Exam 1 – Score Statistics

Letter Grade	Score Range	% Equiv.
A	53 – 60	≥ 88.0
A–	50 – 52	83.0 – 87.9
B+	48 – 49	80.0 – 82.9
B	45 – 47	75.0 – 79.9
B–	42 – 44	70.0 – 74.9
C+	39 – 41	65.0 – 69.9
C	36 – 38	60.0 – 64.9
C–	33 – 35	55.0 – 59.9
D	30 – 32	50.0 – 54.9
F	< 30	< 50

Total # Exams: 164

Mean = 43/60 = 72%

Breakdown by letters:

A : B : C : D : F

43 : 56 : 49: 9: 7

26%: 34%: 29%: 7%: 4%

FMQ: Frequently Missed Questions

- *Which of the choices is **not** an indicator of increased solar activity?*

The items mentioned included: increased number of sunspots, bursts of charged particles being ejected from the surface (otherwise known as CME's or coronal mass ejections), and loops of hot plasma sticking out from the surface (otherwise known as solar prominences). All of these do increase during solar maximum. However, one of the choices was "the number of neutrinos emitted from the Sun increases." This is ***not true***. Solar neutrinos come from the core and are produced steadily, as part of the fusion reactions that power the Sun. I even pointed out, on Sep. 6, that the Hollywood movie "2012" was junk science. Nevertheless, 55% of the class fell into the trap; *only 28% of the class got this question right*. (Moral of the story: always read the question carefully!)

FMQ: Frequently Missed Questions

- *"The present-day composition at the **center** of the Sun is …"*

The same question was on the index card on Sep. 4, yet barely half the class (52%) chose the correct answer. Most of the rest said it was "75% H, 25% He." This is the composition at the **surface** of today's Sun, and was the composition at the center when the Sun first formed and began to undergo fusion reactions. See the Card feedback file for Sep. 4.

- *"Power emitted by a thermal emitter **per unit surface area**."*

In spite of the fact that certain words are in bold-face font, ⅔ of the class said that the power per unit surface area depends on both temperature and surface area. The correct statement is: Total power emitted by an object = (surface area) x (power per unit S.A.). The power per unit S.A. depends ***only*** on temperature (is given by σT^4; see Class or Card slides from Sep. 13).

FMQ: Frequently Missed Questions

- *"Statements about gravitational force: which are true/false?"*

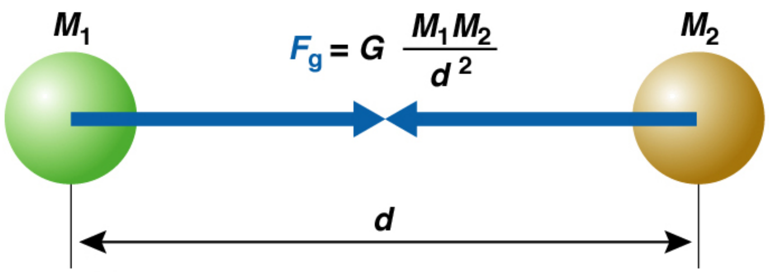
The nature of gravity is something you should have learned in Astronomy 301, but we did review it in Ast 309N on Sep. 20. See the following two slides. More students selected the wrong answer, that the statement "the force of object 1 on object 2 is equal in strength to that of object 2 on object 1" was false, than those who selected the correct answer, that all were true.

- *"Which are you most likely to see in the spectrum of an M star?"*

M is the coolest (traditional) spectral class. You see ionized atoms, and atoms where electrons are in highly excited levels, in hot gases. These are not likely to be seen in the spectrum of an M star. You will see molecules; the gas is too cool to break up the molecules. See slides from Sep. 25 or the Quiz 3 feedback file.

How Gravity Behaves

Between every two objects there is an attractive force. Its strength is directly proportional to both of the masses, and inversely proportional to the square of the distance between the ***centers*** of the two objects.

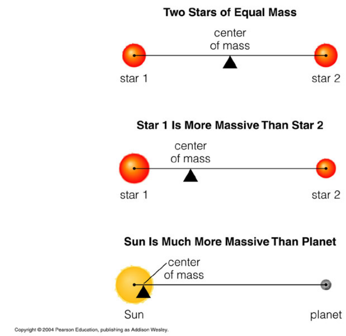


9/20/12

Center of Mass = Center of Gravity

- When two bodies interact by gravity, *both* experience accelerations. **Why?** Because each body feels an equal but opposite force.

- …but the more massive body experiences a smaller acceleration. **Why?** It has more mass, so it is harder to move ("inertia").



- The two bodies actually orbit around a mutual "center of mass" which lies between them but is closer to the more massive body.

9/20/12

FCQ: Frequently Correct Questions

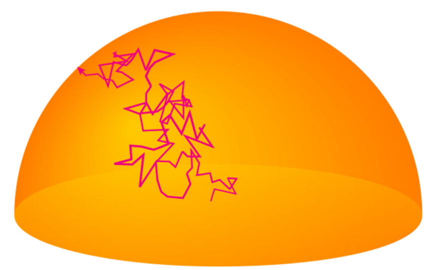
Over 95% of the class answered the following questions correctly!

- *What prevents CME's from hitting the Earth directly?* This question was very similar to question 1 on Quiz 1.
- *What was the resolution of the "solar neutrino problem?"* This was also addressed on Quiz 1.
- *What is the number of waves passing a given point per second?* This defines frequency; we showed this with animations in class.
- *A photon with higher frequency also has …* a shorter wavelength. After some confusion on Quiz 2, we re-emphasized this point.
- *Which are intrinsic vs. relative properties of stars?* We examined this question in the card activity of Sep. 20.

Exam 1 Essay Questions

1. Does it make sense to say that the light we see from the Sun today created "during the last Ice Age"?

Yes! Photons created during fusion reactions in the Sun's core take a circuitous, zig-zag path to get through the radiative zone. Their many detours from outward motion cause them to take a long time to reach the surface (slides, 9/6; card, 9/6).



- This "random walk" is a slow process! It takes about a hundred thousand years for the energy to reach the surface.

Exam 1 Essays, cont'd.

2. Two "recently developed" techniques for studying the Sun.

- Detection of solar neutrinos using underground experiments like Davis, Kamiokande, SNO. These tell us directly about fusion reactions in the core of the Sun.
- The analysis of oscillations/sound waves/surface Doppler shifts has provided information about the structure of the Sun's interior, a technique called *helioseismology*.
- New spacecraft that are monitoring solar activity, such as the Solar Dynamics Observatory (SDO).
- Some people mentioned spectroscopy, but that technique is over a century old, which hardly qualifies as "recent."
- Others mentioned sunspots, which were first observed by Galileo around 1600 (even less "recent")!

Exam 1 Essay Questions

3. Sirius A and B have the same spectral type, but A is much brighter. What can you conclude about their radii?

   Being a binary, they are at the same distance, so their ratio of luminosities is equal to the ratio of apparent brightnesses. If they have the same spectral type, they must have the same surface temperature. Thus, from $L = 4\pi R^2 \sigma T^4$, Sirius A has a larger radius than B. (See slides 14 – 16 on 9/25.)

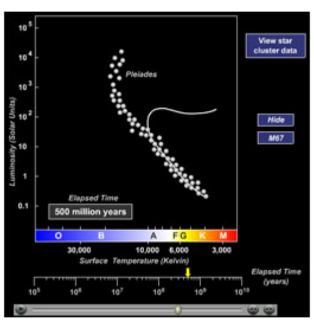
4. Similarities & differences: 1 vs 10 $M_\odot$ Main Sequence stars.

   Both produce energy by fusion of H into He in their cores. The 10 $M_\odot$ star is *more* than a factor of 10 more luminous, because the stronger gravity makes the core hotter & drives faster fusion reactions. It has a shorter Main Sequence lifetime and a hotter surface temperature. The 10 $M_\odot$ star lies higher and farther to the left in the HR diagram than the 1 $M_\odot$ star.

Exam 1 Essay Questions

5. Determining the age of a star cluster.

   You were expected to state, illustrate, and *explain the basis of* the "Main Sequence turnoff" method for deriving the ages of star clusters, see slides and the Card from Sep. 27.



- All stars in a cluster form at once.
- The most massive stars die first.
- As time passes, lower-mass stars begin to move off the Main Sequence.
- Find this "turn-off" point: the cluster's age equals the M. S. lifetime of stars at the turn-off.

Some Misunderstandings

- A few people said that the reason the sunlight we see is "old" is because the Sun is so far away. Light travels so fast through empty space that it takes only 8 minutes to reach us.
- "Random walk" being due to convection. The random walk is a series of repeated absorptions and re-emissions of photons by the gas they are passing through. This happens in the radiative zone of the Sun, where energy is carried by photons (radiation), not the convective zone.
- Focus on answering the question asked: Question 3 asked you to compare the radii of Sirius A and Sirius B, not these stars to the Sun.
- Don't just repeat the question: For question 4, some students just said that the stars have different masses, or that they were both Main Sequence stars. You have to tell us something more than is already stated in the question!