PHYSICS 176: ASTRONOMY
2nd Midterm Exam, April 9, 1999

Name:

Lab section and TA:

Score:

As a member of William and Mary community, I pledge not to lie, cheat or steal, either in my academic or personal life. I understand that such acts violate the honor code and undermine the community of trust of which we are all stewards.

Signed:

You have fifty minutes to complete this exam. You may use a hand-held calculator and a single sheet of formulas. In the following, circle or underline the *best* answer. Mark your answer clearly. Ambiguous answers will be incorrect.

Possibly useful formulae or constants:
$c = 3x10^8$ m/s; $\lambda f = c$; (arc length) $s = R\theta$ (θ in radians); $A_{circle} = \pi R^2$; $V_{sphere} = 4/3\ \pi R^3$; 1 radian = 57.3 deg.; 1 deg. = 60'; 1'=60"; 1 A.U.=$1.5x10^8$ km; 1 nm =$1x10^{-9}$ m; 1 μm = $1x10^{-6}$m; R_{Earth} =6400 km; R_{Sun}=700,000 km.

The radius of Venus is most similar to which of the following?
___ Mercury
___ Earth
___ Mars
___ Europa

In the 1950s, radio observations determined that Venus emitted a black-body spectrum characteristic of a temperature of:
___ 500 K
___ 650 K
___ 750 K
___ 800 K

How much sunlight, on average, does each square meter of the surface of Venus receive compared to each square meter on Earth? Use the fact that the radius of Venus' orbit is .7 A.U.
___ 0.67
___ 2.1
___ 0.44
___ 3.5

How much sunlight, on average, does each square meter of the surface of Mars receive compared to each square meter on Earth? The radius of Mars' orbit is 1.5 A.U.
___ 0.67
___ 2.1
___ 0.44
___ 3.5

Which of the following provides evidence that water once flowed on Mars?
___ Valles Marineris
___ runoff and outflow channels
___ icecaps
___ canals

If Mars once had a significant atmosphere, what happened to it?
___ It escaped into space.
___ It was blown away by volcanic eruptions.
___ It dissolved into the liquid water which once flowed on the surface and became locked into the crust.
___ It froze into the polar icecaps.

A certain star, observed from Earth, has a parallax of 0.07". What would be its parallax as seen from Venus? The radius of Venus' orbit is .7 A.U.
___ 0.05 arc seconds
___ 0.67 arc seconds
___ 0.3 arc seconds
___ 0.1 arc seconds

What is the most likely cause of the Great Red Spot?
___ a large hurricane
___ a large comet impact feature
___ a molten lava pool
___ a volcano

Jupiter is the only planet which radiates more energy than it receives from the Sun. What is the most likely source of Jupiter's excess energy?
___ nuclear fusion
___ decay of radioactive elements
___ cometary impact
___ residual heat from its formation
___ runaway greenhouse effect

What tears a body apart when it is within the Roche limit of a planet?
___ high orbital velocity
___ tidal forces
___ high rate of rotation
___ exposure to intense magnetic fields

What is the angular diameter of the Sun, as seen from Jupiter? The radius of Jupiter's orbit is 5 A.U.
___ 0.1 degrees
___ 0.05 degrees
___ 0.016 degrees
___ 0.005 degrees

What is the round trip travel time for a light signal to go from the Sun to a comet in the Oort cloud and back (with orbital radius of about 1,000 A.U.)?
___ 12 hours
___ 2 days
___ 10 days
___ 1 month

What is the most likely source of *short period* comets?
___ The Kuiper Belt
___ The Oort cloud
___ Tidally induced eruptions on Europa
___ The sun capturing comets from outside the solar system

What is the most likely source of *long period* comets?
___ The Kuiper Belt
___ The Oort Cloud
___ Tidally induced eruptions on Europa
___ The sun capturing comets from outside the solar system

What causes a comet to form a coma and tail as it approaches the inner solar system?
___ the solar wind
___ gravitational interactions with Jupiter
___ tidal effects due to the Sun
___ heating from the Sun

A typical comet contains about 10^{13} kg of water ice. How many comets would have to strike the Earth in order to account for the roughly 2 X 10^{21} kg of water presently found on our planet?
___ 2 million
___ 20 million
___ 200 million
___ 2 billion

What is the process that produces the Sun's energy?
___ burning of hydrogen and oxygen
___ heat left over from its formation
___ fusion of hydrogen into helium
___ fusion of helium into heavier elements

What *direct* product of fusion reactions occurring in the core of the Sun is detectable here on Earth?
___ Gamma rays
___ positrons
___ neutrinos
___ helium

The Sun is about ? times bigger in diameter than the Earth.
___ 10
___ 100
___ 1,000
___ 10,000

An object has a parallax of 1 degree. What is the parallax for a similar object at five times this distance?
___ ½ degree
___ ¼ degree
___ 1/5 degree
___ 1/25 degree

What is the source of Io's volcanic activity?
___ radioactive decay of elements
___ impacts from meteorites
___ tidal heating
___ excess heat emitted from Jupiter

Why does Europa have so few impact craters?
___ It has been shielded from impacts by Jupiter.
___ Tectonic activity in its icy crust has erased most craters.
___ Its surface is mostly liquid water.
___ The craters have been covered over by magma from volcanic eruptions.

What is the most fundamental property of a star? (I.e. that physical property which determines where it lies on the main sequence?)
___ temperature
___ mass
___ luminosity
___ radius

What is the main-sequence (hydrogen core burning) lifetime for stars like the Sun?
___ 10 million years
___ 10 billion years
___ 100 million years
___ 100 billion years

Why is the depletion of hydrogen in the core of a star such an important event?
___ It means the star is about to die immediately.
___ The star is about to explode.
___ The star will begin to change its structure drastically.
___ The star will begin to produce less and less energy until it becomes a black dwarf.

What is the helium flash?
___ A flare that occurs on the surface of solar-type stars.
___ The rapid fusion of helium in the electron-degenerate core of a red giant.
___ The explosion that creates a planetary nebula.
___ The flash of light given off when a star collapses into a white dwarf.

At what stage do the evolution of high- and low-mass stars diverge?
___ After the formation of a carbon core.
___ Immediately after leaving the main sequence.
___ While on the main sequence.
___ At the start of hydrogen-shell-burning.

What is a planetary nebula?
___ The disc of material around a young star that will eventually form a solar system.
___ The ejected envelope of a giant low-mass star.
___ The destroyed remains of a planetary system when a star becomes a red giant.
___ Globular clusters that looked like a cloud of gas to early astronomers.

A white dwarf with an accretion disk is in a binary system. Suddenly it flares, but in a few months settles back to normal. What is it?
___ planetary nebula
___ core-collapse supernova
___ nova
___ carbon-detonation supernova

The formation of a(n) ____ core ultimately leads a massive star to become a supernova.
___ carbon
___ iron
___ helium
___ silicon

The Crab Nebula is now about 1 LY in radius. If it was observed to explode in AD 1054, roughly how fast is it expanding? (Assume constant velocity.)
___ 900 km/s
___ 1000 km/s
___ 2000 km/s
___ 1500 km/s

What distinguishes a nova light curve from the light curves of supernovae?
___ peak brightness is much less
___ return to normal brightness takes only a few months
___ the flare producing the nova may repeat many times
___ all of these

Why do the cores of massive stars evolve into iron, not heavier elements?
___ Fusion of heavier elements disrupts the stability of the core because is takes energy from its surroundings.
___ Iron is the heaviest element that can be formed by fusion.
___ The temperature never gets high enough to allow the fusion of heavier elements.
___ The star goes supernova before the core has a chance to make heavier elements.

A certain telescope can just barely detect the Sun at a distance of 10,000 LY. What is the maximum distance at which it could detect a supernova with a peak luminosity of 10^{10} solar luminosities?
___ 10^7 LY
___ 10^8 LY
___ 10^9 LY
___ 10^{10} LY

The H-R diagram for a particular star cluster shows a main sequence region and a turnoff point which is very sharply defined, i.e. the stars fall on a narrow line which branches away at a well-defined point rather than in a broad band. We can conclude, therefore, that:
___ The chemical compositions of the stars in the cluster are all very similar.
___ The stars in the cluster all have nearly the same temperature.
___ The stars in the cluster all have nearly the same age.
___ The cluster is too far to measure the distance to using trigonometric parallax.