

Date: _____



Conceptual Physics
Class 9 Questions
April 6th, 2018

1 IA	Periodic Table of the Elements																2 VIIIA
1 H Hydrogen 1.008	2 He Helium 4.003																
3 Li Lithium 6.941	4 Be Beryllium 9.012																
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 Al Aluminum 26.982	4 Si Silicon 28.086	5 P Phosphorus 30.974	6 S Sulfur 32.066	7 Cl Chlorine 35.453	8 Ar Argon 39.948										
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Nh Nihonium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]
57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967			
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]			
Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide								

1. The following is a wave of light:



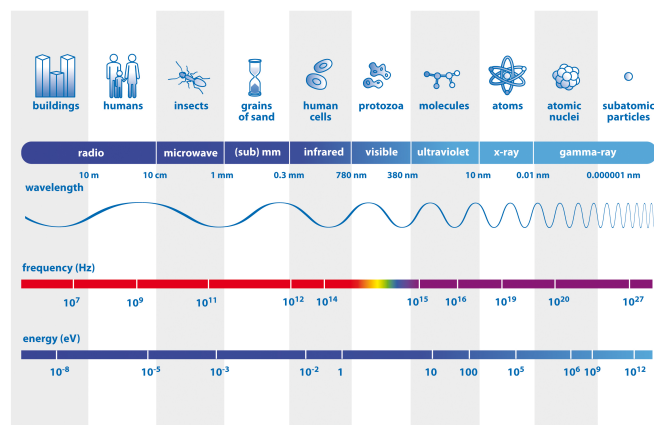
(a) Draw the light-wave *red-shifted*.

- What happens to the frequency? (Increase, decrease, stay the same):
- What happens to the wavelength? (Increase, decrease, stay the same):
- What happens to the energy? (Increase, decrease, stay the same):
- What happens to the intensity? (Increase, decrease, stay the same):

(b) Draw the light-wave *blue-shifted*

- What happens to the frequency? (Increase, decrease, stay the same):
- What happens to the wavelength? (Increase, decrease, stay the same):
- What happens to the energy? (Increase, decrease, stay the same):
- What happens to the intensity? (Increase, decrease, stay the same):

2. In the Doppler effect, light is red-shifted or blue-shifted depending on whether objects are moving away from each other or closer together.
- (a) When two objects come together, light is *blue-shifted* between them. What happens to:
1. The wavelength of the light? (Increase, decrease, stay the same):
 2. The frequency of the light? (Increase, decrease, stay the same):
 3. The energy of the light? (Increase, decrease, stay the same):
 4. The intensity of the light? (Increase, decrease, stay the same):
- (b) When two objects move away from each other, light is *red-shifted* between them. What happens to:
1. The wavelength of the light? (Increase, decrease, stay the same):
 2. The frequency of the light? (Increase, decrease, stay the same):
 3. The energy of the light? (Increase, decrease, stay the same):
 4. The intensity of the light? (Increase, decrease, stay the same):
3. The following diagram represents the EM spectrum of light.

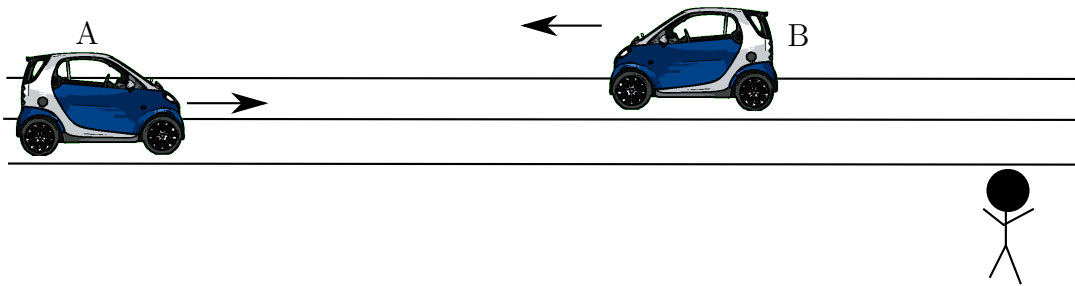


- (a) Order the following photons in terms of *increasing energy*: x-rays, microwaves, infrared, visible light
- (b) Which has the greater *wavelength*: Radiowaves or infrared?
- (c) Which has the greater *frequency*: Visible light or gammarays?

4. When light is reflected from a mirror, perhaps only 80% of the energy comes back. The rest is converted to heat. One could try to explain this in two different ways: (1) 80% of the photons are reflected, or (2) all the photons are reflected, but each loses 20% of its energy. Based on your everyday knowledge about mirrors, how can you tell which interpretation is correct?

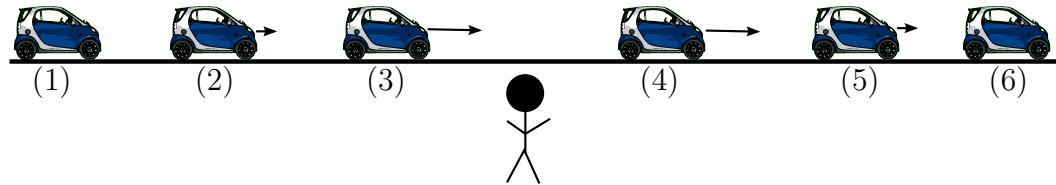
From *Light and Matter*, Chapter 34 Question 3

5. Two cars are driving in opposite directions on a road, by a pedestrian.



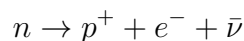
- (a) To the pedestrian on the road, the lights from car A appear
1. Red-shifted
 2. Blue-shifted
 3. Unchanged
- (b) To the pedestrian on the road, the lights from car B appear
1. Red-shifted
 2. Blue-shifted
 3. Unchanged
- (c) To car A, the lights from car B appear:
1. Red-shifted
 2. Blue-shifted
 3. Unchanged
- (d) To car B, the lights from car A appear:
1. Red-shifted
 2. Blue-shifted
 3. Unchanged
- (e) Compare and contrast the light from car A, as it appears to car B and the pedestrian.
- (f) Compare and contrast the light from car B, as it appears to car A and the pedestrian.

6. You are standing by the side of the road, and West of you is a stationary car with its lights on, labelled as (1) in the image below. The car then begins to move, and accelerates East. Part (2) shows the car some time later, moving East and still accelerating. Part (3) shows the car at its highest velocity, which it maintains as it moves past you to part (4). The car then begins to slow down, and so has the same velocity in part (5) as in part (2), and then comes to a complete stop again at point (6). The image below illustrates this, where the car's velocity is indicated by the arrows. Use this to answer the following questions.

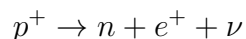


- (a) At which point(s) if any do the car's lights appear red-shifted to you?
- (b) At which point(s) if any do the car's lights appear blue-shifted to you?
- (c) At which point(s) if any are the car's light neither red nor blue-shifted?

7. Carbon comes in 3 main isotopes, carbon-12, carbon-13 and carbon-14.
- (a) How many protons are in a carbon-12 atom?
 - (b) How many protons are in a carbon-13 atom?
 - (c) How many protons are in a carbon-14 atom?
 - (d) How many neutrons are in a carbon-12 atom?
 - (e) How many neutrons are in a carbon-13 atom?
 - (f) How many neutrons are in a carbon-14 atom?
8. The weak nuclear force mediates a form of nuclear decay, where a neutron turns into a proton and in the process emits an electron and an *anti*-neutrino. This is called *beta decay*:

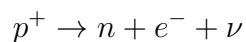


- (a) What is the total electrical charge on the left hand side of this reaction (just the neutron?)
- (b) What is the total electrical charge on the right hand side of this reaction (proton, electron, anti-neutrino) if the anti-neutrino has no charge?
- (c) A comparable decay mediated by the weak force is one where the proton decays. However, in this process a proton decays to a neutron by forming a *positron*, a particle of anti-matter which is the exact opposite of the electron, and a neutrino

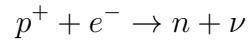


What is the total electrical charge on the left hand side of this reaction (just the proton)?

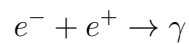
- (d) What is the total electrical charge on the right hand side of this reaction (neutron, positron, neutrino)?
- (e) From the above two reactions, you should notice that the amount of charge is the same on both sides. This is because electrical charge is a conserved quantity in nature (think back to Noether's theorem, there's a symmetry in the electric field that makes this true). Knowing this, explain whether or not the following decay is possible:



- (f) *Electron capture* is the process by which an electron and a proton come together to form a neutron (releasing a neutrino in the process). Using the idea of conservation of charge, explain why this is possible:

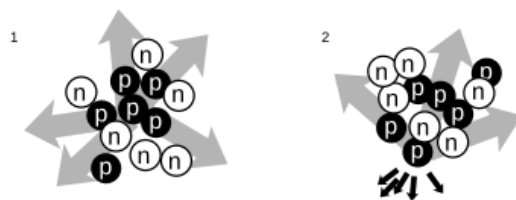


9. The following isotopes undergo either *beta decay* or *electron capture* (described in the previous question). What do they turn into?
- (a) Cobalt-57 undergoes electron capture
 - (b) Carbon-14 undergoes beta decay
 - (c) Aluminum-26 undergoes electron capture
 - (d) Cesium-137 undergoes beta decay
 - (e) Sodium-22 undergoes electron capture
 - (f) Beryllium-7 undergoes electron capture
 - (g) Iron-55 undergoes electron capture
10. When an antielectron and an electron come together, they annihilate causing a gamma ray to be released:



Is charge conserved in this reaction?

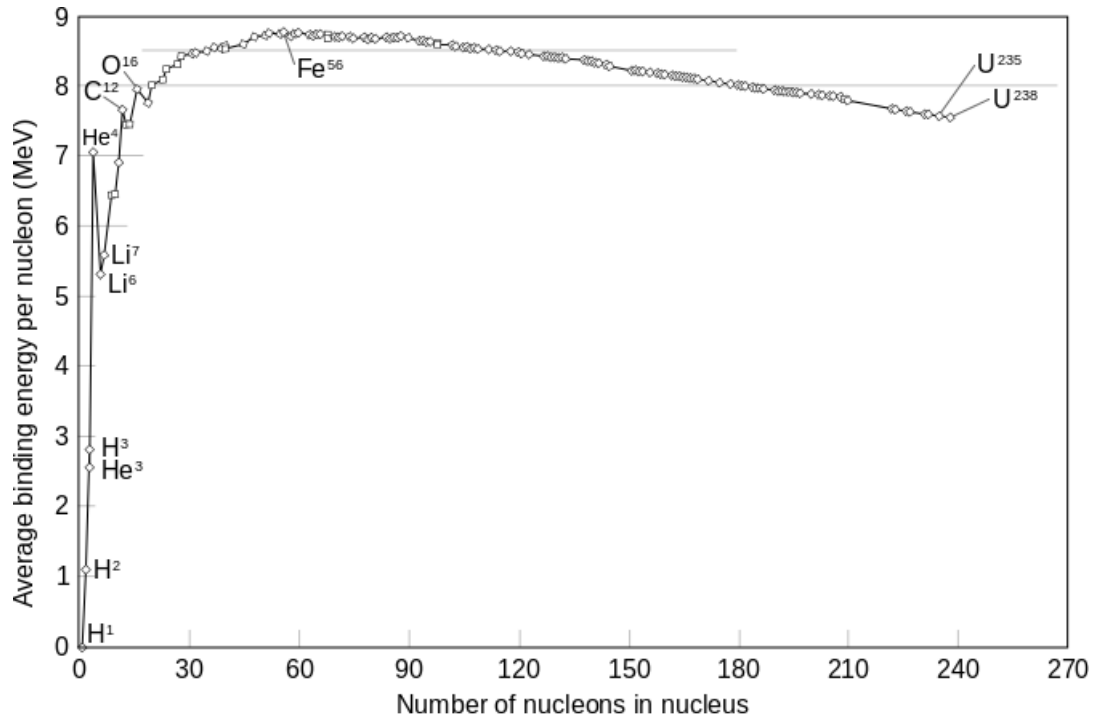
11. In very heavy elements (with lots of neutrons and protons in a nucleus), there are many ways in which the nucleus can be arranged.



The image is taken from *Light and Matter*, Chapter 26.

- (a) What are the two dominant forces acting on the protons in the two figures?
- (b) Very heavy elements tend to be *neutron rich*, meaning that they have far more neutrons than protons. Using the above figure and the forces you listed in part (a), explain why.

12. *Nuclear fusion* is the process by which atomic nuclei come together to create heavier elements. *Nuclear fission* is the process by which atomic nuclei break apart to create lighter elements. The amount of energy released is related to the *binding energy* of the atom: It is the amount of energy needed to disassemble the nucleus into free protons and neutrons.



- When hydrogen-1 (^1H) comes together with free neutrons to create helium-3 (^3He), would the process release or require energy?
- If helium-4 (^4He) broke into hydrogen-2 (^2H), would the process release or require energy?
- Why does the sun release energy by fusing lighter elements (hydrogen, helium) whereas nuclear reactors release energy by breaking apart heavier elements (uranium, plutonium)?
- Following this argument, why is iron-56 (^{56}Fe) the most stable nucleus?