Contents

Unit 1

The Hydrogen Economy

Objectives

- Develop your skills to identify the discourse pattern and predict the types of information before reading a lengthy text carefully;
- Increase your awareness of the communicative purpose of writing and the choice of rhetorical strategies to achieve the communicative purpose;
- Acquaint yourselves with the method of organizing information chronologically;
- Summarize the history and current status of fuel cell technology;
- Analyze the advantages and disadvantages of fuel cell powered vehicles;
- Give an oral account of historical events with the help of time expressions;
- Predict the prospect of the widespread applications of fuel cell technology;
- Use word combination rules to help you build up technical vocabulary;
- Increase your sensitivity to heavy noun groups in scientific texts;
- Follow the flow of events with the help of time expressions when listening to a talk;
- Develop your skills to distinguish the main points from specific details when listening to science news, talks, or interviews.

Task 1: Familiarize yourselves with the following new words, set expressions or lexical chunks to prepare for reading the texts in this unit.

allude to	暗指，影射
alternative energy system	替代能源系统
alternative to	替代
ambient air	环境空气
ammonia borane, NH_3BH_3	硼烷氨
ammonium borohydride, NH_4BH_4	硼氢化氨
Apollo 13 mission	阿波罗 13 号飞行任务
appurtenance	配件
assert	断言，声称
awkwardly extreme temperature	难以控制的极端温度
barely exothermic	几乎不放热的
benchmark	参考标准
bid on (a project)	竞标(项目)
boulder	巨石
bring out side perspectives to discussions	讨论中征求业外人士的意见
broken bolt	破损的螺钉
buy into (the plan)	认可(该计划)

cadmium	镉
carbon dioxide emissions from hydrogen generation	在生产氢过程中的二氧化碳排放
Catch-22	第 22 条军规；左右为难的困境
cathode	阴极
change his trajectory	改变其运动轨迹
chassis	汽车底盘
compact portable power sources	小型便携式动力源
compounds	化合物
compressor	压缩机
concept car	概念车
configuration	配置，结构
consortium	财团
cryogenic temperature	低温
decompose	分解
be decomposed by a catalyst at the anode into electrons and protons	在阳极由催化剂来分解成电子和质子
decomposition reaction	分解反应
discharge and recharge	放电与充电
dry cell	干电池
electric generator	发电机
electric motor	电机
electrode	电极
electrolysis	电解
electrolyte	电解质
electromagnetic induction	电磁感应
electron	电子
energy-conversion device	能源转换装置
energy crunch	能源危机
energy density	能量密度
energy-producing ingredient	产生能量的配料
escalating percentages in subsequent years	以后逐年提高的比例
exhaust fume	废气
exotic technology	奇特的技术
final disposition	最终部署；最终处置
fledgling industry	新兴产业
forging full speed ahead	正在全速发展
fossil fuel	化石燃料
frustrated	受到挫折
frustration	挫折
fuel cell	燃料电池
futuristic	属于未来的

generate energy	产生能量
gestation period	酝酿阶段
hand-cranked	手摇的
hibernation	冬眠，不活跃状态
go into forced hibernation	被迫进入冬眠状态
hibernate	冬眠的，不活跃的
hit the showroom floor	在车展中成功
hurdle	障碍
hydrocarbon	碳氢化合物
hydroelectric plant	水电厂
hydrogen-powered automobile	氢气动力汽车
incandescent bulb	白炽灯
inertia and momentum	惯量和动量
infrastructure	基础设施
infuse ammonia borane into	将硼烷氨注入......
instrumental	有作用的；作为工具的
integrated into a regular gas station	与普通加油站合并
intercept	拦截
internal combustion engine	内燃机
jurist	法学家
kinetic energy	动能
lawsuit	法律诉讼
lead, nickel, cadmium, sodium, lithium, aluminum, zinc	铅、镍、镉、钠、锂、铝、锌
lead-acid battery	铅酸电池
light trucks and delivery vans	轻型卡车和厢式送货车
liquefy	液化
lithium-ion battery	锂离子电池
make grandiose claims	发表宏伟的言论
mark an incremental step toward	标志着朝......方向迈开的一大步
mass and velocity	质量和速度
mechanical linkage	机械联动装置
methanol	甲醇
molten carbonate	熔融碳酸盐
multifaceted	多面的
multiplying	乘，成倍增加
nanometer-scale	纳米级
nanotechnology	纳米技术
next to nothing	几乎为零
nonrenewable resource	不可再生的资源
nudge modern society toward a hydrogen-based economy	促使现代社会向氢经济方向发展
opens up ways to	为......开辟途径

osmium and uranium	锇和铀
outfitting	装配
outnumber by more than three to one gasoline-engine cars	其数量是汽油动力车的三倍多
overall vehicle design	整车设计
paradigm shift	范式转换
pay a premium	出高价
phosphoric acid	磷酸
podium	演讲台
potable water	饮用水
potassium hydroxide electrolyte	氢氧化钾电解质
prompt (sb. to do something)	促使，引起
prompt the reaction	引发反应
proton-exchange membrane cell	质子交换膜电池
prototype vehicle	原型车
public roll-out	首次公开亮相
radar screens	雷达幕；关注范围
range	（续）驶（里）程
realm of the exotic	不熟悉的领域
residuum	残渣，残余物
resurgence	复活，再现
rhetoric	修辞，华丽的言辞
roof-to-bumper windshield	从车顶到保险杠的挡风玻璃（设计）
sodium	钠
solid oxides or molten carbonate as electrolytes	固态氧化物或熔融碳酸盐作为电解质
solid polymer fuel cell	固体聚合物燃料电池
State of the Union Address	国情咨文报告
stationary equipment and portable devices	固定设备和便携装置
storage battery	蓄电池
strike out on his own	独立创业
surreptitiously	偷偷地
synthesize ammonia from hydrogen and nitrogen	用氢和氮合成氨
thermodynamic property	热力学特性
thin electrolytic membrane	电解薄膜
throttle, steering or brake	油门、方向盘和刹车
toxic	有毒的
turn something that large on a dime	使如此浩大的工程突然转向
unmuffled competitor	没有消音器的竞争对手（即汽油动力车）

unprecedented level of respect	前所未有的尊重
unveil	公布于众
venture capital	风险资本
veteran	退伍军人
voltaic pile preceded the fuel cell by 39 years	伏打电堆比燃料电池早 39 年
zero-emission vehicle	零排放车辆

Task 2: Skim through Text I and 1) match the subheadings on the left column with the types of information on the right, 2)identify the sentence in the opening section which indicates the types of information and the organization of the text, 3) explain why the author quotes Present Bush's State of the Union Address.

Subheadings	**The types of information**
1) The opening section	A) The prospect of the hydrogen economy
2) The Gas Battery	B) The application of fuel cells in consumer electronics
3) Electric Car Resurgence	C) The development of various types of fuel cells
4) Into the Mainstream	D) The significance of fuel cell technology
5) Out of the Laboratory, Someday	E) The origin and development of fuel cell technology
6) Fuel-Cell Phone	F) The status of fuel cell cars

The sentence in the opening section which indicates the types of information and the organization of the text: ____

____

Text I

Fuel Cells[1]

Henry Petroski

1 In his **State of the Union address** early in 2003, President George W. Bush called for promoting energy independence for the United States while making dramatic improvements in the environment. The familiar **rhetoric alluded to** a comprehensive plan involving efficiency and conservation as well as developing cleaner technologies for domestic energy production. But the

President soon departed from the familiar and entered the **realm of the exotic** when he asked Congress to take "a crucial step and protect our environment" in distinctly new ways. In the 21st century, he continued, "the greatest environmental progress will come about not through endless **lawsuits** or command-and-control regulations, but through technology and innovation." He proposed spending $1.2 billion on research into **hydrogen-powered automobiles**, which employ fuel cells.

2 The President went on to give an admirably concise definition of the principle of a fuel cell: "A single chemical reaction between hydrogen and oxygen **generates energy**, which can be used to power a car—producing only water, not **exhaust fumes**." He challenged scientists and engineers to overcome obstacles to taking fuel cell powered automobiles "from laboratory to showroom" in a time frame expressed not in cold calendar years but in the very warm and human image of growing up, "so that the first car driven by a child born today could be powered by hydrogen…" Such progress, the President **asserted**, **opens up ways** to protect the environment "that generations before us could not have imagined."

3 It was only the summer before President Bush's address that I was introduced to fuel cells in a more than passing way. Evidently because I had written about invention and the evolution of a wide variety of technologies, I was invited to join an Industry Advisory Committee then being formed by Chrysalix Energy, a Vancouver based **venture-capital** firm investing in early stage fuel-cell technology. In spite of my objections that I knew **next to nothing** about fuel cells, I was persuaded by the committee's chairman, Daniel Muzyka, Dean of Commerce at the University of British Columbia, to join the committee, whose purpose is to **bring outside perspectives to discussions** about an imagined hydrogen economy. In my association with the group thus far, I have participated in a few telephone-conference calls and attended a meeting in Amsterdam. I have heard many presentations and read a large number of books, reports, and articles about fuel cells, their promise, and their shortcomings. In addition, I have read and clipped magazine and newspaper stories that a year ago I might have passed over quickly and have generally become increasingly interested in the history, status and future of the technology.

The Gas Battery

4 Applications of the fuel cell may seem futuristic, but the device itself dates from 1839, when the Welsh-born British **jurist** and scientist Sir William Robert Groves devised a "gas battery." Unlike Alessandro Volta's now-familiar **dry cell**—which contained all its **energy-producing ingredients** and which produced electricity only as long as it could sustain the chemical reaction—Groves's gas battery produced electricity as long as it was fueled by an external source. The simple **voltaic pile preceded the fuel cell**

by 39 years.

5 Within a couple of decades of the invention of the dry-cell battery, Michael Faraday demonstrated the principle of the **electric motor** and soon thereafter that of **electromagnetic induction**, which led to the **electric generator**. By the early 1830s working electric motors were being made, and well before the end of the decade electric driven road vehicles and paddle boats were the subjects of experiments. By 1859, an early version of the **lead-acid battery** used in today's automobiles had been developed—with the most important capability of being repeatedly **discharged and recharged**. As early as 1873, **storage batteries** were powering electric motors and driving vehicles, and by 1882 these electric "cars" could reach speeds of almost 10 miles per hour and travel distances as great as 25 miles. The first demonstration of a vehicle powered by an **internal combustion engine** was still a couple of years away.

6 At the end of the 19^{th} century, an electric vehicle held the world speed record of 61 miles per hour, and in the United States in 1900 almost as many electric-driven cars (1,575) were being manufactured as steam-driven ones (1,684). Combined, they **outnumbered by more than three to one gasoline-engine cars**. The electric vehicle had the clear advantage of quietness over its then **unmuffled competitors**, and it did not need to be **hand-cranked** to be started. However, after the introduction of the Ford Model K in 1906 and the Model T in 1909, the internal-combustion engine became the power source of choice. By 1912, there were 900,000 gasoline powered vehicles in America, outnumbering the 30,000 electrics thirty-to-one. At about the same time, the self-starter and silencer were introduced, thus making the internal combustion engine more user friendly and desirable. It was much faster to add gasoline to a tank than to recharge heavy batteries, and the gasoline provided greater **range**. (Different energy sources are now usually compared by means of a measure known as **energy density**, which is the ratio of power to weight. Today, a conventional lead-acid battery has an energy density of about 35 watt hours per kilogram compared with gasoline's 2,000, although more exotic types of batteries have higher energy densities than do lead-acid cells.) The use of gasoline-powered vehicles in World War I conditioned a lot of young **veterans** to favor the internal-combustion engine. The last new model of an electric car to be built in America during that era was introduced in 1921—at a price four times that of a Model T. The electric vehicle essentially went into forced **hibernation** for decades, until environmental and energy crises reawakened interest in a nonpolluting alternative to the internal combustion engine.

Electric Car Resurgence

7 Unfortunately, battery technology had not advanced sufficiently in the meantime to enable electric cars to be made attractive competitors to gasoline-driven ones in terms of size, range and cost. **Prompted** in part by the

rise in consciousness of ecological issues, electric vehicles began to reappear around 1960, but only in small numbers. Indeed, it was not until 1990, when southern California's South Coast Air Quality District required that by 1998 large manufacturers have 2 percent of their sales in **zero-emission vehicles** (with **escalating percentages in subsequent years)**, that major automobile companies began to look more seriously at alternatives to the internal-combustion engine. And among those alternatives were fuel cells, which had seen development for specialized applications. In particular, the Gemini and Apollo space programs employed fuel cells to provide power, while at the same time providing **potable wate**r as a by-product. The explosion of an oxygen tank and the consequent damage to a pair of fuel cells produced the life-threatening situation on the **Apollo 13 mission**, but fuel cells also served reliably for many other space flights. It was a matter of matching the technology to the application.

8 Just as dry-cell batteries come in a large variety of types and employ a wide range of different materials—**lead, nickel, cadmium, sodium, lithium, aluminum, zinc**—so do fuel cells. The ones powering spacecraft typically operate at relatively low temperatures and have **potassium hydroxide electrolyte**. Small stationary generators operating at intermediate temperatures may use **phosphoric acid**. Some fuel cells, which are suitable for use as large stationary generators, operate at high temperature and use **solid oxides or molten carbonate as electrolytes**.

9 One of the most promising **configurations** has proved to be the **proton-exchange membrane cell**, which operates in the temperature range associated with internal-combustion engines and has a power density that makes it suitable for use in automobiles. The **electrodes** of this device are separated by a **thin electrolytic membrane**. When hydrogen is introduced under pressure, it is **decomposed by a catalyst at the anode into electrons and protons**. The electrons naturally make electricity, which can power a motor or other electrical device. The protons move through the membrane toward the **cathode**, where another catalyst recombines them with spent electrons and oxygen from the **ambient air** to produce water.

10 The wide variety of fuel cells under development is to be expected in a **fledgling industry** populated by hundreds of private and scores of public companies. Among the best known of these is Ballard Power Systems, which is most closely associated with the proton-exchange membrane technology. After receiving a degree in geological engineering from Queens University, Canadian-born Geoffrey Ballard began his career in oil exploration, where he became increasingly frustrated when his opinions were ignored in favor of those from scientists with higher degrees. After going back to school and earning a doctorate in geophysics, Ballard began working for the U.S. Army as a civilian. During the 1973 energy crisis, Ballard was made director of research for a new government office of energy conservation. He was excited

about the position and the possibilities, but he became disillusioned when he found that the research-and-development funding system expected results much more quickly than the 20-year **gestation period** required for new energy systems.

11 Ballard also became convinced that conservation was not the answer to the energy problems facing the U.S. and, especially, the Third World, whose people wanted to enjoy the level of abundance they saw in America and did not want to have to conserve to get there, if indeed that was a possible route. The real need, Ballard believed, was to develop **energy-conversion devices** and techniques that were more efficient and cleaner than the traditional burning of **fossil fuels**. He also saw a need for lightweight and **compact portable power sources**. Thus, Ballard left his job in energy conservation and **struck out on his own** to develop smaller, lighter and more efficient batteries to power everything from video cameras to **light trucks and delivery vans**. He and a financial backer enlisted a chemist, who went to work developing a lithium battery, which in turn attracted further support to power a submarine. The battery work involved living hand-to-mouth, so the Ballard team was always looking for new funding opportunities.

12 When the company, which had started in Arizona, relocated to Vancouver, British Columbia, it was naturally on the lookout for Canadian government funding opportunities. One request for proposals that looked promising was for the development of a low-cost **solid polymer fuel cell**. Since this involved electrochemistry, something the Ballard group had become heavily involved with in its battery work, the project seemed like an ideal one to **bid on**. Ballard had had some experience with fuel cells while working for the U.S. Army, and he knew that the technology was working in the space program.

13 The challenge was not to demonstrate that fuel cells worked but to demonstrate that they could be produced for the consumer market. This meant, of course, that they had to be manufactured with much higher power density and at much lower cost. With the help of **venture capital**, Ballard went on to produce stationary fuel cells, but the real challenge lay in demonstrating a fuel cell-powered vehicle, which meant fitting the power plant and the hydrogen supply to fuel it into a space with predetermined practical requirements and limitations—a bus, as it happens.

14 Meanwhile, in order to secure more capital, the founding members of Ballard Power had given up control of their company to a management team, which at first did not like the bus-project idea. But after Geoffrey Ballard secured federal and provincial support for the bus plan, management also **bought into** it. The **prototype vehicle** proved to be a resounding success when it had its **public roll-out** in 1993.

15 And roll out was literally what it did. As the bus stood idling beside Vancouver's Science World, ready to be driven around to the front as soon as

the speeches were finished, the **compressor** suddenly quit. The problem was a **broken bolt**, and there was not time to fix it. So some Ballard employees **surreptitiously** pushed the bus to get it moving, after which it rolled down an incline and was steered to a stop in front of the **podium**. Since fuel cells were expected to be quiet, no one noticed that the bus had not been under power. After Geoffrey Ballard, who had been alerted to the crisis, and others had spoken of the significance of the occasion, the British Columbia premier announced, "Let's go for a ride." Fortunately, a large crowd had gathered around the bus, and reporters began to question the man responsible for the bus project, Paul Howard. He answered all their questions with great patience, finally telling everyone to come back that afternoon for a ride. The broken bolt was fixed during lunchtime, and the bus ran smoothly for the news cameras. Today, later-generation fuel-cell buses are carrying passengers in Madrid and other European cities.

Into the Mainstream

16 Geoffrey Ballard is no longer with the company that bears his name, but the fuel cell that was so **instrumental** in promoting to "change the world" has reached an **unprecedented level of respect** as an **alternative energy system**. Ballard Power Systems, which has registered the trademark, "Power to Change the World," is **forging full speed ahead**, having established partnerships with Daimler Chrysler, Ford and other automobile manufacturers. The goal is not only to supply the transportation industry with fuel cell engines but also to develop fuel-cell systems for **stationary equipment and portable devices**. And Ballard is, of course, not the only player in the game.

17 The General Motors **concept car** termed Hy-Wire (a word formed from hydrogen and by-wire) is not only powered by a fuel cell but also controlled through "by-wire" technology similar to that already widespread in the aircraft industry. There are no **mechanical linkages** between driver and **throttle, steering or brakes**, since all such connections are by electrical wire, which leaves room for a more imaginative **overall vehicle design**. Since there do not have to be mechanical linkages between pedals and steering wheel and what they normally control, there do not have to be pedals or a steering wheel at all. Hence, the General Motors Hy-Wire vehicle is often described as a "skateboard design," in which the fuel cell and **appurtenances** are incorporated into a rather flat **chassis**, onto which a variety of body types can be mounted (and changed like clothing to fit the mood of the owner). Because there are no mechanical linkages between body and chassis, the imagination of automobile designers is freed up, which can mean a **roof-to-bumper windshield** and a handheld control system that is not unlike the videogame controllers with which younger generations have grown up. The concept car is also referred to as the China car, since it is expected to become available as early as 2008 but no later than 2015—or simultaneously with a potentially booming auto market in Asian countries and elsewhere around the world,

where private vehicle ownership currently rests at only 12 percent.

18 Fuel cells are expected not only to revolutionize the appearance and control of automobiles; they can also greatly change the perception of them as noise-and air-polluters. Since the fuel cell itself has no moving parts, the only sound associated with its operation comes from the devices needed to supply the fuel. (This lack of engine noise was the most striking feature of the first electric vehicle I rode in.) Also, since the only by-product is water vapor, in place of smelly exhaust fumes there will be but wisps of warm vapor or drips of distilled water. Instead of the present image of internal-combustion vehicles as greater polluters of cities than the horses that they displaced about a century ago, fuel-cell powered vehicles could be seen as saviors of the planet—if the problem of **carbon dioxide emissions from hydrogen generation** can be solved.

Out of the Laboratory, Someday

19 Although hydrogen is the most abundant element in the universe, its gaseous form does not occur naturally on Earth. Thus, another source of energy must be employed to produce free hydrogen from its **compounds**. Unfortunately, at least in the early stages of fuel-cell use, hydrogen is likely to be produced from a **hydrocarbon** such as natural gas, which is a less efficient process than that used to convert oil into gasoline. This is also a **nonrenewable resource**, and the greenhouse gas carbon dioxide is produced in the process of releasing the hydrogen. Hydrogen can also be made from water, by **electrolysis**, but it is not as efficient a process. Thus, how to extract large quantities of hydrogen cleanly and efficiently remains a topic of some debate.

20 Of course, the "hydrogen economy" will become a reality only when the elemental gas is as readily available as gasoline is now. In the United States currently, hydrogen-powered cars and buses must be refilled at specialized sites, but Shell Hydrogen has announced plans to have a system for the new fuel **integrated into a regular gas station** in the Washington, D.C. area shortly. The cost of **outfitting** just one such station with the necessary tanks and pumps has been estimated to be between $500,000 and $1 million. At the higher estimate, making hydrogen available at 30,000 gas stations would involve a $30 billion investment, but this is not considered out of the question for introducing a new energy source. A pipeline to bring natural gas from Alaska has been priced at more than $20 billion, and the cost of a single nuclear plant can exceed $10 billion.

21 Thus, the widespread availability of hydrogen at corner locations, although it requires a major commitment on the part of fuel distributors, is in fact within reach. However, the hydrogen economy still faces the familiar **Catch-22** associated with technological change: The **infrastructure** needed to facilitate a **paradigm shift** is not likely to be put into place until the paradigm shifts, but that is not likely to happen until the proper infrastructure exists. In the

final analysis, change depends on technological pioneers who are willing to undertake rough rides over unpaved roads and carry their toolboxes and extra fuel along with them.

22 By the time fuel-celled vehicles are on the road in large numbers, they can be expected to carry enough hydrogen to give them a range as great as today's gasoline powered vehicles. Early demonstration vehicles powered by fuel cells had to be fitted with large hydrogen-storage tanks, which either encroached on interior space or perched obtrusively on the roof. This is not much of a problem for buses, but it certainly is for stylish automobiles. The storage problem must be dealt with before sleek, roomy vehicles with competitive ranges **hit the showroom floor**.

Fuel-Cell Phone

23 Some industry observers believe that fuel cells' first big inroad to the marketplace will be in consumer electronics, an area in which customers have already demonstrated a willingness to **pay a premium** for novelty and convenience. Indeed, it has been said that "half the interest in fuel cells is out of frustration with batteries." Fuel cells can provide power for a much longer time than batteries. One **benchmark** of the portable-power industry is how many hours of continuous power can be gotten out of a kilogram of fuel. The comparison is striking: pure hydrogen, as high as 38,000 hours; **methanol**, from which hydrogen can be extracted, 6,000 hours; a fully charged **lithium-ion battery**, 150 hours. (But these numbers do not include the size of the container, which can be much larger for a kilogram of hydrogen than for methanol.) Unfortunately, unless they are carefully matched to the application, fuel cells are not capable of delivering large bursts of power. Hence, it is foreseen that they will be combined with batteries in many applications, thus exploiting the advantages of each.

24 Recent developments in the consumer electronics industry are likely to accelerate the move toward fuel cells as power sources. Sony, Samsung and others have begun introducing products that combine previously separate devices, such as a cell phone, personal digital assistant, digital camera and MP3 player, with the capability of being continuously connected to the Internet. Such **multifaceted** electronic gadgets also come with relatively large color screens, and their power demands thus consume batteries as quickly as teenagers do soft drinks. Electronics manufacturers are therefore experimenting with powering multi-devices with fuel cells.

25 There is also considerable effort going on in other areas. In Japan, a Ballard partnership recently **unveiled** a pre-commercial version of a stationary one-kilowatt fuel-cell generator capable of providing private residences with power and heat. The system is expected to be on the market by the end of next year. Ballard, which has stated that it wants to complete its transformation "from a technology-focused research and development organization into a

customer-focused production organization," appears to be well on its way to fulfilling its objective.

26 Ballard is far from the only player moving ahead in the fuel-cell business. For more than a year now, six 200-kilowatt fuel cells have been providing power for a juvenile training school in Middletown, Connecticut. The state has encouraged clean energy and is home to a number of small start-up companies focusing on fuel-cell research and technology development. It is also the location of fuel-cell manufactures, including UTC Fuel Cells in South Windsor, which at the end of 2002 was said to be the "world leader in fuel cell production at this point in time." The fuel-cell power plant at Middletown not only provides electric power for the campus but also is used to heat and cool the buildings. It came at a high price, however, for the installation of the forward-looking power plant accounted for about 37 percent of the $49 million total cost of the 227,000-square-foot facility. The decision to employ fuel cells there would not likely have been made without government involvement.

27 But President Bush has asserted the participation of the U.S. government, at least at the research level, and his enthusiasm for a hydrogen future brought considerable renewed attention to what has for so long been an obscure technology promising clean and quiet power. Just weeks after the State of the Union address, Canada's Finance Minister, John Manley, announced an additional $2 billion (Canadian) in funds for "sustainable development" in that country. Canadian fuel-cell interests hope to get some of that money for their ongoing research-and-development efforts, but its **final disposition** is not yet certain. Still, it is a good bet that before long today's **exotic technology** will be familiar, not only in North America but around the world.

Task 3: Identify the time expressions in "The Gas Battery" section and complete the following outline to trace the historical development of battery technology and its applications.

1) In 1800 (Inferred from the sentence "The simple voltaic pile preceded the fuel cell by 39 years.) ____

____

2) In the 1820s (inferred from "Within a couple of decades of the invention of the dry-cell battery"), ____

____

3) By the early 1830s ____

4) In 1839 ____

____

5) Well before the end of the decade, ______________________________________

____

6) By 1859, ____

____

7) In 1873, ____

____

8) By 1882, ____

____

9) At the end of the 19th century, ____

____

10) In 1900, ____

____

11) In 1906-1909, ____

____

12) By 1912, ____

____

13) In 1921, ____

____

Task 4: Identify the time expressions in the "Electric Car Resurgence" section and note down Geoffrey Ballard's experiences and efforts to develop new power systems. Organize the notes into a paragraph in chronological order.

1) After receiving a degree in geological engineering from Queens University,

____

____

2) After going back to school and earning a doctorate in geophysics,

____

3) During the 1973 energy crisis, ____

____

4) When Ballard was convinced that conservation was no answer to the energy

problems, ____

____

5) When his company relocated to Vancouver, British Columbia,

____

____

6) With the help of venture capital, ______________________________

____

7) After Ballard secured federal and provincial support for the bus plan,

____

____

8) In 1993, ____

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Summary:

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Task 5: Determine which of the following is the communicative purpose of the "Into the Mainstream" and "Out of the Laboratory, Someday" sections. Explain the problems to be solved before fuel cell powered vehicles can be widely used.

The communicative purpose of the two sections:

1) To evaluate Geoffrey Ballard' contribution to power technology.
2) To inform the reader of the present status of fuel cell technology.
3) To explain the problems of the automobile industry around the world.
4) To persuade the reader to support the hydrogen-based economy.

Problems

1) ____

____

____

2) ____

____

____

3) ____

____

____

4) ____

____

____

Task 6: Answer the following questions based on the last section of Text I.

1) In what industries or areas are fuel cells more likely to be used in the near future?

   ____.

2) What examples are given to illustrate the application of fuel cells?

   ____

   ____

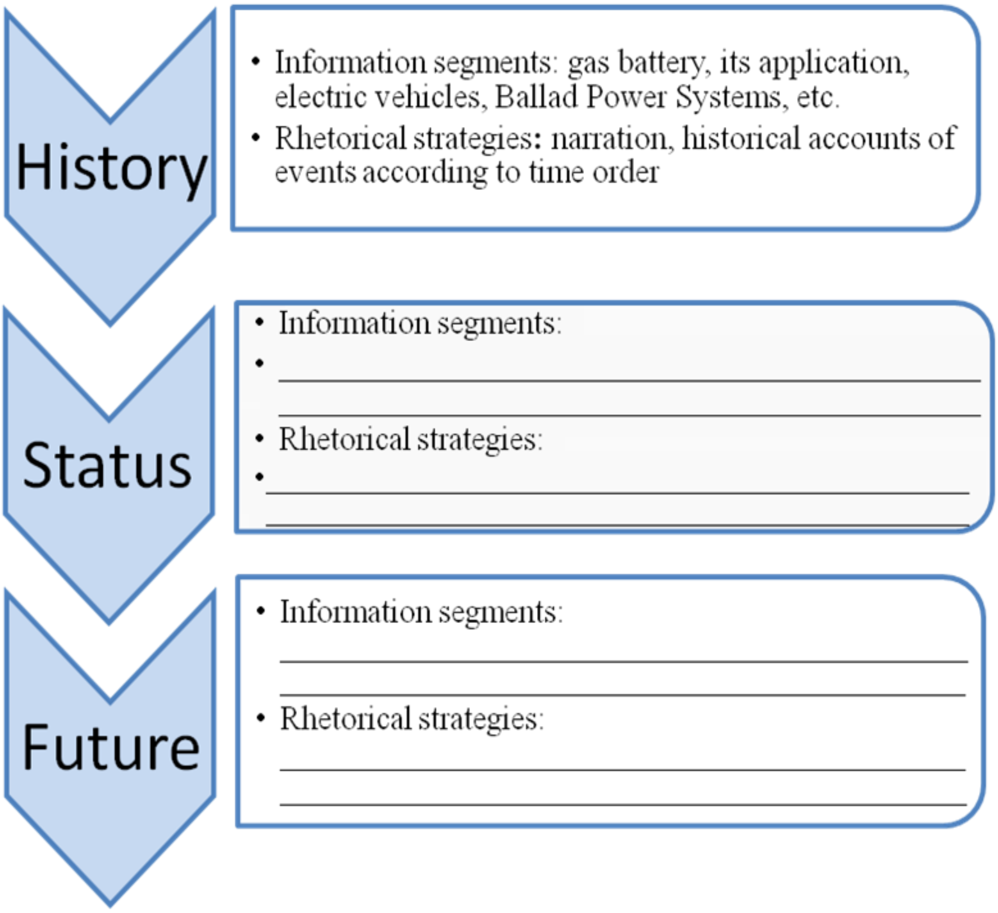
3) What is the prospect of fuel cell technology according to the author?

   ____

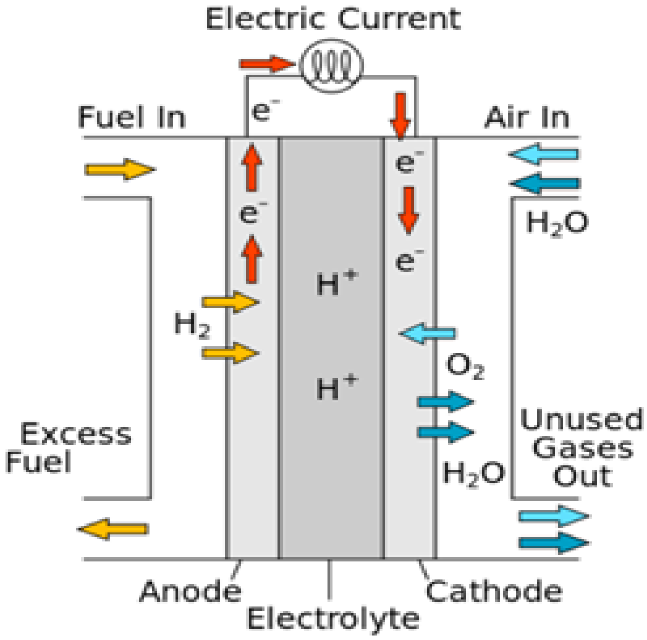
   ____

Task 7：Complete the following diagram which reflects the communicative purpose and information structure of Text I

Note: The writer of an article always has a particular communicative purpose in mind. It may be a body of information to convey, an opinion to express, a problem to solve, a theory to propose, or a controversial issue to discuss, etc. The author’s thoughts are rhetorically organized to form discernible segments or chunks, which are like "building blocks" for the construction of a lengthy text. The types of information and the ways of organizing the information are the author's choices, efforts or means to achieve the communicative purpose, thus they can be regarded as rhetorical strategies. Very often several rhetorical strategies are needed for the construction of a lengthy text in order to achieve the author's communicative purpose.



Task 8: Describe the mechanism or principle of proton-exchange-membrane fuel cells based on the information in paragraph 9 and the following diagram.



Note: A mechanism refers to the interconnectivity between parts of a system and the causal relationships between processes within the system. You can use the following sentences in your discussion.

- The electrodes of the cell are separated by a thin electrolytic membrane.
- Hydrogen is introduced under pressure.
- A catalyst decomposes hydrogen into electrons and protons at the anode.
- The electrons make electricity to power a motor.
- The protons move through the membrane toward the cathode.
- A catalyst combines protons with spent electrons and oxygen from ambient air.
- Water is produced.

Task 9：Explain the meaning of the following list of heavy noun groups. They can be regarded as technical word chunks.

Note: A heavy noun group consists of a head noun and two or more modifications which are either before or after the head noun. They may look complicated, but on the contrary, they are widely used in technical writing exactly because of their simplicity, convenience, and accuracy. The modifications often stand for a clause, a prepositional phrase, or a participle phrase. The following are some examples.

- **early-stage fuel-cell technology:** fuel cell technology at the early stage of its development
- **lead-acid fuel cell powered vehicle:** vehicles that are powered by lead-acid

fuel cells

- **technology-focused research and development organization:** an organization which aims at the research and development of new technology
- **customer-focused production organization:** an organization which aims at manufacturing products for customers
- **research-and-development funding system:** a system for providing funding for research and development

1) proton-exchange membrane cell
2) proton-exchange membrane technology
3) electric-driven road vehicles
4) fuel-cell powered vehicle
5) energy-conversion devices and techniques
6) roof-to-bumper windshield
7) more imaginative overall vehicle design
8) low-cost solid polymer fuel cell
9) lightweight and compact portable power sources
10) greenhouse gas carbon dioxide
11) potassium hydroxide electrolyte
12) high power density
13) energy-producing ingredients
14) carbon dioxide emissions
15) electric-driven cars
16) gasoline-engine cars
17) gasoline-powered vehicles
18) dry-cell battery
19) internal combustion engine
20) zero-emission vehicles
21) hand-held control system
22) hydrogen powered automobiles
23) venture-capital firm

24) lead-acid battery

25) command-and-control regulations

26) stationary one-kilowatt fuel-cell generator

Task 10: Use the prefixes and words provided to form as many new words as possible. Word formation techniques would help you understand the meaning of unknown technical words.

bio-	charge	
de-	carbon	
di-	number	
dis-	oxide	
dys-	physics	
electro-	fuel	
geo-	compose	
hydro-	code	
mechano-	formation	
mono-	generate	
multi-	magnetism	
non-	mechanics	
out-	dimensional	
over-	function	
re-	chemistry	
trans-	degradable	
under-	renewable	

Task 11：Work in groups and discuss the advantages and shortcomings of fuel-cell powered vehicles and IC engine vehicles.

Vehicle Types	Advantages	Shortcomings
Fuel-cell powered vehicles		
IC engine vehicles		

Task 12: Read Text II and explain the author's communicative purpose. Note down why the author thinks that a rapid energy transitions is impossible.

The author's view of a rapid energy transition: A rapid energy transition is impossible.

Reason for this view: Our existing energy system has such a great inertia and momentum that you cannot change it no matter how hard you try.

Explanations:

- Inertia ____

- Momentum ____
____
____

- Technological momentum ____
____
____

- Labor-pool momentum ____
____
____

- Economic momentum ____
____
____

Text II

The Impossibility of Rapid Energy Transitions[2]

Kenneth P. Green

Understanding energy system **inertia and momentum** is key to judging whether a rapid transition toward any type of energy is feasible.

I am tonight setting a clear goal for the energy policy of the United States. Beginning this moment, this Nation will never use more foreign oil than we did in 1977 — never. From now on, every new addition to our demand for energy will be met from our own production and our own conservation. The generation-long growth in our dependence on foreign oil will be stopped dead in its tracks right now and then reversed as we move through the 1980s, for I am tonight setting the further goal of cutting our dependence on foreign oil by one-half by the end of the next decade — a saving of over 4 1/2 million barrels of imported oil per day.

— Jimmy Carter

1 Politicians are fond of promising rapid energy transitions. Whether it is a transition from imported to domestic oil or from coal-powered electricity production to natural-gas power plants, politicians love to **make grandiose claims**. Unfortunately for them (and often the taxpayers), our energy systems are a bit like an aircraft carrier: they're unbelievably expensive, they're built to last for a very long time, they have a huge amount of inertia (meaning it takes a lot of energy to set them moving), and they have a lot of momentum once they're set in motion. No matter how hard you try, you can't **turn something that large on a dime**.

Inertia and Momentum: An Overview

2 In physics, moving objects have two characteristics relevant to understanding the dynamics of energy systems: inertia and momentum. Inertia is the resistance of objects to efforts to change their state of motion. If you try to push a **boulder**, it pushes you back. Once you've started the boulder rolling, it develops *momentum,* which is defined by its **mass and velocit**y. Momentum is said to be "conserved," that is, once you build it up, it has to go somewhere. So a heavy object, like a football player moving at speed, has a lot of momentum — that is, once he's moving, it's hard to change his state of motion. If you want to **change his trajectory**, you have only a few choices: you can **intercept** him, transferring (possibly painfully) some of his **kinetic energy** to your own body, or you can approach alongside and slowly apply pressure to gradually alter his trajectory.

3 But there are other kinds of momentum as well. After all, we don't speak only of objects or people as having momentum; we speak of entire systems having momentum.

Technological Momentum

4 One kind of momentum is *technological momentum*. When a technology is deployed, its impacts reach far beyond itself. Consider the **incandescent bulb**, a current object of hatred for many environmentalists and energy-efficiency advocates. The incandescent light bulb, invented by Thomas Alva Edison, which came to be the symbol of inspiration, has been developed into hundreds, if not thousands, of forms. Today, a visit to a lighting store reveals a stunning array of choices. There are standard-shaped bulbs, flickering flame–shaped bulbs, colored globe–shaped bulbs, outdoor spotlights and floodlights, and more. It is quite easy, with all that choice, to change a light bulb.

5 But the momentum of incandescent lighting doesn't stop there. All of those specialized bulbs led to the building of specialized light fixtures. It's easy to change a light bulb, sure, but it's harder to change its fixture.

6 And there's more to the story, because not only are the devices that house incandescent bulbs shaped to their underlying characteristics, rooms and

entire buildings have also been designed in accordance with how incandescent lighting reflects off walls and windows.

Labor-Pool Momentum

7 Another type of momentum we have to think about when planning for changes in our energy systems is *labor-pool momentum*. It's one thing to say that we're going to shift 30 percent of our electricity supply from, say, coal to nuclear power in 20 years. But it's another thing to have a supply of trained talent that would let you carry out this promise. That's because the engineers, designers, regulators, operators, and all of the other skilled people needed for the new energy industry are specialists who have to be trained first (or retrained, if they're the ones being laid off in some related industry), and education, like any other complicated endeavor, takes time. And not only do our prospective new energy workers have to be trained, they have to be trained in the right sequence. One needs the designers, and perhaps the regulators, before the builders and operators, and each cohort of workers in training has to know there is work waiting beyond graduation. In some cases, colleges and universities might have to change their training programs, adding another layer of difficulty, given the prevalence of tenure in academia.

Economic Momentum

8 By far the biggest type of momentum that comes into play when it comes to changing our energy systems is *economic momentum*. The major components of our energy systems, such as fuel production and refining and electrical generation and distribution, are costly installations that have lengthy life spans and that have to operate for long periods of time before the costs of development have been recovered. When investors put up their money to build, say, a nuclear power plant, they expect to earn that money back over the planned life of the plant, which is typically between 40 and 60 years. Some coal power plants in the United States have operated for more than 70 years! The oldest continuously operated commercial **hydroelectric plant** in the United States is on New York's Hudson River, and it went into commercial service in 1898.

9 As Vaclav Smil points out, "All the forecasts, plans, and anticipations cited above have failed so miserably because their authors and promoters thought the transitions they hoped to implement would proceed unlike all previous energy transitions, and that their progress could be accelerated in an unprecedented manner."

10 When you hear people speaking of making a rapid transition toward any type of energy, whether it's a switch from coal to nuclear power, or a switch from gasoline-powered cars to electric cars, or even a switch from an incandescent to a fluorescent light, understanding energy system inertia and momentum

can help you decide whether their plans are feasible.

Task 13: Read Text III and note down the main points of a new mehtod for hydrogen storage.

The problem with wide applications of hydrogen based fuel cells in transportation:____

____

A new method used by Tom Autrey's team to store hydrogen:

____

____

Explanations:

- The method to get hydrogen out of ammonia borane ____
- Autrey's explanation of the process ____
- The challenge to this method ____

Text III

Filling up with Hydrogen[3]

David Schneider

1 In June, Honda leased its first hydrogen-powered, fuel-cell car to ordinary consumers, the Spallino family of Redondo Beach, California. That transaction **marks an incremental step toward** the hydrogen-fueled transportation system that President Bush championed in his 2003 State of the Union Address, when he announced a $1.2 billion "Freedom Fuel" initiative. That program, among other things, funds research on the

longstanding problem of how to store hydrogen on a vehicle, one of the many possible problems in the effort to **nudge modern society toward a hydrogen-based economy**. The trick is figuring out how to hold hydrogen safely and at sufficient density to allow a typical car to go 500 kilometers or so before having to tank up. While that requirement remains a significant **hurdle**, a new study indicates that the clever use of **nanotechnology** may give hydrogen storage a significant boost.

2 The surprising report, which appeared last June in the journal *Angewandte Chemie*, describes a way of storing hydrogen in the form of the compound **ammonia borane**, **NH_3BH_3**. Tom Autrey of the Pacific Northwest National Laboratory led the group of 12 authors who published the work. It builds on the decades-old idea of storing hydrogen in the form of ammonia, NH_3. Unlike hydrogen gas, which requires **cryogenic temperatures** to **liquefy**, ammonia becomes a liquid at −34 degrees Celsius. It also does so at room temperature and 9 atmospheres pressure, making it much more convenient to use as a transportation fuel. Ammonia is comparatively inexpensive to produce, and the hydrogen can be separated out using catalysts without undue losses.

3 "It's a perfect fuel in many ways," says Ali T. Raissi, head of the hydrogen research and development division at the Florida Solar Energy Center, part of the University of Central Florida. "The only problem it has is the fact that it's **toxic**." This consideration suggests that a better strategy might be to use the compound ammonia borane, which typically takes the form of a powdery solid. This chemical (and its cousin **ammonium borohydride**, NH_4BH_4) were first studied in the 1950s for their possible use in rocket fuel, an idea that was later abandoned. It largely fell off scientists' **radar screens** until the late 1990s, when Gert Wolf of the Technische Universität Freiberg realized that it might be a good medium for storing hydrogen in a vehicle. Indeed, ammonia borane contains almost 20 percent hydrogen by weight, giving the compound more hydrogen per unit mass or volume than even liquid hydrogen.

4 Getting the hydrogen out of ammonia borane isn't difficult and doesn't require additional energy: Once the compound is heated sufficiently, the **decomposition reaction** proceeds on its own. A third of the hydrogen is released at about 110 degrees, a second third at about 155 degrees (at which point ammonia borane is a liquid) and the final third at a higher temperature still, more than 500 degrees. Because the last increment requires **awkwardly extreme temperatures**, the new work of Autrey and his colleagues focused on the first two steps, whereby two-thirds of the hydrogen can be extracted.

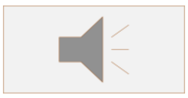
5 Autrey's team **infused ammonia borane into** a **nanometer-scale** scaffolding of silica, a type of material often used as a **substrate for catalysts** because it provides an enormous surface area for reactions. Doing

so allowed the hydrogen-release reaction to take place at lower temperatures and to give off less energy. In chemist Autrey's words: "It's just **barely exothermic**." That difference is important for two reasons. First, it allows engineers to consider using the waste heat from fuel cells to **prompt the reaction** (the most popular type of fuel cells heat up to about 85 degrees). More important, the change in **thermodynamic properties** means that driving the reaction in the opposite direction—regenerating the ammonia borane by somehow putting hydrogen back—becomes less difficult, at least in theory. As Autrey explains, "If you're going to regenerate the stuff, you don't have to go uphill so far."

6 But figuring out exactly how to regenerate ammonia borane from the **residuum** left after hydrogen has been extracted remains a stumbling block. And T. Raissi notes that this is going to be very challenging. "You've got to be smarter than Haber, smarter than Bosch," he says, referring to the German chemists Fritz Haber and Carl Bosch, who at the turn of the 20th century pioneered a system to **synthesize ammonia from hydrogen and nitrogen** by combining these gases at high temperature and pressure in the presence of **osmium and uranium** catalysts—the system used around the world today to manufacture synthetic fertilizer.

7 Autrey agrees that regeneration is critical and says that he and his colleagues are working on the problem in collaboration with others in the **consortium** of government, university and industrial labs that make up the Department of Energy's Center of Excellence for Chemical Hydrogen Storage. But he is otherwise tight-lipped about what avenues his group is investigating. Perhaps their best efforts will fail to resolve this critical issue. Or, just maybe, wielding computational, theoretical and experimental tools not available a century ago, Autrey's interdisciplinary team (or another one) will yet outwit Haber and Bosch. Doing so could help make hydrogen the fuel of choice in future vehicles.

8 Would such a change relieve the **energy crunch** and lower the amount of carbon dioxide released into the atmosphere? That all depends on how one gets the hydrogen, which, after all, is just serving as an energy carrier. Skeptics point out that it would probably come from natural gas, in which case the shift to a hydrogen-based transportation system would not fundamentally resolve current concerns. But at least the term "gas station" would finally make some sense.



Task 14: Complete the following report with the words and collocations you hear.

Who was the greenest President? A recent survey of green groups aimed to find out which presidents had the most environmentally friendly policies.

The top two spots, naturally, went to Republicans: Teddy Roosevelt and Richard Nixon. Roosevelt dominated the survey for his championing of the nascent idea of (1) ________________________ more than a century ago. Nixon garnered support for his passage of landmark legislation like the Clean Air and Clean Water Acts as well as the establishment of the (2) ________________________ Agency.

Rounding out the top three was Jimmy Carter, who gained points for actions like putting (3) ________________________ on the White House.

Who came in fourth? Barack Obama, thanks to often (4) ___________________ steps like raising a car (5) _____________________________ and making (6) ________________________ projects a big part of the federal stimulus package.

Of course, the modern Republican party, including candidate Mitt Romney, has turned against conservation. If Romney likes coal, then he must love

(7) ________________________ and (8) ________________________. The original Republican president, Lincoln, may have created the first (9) ________________________, but his heirs today are more interested in opening such public lands for (10) ________________________ exploitation.

Task 15：Note down some of the inventions in the 20th century which have greatly improved people's lives.

1) In 1875, if you wanted to read at night, you needed to have an oil or a gas lamp. By 1929, ____

2) In the late 19th century, women spent two days a week doing the laundry. By 1950, we had ____

3) In the late 19th century, the only source of heat was a big fireplace in the kitchen. By 1950, we had ____

4) Before 1879 transportation depended entirely on the urban horse. By 1929, ____

5) In 1900, the ratio of motor vehicles to the number of households was zero. 30 years later, the ratio reached ______________________________________

6) In 1885, the average North Carolina housewife walked 148 miles a year carrying 35 tons of water. By 1929, cities around the country ____

7) In the late 19th century, waterborne diseases ____

8) In the first half of the 20th century, __________________________________

9) By 1960 telephone bills, bank statements were being produced ____

Task 16: Answer the following questions according to a program about the properties of lithium, the third element on the periodic table.

1) Why are lithium and batteries are almost synonymous?

____

____

2) What are the two elements before lithium on the periodic table?

____

____

3) What is crucial about lithium?

____

____

4) What does the professor say about the weight of lithium?

____

____

Task 17: Note down the main points of President Obama's State of the Union Address in which he explains his administration's research, technology and energy policies.

1) His policy about responsible young people:

____

____

2) His attitude towards basic research and the reasons:

____

____

3) His plans for oil and gas exploration:

____

____

4) American oil production now:

____

____

5) His energy strategy:

____

____

6) His policy about renewable energy:

____

____

Task 18: Note down the main reasons why the market for electric cars is limited in the UK in spite of the government's promotional efforts.

1) ____

2) ____

3) ____

Task 19: Note down the main points of the speaker's view on a hydrogen economy.

1) The key question about hydrogen economy:

____

____

2) Hydrogen can come from many different sources:

____

____

3) Distance between hydrogen fueling stations:

____

____

4) The real exciting vision:

____

____

Task 20: Work in groups and share each other's knowledge of our government's policies related to electric cars. Explain your attitude towards these policies and electric vehicle development.

Task 21: Use the information from this unit to analyze the prospect of hydrogen based fuel cells to power vehicles. If you think that widespread applications of hydrogen based fuel cells in transportation have a promising prospect, focus on the advantages, government efforts, and technological preparations. If you think otherwise, focus on the challenges or problems.

Unit 2

Space Exploration

Objectives

- Predict the content and the types of information according to the title and subheadings of an article;
- Acquaint yourselves with the General-Particulars discourse pattern in text construction;
- Distinguish general statements from specific details in the description of topography and landscape;
- Note down the similarities and differences between Mars and the Earth;
- Describe the landscape of Mars with the help of your notes;
- Distinguish facts from inferences and hypotheses about Mars;
- Make inferences about Mars on the basis of known facts;
- Use expressions and structures to draw inferences and make hypotheses;
- Define questions to be answered by future Mars missions;
- Note down the main points of science news reports about space exploration.

Task 1: Familiarize yourselves with the following new words, set expressions or lexical chunks to prepare for reading the texts in this unit.

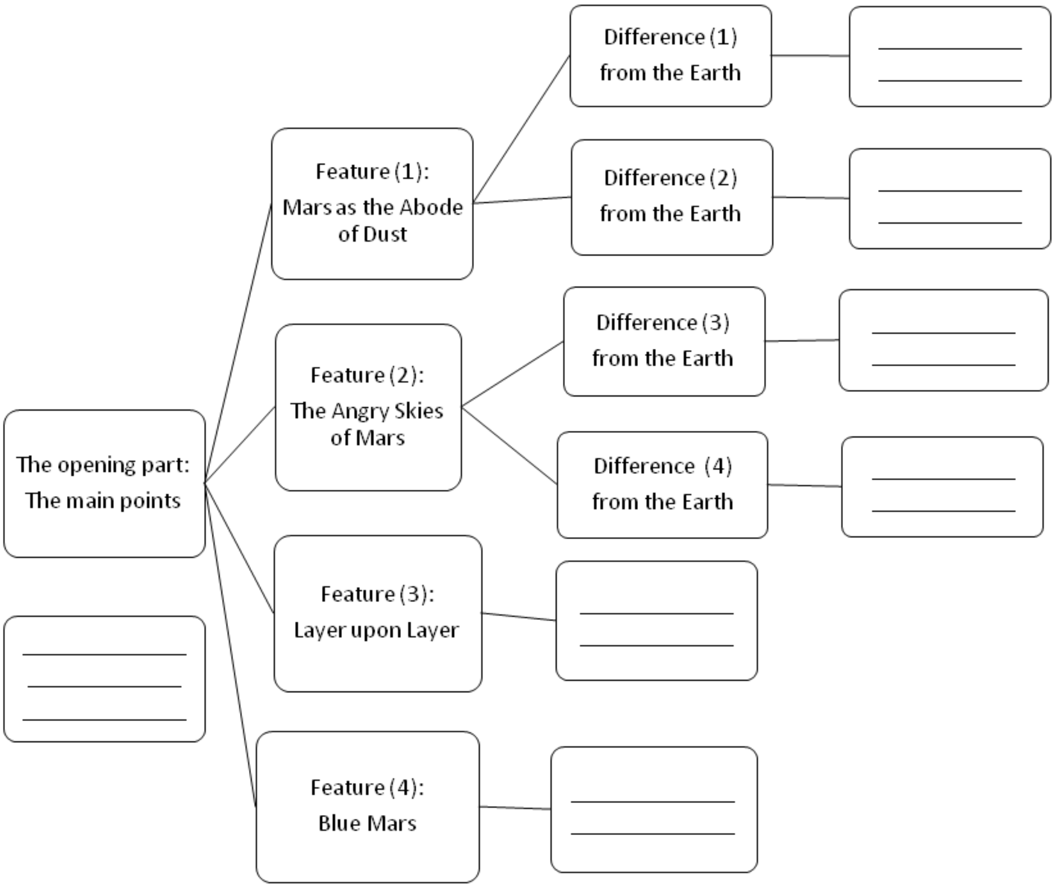
a bank of snow and ice	一层冰雪
admonition	告诫
aeolian activity	风力活动
aeolian erosion or deposition	风蚀或沉积
aftermath	后果
alpha particle x-ray spectrometer	阿尔法粒子 x 射线谱仪
anion	阴离子
aquifer	含水层
artificial satellite	人造卫星
manned satellite	载人卫星
unmanned satellite	不载人卫星
astounding creative power	惊人的创造力
atmospheric cycle	大气循环
atmospheric pressure	大气压
attest to an abundance of water	证明有丰富的水
barren, cratered world	贫瘠、坑洼不平的世界
basaltic	玄武岩
blanketed with a mixture of snow and dust	覆盖着一层雪尘混合物

canyon	大峡谷
celestial limits that earth-bound humans could not transgress	地球人无法跨越的天体范围
chariot	战车
chemical weathering of the underlying bedrock	基岩受化学风化作用
chlorine	氯
come to the fore	凸显出来
condensation	凝结
confluence	汇集
conjecture	推测
corona	日冕
cosmonaut (astronaut)	宇航员
culminate in	达到顶点，以……而告终
decay	衰减
deluge	洪水
distinctively pitted terrain	坑洼不平的特殊地貌
dust avalanche	尘崩
dust devil	尘卷风
dust storm	尘暴
eons	千古
for eons	长期以来
equatorial region	赤道区
formed by surface runoff from rainfall or snowfall	雨雪流经地表而形成
gap in our knowledge	知识空白
geyser	间隙泉
grand convergence of	大融合
grapple with Earth's own history	努力了解地球的历史
gully	深沟
high in altitude	海拔高
high-resolution images	高分辨率图像
hospitable to evolution of life	有利于生物进化的
impacts rework the landscape	陨石撞击改变了地貌
inflatable airlock	充气密封舱
infrared images	红外图像
infrared spectra	红外光谱
infrared spectrometer	红外光谱仪
intense meteor bombardment	陨石的猛烈撞击
intense scientific scrutiny	严格的科学检验
intensive volcanism	剧烈的火山活动
intriguingly	神秘地是
lander	着陆器

lunar module	登月舱
mantle of icy dust	覆盖着一层冻土
mineralogy	矿物学特征
noted	著名的
be noted for	以……而著名
off course	偏离预定轨道
oracular power	神谕的力量
orbiter	轨道飞行器
orbiting the planet	绕该行星轨道运行
permafrost layer	永冻层
polar ice cap	极地冰冠
precipitation	降水
preoccupy	使全神贯注
be preoccupied with	全神贯注于
pristine	处于原始状态
proliferating plants	繁茂的植被
recharge the groundwater	回补地下水源
reminiscent of	使人联想到
rover	巡视探测器
sacred realm of the gods	属于神明的神圣王国
sand dune	沙丘
sand sheet	沙原
satellite launch	卫星发射
sate our voracious curiosity	满足我们永无止境的好奇心
scabland	贫瘠而崎岖的地带
sedimentary debris	沉积的碎片
solar eclipse	日食
stealth crater	隐形陨石坑
stereo camera	立体摄影机
striking dichotomy	截然分明的两部分
sublimation	升华作用
subsurface geology	地下地质结构
terrestrial glacier	地球上的冰川
The resemblance to Earth fell apart.	认为火星和地球相似的说法不攻自破。
tilt of Mars's rotation axis	火星自转轴的倾斜度
time of heavy cratering	陨石坑形成的多发期
topographical measurement	地形测量值
transmit radio signal	传输无线电信号
vestige	残余
viscous fluid	粘稠液体
volatile material	易挥发物质
volcanic flow	火山熔岩流

volcanoes that dwarf any on Earth	高于地球上任何一座火山的火山
weathered, quartz-rich soils, hydrated clays, and salts such as calcium carbonate and sulfate	富含石英的风化土壤、水合黏土，以及碳酸钙和硫酸盐等盐类物质

Task 2: Read the topic sentence and concluding sentence of each paragraph and complete the following diagram that reflects the General-Particulars discourse pattern of the article. Then determine the communicative purpose of the article and the rhetorical strategies to achieve the purpose.



The communicative purpose of the article:

____.

The rhetorical strategies to achieve the purpose:

Text I

The Unearthly Landscapes of Mars: The Red Planet Is No Dead Planet[4]

Arden L. Albee

1 In science as well as science fiction, Mars is usually depicted as a version of Earth in its extreme—smaller, colder, drier, but sculpted by basically the same processes. Even well into the 20th century, many thought the planet had flowing water and **proliferating plants**. **The resemblance to Earth fell apart** when spacecraft in the late 1960s revealed a **barren, cratered world**, more like the moon. But it quickly returned with the subsequent discoveries of giant mountains, deep **canyons** and complex weather patterns. The Viking and Mars Pathfinder images from the surface look strangely Earth-like. Researchers compare the **equatorial regions** of Mars to the American Southwest. For the **polar regions**, the model is the Dry Valleys of Antarctica, a frozen desert in a landscape of endless ice.

2 But if there is one thing researchers have learned from recent Mars exploration, it is to be careful about drawing such comparisons. In the past five years, spacecraft have collected more information about the Red Planet than all previous missions combined. Mars has proved to be a very different and more complicated planet than scientists thought beforehand. Even the single biggest question—Was Mars once warm and wet, possibly **hospitable to the evolution of life**?—is more confused than people have tended to assume. To make sense of Mars, investigators cannot be blinded by their experience of Earth. The Red Planet is a unique place.

Mars as the Abode of Dust

3 Mars exploration has certainly had its **ups and downs**. In the past decade NASA has lost three spacecraft at Mars: Mars Observer, Mars Climate Orbiter (intended as a partial replacement for Mars Observer) and Mars Polar Lander. Lately, though, the program has had a run of successes. Mars Global Surveyor has been taking pictures and collecting **infrared spectra** and other data continuously since 1997. Another, Mars Odyssey, has been **orbiting the planet** for more than a year, mapping the water content of the subsurface and making **infrared images** of the surface.

4 Never before have scientists had such a comprehensive record of the processes that operate on the surface and in the atmosphere. They have also studied the craters, canyons and volcanoes that are dramatic relics of the

distant past. But there is a huge **gap in our knowledge**. Between ancient Mars and modern Mars are billions of missing years. No one is sure of the conditions and the processes that sculpted Mars during most of its history. Even less is known about the **subsurface geology**, which will have to be the subject of a future article.

5 Present-day Mars differs from Earth in a number of broad respects. First, it is enveloped in dust. Much of Earth's surface consists of soil mostly derived by **chemical weathering of the underlying bedrock.** But much of Mars's surface consists of dust—very fine grained material that has settled out of the atmosphere. It is thick even on the highest volcanoes.

6 Dust produces otherworldly landscapes, such as **distinctively pitted terrain**. As dust settles through the atmosphere, it traps **volatile material**, forming a **mantle of icy dust**. **Intriguingly**, the thickness of the icy, dusty mantle on Mars varies with latitude; near the poles, Mars Odyssey has shown, as much as 50 percent of the upper layer of soil may be ice. On slopes, the icy mantle shows signs of having flowed like a **viscous fluid**, much in the manner of a **terrestrial glacier**. This mantle is becoming the focus of **intense scientific scrutiny**.

7 Second, Mars is extremely windy. It is dominated by **aeolian activity** in much the way that Earth is dominated by the action of liquid water. Spacecraft have seen globe-encircling **dust storms,** huge **dust devils** and **dust avalanches**—all wrought by the wind.

8 Where not dust-covered, the surface commonly shows **aeolian erosion or deposition**. Evidence for erosion shows up in craters, from which material appears to have been removed by wind, and in bedrock features that clearly have been carved by windblown sand. Evidence for deposition includes **sand sheets** and moving **sand dunes**. The latter are composed of sand-size grains. Aeolian activity seems to have persisted since the **time of heavy cratering**, back when the solar system was still young. Many images show craters with varying degrees of erosion: some are shallow and partially filled with deposits and sand dunes, whereas others are **pristine**—deeper and bowl-shaped. Michael Malin and Kenneth Edgett of Malin Space Science Systems in San Diego, the research firm that operates the Mars Global Surveyor camera, have inferred a sequence of processes: Sand was blown through the region, and some of it got trapped in craters; other craters formed later. Where and how such a volume of sand was produced and how it was blown around remain a mystery, however.

The Angry Skies of Mars

9 A third way in which Mars differs from Earth is in its amazing variety of weather and climate cycles, many of which are similar to those on Earth, many like nothing on Earth. The Martian day is almost the same as an Earth

day, but the Martian year is 687 Earth days. The **tilt of Mars's rotation axis**, which produces seasons, is very close to that of Earth's. Mars lacks the **precipitation** and oceans that are so crucial to weather on Earth. But the **atmospheric pressure** (less than 1 percent of that on Earth) varies seasonally by about 25 percent, driven by the **condensation** and **sublimation** of carbon dioxide frost at the poles. The thin atmosphere has a very low heat capacity, so the surface temperature swings by more than 100 degrees Celsius from day to night. The thermal properties of the thin atmosphere are dramatically affected by dust and ice particles suspended in the air. The upshot is that, despite being so thin, the atmosphere has complex circulation patterns and dynamics. A daily weather report might talk of strong winds, high-level ice clouds, low-level fogs, seasonal frost, dust devils and massive dust storms.

10 As on Earth, storm systems often spiral southward from the northern polar regions. But the largest dust storms typically start during the southern spring as the planet rapidly heats up. Periodically they come together and encircle the entire planet. Mars Global Surveyor closely followed the evolution of a four-month global dust storm that started in June 2001. Contrary to scientists' expectations, it was not, in fact, one single global storm, but the **confluence** of several regional storms. Malin has compared the climatic effect of the dust raised by this storm with the **aftermath** of Mount Pinatubo's eruption on Earth in 1991—namely, a brief but widespread cooling.

11 The **polar ice caps** play a key role in the **atmospheric cycles**. Their size and shape, as shown by **topographical measurements，**indicate that the caps are predominantly water ice, as opposed to so called dry ice, made of carbon dioxide: dry ice is not as rigid as water ice, and it could not support the observed domelike shape. A major new discovery has been that the layer of dry ice that covers much of the south polar cap is being eroded away at a high rate. Clearly, the erosion cannot go on forever. Nor can the current dust sinks and sources remain in their current states indefinitely. To replenish the ice and dust, other cycles must be occurring, perhaps tied to orbital variations. Malin and Edgett have suggested that wind condition may be less intense now than in the fairly recent past, another hint that the Martian climate changes with time.

12 A fourth major difference between Earth and Mars is the behavior of liquid water. Liquid water is unstable at the surface under present pressure and temperature conditions. It does not rain. Still, water ice can—and does—persist at some depth within the Martian soil during all or much of the year. On Mars, as on Earth, several types of patterned ground mark the presence of ice-rich soil. Mars Odyssey has detected ground ice over most of the planet outside the equatorial regions, and models predict that the ice extends to considerable depths.

13 Liquid water can sometimes leak onto the surface. In 2000 Malin and Edgett described fresh **gullies** that look like water carved features on Earth. In the ensuing excitement, researchers advanced many theories to explain them: leaking **aquifers**; pressurized **geysers** of water; high-pressure outbursts of carbon dioxide gas; volcanic heat sources at depth. Finally, earlier this year Philip Christensen of Arizona State University discovered **gullies** that clearly emerge from underneath **a bank of snow and ice**. He concluded that they are related to Martian climate cycles. In colder periods, slopes become **blanketed with a mixture of snow and dust**. Sunlight penetrates this blanket, heating it enough for water to melt under the snow and to run down the slope, creating gullies. In warmer periods, the blanket melts or evaporates entirely, exposing the gullies.

Layer upon Layer

14 Despite the abundance of water, however, Mars is arid. It has the **mineralogy** of a nearly waterless surface. On Earth, the action of warm liquid water produces **weathered**, **quartz-rich soils, hydrated clays, and salts such as calcium carbonate and sulfate**. Beach sand and sand dunes are largely quartz. On Mars, spacecraft have yet to find any deposits of these minerals. The darker Martian dunes are **basaltic**, consisting mainly of minerals which on Earth would readily weather away. It follows that the present cold and dry atmospheric conditions have persisted since a time far back into the planet's history.

15 Has Mars always differed so much from Earth? Below the mantles of dust and sand are numerous signs that the Red Planet has transformed over time. To begin with, the planet has a **striking dichotomy** in landscape between its northern and southern hemispheres. The southern hemisphere is **high in altitude** and heavily cratered (indicating an ancient surface). The northern one is a vast, low-lying plain with fewer craters (indicating a younger age). In between is the immense Tharsis Plateau, intermediate in age and capped by **volcanoes that dwarf any on Earth**. Using the new **high-resolution images** on these volcanoes, James W. Head III of Brown University has found flow patterns that look strikingly like mountain glaciers—and that may suggest the presence of ice under a blanket of rock and dust.

16 The northern lowlands are exceedingly level, leading to speculation that they were lake beds during a significant chunk of Martian history. They appear to be covered with multiple layers of **volcanic flows** and **sedimentary debris** that originated in the south. Detailed new topographic maps have unveiled **"stealth craters"**— faint circular expressions, evidently part of an ancient cratered surface that has been buried by a thin layer of younger deposits.

17 Along the edge of the southern highlands are features that could only have been carved by liquid water. These features are tremendously larger than their counterparts on Earth. The famous canyon Valles Marineris would run

from Los Angeles to New York with a width extending from New York to Boston and a depth similar to the elevation of Mount McKinley. No terrestrial canyon comes close. At its head is a jumbled terrain, indicating that water flowed not in a steady trickle but in concentrated, catastrophic outflows, scouring the surface along its path. Other Martian outflow channels have similar features. Because these features are carved into the Tharsis Plateau, they must have an intermediate age.

18 Streamlined islands and other features in these channels look much like **scablands** in the northwestern U.S., which were gouged by the Spokane Flood toward the end of the last ice age, about 10,000 years ago. During the massive **deluge**, a lake roughly the size of one of the Great Lakes burst its ice dam and rushed out within just a few days. On Mars, such calamities were 10 to 100 times as devastating. They may have been triggered by volcanic heat sources or by the general heat flow from the interior of the planet. Heat would have melted ice underneath the thick **permafrost layer** building up tremendous pressures until the water finally burst out.

19 The most contentious water-related features of all are the valley networks. Located throughout the southern highlands, they have a branching pattern **reminiscent of** rivers on Earth—suggesting that they were **formed by surface runoff from rainfall or snowfall**. They are the strongest hint that Mars was once as warm as Earth. But these networks look rather different from rain-fed rivers on Earth. They more closely resemble river networks in desert areas, which are fed by water that slowly seeps from subterranean sources. Heated debates have been taking place at scientific meetings over the crucial question: Did it rain on early Mars?

20 The timing of the water networks could be the key to making sense of them. Recent detailed studies of the northern edge of the highlands show that immense amounts of material eroded during—rather than after—the **intense meteor bombardment** that took place early in Martian history. These analyses imply that the distribution of water kept changing as **impacts reworked the landscape**. Craters filled with water and debris, and channels began to link them together into a network, but impacts continually disrupted this process. For instance, the Argyre Basin, 1,000 kilometers in diameter, may once have been filled to its brim with water. It is part of a valley system that brought water from near the South Pole, through the basin, into channels that crossed the equator. The roles of water and ice in these systems, both aboveground and underground, remain unclear. In any case, these networks are very different from hydrologic systems on Earth**.**

21 A final clue to Martian history comes from one of the biggest surprises delivered by Mars Global Surveyor, the extent to which the uppermost crust consists of layered deposits. Almost everywhere that the subsurface is exposed—on walls of canyons, craters, and valleys—it is layered. The layers

differ from one another in thickness, color and strength. They show that the Martian surface has undergone complex sequences of deposition, crater formation and erosion. The oldest layers are the most extensive. The higher layers have been partially stripped away, apparently blown by the wind.

22 Where did the layers come from? The lack of boulder like blocks argues against their being volcanic flows, although they could be volcanic ash. Ultimately, however, most of the layers probably originated in impact debris. On the moon, scientists observe overlapping rings of impact debris, which mark craters of differing ages. Similarly, Mars is so heavily cratered that the upper crust has been stirred up like soil tilled by a gardener. Water and wind then scattered this material.

Blue Mars?

23 In a sense, scientists' ideas about early Mars are more uncertain than they have ever been. This doubt **comes to the fore** when researchers address the question of liquid water. The presence or absence of liquid water is fundamental to geologic processes, climate change and the origin of life. The early valley networks and the later flood channels **attest to an abundance of water**. The evidence for early rainfall suggests that the atmosphere was once much denser. But spacecraft have found no evidence for deposits of carbonate minerals, which would be the **vestige** expected from an early dense carbon dioxide atmosphere.

24 At this point, scientists have three main hypotheses. Perhaps the early atmosphere was indeed thick. The planet might have had lakes, even oceans, free of ice. Robert A. Craddock of the National Air and Space Museum and Alan D. Howard of the University of Virginia recently suggested that the carbon dioxide was lost to space or locked up in carbonate minerals that have so far escaped detection. Intriguingly, Mars Odyssey spectra have revealed small amounts of carbonate in the dust.

25 Alternatively, perhaps Mars had a fairly thin atmosphere. It was a wintry world. Any standing bodies of water were covered in ice. Snow might have fallen, **recharging the groundwater** and leading to temporary trickles of water across the surface. Steven M. Clifford of the Lunar and Planetary Science Institute in Houston, among others, has **conjectured** that melting under a glacier or a thick layer of permafrost could also have recharged subterranean water sources. Although Mars was bitterly cold, periodic bursts of relatively warmer temperatures could have reinvigorated the planet. Orbital shifts, similar to those that trigger ice ages on Earth, drove these climate cycles. Head, John F. Mustard of Brown and others have pointed to the latitude dependence of the ice and dust cover as evidence for climate change.

26 Finally, perhaps the climate cycles were insufficient to make Mars warm

enough to sustain liquid waters. The planet had warm conditions for only brief periods after major impacts. Each such impact deposited water-rich material and pumped enough heat and water into the atmosphere to permit rain. Soon, though, the planet returned to its usual frozen state. Victor Baker of the University of Arizona has argued that the **intensive volcanism** in the Tharsis region periodically made early Mars quite a temperate place.

27 It is also very possible that none of these options is correct. We simply do not yet know enough about early Mars to have any real understanding of its climate. We must wait for future exploration. Unlike Earth, Mars has preserved much of its ancient landscape, which may yield clues to the conditions under which it formed. Indeed, understanding how Mars became so different from Earth will help geologists **grapple with Earth's own history**. The new missions will soon provide some of these clues.

Task 3: Note down the similarities and differences between Mars and the Earth described in paragraphs 3-14. Give an oral summary with the help of your notes. Use words, expressions and structures to indicate or express similarities and differences. Note that some of the comparisons are explicitly stated. Others are implied. For example:

- Much of Earth’s surface consists of soil mostly derived by chemical weathering of the underlying bedrock. But much of Mars’s surface consists of dust. (The difference is explicitly stated.)
- As on Earth, storm systems often spiral southward from the northern polar regions. (The similarity is explicitly stated.)
- A third way in which Mars differs from Earth is in its amazing variety of weather and climate cycles, many of which are similar to those on Earth, many like nothing on Earth. (The similarities and differences are explicitly stated.)
- The Martian year is 687 Earth days. (The difference is implied.)
- Mars lacks the precipitation and oceans on Earth. (The difference is implied.)

Similarities:

____

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Differences:

Task 4：Read the "Layer upon Layer" section and determine which of the following statements about Mars are considered to be known facts and which are inferences from the known facts. Explain what language features that help you distinguish inferences from facts.

1) The darker Martian dunes are basaltic, consisting mainly of minerals which on Earth would readily weather away. (Para. 14)
2) It follows that the present cold and dry atmospheric conditions have persisted since a time far back into the planet's history. (Para. 14)
3) To begin with, the planet has a striking dichotomy in landscape between its northern and southern hemispheres. The southern hemisphere is high in altitude and heavily cratered. The northern one is a vast, low-lying plain with fewer craters. (Para. 15)
4) The northern lowlands are exceedingly level, leading to speculation that they were lake beds during a significant chunk of Martian history. (Para. 16)
5) Along the edge of the southern highlands are features that could only have been carved by liquid water. (Para.17)
6) Because these features are carved into the Tharsis Plateau, they must have an intermediate age. (Para.17)
7) During the massive deluge, a lake roughly the size of one of the Great Lakes burst its ice dam and rushed out within just a few days. (Para. 18)
8) On Mars, such calamities were 10 to 100 times as devastating. (Para. 18)
9) They may have been triggered by volcanic heat sources or by the general heat flow from the interior of the planet. (Para. 18)

10) Heat would have melted ice underneath the thick permafrost layer, building up tremendous pressures until the water finally burst out. (Para. 18)

11) Located throughout the southern highlands, they have a branching pattern reminiscent of rivers on Earth—suggesting that they were formed by surface runoff from rainfall or snowfall. They are the strongest hint that Mars was once as warm as Earth. (Para.19)

12) But these networks look rather different from rain-fed rivers on Earth. They more closely resemble river networks in desert areas, which are fed by water that slowly seeps from subterranean sources. (Para. 19)

13) Recent detailed studies of the northern edge of the highlands show that immense amounts of material eroded during—rather than after—the intense meteor bombardment that took place early in Martian history. (Para. 20)

14) These analyses imply that the distribution of water kept changing as impacts reworked the landscape. (Para.20)

15) For instance, the Argyre Basin, 1,000 kilometers in diameter, may once have been filled to its brim with water. (Para.20)

16) Almost everywhere that the subsurface is exposed—on walls of canyons, craters, mesas and valleys—it is layered. The layers differ from one another in thickness, color and strength. (Para.21)

17) They show that the Martian surface has undergone complex sequences of deposition, crater formation and erosion. (Para. 21)

18) The oldest layers are the most extensive. (Para. 21)

19) The lack of boulder like blocks argues against their being volcanic flows, although they could be volcanic ash. (para.22)

20) Ultimately, however, most of the layers probably originated in impact debris. (Para.22)

Language features to distinguish inferences from facts:

- ____
- ____
- ____
- ____

Task 5: Identify the hypotheses in the "Blue Mars" section about liquid water on Mars and explain the language features to indicate a hypothesis.

Note: Drawing inferences is the act of reasoning from factual knowledge or evidence, while framing hypotheses means providing a tentative explanation that needs to be tested by further investigation.

Hypothesis 1: ____

____

Hypothesis 2: ____

____

Hypothesis 3: ____

____

Task 6: Determine whether the author is certain or uncertain about the information in the following statements.

Note: When the information is presented on the basis of reasoning, the author may use *hedge*s, i.e. words, expressions, and clauses to express uncertainty or avoid complete commitment. On the other hand, when the author wants to express certainty about the information presented, he/she may use *boosters*. For example:

- Malin and Edgett have suggested that wind condition may be less intense now than in the fairly recent past, another hint that the Martian climate changes with time. (hedges, uncertain)
- Perhaps the absence of larger rocks can be explained by the high concentration of condensed volatiles (such as water ice) in the subsurface that were affected by the Heimdall impact: A violent explosion would have removed and crushed the rocks that may have been at the landing site initially. (hedges, uncertain)
- Mars has proved to be a very different and more complicated planet than scientists thought beforehand. (booster, certain)
- Evidence for erosion shows up in craters, from which material appears to have been removed by wind, and in bedrock features that clearly have been carved by windblown sand. (In this sentence, *appears to* is a hedge while *clearly* is a *booster*, meaning that the first chunk of information is not very certain, but the latter chunk of information is certain.)

1) Their size and shape, as shown by topographical measurements, indicate that the caps are predominantly water ice, as opposed to so called dry ice, made of carbon dioxide.

2) Finally, earlier this year Philip Christensen of Arizona State University discovered gullies that clearly emerge from underneath a bank of snow and ice.

3) Along the edge of the southern highlands are features that could only have been carved by liquid water.

4) The timing of the water networks could be the key to making sense of them.

5) The lack of boulder like blocks argues against their being volcanic flows, although they could be volcanic ash.

6) Steven M. Clifford of the Lunar and Planetary Science Institute in Houston, among others, has conjectured that melting under a glacier or a thick layer of permafrost could also have recharged subterranean water sources.

7) Although Mars was bitterly cold, periodic bursts of relatively warmer temperatures could have reinvigorated the planet.

8) A daily weather report might talk of strong winds, high-level ice clouds, low-level fogs, seasonal frost, dust devils and massive dust storms.

9) The planet might have had lakes, even oceans, free of ice.

10) Snow might have fallen, recharging the groundwater and leading to temporary trickles of water across the surface.

11) They appear to be covered with multiple layers of volcanic flows and sedimentary debris that originated in the south.

12) Aeolian activity seems to have persisted since the time of heavy cratering, back when the solar system was still young.

13) So the absence of this gas therefore proves the absence of magnesium sulfate in the soil.

14) Clearly, the erosion cannot go on forever.

15) Ultimately, however, most of the layers probably originated in impact debris.

16) Because these features are carved into the Tharsis Plateau, they must have an intermediate age.

17) All these facts taken together point toward the likely presence of calcium carbonate in the soils that Phoenix has analyzed.

Task 7: Explain how the following nouns are formed and what they refer to. Note that nouns formed from verbs may indicate a natural, geological process, a state/condition, or a result from an action. Some words may have more than one meaning.

Example：

"erosion" can mean the process and act of eroding, the result of the process, or the state of being eroded.

1) circulation (pattern): ____
2) condensation (of carbon dioxide frost): ______________________
3) cratering: ____
4) deposition: ____
5) evaporation: ____
6) exposure: ____
7) (faint circular) expression: ___________________________________
8) (topographical) measurement: _________________________________
9) (sunlight) penetration:____
10) precipitation: ____
11) resemblance: ____
12) sublimation: ____
13) (orbital) variation: ____
14) (chemical) weathering: ____

Task 8: Write an essay which summarizes the striking features of Mars. You can use the General-Particulars discourse pattern and the comparison and contrast strategy in your writing.

Note: There are two common ways to organize a comparison or contrast. One is known as *block comparison*. For example, when comparing Mars and the Earth, you can examine all the features of Mars first and then all the features of the Earth. The other common way of organizing a comparison is called *point by point comparison*, in which features of Mars and the Earth are compared one by one. The latter method is used in this article.

Task 9：Work in groups and list what scientists know and what they are uncertain about Mars.

What scientists know about Mars	What scientists are uncertain about Mars

Task 10：*Write an essay to analyze the early history of Mars on the basis of scientific evidence from Mars missions so far. You can focus on the following points. Use hedges or boosters when necessary.*

- Summarize scientists' hypotheses about the presence of liquid water on early Mars
- Suppose scientists' hypotheses are reliable, draw inferences about the early history of Mars, and then make hypotheses about what might have happened later.

Task 11: Discuss the following questions on the basis of the information in Text II.

1) Should the public support space exploration? Why?

2) What do you learn from Phaethon's tragedy?

3) What do you think of the choral "Ode to Man" cited from Sophocles' tragedy *Antigone*?

(Note that this ode celebrates the “wonder” of man. It begins on an optimistic note by praising man for being able to accomplish whatever goal he sets his sights on—crossing the sea in winter, snaring birds and beasts, taming wild horses. But the point of the ode is that while man may be able to *master* nature by developing techniques to achieve his goals, man should formulate those goals by taking into consideration the common good. Otherwise, man becomes a monster.)

4) Do you agree that the power of science and technology can be compared to the power of the fiery chariot of Apollo?

5) What do you think of the two admonitions: "Nothing in excess" and "Know thyself"?

Text II

The space age began fifty years ago with the launch of Sputnik, the first artificial satellite, on October 4, 1957. It was a great technical and political triumph for the Soviet Union. In the United States, the immediate reaction was a swift and harsh self-assessment marked by very public fretting about a "technology gap." But a dozen years later, at the climax of the space race, the first men on the Moon were Americans. In the decades since, the civilian space program has largely receded from public attention—even as space has become indispensable to the military and the high-tech industry, and as a promising new private space sector is just taking shape.

To mark the Sputnik anniversary—and with it, the beginning of the space age—we have reprinted Hannah Arendt's classic 1963 essay about modern science and the human meaning of our celestial aspirations, and invited five commentators to respond to her argument and to discuss its relevance today: Patrick J. Deneen, Rita Koganzon, Charles T. Rubin, Stephen Bertman (below) and Peter Augustine Lawler.

Chariots in the Sky [5]

Stephen Bertman

1 Until men walked upon it in 1969, the Moon had always marked the first of those **celestial limits that earth-bound humans could not transgress**, limits separating what man **for eons** had regarded as the **sacred realm of the gods** and even modern man could only gaze at in wonder. With the lunar landing, however, human beings for the first time set foot on heavenly soil and, planting a flag, claimed it for mankind.

2 Nine years earlier, spurred on by advances in Soviet rocketry, the Eisenhower administration had already speculated on the possibility of sending American astronauts to the Moon. Under the leadership of Abe Silverstein, director of NASA's Office of Space Flight Programs, the

mission was dubbed the “Apollo program,” named for the ancient Greek god of the sun because, in Silverstein’s words, “the image of the god Apollo riding his **chariot** across the sun gave the best representation of the grand scale of the proposed program.”

3 With the election of John F. Kennedy, the Apollo program was given decisive impetus. In a 1961 message to Congress, President Kennedy announced the national goal of putting a man on the Moon before the decade was out — “the most hazardous and dangerous and greatest adventure on which man has ever embarked.” Under his inspiring leadership, space would become “the edge of a New Frontier,” supplanting the terrestrial frontier of our nation’s westward expansion. Unlike that earlier frontier, the new frontier of space would point to a horizon infinite in extent.

4 The choice of Apollo’s name for the program was tinged with irony. Apollo’s most famous temple in Greece was located at Delphi. There for countless generations Apollo’s priestesses had prophesied the future by drawing upon the god’s **oracular powers**. Carved in marble above the temple’s entranceway were words of wisdom intended as cautions to the faithful. Most prominent among them were “Nothing in excess” and “Know thyself.”

5 The first of these two **admonitions** warned visitors about the danger of going to extremes. A life of moderation is best, the ancient sages taught, because it avoids the harmful consequences of excess. The second warning, for its part, cautioned people to be mindful of their human limitations, lest they be destroyed by overreaching. Taken together, the two admonitions constituted a prescription for averting tragedy, both personal and national.

6 According to mythology, such personal tragedy was visited upon Apollo’s own son, Phaethon. Phaethon’s mother had repeatedly told him he had been fathered by none other than the god Apollo, but the lad harbored doubts. So Phaethon traveled eastward to the horizon where, at dawn, Apollo yoked the team of horses that drew his solar chariot across the sky. “If indeed you are my father,” Phaethon said, “then grant me any wish.” “Of course, my son,” Apollo gladly replied. “Then I choose to drive your chariot across the sky,” the young man proclaimed. Knowing the danger of entrusting the reins of his fiery team to young and inexperienced hands, the horrified god begged his son to reconsider. But the promise had been made, and Phaethon, refusing to relent, mounted the golden chariot.

7 At first the team bolted from its chute as always, climbing upwards to the heavens on its customary track. But sensing the loose hold their inexperienced driver had upon the reins, the horses broke free, diving toward the surface of the earth with the blazing sun in their train. Observing this from the heights of Mount Olympus, Zeus, king of the gods, took action. To

save the earth from incineration, he hurled his thunderbolt at the runaway chariot, striking Phaethon and sending him plunging to his death.

8 Phaethon's youthful enthusiasm had blinded him to his inexperience. Failing to acknowledge his limitations tragically cost him his life.

9 Tragedy was something with which the Greeks were intimately familiar, for, like Phaethon, they were an emotionally-charged people driven by a passion to achieve and often paid a high price for their ambitions. Lovers of freedom, they frequently failed to anticipate the destructive consequences of their impulsive choices. The true causes of tragedy, their storytellers repeatedly reminded them, lie not outside ourselves but within. We are most vulnerable, they taught, not when we are weak but when we are strong, for when we are strong, we can become drunk with power and commit acts of hubris that are irreversible.

10 Sophocles dramatized this propensity in his tragedy *Antigone*. In an ode that celebrated humanity's **astounding creative powers**, he simultaneously pointed to man's penchant for destruction:

> Many are the world's wonders, but none more wondrous than man.
> Under the south wind's gale, he traverses the gray sea,
> knifing through its surging swells.
> Earth, eldest of the gods, imperishable and everlasting,
> he erodes year after year with winding furrows
> cut by his equine team.
> The winged flocks of birds,
> the wild herds of beasts,
> and the salt-sea schools of fish
> he entraps in the woven mesh of his devious net.
> With his devices he overpowers the creatures of the wild,
> reining in the shaggy-maned stallion
> and yoking the stubborn mountain bull.
> Speech he developed and wind-swift thought
> and the talent to dwell together, and learned
> how to evade the chilling frost and pelting rain.
> Ingenious, there is nothing that comes that he cannot master;
> only from Death can he not contrive an escape.
> With a brilliance and subtlety beyond imagining
> he gravitates at times toward evil, at other times toward good.

11 Hannah Arendt understood that, while technology might apply scientific discoveries to human use, science *per se* was unconstrained by any consideration for the good of mankind because the concerns of the scientist, including those of the space scientist, are different from those of the humanist. The concerns of the former are physical and objective; of the latter,

spiritual and subjective. Scientists express their findings through abstract mathematics; humanists, through words and images based on sensory and emotional experience. And most importantly, while the humanities are **preoccupied with** moral and ethical considerations, science and technology in their purest form know no such limits.

12 Viewed in this light, the landing on the moon is symbolic of a profound change in human history, the dissolution of historic limitations, a tendency intrinsic to the two forces, science and technology, that have gone on to become the dominant forces governing Western civilization in these days of the waning influence of traditional ethics and morality. Indeed, so great is their power and so awesome their destructive potential that they can rightly be compared to the fiery chariot of Apollo.

13 Yet, as we have seen, that chariot was only as good as the hands that held its reins. President Kennedy made much the same point when he described the moral challenge space exploration would present. "Space science," he said in his Rice University address in 1962, "like nuclear science *and all technology*, has no conscience of its own. Whether it will become a force for good or ill depends on man". By **sating our voracious curiosity** and **multiplying** the primal force of our will, science and technology together — like Apollo's spirited team — tempt us to fulfill our grandest ambitions by acting on our impulses, however blind we may be to the long-term consequences of their exercise.

14 The dramatic effects of these two forces can be seen by examining the ways in which they have transformed our perceptions of time and space.

15 The Industrial Revolution quickened the pace of everyday life; the Electronic Revolution has accelerated it even further. Unlike the slower mechanical devices of yesteryear, the newer electronic technologies that we now depend upon for our existence operate at nearly the speed of light, infusing our lives with artificial urgency and unremitting stress. To our detriment we have, in Thoreau's words, become "the tools of our tools." While delivering overwhelming quantities of data, electronic communications demand that we respond rapidly with quick decisions, but simultaneously deny us the precious time we need for thoughtful reflection. Meanwhile, a global entertainment industry cultivates our impulses by instantly gratifying our desires while tempting us to desire even more. Dazzled by rapid-fire stimuli and captivated by glittering trivia, we lose sight of the critical facts and enduring truths they obscure.

16 Those stimuli and trivia are generated by commercial interests profiting from our distraction by feeding our appetites in limitless ways. By making the acquisition and possession of material goods and the enjoyment of sensory pleasure the center of our existence, materialism continues to alter the landscape of our lives. More and more, matter is displacing spirit. And while

nature might otherwise constitute by its rhythms and autonomous existence a reminder that there is something more to life than what we can manufacture or buy, nature itself is being increasingly destroyed and displaced by a synthetic man-made environment. Like the demolition of historic buildings, the speed of nature's transformation serves to erase the very memory of an earlier time, even as the speed of social change distances us from the intellectual principles and spiritual values that once sustained us.

17 Some optimists see in the future a **grand convergence of** new scientific discoveries and technologies that will open the unlimited vistas of a Golden Age. Others more pessimistically fear that such a convergence may instead cause humanity to lose control and irrevocably cede its destiny to the machines, an event philosopher Jacques Ellul forecast over a half century ago in *The Technological Society*. These extreme visions reveal a shared truth: The future of mankind will ultimately depend upon what we do here on Earth, not what we do in outer space. Our stature as a race will only minimally be increased or diminished by the "greatest adventure" President Kennedy described long ago. In the end, it will mainly be determined not by whether we ride chariots into the heavens but whether we have the courage to know ourselves.

Task 12: Read Text III and note down the most important events in the history of space exploration around the world. Use your notes to give an oral summary.

Notes:

In 1955: ____

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In 1957: ____

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In 1961: ____

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In 1965: ____

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In 1969: ____

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In 1975: ____

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In 1990: ____

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In 1997: ____

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In 2003: ____

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In 2008: ____

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In 2011: ____

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In 2012: ____

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In 2013: ____

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Text III

Space Explorations Around the World [6]

1 Throughout human history, space has remained a distant realm full of mystery and wonder. From early star charts to the first telescopes, we have long been working towards new discoveries in space and discovering what lies beyond our planet, and perhaps one day revealing the secrets of the universe. Progress had been slow and steady for centuries until the Space Race in the 1950s, when space exploration became a competition between world powers, the United States and the Soviet Union.

2 The Space Race began in 1955, when both the USA and USSR announced plans to launch satellites, after taking control of German rocket technology post-WWII. In the wake of Cold War tensions, the announcement sparked a push for innovations and advances, with increased funding for research and education. The result has been the invention of many new and beneficial technologies that have changed the world, **culminating in** putting a man on the moon, and someday, beyond.

3 Ten countries have had successful **satellite launches** (independently, using their own launch vehicles): Soviet Union, US, France, Japan, China, UK, India, Israel, Iran, North Korea.

Sputnik 1 (USSR)

4 In the first major event in the history of space exploration, the Space Race was initiated by the launch of Sputnik 1 (Satellite 1) by the USSR on October 4, 1957. Sputnik 1 was the world's first **artificial satellite**, as well as the first successful orbital launch. It launched from the Kazakh SSR. The **unmanned satellite** was a metal sphere about the size of a beach ball, 58 centimeters (23 inches) in diameter, and weighing 83 kilograms (184 pounds). Sputnik 1 orbited Earth at 29,000 kilometers (18,000 miles) per hour, completing each orbit in about 96.2 minutes. The satellite **transmitted radio signals** back to Earth during its orbit. It completed 1,440 orbits around the Earth, traveling about 70 million kilometers (43.5 million miles) before **decaying** and burning upon reentry into the atmosphere on January 4, 1958.

5 Sputnik 1 was quickly followed with the launch of Sputnik 2, a month later, on November 3, 1957. Sputnik 2 was notable for being the first animal launched into orbit, with Laika the dog inside. The dog overheated and died within hours of takeoff. The successful launch of Sputnik 1 also spurred the United States to launch their own satellite, which happened on January 31, 1958.

Vostok 1 (USSR)

6 The next major step in space exploration history happened on April 12, 1961, with the first successful human spaceflight. The 27-year-old **cosmonaut** Yuri A. Gagarin of the USSR manned the Vostok 1 (meaning East 1) spacecraft, which orbited Earth once. The flight lasted 1 hour, 48 minutes, and traveled 320 kilometers (200 miles) above Earth. Gagarin made reports back to the ground station throughout his flight. After completing the orbit, the satellite was set to reenter the atmosphere, but it was not able to land at a safe speed. Instead, Gagarin was ejected from the craft about 7 kilometers above ground, his parachute deploying at about 2.5 kilometers (8,200 feet) above ground, and the Vostok 1 also landed with a parachute. Gagarin landed about 280 kilometers (174 miles) **off course** from the intended landing site, ending up in the Saratov region.

Voskhod 2 (USSR)

7 The Soviet spacecraft, Voskhod 2, was launched March 18, 1965, manned by Pavel Belyayev and Alexey Leonov. The spacecraft was in orbit around the Earth. The mission was important to the history of space exploration, as the first time a person moved out of the spacecraft in space, with Alexey Leonov exited the craft and walked in space for 12 minutes, 9 seconds. Cosmonaut Leonov wore a space suit and exited the Voskhod space craft via an **inflatable airlock**. Leonov was successful in his airwalk, but pressure made his spacesuit too stiff to reenter the airlock until he was able to recover. There were also issues resealing the airlock, delays, and a spinout, but the

voyage was otherwise successful.

Apollo 11 (USA)

8 One of the most famous space explorations in history was the first ever manned moon landing was with the United States flight, Apollo 11, with astronauts Neil Armstrong, Buzz Aldrin, and Michael Collins on board. The aircraft was launched on July 16, 1969, from Meritt Island, Florida. The mission was to fulfill President Kennedy's promise to land a man on the moon by the end of the 1960s. The **lunar module** of Apollo 11 landed on the moon July 20, and Armstrong stepped out onto the surface of the moon on July 21, followed shortly afterward by Buzz Aldrin. Armstrong is famously quoted as describing it as “one small step for man, one giant leap for mankind,” acknowledging the importance of the event. Michael Collins remained on the command module for the duration of the trip. The craft landed in the Sea of Tranquility and remained on the moon for over 21 hours, the astronauts remained outside the aircraft for about 2.5 hours. They collected material from the moon to bring back to Earth for research. They also left behind a US flag, a bag of memorabilia including a golden olive branch as a symbol of peace, as well as scientific technology. Apollo 11 returned to earth, landing on July 24 in the Pacific Ocean. This landmark event was one of the most amazing space explorations in history, and effectively the end of the Space Race.

Apollo-Soyuz Test Project (USSR and USA)

9 The ultimate symbol of the end of the Space Race and the start of a truce between the USSR and the USA was the Apollo-Soyuz Test Project, the first joint flight of the two countries, in which cosmonauts and astronauts met in space. The event was one of the most famous space explorations the last of the Apollo voyages and the last space mission of the US until April 1981. The Apollo crew included Thomas Stafford, Vance Brand, and Donald Slayton, while the Soyuz crew were Alexey Leonov and Valeri Kubasov. The two flights launched on July 15, 1975, docking together on the 17th and separating after the mission was complete. Working together, Apollo helped partially block the sun, allowing the Soyuz to photograph the **corona** of the sun. Soyuz returned and landed on July 21, while Apollo returned on July 24. The mission was a success and important to show the cooperation of efforts between the two superpowers, as they moved past the competitive aspects of space exploration and focused on space exploration benefits.

Hubble Space Telescope (USA)

10 Deployed on April 25, 1990, from Florida's Kennedy Space Center, the Hubble Space Telescope is a powerful telescope that orbits the Earth, observing the planet and taking images outside of the Earth's atmosphere, and making new discoveries in space. The telescope has an aperture

measuring 2.4 meters (7.9 feet) and a focal length of 57.6 meters (189 feet). It is equipped with various instruments and cameras, including ultraviolet and infrared cameras, and transmits data back to Earth.

11 While the Hubble Space Telescope was not the first telescope launched into orbit, it is the only one that is serviced in space, rather than bringing it back to Earth for repairs. It **is** also **noted for** being one of the largest space telescopes.

Loss of Space Shuttle Columbia (USA)

12 One of the NASA space explorations was the shuttle, Columbia, which was a successful and spaceworthy aircraft that completed 27 missions before it was destroyed during the last mission on February 1, 2003. The shuttle had been used to repair the Hubble Space Telescope, deploy commercial satellites, and especially for research purposes, like the microgravity spacelab. Its first mission was on April 12, 1981 from Edwards Air Force Base.

13 The final mission of the Columbia launched on Jan 16, 2003, on research expedition for microgravity lab and Earth science studies. On board the Columbia during the mission were 7 crew members: Rick Husband, William McCool, Michael Anderson, David Brown, Kalpana Chawla, Laurel Clark, and Ilan Ramon. At the end of the 16 days of the final Columbia mission, the space shuttle had been punctured, and upon reentry into the atmosphere, the heat destroyed the integrity of the wing and the shuttle broke apart and disintegrated. The accident was a tragedy that resulted in the deaths of everyone on board, and brought to reality the disadvantages of space exploration.

Mars Rovers (USSR, USA, UK, India)

14 Once Earth's orbit and even the moon were conquered with space exploration, the next logical location for exploration was Mars. The first attempts to put a rover on Mars were the USSR's Mars 2 and 3, both in 1971, which failed upon landing and soon after landing. The first successful Mars rover landing was by the United States, with the Sojourner rover, Mars Pathfinder on July 4, 1997, which lost communications a few days after landing. The next attempt was the Beagle 2, launched by the British in 2003 as part of the European Space Agency Mars Express mission. The mission failed 6 days before entry into the atmosphere of Mars.

15 This was followed by the successful US missions, Spirit and Opportunity in 2003, and Curiosity in 2011. Spirit was a successful rover for its first 6 years of operation, exploring 7.73 kilometers (4.8 miles) before getting stuck in 2009 and becoming a stationary observer until it lost contact in March 2010. Opportunity has been on Mars since January 25, 2004, and holds the record for longest time on Mars, continuing today. Curiosity was launched November 26, 2011, landing August 6, 2012 in Mars' Gale Crater, and continues to explore the surface of Mars today. India's Mars Orbiter Mission, or Mangalyaan, launched November 5, 2013, on a mission to Mars to advance Indian technology and to explore the surface of the planet. Mangalyaan is scheduled to reach the Mars orbit on September 24, 2014, and it reached its halfway point on April 11, 2014.

Chandrayaan-1 (India)

16 On October 22, 2008, the Indian Space Research Organization launched its first unmanned lunar space probe, a major event in the country's space program. Chandrayaan 1 was successfully placed into lunar orbit on November 8, deploying the Moon Impact Probe on the 14th, and landing on the moon, near the Shackleton crater. India became the fourth nation to place its flag on the moon, and collected soils in search of water. Though there were some technical issues, the mission was successful but cut short, lasting 312 days (instead of 2 years), but completing most of its missions. The end of the mission was August 28, 2009 when it returned to Earth.

Space Ship One (California, USA)

17 The first manned private spaceflight was developed by the aviation company, Mojave Aerospace Ventures as part of the Tier One program. The first ever test flight was on May 20, 2003, which was unmanned, and followed by two additional test flights. After receiving the appropriate licenses, a manned flight was scheduled to launch from the newly classified Mojave Air and Space Port in Southern California's Mojave Desert, which is a civilian aerospace test center. On June 21, 2004, SpaceShipOne launched Flight 15P, carrying the first civilian astronaut, Mike Melvill. The duration of the flight was just 24 minutes, reaching a height of 100,124 meters (328,491 feet), with just over 10 seconds of time past the boundary to space. There were some issues with the flight, which were later resolved, and the spacecraft was later entered into the competition for the Ansari X Prize, which it won, along with a $10,000 award. Space Ship One marked an important milestone in the space travel timeline, and showcases the advancements of technology and the future of space exploration.

Yutu (China)

18 In one of the most recent space exploration missions, launched December 1, 2013, Yutu was China's first lunar rover, and the first moon rover since Russia's ended operations in 1973. Yutu was part of China's Chang'e 3 mission, landing on the moon December 14, 2013, with the moon's first soft landing in 37 years. The rover landed off course on Mare Imbrium. The mission of Yutu was for China to explore the moon's topography and geology and study lunar soil down to 30 meters (98 feet) and even the crust, deep below the surface. Equipment on the rover included an **alpha particle x-ray spectrometer** and **infrared spectrometer** and **stereo cameras**. The

Yutu rover has exceeded expectations for the duration of its exploration, though it has had various struggles, and it is still in limited use. It may witness the **solar eclipse** by the Earth from the moon's surface.

Space X (California, USA)

19 One of the most promising endeavors in the future of space exploration and private space travel is the California-based Space Exploration Technologies Corporation, known as SpaceX. Headed by Elon Musk, CEO of Tesla and remarkable innovator, the program is working toward a mission of one day colonizing Mars. The group was established in 2002, and has developed several spacecraft, including the Falcon 1 and 9, and the Dragon. The projects of SpaceX have included the development of rocket engines and orbiting satellites, with a focus on lowering costs of development, making it more accessible to private parties. SpaceX also works with NASA as a contractor, conducting missions for the International Space Station, as well as work for the US military. The Red Dragon project is scheduled to be completed in 2018, and would be a research mission looking for water and proof of life on Mars. The company's future projects include liquid-methane-based rocket engines, spacecraft for mars landings, and eventually human voyages to Mars, opening the door for amazing space explorations accessible to everyone.

Task 13: Complete the following news report with the words or word chunks you hears.

Christmas 2003 was bittersweet for Mars scientists. Because one gift they (1) _________________ wanted never arrived: The British-built spacecraft Beagle 2 was (2) _________________ to land on the Red Plant, radio home the good news and begin a (3) _________________. Instead, mission controllers heard nothing. They finally declared the Beagle 2 lost after months of silence. Many space scientists thought it crash-landed or broke up in the thin (4) _________________.

But now Beagle 2's final resting place has been found. New images from NASA's Mars Reconnaissance Orbiter revealed the spacecraft in its intended landing region, a massive (5) _________________ basin near the Martian equator.

The two-meter-wide lander is little more than a low-resolution lump of pixels in the images. But investigators gathered enough information to (6) ________________ what probably went wrong: the probe's (7) ________________ seem to have only partially deployed, throttling Beagle 2's power and preventing it from phoning home. Without contact with (8) ________________, the probe was doomed to a slow demise before it could perform any science.

Nevertheless, the lander appears intact, and the remains of a parachute and an atmospheric-entry cover lie hundreds of meters away. Beagle 2 may now be considered a (9) , delivering the United Kingdom a very late Christmas gift: the nation's first (10) on another planet.

Task 14: Answer the following questions briefly based on what you watch about Mars.

1) Why is Mars a cold planet?

____

2) Why does Mars have a hard time holding the heat it gets?

____

3) How easily does the heat from the Sun escape?

____

4) What are the temperatures at night on Mars?

____

Task 15: Answer the following questions according to a report about Curiosity rover on Mars.

1) How much sample was collected this week?

2) How was the sample collected?

3) What is the color of the sample material?

4) For what purpose was the sample collected?

5) What is the location of the sample?

Task 16: Answer the following questions about NASA's commercial crew program according to Tom Simon.

1) What is NASA's commercial crew program and how is it different from other human spaceflight programs?

2) What is the goal of NASA's commercial crew program?

3) What is going on aboard the space station?

4) What is the purpose of certifying commercial systems for NASA's use?

5) Will the certification approach work effectively according to Tom Simon?

6) What does Tom Simon see as the primary benefits of the commercial crew program?

____

Task 17: Note down the main points about the Thanksgiving food for the astronauts in the international space station.

1) Food available:

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2) The roles of the three NASA food scientists:

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3) Food processing requirement:

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4) Psychological aspect of food:

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____

Task 18: Watch the video clip and complete the following statement which summarizes its main idea.

LRO scientists usually use lasers to ______________________________,
but in the future, they will use lasers to ____________________________.

Task 19: Listen to a program about Curiosity's mission and note down the main points.

1) NASA technicians' feeling when the robot landed on Mars:

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2) The location of Curiosity's landing:

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____

3) Curiosity's mission:

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4) Evidence found by Curiosity:

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5) The reason why water simultaneously boil and freeze:

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____

6) People's assumption in the 1960s about Mars:

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7) The finding of Marina 4:

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8) The finding of Marina 9:

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Task 20: Go to http://www.nasa.gov/ and http://www.spacechina.com/ to find the latest information about space exploration.