Science

Grade 09/10

utah

Aspire

ACT

PLUS

Standard Paper

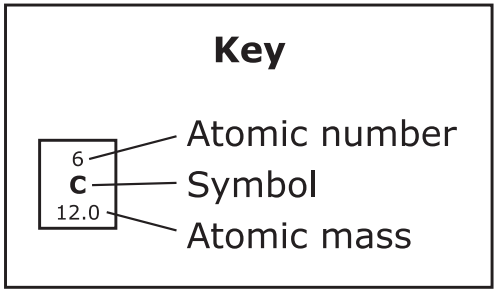
Spring 2021

Student Name _____ Proctor Name _____

HIGH SCHOOL
SCIENCE
SYMBOL LIST

+	Plus Sign
−	Minus Sign
×	Times Sign
÷	Division Sign
$\frac{\square}{\square}$	Fraction
$\square\frac{\square}{\square}$	Mixed Number
y^x	Exponent
$\sqrt{\ }$	Square Root
$\sqrt[3]{\ }$	Cube Root
=	Equal
(•)	Parenthesis
%	Percent
±	Plus Minus Sign
−	Negative Sign
•	Times Dot
/	Division Slash
[•]	Bracket
|•|	Absolute Value
<	Less Than
>	Greater Than
≤	Less Than or Equal
≥	Greater Than or Equal
$\sqrt[n]{\ }$	General Root
log	Common Logarithm
°	Degree Sign
π	Constant Pi
∞	Infinity
i	Imaginary i
e	Exponential e
θ	Theta
sin	Sine
cos	Cosine
tan	Tangent
$\sin^{-1}$	Inverse Sine
$\cos^{-1}$	Inverse Cosine
$\tan^{-1}$	Inverse Tangent

Periodic Table of Elements



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.0																	2 **He** 4.0
2	3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
3	11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 39.9
4	19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
5	37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98.0)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
6	55 **Cs** 132.9	56 **Ba** 137.3	57–71	72 **Hf** 178.5	73 **Ta** 181.0	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89–103	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Nh** (286)	114 **Fl** (289)	115 **Mc** (289)	116 **Lv** (293)	117 **Ts** (294)	118 **Og** (294)

* Mass numbers in parentheses are those of the most stable or most common isotope.

Lanthanide Series	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
Actinide Series	89 **Ac** (227)	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

Science Question Sampler Directions

This question sampler allows students to experience the types of items presented on the Utah Aspire Plus assessment. Items on the question sampler may not be representative of the level of content knowledge presented in the assessment. The question sampler should not be used to measure students' content knowledge.

The science question sampler presents multiple-choice/multiple-select questions and text entry questions based on several passages about scientific topics. After reading a passage, use the information in the passage to answer each question.

Multiple-choice/Multiple-select Questions:

- Read the question and then choose the best answer/answers from the answer choices given.
- If you decide to change your answer, erase your first mark completely.
- It is best to mark an answer for every question even if you are not sure which answer is correct.

Text Entry Questions:

- Write your entire answer inside the box that goes with the question.
- Use your best handwriting as your answers will be entered online by a test administrator.

Please note:

- Any writing in your question sampler booklet will NOT be scored. Your answers in the booklet will be entered online by a test administrator.
- Begin working on the question sampler when you are told to do so.

GO ON TO THE NEXT PAGE.

Tektites are a category of rock found at only a few locations on Earth's surface. Tektites are typically a few inches in diameter or less, glassy in appearance, and shaped like rounded buttons. Two students offered differing viewpoints about the origin of tektites.

Student 1

Tektites are the remains of *space debris* (meteoroids and other extraterrestrial material) that have fallen to Earth. Long ago, large meteorites struck the Moon's surface, ejecting Moon rocks into space. Attracted by Earth's gravity, these rocks fell through the atmosphere at very high speeds. Atmospheric drag caused the surfaces of these rocks to melt and flow, giving the rocks the characteristic tektite shape. Chemical analysis of tektites indicates that the time they spent in space was less than 100,000 years, so they must have come from someplace near Earth. This is consistent with a lunar origin. Further, tektites have virtually zero water content, which is consistent with Moon rocks but different from Earth rocks. In addition, the iron content of tektites is very different from that of Earth rocks.

Student 2

Tektites are a result of meteorite impacts on Earth, not on the Moon, and are made of Earth rocks, not of space debris. Long ago, when meteorite impacts on Earth were more common, some of the larger impacts ejected Earth rocks into the atmosphere at very high speeds. Atmospheric drag heated these rocks as they flew up and then fell back to the surface, giving them the characteristic tektite shape and glassy sheen. Chemically, tektites are the same as common Earth rocks, except for their water content and iron content. Both of these differences are the result of the rocks being heated to over 1,000°C during flight. Further, there are many chemical differences between tektites and Moon rocks. In addition, many tektites are associated with known impact craters on Earth's surface.

1. Which of the following findings would be LEAST consistent with Student 2's viewpoint?

Ⓐ The iron content of nonlunar space debris differs from that of tektites.
Ⓑ The iron content of rocks heated inside Earth differs from that of unheated surface rocks.
Ⓒ Wherever many tektites are located, large impact craters are also found.
Ⓓ Tektites found in Antarctica were formed within the last 10 years.

2. Which of the following statements about tektites is consistent with both students' viewpoints?

Ⓐ Tektites melted due to friction in the atmosphere.
Ⓑ Tektites come from the Moon.
Ⓒ Tektites and Earth rocks have the same iron content.
Ⓓ Tektites typically contain more water than do Earth rocks.

3. The students' viewpoints are similar in that they both indicate that tektites:

Ⓐ have the same iron content as that of other meteorites.
Ⓑ are the result of meteorite impacts.
Ⓒ are among the largest examples of space debris to fall to Earth.
Ⓓ should also be found on the Moon.

GO ON TO THE NEXT PAGE.

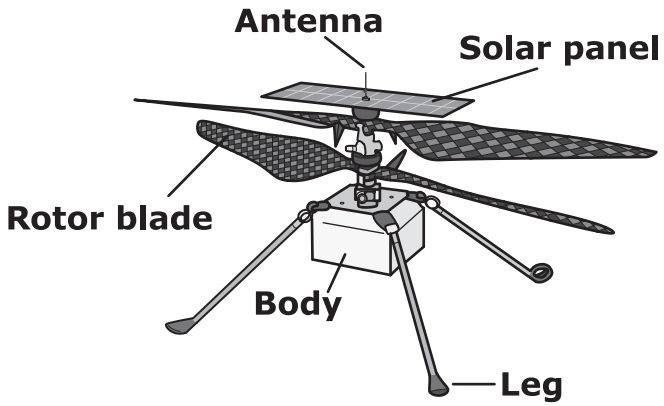
4. Which of the following procedures would best test aspects of both students' viewpoints? A sample of Earth rocks and a sample of Moon rocks are analyzed after the samples had been:

Ⓐ shaken vigorously in separate containers.
Ⓑ spun at high speed in separate containers.
Ⓒ launched from space toward Earth's surface.
Ⓓ dropped into the ocean from Earth's surface.

GO ON TO THE NEXT PAGE.

Mars 2020 is the name of a new NASA mission to and on Mars. During the mission, a rover called *Perseverance* is performing a variety of tests on Martian soil and air. The rover carries a helicopter drone, the *Ingenuity*, which is being used to test powered flight on another planet for the first time. The *Ingenuity* is shown in Figure 1.

Figure 1. The *Ingenuity* Mars Helicopter



Ingenuity's low-density foam and carbon fiber rotors provide the lift necessary for flight. The rotors are driven by two electric motors, which are powered by lithium-ion batteries. The batteries are located in the body of the helicopter and are recharged through a solar panel above the rotors while the helicopter is not in flight. *Ingenuity*'s batteries must charge for an entire Martian day to achieve a 90-second flight. *Ingenuity* will make one flight per day, and a total of five flights are planned.

Ingenuity also carries two cameras and a flight-control system in its body. These systems are kept warm by the heat output by the batteries in the body. The antenna allows *Ingenuity* to communicate flight data with the *Perseverance* rover after a flight is complete.

Because of the distance between Earth and Mars, scientists on Earth cannot control *Ingenuity*'s flight in real time. The flight instructions will be programmed into its flight-control system in advance.

GO ON TO THE NEXT PAGE.

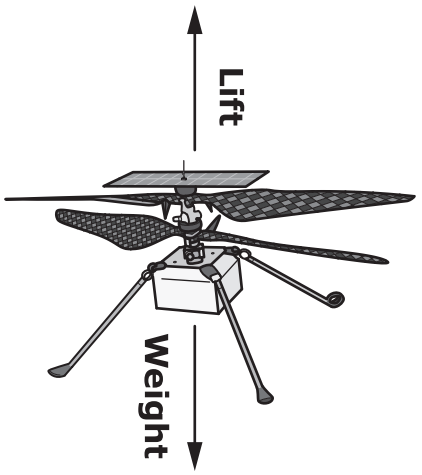
Ingenuity was designed and is being tested with Martian conditions in mind. Table 1 shows some differences between conditions on Earth and Mars.

Table 1. Conditions on Earth and Mars

Condition	Earth	Mars
Gravity at surface (m/s^2)	9.80	3.71
Average solar energy reaching atmosphere (W/m^2)	1,361	586
Average temperature of atmosphere (°C)	15	–63
Density of atmosphere at surface (kg/m^3)	1.22	0.02
Speed of sound at surface (m/s)	340	244
Composition of atmosphere	78% nitrogen 21% oxygen 1% other gases	95% carbon dioxide 3% nitrogen 2% other gases

Figure 2 shows some of the forces acting on a hovering helicopter.

Figure 2. Some Forces on a Hovering Helicopter

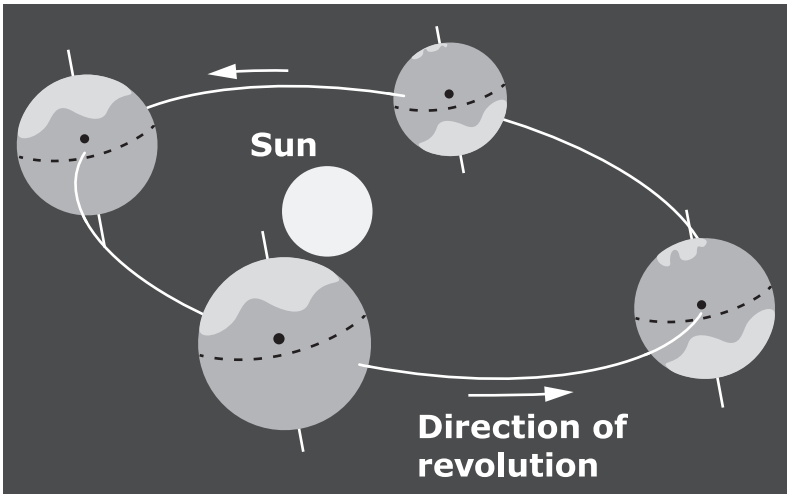


A spinning rotor pushes air in order to achieve lift. The lift that a rotor can achieve is directly proportional to the density of the air, the surface area of the rotor, and the square of the speed of the rotor. Drag forces that are not shown in Figure 2 occur at the tips of the rapidly moving rotor blades. The speed of the rotors is limited because, as the speed of the rotor-blade tips approaches the speed of sound, drag forces at the rotor-blade tips prevent an increase in speed.

GO ON TO THE NEXT PAGE.

In addition to the conditions in Table 1, NASA scientists have to account for seasonal dust storms on Mars with winds that can blow up to 30 m/s. Typical Martian winds are between 2 and 10 m/s. Dust storms can sometimes completely block the surface of Mars from view by orbiting satellites or telescopes on Earth. A multiyear survey of the Mars 2020 landing site concluded that dust storm activity at the site will be at its maximum during the Martian fall season. The landing site, Jezero Crater, is located in Mars's northern hemisphere. Figure 3 shows the orbit of Mars. Mars's rotational axis is tilted 24.9° relative to its orbital plane, which is very similar to Earth's axial tilt of 23.5°.

Figure 3. Martian Orbit and Axial Tilt



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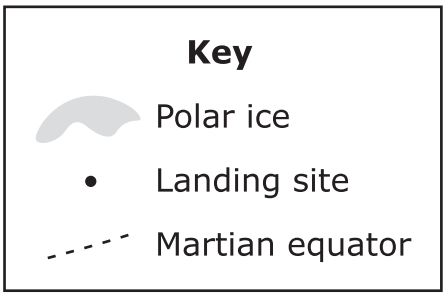

Task Statement: In the questions that follow, you will investigate the solutions developed by NASA as they designed and tested the *Ingenuity* Mars helicopter for the Mars 2020 mission.

GO ON TO THE NEXT PAGE.

5. This question has two parts.

Part A

Powered flight on Mars is more challenging than flight on Earth. Which factor makes it more difficult for the *Ingenuity* to achieve sufficient lift on Mars?

Ⓐ the force of Martian gravity
Ⓑ the distance of Mars from Earth
Ⓒ the density of the Martian atmosphere
Ⓓ the composition of the Martian atmosphere

Part B

Which solution would **most likely** enable *Ingenuity* to achieve sufficient lift on Mars?

Ⓐ building *Ingenuity* with the lowest-density materials possible
Ⓑ equipping *Ingenuity* with an antenna that allows for flight control
Ⓒ increasing the speed of *Ingenuity*'s rotors to 2.6 times the speed required on Earth
Ⓓ decreasing *Ingenuity's* flight times to about half of the maximum flight times that are possible on Earth

6. To test the lift that *Ingenuity* can produce, NASA scientists tested *Ingenuity* in a special chamber on Earth. Which variable should the scientists manipulate in order to test the lift that *Ingenuity* can produce on Mars?

Ⓐ the gravity in the chamber
Ⓑ the sunlight in the chamber
Ⓒ the density of the air in the chamber
Ⓓ the composition of the air in the chamber

7. For some tests of *Ingenuity* that were conducted on Earth, scientists decreased the mass of the helicopter by removing its battery and flight-control system. The scientists connected the helicopter to a system that supplied power and flight control through wires so that the helicopter would continue to operate. What is the **most likely** reason the scientists did this for some tests?

Ⓐ to approximate the effect of Martian gravity on *Ingenuity*
Ⓑ to approximate the effect of Martian sunlight on *Ingenuity*
Ⓒ to approximate the effect of Martian dust storms on *Ingenuity*
Ⓓ to approximate the effect of the Martian atmosphere on *Ingenuity*

8. How could a Martian dust storm create challenges for *Ingenuity*?

Select the blank boxes next to the **two** correct answers.

☐ A by increasing the Martian gravity
☐ B by increasing the Martian wind speed
☐ C by changing the composition of the Martian atmosphere
☐ D by decreasing the temperature of the Martian atmosphere
☐ E by decreasing the solar energy that reaches the Martian surface

GO ON TO THE NEXT PAGE.

Students used a *viscometer* (a device that measures the viscosity of a substance) to study several liquids. The viscometer consisted of a tube to hold a liquid, a metal ball, and a magnetic pad that can hold or release the ball (see Figure 1).

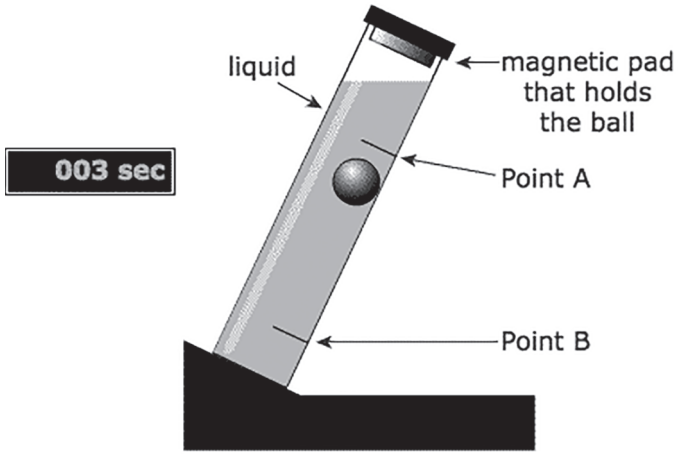

Figure 1

The liquid is added to the tube and allowed to become still. The cap, to which the magnetic pad and ball are attached, is fitted on the tube. The ball is then released from the pad by remote control, and the time it takes for the ball to roll from Point A to Point B (the *roll time*) is measured. Six liquids (Liquids A–F) of known viscosity (in centipoise, cp) at 25°C were supplied with the viscometer for use as standards (see Table 1).

Table 1

Liquid	Viscocity (cp)
A	1
B	50
C	100
D	200
E	500
F	1,000

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Experiment 1

The roll time for each of Liquids A–F was measured at 25°C in the viscometer. The students prepared Figure 2 based on their results.

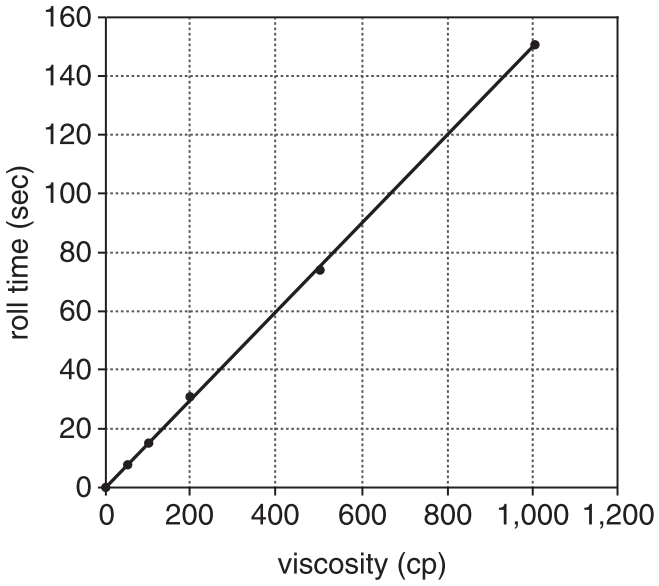

Figure 2

Experiment 2

The roll time of several common liquids was measured at 25°C in the viscometer (see Table 2).

(Note: SAE numbers refer to viscosity ratings set by the Society of Automotive Engineers.)

Table 2

Liquid	Roll time (sec)
Corn syrup	12
Kerosene	2
H_20	1
SAE 10 motor oil	8
SAE 20 motor oil	30
SAE 30 motor oil	60
SAE 50 motor oil	180

GO ON TO THE NEXT PAGE.

9. Based on Experiments 1 and 2, the viscosity of SAE 30 motor oil at 25°C is closest to which of the following?

Ⓐ 30 cp
Ⓑ 60 cp
Ⓒ 200 cp
Ⓓ 400 cp

10. Based on Experiments 1 and 2, the viscosity of SAE 40 motor oil at 25°C would most likely be:

Ⓐ lower than 200 cp.
Ⓑ between 200 cp and 300 cp.
Ⓒ between 300 cp and 400 cp.
Ⓓ higher than 400 cp.

GO ON TO THE NEXT PAGE.

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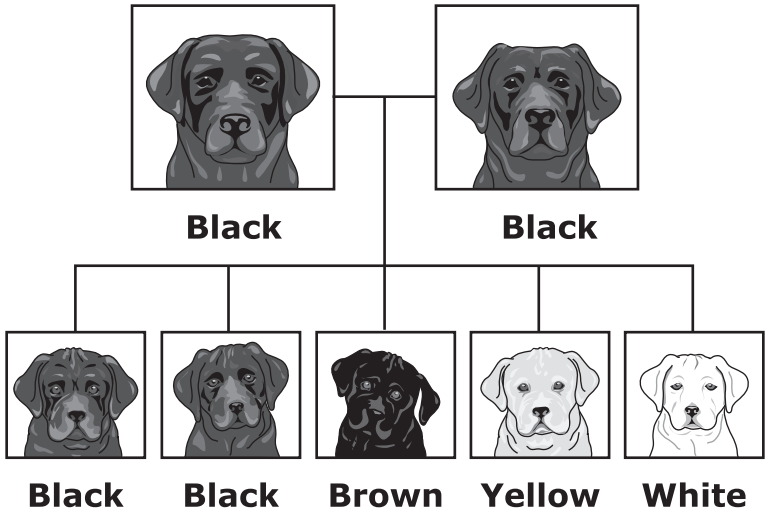
GO ON TO THE NEXT PAGE.

A student's black Labrador retriever dog has a litter of five puppies. Even though the father of the puppies is also black, some of the puppies display other colors, as shown in Figure 1.

Figure 1. A Labrador Retriever Dog Family



Each Labrador puppy develops from a fertilized egg containing 78 chromosomes that come from the mother's egg cell and the father's sperm cell. Egg and sperm cells, also known as gametes, are different from other cells in the body, known as somatic cells. Only gametes are produced by meiosis, a process that separates and distributes chromosomes into newly formed cells. Two simplified models of meiosis are shown in Figure 2. *A* and *a* represent two versions of one gene, and *B* and *b* represent two versions of a second gene.

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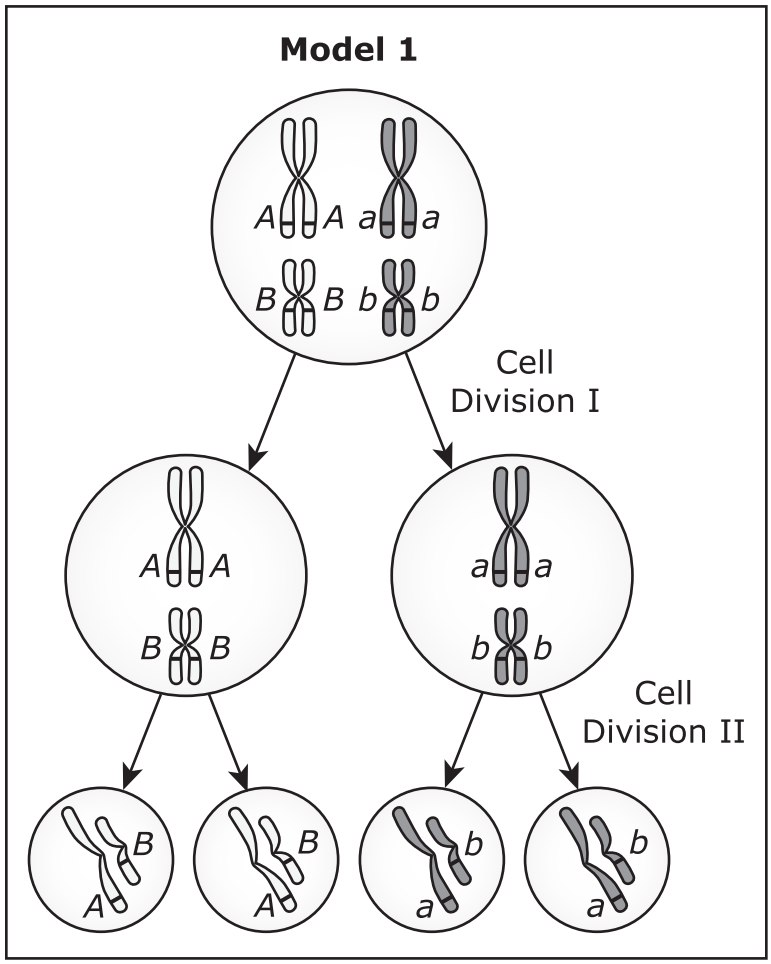
Figure 2. Two Models of Meiosis



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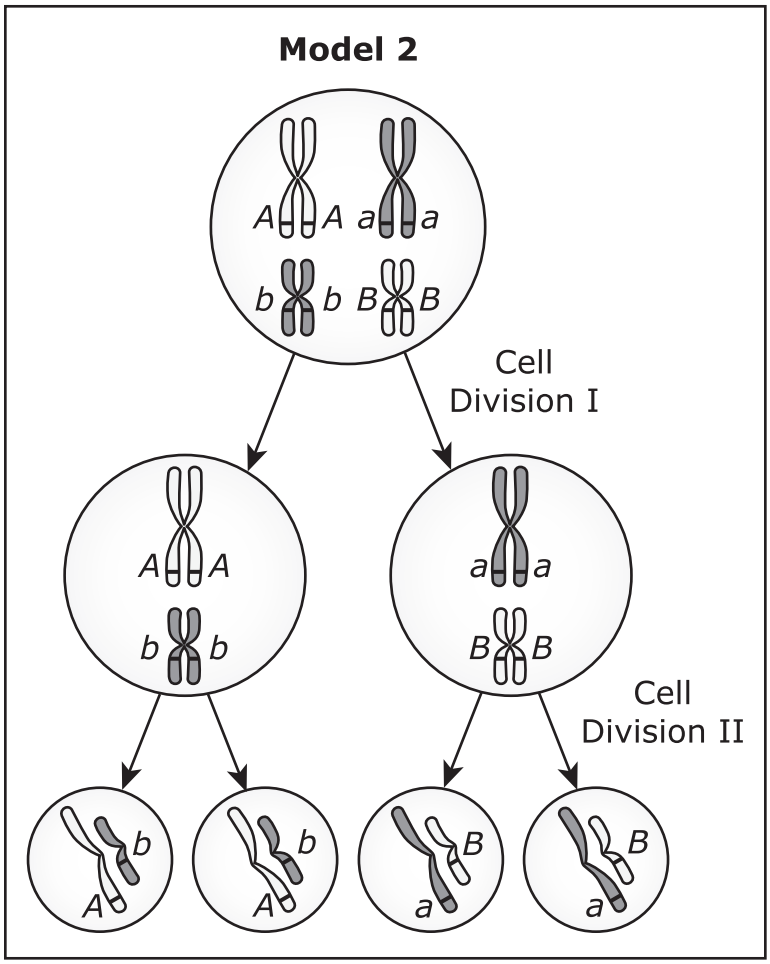
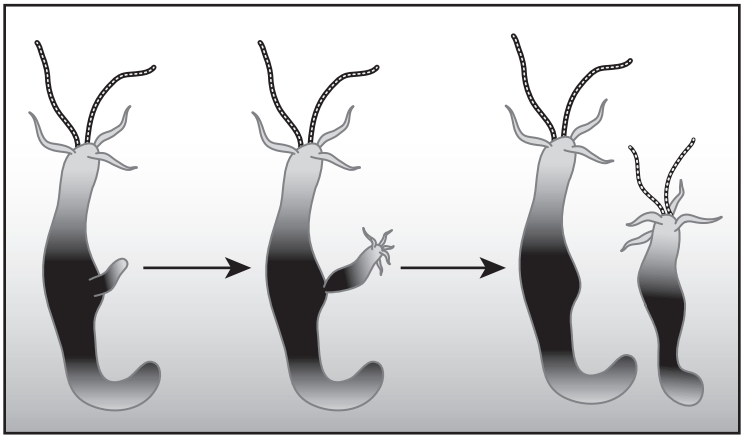


Some animals can reproduce with only one parent. The hydra, a freshwater invertebrate, can reproduce by budding offspring, as shown in Figure 3. But hydra can also produce gametes and reproduce through fertilization. A normal somatic cell of a hydra has 30 chromosomes.

Figure 3. A Hydra Reproducing by Budding



Task Statement: In the questions that follow, you will engage in argument from evidence about the variations between parents and offspring.

GO ON TO THE NEXT PAGE.

11. Why do some of the puppies in Figure 1 have a different color of fur than their parents have?

Ⓐ The chromosomes of three puppies mutated after fertilization.
Ⓑ The chromosomes of three puppies sorted incorrectly during meiosis.
Ⓒ Each puppy received different numbers of chromosomes from each parent.
Ⓓ Each puppy received a different combination of chromosomes from its parents.

12. This question has two parts.

Part A

How many chromosomes are in a normal gamete produced by meiosis in a Labrador retriever dog?

Ⓐ 156
Ⓑ 78
Ⓒ 39
Ⓓ 26

Part B

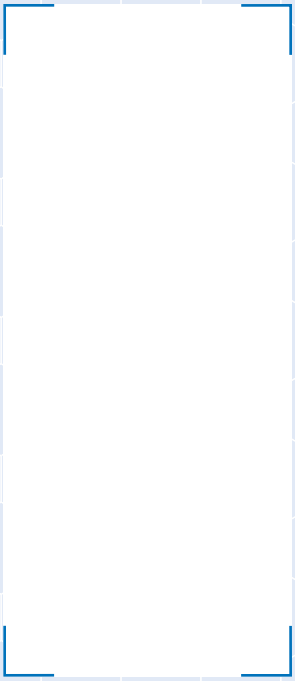
Which statement supports the correct answer to Part A?

Ⓐ DNA is duplicated before both Cell Division I and Cell Division II, so each of the four daughter cells produced contains double the number of chromosomes found in the parent cell.
Ⓑ DNA is not duplicated between Cell Division I and Cell Division II, so each of the four daughter cells produced contains half the number of chromosomes found in the parent cell.
Ⓒ DNA is duplicated before Cell Division I but not before Cell Division II, so each of the four daughter cells produced contains the same number of chromosomes found in the parent cell.
Ⓓ DNA is duplicated neither before Cell Division I nor before Cell Division II, so each of the four daughter cells produced contains one-fourth the number of chromosomes found in the parent cell.

13. Which statement correctly describes how a puppy can have two copies of *A* and two copies of *b*?

Ⓐ Each of the parents contributed one copy of the *A* gene and one copy of the *b* gene.
Ⓑ One parent contributed both copies of the *A* gene, while the other parent contributed both copies of the *b* gene.
Ⓒ One parent contributed a copy of the *A* gene, while the other parent contributed a copy of the *b* gene, and then the genes were duplicated after fertilization.
Ⓓ One parent contributed a copy of the *A* gene, while the other parent contributed a copy of the *b* gene, and then the genes were duplicated during fertilization.

END OF TEST.



1128373 1 2 3 4 5 A B C D E Printed in the USA ISD34183