SUMMER-15 EXAMINATION

Model Answer

Subject code :(17558)

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.

Q No.	Answer	marks	Total marks
1A-a	**Causes of accidents:** **1. Technical causes.** These are due to un safe condition which are originated from a) Mechanical factors b) Environmental factors. ***Mechanical Factors***:(Any two points) i) Unsafe mechanical design or construction. ii) Improper machine guarding. iii) Improper material handling. iv) Broken safety guards. v) Leaking acid valve. ***Environmental factors*.:** (Any two points) i) Too low a temperature to cause shivering. ii) Too high temperature to cause headache , sweating. iii) Too high humidity iv) Defective and inadequate illumination v) Presents of dusts, fume and smoke. 2. **Human causes**.(Any four points) These are due to unsafe acts by our weakness. This is due to some personal factors such as : i) Age. ii) Health iii) No. of dependents iv) Financial positions v) Home environment	2 2	4

	vi) Lack of skill and knowledge. vii) Improper attitude towards work viii) Carelessness ix) Inattentiveness.		
1A-b	**Safety provisions 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 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	4	4

	by alternatives. **OR** 1. Safe work place layout. 2. Design of control facilities. 3. Proper working conditions. 4. Safe material handling 5. Use of personnel protective devices. Safety activities in the organization		
1A-c	**Personal protective equipment: (any four)** **Ear Plug** : It is personnel protective device for ear which is put inside the ear. They are worn in the ear canal, sealing the entrance to the ear **Ear Muffs** : It is again a personnel protective device for ear which is placed on the ear thereby covering the ear completely.This can be worn over the head, behind the neck or under the chin. The cups may also be attached to some safety helmets by adjustable side arms. **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. **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. **Safety boot or shoes for foot protection** : The safety boot or shoe is the most common type of safety footwear, and would	1 mark each for any 4	4

	normally have a steel toe cap. It helps to protect the feet from corrosive or toxic materials. **Goggles for eyes protection**: Goggles projects the eyes from dust , gases, welding arc , lesser light, toxic or chemical substances. **Apron/ lab coat** for body protection		
1A-d	**Factors for selecting personal protective equipment**: i) The nature of the hazardous operation or process. ii) Type of the contaminant and its properties. iii) Duration for which the protection will be needed. iv) Location of the hazardous area. v) State of health of the personnel involved . vi) Functional and physical characteristics and limitation of the protective devices available.	1 mark each for any 4	4
1B-a	**Causes of explosion hazard:** 1. External source of energy **2.** Internal exothermic reaction in which large volume of gases are produced. **3.** The result of the release of internal energy during an uncontrolled reaction. **4.** High pressure inside the vessel due to heating **5.** Dust explosion **Causes of electrical hazard:** 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	3 3	6

	circuit connecting the power source with the ground. **Potential sources :** 1. Voltages between phases and between phases and neutral. 2. Voltages between phases, neutral and earth where there is any conductive surfaces. 3. Voltages across open switch contacts. 4. Voltages across un discharged capacitors. 5. Voltages on disconnected conductors. 6. Voltages caused by static electricity. 7. Incorrect wiring connection. **8.** Faulty equipment.		
1B-b	**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.	3 3	6
2-a	**Harmful effects of ammonia:** Inhalation: Very toxic, can cause death., can cause severe irritation of the nose	4	4

	and throat, can cause life threatening accumulation of fluid in the lungs, coughing, shortness of breath. Skin contact: the gas irritates or burns the skin, permanent scarring can result, can chill or freeze the skin, burning sensation and stiffness, skin becomes waxy white or yellow. Eye contact: corrosive, the gas irritates or burns the eye, blindness can result, can freeze the eye,		
2-b	**Precautions with head protection:** The head protection should be compatible with the work to be done. Most head protection come with internal harness and it is essential that these are adjusted by the worker to fit their own heads. For outside workers in the process industry, the use of chin strap is recommended. The interior of a hat should be kept clean and sweat bands should be regularly cleaned and/or regularly replaced. **Precautions with eye protection:** Laminated lens should never be used. The most important thing in eye protective devices is that the lens, whether glass or transparent plastic, should be optically correct and completely free from flaws and destortions. These should be comfortable for wear. These should be cleaned and kept in a good state of repair regularly and all workers should be trained for proper use of such devices.	2 2	4
2-c	**Procedure for 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	4	4

	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 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 up to 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-d	**Methods of liquid storage:** 1. ***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. 2. ***Open atmospheric tanks*** are used for storing liquids that will not be harmed by water, weather or atmospheric pollution. 3. ***The closed tanks*** have fixed or floating roof. Fixed roof are either domed or coned with intermediate supports. Fixed roof atmospheric tanks require vents to prevent pressure changes which would result from temperature changes and withdrawal or addition of liquids. Vent loss is prevented by using variable volume tank which have floating roofs. Floating roofs must have a seal between roof and tank shell. For storage liquids under pressure, the tank has curved surface in the form of sphere, ellipsoid shapes. *Storage tanks* are made of steel, reinforced concrete, plastics or glass	4	4

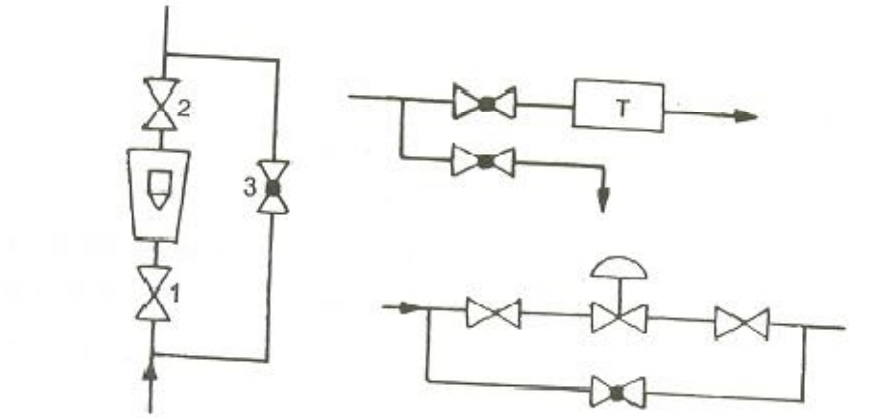
	reinforced plastics. Plastic tanks have resistance to corrosion, lighter construction and low cost. Plastics or glass coating are applied to the corrosive liquids which are to be stored in glass lined tanks.		
2-e	**Methods for fire protection:** 1. If anyone is near you, ask him to report the out break and then give assistance in controlling the fire. 2. Take positions between the fire and the exit, so that your escape cannot be cut off. 3. Do not continue to fight a fire if it is dangerous to do so or if there is a possibility that the escape route may be cut off. 4. If you have to withdraw, close the windows and doors behind you wherever possible. 5. Fire extinguishers should be recharged immediately after use irrespective of whether they have been completely or partially discharged. 6. Some extinguishers have to be turned over to operate, and see how to use them. 7. Fire may be extinguished by withdrawl of flammable contents, interrupting flammable flow, isolating fuel from air, heat removal to below reaction temperature.	4	4
3-a	**Effects of noise :** 1) The main ill-effect of a high noise level is that the persons exposed to it may lose their hearing capacity. 2) A very high noise level like that of an explosion can bring about complete hearing loss instantaneously. 3) High Noise levels also affect work 4) Communication between people becomes difficult in noisy areas which can	½ mark each for any 4	4

	result in it becoming necessary for the speaker to shout or the listener getting the wrong message. 5) High Noise Levels have psychological effects as well. 6) High Noise Levels can affect body functions in many ways such as rise in blood pressure, increased heart rate, muscular and nervous tension, reduction in the functions of digestive organs and increased fatigue. **Legislative Measure** Sound can be measured by 1) Sound level meter 2) Octave Band Analyzer coupled with sound level meter 3) For measurement of continuous sound level in 8 hours of exposure 4) Integrating Meters 5) Dose Meters 6) Digital Sound Level Meter	½ mark each for any 4	
3-b	**Safety precautions in the transportation of inflammable 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 materials are on an appropriate cart. 4. Before transportation details of the packing requirement 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 mark each	4
3-c	**Objectives of Preventive Maintenance are :** i) To minimize the possibility of unanticipated production interruption or major	1 mark each for	4

	breakdown by locating or uncovering any condition this may lead to it. ii) To make plant equipment and machinery always available and ready for use. iii) To maintain the value of equipment and machinery by periodic inspection repairs etc. iv) To maintain the optimum productive efficiency of the plant equipment and machinery. v) To maintain the operational accuracy of the plant equipment. vi) To reduce the work content of the maintenance jobs. vii) To achieve maximum production at minimum repair cost. viii) To ensure safety of life and limbs of the workmen.	any 4	
3-d	Roles of maintenance department in chemical industry: **1)Inspection:** i) Inspection of the plant facilities to examine their condition and to check for repairs needed. ii) Inspection to ensure the safe and efficient operation of plant equipment and machinery. iii)Inspection to make it certain that every working equipment receives proper attention. iv) Inspection to check the maintenance items received from vendors for their fitness. **2)Engineering :** i) Engineering involves alternations and improvement in existing plant equipment to minimize breakdown. ii) Engineering and consulting services to production supervision. **3) Maintenance** : i) Maintenance of existing plant equipment. ii) Engineering and execution of planned maintenance, minor installations of	1 mark each for any 4	4

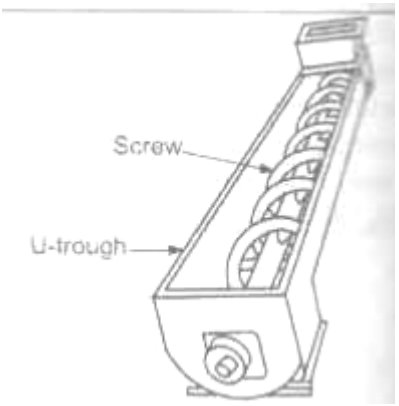
	equipment building and replacements. 4**) Repair:** i) To carry out corrective repair to alleviate unsatisfactory conditions found during preventive maintenance inspection. **5) Overhaul:** i) Overhaul is a planned, scheduled reconditioning of plant facilities such as machinery etc. ii) Overhaul involves replacement, reconditioning, reassembly, etc. **6)Construction :** i) In some organization, maintenance department is provided with equipment and personnel and it takes up construction job too. **7) Salvage :** i) Maintenance department may also handle disposition of scrap or surplus materials. **8) Clerical work:** i) Maintenance department keeps records at i) of costs, ii) of time progress on jobs pertaining to important features of building and production equipment.		
3-e	**Disadvantages of breakdown maintenance** : 1) Breakdown generally occurs at inopportune time. This leads to poor, hurried maintenance and excessive delays in production. 2) Reduction of output. 3) Faster plant deterioration 4) Increased chances of accidents and less safety to both workers and machines. 5) More spoilt material. 6) Direct loss of profit.	1 mark each for any 4	4
4A-a	**Conveyors** are gravity or power devices commonly used to move uniform loads continuously from point to point over fixed paths. The primary function	2	4

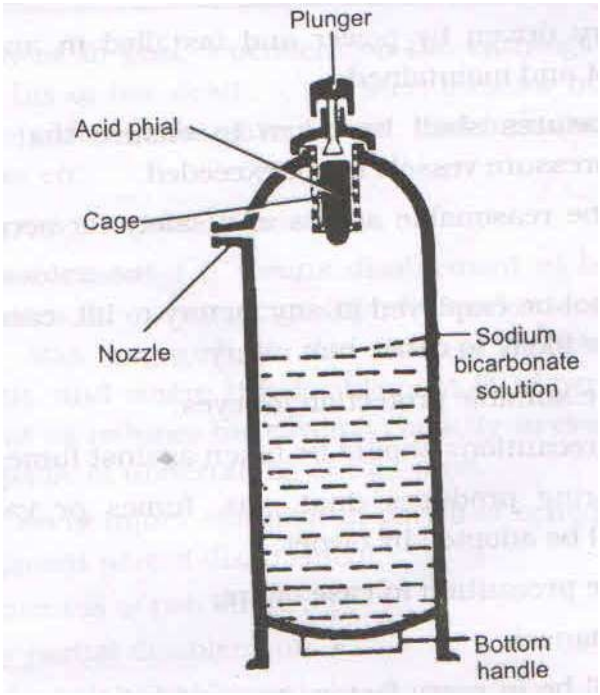
	of conveyor is to move materials when the loads are uniform and the path do not vary. The movement rate and direction is usually fixed. The conveyors are mainly used to transport raw materials from storage area to the processing section and from the finished product to storage area along with the packing and weighing operation. Example of conveyors are Belt conveyor, Chain (flight) conveyor **Elevators** are used where large volumes of material must be elevated from one fixed point to another. In case of elevator direction of movement of material is vertical and speed can be varied. For example bucket 3elevator	2	
4A-b	**Mass flow bins :** Valuable materials are stored in bins, which are cylindrical or rectangular vessels made of concrete or metal. A hopper is a small bin which is used for temporary storage before feeding solids to a process. Mass flow bins having basic conical and plane flow shapes. Mass flow hoppers are characterized by a shallow angle of the converging section. In mass flow bins, every particle of the bulk material in the hopper begins to move when the outlet is opened. Hence mass flow hopper has steep wall slopes of the converging section without any sharp transitions. It has relatively large outlet to the feeder or flow control valve. The cohesive solids stored in mass flow bins form cohesive arch at the opening which act as the obstruction to the gravity flow of material. It is overcome by providing some discharge aid. **Advantages of Mass flow bins:** i) Absence of channeling, surging and flooding. ii) Uniform and steady flow which is independent of the head of material in the bin. iii) The pressure across any horizontal section of the bin are uniform. iv) There are no dead regions within the bin.	2 1 mark each for any 2	4

	v) There is minimum segregation of bulk solid stored.		
4A-c	**ON LINE MAINTENANCE**; In a chemical plant it is 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 rotameter in a pipe line. If we desired to replace a broken glass pipe of rotameter we can closed valve 1 and 2 and open 3 & divert the fluid through by-pass line. After replacement of the glass pipe in the rotameter close valve 3 and open 1 & 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 e.g. The suction side valve of a pump is provided with blind flange and the only suction valve can be removed for maintenance without loss of materials.	2 marks each for any 2 examples	4

<table>
<tr><td></td><td>When the pressure vessels like reactor, distillation column, evaporator 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.</td><td></td><td></td></tr>
<tr><td>4A-d</td><td>Technical specification of foam type extinguisher:
<table>
<tr><th>TYPE</th><th>2lit. foam spray S/P</th><th>6 lit. foam spray S/P</th><th>9lit. foam spray S/P</th></tr>
<tr><td>Capacity(lit)</td><td>2</td><td>6</td><td>9</td></tr>
<tr><td>Fire rating</td><td>8A 55B</td><td>13A 144B</td><td>21A 183B</td></tr>
<tr><td>Height (mm)</td><td>395</td><td>565</td><td>600</td></tr>
<tr><td>Cylinder diameter</td><td>112</td><td>160</td><td>189</td></tr>
<tr><td>Overall width (mm)</td><td>150</td><td>290</td><td>300</td></tr>
<tr><td>Filled weight(kg)</td><td>3.81</td><td>10.09</td><td>14.21</td></tr>
<tr><td>Range of throw(m)</td><td>>2</td><td>>4</td><td>>4</td></tr>
<tr><td>Working pressure at 20ºC</td><td>15</td><td>15</td><td>15</td></tr>
<tr><td>Temperature range(ºC)</td><td>0 to 60</td><td>0 to 60</td><td>0 to 60</td></tr>
</table>
Application of a foam type fire extinguisher :
i) It is effective in extinguishing the fire as well as preventing re-ignition.
ii) It provides a high degree of protection from heat damage to surrounding structures and equipment.</td><td>½ mark for any 6

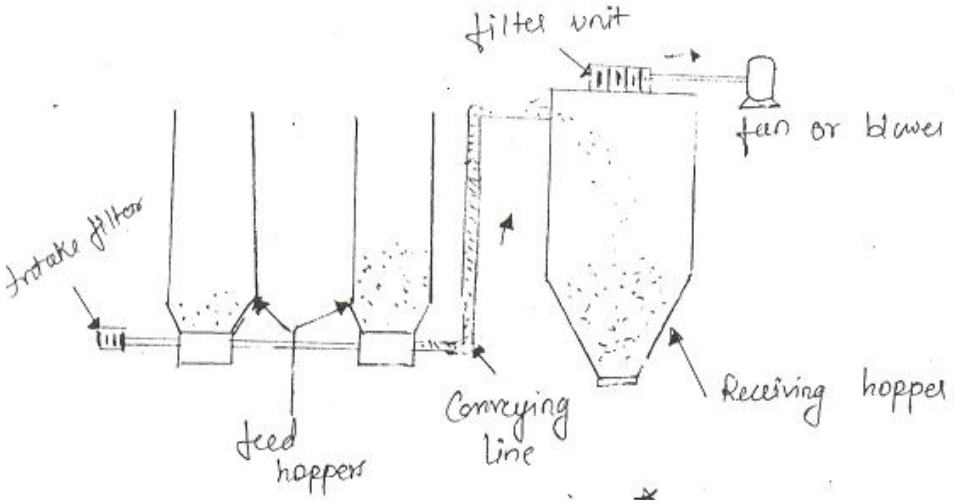
1 mark for any 1</td><td>4</td></tr>
<tr><td>4B-a</td><td>Construction of screw conveyor:
The screw conveyor has helical steel flights cut from flat sheet as circular rings, split on one side and with the two edges then pulled apart to form one helical</td><td>2</td><td>6</td></tr>
</table>

	section of the screw. Number of such sections are riveted together to form a continuous helix of the required length. Now a day, helicoid flight are used, which are formed by rolling a continuous strip of steel into a helix. Fig. shows screw conveyor using a U-trough inside which a helical screw mounted in the bearings which are located at the ends of the trough.  **Figure: Screw Conveyor** **Working of screw conveyor:** In screw conveyor as screw rotates in the material to be conveyed, the flight advances horizontally into a heap of bulk solid, and thus material is lifted by wedging action. The cylindrical casing resists the rotation of the particulate material in the conveyor. Thus material advances by combination of trumbling and shearing action.	2 2	
4B-b	**Audit report** : Audit report identifies safety audit finding , makes observation and recommendation and offers an overall opinion. The report should provide details on suggestions to remedy deficiencies and should high light serious and	3	6

	repeat observations. It also includes issues related to financial **A safety 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. Confirm that safety, health, fire and environmental program activities and controls are in place and functioning. Assess past and current practices to identify and correct safety impediments which may result in personal injuries, property damage or business interruption.	3	
5-a	**Dry chemical extinguisher:**  These are gas cartridge type and are activated by a plunger and controlled by a	2 3	8

	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 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.	3	
5-b	**Start up of a 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 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. When plant is stopped for annual major shutdown, then the procedure to be followed for start- up of a plant is i) 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 temperature. If any leakage is observed, it can be rectified. Thus is the	8	8

	safest and cheapest way of checking the functioning of the plant equipment in total. **ii)** 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 loaded in stepwise and retched to desire capacity in stepwise. 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		
5-c	**Shut down maintenance of sugar industry:** In sugar industry shut down maintenance is done, once the sugar cane supply is over. 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) Electrical Equipment : Proper Insulation should be done and leakage should be prevented.	2 marks each	8
6-a	**Pneumatic conveyor:** Pneumatic conveying is the transportation of dry, granular solids through a pipe line by a stream or air or gas. It consists of the source of compressed air / gas, a feeder and a receiving hopper fitted with a means of separating the conveyed product from the conveying air. Air is blown along a pine line, which carries the bulk solid to be conveyed. Fan or blower is used to deliver air in to the pipe line. Feeders are used to introduce	3	8

	the material in to the pipe line against the conveying gas pressure. Gas – solid disengaging device is used at the discharge in of the pipe line, which separates the conveyed bulk solid from the conveying air stream. The cyclone separator or bag filter units are used for this purpose. The clean gas / air coming out from these devices is fed back for conveying purpose. **Negative Pressure or Vacuum Systems:** It is similar to domestic vacuum cleaner. Complete removal of solids from the conveyed gas, which otherwise may damage the fan or blowers. These systems do not require separate material feeding devices due to absence of adverse pressure gradients. Hence these systems have simple feeding mechanism but larger air filtration plant. Vacuum systems are useful in installations involving picking up of material from several points and discharging them to common point. Hence these systems are well suited for unloading the material from several hoppers and discharging them into pipeline.  ***Note: Same marking should be followed for positive pressure pneumatic conveyor or combine pressure system***	3 2	

6-b **Preventive maintenance chart for centrifugal pump:** — 8 — 8

Pump part	Trouble	Maintenance
Suction Line	No suction	Priming
Impeller	Not rotating	Lubrication, remove air
Casing	Rusting, Wear & Tear	Use anti rusting agent, lubrication
pump	Pump works for a while and then loses suction	Inspect line and position of seal cage stuffing box, check for obstruction in suction line, vent suction back to source of supply.
Delivery pressure	Not enough pressure	Check whether motor is directly across the line and receiving full voltage. Plug inlet and put line under pressure.
power	Pump takes too much power	Check speed of driver, check for too tight stuffing boxes,

6-c **PERT Chart for shutdown maintenance** : — 8 — 8

General format of **PERT** chart for shutdown maintenance is as follows:

Activity	Duration (days)	EST	LST	EFT	LFT	Total time
Maintenance of piping						
Maintenance of valves						
Maintenance of						

	pump							
	Maintenance of compressor							
	Maintenance of H.E.							
	Maintenance of electrical equipment							
	Maintenance of reactor							
	Testing of equipment							
	Starting of production							

PERT provides a frame which defines the jobs to be done, integrates them in a logical sequence and provides a system of control over the progress of the plan.

Activities in shut down maintenance are

1. Cleaning
2. Maintenance work
3. Checking for leakage
4. Electrical maintenance
5. Run with water

All these activities should be planned with PERT and work should be finished in minimum time.