastián Elcano lead the first circumnavigation of the world. 1519–1540: In America, Hernando de Soto expeditions map the Gulf of Mexico coastline and bays. 1525: Modern square root symbol (√) 1540: Francisco Vásquez de Coronado sights the Grand Canyon. 1541–42: Francisco de Orellana sails the length of the Amazon River. 1542–43: Firearms are introduced into Japan by the Portuguese. 1543: Copernicus publishes his theory that the Earth and the other planets revolve around the Sun 1545: Theory of complex numbers is first developed by Gerolamo Cardano of Italy. 1558: Camera obscura is first used in Europe by Giambattista della Porta of Italy. 1559–1562: Spanish settlements in Alabama/Florida and Georgia confirm dangers of hurricanes and local native warring tribes. 1565: Spanish settlers outside New Spain (Mexico) colonize Florida's coastline at St. Augustine. 1565: Invention of the graphite pencil (in a wooden holder) by Conrad Gesner. Modernized in 1812. 1568: Gerardus Mercator creates the first Mercator projection map. 1572: Supernova SN 1572 is observed by Tycho Brahe in the Milky Way. 1582: Gregorian calendar is introduced in Europe by Pope Gregory XIII and adopted by Catholic countries. c. 1583: Galileo Galilei of Pisa, Italy identifies the constant swing of a pendulum, leading to development of reliable timekeepers. 1585: earliest known reference to the 'sailing carriage' in China. 1589: William Lee invents the stocking frame. 1591: First flush toilet is introduced by Sir John Harrington of England, the design published under the title 'The Metamorphosis of Ajax'. 1593: Galileo Galilei invents a thermometer. 1596: William Barents discovers Spitsbergen. 1597: Opera in Florence by Jacopo Peri. Entertainment in the 16th century ^ a b Modern reference works on the period tend to follow the introduction of the Gregorian calendar for the sake of clarity; thus NASA's lunar eclipse catalogue states "The Gregorian calendar is used for all dates from 1582 Oct 15 onwards. Before that date, the Julian calendar is used." For dates after 15 October 1582, care must be taken to avoid confusion of the two styles. ^ de Vries, Jan (14 September 2009). "The limits of globalization in the early modern world". The Economic History Review. 63 (3): 710–733. CiteSeerX 10.1.1.186.2862. doi:10.1111/j.1468-0289.2009.00497.x. JSTOR 40929823. S2CID 219969360. SSRN 1635517. ^ Singh, Sarina; Lindsay Brown; Paul Clammer; Rodney Cocks; John Mock (2008). Pakistan & the Karakoram Highway. Vol. 7, illustrated. Lonely Planet. p. 137. ISBN 978-1-74104-542-0. Retrieved 23 August 2010. ^ Babur (2006). Babur Nama. Penguin Books. p. vii. 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