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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20

Course Code: PET 308

Course Name: HEALTH, SAFETY AND ENVIRONMENT

Program & Sem: B. Tech. (PET) & VII DE

Date: 27.09.2019

Time: 9.30AM to 10.30AM

Max Marks: 40

Weightage: 20%

Instructions:

(i) All questions are compulsory

Part A [Memory Recall Questions]

Answer the Questions. Each sub question carries two marks. (1Qx10M=10M)

1. Define very briefly: (C.O.NO. 1) [Knowledge]
- i. Reliability model
 - ii. Failure
 - iii. Concentration
 - iv. Environment
 - v LD₅₀

Part B [Thought Provoking Questions]

Answer the Questions. Each question carries six marks. (3Qx6M=18M)

2. What are the four main causes of accidents? (C.O.NO.1) [Knowledge]

3. Write the impact of hydrocarbon exposure in plant growth. (C.O.NO.1) [Knowledge]

4. What is the microtox method? How is it different from bioassays?

(C.O.NO.1) [Knowledge]

Part C [Problem Solving Questions]

Answer the Question. The Question carries twelve marks. (1Qx12M=12M)

5. Mention how heavy metal presence is seen in production water and highlight its impacts. (C.O.NO.1) [Comprehension]

Annexure- II: Format of Answer Scheme



SCHOOL OF ENGINEERING

SOLUTION

Date: 27-09-2019

Date:

Semester: III

Time: 1 Hour

Time:

Course Code: PET 308

Max Marks: 40

Max Marks:

Course Name: Health, Safety and Environment

Weightage: 20%

Weightage:

Part A

(1Q x 10M =10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<p>i. A model for assessing, predicting or estimating reliability is called a reliability model.</p> <p>ii. Failure is the inability of an item to function within the stated guidelines.</p> <p>iii. Concentration is the measure of the substance's presence in the environment that the species lives in. These toxicity measurements also include a time interval of exposure. Normally calculated in ppm or mg/L</p> <p>iv. Environment is the surroundings or conditions in which a person, animal, or plant lives or operates.</p> <p>v. The minimum dose of a substance that is required to cause death to 50% of the test species.</p>	2x5=10	15 Mins

Part B

(3Q x 6M = 18 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
2.	<p style="text-align: center;">Solution</p> <p>i. Human error resulting in inappropriate results ii. Improper training of workers and employees iii. Manufacturing defects in equipment and accessories iv. Improper maintenance</p>	1x6=6	7 mins
3	<p><u>Impact on Plant Growth</u></p> <p>→ Hydrocarbons also impact plant growth when released on land. Levels of oil and grease above a few percent in soil (by weight) have shown degradation of plant growth. Levels below a few percent have shown an actual enhancement of some crop growth. A level of 4% oil and grease is recommended as a practical threshold above the hydrocarbons become detrimental to plant life.</p> <p>→ Aromatic hydrocarbons emitted during blowouts can also impact plant growth. Reductions have been observed in term growth rate following blowouts at distances as great as 2 km from the wellhead.</p>	1x6=6	7 mins

✓ Microtox method - (Maskin and Strahl, 1983)
 Another method a viable luminescent bacterium
 photobacterium phosphoreum is used. These
 bacteria emit light as part of their metabolic
 process and results in a reduction in their
 light output. An advantage of the microtox
 method is that the test is completed in 15 minutes.

Microtox uses the same acute exposure as is done in bioassays but the difference lies in the fact that through microtox method, results can be obtained as soon as 15 minutes whereas the bioassays always require 2-3 weeks to show results.

4

1x6=6

7 mins

Part C

(1Q x 12M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
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→ produced water is responsible for a variety of problems in field operations. The most common problems are emulsion, corrosion, scale, microbial growth, suspended particles, foams and dirt.

equipment. A variety of chemicals are often added to the water to meet these problems.

- Emulsion breakers: surfactant, alcohol, glycol, etc.
- Corrosion Inhibitors: corrosion inhibitors are to dissolved oxygen, carbon dioxide, hydrogen sulfide and gas.

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→ complex mixtures with low surface tension (NAPCO), alkyl phosphate (AMP) and amine nitrate (AN) can also effective in doing so.

Corrosion

→ hydrogen sulfide can be removed from drilling fluids with a zinc-organic zinc chloride. The chemical reacts with hydrogen sulfide, producing insoluble zinc sulfide (ZnS) and a soluble zinc chloride.

With hydrogen sulfide, reducing insoluble zinc sulfide (ZnS)

→ Scale inhibitors: Scale can be prevented by organic phosphates esters of amino alcohol, phosphonates or acrylic acid type polymers (cation polyelectrolyte polymers). These chemicals adsorb onto the crystals and prevent them from scale growth.

→ Biofouling: It includes substances that inhibit ammonium salts and other scale salts. Chlorine compounds are used as biocides in municipal drinking water systems.

→ Corrosion inhibitors: Corrosion inhibitors are used in oil and petroleum processing.

→ Flame retardants: Silicones, phosphates, and aluminum hydroxide.

→ Surfactants: Surfactants are used in detergents, emulsions, and foams. They are used in paint, agriculture, and food. Surfactants are also used in detergents, emulsions, and foams. Surfactants are also used in detergents, emulsions, and foams.

→ Air could be sensitive to eye & nose
→ Chronic exposure to dust, fumes and irritants
→ Plasma (protein forming) and activity in the
→ chronic exposure to hydrocarbons, acid anhydrides
→ Irritation to mucous membranes, especially
→ Health and aggravation of respiratory conditions
Such as asthma.
→ For instance → prolonged or repeated exposure
may cause various systemic effects,
including damage to the nervous and circulatory
systems, some pesticides are carcinogenic
→ Alcohol can be fatal if ingested in quantities
of about 1 gram/lb. Liver does not
→ to the mouth, throat, and stomach and can cause
disorders of a large water diffusive base.
→ Repeated exposure can cause kidney, brain or
liver damage. Also secondary and third order
can also be affected.

At very low concentrations, some cells are sensitive to heavy metal activity. At low concentrations, heavy metals can be toxic, but as the concentration increases, they are generally absorbed and excreted without any effect. The environmental impact of heavy metals is generally assessed by their toxicity to aquatic organisms. Heavy metals are found in various forms in the environment. Specific mechanisms of heavy metal toxicity are not yet fully understood, but they are known to be toxic to many organisms. Heavy metals can also be toxic to humans, particularly in the form of lead, mercury, and cadmium.



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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem. 2019-20

Course Code: PET 308

Course Name: HEALTH, SAFETY AND ENVIRONMENT

Program & Sem: B.Tech (PET) & VII DE

Date: 16.11.2019

Time: 9:30 AM to 10:30 AM

Max Marks: 40

Weightage: 20%

Instructions:

- I. Answer all questions
-

Part A [Memory Recall Questions]

Answer all the Questions. Each sub Question carries two marks. (5Qx2M=10M)

1. (C.O.NO.2) [Knowledge]
- I. What is the method of removal of top layer of the earth's surface for remediation of contaminated sites called?
 - II. What are the most commonly used liquid phase tracers?
 - III. What is the difference between radiation exposure and dose?
 - IV. What is the maximum sound limit for chronic exposure to prevent hearing loss?
 - V. Name the personal protective equipments used for body protection.

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries six marks. (3Qx6M=18M)

2. Explain the methods used for removing volatile hydrocarbons from contaminated site? (C.O.NO.3) [Comprehension]

3. In a gas gathering station, an operational pipe has burst due to negligence and caused gas leakage and needs to be repaired immediately. What is the minimum PPE you will suggest for the said operation? What changes will you add if the gas has caught fire? (C.O.NO.3) [Application]
4. An oil spill has occurred in a well site. The affected area contains both shale and sandstone formation in separate locations. The HSE officer has decided to use bio remediation as one of the methods to decontaminate the soil. Where should he implement it? Justify your answer. (C.O.NO.3) [Application]

Part C [Problem Solving Questions]

Answer the Question. The Question carry twelve marks. (1Qx12M=12M)

5. Explain the process of air sparging with neat diagrams. (C.O.NO.3) [Comprehension]



SCHOOL OF ENGINEERING

Semester: VII

Course Code: PET 308

Course Name: Health, Safety and Environment

Date: 16-11-2019

Time: 1 Hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	2	2	1x 10	=	10							
2	3	3				1x 6	=	6				
3	2	2				1x 6	=	6				
4	3	3				1x 6	=	6				
5	3	3							1x 12	=	12	
	Total Marks				10			18			12	40

K = Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II: Format of Answer Scheme



SCHOOL OF ENGINEERING

SOLUTION

Date: 16-11-2019

Semester: VII

Time: 1 Hour

Course Code: PET 308

Max Marks: 40

Course Name: Health, Safety and Environment

Weightage: 20%

Part A

(1 x 10 = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<ul style="list-style-type: none">i. Excavationii. Antimony 124, Iridium 192, Scandium 46, Iodine 131iii. Exposure is defined as the electrical charge released from ionization per unit mass of air. Dose is defined as the energy from radiation absorbed per unit mass of material.iv. 85 Decibelsv. coveralls/overalls, body harness	2x5=10	15 Mins

Part B

(3Qx6M = 18 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
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2

4. Vaporization:-

Volatile hydrocarbons can be removed from soil by vaporization. Natural vaporization can be enhanced by tilling the soil. For hydrocarbons located deeper than normal tilling depth, vaporization can be enhanced by injecting air or by pulling a vacuum on the soil. This process lowers the partial pressure of the hydrocarbon in the vapor phase in the soil, inducing further vaporization.

An emerging variation on volatilization is to heat the soil. Because the vapor pressure of volatile hydrocarbons increases almost exponentially with temperature, volatilization can be significantly enhanced through heating. Injecting steam has proven to be effective in vaporization of volatile hydrocarbons.

Volatilization may not be a good remediation process if the hydrocarbon contaminant contains nonvolatile components. Once the volatile components have been removed, the remaining components will be heavier, more viscous, and less likely to be recovered by any subsequent processes. However, because the most toxic hydrocarbon components tend to be the

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most volatile, any remaining hydrocarbon in the soil would tend to have a relatively low toxicity.

1x6=6

7 mins

3

Coveralls, Leather Gloves, Safety Shoes, Hard hats, Gas Mask (with or without oxygen cylinders), Eye goggles.
In event of fire, face shields are to be used instead of eye goggles. Oxygen cylinders have to be avoided.

1x6=6

7 mins

4

Bio remediation should be used in the Sandstone formation. Justification:

1x6=6

7 mins

Fertile soil naturally contains upto one million hydrocarbon degrading bacteria per gram of dry soil. By adding nutrients and ensuring the availability of oxygen, in situ bioremediation can effectively degrade many hydrocarbon contaminants. This process can take several months to several years to complete.

Sandy soils with high permeability allow higher levels of biological activity than do soils containing significant quantities of silt or clay. The more permeable soils permit a more rapid transport of air (oxygen), water, and nutrients to the sites of biological activity.

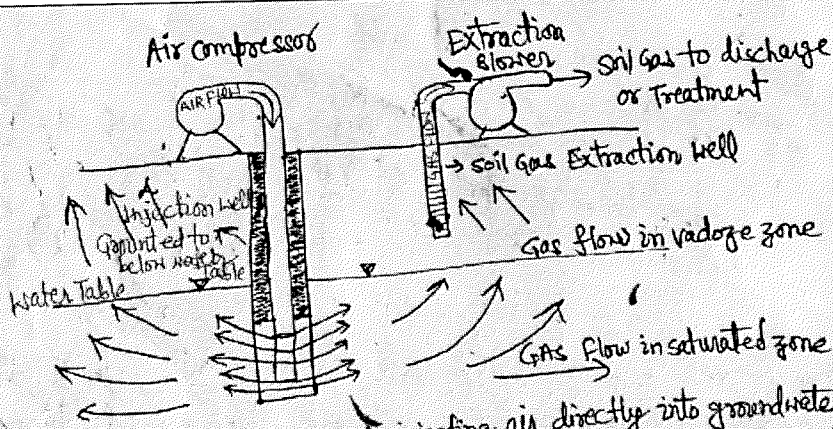
To supply an adequate amount of oxygen, air is commonly injected into the formation in a process called air sparging.

The injection of hydrogen peroxide has also been suggested as a means of increasing the oxygen level. Hydrogen peroxide, however, is toxic and its use may not be permitted.

Part C

(1Q x 12M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
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Air sparging is the process of injecting air directly into groundwater. Air sparging remediates groundwater by volatilizing contaminants and enhancing biodegradation. It is akin to blowing bubbles from a straw into a bowl of water. As bubbles rise, the contaminants are removed from the groundwater by physical contact with water air and are carried up into the unsaturated zone. As the contaminants move into the soil, a soil vapor extraction system is usually used to remove vapors. The addition of oxygen to contaminated groundwater and soils also enhances biodegradation of contaminants in and above the water table, as it acts as a nutrient for bacteria.



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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Date: 20 December 2019

Course Code: PET 308

Time: 9:30 AM to 12:30 PM

Course Name: HEALTH, SAFETY AND ENVIRONMENT

Max Marks: 80

Program & Sem: B.Tech (PET) - VII (DE-III)

Weightage: 40%

Instructions:

- (i) Read the all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.
- (iii) Scientific and Non-programmable calculators are not permitted.

Part A [Memory Recall Questions]

Answer all the Questions.

(2Q=20M)

1. Fill in the blanks. Each sub question carries 1 mark.

(Q i-x) (10Qx1M=10M)

- i. _____ is a model for assessing, predicting and estimating reliability. (C.O.No.1) [Knowledge]
- ii. Under _____ act potentially responsible parties are identified as anyone who has contributed to the waste generation at any point of time. (C.O.No.3) [Knowledge]
- iii. _____ are accessories or equipment that ensure failure without endangering human life. (C.O.No.1) [Knowledge]
- iv. _____ is the degree to which a substance can damage an organism. (C.O.No.1) [Knowledge]
- v. The concentration below which no observable effects are observed is _____. (C.O.No.1) [Knowledge]
- vi. Maximum tolerable sound level in the form of chronic exposure is _____. (C.O.No.2) [Knowledge]
- vii. Gloves used for exposure to heat are typically made of _____. (C.O.No.3) [Knowledge]
- viii. Sources of radioactivity in the industry are _____. (C.O.No.3) [Knowledge]
- ix. Keeping optimum concentration of bacteria and nutrients is important for removal method called _____. (C.O.No.2) [Knowledge]
- x. Natural remediation of oil spill by action of sunlight is called _____. (C.O.No.4) [Knowledge]

2. Answer the questions very briefly. Each sub question carries 2 marks.

(5Qx2M=10M)

- i. What are the Class I and Class II wells under the Safe Drinking Water Act?

(C.O.No.3) [Knowledge]

- ii. What is the difference between dose and concentration? (C.O.No.1) [Knowledge]
- iii. In subsurface disposal of liquids, how is the water prevented from plugging the formation? (C.O.No.4) [Knowledge]
- iv. Under what conditions the formation of chocolate mousse is stable? (C.O.No.4) [Knowledge]
- v. How can particulates from such as soot be removed from flue gas? (C.O.No.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

3. State the provisions under the Subtitle C of the Resource Conservation and recovery act (1976). (C.O.No.2) [Comprehension]
4. Explain the methods of bioassay and microtox method of Toxicity measurement. (C.O.No.4) [Comprehension]
5. Briefly explain the mechanical methods involved in Enhanced removal of oil. (C.O.No.4) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries 15 marks. (2Qx15M=30M)

6. In a deep marine location, far off from the coast, a pipeline set by Exxon Valdez company has split open due to neglected pressure control. The company has decided to use only natural processes to remediate this offshore release of oil. Discuss all the methods involved. (C.O.No.4) [Application]
7. A drilling service provider has been instructed by the exploration and production company to use subsurface injection wells for waste disposal of both liquids in the form of drilling mud as well as solids in the form of drill cuttings. Discuss the steps involved in both the types of subsurface disposal. (C.O.No.4) [Application]



SCHOOL OF ENGINEERING

Semester: VII

Course Code: PET 308

Course Name: Health, Safety and Environment

Date: 16-11-2019

Time: 1 Hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	1,2,3,4	1,2,3,4	10			
2	1,2,3,4	1,2,3,4	10			
2	2	2		10		
3	4	4		10		
4	4	4		10		
5	4	4			15	
6	4	4			15	
	Total Marks		20	30	30	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:


18-12-19

Reviewer Comment:

Annexure- II: Format of Answer Scheme



SCHOOL OF ENGINEERING

SOLUTION

Date: 20-12-2019

Semester: VII

Time: 9.30am-12.30pm

Course Code: PET 308

Max Marks: 80

Course Name: Health, Safety and Environment

Weightage: 40%

Part A

(1 x 10 = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<ul style="list-style-type: none">i. Reliabilityii. CERCLAiii. Fail-safeiv. Toxicityv. NOECvi. 85vii. Leatherviii. Tracersix. Bioremediationx. Photo-oxidation	2x10=20	15 Mins

Part B

(3Qx6M = 18 Marks)

Q No	Solution	Scheme of Marking	Max Tim requr ed for each Que tion
2	<p style="text-align: center;"><i>Environmental Regulation</i></p> <p>Under RCRA, a waste is any material that is discarded or is intended to be discarded. It is the intent of future use that determines whether it is considered a waste regulated under RCRA. This act also defines solid wastes as any wastes that are either solid, semisolid, liquid, or gases contained in storage vessels. It further defines a hazardous waste as any solid waste that can cause or significantly contribute to an increase in mortality or in serious irreversible or incapacitating reversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.</p> <p>Under RCRA, it is a crime to</p> <ol style="list-style-type: none"> 1. knowingly cause hazardous materials to be transported to an unpermitted facility or to knowingly transport hazardous materials without a manifest, 2. knowingly treat, store, or dispose of hazardous wastes without a permit or in violation of a permit, 3. knowingly falsify records, labels, manifests, or other documents used for complying with the Act, 4. or knowingly fail to comply with, or interfere with, record-keeping requirements under the Act. <p>Violations of RCRA include fines of up to \$50,000 per day and two years of imprisonment. If human life is threatened by "knowing endangerment," violations are a crime with fines of up to \$1,000,000 and 15 years of imprisonment.</p> <p>The EPA has established five criteria to determine whether a waste is hazardous or not under this act. There are four generic criteria that are based on the waste properties. These criteria are discussed below. The fifth criterion is for the waste to be listed by name. Listed wastes are those that are known to be hazardous, such as carcinogens and poisons. The designation of whether a material is considered hazardous or not is normally provided on Material Safety Data Sheets.</p> <p>A waste is considered to be characteristically hazardous if it fits any of the following generic criteria:</p>	1x10=10	15mins
3		1x10=10	15 min

Bioassay :- (Biological assay)

It is a type of scientific experiment. Bioassays are typically conducted to measure the effects of a living organism and are essential in the development of new drugs and in monitoring environmental pollutants.

Limitations of Bioassay :-

- ① Test yield only acute lethal concentrations
- ② They are conducted in a laboratory and do not necessarily represent the field conditions that would actually be encountered if exposure occurred. Field conditions normally involve different concentrations and different mixtures of potentially toxic materials
- ③ They do not provide adequate information about chronic effects, including the mutagenic or carcinogenic activity of a substance.
Many substances called mutagens can alter the structure of DNA molecules in individual cells. If mutation results in cancer, the substance is called carcinogenic.
- ④ Another significant limitation to bioassays is the time it takes for results to be obtained

Bioassay typically take two to three weeks to be completed.

microtox method :- (Hoskin and Strohl, 1993).

In this method a marine luminescent bacterium, photobacterium phosphoreum, is used. These bacteria emit light as part of their metabolic processes and results in a reduction in their light output. An advantage of the microtox method is that the test is conducted in 15 minutes.

① Mechanical methods :-

- Mechanical methods for removing oil from open water normally consist of putting physical barriers between the oil and the shoreline and using skimmers to remove the oil.
- Physical barriers are normally placed to either concentrate the oil in a small area for easier removal or to keep oil away from very sensitive shoreline habitats.
- The most common physical barriers used are floating booms. Booms are vertical sheets that extend above the water level by 4 to 12 inches and below the water level by 12 to 24 inches.

- Booms come in various sizes for used with different wave heights and wind speeds.
- For sensitive wetlands with very shallow water earthen dikes could be constructed as a temporary barrier.
- A variety of skimmers are available to mechanically collect oil. Skimmers often use oil-wet sorbent materials like polyurethane or polypropylene to collect the oil. These sorbent materials can absorb many times their weight in oil without collecting much water.
- Booms and skimmers are ~~available to mechanically collect oil~~ most effective when the waves, wind and current are low and when used ~~very soon~~ soon after the oil has been released. Even under ideal conditions, this equipment is most effective on relatively small spills.

Part C

(1Q x 12M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time required
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5

- When oil is spilled on water, it spreads out over the water surface and moves with the wind and water currents. The thickness of an oil slick is typically between 0.09 and 0.2 mm, with an average thickness of about 0.1 mm.
- oil slicks are not continuous, however, they tend to break up into long patches, with stretches of relatively open water between each patch.
- oil released on open water is transported by local water currents. Because these currents flow parallel to the shoreline, they tend to keep oil slicks away from sensitive shoreline habitats. The motion of oil slicks, however, is also affected by winds, which can blow the slicks to shore. The average speed of a wind-driven oil slick is about 3-4% of the wind speed.
- Evaporation removes between one and two thirds of the oil from the slick during the first few hours. The evaporation rate, however, depends on the oil composition, temperature and wind.

- Dissolution of hydrocarbon components can also remove some oil from a slick. The solubility of crude oil varies somewhat with composition, but the average solubility is about 30 mg/l. The most soluble components are the low molecular weight aromatics such as benzene, toluene and xylene. These compounds however, are very volatile and are removed primarily by evaporation. Many of the compounds that do dissolve are eventually evaporated back into the air.
- oil slicks can be broken by surface turbulence from wind and wave action into a floating water-in-oil emulsion called chocolate mousse. Mousse, once formed, a long-lasting and very difficult to clean up. The formation of this stable emulsion is ~~for~~ more likely for heavy oil at lower temperatures.
- oil that is broken into small droplets can be dispersed into the water column from turbulence as an oil-in-water emulsion. Large droplets will usually float back to the surface and be recombined with the slick. Small droplets, however can be taken up by marine organisms and incorporated into fecal pellets or can be sorbed onto suspended particles, particularly clays from river runoff. Because the settling rate of suspended particles can be low, water currents can disperse the

	<p>Sorbed hydrocarbons long distance away from the spill site, keeping their concentration at any particular location relatively low.</p> <p>→ oil that has been either evaporated or dissolved can be decomposed by photo-oxidation. When exposed to sunlight, high-energy photons from the sun break the hydrocarbon molecules, which then react with oxygen, destroying the original molecule. The toxicity of partially photo-oxidized hydrocarbons, however, can be higher than that of the original hydrocarbons. Because the surface-to-volume ratio for an oil slick is low, photo-oxidation does not remove a significant amount of oil from the slick itself.</p> <p>→ some of the dissolved oil compounds can be hydrolyzed. In this process, the normal thermal thermal motion of the molecules in water occasionally breaks a chemical bond on the hydrocarbon. The broken bond then reacts with hydrogen or hydroxyl ions in the water. The reaction can be catalyzed by copper or calcium and can be accelerated if the hydrocarbon is adsorbed onto suspended sediments.</p> <p>→ oil remaining in the marine environment will eventually be removed by biological degradation from bacteria, yeasts, or fungi. The degradation rate, however, depends on the availability of oxygen and nutrients, such as nitrogen and phosphorus. Bacterial degradation is a major mechanism for the eventual removal of hydrocarbons from a marine environment, but is slow compared to other mechanisms.</p>		
6		1Qx15=15	20 mins

1. Disposal of Wastewater

- The most common disposal method for waste liquids, such as produced water, is to inject them into a subsurface formation.
- Disposal wells must be completed in a formation that is permeable and porous, and has low pressure and a large storage volume. The disposal formation must also be geologically isolated from any fresh-water aquifers.
- To prevent the water from plugging the formation, the water must normally be treated to remove free and emulsified oils, suspended solids, and some dissolved solids, such as iron and scale, prior to disposal.
- One disposal method that is growing in popularity is annular injection in existing wells. In this process, the wastewater is injected down the annulus of an existing production & injection well.
- One disposal method that is growing in popularity is annular injection in existing wells. In this process, the wastewater is injected down the annulus of an existing production & injection well and into a formation above the existing completion.

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- A major concern with underground disposal of water is the potential for the well to provide a vertical communication path from the disposal formation to any overlying freshwater aquifers. Possible communication paths include flow up the inside of the casing through leaks in the casing and flow up the outside of the casing through a bad cement bond.

2. Disposal of solids:

→ Subsurface burial is a common method for disposal of solid wastes. Drill cuttings and used mud are typically left in reserve pits after a well is drilled. After the free liquids are removed, the remaining materials are covered by soil and the site is revegetated.

→ One major concern with the burial of solids is the potential for heavy metals, hydrocarbons, and salts to migrate away from the site. Salt buried in reserve pits can migrate both downward and upward.

The two metals most commonly found in drilling fluids at concentrations above those found in most soils are barium and chromium. These metals are in a non-soluble form and have a very limited potential for migration or bio-uptake.

→ For bits containing high salt or hydrocarbon levels, regulations may require the use of an impermeable bit liner to prevent leaching.

→ A developing new technology for the disposal of drill cuttings is to grind them into small particles and inject them into a well as a slurry.

