a place of mind

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Physics
Modern Physics Problems

Science and Mathematics Education Research Group

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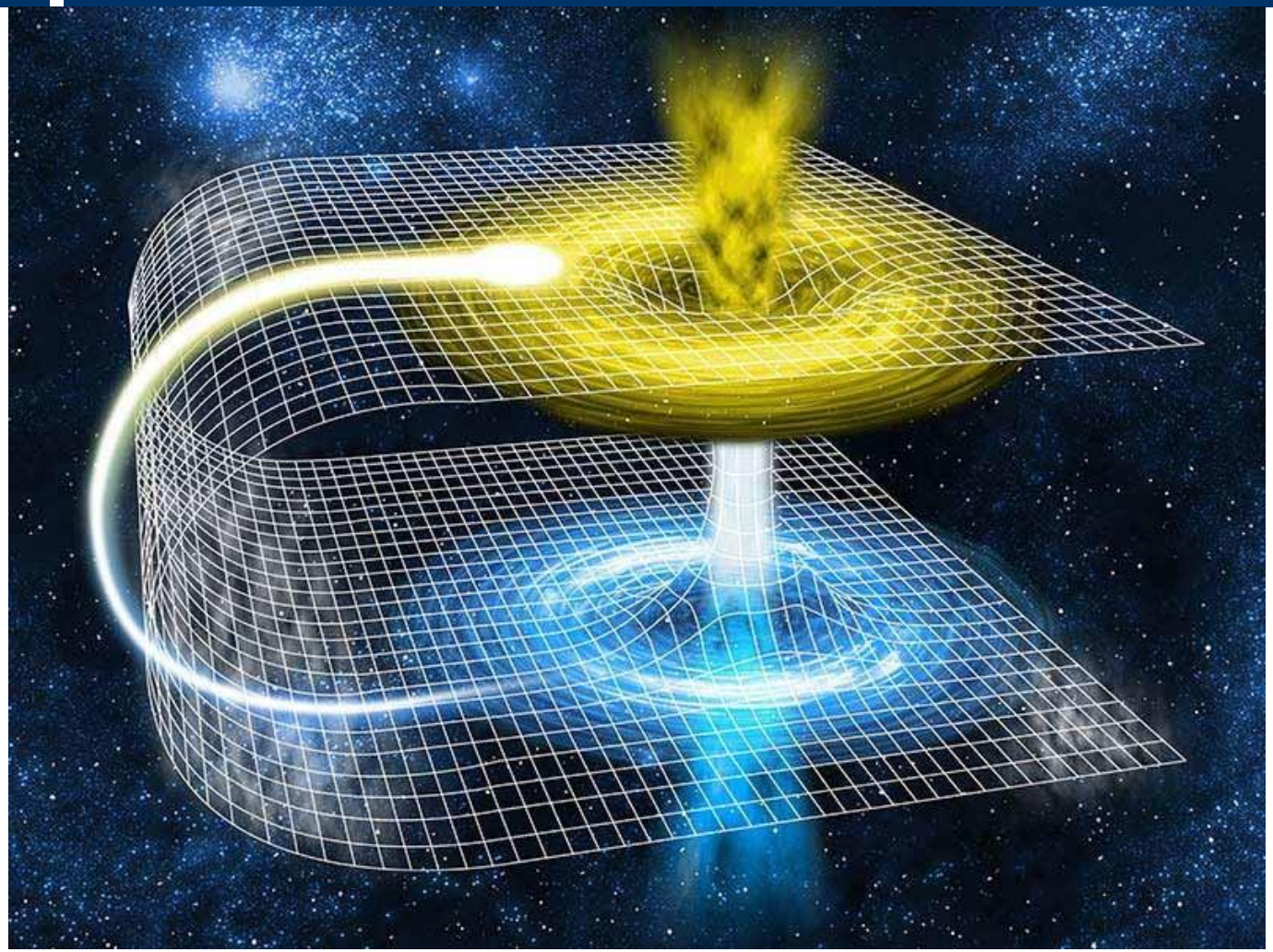
Modern Physics Problems



Retrieved from: http://www.thegreatcourses.com/courses/einstein-s-relativity-and-the-quantum-revolution-modern-physics-for-non-scientists-2nd-edition.html

Modern Physics Problems

The following questions have been compiled from a collection of questions submitted on PeerWise (https://peerwise.cs.auckland.ac.nz/) by teacher candidates as part of the EDCP 357 physics methods courses at UBC.

Modern Physics Problems I

You have a radioactive isotope that has a half-life of 1 day. If you have 100 kg of this isotope, how long would you have to wait for there to be less than 10 % of the original isotope left?

A. 10 days

B. 4 days

C. 2 days

D. You cannot tell for certain given the available data.

Solution

Answer: B

Justification: When determining how quickly a radioactive substance decays, we use the half-life.

This half-life is a measurement of the time it takes for approximately half of the atoms in a radioactive substance to decay.

After 1 day, half of the material would have likely decayed, meaning you would likely find 50% left behind. After another day, half of the remaining material would have likely decayed, leaving behind half of 50% of the original, or 25%. After another day another half of the remaining material would have likely decayed, leaving half of 25%, or 12.5% of the original amount behind. After the fourth day, half of 12.5% would have likely decayed, leaving 6.25% of the original amount.

Therefore Answer **B** is correct.

Solution continued

Answer **A** is incorrect because this is operating under the assumption that only 10% decays each day.

Answer **C** is incorrect because this is operating under the assumption that half-life decay is linear instead of exponential (meaning half decays the first day, and then the second half decays on the second day, instead of half of the remaining amount).

Answer **D** is incorrect because while radioactive half-lives indicate a time where it is probable (but not certain) that an amount of atoms will decay, with 100kg, the amount of atoms means that the unlikely probabilities end up becoming far less significant and it is practically guaranteed that the amount decayed will be accurately predicted by a half-life.

Modern Physics Problems II

You have a radioactive isotope that has a half-life of 1 day. If you have 100 atoms of this isotope, how long would you have to wait for there to be less than 10 % of the original isotope left?

A. 10 days

B. 4 days

C. 2 days

D. You cannot tell for certain given the available data.

Solution

Answer: D

Justification: When determining how quickly a radioactive substance decays, we use the half-life.

This half-life is a measurement of the time it takes for approximately half of the atoms in a radioactive substance to decay.

What is important to remember however is that this is not a guarantee that there will be only half of the amount left after one half-life.

Rather, radioactive decay is a random process, so after one half-life it is merely probable that half of the material has decayed, but it is not a certainty. There can be more or less than half of the material that has decayed after one half-life.

So after 1 day, there could be 50% left, of 55%, or 45%, or even 100% or 0%. As you move farther away from 50%, it becomes increasingly unlikely that that amount is left behind, but it is still a possibility.

Solution continued

Thus, we cannot say with absolute certainty that there will be any amount of material left after any amount of time. When we are dealing with large numbers of atoms, for example on the scale of kilograms, the numbers involved mean that it is practically guaranteed to decay in the amounts predicted by the statistics.

When we are dealing with amounts as small as a hundred atoms, the probabilities become a much more important consideration.