



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC - 27001 - 2005 Certified)

SUMMER-14 EXAMINATION

Model Answer

Subject code : (12207)

Page 1 of 25

**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.



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 2 of 25

Q No.	Answer	marks	Total marks
1a-i	<p><b>Preventive maintenance :</b></p> <p>It is a system of scheduled , planned which tries to minimize the problem of breakdown maintenance. It is a stich- in –time procedure. It locates big spots in all equipment, provides them regular inspection and minor repairs thereby reducing the danger of unanticipated breakdowns. The principle of preventive maintenance is that prevention is better than cure. Preventive involves .</p> <ol style="list-style-type: none"><li>1) Periodic inspection of equipment and machinery to uncovered conditions that lead to production breakdown and harmful depreciation.</li><li>2) Upkeep of plant equipment to correct such conditions while they are still in a minor stage.</li></ol> <p>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.</p>	4	4
1a-ii	<p><b>Objectives of safety in chemical industry :</b></p> <ol style="list-style-type: none"><li>1) To increase the rate of production</li><li>2) To reduce the cost of production.</li><li>3) To reduce the damage to equipment and machinery</li><li>4) To protect the life and limbs of the workers.</li></ol>	One mark each point	4
1a-iii	<p><b>Main causes of mechanical hazards :</b></p> <p>The common sources of mechanical hazards are unguarded shafting , shaft ends, belt drives , gear trains, projections on rotating parts, chain and sprocket drives and exposed component parts of machines or power driven equipment which rotated rapidly or have considerable power and main catch the worker, tangling him in the machine before he can get free , shear point where a part moving in position past a stationary or moving object would have a scissor like</p>	½ mark each for any 8 causes.	4

**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 3 of 25

[illegible]



	<p>In water system fire extinguishers when the plunger is struck , it breaks the acid bottle, the sulfuric acid and sodium bicarbonate solution react together to release CO<sub>2</sub> gas. The gas generated creates pressure, which forces the water out of the extinguishers nozzle and fire is extinguished.</p> <p>In foam type fire extinguishers , chemical foam is formed by a chemical reaction in which masses of bubbles of CO<sub>2</sub> gas and a foaming agent produced froth. The powerful frothy foam jet will come out and extinguishes fire.</p>		
1bii	<p><b>Documentation of safety audit :</b></p> <p>The safety audit must be documented in two major portions. The first part involves checklists; the latter part involves the final report.</p> <p>Checklists are an integral component of the overall safety audit. These forms should suit the organization and the type of safety audit ( general and/or specific). In the planning stages, key employees should be involved to ensure that all safety programs, operations, and hazards are addressed. At a minimum, include checklists for housekeeping, smoking, personal protective equipment, machinery/equipment and hand tools, fire safety, electrical safety, and chemicals. At the end of this paper is a checklist that you can use to help you identify areas to include in your safety audit. The checklist covers general safety programs and regulatory compliance; facilities and equipment; and specific hazards and operations.</p> <p>The second portion of the documentation, the final report, identifies the safety audit findings, makes observations and recommendations, and offers an overall opinion. The report should provide detail on specific suggested enhancements to remedy deficiencies, and should highlight serious and “repeat” observations.</p> <p>The final report should be communicated to management in a timely manner. Management should take ownership of the audit results and should</p>	3	6



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 5 of 25

	approve improvements to safety and health programs, processes, and equipment.		
2-a	<p><b>Objectives of good plant layout:</b></p> <ol style="list-style-type: none"><li>1. Economy in handling of materials, work in progress and finished goods.</li><li>2. Minimization of production delays.</li><li>3. Lesser work in progress and minimum manufacturing cycle time.</li><li>4. Efficient utilization of available space.</li><li>5. Easy supervision and better production control.</li><li>6. Greater flexibility for change in product design and for further expansion.</li><li>7. Better working conditions by eliminating causes of excessive noise, objectionable odour, smoke etc.</li></ol> <p><b>Principles of good plant layout :</b></p> <ol style="list-style-type: none"><li>1. The layout should be such that every workman has enough space to move and operate.</li><li>2. The minimum distance between each equipment should be 75 cm.</li><li>3. The floor distance should be minimum 4.5m.</li><li>4. There should be proper light and ventilation on each floor.</li><li>5. Floor must be of non skid type.</li><li>6. Windows of proper dimension should be provided to get natural day light.</li><li>7. A grid type of layout is essential with roads and fire water systems at a maximum of 300 m. centre to centre, serving two sides of each major hazard.</li><li>8. Equipment within process unit should be located with due consideration to potential hazard.</li></ol>	<p>½ marks each for any four</p> <p>½ marks each for any four</p>	4
2-b	<b>Types of hazards :</b>	½ marks	4



**SUMMER-14 EXAMINATION**

**Model Answer**

Subject code : (12207)

Page 6 of 25

	<div>1) Mechanical hazards</div> <div>2) Electrical hazards</div> <div>3) Noise hazards</div> <div>4) Radiation hazards</div> <div>5) Explosion hazards</div> <div>6) Toxic hazards</div> <div>7) Chemical hazards</div> <div>Chemical hazards :</div> <div>Different Hazards chemical materials are :</div> <div>Explosives, Non-flammable and flammable gases, flammable liquids, flammable solids, oxidizing materials, poisonous materials, radioactive materials, corrosive materials etc.</div> <div>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.</div>	<div>each for</div> <div>any 4</div> <div>2</div>																			
2-c	<table><tr><th>Class</th><th>Description</th><th>Suitable type of extinguishes</th></tr><tr><td>A</td><td>Fires involving ordinary combustion materials like wood , paper, cloth etc where effect of water is essential to extinguish.</td><td>Soda acid</td></tr><tr><td>B</td><td>Fires in flammable liquids like oil, solvents, petroleum prod, varnish paint where blanketing effect in essential</td><td>Foam , CO<sub>2</sub>, gas, dry chemical powder</td></tr><tr><td>C</td><td>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.</td><td>CO<sub>2</sub> Gas, chemical power</td></tr><tr><td>D</td><td>Fires involving metal like Mg, Al K etc. where its burning is reacting to water and which require special extinguishing media or technique</td><td>Special powder</td></tr><tr><td>E</td><td>Fires involving electrical equipment</td><td>CO<sub>2</sub>, gas, dry</td></tr></table>	Class	Description	Suitable type of extinguishes	A	Fires involving ordinary combustion materials like wood , paper, cloth etc where effect 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 <sub>2</sub> , 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.	CO <sub>2</sub> Gas, chemical power	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	CO <sub>2</sub> , gas, dry	4	4
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**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 7 of 25

		where the electrical non conductivity of the extinguishing media is of prime importance	chemical powder but when the ele3ctrical equipments is dancercised. Even soda acid or foam is suitable.											
2-d	<b>Different modes of transport of Chemicals are:</b>  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	4									
2-e	<b>Audit report :</b>  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 repeat observations.  <b>General content of audit report:</b> <table><tr><td>Activity</td><td>Description</td><td>Remark/ suggestions</td></tr><tr><td>Plant safety review</td><td>Adequacy of operations, equipment and building safety</td><td></td></tr><tr><td>Job safety analysis</td><td>Standard operating procedures to be</td><td></td></tr></table>			Activity	Description	Remark/ suggestions	Plant safety review	Adequacy of operations, equipment and building safety		Job safety analysis	Standard operating procedures to be		4	4
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**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 8 of 25

		updated where necessary			
	Operator review	Check for deviation from standard operating procedure and work habits.			
	Supervisors safety meetings	Education ,training, drills, follow-up			
	Management development seminar	Development of management competence			
	Supervisory training	Training of foreman for supervisory role			
	Safety committee	Motivational safety suggestions			
	Plant managers meeting	Communication , education, training, innovation, follow-up.			
	Critical incident technique	Observation of un-safe acts, conditions, reports of near misses			
	Central plan safety committee	Safety policy			
	Safety review committee	Review of safety of new processes and / or equipment.			
	Work safety procedures review.	Review of work safety procedure.			
2-f	<b>Shutdown maintenance :</b> <p>Shutdown maintenance is the maintenance work carried out when machine, equipment or plant is not working or is shut down.</p> <p>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.</p> <p><b>Important steps in shutdown process are :</b></p> <ol style="list-style-type: none"> <li>1) Identify material storage and laydown areas .</li> <li>2) Designate equipment wash areas.</li> </ol>			4	4





**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 9 of 25

	<p>3) Establishing crew- marshalling areas in the event of an emergency .</p> <p>4) Determine what lunch, lavatory and change room facility requirements are required.</p> <p>.Planning and scheduling are concurrent activities for shutdown.</p>		
3-a	<p>When plant is stopped for annual major shutdown, then the procedure to be followed for start- up of a plant is</p> <p>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 safest and cheapest way of checking the functioning of the plant equipment in total.</p> <p>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</p>	<p>02 mark</p> <p>02 mark</p>	<p>4</p>
3-b	<p><b>Benefits of Safety Audit</b></p> <p>i) Safety audit can be used by management to uncover safety and health problems before personal injuries, property damage, or business interruptions occur.</p> <p>ii) A safety audit also serves as a visible process that management can execute to demonstrate to employees that they are interested in their safety.</p> <p>iii) A safety audit uncovers unsafe conditions and poor work practices, which are the principal causes of accident.</p> <p>iv) Safety audit can reduce illness and injuries, and associated medical,</p>	<p>1 mark</p> <p>each for</p> <p>any four</p> <p>points</p>	<p>4</p>



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 10 of 25

	<p>insurance and litigation.</p> <p>v) Safety audit can improve business operation. It can maintain, and in some instances, increases productivity, by reducing interruptions caused by accidents.</p> <p>vi) Safety audit identifies conditions where machinery, equipment or tools need repair or replacement, thus increasing the efficiency of the business operation.</p>		
3-c	<p>Principles of Materials handling includes:</p> <p><b>i) Planning Principles:</b> In this material handling should be planned and well integrated with production activity to obtain maximum overall operating efficiency.</p> <p><b>ii) Operating Principles:</b> It includes</p> <p>a)Unit load handling principle:</p> <ul style="list-style-type: none"><li>• Material should handle in bulk over distances.</li><li>• Fragile or breakable materials should be arranged in trays or in layers separated by wood or card board, the whole being held by strapping.</li></ul> <p>b)Gravity Principle : It suggests that</p> <ul style="list-style-type: none"><li>• Material wherever possible should be moved using most economical gravity (motive) force.</li></ul> <p>c) Flow of materials Principle: According to this material handling efficiency is the greatest when it approaches steady flow of materials, in as straight as possible with minimum of interruptions and minimum of back tracking.</p> <p><b>iii)Equipment principles:</b> It includes mechanization principle, terminal time principle, dead weight principle, standardization principle, maintenance principle, speed principle &amp; versatility principle</p> <p><b>iv)Costing Principles:</b></p> <p>a) Equipment selection principle:</p>	1 mark each for any four points	4



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 11 of 25

	<p>b) Replacement principle: Material handling cost is the lowest if the equipment is used only for its economic retentive period and is replaced by an alternative based on engineering economic principles.</p> <p>c) Handling cost appraisal principle: Periodic analysis of materials handling costs highlights areas of improvements.</p> <p><b>v) General Principles :</b></p> <p>a) Safety principle : Materials handling efficiency increases as working conditions are made safer and safer.</p> <p>b) Training principle This principle suggest that each employee should be given basic training in material handling techniques.</p> <p>c) Identification principle: Material must be kept identified by labeling on pallets and boxes.</p> <p>d) Location principle: All handling equipment should be placed at the right place and at the right time to avoid hunting and delays in materials handling.</p> <p>e) Material treatment principle: All types of materials should be treated as important since material handling costs are not related to the cost of materials.</p>																										
3-d	<p><b>Technical specification of foam type extinguisher:</b></p> <table border="1"> <thead> <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> </thead> <tbody> <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> </tbody> </table>	TYPE	2lit. foam spray S/P	6 lit. foam spray S/P	9lit. foam spray S/P	Capacity(lit)	2	6	9	Fire rating	8A 55B	13A 144B	21A 183B	Height (mm)	395	565	600	Cylinder diameter	112	160	189	Overall width (mm)	150	290	300	Any 6 Specifications of a single capacity extinguisher may be given mark 1/2 mark each	4
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**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 12 of 25

	<table border="1"> <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>&gt;2</td><td>&gt;4</td><td>&gt;4</td></tr> <tr> <td>Working pressure at 20°C</td><td>15</td><td>15</td><td>15</td></tr> <tr> <td>Temperature range( °C)</td><td>0 to 60</td><td>0 to 60</td><td>0 to 60</td></tr> </table> <p><b>Application of a foam type fire extinguisher :</b></p> <p>i) It is effective in extinguishing the fire as well as preventing reignition.</p> <p>ii) It provides a high degree of protection from heat damage to surrounding structures and equipment.</p>	Filled weight(kg)	3.81	10.09	14.21	Range of throw(m)	>2	>4	>4	Working pressure at 20°C	15	15	15	Temperature range( °C)	0 to 60	0 to 60	0 to 60	1 mark for any one	
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3-e	<p><b>Toxic hazards:</b> In toxic hazard a substance has the ability to produce any ill effects on the human body when it reaches a susceptible site..</p> <p><b>Causes of toxic hazard:</b> The toxic chemicals enter the human body through Inhalation, Ingestion and skin absorption beyond a prescribed level and it causes harm to a body.</p> <p><b>Effects of toxic hazard:</b> In the body toxic chemicals are destroyed and disposed of 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 fails to dispose of the toxic chemicals. The continued presence of toxic chemicals cause pathological changes in the body , structural or functional damage, inflammations, disorders of growth or repair and diseases.</p>	1  1  2	4																
4-a-i	<p><b>Line diagram of storage</b></p> <p><b>Factors controlling the layout are:</b></p> <p>i) Overall integration of factors ii) Minimum movement</p> <p>iii) Unidirectional flow iv) Effective use of available space</p> <p>v) Maximum visibility vi) Maximum accessibility</p>	2     1/2 mark each for any four	4																



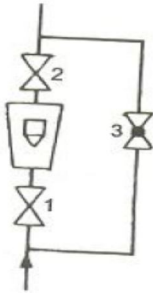
**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 13 of 25

	vii) Minimum handling viii) Inherent safety ix) Safe and improved environments x) Maximum flexibility xi) Maximum security		
4-a-ii	<p>Roles of maintenance department in chemical industry:</p> <p><b>1) Inspection:</b></p> <p>i) Inspection of the plant facilities to examine their condition and to check for repairs needed.</p> <p>ii) Inspection to ensure the safe and efficient operation of plant equipment and machinery.</p> <p>iii) Inspection to make it certain that every working equipment receives proper attention.</p> <p>iv) Inspection to check the maintenance items received from vendors for their fitness.</p> <p><b>2) Engineering :</b></p> <p>i) Engineering involves alternations and improvement in existing plant equipment to minimize breakdown.</p> <p>ii) Engineering and consulting services to production supervision.</p> <p><b>3) Maintenance :</b></p> <p>i) Maintenance of existing plant equipment.</p> <p>ii) Engineering and execution of planned maintenance, minor installations of equipment building and replacements.</p> <p><b>4) Repair:</b></p> <p>i) To carry out corrective repair to alleviate unsatisfactory conditions found during preventive maintenance inspection.</p> <p><b>5) Overhaul:</b></p> <p>i) Overhaul is a planned, scheduled reconditioning of plant facilities such as machinery etc.</p>	1 mark each for any four	4



	<p>ii) Overhaul involves replacement, reconditioning, reassembly, etc.</p> <p><b>6) Construction :</b></p> <p>i) In some organization, maintenance department is provided with equipment and personnel and it takes up construction job too.</p> <p><b>7) Salvage :</b></p> <p>i) Maintenance department may also handle disposition of scrap or surplus materials.</p> <p><b>8) Clerical work:</b></p> <p>i) Maintenance department keeps records at i) of costs, ii) of time progress on jobs pertaining to important features of building and production equipment.</p>		
4a-iii	<p><b>ON LINE MAINTENANCE;</b> 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 Rota meter 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 &amp; divert the fluid through by-pass line. After replacement of the glass pipe in the rotameter close valve 3 and open 1 &amp; 2. Thus it is possible to attend maintenance jobs in the line without stopping the production.</p> 	2	4
4a-iv	<p><b>Procedure for maintenance of jacketed reactor :</b></p> <p>Jacketed reactors generally consist of a vertical vessel equipped with an agitator</p>	4	4



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 15 of 25

	<p>and external jacket. Other components from maintenance point of view are stuffing box, gear box, coupling, safety devices- valve and electric motor.</p> <p>Impeller and shaft of agitator during operation faces a problem of corrosion, abrasion and bending the content of the reactor is responsible for this. The effect of this will be improper mixing; batch will not be complete in given time unbalancing and vibrations. Maintenance involves refilling of material, rectification of bend or replacement of this part by new one.</p> <p>In case of coupling we have to see that proper size and number of nuts and bolts is used or not. Also we have to check for proper tightening and alignment.</p> <p>For gear box we have to use proper lubricant, the level of lubricant should be maintained and it should be replaced when it deteriorates. The O-ring seal of gear box should be inspected periodically and replaced as and when damaged. Bearing of the gear box should be inspected periodically.</p> <p>In case of jacket for removal of scale use suitable discarding agents, acid cleaning may be practiced.</p> <p>Leakage through stuffing box should be rectified by replacement of new packing material. In case of reactor operated at high pressure, gland packing should be replaced after every batch. The safety valve should be tested for its operation and maintained properly.</p> <p>Electric motor should be checked for overheating if overheating is there then check bearing and winding</p>		
4b-i	<p>Types of personal protective equipment</p> <p><b>1. Respiratory protective equipment are further classified as</b></p> <p><b>i) Air purifying type</b></p> <p>a) Mechanical filter respirators : These give protection against dust and particulate matter only and don't provide any protection against harmful vapors, gases or oxygen deficient atmospheres</p>	<p>Any 6 Points may be given mark 1 mark each</p>	6



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page **16** of **25**

	<p>b)Canister gas masks: The canister contains certain neutralizing chemicals Which can absorb a particular contaminant</p> <p>c)Chemical cartridge respirator : This masks are effective only at very low concentration and cannot be used in emergency</p> <p><b>ii) Supplied air type:</b> Here is supplied to the full face mask or hood so that wearer gets constant supply of breathable air drawn from a non contaminated area away from his place of work.</p> <p><b>iii) Self-contained breathing apparatus :</b> These are designed to supply complete respiratory protection in any concentration of toxic gasses or even in environment deficient of oxygen</p> <p><b>2. Non respiratory personal protective equipment consist of</b></p> <p><b>iv) For protection of eyes goggles</b> and spectacles are used may be needed from Sparks, glares,. Dust, gasses, vapors etc. Use of goggles is compulsory for operations such as gas cutting, welding, grinding, chipping etc.</p> <p><b>v) For a face and eye protection face shield</b> and hoods are used. Face shields Protect face and neck from flying particles, chemical splashes etc. tinted transparent plastic shields protect against glare.</p> <p><b>vi) Helmets, hard hats</b> and caps are used for the protection of head. Industrial Safety helmets can protect against falling objects or impact with fixed objects. Caps, helmets etc which can protect the scalp and hair from entanglement.</p> <p><b>vii) For protection of foot and legs</b>, safety shoes, boots, foot guards, leg guards are used. The common types of safety shoes are generally with leather or rubber or PVC sole and having reinforces metal toe cap, which protects to toes against falling objects, accidental kicking against sharp objects.</p> <p><b>Viii) Ear muff</b>, ear plug can be used for protection of ear.</p>		
4-b-ii	<b>Fire may be extinguished</b> by withdrawal of flammable contents, interrupting	3	6





**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 17 of 25

	<p>flammable flow, isolating fuel from air, heat removal to below reaction temperature.</p> <p><b>Withdrawal of flammable contents</b> can be accomplished by 1).Blowing down the vessel and piping contents ( 2)Pump out or 3)draining Flammable flow may be interrupted by the shutdown of pumps, closing of valves.</p> <p><b>Isolation of flammable flow</b> from the air is accomplished by blanketing with steam or water spray, foam, CO<sub>2</sub> etc.</p> <p><b>CO<sub>2</sub> type (fire extinguishers) system:</b></p> <p>In CO<sub>2</sub> type fire extinguishers CO<sub>2</sub> 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 valve through which the rate of discharge can be regulated. CO<sub>2</sub> 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.</p>	3																																				
5-a	<p><b>PERT Chart for shutdown maintenance :</b></p> <p>General format of <b>PERT</b> chart for shutdown maintenance is as follows:</p> <table><tr><th>Activity</th><th>Duration (days)</th><th>EST</th><th>LST</th><th>EFT</th><th>LFT</th><th>Total time</th></tr><tr><td>Mainten ance of piping</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Mainten ance of valves</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Mainten ance of pump</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Mainten ance of compres sor</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>	Activity	Duration (days)	EST	LST	EFT	LFT	Total time	Mainten ance of piping							Mainten ance of valves							Mainten ance of pump							Mainten ance of compres sor							4	4
Activity	Duration (days)	EST	LST	EFT	LFT	Total time																																
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**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 18 of 25

	Maintenance of H.E.								
	Maintenance of electrical equipment								
	Maintenance of reactor								
	Testing of equipment								
	Starting of production								
5-b	<b>Important precautions in transportation of <math>H_2SO_4</math>:</b> <ol style="list-style-type: none"> <li>1. The driver and cleaner of the truck transporting <math>H_2SO_4</math> should be instructed about the hazardous nature of the chemical and precautions to be taken in case of any accidents.</li> <li>2. The physical and chemical details of the chemical should be clearly indicated on the outside of the vehicle carrying <math>H_2SO_4</math>.</li> <li>3. <math>H_2SO_4</math> is stored and transported in tanks fabricated from carbon steel.</li> <li>4. Storage tanks should be enclosed by a secondary container wall having a capacity not less than 120% of the largest tank volume.</li> <li>5. Wall thickness of the container should be carefully calculated to provide for corrosion allowances..</li> </ol> <b>Important precautions in transportation of Phenol:</b> <ol style="list-style-type: none"> <li>1. Phenol is normally transported in drums.</li> </ol>							½ mark each for any four	4



	<p>2. Avoid direct contact of chemical with body</p> <p>3. Avoid contact with water as phenol is soluble in water.</p> <p>4. The driver and cleaner of the truck transporting phenol should be instructed about the hazardous nature of the chemical and precautions to be taken in case of any accidents.</p> <p>5. The physical and chemical details of the chemical should be clearly indicated on the outside of the vehicle carrying phenol.</p>	any four	
5-c	<p><b>Ear Plug :</b></p> <p>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</p> <p><b>Ear Muffs :</b></p> <p>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.</p>	<p>2</p>     <p>2</p>	4
5-d	<p><b>Preventive measures to avoid electrical hazards:</b></p> <p>The danger of injury through electrical shock is present whenever electrical power is used.</p> <ol style="list-style-type: none"> <li>1. All electrical should be adequately insulated, grounded or isolated to prevent bodily contact with any source of dangerous potentials.</li> <li>2. To prevent electrical shock, ensure that all equipment are properly grounded.</li> <li>3. To reduce the risk of shock, do not contact any electrical components, and keep the work area dry.</li> <li>4. Check all equipment regularly and wear the proper protective equipment when working with high voltages or currents.</li> <li>5. The primary effects of electrical shock are due to current actually</li> </ol>	<p>1 mark each for any four points</p>	4



	<p>flowing through the body. Electrical burns occur when the body completes a circuit connecting the power source with the ground. Although the resistance of dry , unbroken skin to electrical current is relatively high, the amount of current necessary to kill a 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.</p>		
5-e	<p><b>Instrumentation for safe plant operations :</b></p> <p>Most accidental release are the result of either mechanical failures or measure to prevent such failures such as venting through emergency vents, relief valves or rupture discs. Where the mechanical failures is the result of defective materials, inadequate design or external factors , little can be done by means of instrumentation to prevent the release. Many failures are due to process upsets such as over pressure, internal explosion , and runaway reactions. The probability of these failures occurring can be reduced by proper instrumentations.</p> <p>Process instrumentation system can normally be divided into two parts.</p> <ol style="list-style-type: none"> <li>1) <b>Control instrumentation</b> :- Control failure may result in unsafe condition. Eg. Pressure gauge, level indicators, controllers for parameter like pressures, temperature, flow , level etc.</li> <li>2) <b>Safety instrumentation</b> :- It must be designed to fail safe when ever possible. Eg. Safety valve , rupture disc, gas detectors etc.</li> </ol>	2	4
5-f	<p><b>Controlling methods of toxic chemical-Cl<sub>2</sub></b></p> <p>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</p>	2	4



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page **21** of **25**

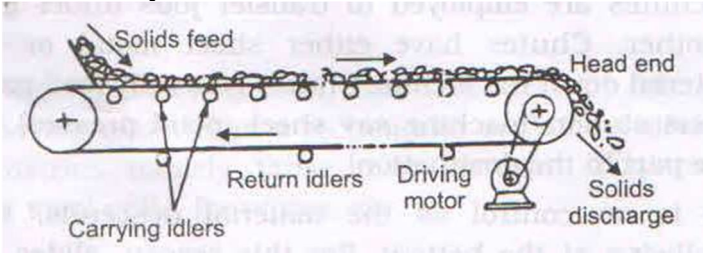
	<p>carbon, H<sub>2</sub>S, SO<sub>2</sub>, CO etc.</p> <p><b>To control hazards of ammonia:</b></p> <ol style="list-style-type: none"><li>1. Provide information pertaining to the hazards of ammonia.</li><li>2. Design and install receiving/ storage vessels according to generally accepted good engineering practices.</li><li>3. Ensure that safety relief valves and relief systems for storage vessels are properly designed and installed.</li><li>4. Place barriers around receiving and storage vessels and other equipment.</li><li>5. Conduct a process hazard analysis.</li><li>6. Provide training specific to the operation of a receiver and storage vessel.</li><li>7. Maintain proper oxygen and water content in vessel to avoid stress corrosion and cracking in welds of vessels.</li><li>8. Routinely inspect for corrosion of the receiving and storage vessels.</li></ol>	1/2mark each for any four	
6-a	<p><b>Predictive maintenance:</b></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 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.</p>	4	4



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 22 of 25


	<p><b>Four senses adopted for predictive maintenance technique (Human senses) :</b></p> <ol style="list-style-type: none"> <li>1. Ear : eg. Unusual sound coming out of rotating equipment.</li> <li>2. Eye : eg. Excessive vibration of equipment or dislocation of moving part.</li> <li>3. Touch : eg. Excessive temperature of equipment.</li> <li>4. Smell : eg. Unusual smoke coming out of equipment.</li> </ol> <p><b>Four sensitive instruments adopted for predictive maintenance technique:</b></p> <ol style="list-style-type: none"> <li>1. Audio gauges : eg. Unusual sound coming out of rotating equipment.</li> <li>2. Vibration analysor : eg. Excessive vibration of equipment</li> <li>3. Amplitude meter : eg. Excessive temperature of equipment.</li> <li>4. Pressure, temperature and resistance strain gauges: eg. Excessive temperature of equipment.</li> </ol>		
6-b	<p><b>Belt Conveyor</b></p> 	4	4
6-c	<p><b>PPE</b> means Personal Protective Equipment .</p> <p><b>PPE are classified into</b></p> <ol style="list-style-type: none"> <li>1) Respiratory protective equipment</li> <li>2) Non-Respiratory protective equipment</li> </ol>	1 1	4
		1 mark	



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page 23 of 25

	 <p>The image displays various personal protective equipment (PPE) items. At the top left are two orange earplugs. To their right are a pair of orange work gloves. Below the earplugs are two yellow safety helmets, one showing the interior. At the bottom left is a diagram of safety glasses with labels: 'Adjustable Arm(s) (or Temple)', 'Top Shield', 'Frame', 'Bridge', 'Anti-fog Impact-resistant Lens(es)', 'Lens Marking', and 'Side Shield(s)'. To the right of the glasses is a pair of yellow rubber boots.</p>	each for any two	
6-d	<b>Radiation Hazard :</b> Nuclear Industry, Hospital (X-ray division) are some industries where radiation	1	4



**SUMMER-14 EXAMINATION**  
**Model Answer**

Subject code : (12207)

Page **24** of **25**

	<p>hazard takes place.</p> <p>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.</p> <p><b>Radiation hazard can be avoided by:</b></p> <ol style="list-style-type: none"><li>1 .Limiting the exposure time</li><li>2. Using shielding from radiation</li><li>3. Using personal protective devices like rubber gloves, rubber shoes, cotton caps etc. to avoid external hazard.</li><li>4. Using fresh air mask if the air is contaminated</li><li>5. Continuously monitoring the amount of radiation received.</li></ol>	3	
6-e	<p><b>Disadvantages of breakdown maintenance :</b></p> <ol style="list-style-type: none"><li>1) Breakdown generally occur at inopportune time. This leads to poor, hurried maintenance and excessive delays in production.</li><li>2) Reduction of output.</li><li>3) Faster plant deterioration</li><li>4) Increased chances of accidents and less safety to both workers and machines.</li><li>5) More spoilt material.</li><li>6) Direct loss of profit.</li><li>7) Breakdown maintenance can not be employed for those plant items which are regulated by statutory provision eg. Cranes, lifts, and pressure vessels.</li></ol>	One mark each for any four	4





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**SUMMER-14 EXAMINATION**

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Subject code : (12207)

Page **25** of **25**