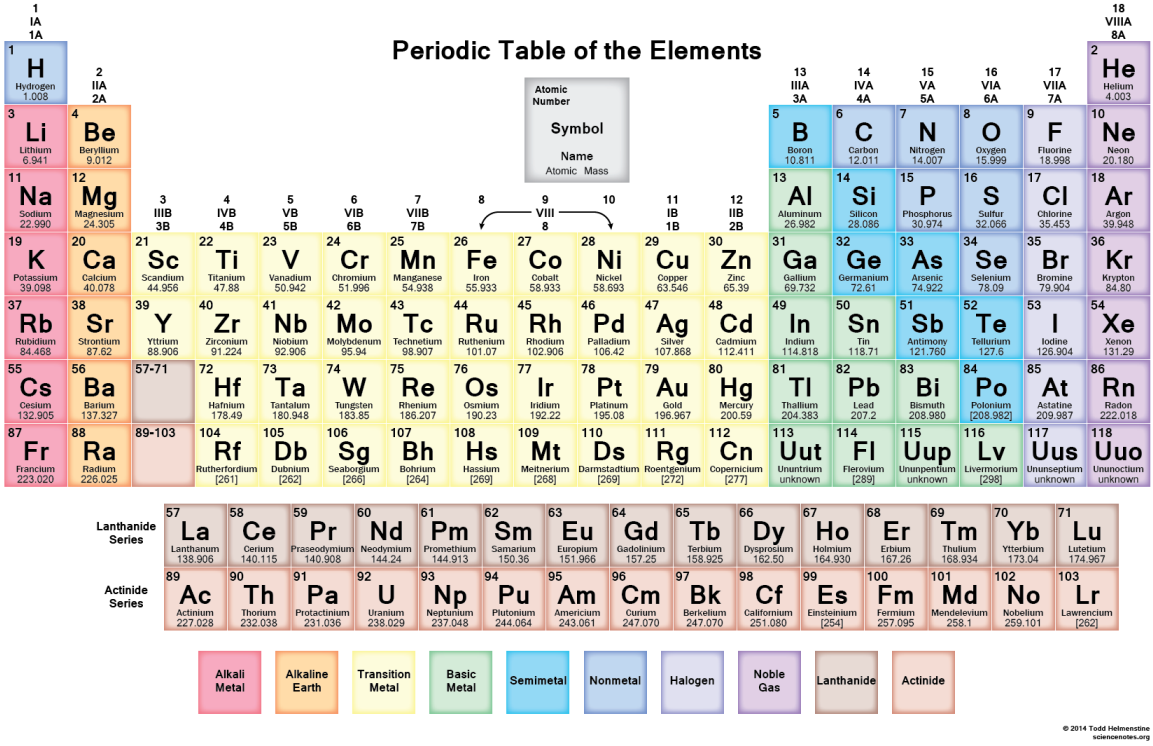
Name: _____

Cornell University
Prison Education Program

Conceptual Physics
Class 13 Questions
May 4th, 2018

The following might be useful for today's class questions:



Part 1: Probability

1. You have a jar with 73 red balls, and 27 blue balls. You randomly draw a ball from this jar. What is:
   (a) The percent chance that you will draw a red ball?

   (b) The percent chance that you will draw a blue ball?

   (c) The probability that you will draw a red ball?

   (d) The probability that you will draw a blue ball?

   (e) The probability of drawing a red or blue ball?

2. Give an example of 2 statistically *independent* events.

3. Give an example of 2 statistically *dependent* events.

4. You toss a coin in the air 3 times. What is the probability that:
   (a) It will land heads all 3 times?

   (b) It will land heads twice (and only twice)?

   (c) It will land heads 2 or 3 times?

   (d) It will land tails 2 or 3 times?

5. You are tossing a fair coin, which has a 1/2 probability of landing heads and a 1/2 probability of landing tails. If you toss the coin in the air 300 times, how many times **on average** would you expect it to land:

   (a) Heads:

   (b) Tails:

6. You are tossing a trick coin, which has a 2/3 probability of landing heads, and a 1/3 probability of landing tails. If you toss the coin 300 times, hoe many times **on average** would you expect it to land:

   (a) Heads:

   (b) Tails:

7. Based on your answers to the two previous questions, how could you tell if a coin was fair (without any special equipment or knowledge of how coins can be biased)?

8. There are 52 cards in a deck. You are dealt 2 cards (without refilling the deck). What is the probability that you will have both the ace of spades and the ace of diamonds?

9. Why isn't it valid to define randomness by saying that randomness is when all outcomes are equally likely?

   From *Light and Matter*, Chapter 33 Discussion Question B

10. Suppose you have two identical loaded four-sided dice, with P(4) = 1/2, and P(1) = P(2) = P(3) = 1/6.

    (a) If you rolled one die many times, what is the average value you would roll?

    (b) If you rolled both dice there are 16 possible rolls you could get. What is the probability of each?

    (c) If you add up the values of your two rolls, you could get between 2 and 8. What is the probability of each possible sum?

    (d) What is the average sum you would get if you rolled both dice many times?

11. Does the number of radioactive nuclei in a sample decrease to exactly half its original value in one half-life? Explain in terms of the statistical nature of radioactive decay.

12. Describe the following kinds of radioactive decay;

    (a) Alpha decay:

    (b) Beta decay:

    (c) Gamma decay:

13. You have a block of radioactive material, and measure the number of initial decays to be 128 million. If it has a half-life of 4 hours, what do you expect its radioactivity level to be after:

    (a) 4 hours?

    (b) 8 hours?

    (c) 16 hours?

14. Does the number of radioactive nuclei in a sample decrease to exactly half its original value in one half-life? Explain in terms of the statistical nature of radioactive decay.

15. What distinguishes between:

    (a) Different kinds of elements?

    (b) Different isotopes within an element?

16. Physicists thought for a long time that bismuth-209 was the heaviest stable isotope. (Very heavy elements decay by alpha emission because of the strong electrical repulsion of all their protons.) However, a 2003 paper by Marcillac et al. describes an experiment in which bismuth-209 lost its claim to fame it actually undergoes alpha decay with a half-life of 2×10^{19} years.

    (a) After the alpha particle is emitted (two protons and two neutrons), what is the isotope left over?

    (b) Compare the half-life to the age of the universe, which is about 14 billion years.

17. What is the source of energy emitted in radioactive decay? (Hint: think about conservation laws from before)

Part 2: Quantum Mechanics

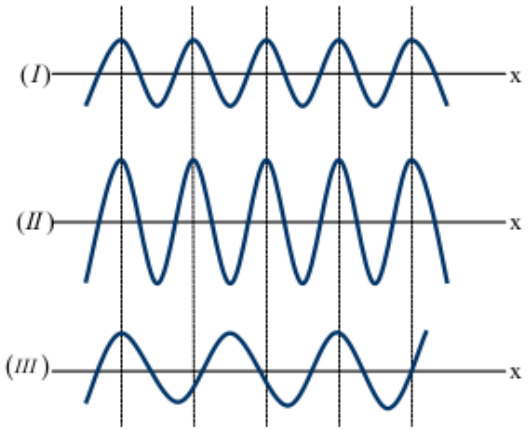
18. What is the Heisenberg uncertainty principle?

19. What is the concept of *wave-particle duality*?

20. How would the wavelength of an object change if:
    (a) Its mass increased?

    (b) Its velocity decreased?

21. Three particles of equal mass are traveling in the same direction. The waves of the three particles are as shown.



Rank the speeds of the particles (I), (II) and (III) by circling one of these four possibilities.

A. $v_{II} > v_I > v_{III}$

B. $v_{II} > v_{III} > v_I$

C. $v_I = v_{II} > v_{III}$

D. $v_{II} > v_I = v_{III}$

22. According to the uncertainty principle, the more we know about an electron's position, the less we know about its

A. speed.

B. momentum.

C. kinetic energy.

D. all of these.

23. A metal surface is struck with light of wavelength 400nm, releasing a stream of electrons. If the 400nm light is replace by a 300nm light with the same number of photons incident on the metal per second, what will happen?

    A. More electrons are emitted in a given time interval

    B. Fewer electrons are emitted in a given time interval

    C. Emitted electrons are more energetic

    D. Emitted electrons are less energetic

    E. None of the above

24. A metal surface is struck with light of wavelength 400nm, releasing a stream of electrons. If the light intensity increases without changing the wavelength, what will happen?

    A. More electrons are emitted in a given time interval

    B. Fewer electrons are emitted in a given time interval

    C. Emitted electrons are more energetic

    D. Emitted electrons are less energetic

    E. None of the above

25. Why do we not notice quantum effects in our day-to-day lives?