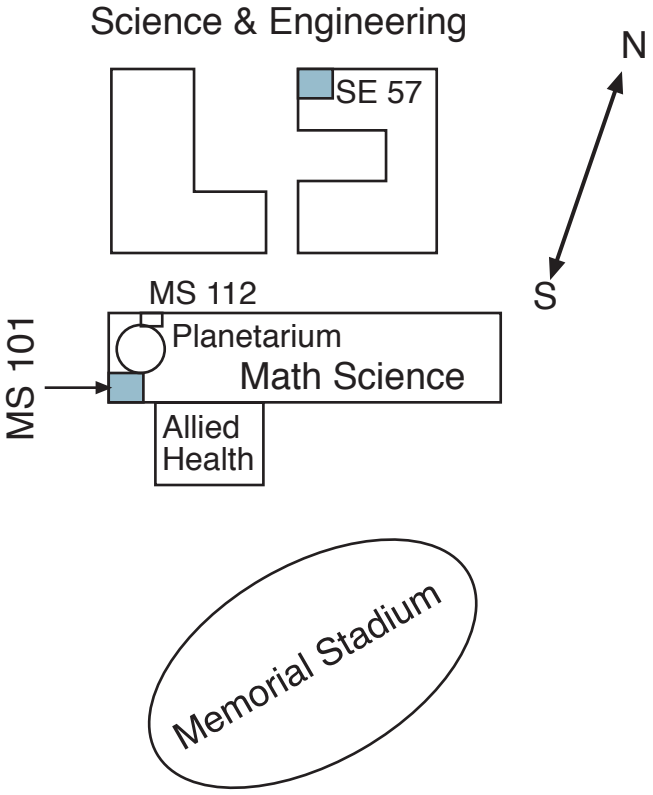



Spring semester
**Instructor: Nick Strobel**
**Office:** MS 101, 395-4526 (leave a message if I'm not there)
also: **nstrobel@bakersfieldcollege.edu**.
**Department Office:** SE 57, 395-4401 (another place to leave messages)
**Lectures:** MW 8 to 9:25 AM in the Planetarium (MS 112)
**Office Hrs:** TTh 12:10 – 1:40 pm in MS 101
**Required Texts:** ***Life in the Universe*** (3rd edition) at campus bookstore and the *Astronomy B2 Student Guide* at campus bookstore
**Prerequisites:** Reading Level 5
**Recommended:** First semester college algebra.
Astronomy class website:
`http://inside.bakersfieldcollege.edu` and choose the ASTR B2 link for the current semester

**Course Overview:**

Astrobiology is the scientific study of the origin, evolution, distribution, and future of life in the universe. The study of astrobiology (from "astronomy" + "biology") brings together researchers from historically separate scientific fields such as astronomy, microbiology, ecology, geology, paleontology, and chemistry and encourages them to work together to answer among the most fundamental questions science can pose: What is life? How did we get here? Are we alone in the universe? How can we tell if we are?

We begin by studying life on Earth, the only place in the universe where we know life exists. How did life begin here? How has it responded to changes in the environment? How has it changed the environment? What conditions does earthly life need to exist?

Then we look beyond Earth to the possibilities of life elsewhere. Most of life on the Earth is microbial, and it is likely that microorganisms will be the type of life we will find elsewhere in the universe. Astrobiologists try to figure out how to search for microbes and other life on the planets and moons in our Solar System and on Earth-like planets orbiting other stars. How do you detect evidence of biology when you cannot hold a soil sample in your hand? Does life leave its mark on a planet so that we can detect its presence remotely? Is life common? Or is our life-filled Earth rare and unique?

Finally, even more significant would be to find complex life (multi-cellular life more complex the microbes), especially self-aware, intelligent life capable of communicating ideas in a symbolic language across the vastness of empty space. How would we detect them? How would we communicate with them? Should we?

**Learning Outcomes:**

At the end of the Life in the Universe (Astr B2) course, the successful student **will be able to:**

1. Demonstrate a correct understanding of the cause of a given phenomenon, the physical nature of a given object including the chemical, molecular, and cellular nature of Life, and the properties and processes of a habitable world [this is the "what we know" SLO]
2. Describe the scientific method, give the evidence for an explanation and describe the technique(s) used in determining either the property of something including extra-terrestrial life, how it interacts with its environment, or its origin and history [this is the "how we know" SLO]

3. Solve word problems and apply concepts to new situations not given in the book or in lecture using logical, deductive reasoning.
4. Use a computer to locate information on the internet.

**Grading:** Your grade will be based on your performance on three exams (each about 11% total grade) + final (about 18% total grade), 8 homework assignments posted on the web (about 15% total grade combined), 11 quizzes (about 26% total grade combined), & in-class projects – classroom participation (about 8% total grade combined). All points will be added up and the sum divided by the maximum possible. **The course grade will be determined by the following percentage scale:**

**90 – 100% = A, 80 – 89.9% = B, 65 – 79.9% = C, 50 – 64.9% = D, below 50% = F.**

The *homework* assignments will stress **critical reasoning** (and some computation). All of them will be due by the *beginning* of class on the due date. Homework assignments may be turned in via email in `plain text format`—**NO word processing file attachments**. Exam questions are drawn partly from the required homework assignments. Homework assignments are posted exclusively on the class website. Do your own work—see cheating policy below. **No late (including tardy) homework assignments will be accepted.**

Quizzes & exams are multiple-choice format. The exam material will be drawn from homework, quizzes, in-class projects, lectures, and the textbook review questions. The exams are *closed book*—no live or electronic help, except a calculator, is allowed. Dates for exams are given at the end of the syllabus and also on the class website. **There are no make-up quizzes or exams without hardcopy documentation of a medical or legal emergency from an officially-recognized neutral third party.** Any other reason, **including work schedules**, will ***not*** be accepted. You will need to do the quiz or exam make-up the week of your return. If you have another school/work activity or family event that prevents you from taking the exam or quiz on the given date, *you* will need to arrange with the instructor an alternate quiz/exam time that is **before** the given date.

**Your Role + Expectations:**

**Your role: I expect you to take responsibility for your own learning.** This a voluntary college course that meets just two times a week for 85 minutes a lecture. Because of the limited time spent in class, you will need to spend **at least** 6 hours a week *outside* of class reviewing lecture material, reading the textbook, and doing the homework assignments. You will not pass if you only attend every lecture and do just the in-lecture-period work. Your grade is determined only by *your* performance on the required assignments not on "how well I feel you did". ***It is possible in a college course to get an "F" if your performance on the required assignments is below the "D" threshold regardless of the effort you put into the course.***

- **Be prepared to learn astrobiology when you come to lecture.** Conversing with your neighbor about something unrelated to the topic of the class prevents you and them from learning the concepts and makes it very difficult for other classmates to learn. **Turn OFF your cell phone in class!**
- **Take the initiative to seek clarification of the concepts.** As an adult, one needs to have the self-motivation to learn anything. I can only help you learn. I will present the material in as clear and logical way as I can and give assignments that require you to think critically about the concepts. Then it is up to you. I expect you to ask questions when you do not understand something, either in class or in office hours or via email.
- **Astrobiology deals with some very mind-expanding stuff** requiring sophisticated abstract and logical thinking so you will need to give your brain **TIME** to mull over and digest the concepts. Finding sufficient **TIME** to study the concepts and think and synthesize the concepts is the greatest stumbling block to students. Students who try to cram their studying in the day before an assignment is due get D's and F's.
- Attendance in lecture is voluntary. If you miss a lecture, I expect you to see me after class or in my office or check the class website to find out what you missed. **If you miss four or more classes during the semester or an exam, you *MAY* be dropped from the course. *However,*** do not assume that I will automatically do this for you. If you wish to drop, then drop via InsideBC (`https://inside.bakersfieldcollege.edu`).
- **If you are tardy, I expect you to enter quietly and sit in the BACK of the room without disturbing anyone.**
- Use the study tips in the Astronomy Notes website. They include how to more efficiently and effectively use your textbook to succeed in the class and tried-and-true techniques for taking multiple-choice exams.

- Students with disabilities who believe they may need accommodations in this class are encouraged to contact Disabled Student Programs & Services at Student Services Building, 1st Floor, Counseling Center, 395-4334, as soon as possible to better ensure such accommodations are implemented in a timely fashion.
- How will you succeed at BC this semester? What determines success is not circumstance, but habit. **Habits of Mind, It's POSSIBLE at BC** has many free tools intended to help you accomplish your goals in school. Only you can overcome the challenges you face this semester and in life. Start out successfully with these steps:

  1. Visit the **Habits of Mind** website: www.bakersfieldcollege.edu/habits-of-mind .
  2. Download the app for Habits of Mind at Bakersfield College for power in your palm.
  3. Ask for help, do the work, and refuse to quit.

  Success takes energy, planning, and strategies for both the expected challenges in school as well as the unexpected twists life can take. Ask your professor for more information. Now is the time to develop new habits.

## Late Assignments

**Absence for an exam or quiz will result in zero credit.** In the event of an unavoidable and *documented* medical or legal emergency that prevents you from taking a quiz or exam, I will consider a make-up quiz or exam on an individual basis. **Work schedules are not valid excuses.** The documentation must be from an officially-recognized neutral third party. You must take the exam or quiz the week of your return. Abuse of this policy will void your privilege of a make-up exam or quiz. It is possible to take the exam or quiz *early* in the case of medical, legal, or job conflicts. Exam and quiz dates are given on the class website. The Final Exam will be comprehensive and will be on the date given in the printed class schedule.

**Homework are due at the beginning of class** on the given due date. **No late homework (including tardy!) will be accepted.** If you are sick, have a classmate turn it in. **Assignments, including quizzes and exams, can always be turned in *EARLY*.**

I do not like people distracting their classmates by turning in something tardy after I have started instruction! *If you are tardy when a homework assignment is due, do NOT turn it in at all.* I want you to pay attention in class, not work on assignments that should be completed beforehand. Turn the assignment in the lecture before if you plan to miss class or be unavoidably late! You can also email me the homework **but** only if they are emailed by **the beginning of class time** of the due day (not a minute or more later!!). Emailed assignments sent after the beginning of class time will simply be returned with no credit. **The emailed assignments *must* be in the BODY or your email message—no file attachments.**

**Absence of an in-class project (not pop quizzes or homework) will result in half credit** provided the work is made up within one week of the day when the project is given. Make-up of an in-class project requiring one of us to set something up will have to be done at a time that is convenient for *me*, the instructor. I will be lenient in the case of unavoidable and *documented* medical or legal reasons. Other miscellaneous (and missed) in-class activities that may contribute to your participation grade will be dealt with on an individual basis.

**Cheating:** By cheating, you are being unfair to yourself and your classmates. Cheating is defined as not doing your own work on class assignments or on exams. There is a distinction between being helped by someone and copying someone's work. State your answers to the homework in your **own** words. Do NOT show your written (or electronic) copy of your assignment to other classmates. If you help someone out, be sure that they can articulate their response in their own words. **NO group solutions!** If copying is noticed by me, each person will get a fraction of the total group's solutions grade. Cheating on an exam will result in zero credit with no make-up possible. **Permitting someone to copy from you is just as bad.** It takes less effort to play fair than to devise clever ways of deceiving your instructor and classmates.

Repeated or flagrant examples of cheating may result in expulsion from the class and assignment of a grade of "F", in accordance with Bakersfield College academic policy. In addition the instructor will report such cheating to the College Administration, who may apply additional penalties, including ones possibly

as severe as expulsion from the College, and placing a permanent mark on the student's academic record.

**Exam Dates:**

**Exam 1: Wednesday, February 19.** **Exam 2: Wednesday, March 19.**
**Exam 3: Wednesday, April 23.**
**Final: *Wednesday*, May 14 at 8 AM for 1 hr 50 min. The final is "cumulative", "comprehensive" = over the entire semester's material.**

**Introduction and Scientific Method**
**Lecture outline --** 1

**Reading:** chapter 1 and sections 2.3 and 3.2 in ***Life in the Universe***

Vocabulary terms used:
**extra-terrestrial life—**life beyond Earth.
**exoplanet—**planets orbiting other stars besides the Sun (also called "extrasolar planets").

**astronomical unit—**average distance between the Earth and the Sun (149.6 million kilometers). Used for inter*planetary* distances. Abbreviated with "AU".
**light year—**distance light travels in one year (9.461 trillion kilometers, over 63,000 AU!). Used for inter*stellar* distances.

**model—**an abstraction that is a simplified view of reality.
**theory—**a logical, systematic set of principles or explanation that has undergone testing or validation from careful observations and has stood up against attempts to prove it false. A scientific theory can be used to make a variety of predictions of what will happen under different circumstances**.**

# Outline

**Universe of Life?**

What do we mean by life?

Possible definitions _____

Why such great interest now?

_____

_____

_____

What does Astronomy say?

_____

_____

What does Planetary Science say?

_____

_____

What does Biology say?

_____

_____

_____

Conclusion: _____

**Introduction and Scientific Method**
**Lecture outline --** 2

**Astrobiology**

What the word means _____

Three things it studies

1. _____
2. _____
3. _____

Sense of Scale (section 3.2 of textbook)

Size (solar system model)

If Pluto's orbit is size of quarter, next star is how far away _____

Milky Way Galaxy is size of _____

Time (cosmic calendar)

If entire 13.7 billion year history of universe squeezed to one cosmic year:

Origin of universe = _____
Formation of solar system = _____
Life on Earth began = _____
Surface life appeared = _____
First modern humans (Homo Sapiens) appeared = _____
All of recorded human history = _____

If universe's history was put on the solar system model between the Sun and Uranus, then each big step (1 meter) would equal _____ years.

The solar system formed_____ steps beyond Saturn = _____ years ago.

Life began_____ steps beyond Saturn = _____ years ago.

All of human history_____

Figuring out how things work (section 2.3 of textbook)

Observe
Generalize
What separates a scientific theory or model from other types of explanations:_____

Observe + experiment
Revise, expand, or reject the theory/model

What is the sole judge of scientific truth: _____

"Scientific truth" — _____

Assumption #1: _____

Assumption #2: _____

Self-imposed limitation: _____

**Introduction and Scientific Method**
**Lecture outline --** 3

Communicate results in clear, logical fashion & Peer Review

Value of Astronomy

Bogus Science Signs

Why/how astrology is not a science

**History of Astronomy (Science)**
**Lecture outline –** 1

**Reading:** chapter 2 in ***Life in the Universe***

Vocabulary terms used:

**retrograde motion—**when a solar system object (e.g., a planet) moves "backward" (westward) with respect to its normal eastward drift against the stars. It happens when the Earth is closest to the object.

**paradigm—**a general agreement of belief of how the world works; what could be called "common sense".

**geocentric universe—**model of the universe with the Earth at the center and all other objects moving around it.

**epicycle—**a device in geocentric models that makes a planet execute a small circular motion around a point that is itself in a circular orbit around the Earth. An epicycle explains retrograde motion in a geocentric universe model.

**Occam's Razor—**a way of approaching the development of a scientific model based on the belief that "the best model is the simplest one—the one requiring the fewest assumptions and modifications in order to fit the observations" (i.e., nature prefers the simplest most elegant solution).

**heliocentric universe—**model of the universe with the Sun at the center and all other objects moving around it.

**semi-major axis—**the distance between the *center* of an elliptical orbit and one end of the orbit along the long dimension of the elliptical orbit. It equals the *average distance* between a planet and the Sun or a planet and its moon. It is 0.5 × major axis.

**perihelion—**closest point of an orbit around the Sun.

**aphelion—**farthest point of an orbit around the Sun. Perihelion+aphelion = major axis.

**focus—**one of two special points along the long axis of an ellipse such that the addition of the distances (satellite to focus#1) plus (satellite to focus#2) always equals the same numerical value. It is *not* at the center of the elliptical orbit unless the orbit is perfectly circular.

**eccentricity—**measures how far from a circular shape the ellipse is. Numerically, the eccentricity $\boldsymbol{e} = 1 -$ (perihelion / semi-major axis). The eccentricity $\boldsymbol{e} = 0$ for a circle and $\boldsymbol{e}$ = nearly one (1) for very long, skinny ellipses. <u>*Minor*</u> axis = major axis × Sqrt($1–e^2$) = width of the ellipse.

**velocity—**description of an object's motion that includes both speed AND the direction.

**acceleration**—a *change* in motion = (the **velocity** change)/(time interval of change). It involves a change in the speed (increase or decrease) OR direction OR both speed and direction.

**force**—something than can *cause* an acceleration.

**inertia**—the property of an object describing its tendency to stay at the same velocity (or rest) unless a force acts on it.

**Newton's 1st law of motion**—a body at rest remains at rest, and one moving in a straight line maintains a constant speed and same direction unless it is deflected by a **force**.

**mass**—the amount of material an object has; measures the amount of inertia an object has.

**Newton's 2nd law of motion**—the amount of force needed to cause an acceleration depends on an object's mass, such that the force applied = mass of an object × acceleration.

**Newton's 3rd law of motion**—for every action force ON an object, there is an equal but *opposite* force BY the object.

**History of Astronomy (Science)**
**Lecture outline –** 2

**Newton's law of gravity—**the force of mutual attraction between two objects = G×(mass #1) ×(mass #2) / (distance between objects)$^2$.
**weight—**the amount of gravity felt by an object.

# Outline

Peculiar motion of planets _____

**Ancient History**
Importance of Greeks _____

*Pythagorean paradigm:*
- Orbit shapes _____
- Speed of planets in orbits _____
- Position of the Earth _____

Aristotle
Earth vs. rest of universe _____
Implication for possibility of extra-terrestrial life

Ptolemy's model
Type of model _____
Why use **epicycles** _____

## Modern History

State of Ptolemy's model by time of Renaissance _____

Occam's Razor and Ptolemy's model

**Copernicus'** model
Type of model _____
Why develop this type of model _____

Orbit shapes + speeds _____
Position of Earth _____ position of Sun _____
How explain retrograde motion _____
Earth status and extra-terrestrial life: _____
Accuracy of Copernicus' model vs. Ptolemy's model _____
Major observation against Copernicus' model _____

**History of Astronomy (Science)**
**Lecture outline –** 3

**Galileo**

First person to _____

Discoveries _____

Observation that disproved geocentric model and why _____

How Galileo changed the method of science _____

**Johannes Kepler**

Why accurate observations are important _____

Kepler's motivating belief

Type of model he preferred _____

Replacement of the Pythagorean paradigm

**Kepler's first law:** shape of orbits _____ and position of Sun _____

**Kepler's second law:** orbit speeds _____ ; fast speed when _____ and slow speeds when _____

**Kepler's third law:** (planet's sidereal period in years _____) = (planet orbit's semi-major axis in AU _____). An AU = _____

Example of Kepler's 3rd law

How to draw an ellipse using two tacks and string looped around the tacks.

Focus corresponds to _____ in the drawing

Why accurate observations are needed to see elliptical nature of planet orbits ____

The eccentricity of typical comet orbits _____

**History of Astronomy (Science)**
**Lecture outline –** 4

**Isaac Newton**

What do you mean by "motion" or "*change* in motion"?

Speed = _____ / _____.

In the same time interval, greater speed means _____

In the same distance, smaller speed means _____

Difference between **velocity** and speed.

Examples of acceleration

Newton's three universal laws of motion

Given same force, which object accelerates more: _____

Size of force needed to move greater mass with same acceleration: _____

Size of reaction _____ amount of reaction _____

## Newton's law of gravity

force of gravity = ($G$ × _____× _____) / (distance _____). "$G$" is a number that is used in *all* calculations of gravity. Gravity is always attractive and attracts directly toward each object.

**Characteristics of gravity:** what gravity depends on.

- Mass increase ⇒ gravity _____
- Distance increase ⇒ gravity _____
- How distance is measured _____
- Composition dependence _____
- Range of gravity force _____

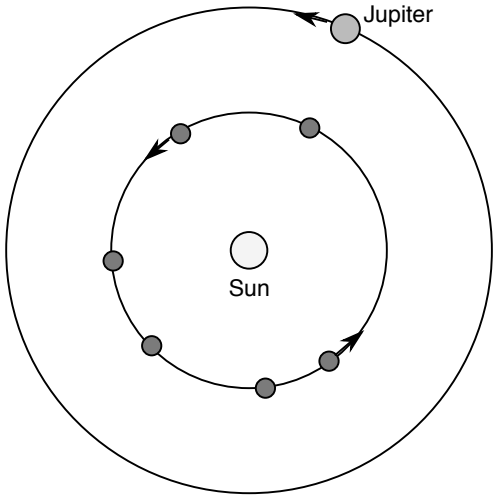
## How things fall (Galileo vs. Aristotle)

- Falling objects _____
- All objects fall with the _____ acceleration; dependence on mass _____
- Gravitational acceleration = G × (planet mass) / (distance to center _____)
- "Weightlessness" explained: at the same distance all objects fall or orbit _____

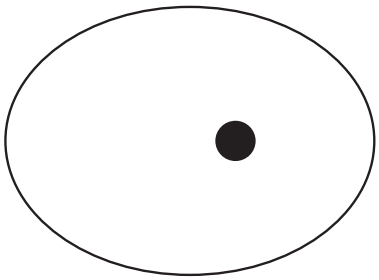
**Determining the mass of the Earth**

## 3.1 History of Astronomy

1. (0.5 pt) Circle the position of the Earth that will make Jupiter appear to move in a retrograde loop: (hint: see Figure 2.5 in the textbook.)

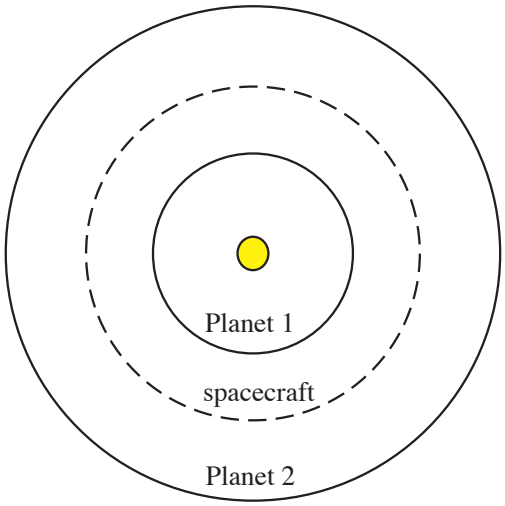



2. (0.5 pt) A moon's closest distance to a planet is 300,000 kilometers and its farthest distance is 500,000 kilometers. What is the *semi-major axis* of its elliptical orbit? Also, draw the semi-major axis length on the orbit figure below. (See Figure 2.7 in the textbook for help.)

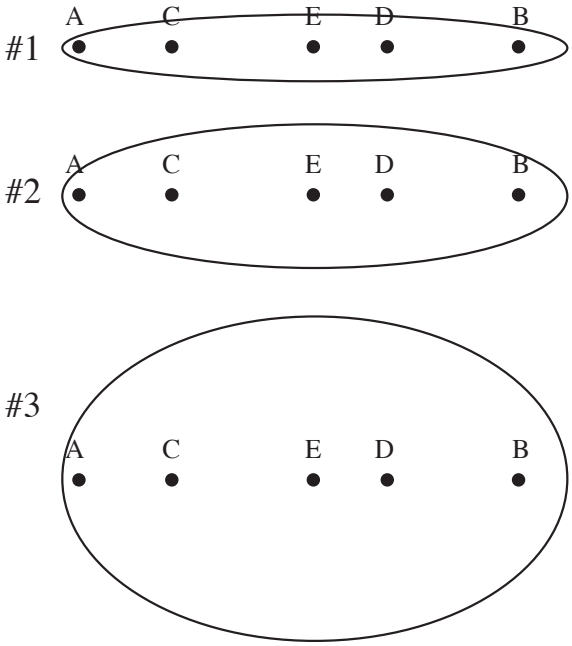


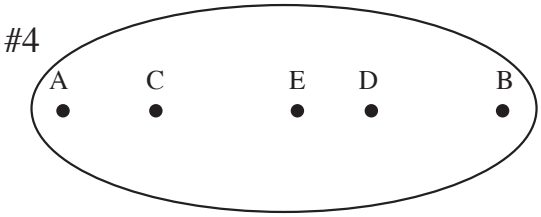
O V E R

3. (1 pt) NASA wishes to put a satellite into a circular orbit around the Sun with an orbital period of 16 years.




(a) Between which planets will this satellite orbit? Some planet orbital period you will need: Mercury–0.24 years, Venus–0.62 years, Earth–1.0 years, Mars–1.9 years, Jupiter–12 years, Saturn–29 years, Uranus–84 years, Neptune–165 years, Pluto–249 years. (Hint: how does the orbital period depend on distance?)




4. (1 pt) **Left column:** Match the focus position with the orbit number. You can use a focus letter only once. Position E is in the center. **Right column:** Match orbit number with the given eccentricity.

orbit #1 _____ 0.9 _____

orbit #2 _____ 0.8 _____

orbit #3 _____ 0.6 _____

orbit #4 _____ 0.45 _____