پودمان پنجم

کسب اطلاعات فنی

کسب اطلاعات فنی از منابع غیرفارسی با هدف یادگیری همیشگی و توسعهٔ مهارت‌های کسب‌شده از ضروریات پیشرفت در کسب و کار موفق است.

وَ مِنْ آيَاتِهِ خَلْقُ السَّماوَاتِ وَالاْرْضِ وَاخْتِلاَفُ اَلْسِنَتِكُمْ وَاَلْوَانِكُمْ اِنَّ فِى ذَلِکَ لاَيَاتٍ لِلْعَالِمِينَ

و از نشانه‌های او آفرینش آسمان‌ها و زمین، و تفاوت زبان‌ها و رنگ‌های شماست؛ در این، نشانه‌هایی است برای اهل دانش.

And of Allah's Signs of Power is the creation of the heavens and the earth and also the variation of the languages and the colour of you people; verily, in all these are Signs for men of knowledge.

Surah Ar-Rum [22] - Al - Qur'an al - Kareem

Part One

Chemical industries

Match the pictures with phrases.

A. 1 Water purification

B. 2 Drug

C. 3 Oil, gas and petrochemicals

D. 4 Agriculture

Chemical industries

The chemical industry includes all the manufacturing plants that convert raw materials (oil, natural gas, air, water, metals, and minerals) into more than 70,000 different chemical products. This industry has influenced all aspects of our life including Transportation, Agriculture, Environment, Hygiene, and so on. It has also significantly used in re-cycling that helps in utilizing the waste materials, and gives one more life-cycle for the products.

Iran: A land of opportunity

Iran is the 18th largest country of the world. It stretches from the Caspian Sea in the north to the Persian Gulf in the south. Iran is one of the world's major countries in oil export and it is rich

in natural resources. It is bordered to the north by Armenia, Azerbaijan, and Turkmenistan, to the east by Afghanistan and Pakistan, to the south by Persian Gulf and the Gulf of Oman, and to the west by Iraq and Turkey (Fig. 1).

Fig. 1: Map of Iran

Read and According to the below text, answer the following questions.

Economy and demographics
Second Largest economy in the Middle East and North Africa, after saudi Arabia
Production capacity expected to reach 180 mt/g by 2025
Population:80.8 mllion
High levels of education: 71 percent of 18-24 year olds are enrolled in tertinary education.
Diversified economy:18th largest automaker in the world,14th largest steel producer.

Iran's Petro chemical industry
Second-Largest. gas reserves globally 34 trillion cubic feet.
4.8 Percent of the global petrochemical market
Controlled by the National petrochemical company (NPC)
52 Petrochemical plants with a total production capacity of about 60 mt and an output of 51 mt (2016)
Production capacity expected to reach 180 mt per year by 2025
Key export partners: methanol, urea, Polyolefins, ammonia, monethylene glycol (meg) and para-xylene.

A. Choose the best answer.

- Iran is (the first/the second) largest economy in the Middle East and North Africa.
- In Iran, (population/ production capacity) is expected to reach 180 mt/y by 2025.

B. True/ False

- Iran's petrochemical industry is the largest gas reserves globally. ---------
- Key export products of Iran are methanol, urea, polyolefins, ammonia, monoethylene glycol (meg) and para-xylene. ----------

Structure of the chemical industry:

Raw materials are converted into products for other industries and consumers.
Basic raw materials can be divided into:

- ❖ Organic, and
- ❖ Inorganic.

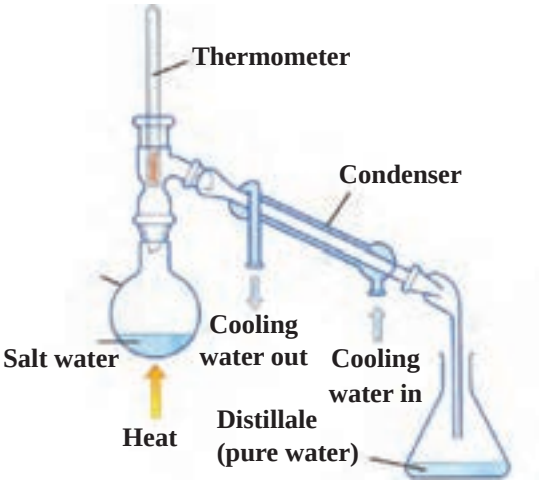
Inorganic raw materials include:

- ✓ Air
- ✓ Water, and
- ✓ Minerals.

Fossil fuels and biomass belong to the class of organic raw materials.

As you know, chemical industry converts raw materials into different products. This is done by various physical and chemical processes such as distillation, extraction, filtration, and etc.

Match the pictures with the words and phrases.



A.

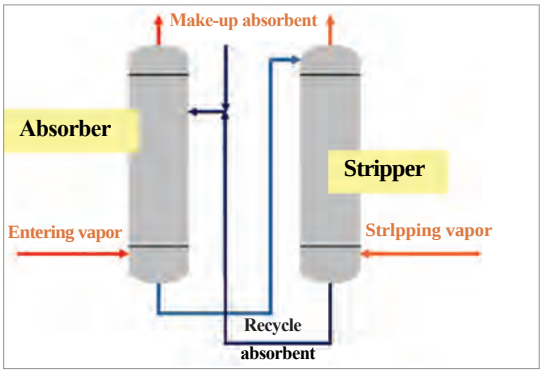
1 **Crystallization**

B.

2 **Distillation**

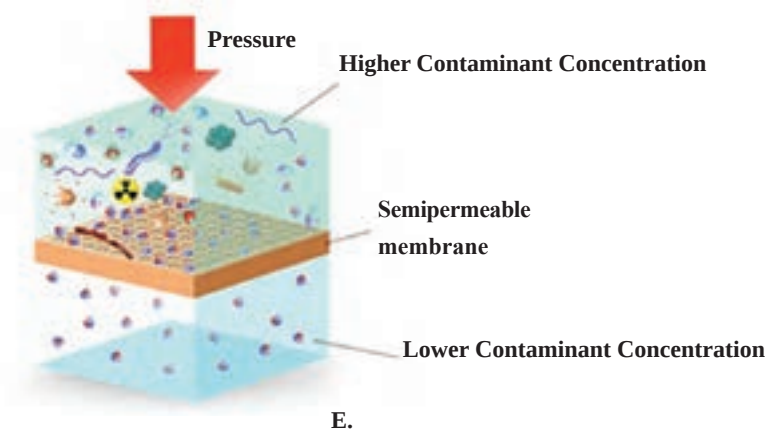
C.

3 Membrane processes



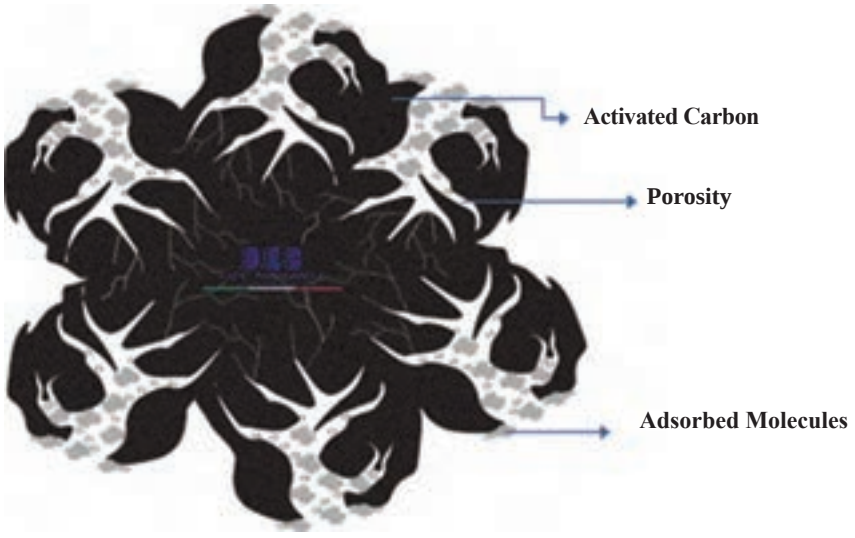
D.

4 Adsorption



E.

5 Absorption and stripping



F.

6 Extraction

Traditional chemical engineering processes

Chemical products are made by a combination of processes that include synthesis, separation, and purification. The traditional chemical engineering methods of separation and purification include distillation, crystallization, adsorption, membrane processes, absorption and stripping, and extraction. These technologies are briefly described below.

Distillation

Distillation is by far the most widely used separation process for fluid mixtures (mostly liquids) that can be vapourized. Distillation is a process for isolating components from a mixture based on differences in boiling points. In this process, vapours are generated from mixtures by heating and are then condensed into liquid products.

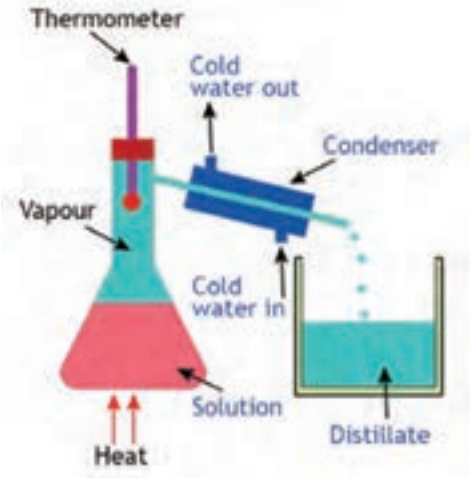


Fig.2: Distillation

Distillation processes are widely used for the separation of organic chemicals and for the separation of gases, usually at cryogenic temperatures, as in the production of oxygen and nitrogen from air (Fig.3).

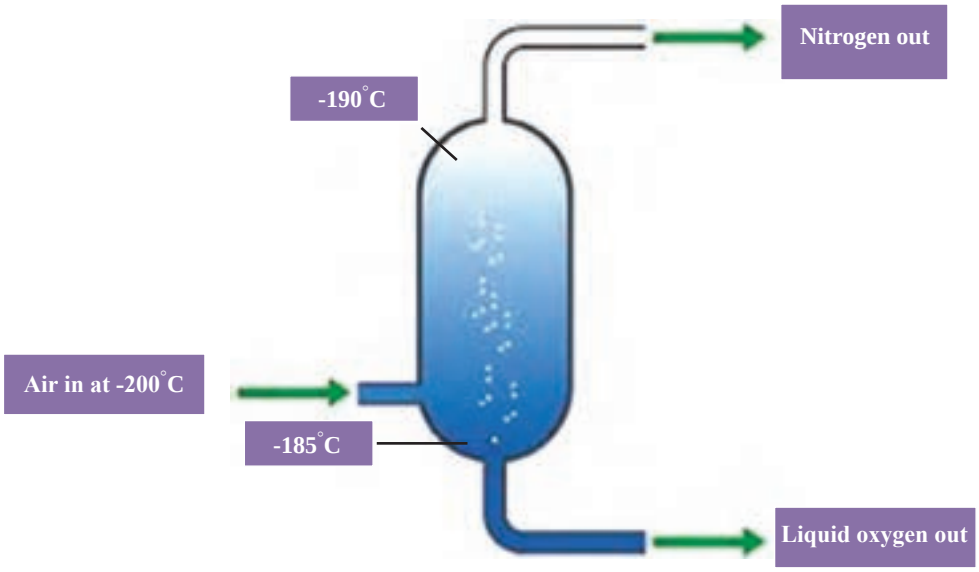


Fig.3: The production of oxygen and nitrogen from air

Crystallization

know more

Crystallization is one of the oldest unit operations in the separation techniques used for industrial and laboratory processes. Crystallization is used to achieve several functions: separation, purification, concentration, solidification, and the production of a crystal. Because the heat of crystallization is typically much lower than the heat of vaporization, considerable energy savings can be realized in applications where crystallization is an effective means of separation.

Solutes can be recovered from solutions by reducing the solubility through cooling, heating, evaporation, chemical reaction, or by adding a nonsolvent to the mixture.

Different steps of crystallization are shown in Fig. 4.

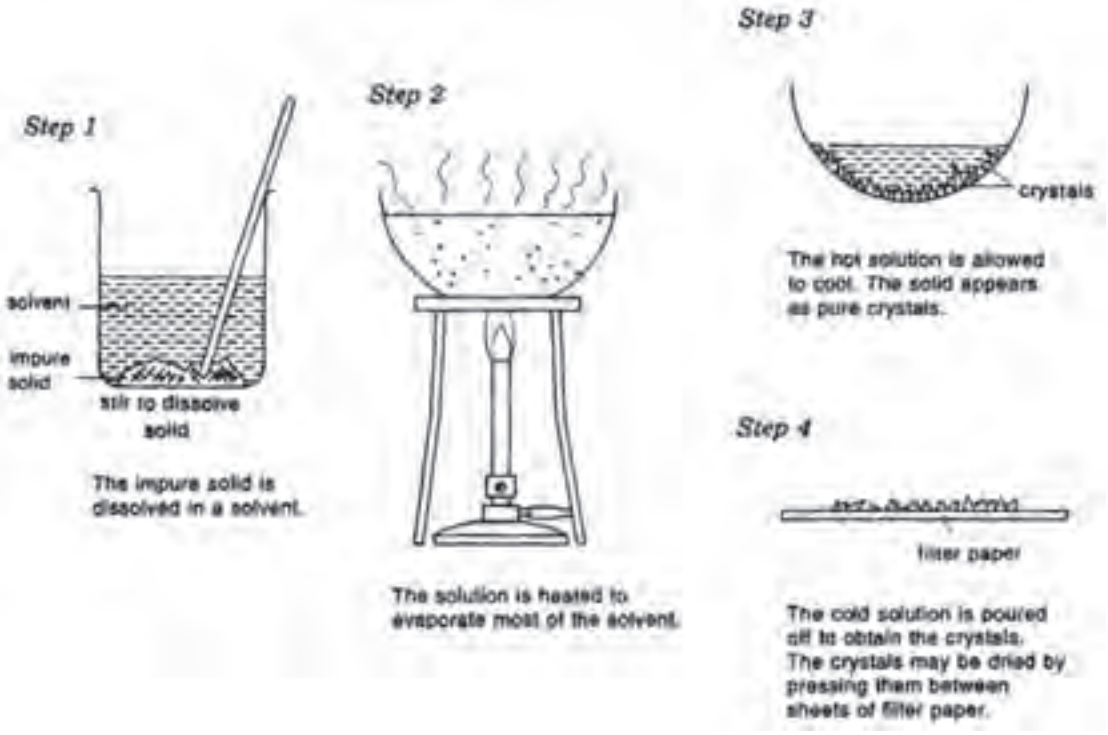


Fig.4: Crystallization

Adsorption

Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent (Fig.5).

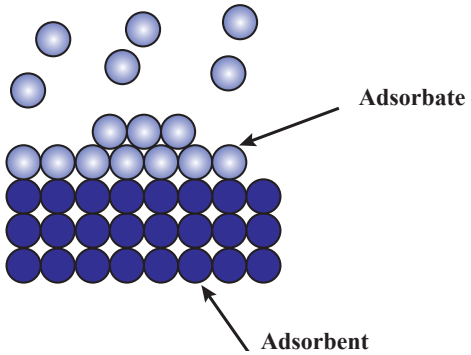


Fig.5: Adsorption process

This process differs from absorption (Fig. 6). Adsorption is a surface-based process while absorption is the process in which a fluid is dissolved by a liquid or a solid (absorbent).

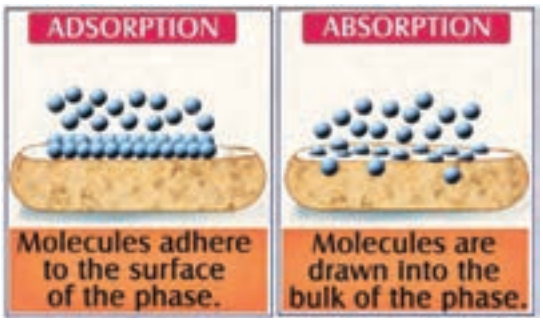


Fig 6: Adsorption and absorption

The adsorption separation process is necessarily cyclic, alternating between adsorption and desorption. Desorption can be accomplished by increasing the temperature, reducing the pressure, or a combination of both.

Membrane processes

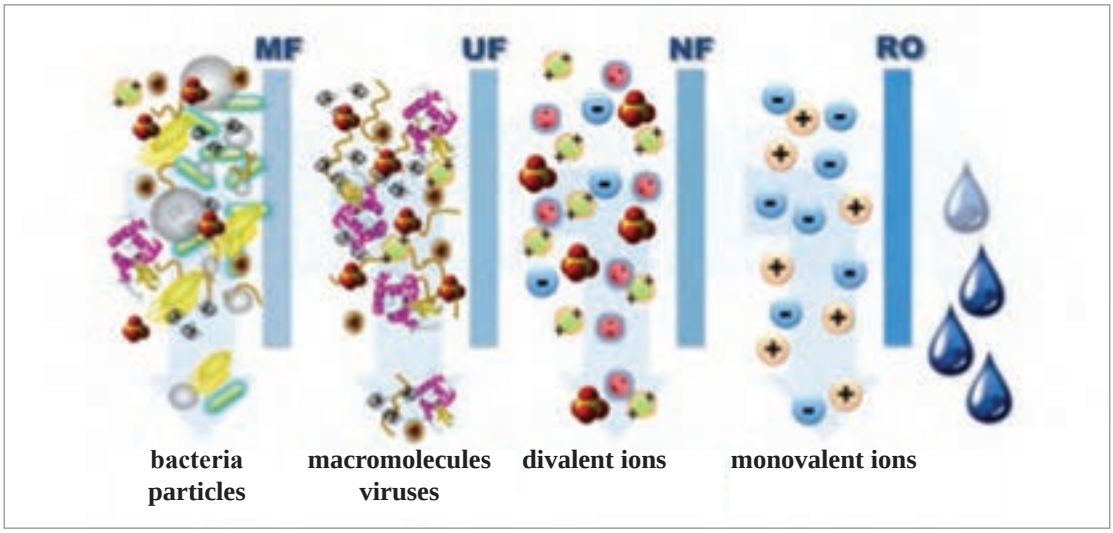
Separation processes involving membranes require two bulk phases that are physically separaed by a third phase, the membrane. In all membrane processes, the feed is separated into two phases: the materials that go through the membrane and the portion of the feed retained by the membrane.

Note: Membrane processes typically do not involve a phase change and therefore do not involve a specific heat of vapourization (like distillation) or a specific heat of crystallization (like crystallization). Because there is no phase change, highly selective membranes can complete separations with considerably less energy than other methods.

Types of membrane processes are:

- ✓ Microfiltration (MF)
- ✓ Ultrafiltration (UF)
- ✓ Nanofiltration (NF)
- ✓ Reverse osmosis (RO)
- ✓ Dialysis /Electrodialysis (ED)

- Look and then answer the questions with your own knowledge.



Membrane processes

1 Which filtration system is good for drinking water? (RO/MF)
2 Which filtration system is not commonly used for distillated water? (MF/None of them)
3 Which filtration system is suitable for deionized water? (All of them/RO)

Absorption and stripping

Absorption refers to the transfer of one or more components of a gas phase to a liquid phase in which the gas phase is soluble. Stripping is exactly the reverse, the transfer of a component from a liquid phase in which it is dissolved to a gas phase (Fig. 7).

know more

There are three types of absorption processes: separation based on physical solution; separation based on reversible chemical reaction; and separation based on irreversible chemical reaction. Absorption processes require the generation of extensive areas of liquid surfaces in contact with gas phases.

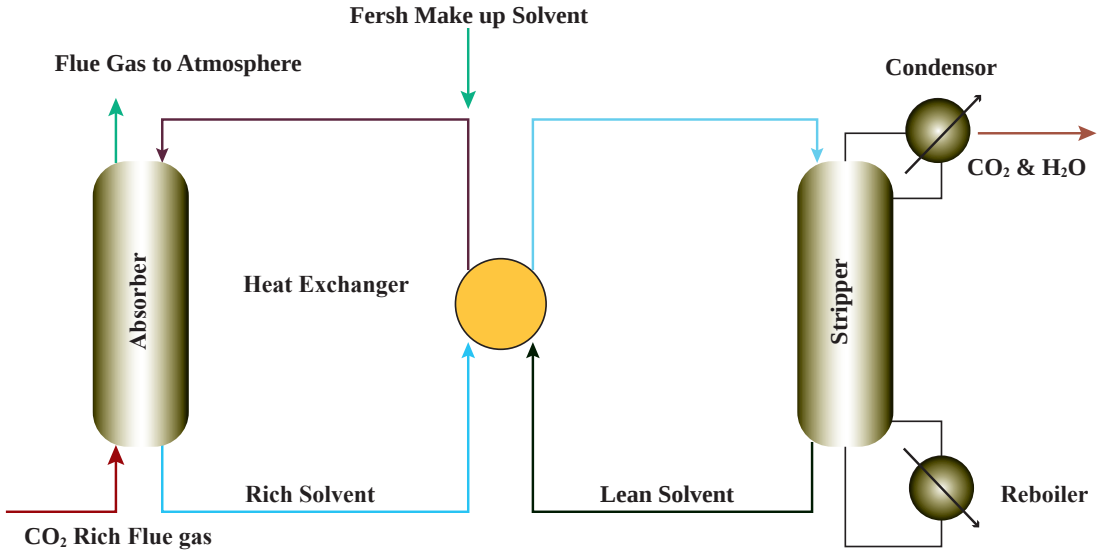


Fig.7: Absorption and stripping

Extraction

Liquid - liquid extraction is a separation technique involving two immiscible liquid phases. During liquid-liquid extraction, the solvent phase, extracts the solutes from the other liquid phase (Fig.8).

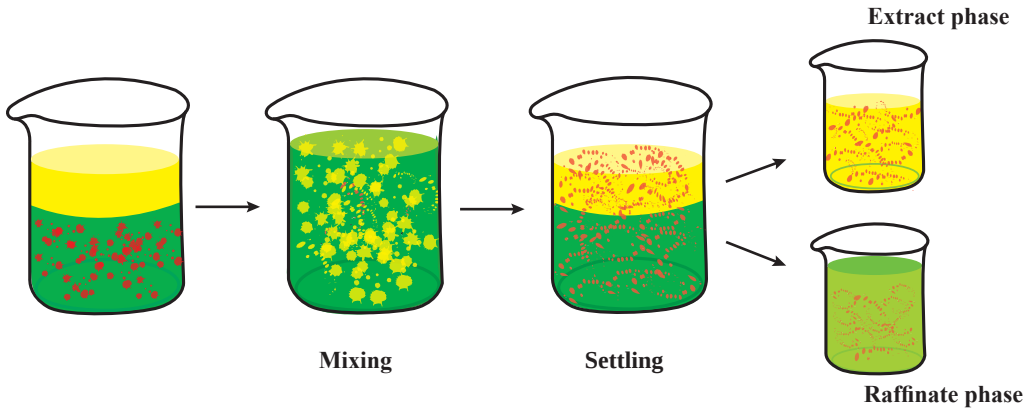
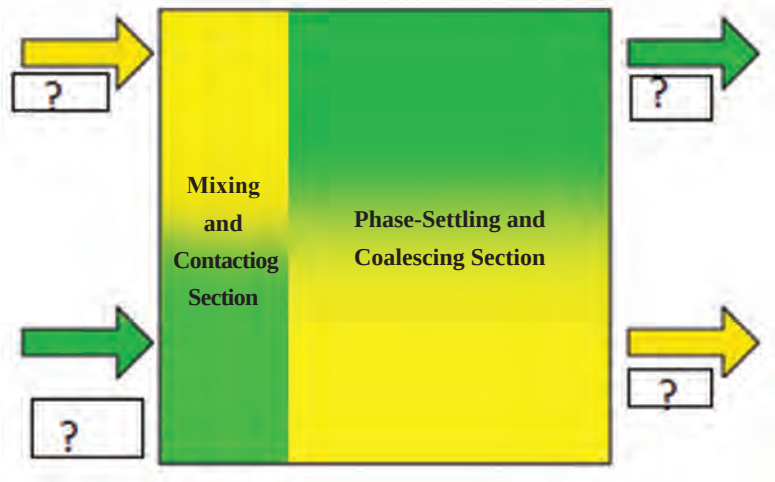


Fig.8: Extraction

Solvent recovery and raffinate clean up follow the separation. There is usually more than one possible method of purifying the solvent and raffinate phases and, therefore, process design is important.

Fill in the blanks with the given words.

Extract, Solvent, Raffinate and Feed



Mostly the chemical industry (Fig. 9) concentrates on producing polymers, and plastics. They are not only used in packing, but also in numerous other applictions, like wiring, furniture, clothing, home decorations and electronics. PVC piping, water tanks, huge storage containers are made out of plastics.

Fig.9: A chemical plant

Branches of various chemical industries are:

- Oil, gas and petrochemicals
- Water, soil and air purification
- Food, and drug,
- Soaps and detergents
- Fertilizers and pesticides
- Mineral products
- Etc.

Part Two

Air purification

Match the pictures with phrases.

A.

1 **Burning waste**

B.

2 **Vehicular emissions**

C.

3 **Air purification**

D.

4 **Air pollution**

E.

5 **Household combustion devices**

F.

6 **Forest fires**

Air purification

Air pollution has grown up to be a serious problem for both people and governments since it disturbs sustainable development along with threatening people's health. Vehicular emissions and industrial fossil fuel consumption can affect the regional air quality. High population density, rapid urbanization, and economic growth have been found to be the main reasons behind the global problem of increasing air pollution.

Air pollution is referred to as contamination of indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases, which can be fatal.

Note: Particle pollution, also called particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Particles less than or equal to 10 micrometers in diameter are so small that they can get into the lungs, potentially causing serious health problems (Fig.10).

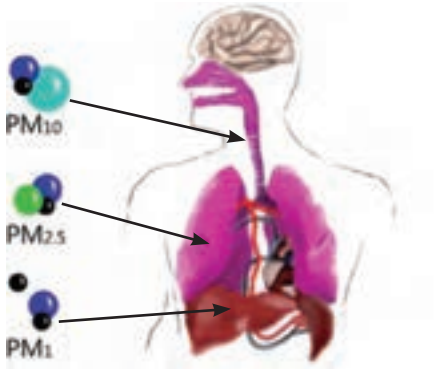


Fig.10: Particles less than or equal to 10 micrometers in diameter can get into the lungs.

- Use the appropriate phrases in parentheses.

Clean air

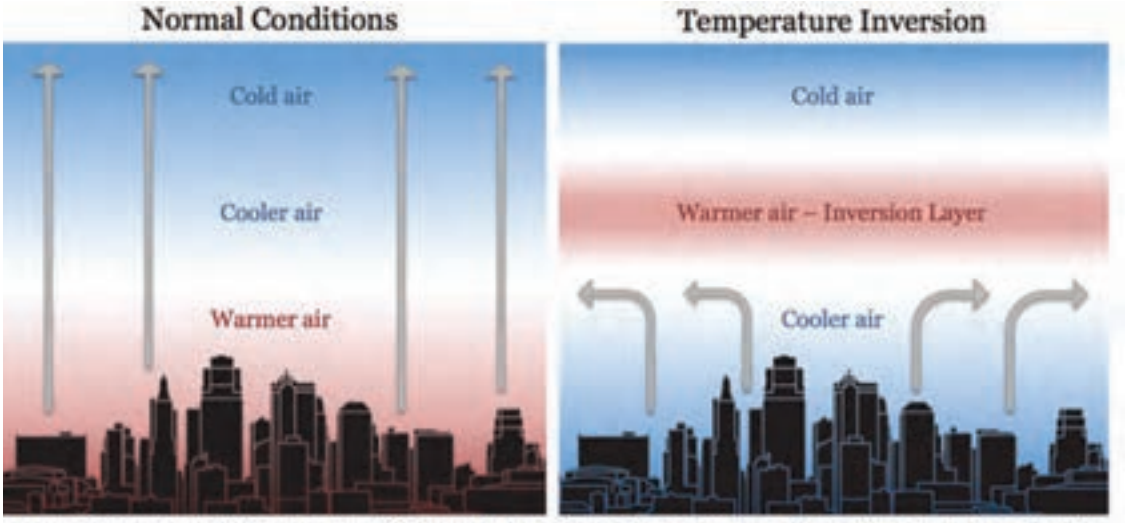
Polluted air

- Which one is better? (Clean air/Polluted air)
- (Clean air/Polluted air) is synonym of fresh air.
- (Clean air/Polluted air) is opposite of fresh air.

Note: Iran shut primary schools in Tehran and other parts of the country on Sunday due to air pollution (Fig. 11).

Fig.11: Air pollution in Tehran

Every year, Tehran suffers some of the worst air pollutions in the world when cool temperatures cause an effect known as "temperature inversion". The phenomenon creates a layer of warm air above the city that traps pollution from its more than eight million cars and motorbikes (Fig. 12).



Arrows show air flow in normal conditions on the left and during temperature inversion on the right. In normal conditions, warm air rises and normal convective patterns persist. During temperature inversion, the warm air acts as a cap, effectively shutting down convection and trapping smog over the city.

Fig.12: Temperature inversion phenomenon

Note: "We need clean air for our children's future." An air purifier or air cleaner is a device which removes contaminants from the air in a room (Fig.13).

Fig.13: An air purifier

Personal protective equipment

Personal protective equipment (PPE) refers to protective clothing, helmets, or equipment designed to protect the body from injury or infection. The gas mask is a mask used to protect the user from inhaling airborne pollutants and toxic gases (Fig.14).

Fig.14: Air-purifying respirator

Filtration

Filtration is any of various mechanical, physical or biological operations that separate solids from fluids (liquids or gases) by adding a medium through which only the fluid can pass (Fig.15). The fluid that passes through is called the filtrate. In physical filters oversize solids in the fluid are retained. However, the separation is not complete; solids will be contaminated with some fluid and filtrate will contain fine particles (depending on the pore size and filter thickness). Filtration occurs both in nature and in engineered systems.

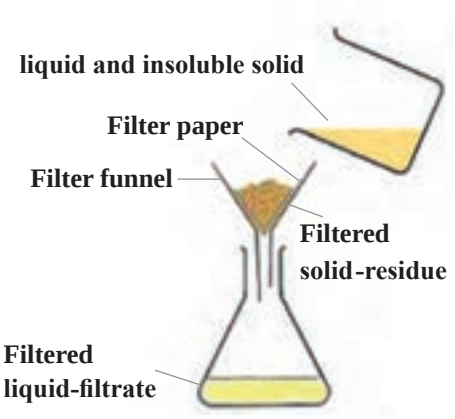
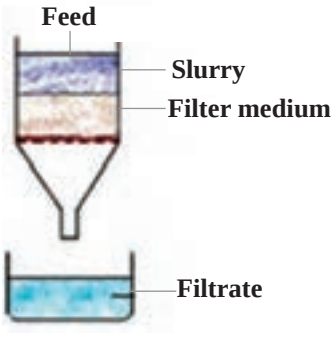


Fig.15: Simple filtration

Match the words and phrases with your own knowledge.



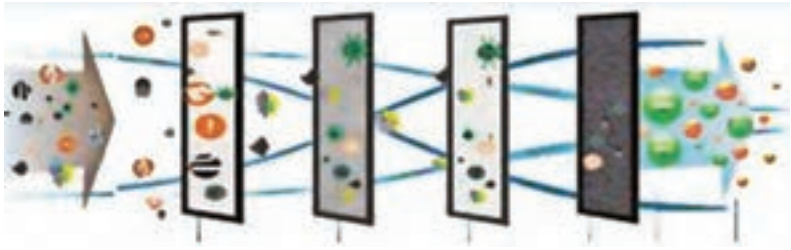
Word	Phrase
Feed, Slurry	Clear liquid passing through the filter
Filter medium	Porous medium used to retain solid
Filter cake	Suspension to be filtered
Filtrate	Accumulated solids on the filter

- Choose the best answers.

✓ A (filter cake/filtrate) is formed by the substances that are retained on a filter. The filter cake grows in the course of (filtration/filtrate), becomes "thicker" as particulate matter is being retained.

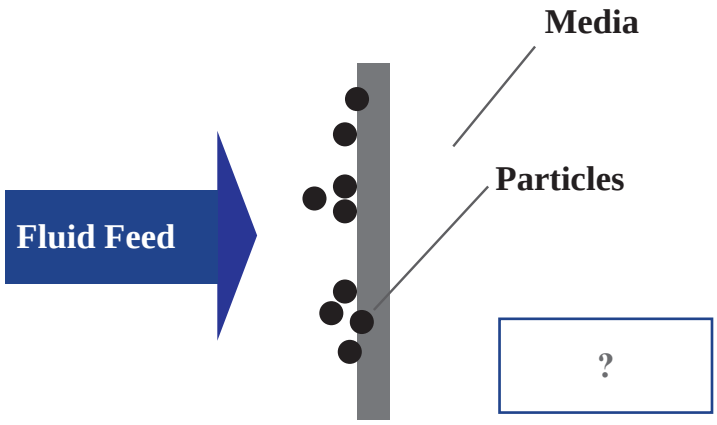
✓ Due to the deposition of (solids/liquids), the thickness of filter cake is (decreased/increased) and so it makes a limitation to further filtration.

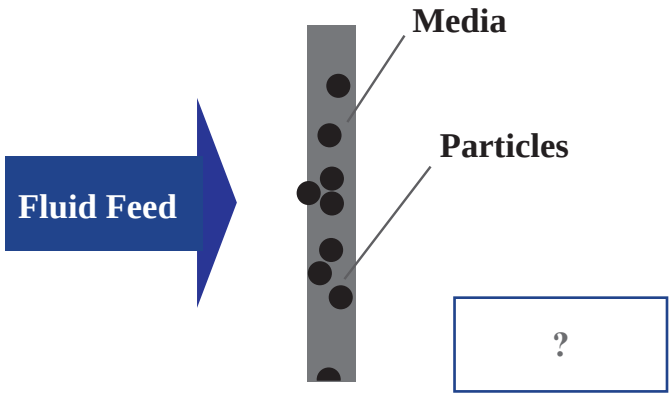
Fresh air /Polluted air



Fresh air /Polluted air

- Which one is Surface Filtration or Depth Filtration?





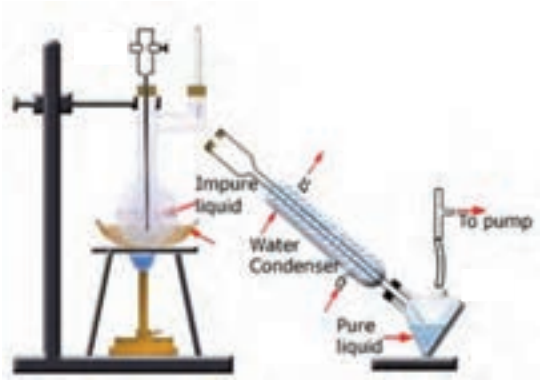
Part Three

Crude oil

Match the pictures with phrases.

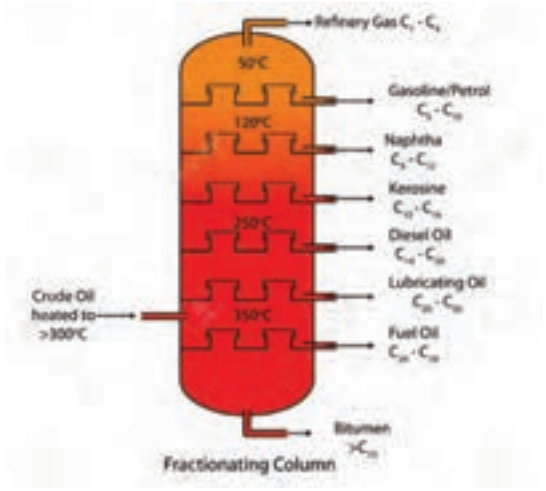
A.

1 **Crude oil distillation**



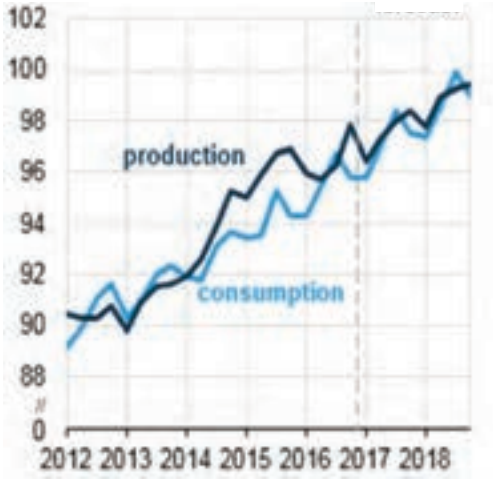
C.

3 **World fuels production/consumption (mb/d)**



B.

2 **Crude oil**



D.

4 **Vacuum distillation**

Crude oil

Petroleum or crude oil is a naturally material composed of hydrocarbon deposits and other organic materials. The composition varies widely depending on where and how it was formed. Crude oil, as a fossil fuel, is refined to produce usable products such as gasoline, diesel and various forms of petrochemicals. It is a nonrenewable resource, which means that it cannot be replaced naturally at the rate we consume it and is therefore a limited resource.

History of Oil in Iran

The Anglo-Persian Oil Company (APOC) was a British company founded in 1908 following the discovery of a large oil field in Masjid Soleiman, Iran. The Masjid Soleiman, located in the Khuzestan province in the southwest of the Islamic Republic of Iran, is the place where the country's first oil well was drilled (Fig. 16).

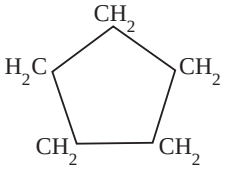
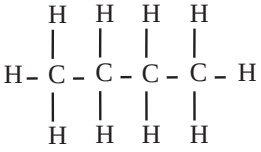
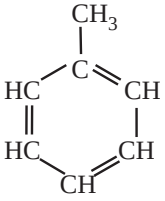
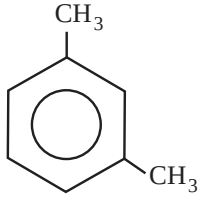
Fig. 16: The country's first oil well in Masjid Soleiman

Hydrocarbons in Crude Oil

There are four main types of hydrocarbons found in crude oil.

- ✓ paraffins (15-60%)
- ✓ naphthenes (30-60%)
- ✓ aromatics (3-30%)
- ✓ asphaltenes

- Choose the best answer with your own knowledge.

Molecular Structure معادل انگلیسی ساختار مولکولی	Name
	Cyclopentane or Cyclohexane
	Butane or Propane
	Benzene or Toluene
	Xylene or Toluene

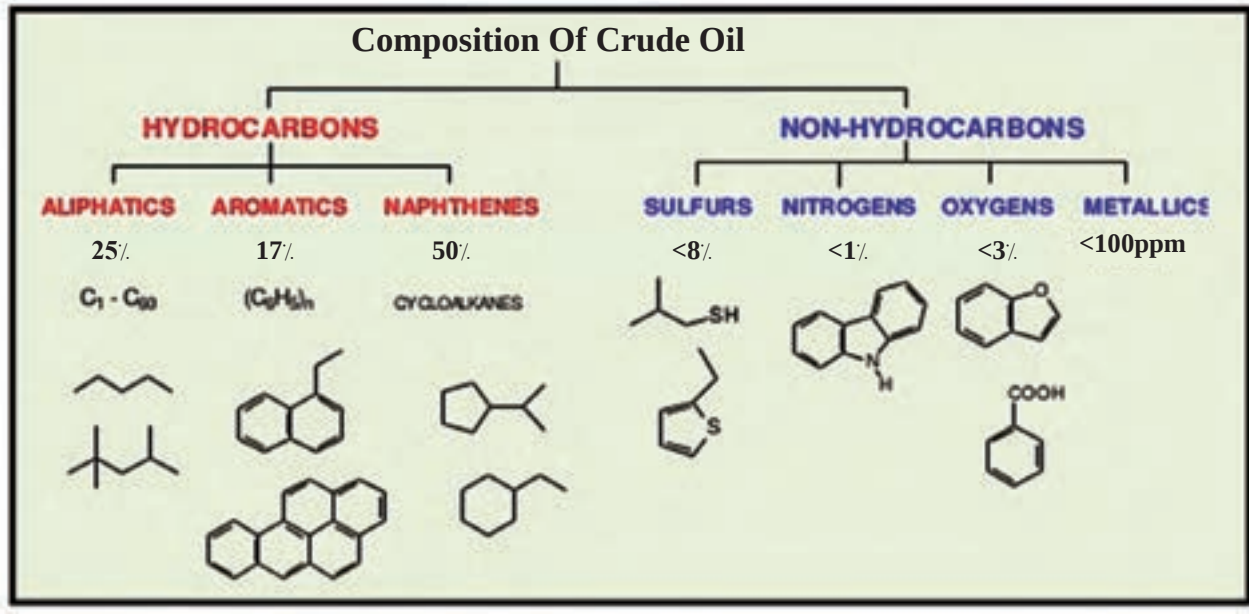
Elemental Composition of Petroleum

Although there is considerable variation between the ratios of organic molecules, the elemental composition of petroleum is well-defined:

- ✓ Carbon - 83 to 87%
- ✓ Hydrogen - 10 to 14%
- ✓ Nitrogen - 0.1 to 2%
- ✓ Oxygen - 0.05 to 1.5%
- ✓ Sulfur - 0.05 to 6.0%
- ✓ Metals - < 0.1%

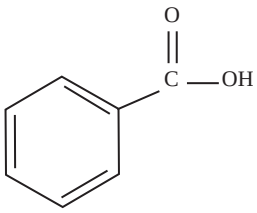
The most common metals are iron, nickel, copper, and vanadium.

- Look, Read and Practice.



True/False

1 $(C_6H_5)_n$ is an aliphatic hydrocarbons. .....

2  is a hydrocarbon substance in crude oil. .....

3 Bezoic acid ($C_7H_6O_2$) is a Colourless crystalline solid and a simple aromatic carboxylic acid. .....

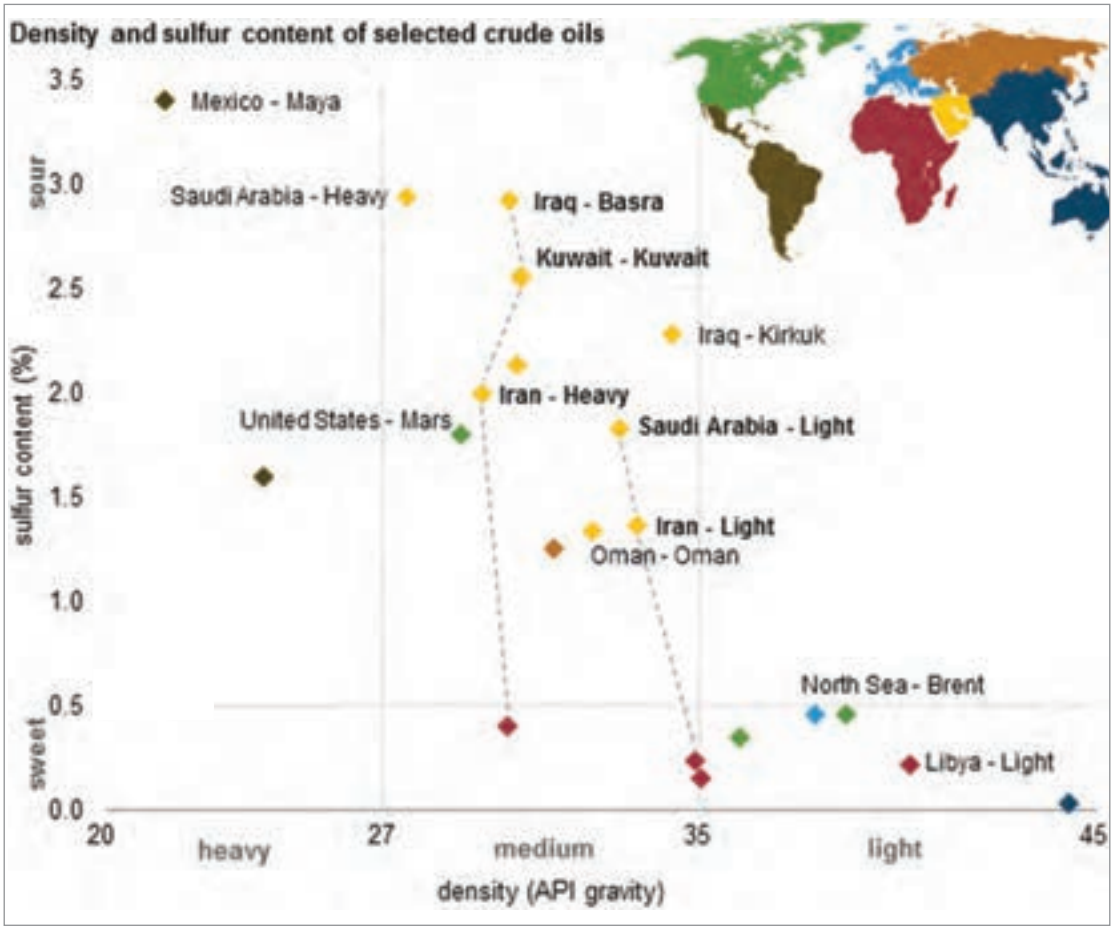
4 Cycloalkanes are also called naphthenes. .....

Petroleum colour and viscosity

The colour and viscosity of petroleum vary markedly from one place to another (Fig.17). It is usually dark brown or blackish, although it may be greenish, reddish, or yellowish.

Fig. 17: Crude oil

- Look at the picture carefully and then fill in the blanks with appropriate words.



- Types of selected crude oil of Iran are --------- and ---------.
- The density of Iran-Light crude oil is ---------, approximately.
- Sulfur content of Iran-Heavy crude oil is about ---------.

Crude oil refinery

A crude oil refinery is a group of industrial facilities (Fig. 18) that turns crude oil into finished petroleum products.

Fig. 18: Tehran crude oil refinery

- Choose the appropriate words with your own knowledge.

(Extraction/Distillation) is the process in which the components of a liquid mixture are separated by heating it to a certain temperature and condensing the resulting vapors. This process, which is a (physical/chemical) separation process and not a (physical/chemical) reaction, is a unit operation of practically universal importance in chemical industries.

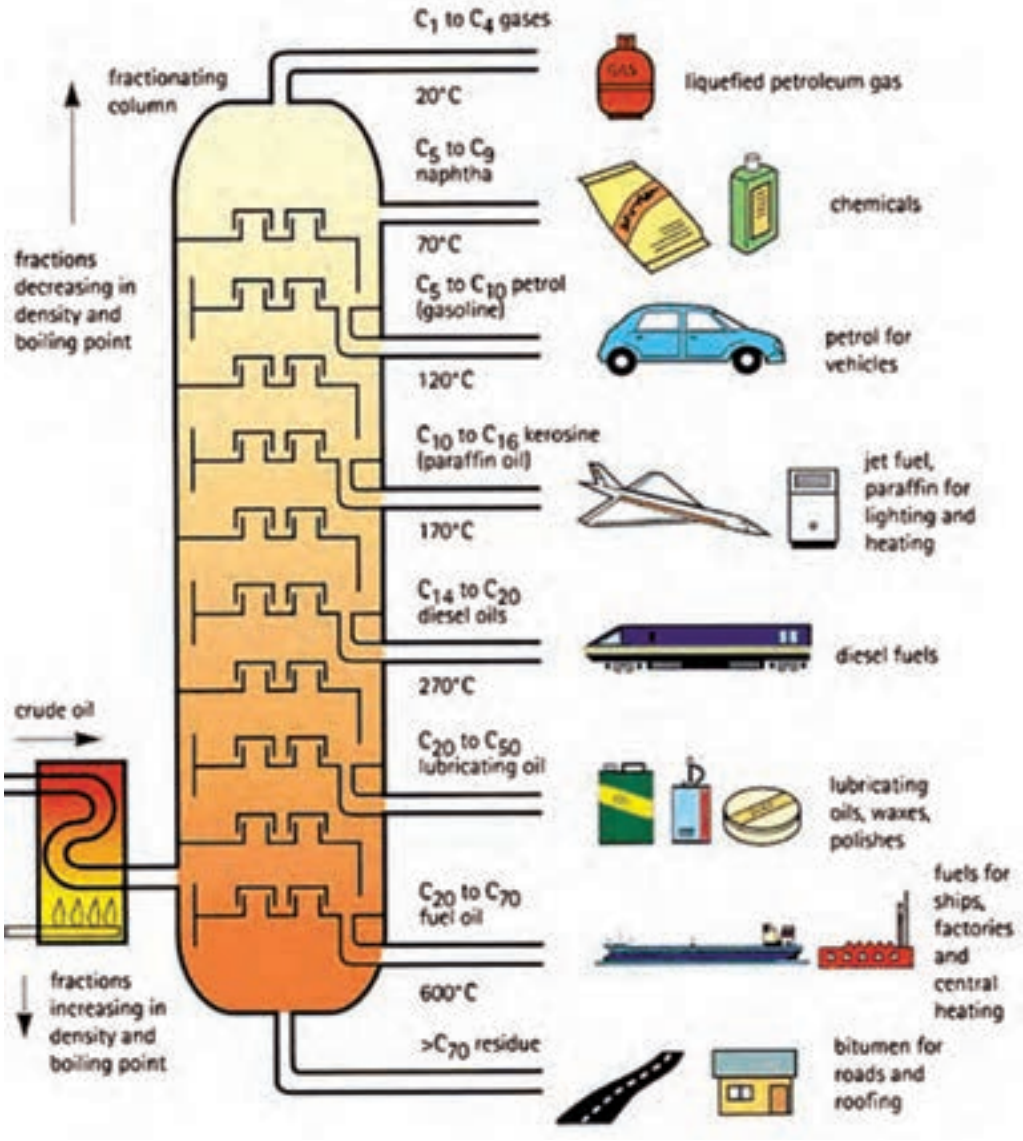


Fig. 19: Distillation of crude oil

The diagram above presents a conventional version of the distillation process. Crude oil is made up of a mixture of hydrocarbons, and the distillation process aims to separate it into broad categories of its component hydrocarbons, or "fractions". Crude oil is first heated and then put into a distillation column, also known as a still, where different products boil off and are recovered at different temperatures.

Lighter products, such as butane and other liquid petroleum gases (LPG), gasoline blending components, and naphtha, are recovered at the lowest temperatures. Mid-range products include jet fuel, kerosene, and distillates (such as home heating oil and diesel fuel). The heaviest products such as residual fuel oil are recovered at temperatures sometimes over 600 degrees Centigrade.

The simplest refineries stop at this point. Although not shown in the simplified diagram above, most refineries reprocess the heavier fractions into lighter products to maximize the output of the most desirable products.
In fact, distillation of crude oil is carried out in two units, first in an Atmospheric Distillation Unit, and then in a Vacuum Distillation Unit (Fig. 20) that further processes the residue from atmospheric distillation.

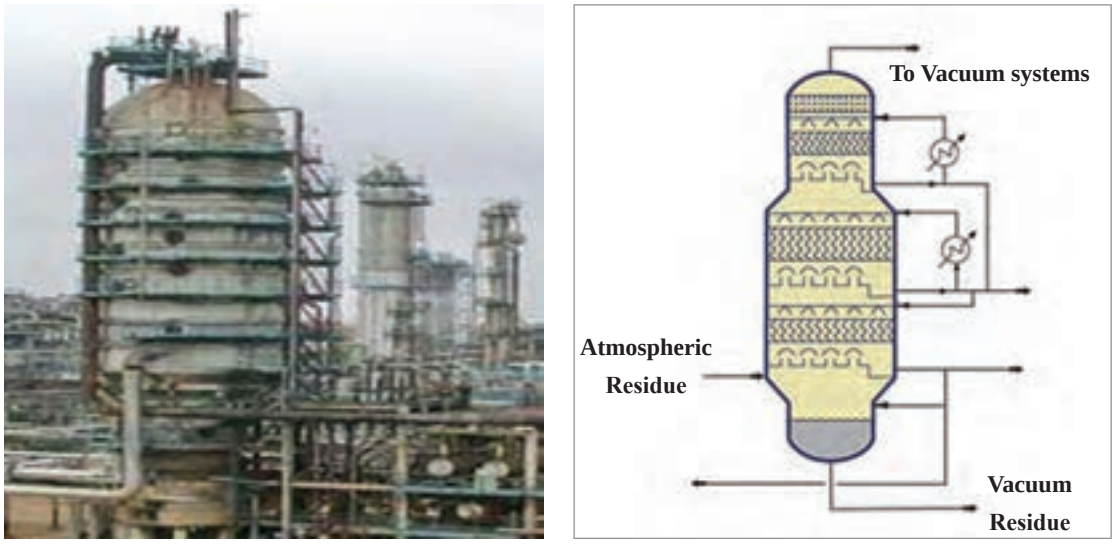


Fig. 20: Vacuum distillation tower

Around a third of the oil and gas extracted worldwide comes from offshore sources (Fig.21).

Fig. 21: Offshore sources of oil and gas

The Iranian Offshore Oil Company (IOOC) is a subsidiary of the National Iranian Oil Company. Its activities cover important areas of the Persian Gulf and its main operations are in Bushehr Province and on the Islands of Kharg, Sirri and Lavan.

Part Four

Chemical laboratory equipment

Match the pictures with phrases.

A.

1 Safety goggle

B.

2 Beaker

C.

3 Erlenmeyer flasks

D.

4 Burette

E.

5 Cylinders

F.

6 Test tube

G.

7 Pipette

H.

8 Thermometer

Chemical laboratory

Chemistry is a science, which necessarily needs some place for its experimental activities – for realization of chemicals and chemical reactions. This place is called laboratory (= a lab). A chemical lab is full of specific chemicals and laboratory equipment for measurement, and experimentation in scientific research. It is a place, where everyone has to respect operating, safety and hygienic rules.

A chemical lab requires:

- ✓ laboratory table
- ✓ console
- ✓ furniture
- ✓ weighing room
- ✓ chemicals, tools and lab equipment

These requirments are demonstrated in Fig.22 .

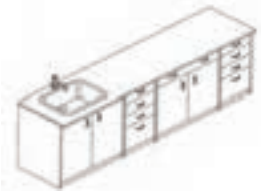
Name	Figure
Laboratory table	
Console	
Furniture (laboratory glasswares, storage bottels and very frequently used tools are stored in racks next to the wall)	
Weighing room	

Fig. 22: Lab requirements

Laboratory tools are made of laboratory glass and porcelain, metals, plastic, and rubber. Laboratory glasswares are resistant against chemical substances (Fig. 23).

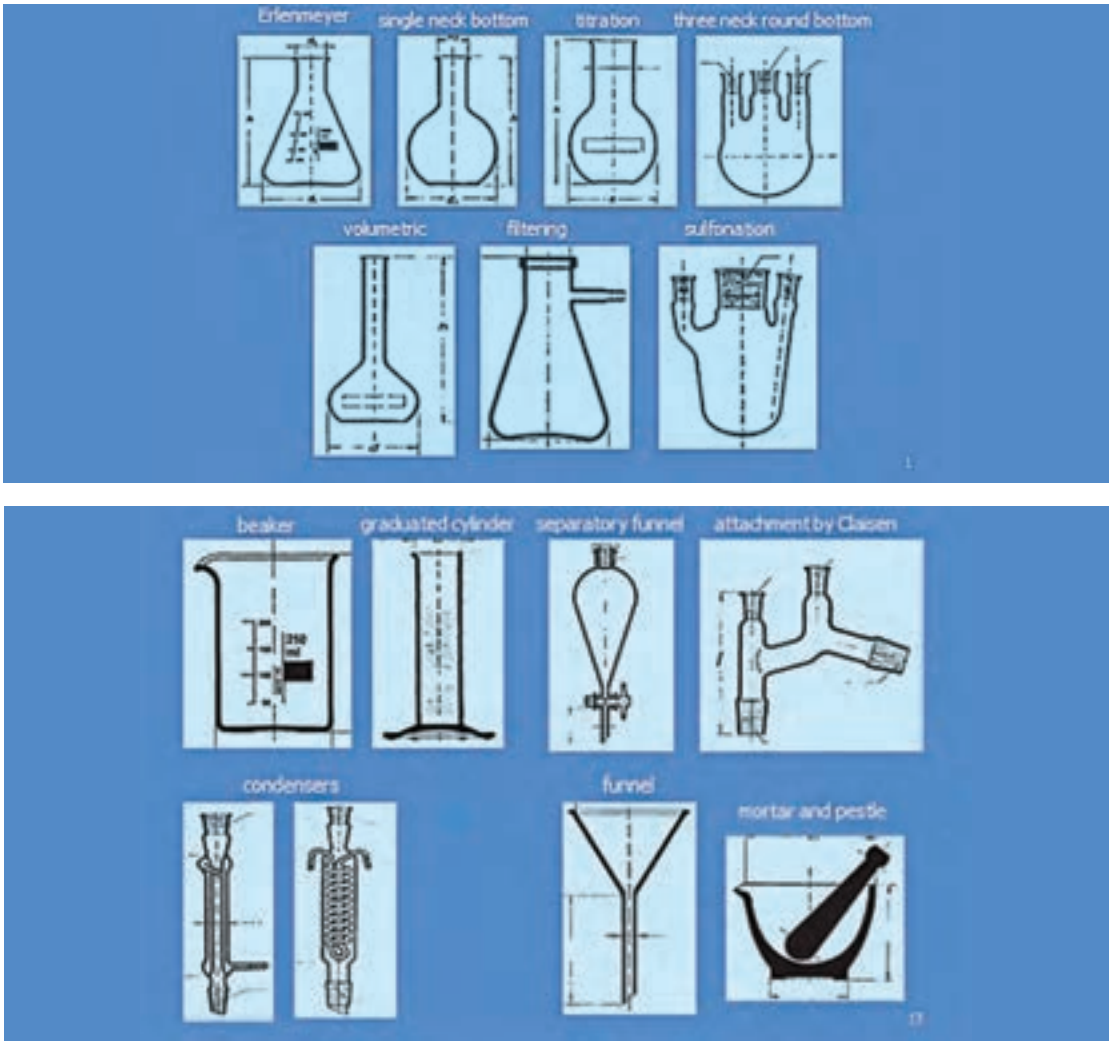


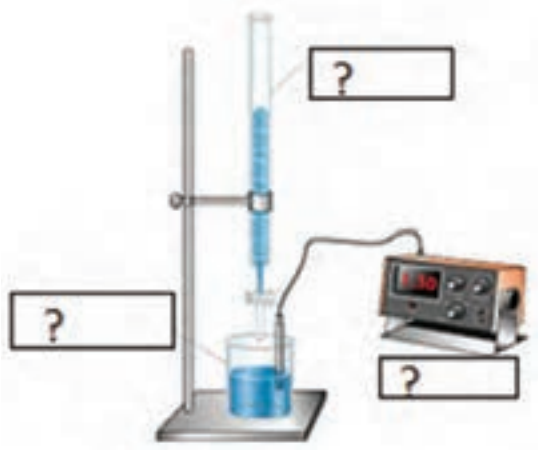
Fig. 23: Laboratory glassware- examples

Laboratory plastic and rubber tools are made of various material such as polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), teflon, polycarbonate (Fig. 24).

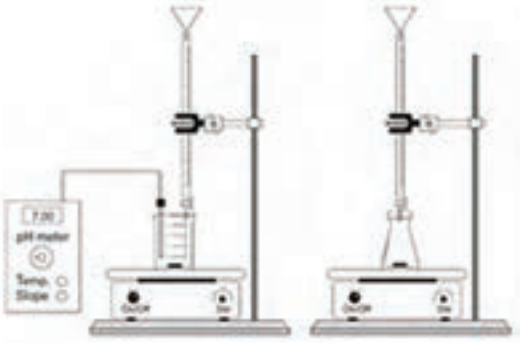
Fig. 24: Metallic, plastic and rubber tools - examples

- Fill in the blanks with the given phrases.

pH-meter, Beaker, Burette



Which titration setup is good for you? pH meter method or colour indicator method.



A:pH meter method **B: Colour in dicator method**

Calibration of thermometer

In this section, we explain how to calibrate a stem-type thermometer and how to use it to correctly measure the air temperature of the laboratory.

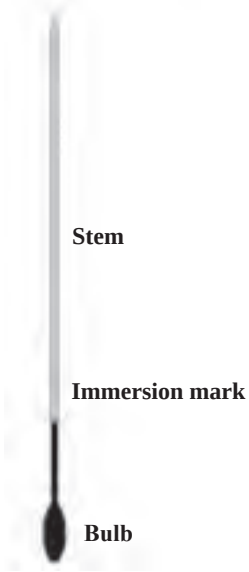


Fig. 25: A stem - type thermometer

One of the most common types of laboratory thermometers is the stem-type or liquid-expansion thermometer (Fig. 26). In this type of thermometer, an expansion liquid, usually mercury or alcohol, fills a glass bulb attached to a long stem with a uniformly expansion column. When heated, the liquid expands up the bore until the bulb reaches thermal equilibrium with the material whose temperature is being measured. The expansion of the liquid is such that the height it reaches in the stem is linear with temperature. These thermometers are typically marked with equal spacings along the stem. They are then calibrated at two different "fixed point" temperatures. Alcohol thermometers are of lower accuracy than mercury thermometers, but are more commonly used in the chemical laboratories because mercury is toxic and difficult to clean-up in the case of breakage.

know more

As with any measuring device, the accuracy of a thermometer depends on its calibration. Calibration is such that a measurement is performed whose result is well known. For a stem thermometer, because the markings along the stem cannot be adjusted, a correction curve is prepared such that thermometer readings can be converted to accurate temperatures. Known temperature baths for calibration can be generated using the ice point and the boiling point of water. These temperature baths are called "fixed points" because of their use as calibration markers for thermometers.

Fig. 26: Laboratory liquid - expansion thermometer

Procedure

Thermometer identification

1 If possible, note the manufacturer, serial number and manufacture date of the thermometer.

2 Note the temperature range of the thermometer.

3 Note whether or not the thermometer is a Total Immersion or Partial Immersion type.

know more

Partial Immersion thermometers will have an immersion mark and are designed so that only that part of the stem is exposed to the temperature being measured. Total Immersion thermometers are designed so that both the bulb and the entire liquid column must be exposed to the temperature being measured.

4 Check to make sure that the liquid in the stem of the thermometer has not separated. If it has, ask your laboratory instructor for a new thermometer.

Calibration at the ice point of water

1 Fill a container with crushed ice (You will have to share a container with another group, so become friendly with your neighbours).

2 Add enough pre - cooled distilled water to cover the ice, but not so much water such that the ice floats.

3 Thoroughly stir the ice-water mixture.

4 Hang your thermometer until it is appropriately inserted into the ice - water.

5 Allow the temperature shown by the thermometer to stabilize (about 10 minutes is required to establish thermal equilibrium). After 3 minutes at the stable temperature, record the temperature to the correct precision.

6 The ice point of water is remarkably stable at 0.00 ^{o}C (Fig.27).

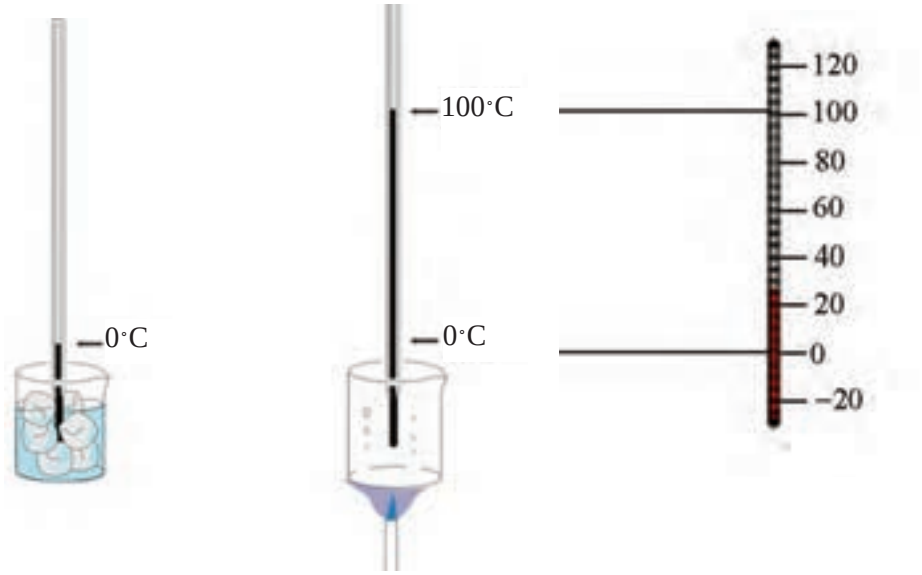


Fig. 27: Thermometer calibration

Calibration at the boiling point of water

1 Set up a hot plate with a 500 mL Florence flask resting on it. The flask should be supported by a clamp from a ring stand.

2 Fill the flask about half full with distilled water. Add a few boiling chips to promote smooth boiling.

3 Hang the thermometer from the ring stand as before.

Note: Using a Florence flask helps promote the reflux. It is a type of flask used as an item of laboratory glassware for holding liquids. A Florence flask has a round body, a single long neck, and often a flat bottom (Fig.28).

Fig.28: A Florence flask

4 Turn on the hot plate and allow the water to come to its boiling point.

5 Allow the temperature shown by the thermometer to stabilize (about 10 minutes after a rolling - boil has been achieved). After 3 minutes at the stable temperature, record the temperature to the correct precision.

6 The boiling point of water is extremely sensitive to the atmospheric pressure. You will be provided with the day's atmospheric pressure. Use this, along with the data in the appendix, to determine the correct boiling point of water. You may have to interpolate the data in the table.

Appendix

Atmospheric pressure(mmHg)	Boiling point water (°C)
760	99.996
750	99.629
740	99.257
730	98.880
720	98.499
710	98.112
700	97.720
690	97.323
680	96.921
670	96.512
660	96.098
650	95.676
640	95.249
630	94.814
620	94.371
610	93.921

Air temperature

The air temperature in the room will be measured by measuring the temperature of a large water bath that has been allowed to come to thermal equilibrium with the air.

1 Hang your stem thermometer from the ring stand into the water bath provided (everyone will share the same large bath).

2 Allow for thermal equilibrium to be established. Make the appropriate readings.

جدول ارزشیابی پودمان کسب مهارت‌های فنی

عنوان پودمان	تکالیف عملکردی (شایستگی‌ها)	استاندارد عملکرد (کیفیت)	نتایج	استاندارد (شاخص‌ها، داوری، نمره‌دهی)	نمره
کسب اطلاعات فنی	تصویر فرایندهای شیمیایی را به معادل‌های انگلیسی آن مرتبط کند.	به‌کارگیری مفاهیم اصلی صنایع شیمیایی و کتابچهٔ راهنمای ابزار و دستگاه‌ها (به زبان انگلیسی)	بالاتر از حد انتظار	■ با استفاده کاتولوگ انگلیسی، دماسنج‌ها را تنظیم کند.	۳
	مفهوم فارسی هر فرایند را با توجه به متن موجود در کتاب، توضیح دهد. تمرین‌های موجود در کتاب و مشابه آن را حل کند.		در حد انتظار	■ تصویر اصطلاحات و وسایل آزمایشگاهی را به معادل انگلیسی آنها نشان دهد.	۲
	با دیدن تصویر، توضیح فارسی مناسب را ارائه دهد.		پایین‌تر از حدانتظار	■ مفهوم ساده‌ای از تعریف فرایندها و کالیبراسیون دماسنج را به فارسی بگوید.	۱
	نمرهٔ مستمر از ۵				
	نمرهٔ شایستگی پودمان از ۳				
	نمرهٔ پودمان از ۲۰				

منابع

۱ برنامه درسی درس دانش فنی تخصصی، رشته صنایع شیمیایی ۱۳۹۳، دفتر تألیف کتاب های درسی فنی‌وحرفه‌ای وکاردانش

۲ مارتین سیلبربرگ، اصول شیمی عمومی، جلد اول و دوم، مجید میرمحمد صادقی ـ غلامعباس پارسافر ـ محمدرضا سعیدی، ۱۳۹۳، مرکزنشرنوپردازان

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۷ اسگوک، وست، هالر، ویدا توسلی، هوشنگ خلیلی، علی معصومی، مبانی شیمی تجزیه، جلد اول ۱۳۸۷، مرکز نشر دانشگاهی تهران، چاپ نهم

۸ احمد خواجه نصیر طوسی، شیمی و جامعه، ۱۳۷۲ انتشارات فاطمی.

۹ علی افضل صمدی، شیمی عمومی، ۱۳۷۷، نشر نی

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سازمان پژوهش و برنامه‌ریزی آموزشی جهت ایفای نقش خطیر خود در اجرای سند تحول بنیادین در آموزش و پرورش و برنامه درسی ملی جمهوری اسلامی ایران، مشارکت معلمان را به‌عنوان یک سیاست اجرایی مهم دنبال می‌کند. برای تحقق این امر در اقدامی نوآورانه سامانه تعاملی بر خط اعتبارسنجی کتاب‌های درسی راه‌اندازی شد تا با دریافت نظرات معلمان دربارهٔ کتاب‌های درسی نونگاشت، کتاب‌های درسی را در اولین سال چاپ، با کمترین اشکال به دانش‌آموزان و معلمان ارجمند تقدیم نماید. در انجام مطلوب این فرایند، همکاران گروه تحلیل محتوای آموزشی و پرورشی استان‌ها، گروه‌های آموزشی و دبیرخانهٔ راهبری دروس و مدیریت محترم پروژه آقای محسن باهو نقش سازنده‌ای را بر عهده داشتند. ضمن ارج نهادن به تلاش تمامی این همکاران، اسامی دبیران و هنرآموزانی که تلاش مضاعفی را در این زمینه داشته و با ارائهٔ نظرات خود سازمان را در بهبود محتوای این کتاب یاری کرده‌اند به شرح زیر اعلام می‌شود.

اسامی دبیران و هنرآموزان شرکت‌کننده در اعتبارسنجی کتاب دانش فنی تخصصی ـ کد ۲۱۲۵۲۰

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