



WINTER-19 EXAMINATION
Model Answer

Subject Title: Industrial Safety & Maintenance

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Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.



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Q No	Sub q.no	Answer	marks
1		Answer any 5	10
1	a	Safety planning: It is the first step of safety management where in a safety manager decides in advance safety objectives, policy, procedure, strategies, rules, programmes, method, budget, schedules and necessary means for achieving these objectives, considering facts and anticipating foreseeable events that may affect safety of plant, people and environment.	2
1	b	Objectives of safety audit: 1. To provide the safe working place to every working staff and management. 2. To identify different level of hazards in each working place or department of an organization. 3. Confirm that safety, health, fire and environmental program activities and controls are in place and functioning. 4. Verify that the facility is in compliance with internal benchmarks and government regulations. 5. Assess past and current practices to identify and correct safety impediments which may result in personal injuries, property damage or business interruption.	1 mark each for any 2
1	c	Importance of Plant Maintenance : In modern industry, equipment and machinery are a very important part of the total productive effort. With the development of special purpose and sophisticated machines, equipment and machinery cause a lot more money and therefore their idle or downtime becomes much more expensive. For this	2



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		<p>reason, it is vitally important that the plant machinery should be properly maintained.</p> <p>The term plant maintenance includes all work relating to the economical preservation of facilities and equipment of plant, at a level satisfactory to perform their designed function. Maintenance division of the factory ensures the availability of the machines, buildings and services required by other section of the factory for the performance of their function.</p>	
1	d	<p>Toxic Hazards.</p> <p>A Substance is said to be toxic to the human body , if it has the ability to produce any ill effects on the human body when it reaches a susceptible site. The effect of toxic substances on the body depend on a number of factors like quantity, the form, solubility, sensitivity, individual susceptibility, personal habit etc.</p> <p>Causes of toxic hazards are:</p> <ol style="list-style-type: none">1. Inhalation2. Contact with skin3. Contact with eyes4. Ingestion <p>Remedies of toxic hazards:</p> <p>In the body toxic chemicals are destroyed and disposed off by the body through excretion. However when the quantities are too large for the body to cope with or in case of chronic exposure continuously for the long time the body face to disposed off the toxic chemicals. The continued presents of toxic chemicals cause pathological changes in the body , structural or</p>	<p>1</p> <p>1</p>



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		functional damage, inflammations , disorders of growth or repair and diseases. Give awareness about toxic hazards in the industry Educate workers about the first aid to be given in case of any emergency.	
1	e	Tools for safety planning are: 1. Identify problems 2. Establish objectives or goals 3. Develop planning premises(eg. Land, labour, capital, market, money, time, production, public relation, employee relation, reputation, morals, policy, programmes, rules, emergencies, new inventions, etc.) 4. Determine alternative course of action 5. Evaluate the alternatives 6. Select a course of action Formulate derivative (final) plan and sub pland as per need.	2
1	f	Types of investigations: 1. Failure mode & effect analysis 2. HAZOP 3. Fault tree 4. Event tree 5. Cost effectiveness 6. Statistical method 7. Critical incident method 8. System safety	½ mark each for any 4
1	g	Control of hazard in fertilizer plant: (any 2)	1 mark



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		<ul style="list-style-type: none">• Always wear chemical goggles and adequate skin cover.• Inspect equipment before each day's work and correct any abnormal conditions.• Water is the first aid treatment of choice when ammonia gets into the eyes or on the skin. In case of mishap, flush affected areas for 15 minutes and get medical help as soon as possible.• Make sure all valves, lines, and connections are secure in order to reduce the chance of either leaks or being doused during transfer.	each for any 2
2		Answer any 3	12
2	a	Importance & Objectives of plant safety: <ol style="list-style-type: none">1. To increase the rate of production.2. To reduce the cost of production.3. To reduce the damage to equipment and machinery.4. To protect the life & limbs of the workers.	1 mark each
2	b	Procedure of safety Auditing : <p>Safety audit is carried out by a team whose members are not involved in the plant or activity being audited. The expertise of the team should be compatible with the type of audit. It is beneficial to include the managers of other plants or units in an audit team as well as one previous auditor of the same unit. Audits are carried out in a formal way using a carefully drawn up checklist of items and descriptive standards for each item. A line manager or supervisor of the plant under audit should be asked to accompany the auditor inspecting it. He</p>	4



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		<p>should be informed of all corrections and improvements required by the auditors so that he can start taking the necessary steps before the audit report is submitted to management. The main object of inspection should be to determine whether the layout design and condition of equipment and protective features are upto standard and to ensure that the protective features will work in an emergency. The auditing should give a verbal report to the management on completion of audit followed by a clear and concise written report within two weeks.</p>	
2	c	<p>Main features of Factories Act 1948:</p> <p>The main objectives of Indian Factories Act 1948 are to regulate the working conditions in factories, to regulate health, safety, welfare and annual leave and enact special provision in respect of young persons, women and children who work in factories.</p> <ol style="list-style-type: none">1. Working hours: According to the provision of working hours of adults, no adult worker shall be required or allowed to work in a factory for more than 48 hours in a week. There should be a weekly holiday.2. Health: For protecting the health of workers, the Act lays down that every factory shall be kept clean and all necessary precautions shall be taken in this regard.3. Safety: In order to provide safety to the workers, the Act provides that the machinery should be fenced, no young person shall work at any dangerous machine.4. Welfare: For the welfare of the workers, the Act provides that in every factory, adequate and suitable facilities should be provided and	4



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		<p>maintained for the use of workers.</p> <p>5. The provisions of the factory act,1948 or any rules made under the Act or any order given in writing under the Act is violated, it is treated as an offence, penalties can be imposed.</p>	
2	d	<p>Basic steps necessary for controlling plant hazards:</p> <ol style="list-style-type: none">1. Elimination: Physically remove the hazard is the most effective hazard control. For example, if employees must work high above the ground, the hazard can be eliminated by moving the piece they are working on to ground level to eliminate the need to work at heights.2. Substitution: It involves replacing something that produces a hazard with something that does not produce a hazard.3. Engineering controls: It includes designs or modifications to plant, equipment, ventilation systems and processes that reduce the source of exposure.4. Administrative controls: They are changes to the way people work. Example includes procedure changes, employee training and installation of signs and warning labels.5. Personal Protective Equipment: This includes gloves, apron, respirators, helmets, safety shoes, goggles atc.	4
3		Answer any 3	12
3	a	<p>On line maintenance of Rotameter:</p> <p>In a chemical plant, it is a normal practice to do on line maintenance work. This avoids total shutdown of the equipment or plant. This is possible, if proper pipe fittings are installed at the time of erection. e.g. Suppose there is a Rota meter</p>	2 marks for descript ion, 2



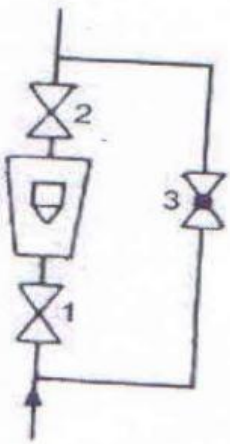
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		<p>in pipe line. If we desire to replace a broken glass pipe of Rota meter, we can close valve 1 & 2 and open 3 and divert the fluid through by pass line. After replacement of the glass pipe in the Rota meter close valve 3 and open 1 and 2. Thus it is possible to attend maintenance jobs in the line without stopping the production.</p> 	marks for diagram
3	b	<p>Instrumentation provided for safe plant operation:</p> <p>After understanding various types of chemical hazards in foregoing parts, we should process to know instruments, equipment and other control measure. To maintain, control, measure, alarm and record process parameters, various industrial instruments and safety devices are used. Their proper selection, application and maintenance are most important. Some instruments are mentioned below.</p> <p>Basic Instruments: Anemometer; barometer, bolometer, pyrometer, pressure gauges, Atomometer, calorimeter, dilatometer, hydrometer,</p>	4



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		<p>thermocouple etc</p> <p>Specific instruments: Gas/Fume/Vapour detector & alarm leakage warning instrument. This is an electrical instrument Having a sensor and audible alarm to give warning, when preset, air gas mixture exceeds the set TLV or LEL limit. It detects flue gases, LPG, smoke, petrol vapours, Paraffin fumes, hydrocarbons, ammonia, Freon, hexane, acetone, benzene, chloroform fumes, CO₂, H₂S, methane, solvent vapours and many poisonous /explosive gases, various type of glass detector hand models are also available.</p>	
3	c	<p>Accident and Incident analysis is carried out in order to determine the cause or causes of an accident (that can result in single or multiple outcomes) so as to prevent further accidents of a similar kind. It is part of <i>accident investigation or incident investigation</i>. These analyses may be performed by a range of experts, including health and safety advisers. Health and safety and patient safety professionals prefer using the term "incident" in place of the term "accident". Its retrospective nature means that accident analysis is primarily an exercise of directed explanation; conducted using the theories or methods the analyst has to hand, which directs the way in which the events, aspects, or features of accident phenomena are highlighted and explained.</p> <p>Identify and locate the main source of accidents from actual experience, materials, machines, tools, jobs, men and methods most likely to produce injuries.</p> <p>Disclose the nature and size of the accident problem in departments and among occupations</p>	4



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		<p>Indicate the need for engineering revision by identifying the unsafe conditions, materials, equipment and environment.</p> <p>Disclose inefficient operating procedures, processes, poor layout and outdated methods to reduce accidents.</p> <p>Disclose the unsafe practices for training of employees</p> <p>Disclose improper placement of personnel instances of handicaps contributing to accidents</p> <p>Guide supervisors to use their maximum time for safety work by providing them information about the hazards in their departments.</p>	
3	d	<p>Fault Tree Analysis (FTA) :</p> <p>It is a method to represent the logical combinations of various systems which lead to a particular outcome (top event).</p> <p>It is a graphic model that determines various combinations of equipment faults and failures that can result in an accident.</p> <p>This is a sophisticated form of reliability assessment and it requires considerable time and skill. The procedure is to start from a selected undesirable top event such as 'gas coming out of a scrubber' and then trace it back to the combination of faults and conditions which could cause the events to occur. Apart from identification of hazards, it is widely used for quantitative risk analysis. It will be necessary to obtain meaningful failure data of each component to arrive at the frequency of occurrence of the 'top event'. Fault tree is developed from top to bottom through a series of symbols which define the flow of logic from the base causes of an event itself. Detailed' probability data are most desirable.</p>	4



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		This method of Fault Tree Analysis was developed by Bell Laboratories (USA) in 1961 to predict potential catastrophic events which could occur with the Air Force. It is more useful to assess chemical hazards.	
4		Answer any 3	12
4	a	Procedure and plans for safe plant operation: <ol style="list-style-type: none">1. Starting sequence should be well defined, written and known to the workers involved in this work.Starting in sequence of utilities like water, air, power; purging, charging, slow and gradual heating, monitoring of pressure, temperature, flow and reaction rate, cooling if necessary, starting of exhaust system, scrubber or condenser etc., observing noise, vibration, speed, alignment, synchronizing etc. are all important.During start-up if drains remain open, vent valves remain closed, wrong valves are operated, unwanted material enters e.g. oxygen instead of nitrogen as blanketing over flammable reaction, water where it is incompatible, air instead of steam or steam instead of air, excess or less charging of material or catalyst, delayed cooling or heating, not starting of any pump or instrument, no indication or alarm due to failure or malfunctioning of instrument in the beginning, no starting of local exhaust or scrubber when it is essential and failure of interlock or trip resulting in unwanted mixing or reaction, mixing of air with hydrocarbons, contacting hot oil and water, thermal or mechanical shocks etc. are some of the examples of possible disorders.Correct identification of pipelines, valves and gauges, correct sequence	4



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		<p>of control operation, correct charging or addition-rate and instead of relying on instruments only Counter-check of other parameters and strict manual observation and satisfaction are requisite precautions for safe start-up procedure.</p> <p>5. Attention should be paid on preparatory activity, verifying content, removal of air or venting, purging and disposal of purged material, removal or addition of water, slow and sequential starting of heating or cooling, gradual reaching of working parameters and normal operation.</p> <p>6. Other points needing attention in start-up are removal of shutdown blinds, providing running blinds, opening of scrubber or discharge line valve, opening of isolation valve before safety valve, starting of local exhaust ventilation, pump cooling and priming, readiness of firefighting equipment, leak detection, opening vents and drains before allowing steam in the system, partial opening of steam valves, introducing steam from the bottom part, observance of level and overflow if any, safe increase in loading, avoidance of incompatible material, avoidance of moisture and impurities in breathing air, purging of blow down tanks and flare, removing air from vacuum equipment, inspecting joints and valves for leakage, verifying steam traps working for condensate discharge, safe displacement of steam, water or purge gas after their use, removing residual water before, introducing hot oil (initially cold oil should be introduced), using heat-exchanger for indirect and gradual heating or cooling etc.</p>	
4	b	Event Tree Analysis (ETA) :	4



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		<p>Event tree analysis is a method to illustrate the intermediate and final outcomes which may arise after the occurrence of a selected initial event.</p> <p>This technique is complementary to Fault Tree, but in reversed direction. Whereas a fault tree starts from a final event and works from the top down, an Event Tree begins with an initial event such as a power failure and explores all possible outcomes by working from the bottom up. An illustration is shown below, for an initial event of release of flammable gas. ETA identifies the sequences of events following an initiating event that results in accident. Event tree considers operator response or safety system response to the initiating event in determining the potential sequence.</p>	
4	c	<p>Hazop (Hazard & operability) study is carried out by application of guidewords to identify all possible deviations from design intent having undesirable effects on safety or operability, with the aim of identifying potential hazards. Hazop study is normally undertaken at an advanced stage of project implementation when the design criteria are well established. The study can be used for both new and working plants. They have to be carried out by multidisciplinary teams of experienced technical personnel having detailed knowledge of both the design, and operation of a plant. A preliminary Hazop study is intended to review the general parameters of materials processed, unit operations and layout of individual units and plant sub-units. A detailed Hazop study is required after the finalization of the designs to identify the potentially hazardous situations and to arrive at agreeable options to rectify design deviations and anomalies</p>	4
4	d	<p>Effects of radiation hazard:</p>	4



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		<p>1 .Ultraviolet radiation: Short term sunburn conjunctivitis Long term-premature skin ageing, skin cancer and cataract</p> <p>2. Infra-red radiation: Burns to skin and eye tissues.</p> <p>3. X rays: X rays are ionizing radiation. Ionizing radiation can affect human cells by stripping one or more electrons from an individual atom and forming an electrically charged particle called an ion. These ions can disrupt the machinery of cells, kill them or harm the genes that pass human traits from one generation to the next. Sometimes a damaged DNA molecule instructs a cell to mobilize all its resources and the resources of all its neighbors to produce as many copies of itself as possible. The offspring preserve the mandate, and a chain reaction takes place that crashes the system. This runaway reproductive zeal of a misguided cell is known as cancer and it is the worst hazard of radiation exposure.</p>	
4	e	<p>Procedure for shut down of a plant:</p> <p>A plant shutdown, or turnaround, is a temporary closure of a building to perform maintenance. The main activities should be preventative in nature with the focus on equipment inspections. This is the opportune time to replace worn-out or broken process materials and equipment at their useful end-of-life. An effective plant shutdown should result in reduced unplanned downtime, reduced overtime, and greater operational efficiencies. Five distinct phases of a plant shutdown are scoping, planning, scheduling, execution, and wrap up.</p> <p>Shutdown operation needs sequential steps like cooling and de-pressuring, pumping out, removal of residual content e.g. hydrocarbons, corrosive or toxic</p>	4



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		<p>chemicals, water, oil, pyrophoric catalyst, disposal of effluents and sludge, drainage and blinding and isolation activities.</p> <p>Heat source should be cut off, cooling may be continued till required, where vacuum is possible due to cooling, inert gas or air (if compatible) should be introduced to maintain atmospheric pressure, pumping out material after cooling and de-pressuring and pumped out hot oil should be cooled below its flash point. Residual hydrocarbons can be removed by purging with steam, water or water followed by steam. After purging, air should be allowed into the system. Residual water should be removed. Lastly running blinds should be removed and shutdown blinds should be installed.</p> <p>If the shutdown is required due to any fault, the cause of the fault should be found, studied and removed before restarting the plant.</p>	
5		Answer any 2	12
5	a	<p>Safety Organization:</p> <p>One of the biggest issues facing employers today is the safety of their employees. Workplace accidents are increasingly common. Organizations have a moral responsibility to ensure the safety and well-being of their members. Organizational practices that promote safety can also help a company establish competitive advantage by reducing costs and complying with safety laws.</p> <p>Workplace safety can be quite expensive. Unintentional injuries alone cost more than \$146.6 billion per year for medical and insurance costs, workers' compensation, survivor benefits, lost wages, damaged equipment and materials,</p>	2



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	<p>production delays, other workers' time losses, selection and training costs for replacement workers, and accident reporting.</p> <p>State and federal governments strictly regulate organizational safety practices. The government views safety violations very seriously, and the penalties for violating safety laws can be quite severe. In addition to being issued large fines, employers who violate safety regulations can be held liable for criminal charges.</p> <p>Organizations have a moral responsibility to ensure the safety and well-being of their members. Organizational practices that promote safety can also help a company establish competitive advantage by reducing costs and complying with safety laws.</p> <p>They create a Safety Department charged with the responsibility of keeping the company's safety program (ugh), and somehow making sure that everyone follows safety rules. They also keep track of the injuries (measuring failure).</p> <p>Safety department provides leadership in developing measures and practices that that prevent accidents and ensure compliance with OSHA standards. This includes: continuously monitor the workplace for hazardous safety and health conditions. Ensure safety and health hazards are corrected, eliminated or guarded.</p> <p>Safety Manager Responsibilities Include: Developing and executing health and safety plans in the workplace according to legal guidelines. Preparing and enforcing policies to establish a culture of health and safety. Evaluating practices, procedures and facilities to assess risk and adherence to the law.</p>	<p>2</p> <p>2</p>
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		<p>Four Principles of a Safety Management System</p> <ol style="list-style-type: none">1. Education. Education of all staff and management so that everyone understands safety policies and standards is essential to effective integrated safety management. ...2. Job-Site Maintenance. Regular and effective maintenance and repair of tools and equipment is an important element of safety. ...3. Safety Equipment. ...4. Communication.	
5	b	<p>Accident investigation:</p> <p>Philosophy of industrial accident investigation should be clear and well explained to workers. It should not be oriented towards fault-finding and blaming any individual. Its main objective is to find out the real cause of the accident and then based on it, to suggest appropriate remedial measures to prevent its recurrence.</p> <p>Steps involved in accident investigation:</p> <ol style="list-style-type: none">1. Provide first aid and/or medical care to the injured persons and take action to prevent further injury or damage. This is the first priority.2. Report the accident as required by your company's policies.3. Investigate the accident as soon as possible after it occurs. This allows you to observe the conditions as they were at the time of the accident, prevents the disturbance of evidence, and allows you to identify witnesses. You will need to gather physical evidence, take photographs,	<p>1</p> <p>2</p>



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and interview witnesses to understand the chain of events that led to the accident.

4. Identify the causes of the accident. Note that there are usually multiple causes.
5. Report your findings in a written report. In preparing the report, it is helpful to prepare step-by-step account or timeline working back from the moment of the accident, listing all possible causes at each step. This account can be helpful in preparing the final report, which should clearly explain the evidence for your conclusions.
6. Develop a plan for corrective action to prevent the accident from happening again. These actions should be specific, constructive, address root causes of the accident, and address the causes described in the report.
7. Implement your corrective action plan. It is helpful to set a deadline for implementation of corrective actions and there should be monitoring in place to ensure that they are completed.
8. Follow up to evaluate the effectiveness of the corrective actions taken.
9. Make adjustments as needed to continue to improve.

Purpose of investigation and Report:

1. To learn accident causes so that similar accidents can be prevented by improvement of working conditions, actions and supervision. This helps in designing accident prevention strategies.
2. To make hazard known to the management, workers and supervisors to direct their attention to accident prevention.



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3. To find facts to determine legal liability and information for preventive purposes. If the purpose is to fix blame or responsibility, vital information will often withheld or distorted. Therefore an investigation should be for the preventive purposes to disclose facts and not faults.
4. To establish procedure to combat damage claims under compensation laws.
5. To determine the change or deviation that produced an error that in turn resulted in an accident.
6. In case of accident affecting the society as a whole the Government may intervene for the purpose of banning of the hazardous material or process.
7. To find out injury rates to compare safety performance.
8. To use the record for the purpose of job safety analysis.

Types of investigations:

1. Failure mode & effect analysis
2. HAZOP
3. Fault tree
4. Event tree
5. Cost effectiveness
6. Statistical method
7. Critical incident method
8. System safety

Content of Accident Investigation report:

1. Name and address of the factory.



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		<ol style="list-style-type: none">2. Name and address of the investigator and with whom.3. Facts finding including date, time, place and manner of the accident, persons involved, result, etc.4. Drawings, photographs, sketches, records, registers, documents pertaining to accident.5. The process at the time of the accident.6. The causes of the accident in details and with break up.7. The remedial measures.8. The breach of law, if any.9. Compensation to be paid and information for insurance purpose.10. The delivery of the report to whom and how.	
5	c	<p>The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India. It is considered to be the world's worst industrial disaster.</p> <p>The disaster happened because water entered a tank containing Methyl isocyanate. This caused a chemical reaction which resulted in the buildup of much Carbon dioxide, among other things. The resulting reaction increased the temperature inside the tank to reach over 200 °C (392 °F). As the cool morning breeze picked up pace, it carried the poisonous gas leaking from the Union Carbide factory to rest of the city and killing people - both awake and asleep. As per government's affidavit, about 3,000 people died of poisonous gas within a few hours of the incident.</p> <p>It is estimated that about 40 tonnes of methyl isocyanate (MIC) gas and other</p>	6



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chemicals leaked from the Union Carbide factory. Methyl isocyanate is extremely toxic and if its concentration in air touches 21ppm (parts per million), it can cause death within minutes of inhaling the gas. In Bhopal, the level was multiple times higher.

The leakage of gas was reported from Plant Number C. As per official record, methyl isocyanate got mixed with water used for cooling the plant. The mixture led to generation of volumes of gases, which put tremendous pressure on Tank Number 610.

The tank cover gave way to building gaseous pressure releasing tonnes of the poisonous gas, which diffused over large area. Approximately 5 lakh people were exposed to the leakage of methyl isocyanate gas.

Tragedy did not strike Bhopal on the intervening night of 2-3 December 1984 but thereafter. The massive leakage of Methyl Isocyanate (MIC) gas from the Union Carbide plant resulted in colossal loss of life and an estimated 8,000 died within two weeks and more than five lakh were affected. Breathing **Methyl Isocyanate** can irritate the nose and throat. * Breathing Methyl Isocyanate can irritate the lungs causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath. It reacts exothermically with water to produce carbon dioxide, methylamine, dimethylurea and/or trimethylbiuret. Heat of reaction causes evolution of the vapors of the **isocyanate**. ... Airborne vapors of methyl Isocyanate are explosive when exposed to heat, flame or sparks.

Safety failures which caused Bhopal tragedy:



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		<p>1. During the leakage of methyl Isocyanate from the storage tanks of union carbide the water sprayers of the industry was not in working conditions.</p> <p>2. There was unavailability of safety officer who has the knowledge of handling such tragedy.</p> <p>3. Lack of safety management in workers</p> <p>4. Gas scrubbers were not in working condition.</p> <p>5. Absence of occupiers in industry at that situation.</p>	
6		Answer any 2	12
6	a	<p>Hazard: A hazard in anything in the work place that has the potential to harm people. It includes objects in the workplace such as machinery or dangerous chemicals.</p> <p>Types of hazards : 1) Mechanical hazards 2) Electrical hazards 3) Noise hazards 4) Radiation hazards 5) Explosion hazards 6) Toxic hazards 7) Chemical hazards</p> <p>1. Radiation hazard: The radiation is produced when atoms of natural radioactive material decay or split, generating streams of photons vibrating at enormous speeds in wavelike form. Radiation has two basic forms: ionizing and nonionizing. In chemical plants workers may be exposed to various forms of nonionizing radiation. Radiation hazards occurred during testing of nuclear weapons, establishment of nuclear power plants, mining and refining of plutonium and thorium and preparation of radioactive isotope.</p> <p>Sources of radiation hazard:</p> <p>1. Natural sources:</p> <p>They are mainly of cosmic radiation received from from the space, and the</p>	2 marks each for any three hazard and its description



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naturally occurring radioisotopes present in the environment and those contained within the body of the organisms.

Another source is the presence of radionuclides in the lithosphere, hydrosphere and atmosphere.

2. Man made sources:

1. Nuclear weapons
2. Atomic reactors and nuclear fuel
3. Radioactive isotopes
4. Hospital (X-ray division)

2.Noise hazard:

Un wanted sound is called noise. Sound levels that cause hearing loss begin at 85 db. Hearing loss occurs more quickly with louder noise. High sound levels cause serious health risks. Hearing damage results from an exposure to loud noises over an extended period of time.

Effect of noise on human being :

High sound levels pose serious health risk to the people who work long hours around the equipment which generate high noise levels. Hearing damage results from an exposure to loud noises over an extended period of time. Deafness and loss hearing usually occur with the high frequency sound and not be lower frequency sound. Hearing is lost as auditory nerve endings are exposed to the same frequency of sound for extended time periods. The nerves lose their ability to recover from that hostile frequency. The ability to hear that sound frequency is then decreasing forever. Hearing loss accumulates over time and cannot be revers. Hearing aid assistance may be necessary.



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Protection of noise hazard:

- i) Reduction at source:** wherever possible it would be advisable to reduce the noise at the source itself. eg change the bearings if it makes noise due to wear.
- ii) Vibration isolation:** In case of machine like reciprocating compressors and power presses, the mechanical vibrations are transmitted through the structures, walls and the floor which increases the noise level at the workplace. Reduction of noise levels can be achieved by,
 - a) Using vibration resilient mounts to fix the machine to foundations.
 - b) Special heavy foundations with a large weight compared to the weight of machine.
- iii) Vibration Damping:** Machine parts, ventilation duct cause noise in this manner. The noise in these cases can be reduced by damping- by stiffening the member.
- iv) Silencers:** Where noise due to movement of gases or air is the problem, silencers are the right solution. Silencers can be used at the inlet/outlet of compressors, exhausts, release of steam and gases and pressure relief valves of pneumatic machines.
- v) Noise insulation:** It may be necessary to insulate the source from all the sides although insulating two or three sides also give reduction of a lower degree.
- vi) Noise absorption:** Noise absorption material, normally soft and porous, prevent reflection of noise and also convert some of the noise energy into heat energy.

3. Electrical hazard:

The danger of injury through electrical shock is present when ever



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electrical power is used. All electrical should be adequately insulated, grounded or isolated to prevent bodily contact with any source of dangerous potentials. To prevent electrical shock, ensure that all equipment is properly grounded. To reduce the risk of shock, do not contact any electrical components and keep your work area dry. Check all equipment regularly and wear the proper protective equipment when working with high voltages or currents.

Electrical burns occur when the body completes a circuit connecting the power source with the ground. Although the resistance of dry, unbroken skin to electric current is relatively high, the amount of current necessary to kill person is small. Therefore it is easy to exceed lethal levels of current flow, especially if the skin is broken, wet or damp with sweat.

Common sources of electrical hazards :

The danger of injury through electrical shock is present whenever electrical power is used. The primary effect of electric shock are due to current actually flowing through the body. Electrical burns occur when the body completes a circuit connecting the power source with the ground.

Potential sources :

5. Voltages between phases and between phases and neutral.
6. Voltages between phases, neutral and earth where there is any conductive surfaces.
7. Voltages across open switch contacts.
8. Voltages across undischarged capacitors.



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		<p>9. Voltages on disconnected conductors.</p> <p>10. Voltages caused by static electricity.</p> <p>11. Incorrect wiring connection.</p> <p>12. Faulty equipment.</p> <p>4.Mechanical Hazard:</p> <p>In a chemical plant, welding and cutting are seldom done where mechanical hazards are occurred. The use of or the closeness to, mechanical equipment can present hazards to the welder. Knowledge of the proper use of power tools, such as grinders, chippers, drills and various hand tools, is important to welder safety. Moving parts of machine if not properly guarded can cause mechanical hazards. During handling of sharp heavy, rough and hot materials, suitable hand gloves and pads must be used to avoid mechanical hazards. In chemical plant to avoid mechanical hazards machines must be stopped and locked in stationary position before being oiled, lubricated or adjusted.</p> <p>5.Explosion Hazard :</p> <p>Explosive substances include any material for making any explosive substance, also any apparatus, machine or material used with any explosive substance.</p>	
6	b	<p>Predictive maintenance:</p> <p>Predictive maintenance makes use of human sense or other sensitive instruments such as audio gauges, vibration analyser, amplitude meter , pressure , temperature and resistance strain gauges etc. to predict trouble before</p>	3



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timeframe. It details when given maintenance tasks are performed and by whom. Scheduled maintenance may occur at repeating intervals or in response to a work request.

Scheduled maintenance often occurs at repeating intervals, such as changing an air filter every March and September, or conducting a performance inspection at the start of each year. Maintenance may also be scheduled to fulfill a work order. Once a problem is discovered, a maintenance scheduler works with a maintenance planner to resolve the problem. A time is then scheduled to conduct necessary repairs.

In addition to managing the time at which maintenance tasks should occur, scheduled maintenance also deals with who performs those tasks. The time it takes for the job to be completed is compared with available work hours, which are factored into the schedule. The key here is to make sure those who should perform a given task are available to do so. Without coordinating a set time with maintenance workers and contractors, there is no guarantee that necessary work will be completed on time. This inevitably damages schedule compliance.

This method of maintenance incorporates inspection, lubrication, repair and overhaul of certain equipment which if neglected may result in breakdown. Scheduled maintenance practice is generally adopted for overhauling of machines, cleaning of water and other tanks, white washing of buildings etc. In a time-based maintenance strategy, assets are periodically inspected, serviced and cleaned, with parts replaced in an effort to prevent sudden failure. While this allows those responsible for maintenance and servicing to reduce the



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	<p>likelihood of failure through scheduled checks and is far more effective than running breakdown maintenance, it cannot guarantee breakdown won't happen.</p> <p>Advantages of scheduled maintenance:</p> <ul style="list-style-type: none">• Usually made up of tasks that don't require extensive training, such as lubricating and retightening screws• Lower long term costs compared with breakdown maintenance	2
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