SAMPLE PAGES FOR

CHALLENGE THE 10TH GRADE SCIENCE

Florida **C**omprehensive **A**ssessment **T**est

RICHARD LEDBETTER

SANTA FE COMMUNITY COLLEGE

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6001-101 Chapel Hill Road, Raleigh, NC 27607 • (919) 851-8221

PLANETS

The solar system consists of the Sun, four inner and five outer planets, moons and some smaller objects. All of the planets and other objects in the solar system revolve around the Sun in a slightly elliptical orbit. *The planets have characteristics that are similar to and different from those of the Earth.*

What are the terrestrial planets?

The inner planets have the following traits: relatively small size, high density, few satellites or moons, and consisting mainly of rock and solid material. Since these planets all have a solid surface they are called the **terrestrial planets**.

Mercury is the closest planet to the Sun. It is about one-third the size of the Earth. It revolves around the Sun in about 88 days. Mercury has no atmosphere and no weather. This means that the planet has many craters that have remained unchanged. **Venus** is the second planet from the Sun. Venus and Earth are about the same size, yet Venus has 90 times as much atmosphere. Venus's atmosphere contains 96% carbon dioxide. Clouds on Venus are made of sulfuric acid instead of water, as on Earth. The temperature of the surface of Venus is over 600 ˚F. **Earth** is the third planet from the Sun. With an atmosphere of nitrogen and oxygen and lots of surface water, the Earth is an ideal place to for life. The fourth planet from the Sun is **Mars**. Mars is about one-tenth the mass of the Earth and one-half the Earth's volume. Mars has many craters, large mountains and valleys and an atmosphere composed mainly of carbon dioxide. There is evidence that water once flowed on Mars. But temperatures and pressures today do not support liquid water on the planet.

Saturn with its rings of ice and rocks

What are the gas giants?

The outer planets are called the **gas giants**. These planets are much farther from the Sun, so they are much colder than the inner planets. Ice, heavy atmospheres and lots of satellites are traits of the outer planets. Most of these planets are huge compared to the Earth. **Jupiter** is the fifth planet from the Sun. It has about 300 times the mass of the Earth and is about 1300 times the Earth's volume. Jupiter has a density slightly greater than that of water. Jupiter's atmosphere contains mainly hydrogen, helium, methane, and ammonia. Jupiter has four moons, rings, volcanoes, and giant hurricanes. **Saturn** is the sixth planet from the Sun. Saturn's atmosphere is similar to Jupiter's. Saturn is the second largest planet in the solar system, yet its density is so low that it would float on water. Saturn has an extensive ring system and two moons.

Uranus is the seventh planet from the Sun. It is the third largest planet in the system and has a density slightly higher than that of water. Uranus has a methane atmosphere, rings, and five moons. It takes Uranus 84 years to revolve around the Sun. That means winter lasts for 21 years on the planet. The good news is that summer lasts 21 years also. **Neptune** is the eighth planet from the Sun. Neptune is very hard to see because it is so far away from the Earth and the Sun. Neptune has eight moons, rings, and an active atmosphere like those of Jupiter and Saturn. **Pluto** is the farthest planet from the Sun. Pluto is about the same size as the Earth's moon. Pluto has a solid surface of frozen methane and a thin atmosphere of methane gas. Pluto has one moon. Pluto's orbit around the Sun is so elliptical that at some times Pluto is closer to the Sun than Neptune.

Can other planets support life?

Earth appears to be unique in its ability to support life as we know it in our solar system. Planets that have a solid surface, like Mars, Mercury, and Venus, each have at least one major limitation that hinders the development of life. Mercury is too hot, Mars has no oxygen , and it rains sulfuric acid on Venus. Planets without solid surfaces, like Jupiter and Saturn, have numerous other limitations on supporting life.

Further Study

terrestrial planets	gas giants	elliptical
Mercury	Venus	Mars
Jupiter	Saturn	Uranus
Neptune	Pluto	

Questions for you to answer

1. Which planet is closest to the Sun?

2. Which planet is farthest away from the Sun?

3. What is a major characteristic of the terrestrial planets?

4. What is a major characteristic of the outer planets?

5. Do any of the planets in our solar system have characteristics that allow the development and support of life? Please explain your response.

STARS

More than a billion, billion stars fill the universe. Some are very large and are called **supergiants**, while others, called **dwarfs**, are much smaller than our Sun. The distances between stars is huge compared to the distance from the Earth to our Sun. The star nearest our Sun is over 300,000 times the distance between the Earth and the Sun. Since the distances between stars are so large, these distances are measured in **light-years**. This is the distance light would travel in a year, which is about 9.5 trillion kilometers. Most stars make energy in the same way as the Sun.

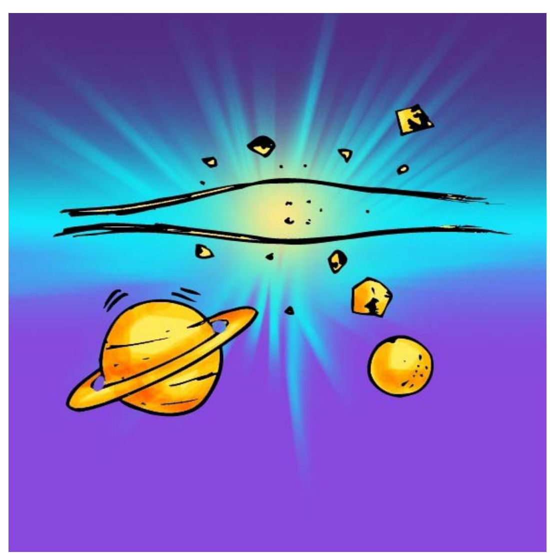
How close are stars?

The Draper classification system groups stars based on their temperature. The system ranges as follows: O, B, A, F, G, K, and M. Stars of the "O" type are blue-white in color and are the hottest. "M" stars are the coolest and appear red. The Sun is a "G" star.

Stars' life cycles last for billions of years. The **life cycle** begins when dust and gas collect into a **protostar**. The protostar then becomes a **main sequence** star. Our Sun is currently a main sequence star. *The development and ultimate death of stars has been categorized into three groups based on the stars' mass.* Stars like our Sun contract under their own weight as they run out of hydrogen. As the **core** heats up as it contracts, the outer layers of the star expand until it becomes a **red giant**. Helium then undergoes fusion and turns into carbon. Eventually the star cools and forms a **white** or **black dwarf**.

Do stars have a life cycle?

Stars more massive than our Sun will also fuse helium into carbon when their supply of hydrogen runs out. However, their greater mass provides the gravitational energy to continue fusing carbon into heavier elements such as iron. At this point the star collapses under its own gravity and heats up. The core eventually explodes in a **supernova,** releasing tremendous amounts of energy and matter into space. The core remains cool and forms either a **neutron star** or a **black hole**. *Stars with two to three times the mass of our Sun develop into neutron stars and those with five to six times the Sun's mass develop into black holes.*



A supernova explosion

Further Study

supergiant	dwarfs	light-years	life cycle
protostar	main sequence	core	red giant
white dwarf	black dwarf	supernova	neutron
star	black hole		

Questions for you to answer

1. Why is the distance between stars measured in light-years instead of meters or kilometers?

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2. Which star would be hotter, a white-colored star or an orange-colored star?

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3. What are the starting materials for all stars?

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4. At what point in its life cycle is our Sun?

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5. What is the future fate of our Sun?

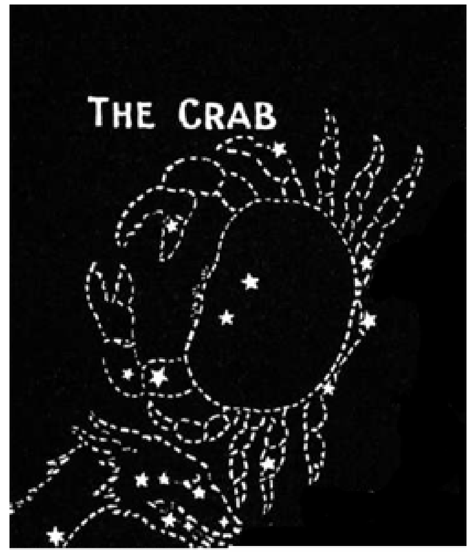
6. Which star is older, a main sequence star or a black dwarf?

7. A star has six times the mass of our Sun. What will be the eventual fate of this star?

GALAXIES

What is a constellation?

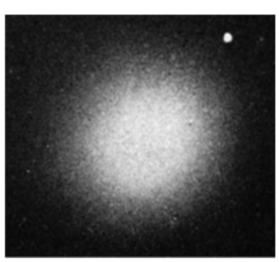
When looking up at the sky at night, it's hard to believe that what appears in the sky is only a fraction of the stars in the universe. *The universe is a vast collection of stars.* Billions and billions of stars make up the known universe. Stars occur in fixed patterns in the sky called **constellations**. These constellations appear to shift to the west a little bit each night. Scientists who study space, called **astronomers,** recognize 88 different constellations. Constellation names come from real and imaginary animals, or ancient gods or heroes. The constellations rarely look like the animal or hero they're named for. Some common constellations include Ursa Major, Orion, Hercules, and Draco.



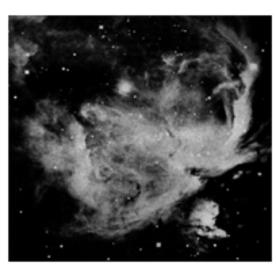
The Crab Constellation

What are the types of galaxies?

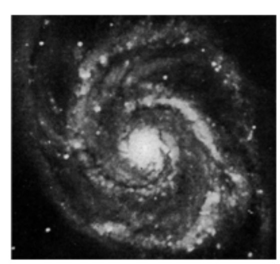
Stars cluster to form **galaxies**. Scientists estimate that about one trillion galaxies make up the known universe. Galaxies are typically about 100,000-light years across and are made up of over 100 billion stars. These galaxies and the stars that make them up share similar elements, forces, and forms of energy with the Sun. Astronomers classify galaxies by their shape into three major groups: **spiral**, **elliptical,** and **irregular.** Our solar system is part of the **Milky Way** galaxy. The Milky Way is a spiral galaxy. Our solar system, in a spiral arm of the galaxy, rotates around the center of the Milky Way about once every 200 million years.



Elliptical



Irregular



Spiral

Galaxies

Further Study

universe	constellations	astronomers	galaxies
Milky Way	spiral galaxy	elliptical galaxy	
irregular	galaxy		

Questions for you to answer

1. What objects make up the bulk of the universe?

2. What is a constellation?

3. What are constellations named after?

4. What is a galaxy?

5. Name and describe the shape of the three types of galaxies.

6. What is the name of the galaxy that contains our solar system?

7. Describe the motion of our solar system through our galaxy.

ASTRONOMICAL TIME AND DISTANCE

What is time?

Time. You probably know how to measure it, but it’s very hard to come up with a definition of time. **Time** is usually measured relative to the Sun’s apparent path in the sky. Days, years, seconds, and minutes are used to measure time by comparing the position and movement of the **Sun**. Natural events can occur over a wide range of times. For instance, lightning takes a fraction of a second to flash across the sky. The Moon takes about 28 days to complete its path around the Earth. A baby born today takes about 70 or 80 years to live his or her life. A star “lives” its life for billions of years.

How is distance measured?

Distances between different natural features also display a variety of measurements. The distance between the atoms of a molecule is about one millionth of a meter. The distance from the top of this page to the bottom is about one foot. The distance to Mars is about 100 million kilometers, while the distance across the Milky Way is about 100,000 light-years. A **light-year** is the distance light would travel in one year. This distance is about 9,500,000,000,000,000 meters.

Astronomical time and distance involves extremes rarely encountered in daily life. It’s hard to imagine a universe created in a fraction of a second. Or that light from the farthest galaxy has been traveling at 186,000 miles per second for over eight billion years to strike the Earth today. These ideas tend to defy our conception of time and space.

Further Study

time distance Sun light -year

Questions for you to answer

1. Why is time hard to define?

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2. How is time measured?

3. What is a light-year?

4. Why are light-years used to describe the distances to stellar objects?

5. The age of Earth is thought to be around four billion years. How could light have left the farthest galaxy eight billion light-years away and reach Earth today when the light left long before Earth was formed?

STELLAR EQUILIBRIUM

What is stellar equilibrium?

Gravity holds stars together. Gravity attempts to pull all materials to the center of the star. So why don't all stars immediately collapse? Because **thermal** and **radiation pressure** generated by high temperatures within the star push outward, keeping the star from collapsing. *This balance between the inward pull of gravity and the outward push of thermal pressure is called **hydrostatic** or **mechanical stellar equilibrium**.* Mechanical equilibrium maintains the size and shape of a star.

What is mechanical equilibrium?

Astronomers have reasoned that the **density** and temperatures of stars layers increase with increasing depth. The deeper layers have more material on top, increasing the weight on the layer. As the weight increases the layers become more compressed, increasing their density. This in turn increases the pressure and temperature of the materials being compressed. These compressed materials then create a large outward pressure to support the additional weight. A common bicycle pump can help illustrate this phenomenon. Raise the plunger of the pump to its uppermost position. Place your fingers over the tip where the air exits so that air cannot escape. Push down on the plunger. The force you exert on the plunger causes the air trapped inside the pump to apply a pressure back on your hand. In fact, if you let go of the plunger, it will return to its normal position, that is, return to its equilibrium state. This demonstrates the relationship between applied force (weight of materials above the layer) and pressure (outward push from high-temperature compressed materials).

What is thermal equilibrium?

Most stars also maintain **thermal equilibrium**. If a star begins to cool, the pressure supporting the outer layers will decrease. **Gravitational forces** will then take over and collapse the star. As the star's layers collapse, the temperature within the lower layers will increase. The **fusion** reactions that convert hydrogen to helium will occur at faster rates. This will further raise the temperature and pressure of the lower layers. The increased pressures will keep additional collapse from occurring, thereby returning the star to its state of thermal stellar equilibrium.

Further Study

gravity	thermal pressure	radiation
pressure	hydrostatic equilibrium	mechanical stellar
fusion	density	equilibrium
gravitational forces	thermal equilibrium	

Questions for you to answer

1. Why are stars round?

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2. What keeps stars from collapsing?

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3. What is mechanical stellar equilibrium?

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4. What is the relationship between the density and temperature of stars layers and the increasing depth of the layers?

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5. What is thermal stellar equilibrium?

6. A star begins to cool. What will temporarily happen to the size of the star?

COSMOLOGY

What is the Big Bang therory?

Cosmology *is the study of the beginning and end of the universe*. The **Big Bang theory** describes the origin of the universe as an explosion that continues today. Approximately 20 billion years ago, no atoms or molecules existed. Subatomic particles and radiation filled space. A high-temperature explosion instantly created the universe. Over time the materials cooled and collected into larger particles. Ultimately these particles formed all of the objects in the heavens.

What evidence supports the Big Bang therory?

Some doubt this proposed beginning of the universe. They do not believe that the universe began with an explosion. In fact, many believe that the universe is not aging. There are two indications that the universe is aging. First, hydrogen is converted to heavier elements through **nuclear fusion**. No evidence exists that the process is reversible. The amount of heavier elements present in the universe is increasing while the amount of hydrogen is decreasing. This indicates that the universe is aging. Second, all bodies in the universe are moving away from each other. This would indicate that at an earlier time they were closer together at some central point. It is tempting to believe that the Earth and our Milky Way galaxy are at the center of the universe. However, evidence suggests that this is *not* the case. Our own galaxy is a relatively insignificant galaxy in a remote corner of the universe.

What is the fate of the universe?

What fate awaits our universe? Two theories have been proposed. The first suggests that the universe will continue expanding forever. Since all objects continue in a straight line unless some outside force acts to change the objects' motion, the objects of the universe should expand forever. The second theory states that the universe will reach a point in its expansion, at which its objects will begin to reverse their paths and move toward their original positions. The objects will collapse at a single point in space and another big bang will take place, starting the process again.

Further Study

cosmology   Big Bang theory   nuclear fusion

Questions for you to answer

1. What is the Big Bang theory?

2. What evidence supports the Big Bang theory?

3. Nuclear fusion is said to be an irreversible process. What does this mean?

4. How can we tell that all objects in the heavens are moving away from each other if we are not at the center of the universe?

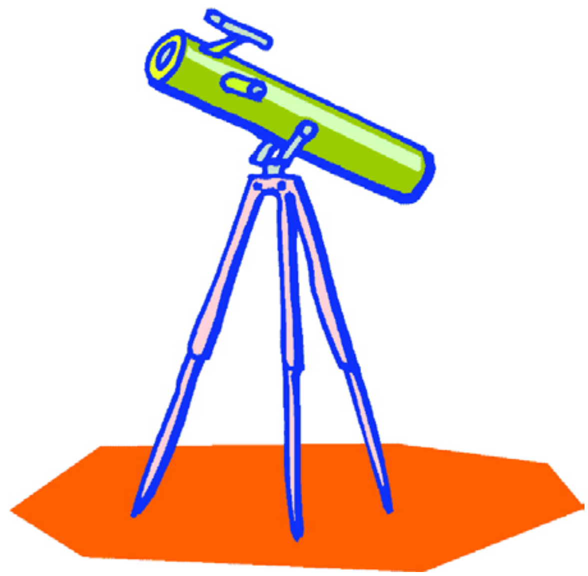
5. Describe the two possible fates of our universe.

ASTRONOMY TOOLS

Black holes, neutron stars, distant galaxies. How can **astronomers** stuck here on Earth know what's truly out in space? *Scientists collect and generate data about the universe using a number of tools including x-ray telescopes, computer and supercollider simulations, nuclear reactions, and space probes. Scientists have also enlisted the use of supercomputers to do high speed mathematical calculations that help predict the nature and existence of matter at distant locations in the universe.*

What tools do astronomers use?

Optical telescopes use mirrors and lenses to collect and magnify light from distant objects. Cameras record the images from space for later study. **Radio telescopes** operate much like optical ones, except that they collect radio waves from the electromagnetic spectrum instead of visible light waves. **Radar astronomy** works by sending radio signal pulses to space objects. These waves bounce off the object and return to a radio telescope, much like an echo. The pattern of the reflected waves provides information about the nature of the space object. All of these methods are limited by the Earth's **atmosphere**. Air movement and changing temperatures cause stellar images to appear to dance. You've probably noticed this as the twinkling of stars. Although beautiful in a night sky, this dancing causes severe problems for astronomers. Space probes, including telescopes placed in space above the Earth's atmosphere have enabled scientists to reduce some of these problems. Image resolution has improved significantly as a result of these probes.



Optical telescopes collect and focus light.

Not all astronomers' tools involve outer space. Some researchers use **supercolliders**, simulations, and the study of nuclear reactions to decipher the nature of heavenly bodies. Particles can be accelerated to high speeds and collided to determine their makeup. Nuclear reactions are conducted to study how stars make energy using the fusion process. All of these methods build our core knowledge of the nature of stellar objects.

Further Study

astronomers	optical telescopes	radio telescopes
radar astronomy	atmosphere	supercolliders

Questions for you to answer

1. Name three tools astronomers use to study space.

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2. How are optical and radio telescopes alike?

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3. How are optical and radio telescopes different?

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4. How are radio and radar astronomy different?

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5. What is a major limitation of optical, radio, and radar astronomy conducted on Earth?

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6. How do astronomers solve this problem?

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Chapter Test #5

EARTH AND SPACE

The following twenty multiple-choice questions cover the topics presented in Chapter 5. In answering each question try to avoid guessing at answers. Make sure that you completely understand each question and answer. If not, review the material presented in the chapter.

1. An astronaut has a mass of 60 kilograms on Earth. What would the astronaut's mass be on the Moon? The surface of the Moon has about one-sixth the gravitational attraction of the surface of the Earth.
   a. 0 kilograms b. 10 kilograms
   c. 20 kilograms d. 60 kilograms

2. Why is the Moon unable to have an atmosphere?
   a. Oxygen would be in the gas phase on the Moon.
   b. Nitrogen would be in the liquid phase on the Moon.
   c. The Moon does not have a strong enough gravitational pull to hold an atmosphere.
   d. The craters on the Moon release a gas that builds up above the Moon's surface.

3. What causes the different phases of the Moon as seen on Earth?
   a. The light emitted from the Moon as it changes position.
   b. The Moon reflecting sunlight at different points in its path as it rotates around the Earth.
   c. The solar flares emitted by the Sun.
   d. The Earth reflecting sunlight onto the Moon's surface.

4. What event occurs when the Moon blocks sunlight from reaching the surface of the Earth?
   a. a new moon b. a full moon
   c. a solar eclipse d. a lunar eclipse

5. Which of the following is a characteristic of a terrestrial planet?
   a. is composed mainly of gases b. has a solid surface
   c. has a liquid surface d. has rings

6. Which of the following is correct in terms of increasing distance from the Sun?
   a. Jupiter, Mars, Neptune
   b. Earth, Saturn, Pluto
   c. Mercury, Neptune, Mars
   d. Uranus, Pluto, Venus

7. What causes the high and low tides in the Earth's oceans?
   a. the Sun and Moon's gravitational pull
   b. the Sun's gravitational pull
   c. the Moon's gravitational pull
   d. the planet's gravitational pull

8. Which of the following is a characteristic of a gas giant planet?
   a. has no moons
   b. has no rings
   c. is composed of silicates
   d. has a very cold temperature

9. What causes the different seasons on the Earth?
   a. the distance from the Sun to the Earth
   b. the tilt of the Earth's axis
   c. the Earth's oceans
   d. the Earth's atmosphere blocking sunlight

10. How does the Sun create its energy?
    a. by nuclear fission
    b. by a chemical reaction
    c. by a physical reaction
    d. by nuclear fusion

11. How does the distance from the Earth to the Sun compare to the distance from the Sun to its nearest star neighbor?
    a. The distance to the Sun's nearest star neighbor is much closer than the distance from the Sun to the Earth.
    b. The distance to the Sun's nearest star neighbor is about the same as the distance from the Sun to the Earth.
    c. The distance to the Sun's nearest star neighbor is a little bit more than the distance from the Earth to the Sun.
    d. The distance to the Sun's nearest star neighbor is much larger than the distance from the Sun to the Earth.

12. Which of the following units is comonly used to measure the distance between stars?
    a. meters
    b. miles
    c. kilometers
    d. light-years

13. Which of the following stars would have the highest temperature?
   a. a white-blue colored star   b. a yellow colored star
   c. an orange colored star   d. a red colored star

14. Which of the following stars is probably the oldest?
   a. main sequence star   b. white dwarf
   c. our Sun   d. giant star

15. What happens to the temperature of progressively deeper layers as a star collapses?
   a. The temperature increases.
   b. The temperature decreases.
   c. The temperature remains the same.
   d. None of these

16. Which of the following is *not* one of the major types of galaxies?
   a. irregular   b. spherical
   c. spiral   d. elliptical

17. A star has two times the mass of our Sun. What will be the eventual fate of this star?
   a. main sequence star   b. neutron star
   c. black hole   d. none of these

18. An object that spins on its own axis is said to be
   a. eclipsing.   b. revolving.
   c. stationary.   d. rotating.

19. What term relating to stars is defined as the balance between the inward gravitational force and the outward push from thermal pressure?
   a. hydraulics   b. stellar equilibrium
   c. sequencing   d. fusion

20. For a given star, what happens to the density of the star as the depth increases toward the core?
   a. the density increases   b. the density decreases
   c. the density does not change   d. none of these