MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

SUMMER 2013 EXAMINATION

Model Answer

Subject & code:PSM(12207)

Important instructions to examiners :

1. The answers should be examined by keywords 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 given more importance.
4. While assessing figures, examiner may give credit for principal components indicated in a 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 answer and model answer.
6. In case of some questions credit may be given by judgment of relevant answer based on candidates understanding.

Q.No.	Answer	Mark	Total Mark
1. A) a.	**Preventive maintenance**. Preventive maintenance is a system of scheduled, planned maintenance tries to minimize the problem of breakdown maintenance. It is a stich- in- time procedure. It locates weak spots in all equipment, provides them regular inspection and minor repairs there by reducing the danger of unanticipated break downs. The principle of preventive maintenance is that prevention is better than cure. Preventive maintenance involves.	2	4

	i. Periodic inspection of equipment and machinery to uncover conditions that lead to production break down and harmful depreciation. ii. Upkeep of plant equipment to correct such conditions while the are still in a minor stage. The key to all good preventive maintenance programs is inspection. Help can be taken of suitable statistical techniques in order to find how often to inspect.	1 1	
1.A) b	**Importance of safety**. Safety is important in the following points 1. To protect the life of workers working in the plant 2. To protect the equipment from damage so that life of it can be increased. 3. To prevent the loss of time for production. **Objectives of safety:** 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.	2 ½ mark each	4
1.A) c	**Chemical Hazards.** Different Hazards chemical materials are : Explosives, Non-flammable and flammable gases, flammable liquids, flammable solids, oxidizing materials, poisonous materials, radioactive materials, corrosive materials etc. Harmful effects of chemicals on human beings are they can cause this comfort, induce vomiting and headache, can cause breathlessness, can produce allergic reactions, narcotic etc.	2	4

	Toxic Hazards. 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. 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 functional damage, inflammations , disorders of growth or repair and diseases.	2	
1 A) d	**Four non respiratory equipment used for personal protection in plant.** 1. Gloves for hand and arm protection: To safeguard workers there will be purpose-made gloves, supplied by manufacturers specializing in products , capable of protecting them from the hazards. 2. Helmets, hard cap for head protection. : Industrial safety helmet can protect the worker against following objects or impact with fixed objects. Caps and helmets protect the head of contamination with toxic substance. 3. Safety boot or shoes for foot protection. : The safety boot or shoe is the most common type of safety footwear, and would normally have a steel toe cap. It helps to protect the feet from corrosive or toxic materials. 4. Goggles for eyes protection: Goggles projects the eyes	1 mark each for any four equipment	4

	from dust , gases, welding arc , lesser light, toxic or chemical substances. 5. Apron/ lab coat for body protection 6. Ear plug/ ear muff for ear protection		
1 B) 1.	**Classification of Fire**	4	6

Class	Description	Suitable type of extinguisher
A	Fires involving ordinary combustion materials like wood , paper, cloth etc whereeffect of water is essential to extinguish	Soda acid
B	Fires in flammable liquids like oil, solvents, petroleum prod, varnish paint where blanketing effect in essential	Foam, CO_2 Gas, dry chemical powder.
C	Fires involving gaseous substances under pressure where it is necessary to dilute burning gas at a very high rate with an inert gas or powder	CO2 Gas , chemical powder
D	Fires involving metal like Mg, Al K etc. where its burning is reacting to water and which require special extinguishing media or technique	Special powder
E	Fires involving electrical equipment where the electrical non conductivity of the extinguishing media is of prime importance	CO2 Gas, dry powder, but when the electrical equipment is de-energised , soda acid or foam is suitable.

Causes of fire : 2

1. Spark and short circuit in electrical systems.
2. Friction in rotating equipment.

	3. Open flames , smoking and hot surface. 4. Static electricity . 5. Leakages of flammable liquids, vapour or gasses. 6. Lighting.		
1.B 2.	**Objectives of Safety Audit :** Safety audit is a proactive process by which and organization is able to continually evaluate and monitor the progress of its safety and health programs. Audits are designed to rate an organization's total safety and health program, identify it's strength and weakness , show where improvement are needed , and obtain commitment and target dates for correcting problems.	1	6
	Objectives are: 1. Confirm that safety, health, fire and environmental program activities and controls are in place and functioning. 2. Verify that the facility is in compliance with internal benchmarks and government regulations. 3. 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 two points	
	Procedure of safety Auditing : 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 should be	3	

	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.		
2.-1	Safety in chemical industry is done with the following points: 1. Plant location: The first and major feature that should be considered from the point of view of safety of industry is plant location and design. Plants must be built in a fail safe manner. The first point to be considered is the location of the plant in the selected plot and arrangement of different buildings within it. 2. Process design: This is the step where plant safety is first considered. Physicochemical and thermodynamic properties of raw materials, intermediate products and final products should be considered. Hazardous properties such as corrosion, flammability, explosivity, toxicity of chemicals used and produced should be taken in to account. Experiments connected to the process should be carried out in well equipped laboratories. Pilot plants should be setup to study the actual process which are going to be carried out. 3. Equipment and structure design: Materials of construction for equipment should be properly chosen. Materials should possess good resistance to corrosion. Strength of materials should be tested before it is adopted for equipment fabrication. It should have suitable formal	02 mark each for any two points	4

	properties. Equipment should be designed in such way that they can withstand the over load. Equipment for high pressure, high temperature reactions should be designed properly to withstand process condition. Equipment which may corrode quickly should be provided with stand by alternatives.		
2-2	**1) Explosion Hazard** : Explosive substances include any material for making any explosive substance, also any apparatus, machine or material used with any explosive substance. Classes of explosive are : 1. Category X: Those explosives which have a fire or a slight explosion risk. 2. Category Y: Those explosives which have a mass fire risk or moderate explosion risk, but not the risk of mass explosion. 3. Category Z: Those explosives which have a mass explosion risk and major missile effect. 4. Category ZZ: Those explosives which have a mass explosion risk and minor missile effect. In case of any explosive which is liable to be dangerously affected by water, due precautions shall be taken to prevent water from coming in contact with such explosives. Packages containing explosive shall not be allowed to remain in the sun or exposed to excessive heat. **2) Electrical Hazard :** The danger of injury through electrical shock is present when ever electrical power is used. All electrical should	2 2	4

	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.		
2-3	**Fire prevention using portable (water) extinguisher :** Water extinguisher consists of sodium bicarbonate solution in its body and sulfuric acid in the acid phial (bottle). When the plunger is struck, it breaks the acid phial (bottle). The sulfuric acid and the sodium bicarbonate solution react to other to release CO_2 gas. The gas generated creates pressure, which forces the water out of the extinguisher nozzle. Before operating this extinguisher, it is advisable to check whether these extinguishers are of up right type or turn over type. Direct the jet at the base of the fire and sweep it across the area of fire. Attack a vertically spreading fire at its lowest point and follow it up . Search out for hot spots and ensure that the fire is completely extinguished and that it is not left smoldering.	4	4
2-4	Different method of storage of different types of chemicals. 1. Bulk storage: Solid like sulfur, coal, etc are stored	1 mark for any four	4

	outdoors in large piles or heats. The piled solids are removed from the pile by tractor shovel. This is the most economical method for storing large quantities of materials. 2. Bin storage: Valuable materials are stored in bins, hoppers or silos which are cylindrical or rectangular vessels made up of concrete or metal. 3. Underground storage: Liquids are stored underground in porous media between impervious rock. Cavities are formed in salt domes by dissolving the salt and pumping it out. This method has application for storing petroleum product, both liquid and gasses. Hazardous or radioactive materials are stored in underground tunnels or storage tanks. 4. Liquid storage: Open atmospheric tanks are used for storing liquids that will not be harmed by water, weather or atmospheric pollution. The closed tanks have fixed or floating roof. For storing liquids under pressure, the tank has curved surface in the form of sphere, ellipsoid shape. 5. Gas storage: Certain gasses like NH_3 , HCl are stored by dissolving them in liquids. Gases may stored under high pressure in pressure vessels that reduces the volume. The small portable pressure vessel is useful for storing small quantities of Freon and petroleum gas.	points	
2-5	A safety Audit Report: A report is prepared in two major portions. The first part involves check list, second part involves the final report. Checklist should suit the organization and the type of safety audit. In the planning stages key employees should be involved to ensure that all safety programmes, operation and hazards are	01 1.5	4

	addressed. Checklist covers general safety programmes and regulatory complaints, facilities and equipment and specific hazards and operations. Final report identifies the safety audit findings, makes observations and offers an overall opinion. The report should provide detail on specific suggested enhancements to remedy deficiencies, and should highlight serious and repeat observations. The final report should be communicated to management in a timely manner.	1.5	
2-6	On line maintenance : 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. eg. Suppose there is a Rota meter 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. If we provide a stand by pump in a process pipe line it is possible to attend the faulty pump, without stopping the production, by using a stand by pump. When a valve is to be attended for its maintenance by removing it from pipe line, then blind flange is useful eg. The suction side valve of the pump is provided with blind flange and the only suction valve can be removed for maintenance without loss of materials. When the pressure vessels like reactor evaporator, distillation	4	4

	column is leaking then it is difficult to do maintenance work without stopping the production. When the insulation get damaged due to any reason, it is possible to attend it without stopping the production since insulation is fixed externally. Only precaution is to be taken if the pipe line or equipment is at high temperature.		
3-1	**Preventive maintenance Scheduling** involves determining calendar inspection dates that will fulfill the frequency requirements in the most efficient way. Schedules should be set in consultation with production department and as per production needs. Preventive maintenance inspection can be classified into three as: i)Routine up keep ii)Periodic Inspection iii)Contingent work **Importance of Preventive maintenance Schedule in a chemical plant :** i) It reduces the overall cost of production ii) It protect man and machinery in a plant	03 01	04
3-2	**A safety Audit Report**: A report is prepared in two major portions. The first part involves check list, second part involves the final report. Checklist should suit the organization and the type of safety audit. In the planning stages key employees should be involved to ensure that all safety programmes, operation and hazards are addressed. Checklist covers general safety programmes and regulatory complaints, facilities and equipment and specific hazards and operations. Final report identifies the safety audit findings, makes	01 1.5	04

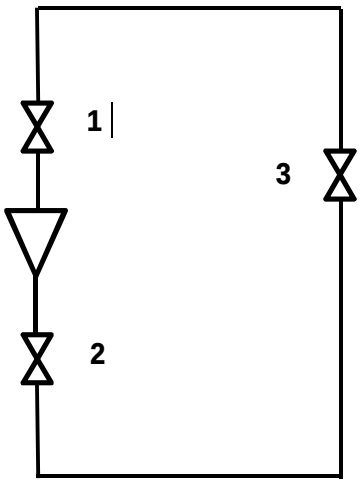
	observations and offers an overall opinion. The report should provide detail on specific suggested enhancements to remedy deficiencies, and should highlight serious and repeat observations. The final report should be communicated to management in a timely manner.	1.5	
3-3	Different modes transport of Chemicals are: i) Pipelines : for transporting liquid chemicals. ii) Tankers: used for bulk chemical transportation. It should be properly labeled and carry appropriate hazard warning panels. Drivers must be trained in the handling of accidental spills. iii) Trucks (Drums containing chemicals)/Container: Before moving containers, check and tighten caps, taps or other enclosures. Wherever possible, flammable liquids should be transported in rugged pressure resistant safety cans. iv) Freight elevators: used where hazardous chemicals are to be transported. v) Conveyors: For transporting solid chemicals.	1 mark each, for any four	04
3-4	**CO_2 type fire extinguishers:** In CO_2 type fire extinguishers CO_2 gas is stored in the cylinder under pressure. The gas is discharged through a horn. These extinguishers are operated by removing the safety pin and operating a simple wheel value through which the rate of discharge can be regulated. CO_2 extinguishes fire primarily by reducing the oxygen content below that which will support combustion, normally between 35 and 75% in air. There is also some cooling effect.	02	04

	Foam extinguishers: In foam extinguishers, chemical foam is formed by a chemical reaction in which masses of bubbles of CO2 gas and a foaming agent produce froth. To use these extinguishers, pull the plunger up and turn it right and left to rest on the cap. Turn the extinguisher upside down. A powerful frothy foam jet will be coming out. Direct this jet at the level of the burning liquid. The foam builds up and flows across the surface of the liquid.	02	
3-5	**Mechanical Hazard in a chemical Plant: In a chemical plant, welding and cutting** are seldom done were 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 grindess, 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. **Radiation Hazard** : The radiation is produced when atoms of natural radio active 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.	02 02	04

<table>
<tr><td>4-A) 1.</td><td>Characteristics of chemicals to be considered while storing:
i) Hazardous nature
ii) Flammability
iii) Corrosive or oxidizing nature
iv) Water reactivity
v) Ignition properties
vi) Toxicity.
vii) Chemical stability
viii) Shock sensitivity</td><td>1/2 mark each</td><td>04</td></tr>
<tr><td>4-A) 2</td><td>During shut-down maintenance generally chemical plants are closed half yearly or yearly for carrying out major maintenance work of total plant equipment. The sugar cane factory is stopped, once the sugar cane supply is over. During shut down of the plant, maintenance work like changing of parts, lubrication, overhauling of all the equipment in the plant, cleaning of equipment and plant are done. Maintenance department and process plant people are involved in the process.</td><td>04</td><td>04</td></tr>
<tr><td>4-A) 3</td><td>Preventive maintenance chart for centrifugal pump:
<table><tr><th>Pump part</th><th>Trouble</th><th>Maintenance</th></tr><tr><td>Suction Line</td><td>No suction</td><td>Priming</td></tr><tr><td>Impeller</td><td>Not rotating</td><td>Lubrication, remove air</td></tr><tr><td>Casing</td><td>Rusting, Wear & Tear</td><td>Use anti rusting agent, lubrication</td></tr></table></td><td>2 mark each for any two points</td><td>04</td></tr>
<tr><td>4-A) 4</td><td>Start up procedure of a chemical plant:
A chemical plant is started at two different times,
1. When it is constructed, erected and to be commissioned first time for production. The procedure here to be followed is to take water in the plant to check the fluid flowing through equipment and pipelines without any leakage, at the desired flow rate, pressure and</td><td>02</td><td>04</td></tr>
</table>

	temperature. If any leakage is observed, it can be rectified. This is the safest and cheapest way of checking the functioning of the plant equipment in total. 2. When plant is stopped for annual major shutdown, then also above cited procedure is usually followed at the starting of the plant. Once it is assured that fluid flow takes place without any problem, the total plant water is drained off and water is removed and then slowly raw materials are taken into the process equipment. The plant is slowly loaded in stepwise and reached to desire capacity in stepwise manner. It is always advisable to operate the plant with 50% capacity for few days and after full satisfaction of plant working, it is taken up to full capacity.	02	
4. B) 1.	Different respiratory equipments used as personal protective equipments in a chemical plant are 1. Air Purifying Type a. Mechanical filter respirators: These give protection against dust and particulate matters only and do not provide any protection against harmful vapours, gases or oxygen deficient atmospheres. b. Canister gas masks: This consists of a full face mast connected to a canister through corrugated hose. The canister contains certain neutralizing chemicals, which can absorb a particular contaminant. c. Chemical Cartridge Respirators: These are similar to canister gas masks with the difference that one or two chemical cartridges are used with a half face mask. These masks are effective only at very low concentration and cannot be used in emergency. 2. Air Supplied Type:	02 mark for each point	06

	Here air is supplied to the full face mast on hood so that the wearer gets constant supply of breathable air drawn from a non contaminated area away from working place. This includes- Air line respirators: They use a source of filtered and low pressure compressed air or oxygen, instrument air which is usually at low pressure and free from oil. Fresh air or Suction Hose Masks: Here the wearer draws in air by his own breathing effort, from a source supplying breathable air, placed at a distance. On account of limited hose length, this restricts the free movement of the operator. 3. Self Contained Breathing Apparatus: These are designed to supply complete respiratory protection is any concentration of toxic gases or even in environment deficient of oxygen. These are mainly of three types. a. With compressed air or oxygen cylinder b. Oxygen rebreathing or recirculating type c. Oxygen regenerating type		
4-B) 2	Dry Chemical Extinguisher System: These are gas cartridge type and are activated by a plunger and controlled by a simple squeeze grip action thus enabling the discharge of the dry chemical powder, generally sodium or potassium bicarbonate base or ammonium phosphate base. To operate, remove the safety clip and press puncturing lever down. This will release CO_2gas from the cartridge and pressurize the chamber containing dry chemical. The discharge is controlled by the nozzle located at the end of the hose. **Working** :On fires involving either liquids in containers or spilled liquids, direct the jet towards the near edge of the fire and	03 03	06

	with rapid sweeping motion, drive the fire towards the far edge until all the flames are extinguished. On fires in falling liquids, direct the jet at the base of the flame and sweep upwards. On fires in electrical equipments, direct the jet straight at the fire. Where the equipment is closed, direct the jet into any opening with the object of penetrating the interior.		
5-1	On line maintenance : 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 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. Fig.  	03 01	04
5-2	**Safety precautions in the transportation of inflammable**		4

	liquids: 1. Inflammable liquids shall be transported in rugged pressure resistant safety cans. 2. Original containers of inflammable liquids shall be placed in an outside container or acid carrying bucket. 3. Not more than five gallons of inflammable liquids in glass container shall be transported on the freight elevator unless the original shipping carton is used and the material are on an appropriate cart. 4. Before transportation details of the packing requirements should be obtained from the hazard data sheet. The packing group for which the chemical belongs will decide the amount which can be transported at any one time.	1 1 1 1	
5-3	1. **Gloves for hand and arm protection**: To safeguard workers there will be purpose-made gloves, supplied by manufacturers specializing in products, capable of protecting them from the hazards. 2. **Helmets, hard cap for head protection**. : Industrial safety helmet can protect the worker against following objects or impact with fixed objects. Caps and helmets protect the head of contamination with toxic substance. 3. **Safety boot or shoes for foot protection**. : The safety boot or shoe is the most common type of safety footwear, and would normally have a steel toe cap. It helps to protect the feet from corrosive or toxic materials. 4. **Goggles for eyes protection:** Goggles projects the eyes from dust , gases, welding arc , lesser light, toxic or chemical substances. 5. **Ear plugs and ear muffs for ear protection:** When it is not possible to reduce the noise level to recommended level by engineering means, suitable ear protection	1 mark each for any four equipment	4

	should be used. Ear protection fall into two groups- ear plugs and ear muffs. These when properly fitted and used, can reduce the noise level by 60 to 40 decibels.		
5-4	**Controlling methods of toxic chemical- NH_3:** 1. Provide information pertaining to the hazards of ammonia. 2. Design and install receiving / storage vessels according to generally accepted good engineering practices. 3. Ensure that safety relief valves and relief systems for storage vessels are properly designed , installed in vapour space and discharged to a safe location. 4. Place barriers around receiving and storage vessels and other equipment to protect them from impact. 5. Maintain proper oxygen and water content in vessels to avoid stress corrosion cracking in welds of vessels. 6. Routinely inspect for corrosion of the receiving and storage vessel. **Controlling methods of toxic chemical-Cl_2** Chlorine should be stored in cool, dry, well ventilated area in tightly sealed container that are labeled. Containers should be protected from exposure to weather , extreme temperature changes and physical damage and they should be stored separately from flammable gases and vapours, combustible substances , reducing agent , finely divided metals, arsenic, boron, calcium, activated carbon, H_2S, SO_2, CO etc.	2 2	4
5-5	Objectives of good plant layout: 1. Economy in handling of materials, work in progress and finished goods. 2. Minimization of production delays.	01 mark each for any four points	04

	3. Lesser work in progress and minimum manufacturing cycle time. 4. Efficient utilization of available space. 5. Easy supervision and better production control. 6. Greater flexibility for change in product design and for further expansion. 7. Better working conditions by eliminating causes of excessive noise, objectionable odour, smoke etc.		
5-6	**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 decrease for ever. Hearing loss accumulates over time and can not be revers. Hearing aid assistance may be necessary. **Legislative measures:** **1. Administrative:** a. Use protective devices. **b.** Do proper maintenance of equipment from time to time. **c.** If level crosses the allowable limit, take proper measures to minimize it.	3 01	4
6-1	**Shut down maintenance in sugar industry:** In sugar industry shut down maintenance is done, once the sugar cane supply is over.	01 mark each	04

	Different equipment for which maintenance is done are i) Shredder and Cane crushing mill: Cleaning and maintenance for wear and tear of cane crushing mill is needed. ii) Boiler: All boiler mountings and accessories are to be checked for its proper functioning. iii) Evaporators and Crystallizer: Instrumentation and control system should be checked. iv)ElectricalEquipment : Proper Insulation should be done and leakage should be prevented.		
6-2	**Four modes transportation of solids** : 1. **Conveyors** are employed to transport materials over fixed path mostly horizontally. Screw conveyors consist of helical steel flights cut from flat sheet. As screw rotates in the material to be conveyed , the flight advances horizontally and thus material is transported. Belt conveyor can operate over short distances at speed slow enough for manual picking with low capacity. 2. **Bucket elevators:** Bucket elevators are the simplest and the most dependable unit for making vertical lifts. They are available in wide range of capacities and may operate entirely in the open or be totally enclosed. 3. **Pneumatic conveyor:** Pneumatic conveying is the transportation of granular solids through a pipe line by a stream of air or gas. It consist of the sources of compressed air, a feeder and a receiving hopper fitted with a means of separating the conveyed product from the conveying air. 4. **Trucks**: Trucks are used for transporting solids over a	1 mark each	4

	long distance.		
6-3	**Dust respirator** : Dust respirators are designed for protection against the higher levels of toxic particulate material. The mass can be adapted for respirators or breathing apparatus. Their life expectancy is between one and five years and the filters are likely to last two months. **Blasting helmet** : Blasting helmets are used when operators are carrying out blast cleaning of structures, castings etc. A full protective suit made in rubberized canvas is donned by operator, and then an independent blasting helmet is applied over the head and fixed to be full suit. External clean air is supplied via a compressor with a filter , or from a compressed air supplied again with a suitable filter. Work inside a full blasting suit is very difficult work efficiency will be low, fatigue will be high and such suit should only be used when all other precautions can not be reasonable applied.	2 2	4
6-4	**Hazardous properties of chemicals** : 1. Irritation of eyes, conjunctivitis, irritation of noise and thought. eg. Ammonia. 2. Blood cancer, eg. Irritation, burning, anaesthetic effects eg. Benzene. 3. Irritation of eyes , mucous membrane , depression , mental deterioration. eg. Bromine. 4. Fire hazard, explosion hazard eg.CO, CS_2 5. Corrosion hazard eg. Bromine. 6. Highly reactive hazard eg. Phosgene. 7. Disaster potential hazard eg.SO_2, naphtha H_2S.	1 mark each for any four hazard	4

6-5	Predictive maintenance: 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 the equipment fails. Unusual sounds coming out of a rotating equipment predict a trouble , an electric cable excessively hot at one point predict a trouble. Simple hand touch can point out many unusual conditions and thus predict a trouble. In predictive maintenance , equipment conditions are measure periodically or on a continuous basis and this enables maintenance men to take a timely action such as equipment adjustment , repair or overhaul. Predictive maintenance extends the service life of an equipment without fear of failure.	4	4