2009 LSU-PHYSICS IQ TEST ANSWERS

(1) How many incoming graduate students (and how many countries)?
D - 27   [With 8 in the medical physics masters program and the rest in the Ph.D. program]
                [6 countries; China, Romainia, India, U.S., Ukraine, and Iran]

(2) Biking north, wind springs up from the east, do you slow down?
C - Your velocity slows down (wind resistance force goes like the square of the relative velocity). In the rest frame of the biker, they originally feel a wind from the north at 10 mph. After the east wind springs up, the biker feels a wind of 14 mph from the north-east. Wind forces go roughly as the square of the wind velocity. So originally, the wind force has one-unit to the south, while later the wind force has two-units to the SW. As the biker will lean the bike to counter any E/W force, the only force that matters is the component in the direction of motion. Originally this will be one-unit south, while after the east wind springs up the force N/S component will be 1.4-units to the south. So adding the east wind increases the force acting southward, and the rider must slow down.

(3) Vote on which people have similar personalities as Star Trek characters:
A - Captain Kirk → Jonathan Dowling
B - Mr. Spock → Sai Vinjamampathy
C - Dr. McCoy → Kip Matthews
D - Lt. Uhuru → Arnell Dangerfield
E - Ensign Sulu → Rongying Jin

(4) How many times has the Black Party been postponed due to a hurricane hitting near the planned party date?
C - 3 [Katrina, Gustav, Ike]
Katrina hit 29 August 2005, Party scheduled for 30 August 2005 but postponed
Rita hit 24 September 2005, Party scheduled for 20 September 2005 and held on time
Gustav hit 1 September 2008, Party scheduled for 3 September but postponed
Ike hit 13 September 2008, Party rescheduled for 12 September but postponed to 19 Sept

(5) Place ice-cube in microwave, so what happens?
C - The ice-cube will melt in ~3 minutes [microwaves work on trace melt water which then melts the ice].

(6) How many neutrinos from SN1987A interacted inside human eyes?
B - 10^2
The fast method is to equate the neutrino visibility of all human eyeballs to an equal volume of water that is monitored as was the SuperKamiokande experiment. In 1987, with the world having ~5 billion people, there were ~10^{10} eyeballs. I'll estimate 1 cm^3 as the average volume for one eyeball's detection area. Thus the number of humanly detectable neutrinos would be the same as the number of neutrinos that interact in a volume of 10^{10} cm^3 of water. The SuperKamiokande, which saw ~10 SN1987A neutrinos, has a volume (I estimate of the classic picture showing a technician in a rowboat inside SuperKamiokande) of $(10m)^3$ or 10^9 cm^3. So the water-equivalent volume of human eyeballs is ~10 times larger than SuperK, so the humans should have ~100 interactions detectable from SN1987A.

(7) Order Department wedding dates:

E	B	C	D	A
First				Most recent

A - Becky Ringuette and Chris -- June 21, 2009
B - Chris Britt and Bonnie -- July 12, 2008
C - Jan Staff and Kuriko -- March 21, 2009
D - Robert Hynes and Jo -- June 20, 2009
E - Sarvnipun Chawla and Deepie -- January 11, 2008

(8) What is the 'kill-radius' of Sco X-1?
C - ~30 light years [i.e., airless planets around the many stars near to Sco X-1 are sterilized]
Let us take the mission duration to be ~100 days (10^7 seconds)
Each 10 keV photon has energy ~10^{-8} erg/photon, so Sco X-1 has luminosity of ~10^{46} photon/s
Over the time of the mission, Sco X-1 emits ~10^{53} photons
It would take perhaps 10,000 chest x-rays to be lethal, with a dose of 10^{17} photons
Cross section of human body is ~10,000 cm^2, so lethal dose is ~10^{13} photons/cm^2
By the inverse-square law, KillRadius = SQRT[10^{53}/($4\pi 10^{13}$)] = $10^{19.5}$ cm
A light year is (3×10^7 s/yr)*(3×10^{10} cm/s)^2 = 10^{18} cm
So the kill radius of Sco X-1 is ~30 light years

(9) Drop 'bounce rocket' (small bouncy ball on top of big bouncy ball) from height of 2.0 feet, then how high will the smaller ball fly up to?
D - 18.0 feet
This is seen by experiment with the balls provided (allowing for the non-perfect bounces). Here is a theory way. The balls drop to the ground level and hit with some velocity V. The big ball on the bottom will rebound with a velocity V upwards (recall that the balls are perfectly elastic). Now transform to that reference frame. In this frame, the small ball is moving downward with velocity 2V, and it will bounce upwards at a velocity of 2V. Now transform back to the laboratory frame, and you see that the upward velocity of the small ball is 3V. The kinetic energy of the small ball at the time of its bounce will be m(3V)^2/2. When the ball rises to its peak height, this kinetic energy will all be transformed into potential energy of mgH. So height is proportional to the square of the velocity. If the (perfectly elastic) small ball is dropped from 2 feet alone, then it will rebound with velocity V and fly up to 2 feet above the ground. With the bounce rocket, the small ball will rebound with 3V, and will fly 9 times higher than before, or 18 feet.

(10) In homage to Enrico Fermi, roughly, how many barbers *are* there in Baton Rouge?
D - ~300
Fermi asked the question concerning Chicago, and it remains as a classic order-of-magnitude question for physicists. Baton Rouge has ¾ million people, of which perhaps a third use barbers. Each person has roughly 4 haircuts a year, so there are a million haircuts per year throughout Baton Rouge. Each barber might work 300 days per year and perhaps 10 haircuts per day, for ~3000 haircuts per year per barber. Thus, it will take ~300 barbers in Baton Rouge to produce a million haircuts per year. [Alternatively, I counted the number of barbershops in the Baton Rouge phone directory, and there were close to 100. With ~3 barbers working per barbershop, we again get ~300 barbers in Baton Rouge.]