equations 2.14
2.16

Horizontal → equatorial
(a, A) ← (δ, α)
sidereal time: θ − α = h

Eq 2.16 Zenith →

① $\sin A \cos a = \sin h \sin \delta$ "From horizontal to equatorial"

② $\cos A \cos a = \cos h \cos\delta \sin\phi - \sin\delta \cos\phi$

~~$\cos h \cos\delta \cos\phi +$~~

③ $\sin a = \cos h \cos\delta \cos\phi + \sin\delta \sin\phi$

in the case $h = 0$ "upper culmination"

in ③ $\sin a = \cos 0 \cos\delta \cos\phi + \sin\delta \sin\phi$

$\sin a = \cos\delta \cos\phi + \sin\delta \sin\phi$ → $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\sin a = \cos(\delta - \phi)$

→ $a + \delta - \phi = 90°$

$a = 90° - \phi + \delta$ because cos is an even function

or $a = 90° + \phi - \delta$ then $\cos\theta = \pm\sin(\ldots)$

$\sin\lambda = \cos c$

$\lambda = 90° - c$

or $\lambda = 90° + c$

2.6 and 2.12, we find substitutions into (2.5):

$z = 90° - \phi$. (2.13)

2.5 The Equatorial System 19

→ When $h = 0$

$$a = \begin{cases} 90° - \phi + \delta, & \text{object culminates south of zenith} \\ 90° + \phi - \delta, & \text{object culminates North of zenith.} \end{cases}$$

When $a = 0$ → object is on the Horizon

$a = 90° - \phi + \delta = 0$

$\delta = \phi - 90°$

If $\delta > \phi - 90°$ → $a > 0$ (+) we can see object (above horizon)

If $\delta < \phi - 90°$ → $a < 0$ (−) → we can't, below.

Case $h = 12h$

$\sin a = -\cos\delta\cos\phi + \sin\delta\sin\phi$

$\sin a = -\cos(\delta + \phi)$ → $\sin -a = \cos(\delta + \phi)$

$-a + \delta + \phi = 90$

$a = \delta + \phi - 90°$

$a = (+)$ $\delta + \phi > 90°$ → $\delta > 90° - \phi$ object above horizon

Ex Eq 2.16, $h = 12h$, $\phi = 32°$, Find δ at which object can be seen?

7) Write down the second Kepler law and explain it. **(2 points)**

The radius vector of a planet in orbit sweeps equal Areas in equal amounts of time. ($\dot{A}$ = constant = $\frac{1}{2}k$)
This means that a planet moves faster when it's closer to sun or any other object that it orbits around, and slower when it's farther.

2

8) The speed of light $c = 3.0\times10^8$ m/s. Express c in astronomical units per minute. **(1point)**

$$3*10^8 \frac{m}{s} * \frac{1AU}{1.4959787*10^{11} m} * \frac{60\ s}{1\ min}$$

$$= 0.120322568$$

c= 0.120322568 AU/min

1

9) The perihelion and aphelion of the orbit of Eros are 1.1084 and 1.8078 astronomical units from the Sun. What is the velocity of Eros when its distance from the Sun equals 1.524 astronomical units? **(4 points)**

$$a = \frac{1}{2}(a_{peri} + a_{aph})$$

$$\Rightarrow 2a = 1.1084 + 1.8078 = 2.9162\ AU$$

$$a = \frac{-\mu}{2h} \Rightarrow h = \frac{-\mu}{2a}$$

$$\frac{1}{2}V^2 - \frac{\mu}{r} = h = \frac{-\mu}{2a} \Rightarrow \frac{1}{2}V^2 = \mu\left(\frac{1}{r} - \frac{1}{2a}\right)$$

$$\Rightarrow V = \sqrt{2\mu\left(\frac{1}{r} - \frac{1}{2a}\right)}$$

$$= \sqrt{2*6.673*10^{-11}*1.989*10^{30}\left(\frac{1}{1.524*1.496*10^{11}} - \frac{1}{2.9162*1.496*10^{11}}\right)}$$

$$= 23.576\ Km/s$$

4

1) Rank the three astronomical objects: Sun, Earth and Moon according to their masses, greatest first. **(1 point)**

Sun > Earth > Moon

2) At the town of Birzeit, the geographic coordinates are: Latitude: $\phi = 32.01087°$ north and Longitude: $\lambda = 35.13119°$ East of Greenwich. Convert these coordinates to Time units, (Express it on the form 00h 00min 00sec). **(3 points)**

$\phi =$ 02 h 08 min 02 sec $\lambda =$ 02 h 20 min 31 sec

3) True or False **(1 point each):**

a. The sum of the angles of a spherical triangle is always greater than 180°. (.....T.....)

b. The sum of the angles of a spherical triangle is always 200°. (.....F.....)

c. When the sun is at the vernal equinox, its right ascension α and its declination δ are both zeros T

e. The Horizontal system has two coordinates: the altitude or elevation (*a*) which ranges between [-90°, +90°] and the azimuth (A) which ranges between [0°, 360°]. (.....T.....)

f. The hour angle (h) of an object grows at a steady rate due to the Earth's rotation. (.....T.....)

g. When a star is at upper culmination, its hour angle h =0. (.....T.....)

h. All latitude circles are great circles. (.....F.....)

i. According to the virial theorem, the potential energy (U) and the kinetic energy (T) of the system are related as: $< T > = - 2 < U >$. (.....F.....)

j. A radio telescope covers a frequency range in the visible spectrum region only. (.....F.....)

4) **(3 points)** Explain the effect of **Aberration** on the apparent direction of an object. Also estimate the maximum possible value of the aberration due to:

1- The orbital motion of the Earth around Sun.

2- The Earth's rotation

Aberration is the shift in the apparent direction of an object towards a moving observer's direction of motion.

1) Due to orbit around sun : 23"

2) Due to earth rotation : 0.3"

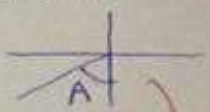
5) The coordinates of the moon at a given moment in a given location as follows: Latitude ϕ = 60.16°, right ascension α = 2h 55 min 7s, declination δ = 14° 42′, sidereal time Θ = 6h 19min 26s. Calculate the altitude (a) and the azimuth (A) of the moon at this location. Also, based on your calculations, decide whether the moon is above the horizon or not and in which quadrant. *(Hint, use the given formulas on the first page)* **(6 points)**

6

A = 61.96°

a = 31.5°

$a > 0$ above horizon



SW

above horizon, third quadrant

$\Theta = \alpha + h$, $\delta = 14 + \frac{42}{60} = 14.7°$

$h = \Theta - \alpha = 6.3238889 - 2.9186111 = 3.4052778$ hr

$h = 3.4052778$ hr $= 51.079°$

$\sin a = \sin h \cos\delta \cos\phi + \sin\delta \sin\phi \Rightarrow a = 31.5°$

$\sin A \cos a = \sin h \cos\delta \Rightarrow A = 61.96°$

6) The coordinates of Helsinki are 25° E and 60° N. The coordinates of Chicago are 88° W and 42° N. Find the distance between these two cities- in kilometers- along the shortest route. (Radius of Earth is 6370 km). **(4 points)**

4

$\cos\Psi = \sin\phi_1 \sin\phi_2 + \cos\phi_1 \cos\phi_2 \cos(\lambda_1 - \lambda_2)$

$= \sin(60°)\sin(42°) + \cos(60°)\cos(42°)\cos(25 - -88)$

$\Psi = 64.26°$

$D = R\Psi = 6370 \text{ Km} * 64.26° * \frac{\pi}{180°} = 7144 \text{ Km}$

6) At night, the diameter of the pupil of the human eye is about 5mm and the resolving capability of the eye is about 3′. If the diameter of the objective lens of a telescope is 100mm. Estimate a range for the useful magnification of such telescope. **(4 points)**

4

ω_{max} = 159

ω_{min} = 20

$\omega_{max} = \frac{e}{\theta} = \frac{eD}{\lambda} = \frac{3' * 100 \text{ mm}}{550 \text{ nm}}$

$= \frac{\frac{3}{60} * \frac{\pi}{180} * 100 \text{ mm}}{550 * 10^{-6} \text{ mm}}$

$= 158.66 \approx 159$

$\omega_{min} = \frac{D}{d} = \frac{100 \text{ mm}}{5 \text{ mm}} = 20$

3

6.5

Student Name: ..... ID: 1163113

1) Define the **inferior conjunction of Venus** as seen from Earth. Sketch the configuration of Earth, Sun and Venus when this occurs. **(2points)**

2) inferior conjunction of Venus is is happen when Venus is set behind Sun

2) A ***superior planet*** (planet outside the orbit of the Earth) is said to be in *opposition* when: **(1point)**

1) when is set behind the Earth

3) The configuration to the right represents which Astronomical phenomenon? Explain when it happens. **(2points)**

0.5) Eclipse ? Total Solar Eclipse

is happens when the moon is set between the sun and the earth

1) New moon 2) [illegible]

4) Name the terrestrial planets. **(2points)**

2) Mercury, Venus, Earth, Mars

5) What is the largest body in the solar system? **(1 point)**

1) ~~Jupiter~~ Sun

6) Based on the information in the table, decide the day and date of the FIRST day of Ramadan next month and explain why? **(2 points)**

In Birzeit in 2019: Newmoon is on May 5th at 01:45		
Day and date	Sunset time	Moonset time
Saturday, May 4th	19:21	18:54
Sunday, May 5th	19:22	19:54
Monday, May 6th	19:22	20:55

Monday / 4th June because the synodic month = 29.25 day

synodic month is between new moon - new moon

28/27

5.5/6

Student Name and number: Ahmed Awawda 1163113

1) Write down one condition for internal equilibrium in stars, define all symbols and their SI units

i) Mass density $\frac{dM_r}{dr} = 4\pi r^2 \rho$

ρ: density in $\frac{kg}{m^3}$

M_r: mass of shell with radius r and in Kg

r: radius of shell in the stars in (km)

2) The luminosity of the Sun is 3.9×10^{26} W, the mass of a proton is 1.00728 amu, and that of the He nucleus is 4.001514 amu (1 amu is 1.6604×10^{-27} kg)

a) How much energy in Joules is produced in each pp reaction in the Sun?

$E = (4 \times 1.00728 - 4.001514) \times 1.6604 \times 10^{-27}) * c^2$

$\Rightarrow E = 4.1253302 \times 10^{-12}$ J ok

b) How many pp reactions take place in the Sun every second?

$\#$ of P-P reactions $= \frac{L}{E_{p-p}}$

$= \frac{3.9 \times 10^{26} \frac{J}{s^{-1}}}{4.1253302 \times 10^{-12} J}$

$\Rightarrow \#$ of P-P reactions $= 9.4538 \times 10^{37}$ reaction/sec

$\int_0^P dP = -G M_r \int_R^{R/2}$

$\int_0^P dP = \frac{1}{4} \mu$

$\frac{3.9 \times 10^{26} \frac{J}{s}}{} = (X) \frac{4.12 \times 10^{-12} J}{sec}$

10.3 Stellar Energy Sources

235

Fig. 10.5. The proton-proton chain. In the

BIRZEIT UNIVERSITY
Physics Department

7.5

PHYS233: Astronomy

Quiz #1

Student Name and ID: Amera Masalmah 1161269

Useful constants and formulas:

a= 6378137 m, b= 6356752 m, $\tan\phi' = (b^2/a^2)\tan\phi$

Q1: At the town of Birzeit, the geographic coordinates are:

Latitude: $\phi = 31.959193°$ north and Longitude: $\lambda = 35.182007°$ East of Greenwich.

a) Express these Latitude and Longitude in Time units. (i.e. on the form: hh mm ss)

$\phi =$ 02h 07' 50"

$\lambda =$ 02h 20' 44"

3/3

0.3496487133

0.4586793

24h → 360°

? ← 31.959193°

2.130612867

-2

0.130612867

1h → 60°

0.130612867 → ?

7.836777207'

-7

0.836777207'

1' → 60"

0.836777207 → ?

b) The geocentric latitude ϕ' of Birzeit is (Express it in degrees, minutes of arcs and seconds of arcs)

$\tan\phi' = \frac{b^2}{a^2}\tan\phi$

$\phi' = 31.78661664°$

-31

0.78661664

47

12

2/2 31° 47' 12"

degree minutes of arc seconds of arc

Also state whether it is less or greater than the geographic latitude.

0.5/0.5 less than the geographic latitude

0.5/1

Q2: Define Parallax and its effect on locating objects in the sky

Parallax: difference of the observed direction

0.5/1

Q3: When the sun is at the vernal equinox, its right ascension $\alpha =$ 0°

Its declination $\delta =$ 0°

1/1

7/7

Physics Department

PHYS233: Astronomy

Spring 2018-2019. Quiz #3

Student Name and ID: Ahmed Awawda 1163113

(2.5)

1) Write down one condition for internal equilibrium in stars, define all symbols and their SI units

$\frac{dM_r}{dr} = 4\pi r^2 \rho$ ✓ (M_r: the mass of parts in the ring or mass of the shell (sphere) with radius r unit kg)

(r = radius of the shell unit meter)

(ρ: density unit $\frac{kg}{m^3}$)

2) Complete the First reaction in the pp chain.

$^1H + {}^1H \rightarrow {}^2_1H + e^+ + \nu_e$ ok → neutrino

(positron)

(1.5)

3) The mass of a proton is 1.00728 amu, and that of the He nucleus is 4.001514 amu (1 amu is 1.6604×10^{-27} kg).

a) How much energy in Joules is produced in each pp reaction in the Sun?

$E = \Delta m c^2 = ((4 \times 1.00728 - 4.001514) * 1.6604 \times 10^{-27}) \times (3\times10^8)^2$

$\Rightarrow E = 4.125302 \times 10^{-12}$ J ✓

(2)

b) How many helium atoms are made for each Joule of energy generated?

$\#\text{ of reaction} = \frac{1\ J}{4.125 \times 10^{-12}\ J} = 2.42 \times 10^{11}$ reaction

$\#\text{ of atoms} = 2.42\times10^{11}\ \text{reaction} \times \frac{1\ \text{He atom}}{1\ J}$

$\#\text{ of atoms} = 2.42\times10^{11}$ atoms/Joule ✓

(1

5.5/6

Student Name and number: Ahmed Awawda 1163113

1) Write down one condition for internal equilibrium in stars, define all

3) Explain the Solar Neutrino Problem and say if it has been solved or not (1.5 points)

there is a deficit between the measured flux of neutrinos from the Sun theoretically and the experimental (is less than theoretically the expected number of solar neutrino emitted by given a determined accurate of the Sun's internal operation. Yes, we solved it the traveling neutrino oscillate

4) The critical mass is on the form $M = CP^aG^bp^c$, where C is a dimensionless constant, P the pressure and the density ρ. Determine the constants a, b and c based on dimensional analysis. **(1.5 points)**

a= $\frac{3}{2}$ b= $\frac{3}{2}$ c= 2

5) The semimajor axis of the minor planet 1982RA is 1.568 AU and the distance from the Sun on October 8, 1982, was 1.17 AU. Find its velocity in SI units. **(2 points)**

$v = \sqrt{2\mu\left(\frac{1}{r} - \frac{1}{2a}\right)}$

v= 6.5044 AU/a

≈ 31 Km/s

6) The Temperature gradient is one of the Internal Equilibrium Conditions of a star given by the differential equation: define all symbols and their SI units. **(3 points)**

$$\frac{dT}{dr} = \left(-\frac{3}{4ac}\right)\left(\frac{\kappa\rho}{T^3}\right)\left(\frac{L_r}{4\pi r^2}\right)$$

K : mass absorption coefficient (unit kg)

r: radius of the star unit in (m) C : speed of light (unit $\frac{m}{s}$)

P ; density unit in $\frac{kg}{ms}$, T : Temperature in kelvin (K)

L ; luminosity in Watt , a : radiation constant (unit $g.m^{-1}K^{-4}$)

luminous flux

7) Calculate The acceleration of gravity at the Solar Surface in (m/s^2). Compare it to the acceleration of gravity at the surface of Earth ($g_{earth} = 9.8\ m/s^2$). **(1.5 points)**

g_0= 274 m/s^2

$F = -\frac{G m m_0}{r^2} = m_0 g$

Part I: True or False: (18 points)

1. The *terrestrial* (Earth-like) planets are more dense than the *Jovian* (Jupiter-like) or *giant* planets. (.....T.....)
2. The Earth's satellite, *the Moon*, circles the Earth counterclockwise. (.....T.....)
3. When the Moon is close to its perigee, its speed is greater than average. (.....T.....)
4. The center-of-mass of the Moon-Earth system is located inside Earth. (.....T.....)
5. The hour angle (h) of an object grows at a steady rate due to the Earth's rotation. (..F..)
6. The sidereal day is shorter than the solar day. (.....T.....)
7. As a *protostar*, the Sun started cooler and more luminous than it is today. (.....F.....)
8. *Inferior planets* (Mercury and Venus) are never in opposition. (.....T.....)
9. The configuration to the right shows the Sun, Moon and Earth during a total solar eclipse. (.....T.....)

10. The midnight sun can be seen in Palestine. (.....F.....)
11. About 3 days after the newmoon, the waxing crescent moon can be seen in the eastern evening sky in Palestine.(.....T.....)
12. The Chromosphere is the innermost layer of the solar atmosphere. (.....T.....)
13. When the Moon is in its perigee, the distance between its center and Earth center is about 406700 km. (.....T.....)
14. The diameters of the *terrestrial* (Earth-like) planets are much larger than those of the *Jovian* (Jupiter-like) or *giant* planets. (.....F.....)
15. Venus is the closest planet to the sun. (..F.....)
16. The Giant phase is the longest phase in stellar evolution. (.....T.....)
17. In the HR diagram, stable stars with the smallest mass and lowest temperature are found in t upper left corner of the diagram. (.....T.....)
18. For a star, the dynamical time scale is longer than the nuclear time scale. (.....T)

$t_d \leq t_n \leq t_n$

art II: Exercises

1) Name one constant of motion in celestial mechanics. **(1 point)**

.....

2) The synodic month of the Moon is defined as **(1 point)**

Mean that the number of days it found from full moon to full moon

3) Explain the Solar Neutrino Problem and say if it has been solved or not (1.5 points)

There is a deficit between the measured flux of neutrinos from the Sun theoretically and the experiments which the experimentally is less than theoretically. The expected number of solar neutrino was computed using the standard solar model by gives a detailed account of the Sun's internal operation. Yes, we solved is the [illegible] in his travelling neutrino oscillate to each into three forms ν_e, ν_τ [illegible]

4) The critical mass is on the form $M = CP^aG^b\rho^c$, where C is a dimensionless constant, P the pressure and the density ρ. Determine the constants a, b and c based on dimensional analysis.(1.5 points)

a= $\frac{3}{2}$ b= $\frac{3}{-2}$ c= 2

5) The semimajor axis of the minor planet 1982RA is 1.568 AU and the distance from the Sun on October 8, 1982, was 1.17 AU. Find its velocity in SI units. (2 points)

v= 6.5044 AU/a

$\approx$ 31 Km/s

$$V = \sqrt{2\mu\left(\frac{1}{r} - \frac{1}{2a}\right)}$$

6) The Temperature gradient is one of the Internal Equilibrium Conditions of a star given by the differential equation: define all symbols and their SI units. (3 points)

$$\frac{dT}{dr} = \left(-\frac{3}{4ac}\right)\left(\frac{\kappa\rho}{T^3}\right)\left(\frac{L_r}{4\pi r^2}\right)$$

K : mass absorption coefficient (unit kg)

r: radius of star unit in (m) C: speed of light (unit $\frac{m}{s}$)

P: density unit in $\frac{kg}{m^3}$, T: Temperature in kelvin (K)

L: luminosity energy flux in watt, a: radiation constant (unit $g \cdot m^{-1} K$

7) Calculate The acceleration of gravity at the Solar Surface in (m/s^2). Compare it to the acceleration of gravity at the surface of Earth (g_{earth} = 9.8 m/s^2). (1.5 points)

$g_\odot$= 274 m/s^2

$$F = \frac{-G m_1 m_2}{r^2} = m_\odot g$$

8) The time interval between two successive oppositions of Mars is 779.9 days. Calculate the semimajor axis of Mars' orbit in AU. (Hint: use Kepler's third law with $M_\sigma \ll M_\odot$). **(2 points)**

$P^2 = \frac{4\pi^2}{G(m_1+m_2)} a^3$

$a_\sigma =$ 1.658777 AU

$4.540517205 \times 10^{15} = \frac{}{G(1.989 \times 10^{30} \times 3)}$

$\Rightarrow a^3 = 1.528065414 \times 10^{33}$

9) Find the distance in km between Ramallah $(\varphi, \lambda) = (31.89804°N, 35.20427°E)$ and New York City $(\varphi, \lambda) = (40.7128°N, 74.0060°W)$ along the shortest route. **(1.5 points)**

9.152,105 km.

10) The right ascension (α) of the Sun on June1, 1983, was 4h 35min and declination (δ) 22°. Find the ecliptic longitude (λ) and latitude (β) of the Sun and the Earth. Express your answer on the form: 00° 00'. **(2 points)**

$\alpha = 4h\ 35\ min = 68.75$

$\delta = 22°$

24 h → 360°

$\lambda_\odot =$ 69°05' $\beta_\odot =$ 19° 42'

$\lambda_\oplus =$ 249°05' $\beta_\oplus =$ 19° 42'

11) The mass of a proton is 1.00728 amu, and that of the He nucleus is 4.001514 amu.

a. How much energy is produced in ONE ppI reaction. Express your result in units of Joule and in units of eV. ($1eV = 1.6 \times 10^{-19}$ J). **(2 points)**

$1eV \longrightarrow 1.6 \times 10^{-19}$ J

$X \longleftarrow 4.125330 2 \times 10^{-12}$

4.12.63302 $\times 10^{-12}$ Joule 25.783.313.75 eV

$= 25,783313\ 75 \times 10^{6}$

b. How many pp reactions take place in the Sun every second? **(1 points)**

9.4538 $\times 10^{37}$ reaction /sec

c. How many neutrinos produced in these pp reactions in one second? **(1 points)**

1 n.....every.....p.p.....reaction $\#\nu_e =$

3) Explain the Solar Neutrino Problem and say if it has been solved or not (1.5 points)

there is a deficit between the measured flux of neutrinos from the Sun theoretically and the experimental (is less than theoretically the expected number of solar neutrino emitted by given a determined accurate of the Sun's internal operation. Yes, we solved it the traveling neutrino oscillate

4) The critical mass is on the form $M = CP^aG^bp^c$, where C is a dimensionless constant, P the pressure and the density ρ. Determine the constants a, b and c based on dimensional analysis. **(1.5 points)**

a= $\frac{3}{2}$ b= $\frac{3}{2}$ c= 2

5) The semimajor axis of the minor planet 1982RA is 1.568 AU and the distance from the Sun on October 8, 1982, was 1.17 AU. Find its velocity in SI units. **(2 points)**

$v = \sqrt{2\mu\left(\frac{1}{r} - \frac{1}{2a}\right)}$

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6) The Temperature gradient is one of the Internal Equilibrium Conditions of a star given by the differential equation: define all symbols and their SI units. **(3 points)**

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K : mass absorption coefficient (unit kg)

r: radius of the star unit in (m) C : speed of light (unit $\frac{m}{s}$)

P ; density unit in $\frac{kg}{ms}$, T : Temperature in kelvin (K)

L ; luminosity in Watt , a : radiation constant (unit $g.m^{-1}K^{-4}$)

luminous flux

7) Calculate The acceleration of gravity at the Solar Surface in (m/s^2). Compare it to the acceleration of gravity at the surface of Earth ($g_{earth} = 9.8\ m/s^2$). **(1.5 points)**

g_0= 274 m/s^2

$F = -\frac{G m m_0}{r^2} = m_0 g$