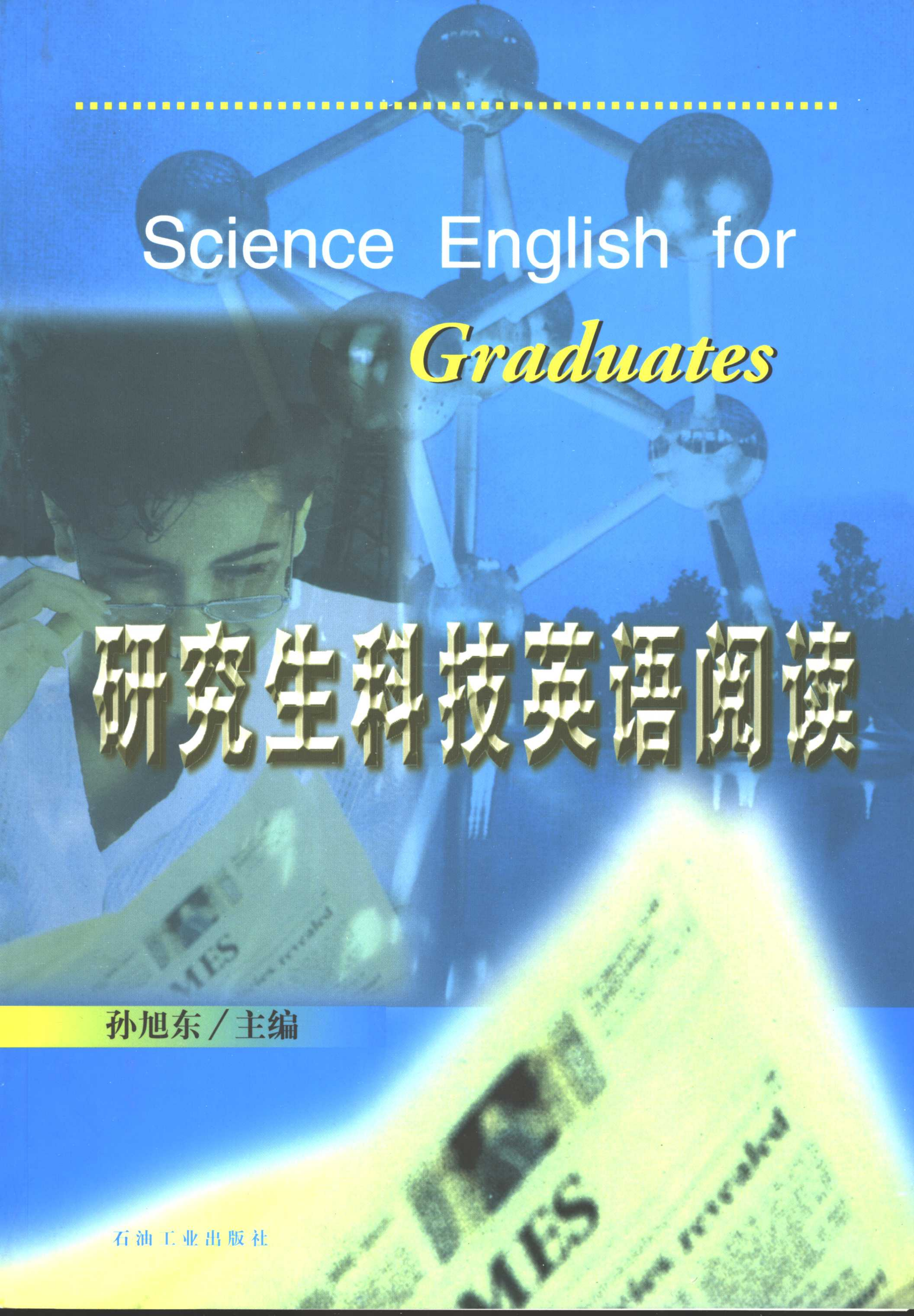

Science English for *Graduates*

研究生科技英语阅读

孙旭东／主编

石油工业出版社

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内 容 提 要

本书收集了27篇科技英语文章，内容以能源科技为主。选编的文章语言新颖，文笔流畅，选词精当，可读性强。语言的深度适合研究生和高年级本科生阅读。编写的目的是：从阅读较为生疏而复杂的能源科技领域文章入手，让学生掌握能源及相关专业的科技英语表达方法和词汇，熟悉科技英语的选词原则、文体模式和句法结构，提高学生对科技论文的阅读理解能力和写作能力。可做为能源专业学生科技英语教材。

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目　　录

1. The Diverse Challenges in a Mining Geophysics Career

The old saying "Jack-of-all-trades but master of none" does not apply to mining geophysicists — we are expected to be "Jack-of-all-trades and master of many." In other words, a mining geophysicist needs a broad background, extensive training, experience in many branches of geophysics, and the ability to communicate across disciplinary boundaries.

The path leading to my eventual career was accidental, turbulent, and chaotic. Sometimes out of chaos comes some order. The oil crises of the 1970s impacted many lives globally, but also created opportunities. It occurred during my formative years in high school and college. The Philippine government embarked on a program to subsidize the U.S. training of local physics graduates in nuclear physics because the country was building a nuclear power generation plant to lessen dependence on foreign oil.

While waiting for the bureaucratic wheels to engage, I completed my training in nuclear engineering and did astronomical research at the Manila Observatory. I applied to a dozen U.S. institutions, but SEG was the only one that responded. That SEG scholarship, first awarded in 1979, exposed to me exploration geophysics and the petroleum industry for the first time. The impact was positive such that I changed my career plans.

Employment opportunities in the petroleum and geophysical service industries had evaporated by the time I completed my graduate studies in 1982. Even though all aspects of the oil business were contracting, I went to Houston to look for a job. I managed to work for three companies and survived two layoffs in the next three years before I became a mining geophysicist.

This was a similar to a path I took 25 years ago when I joined my high school track team. I had ability in several areas, but no overwhelming strength. So I tried the sprints, middle distance, long distance, and jumping events. I constantly ended up "third best" in these — good enough to get on the team but not good enough to even be eligible for top NCAA competition where a minimum of "second best" was required. The coach suggested that my strong combination of speed, endurance, and jumping ability might better fit the high and low hurdles. It also would involve an instant promotion since the team had only one runner in these events. My response was: "What's a hurdle?"

Even though I technically became "second best" overnight in the hurdles events, constant training and practice were necessary to develop the proper techniques to reach the top.

It was virtually 14 years later when I came to CONSOL R & D in 1985 for a job interview after having recently been laid off from a major oil company. During the interview, I wondered: "what's coal-mining geophysics?"

The Conoco supervisor, however, offered me the job even though I had no experience in mining geophysics. Apparently, my diverse academic background, training, and experiences seemed to complement Conoco's planned expansion of its coal geophysics program. I believe this supervisor and my high school track coach made wise decisions for good reasons.

However, just as with my track experience, instant transformation into a mining geophysicist did not ensure success. Again, training and practice were needed.

Employment and career opportunities in mining geophysics hinge on the same business cycle as the petroleum industry. To survive and prosper in difficult and competitive environments, you need good defensive and offensive strategies. For a mining geophysicist, a good defense is built on a strong academic background in physics, math, geology, geophysics, and electrical engineering. A working knowledge of computer hardware and software programming is invaluable. Moreover, ample common sense, open-mindedness, and self-motivation are a must.

However, the more challenging work lies ahead because the field is not static, but dynamic. Your offensive tactics may change and /or evolve depending on the challenges. But certain things stand out constantly. Effective communication is critical. You will need to qualify and quantify the capabilities and limitations of each geophysical method in terms that a client can readily understand, because a lot is at stake. For example, a single lost production day costs a coal company an average of $1 million. If geophysical methods can be employed to reduce the number of down days per year, the resultant savings would pay for the survey costs many times over.

The mining industry operates in a very competitive business environment that is result-driven and unyielding. Consequently, the mining geophysicist has to overcome adversity and skepticism. Mining engineers are usually the users of your data, and often in a position to subsequently influence and / or decide the fate of your career or future contracts. Therefore, it's imperative that you learn how to work with them, not against them. But engineers are only one group with whom you will interact. At CONSOL, I regularly interact with a wide spectrum of professionals --- coal miners, engineers (mining, civil, and electrical), geologists, managers, and corporate executives, which has enriched my knowledge base.

Before a mine is opened and put into production, engineering and environmental issues related to upstream and downstream operations will also have to be addressed. Thus, the mining geophysicist, either as a hired consultant or in-house expert, will have to be competent in all aspects of several geophysical techniques because the problem or challenges can be diverse, varied, and unique.

Locations of most major coal basins around the world are well known. Coal exploration programs are conducted primarily to detect geologic anomalies (*i.e.* faults, sandchannel, washout, rolls and thin coal) and old mine workings that adversely affect future mining operations rather than to find more coal.

High-resolution surface seismic reflection surveys are conducted to provide continuous subsurface profiles between exploratory drill holes that are usually spaced hundreds or a few thousand feet apart. In addition, shallow VSP surveys are also conducted to complement and improve the interpretations of geophysical logs and seismic data.

When geologic anomalies become too small and difficult to be detected by surface seismic, sources and receivers may be taken underground to improve its detection and mapping. Due to the large acoustic impedance contrasts of coal with respect to shales and sandstones, the coal seam acts like a waveguide to seismic energy. Underground in-seam seismic reflection is used to measure distance to old mine workings to ensure sufficient barrier thickness for safety considerations.

Reconnaissance surveying for other minerals requires employment of various electromagnetic (EM) techniques such as magnetollurics, induced polarization, electrical resistivity, ground conductivity, *etc.* Some of these tools measure or induce natural electric and / or magnetic properties to find localized anomalies that may indicate the presence of certain mineral deposits.

Many mining operations involve engineering and environmental issues which may relate to the short-term and long-term effects of the mine on the land, groundwater, and the environment. Construction of support facilities and processing plants may also require some engineering geophysics studies. Thus, various geophysical techniques such as seismic refraction, electrical resistivity, ground conductivity, magnetometre, ground-probing radar, and borehole imaging methods may also be employed.

Mining geophysicists generally experience high degrees of pride and satisfaction in their work because they get to conduct projects from point alpha to omega. They are involved in the planning, field design, acquisition, data processing, modeling, and interpretation of seismic and other geophysical data. The opportunity to go underground to verify one's interpretation with actual geology is especially satisfying.

To determine if mining geophysics is suitable for you, the following simple test questions are provided. Are you the Indiana Jone-type person who seeks adventure, challenge, and pursuit of the Holy Grail? Do you feel stifled in your current job because you perform only one aspect of geophysics such as seismic data processing or interpretation? Do you seek to expand your knowledge about other geophysical techniques? Do you prefer to compete in an all-around event? If you answered yes to all the above questions, then you may have the right stuff to pursue a career in mining geophysics.

(From *The Leading EDGE*, Vol. 18, No. 3, March, 1998)

New Words

1. Jack-of-all-trades /'dʒekəv'ɔːltreidz/ adj. 杂而不精的

2. turbulent	/'tə:bjulənt/	adj.	汹涌的
3. chaotic	/kei'ɔtik/	adj.	杂乱无章的
4. eventual	/i'ventjuəl/	adj.	最终的
5. formative	/'fɔ:mətiv/	adj.	构成的；形成的
6. embark	/im'ba:k/	vi.	开始；从事
7. subsidize	/'sʌbsidaiz/	vt.	资助
8. evaporate	/i'væpəreit/	vi.	消失
9. contracting	/kən'træktiŋ/	vi.	缩小；萎缩
10. layoff	/'leiɔf/	n.	失业
11. sprint	/sprint/	n.	短跑
12. eligible	/'elidʒəbl/	adj.	有资格的
13. endurance	/in'djuərəns/	n.	耐力
14. hurdle	/'hə:dl/	n.	跨栏
15. address	/ə'dres/	vt.	提出
16. in-house	/in'haus/	adj.	内部的
17. anomaly	/ə'nɔməli/	n.	异常
18. sandchannel	/'sændtʃænəl/	n.	沙道
19. washout	/'wɔʃaut/	n.	冲淤构造
20. profile	/'proufail/	n.	剖面
21. in-seam	/in'si:m/	adj.	地层的
22. reconnaissance	/ri'kɔnisəns/	n.	勘测
23. magnetollurics	/ˌmægnitou'ljuriks/	n.	古电磁学
24. polarization	/ˌpoulərai'zeiʃən/	n.	(电)极化
25. refraction	/ri'frækʃən/	n.	折射(作用)
26. magnetometre	/ˌmægni'tɔmitə/	n.	磁强计；地磁仪
27.grail	/greil/	n.	梦寐以求的东西

Exercises

I. Useful collocations:

broad background, extensive training, to lessen dependence on, instant promotion, working knowledge

II. Discuss the style of this paper. Is it more academic or autobiographic, or is it just between the two styles? Give examples to illustrate your ideas.

III. Explain the following sentences in your own words.

1. However, the more challenging work lies ahead because the field is not static, but dynamic.

2. The mining industry operates in a very competitive business environment that is result-driven and unyielding.
3. Employment and career opportunities in mining geophysics hinge on the same business cycles as the petroleum industry.
4. Mining geophysicists generally experience high degrees of pride and satisfaction in their work.
5. You will need to qualify and quantify the capabilities and limitations of each geophysical method in terms that a client can readily understand.

IV. Choose the word or phrase which best completes each sentence.

1. Medieval travellers' tales of fantastic creatures were often fascinating but not always _______.
   A. credible B. creditable C. conceivable D. imaginable
2. He had always had a good opinion of himself, but after the publication of his best-selling novel he became unbearably ______.
   A. bigoted B. proud C. conceited D. cocksure
3. He made some _______ sketches which would serve as guides when he painted the actual portrait.
   A. primary B. elementary C. fundamental D. preliminary
4. No human being is ______ but Alistair Allington made very few mistakes.
   A. fallacious B. plausible C. infallible D. correct
5. After his long illness, the old man appeared so thin and ______ that a gust of wind might have blown him away.
   A. flimsy B. powerless C. frail D. withered
6. The Romans _______ a large part of Europe and the Middle East.
   A. submitted B. subdued C. oppressed D. predominated
7. He is considered to be an outstanding artist but I consider his work to be quite ________.
   A. mediocre B. medium C. moderate D. intermediate
8. He paid his bill with a(n) _______ twenty-pound note.
   A. imitation B. artificial C. illegal D. counterfeit
9. He lives entirely alone ________ the rats, bats, moths and mice.
   A. in spite of B. besides C. allowing for D. apart from
10. Many countries have now succeeded in _________ the malarial mosquito.
    A. erasing B. eradicating C. abolishing D. obliterating

V. Can you find any example for needless word or repeated information from the text? If you can, give reasons to clarify why the words or phrases are not necessary.

2. Composition and Physical Properties of Petroleum

General Composition of Petroleum

What is petroleum? Petroleum is a mixture of naturally occurring hydrocarbons which may exist in the solid, liquid, or gaseous states, depending upon the conditions of pressure and temperature to which it is subjected. Virtually all petroleum is produced from the earth in either liquid or gaseous form, and commonly, these materials are referred to as either crude oil or natural gas, depending upon the state of the hydrocarbon mixture. Crude oil is the most sought after of these naturally occurring hydrocarbons, but natural gas is commonly produced along with the crude oil. In the early years of the petroleum industry, natural gas was considered to be a nuisance and was burned at the well site. In recent years with the advent of transcontinental transmission lines and petrochemical industries, the value of natural gas as a fuel and a raw product has increased the value of natural gas to the point where it is no longer a nuisance but a valuable raw material.

Petroleum consists chemically of approximately 11 to 13 wt % hydrogen and 84 to 87 carbon. Traces of oxygen, sulfur, nitrogen, and helium may be found as impurities in crude petroleum. Although all petroleum is constituted primarily of carbon and hydrogen, the molecular constitution of crude oils differs widely. About 18 series of hydrocarbons have been recognized in crude petroleum. Among them, the most commonly encountered are the paraffin, the olefine, the polymethylene, the acetylene, turpentine, and benzene. Natural gas is composed predominantly of the lower-molecular weight hydrocarbons of the paraffin series.

Hydrocarbons can be classified into essentially four categories depending on the structural formula. Two of the categories refer to the structural arrangement of the carbon atoms in the molecule. These are (1) saturated or single bonds and (2) unsaturated or multiple-bond compounds.

Physical Properties of Hydrocarbons

The detailed analysis of a crude oil is virtually impossible to obtain. Therefore, crude oils are classified according to their physical properties. Among the physical properties commonly considered in various classifications are color, refractive index, odor, density, boiling point, freezing point, flash point, and viscosity. Of these, the most important physical properties from a classification standpoint are the density (specific gravity) and the viscosity of the liquid petroleum. The specific gravity of liquids is defined as the ratio of the density of the liquid to the density of water, both at specific conditions of pressure and temperature.

The specific gravity of crude oils ranges from about 0.75 to 1.01. Since crude oils are generally lighter than water, a Baumé-type scale is used in the petroleum industry. This scale is referred to as the API (or American Petroleum Institute) scale for crude petroleum and relates the specific gravity through a modulus to an expression of density called API gravity. The API gravity yields numbers greater than 10 for all materials having specific gravity less than 1. Since the density of a liquid is a function of temperature and pressure, it is necessary to designate standard conditions for reporting specific gravity and API gravity. The petroleum industry has adopted as standards a temperature of 60℉ and atmospheric pressure.

Viscosity of crude oil ranges from about 0.3 centipoise for a gas-saturated oil at reservoir conditions to about 1,000 centipoises for a gas-free crude oil at atmospheric pressure and 100℉. Viscosity of crude-oil and liquid-petroleum products are frequently reported in terms of the time of efflux, in seconds, of a known volume of liquid through a standardized orifice. The times reported depend on the instrument employed, and the time of efflux from such instruments has a complex functional relationship to the kinematic viscosity, which is usually expressed in centistokes. The absolute viscosity in centipoises is obtained by multiplying the kinematic viscosity in centistokes by the density of the fluid in grams per cubic centimeter.

Other physical properties of liquid petroleum are frequently correlated with API gravity and viscosity. In general, such correlations have rather limited application.

Natural gas is composed largely of hydrocarbons of the paraffin series. Methane and ethane frequently comprise 80 to 90 per cent by volume of a natural gas. Other hydrocarbons, ranging in molecular weight from 44 (propane) to in excess of 142 (decane), together with impurities, compose the remaining percentage. Carbon dioxide, nitrogen, and hydrogen sulfide are the more common impurities found in natural gas. Helium and other inert rare gases occasionally occur in small concentrations in natural gases.

Gas gravity is widely used to characterize natural gases. Gas gravity is the ratio of the density of a gas at atmospheric pressure and temperature to the density of air at the same condition of pressure and temperature. Since at the atmospheric pressure and temperature the density of natural gas are directly proportional to the molecular weight, the gravity is the ratio of the molecular weight of the gas to the molecular weight of air. The molecular weight of methane is 16. Therefore, the gravity of pure methane is 0.55 or $16 \div 29$. Gas gravities for natural gases range from 0.6 to 1.1, depending on the relative concentration of the heavier hydrocarbons present in the gas.

Compositional analyses of natural gases are readily obtained by low-temperature distillation, chromatography, or mass spectrometry. Volume or mole percentages of the individual components present are ordinarily reported through heptanes plus. The heptanes-plus fraction includes heptane and all heavier hydrocarbons.

Natural gas is also described as dry or wet gases depending on the amount of condensable hydrocarbons present in the mixture. Pentane and heavier components are considered to be condensable hydrocarbons, as at atmospheric pressure and temperature pure pentane exists as a liquid. The higher hydrocarbons-methane, ethane, propane, and butane- exist in the gaseous state at atmospheric condition.

(From *Petroleum Reservoir Engineering*, physical properties, J. W. Amyx, Daniel M. Bass, JR. Robert L. Whiting, McGRAW-HILL, Inc. 1988)

I. New Words

1. nuisance	/ˈnjuːsns/	n.	麻烦的事；障碍
2. advent	/ˈædvənt/	n.	出现
3. transcontinental	/ˈtrænzˌkɔntiˈnentl/	adj.	横贯大陆的
4. nitrogen	/ˈnaitridʒən/	n.	氮
5. helium	/ˈhiːljəm/	n.	氦
6. olefine	/ˈouləfin/	n.	烯（属）烃
7. polymethylene	/ˌpɔliˈmeθiliːn/	n.	聚甲撑
8. acetylene	/əˈsetiliːn/	n.	乙炔；双亚乙基
9. turpentine	/ˈtəːpəntain/	n.	松节油
10. benzene	/ˈbenziːn, benˈziːn/	n.	苯
11. predominantly	/priˈdɔminəntli/	adv.	主要地
12. multiple-bond	/ˈmʌltipəlˈbɔnd/	n.	重键
13. refractive	/riˈfræktiv/	adj.	折射的
14. standpoint	/ˈstændpɔint/	n.	立场；角度；观点
15. modulus	/ˈmɔdjuləs/	n.	模量；模树；系数（复moduli/mɔdjulai/）
16. centipoise	/ˈsentipɔiz/	n.	厘泊（动力粘度单位，符号为 cP,为非法定计量单位。1cP=1mPa・s。）
17. efflux	/ˈeflʌks/	n.	流出
18. orifice	/ˈɔrifis/	n.	口；孔；喷嘴
19. kinematic	/ˌkainiˈmætik/	adj.	运动学的
20. centistoke	/ˈsentistouk/	n.	厘沲（运动粘度单位，符号为 St，为非法定计量单位。$1St=10^{-4}m^2/s$。）
21. methane	/ˈmiːθein/	n.	甲烷；沼气
22. ethane	/ˈeθein/	n.	乙烷
23. decane	/ˈdekein/	n.	癸烷
24. inert	/iˈnəːt/	adj.	惰性的
25. concentration	/ˌkɔnsenˈtreiʃən/	n.	集中；浓缩；浓集
26. distillation	/ˌdistiˈleiʃən/	n.	蒸馏；蒸馏法
27. chromatography	/ˌkrouməˈtɔgrəfi/	n.	色谱法；色层分析法
28. spectrometry	/spekˈtrɔmitri/	n.	光谱分析
29. mole	/moul/	n.	摩尔
30. heptane	/ˈheptein/	n.	庚烷
31. condensable	/kənˈdensəbl/	adj.	可凝结的

32. pentane	/pentein/	n.	戊烷
33. propane	/proupein/	n.	丙烷
34. butane	/bju:tein/	n.	丁烷

I. Technical Terms

1. transcontinental transmission line	横贯大陆输油管线
2. refractive index	折射率；折光率
3. flash point	闪（燃）点
4. specific gravity	相对密度（旧称比重）
5. Baumé-type scale	波美度
6. API gravity	美国石油学会标准重度，API 度
7. gas-saturated oil	天然气饱和的原油
8. gas-free crude oil	脱气原油
9. kinematic viscosity	动力粘度
10. hydrogen sulfide	硫化氢
11. inert rare gas	稀有惰性气
12. mass spectrometry	质谱测量法
13. mole percentage	摩尔百分数

Exercises

I. Useful collocations:

general composition, detailed analysis, virtually impossible, physical properties, various classification, from a standpoint, atmospheric pressure, functional relationship, composed largely of, proportional to, compositional analysis

II.Answer the following questions.

1. How do we usually classify crude oil?
2. What does chemical classification of crude oil depend?
3. What physical properties are important in affecting the qualities of different crude oil?

III.Pick out all the sentences in passive voice in the text and classify them in terms of the purpose of using the voice instead of active voice.

IV. Choose one of the words given and fill in each blank.

Muskingum College, located in southeast Ohio, is easily __1__ by major east-west and northsouth highways. Muskingum college is rich in tradition, its proud heritage __2__ back to the first half of the nineteenth century when Ohio was an infant state and covered wagons were bringing 3___ settlers westward over the newly-completed National Road through New Concord. The college's Indian name, sometimes mispronounced and __4__ misspelled, is a source of pride to those who cherish the history of that colorful part of frontier America "beyond the Alleghenies."

During its first half-century Muskingum College adhered to the educational patterns of the classic college of the period. In 1854 women were __5__ on an equal basis with men. After the Civil War a period of steady growth began, accelerating until the frontier classical college of less than 100 students has evolved into a modern liberal arts and sciences college of some 1,300 students, with a 215 acre campus and an endowment whose market value is more than $40 million.

Muskingum College has been continuously accredited since 1919 by the North Central Association of Colleges and Schools and is __6__ by, and receives periodic reauthorization from, the Ohio Board of Regents to grand its degrees. It is fully approved for teacher education by Ohio Department of Education.

The mission of Muskingum is for __7__ quality academic programs in the liberal arts and sciences in the setting of a residential, coeducational, church-related college and in the context of a caring community where individual __8__ is encouraged and human dignity is respected. Its primary purpose is to develop --- intellectually, spiritually, socially and physically---whole persons, by __9__ critical thinking, positive action, ethical sensitivity and spiritual growth, so that they may lead vocationally productive, personally satisfying and socially responsible lives.

Muskingum College deliberately promotes programs that encourage and develop international awareness and understanding. Formal student exchange agreements exist between the College and universities around the world, and a wide range of additional study abroad opportunities is available. The Liberal Arts Essential program requires exposure to international perspectives, and an international faculty and student body add __10__ to the campus.

words given:				
fulfillment	often	accessible	reaching	admitted
fostering	adventurous	authorized	diversity	offering

V. Reading comprehension:

Despite the excitement by its huge market, China remains a difficult place for Western companies to conduct business. The challenges range from gaining access to suppliers to securing distribution rights. But perhaps the biggest challenge is assembling an effective team of managers, according to two researchers at Boston University's School of Management who are conducting a project on human resource practices in China.

For Westerners in China, that means attracting—and retaining both expatriate and local management talent. Without a doubt, many global companies are already expert at such human-resource practices. But, say the researchers, the rules are different in China.

"Too many companies have rushed into China recently in order not to miss out on the market," says Fred Foulkes, a professor of management policy who is working on this project with Susan McEwen-Fial, a senior research associate. "In their rush, these companies have neglected the hardest part of doing business in China; the people part. The result is that many have jeopardized their performance in the long run."

McEwen-Fial and Foulkes surveyed and interviewed managers at dozens of Western companies doing business in China—some success stories, other not. McEwen-Fial herself spent several years there, as a researcher and also as a project manager with one Western venture. Their research indicates that Western companies entering China must first pay attention to the expatriate managers who will oversee the venture. Successful companies, the researchers found, select and nurture these candidates carefully, preferring a large investment of time and money up front to the risk of an expensive and embarrassing failure later. One useful technique: successful companies have intensively educated their expatriates in Chinese life and customs before sending them abroad.

1.Which of the following is not a problem for foreign companies in China?

A. gaining access to suppliers　　B. securing distribution rights

C. seeking for market　　D. selection of managers

2."The rules are different" refers to those of ________.

A. doing business　　B. human resource practices

C. company organization　　D. life and customs

3.The passage implies that foreign managers and businessmen are frustrated by ________.

A. the Chinese way of doing business

B. the Chinese way of life and customs

C. the Chinese language

D. the Chinese people's likes and dislikes of foreign products

4.If a company wants to do successful business in China, it ________.

A. needs to overlook the cultural differences

B. has to make their managerial personnel experts in Chinese customs

C. must invest large sums of money in technical training

D. must learn the Chinese way of human resource practices

5.The word "oversee"(Line 5, the last Para.) is closest in meaning to "________".

A. manage　　B. observe　　C. survey　　D. inspect

3. Porosity

From the reservoir-engineering standpoint, one of the most important rock properties is porosity, a measurement of the space available for storage of petroleum hydrocarbon. Porosity is defined as the ratio of the void space in a rock to the bulk volume of that rock multiplied by 100 to express in per cent. Porosity may be classified according to the mode of origins (1) original and (2) induced. Original porosity is typified by the intergranular porosity of sandstones and the intercrystalline and oolitic porosity of some limestones. Induced porosity is typified by fracture development as found in some shales and limestones and by the vugs or solution cavities commonly found in limestones. Rocks having original porosity are more uniform in their characteristics than those rocks in which a large part of the porosity is induced. For direct quantitative measurement of porosity, reliance must be placed on formation samples obtained by coring.

Early investigations of porosity were conducted to a large extent by investigators in the fields of ground-water geology, chemical engineering, and ceramics. Therefore, much of the interest was centered on the investigation of porosity of unconsolidated materials. In an effort to determine approximate limits of porosity values, Slichter and, later, Graton and Fraser computed the porosity of various packing arrangements of uniform spheres. The porosity for cubical packing (the least compact arrangement) is 47.6 per cent, and that for rhombohedral (the most compact arrangement) is 25.96 per cent.

The investigators recognized that naturally occurring materials were composed of a variety of particle sizes and that not only the arrangement but the regularity and distribution of particle size would affect porosity. The configuration of the pore space is different from that which would be obtained from the packing of uniform spheres. Furthermore, a portion of space is filled with clay and cementing material.

Grain-size distribution may be characterized in part by skewness of the distribution. Skewness is a statistical measure of the uniformity of the distribution of a group of measures. In general, smaller grain size and greater angularity tend to increase the porosity while an increase in range of particle size tends to decrease porosity.

In dealing with reservoir rocks, it is necessary, because the cementing materials may seal off a part of the pore volume, to define total porosity and effective porosity. Total porosity is the ratio of the total void space in the rock to the bulk volume of the rock; effective porosity is the ratio of the interconnected void space in the rock to the bulk volume of the rock, each expressed in per cent. From the reservoir-engineering standpoint, effective porosity is the quantitative value desired, as this represents the space which is occupied by mobile fluids. For intergranular materials, poorly to moderately well cemented, the total porosity is approximately equal to the effective porosity. For more highly cemented materials and limestones, significant difference in total porosity and effective