CBSE | DEPARTMENT OF SKILL EDUCATION

AIR CONDITIONING & REFRIGERATION (SUBJECT CODE - 827)

MARKING SCHEME FOR CLASS - XII (SESSION 2023-2024)

Max. Time: 3 Hours **Max. Marks: 60**

General Instructions:

1. Please read the instructions carefully.
2. This Question Paper consists of **24 questions** in two sections – Section A & Section B.
3. Section A has Objective type questions whereas Section B contains Subjective type questions.
4. **Out of the given (6 + 18 =) 24 questions, a candidate has to answer (6 + 11 =) 17 questions in the allotted (maximum) time of 3 hours.**
5. All questions of a particular section must be attempted in the correct order.
6. **SECTION A - OBJECTIVE TYPE QUESTIONS (30 MARKS):**
   - **i.** This section has 06 questions.
   - **ii.** There is no negative marking.
   - **iii.** Do as per the instructions given.
   - **iv.** Marks allotted are mentioned against each question/part.
7. **SECTION B – SUBJECTIVE TYPE QUESTIONS (30 MARKS):**
   - **i.** This section contains 18 questions.
   - **ii.** A candidate has to do 11 questions.
   - **iii.** Do as per the instructions given.
   - **iv.** Marks allotted are mentioned against each question/part.

SECTION A: OBJECTIVE TYPE QUESTIONS

Q. No.	QUESTION	Source Material (NCERT/PSSCIVE/ CBSE Study Material)	Unit/ Chap. No.	Page no. of source material	Marks
Q. 1	**Answer any 4 out of the given 6 questions on Employability Skills (1 x 4 = 4 marks)**				
i.	Positive thinking: to think that one can get things done and be happy.	Employability skills textbook Class XII	2 Self management Skills	Pg.23	1
ii.	A spreadsheet or electronic Spreadsheet is also a long sheet of rows and columns on the computer screen. This helps to manage and organize data in rows and columns. Spreadsheets can be used to do calculations on data, create data reports, manage accounting documents, do data analysis, etc. You can also create graphical representation of data.	Employability skills combined book/Study material Class XII	3 ICT Skills	Pg.14	1
iii.	Entrepreneurs identify an innovation to seize an opportunity, mobilise funds, raise capitals and take calculated risks to open market or new business for products, processes and services.	Employability skills textbook Class XII	4 Entrpreneurship Skills	Pg.78	1
iv.	A green collar worker is one who is employed in the environmental sectors of the economy.	Employability skills textbook Class XII	5 Green Skills	Pg.112	1

	Green collar workers include professionals, such as green building architects, environmental consultants, waste management or recycling managers, environmental or biological systems engineers, landscape architects, solar and wind energy engineers and installers, green vehicle engineers, organic farmers, environmental lawyers and business personnel dealing with green services or products.				
v.	M I N T S Months I Names Titles Starting letter of sentences MINTS is a set of simple rules that help you to capitalise words correctly.	Employability skills textbook Class XII	1 Communication skills	Pg.9	1
vi.	The steps to open an already saved workbook are: 1. Select Open option from the File menu. Or Click Open icon on the Standard bar. Or Press Ctrl + O 2. The Open dialog box appears. 3. Select the drive and the folder from where you want to open the file. 4. Select the file and click Open button.	Employability skills combined book/Study material Class XII	3 ICT Skills	Pg.17	1
Q. 2	**Answer any 5 out of the given 7 questions (1 x 5 = 5 marks)**				
I	A current starting relay is connected in the circuit in (a) Parallel with the running winding (b) Series with the starting winding (c) Series with the running winding (d) Parallel with the starting winding **ANSWER: (c) Series with the running winding**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-4	60	1
ii	In the sensible heating process of air the D.B.T. of the air is (a) Increased (b) Decreased (c) Increased with increase in moisture content of air (d) Remains unchanged **ANSWER: (a) Increased**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-1	07	1
iii	Humidification of air is known as (a) Decrease in moisture content of air (b) Increase in moisture content of air (c) No change in moisture content of air (d) None of the above **ANSWER: (b) Increase in moisture content of air**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-1	9	1
iv	A desert cooler is also known as (a) Water cooler (b) Brine cooler (c) Evaporative cooler (d) Water chiller **ANSWER: (c) Evaporative cooler**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 5	64	1
v	To limit the flow of heat into a refrigerator, which one of the followings is used	CBSE STUDY MATERIAL AIR-	UNIT-2	18	1

	(a) A thermal conducting material (b) A thermal insulating material (c) An electric conductor (d) An electric insulating material **ANSWER: (b) A thermal insulating material**	CONDITIONING & REFRIGERATION (CODE-827)			
vi	For summer air conditioning, which one among the following psychrometric process is used (a) Sensible cooling process (b) Sensible heating process (c) Cooling with dehumidification of air process (d) Humidification process **ANSWER: (c) Cooling with dehumidification of air process**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	Unit-1	11	1
vii	Over load protector in a refrigerator is used as (a) A starting device (b) A safety device (c) A stabilizer (d) None of the above **ANSWER: (b) A safety device**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-4	62	1
Q. 3	**Answer any 6 out of the given 7 questions (1 x 6 = 6 marks)**				
I	Which one of the followings is used as refrigerant in an ice plant (a) Air (b) Water (c) NH3 (d) CO2 **ANSWER: (c) NH3**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -3	54	1
ii	Which one of the followings is not a secondary refrigerant (a) Water (b) Ammonia (c) Air (d) Brine **ANSWER: (b) Ammonia**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -3	51	1
iii	The insulating material used now-a-days in refrigerators is (a) Glass wool (b) PUF (c) Thermocole (d) None of the above **ANSWER: (b) PUF**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 2	19	1
iv	PUF can be used for operating temperature in the range of (a) 0-1000 C (b) 0-1500C (c) -100 to 1000C (d) -200 to 1500C **ANSWER: (d) -200 to 1500C**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 2	20	1
v	Which one of the following is also a current type relay (a) Potential relay (b) Hot wire relay (c) Solid state relay (d) None of the above **ANSWER: (b) Hot wire relay**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -4	60	1

vi	The conditioned air is supplied to the conditioned space through (a) Shafts (b) Sheets (c) Ducts (d) None of the above **ANSWER: (c) Ducts**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 5	67	1
vii	The ducts normally used are made of (a) G.I. Sheets (b) Cloth (c) Stone (d) None of the above **ANSWER: (a) G.I. Sheets**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 5	67	1
Q. 4	**Answer any 5 out of the given 6 questions (1 x 5 = 5 marks)**				
i	Evaporator of a refrigerator is also known as (a) Freezer (b) Condenser (c) Capillary tube (d) Compressor **ANSWER: (a) Freezer**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 3	42	1
ii	Which one of the following types of condenser is used in a window air conditioner? (a) Air cooled condenser (b) Water cooled condenser (c) Evaporative condenser (d) None of the above **ANSWER: (a) Air cooled condenser**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 6	69	1
iii	Constant pressure expansion valve is also known as (a) Float valve (b) Automatic expansion valve (c) Thermostatic expansion valve (d) Solenoid valve **ANSWER: (b) Automatic expansion valve**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -3	36	1
Iv	Which one of the followings is used as a refrigerant control device in a refrigerator (a) Capillary tube (b) High side float valve (c) Low side float valve (d) Automatic expansion valve **ANSWER: (a) Capillary tube**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -3	36	1
V	Drier in a refrigeration system is used to (a) Clean the evaporator (b) Absorb the moisture from refrigerant (c) Add the moisture to refrigerant (d) Clean the condenser **ANSWER: (b) Absorb the moisture from refrigerant**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT -3	35	1
Vi	In an evaporative condenser which of the following is used as cooling medium (a) Air (b) Water (c) Combination of air and water both (d) None of the above	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 3	34	1

	ANSWER: (c) Combination of air and water both				
Q. 5	**Answer any 5 out of the given 6 questions (1 x 5 = 5 marks)**				
i	When discharge pressure of the compressor becomes excessive which one of the following operates (a) H.P. Cutout (b) L.P. Cutout (c) Both H.P. and L.P. Cutout (d) Oil pressure cutout **ANSWER: (a) H.P. Cutout**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 4	55	1
ii	The low pressure control protects the system against the following (a) Leak of air in the system (b) Extreme compression ratio (c) Freezing up of the evaporator (d) All of the above **ANSWER: (d) All of the above**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 4	55	1
iii	For ice making, the ice can, after freezing are dipped in hot water, this process is known as (a) Sensible heating (b) Sensible cooling (c) Thawing (d) Cleaning of ice **ANSWER: (c) Thawing**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT 5	68	1
iv	Non-ferrous metals are never used with one of the following refrigerants (a) R-12 (b) R-22 (c) NH3 (d) CO2 **ANSWER: (c) NH3**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-3	55	1
v	The butter prepared from the cream removed from the milk is stored at a temperature range of (a) 0 to 100 C (b) -17.8 to -330 C (c) -10.3 to -5 0 C (d) 10.5 to 150 C **ANSWER: (b) -17.8 to -330 C**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-5	65	1
vi	Pasteurization of milk is carried out to (a) Kill the virus (b) Kill the pathogenic bacteria (c) Make the milk white (d) None of the above **ANSWER: (b) Kill the pathogenic bacteria**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-5	65	1
Q. 6	**Answer any 5 out of the given 6 questions (1 x 5 = 5 marks)**				
i	Dip tanks are used in the (a) Cold storage (b) Milk dairies (c) Refrigerators (d) Ice plants **ANSWER: (d) Ice plants**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-5	65	1
ii	A.H.U. is used in (a) A central air conditioning plant	CBSE STUDY MATERIAL AIR-	UNIT-6	76	1

	(b) A refrigerator (c) A water cooler (d) A deep freezer **ANSWER: (a) A central air conditioning plant**	CONDITIONING & REFRIGERATION (CODE-827)			
iii	In all water system the working fluid used is (a) Air (b) Water (c) Air and water both (d) A refrigerant **ANSWER: (b) Water**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	69	1
iv	The function of a filter in the air conditioning system is (a) To cool the air (b) To heat the air (c) To clean the air (d) All of the above **ANSWER: (c) To clean the air**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	74	1
v	A blower in an air conditioning system is used to handle large quantities of (a) Refrigerant (b) Conditioned air (c) Water (d) All of the above **ANSWER: (b) Conditioned air**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	71	1
vi	Central air conditioning system is used for (a) Summer air conditioning only (b) Winter air conditioning only (c) Year round air conditioning (d) None of the above **ANSWER: (c) Year round air conditioning**	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	69	1

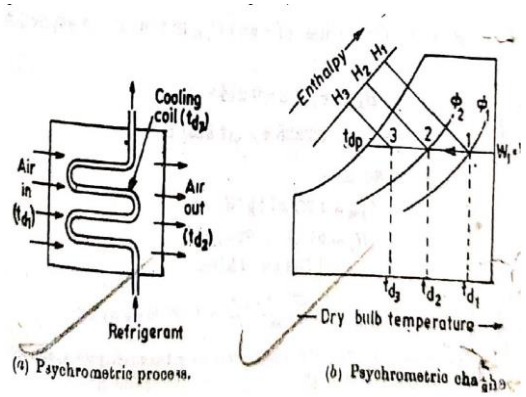
SECTION B: SUBJECTIVE TYPE QUESTIONS

Q. No.	QUESTION	Source Material (NCERT/PSSCIVE/ CBSE Study Material)	Unit/ Chap. No.	Page no. of source material	Marks
Answer any 3 out of the given 5 questions on Employability Skills in 20 – 30 words each (2 x 3 = 6 marks)					
Q. 7	Simple sentence A simple sentence is one that has only one subject and one predicate or has only one finite verb. Eg: Emma is writing a letter. Complex sentence A complex sentence is one, which consists of two or more coordinate clauses, joined by a coordinating conjunction Eg: Whenever it rains, I like to wear my blue coat.	Employability skills textbook Class XII	1 Communication skills	Pg.16	2
Q. 8	•Openness: Individuals with openness to experience are, generally, creative, curious, active, flexible and adventurous. If a person is interested in learning new things, meeting new people and	Employability skills textbook Class XII	2	Pg.33	2

	making friends, and likes visiting new places, the person can be called open-minded. • Consciousness: Individuals, who listen to their conscience, are self-disciplined, do their work on time, take care of others before themselves and care about others' feelings. • Extraversion: Extroverts are individuals, who love interacting with people around and are, generally, talkative. A person, who can easily make friends and make any gathering lively, is confident and an extrovert. •Agreeableness: Individuals having such a trait are, generally, kind, sympathetic, cooperative, warm and considerate. They accommodate themselves in any situation. For example, people who help and take care of others are, generally, agreeable. • Neuroticism: Neuroticism is a trait, wherein, individuals show tendency towards anxiety, self-doubt, depression, shyness and other similar negative feelings. People, who have difficulty in meeting others and worry too much about things, show signs of neuroticism. **All points briefly explained.**		Self management Skills		
Q. 9	To print a worksheet, the steps are: 1. Click File ➢Print. 2. The Print dialog box will appear 3. Select the printer, the range to be printed, and the number of copies. 4. Click the Print button.	Employability skills combined book/Study material Class XII	3 ICT Skills	Pg.36	2
Q. 10	**'Startup India'** 'Startup India', a flagship initiative of the Government of India, is intended to build an ecosystem for the growth of startup business. Startup policies have been formulated by the States. Under this scheme, new startups in India can avail regulatory and tax benefits, capital gain exemption, as well as, access to government funding, if they fulfil the criteria. **(Website: http://startupindia.in)**	Employability skills textbook Class XII	4 Entrepreneurship Skills	Pg.89	2

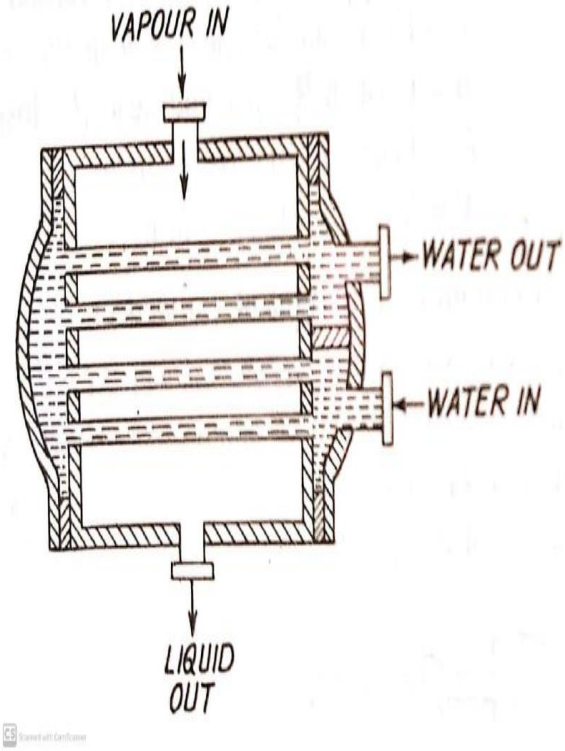
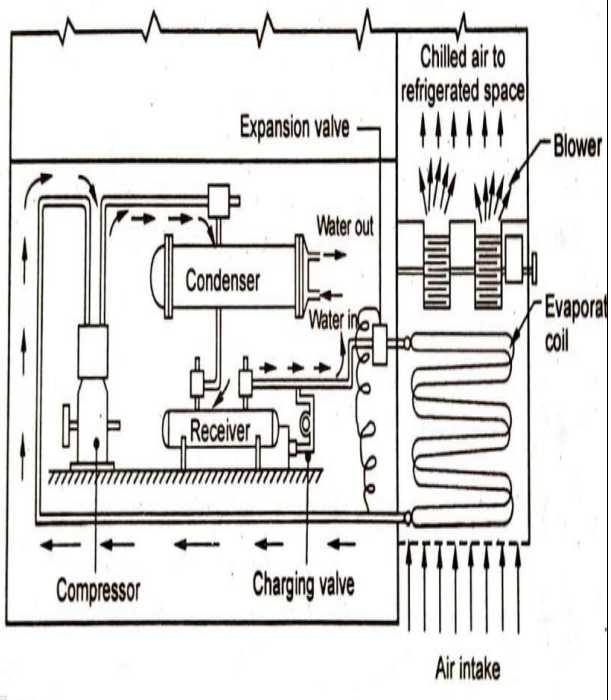
Q. 11	The Energy Efficiency Services Limited (EESL), under the Ministry of Power, has launched an 'electric vehicle programme', which aims towards offering a comprehensive solution to facilitate the adoption of disruptive technology in India. The EESL seeks to create market for electric vehicle, a technology poised to boost e-mobility in the country. Some electric vehicle technologies are hybridised with fossil fuel engines (for example, plug-in hybrid electric vehicles, or PHEVs), while others use only electric power via a battery (battery electric vehicles)	Employability skills textbook Class XII	5 Green Skills	Pg.115	2
Answer any 3 out of the given 5 questions in 20 – 30 words each (2 x 3 = 6 marks)					
Q. 12	What is an Insulating material? Explain. **ANSWER:** Heat always travels from high temperature to low temperature space. In all the refrigeration systems, the surroundings are always at higher temperature and heat tends to travel from the surroundings to the refrigerated space. It is necessary to isolate the refrigerated space from surroundings with a good thermal insulating material. These materials are mostly non-metallic and have a basic structure in which there are numerous cells containing air or other gases. However, some insulating materials are metallic and have heat reflecting surfaces	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-2	19	2
Q. 13	Write the name of the psychrometric process which can be used for summer air conditioning **ANSWER:** Cooling with dehumidification process is used for air conditioning in summers. The process is carried out by passing the air over a cooling coil whose temperature is lower than the *D.P.T*. of the air.	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-1	11	2
Q. 14	Write the names of various refrigerant control devices. **ANSWER:** There are six basic types of refrigerant flow controls, namely: A) The automatic expansion valve or constant pressure expansion valve B) The thermostatic expansion valve or constant superheat expansion valve C) Capillary tube D) High side float valve E)Low side float valve F) Solenoid valve	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-3	36	2

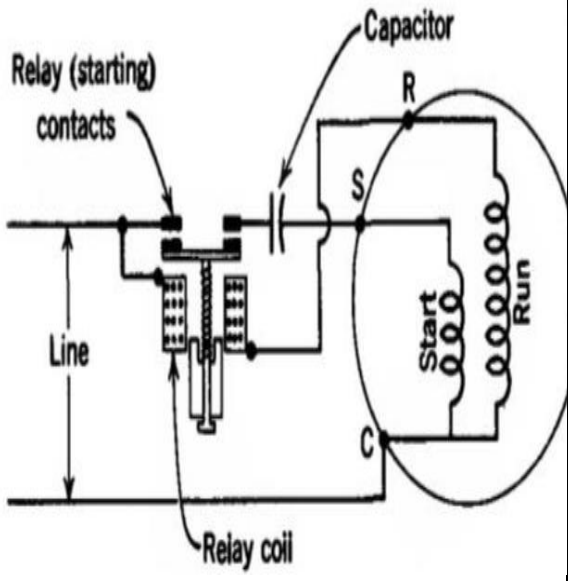
Q. 15	Write the names of various commercial applications of refrigeration. **ANSWER:** Refrigeration and air conditioning systems have a great importance in domestic as well as in commercial purposes because there is all vehicles, residences, auditoriums, cinema halls, dairy farming, preservation of food, military weapons, hospitals instruments, printing & stationary, IT sector, ice plants, cold storages, ice cream plants all are required with the refrigeration and air conditioning systems.	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-5	63	2
Q. 16	Write about the function of a fan in an air conditioning system. **ANSWER:** The function of the fan is to produce air movements through heating, ventilating, and air-conditioning apparatus. The fan essentially consists of a rotating wheel which is surrounded by a stationary member known as housing. According to the function performed, fans may be called as: (a) Blowers: - When the fan is used to discharge air against a pressure at its outlet it is known as a blower. (b) Exhauster: - When the fan removes air or gases from a space by suction it is called as exhauster.	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	71	2
Answer any 2 out of the given 3 questions in 30– 50 words each (3 x 2 = 6 marks)					
Q. 17	Explain the desirable properties of an ideal refrigerant. **ANSWER:** A refrigerant is said to an ideal refrigerant if it has all of the following properties: 1. Low boiling point. 2. Low freezing point. 3. High critical temperature. 4. High latent heat of vaporization. 5. Low specific volume of vapour. 6. Low specific heat of liquid. 7. High thermal conductivity. 8. Low viscosity. 9. High dielectric strength. 10. Non-corrosive to metal. 11. Non-flammable and non-explosive. 12. Non-toxic. 13. Low cost and easily available. 14. Chemically inert. 15. Easy to liquefy at moderate pressure and temperature. 16. Easy to locating its leaks by odour or suitable indicator. 17. Mixes well with oils. 18. Environment friendly. (Any six important properties can be given)	CBSE STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-3	51	3
Q. 18	Explain the different modes of heat transfer.	CBSE STUDY MATERIAL AIR-	UNIT-2	17	3

	ANSWER: The difference in temperature provides the necessary potential for heat transfer. There are three modes of heat transfer. These are conduction, convection and radiation. ➢ Conduction. Essentially heat is transferred within a stationary medium by conduction, viz. from particle to particle, whether it be solid, liquid or gas. ➢ Convection. In convection, there must be a bulk flow of the fluid. Heat is carried away from the wall surface by the flowing fluid. Convection, however, takes place in two ways, viz., forced convection and natural or free convection. In forced convection, the flow of the fluid is produced by an external source such as a pump or a fan. Radiation. In radiation, heat is transferred in the form of electromagnetic waves. For radiative heat transfer, therefore, the presence of a medium is not necessary	CONDITIONING & REFRIGERATION (CODE-827)			
Q. 19	Explain sensible cooling process with the help of psychrometric chart. **ANSWER:** The cooling of air, without any change in its specific humidity is known as sensible cooling. Let air at temperature t_{d1} passes over a cooling coil of temperature t_{d3}, as shown in figure below. A little consideration will show that the temperature of air leaving the cooling coil t_{d2} will be more than t_{d3} (Note that the temperature of the cooling coil t_{d3} must be greater than D.P.T. of air for sensible cooling of air).  The process of sensible cooling on the psychrometric chart is shown by a horizontal line 1-2 extending from right to left as shown in figure. The point 3 represents the surface temperature of the cooling coil. The heat rejected by air during sensible cooling may be obtained from the psychrometric chart by the enthalpy difference (H_1-H_2) as shown	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-1	8	3

	in figure. It may be noted that the specific humidity during the sensible cooling remains constant (i.e. $W_1=W_2$). The dry bulb temperature reduces from t_{d1} to t_{d2} and relative humidity increases from $\emptyset_1$ to $\emptyset_2$ as shown in figure above.				
Answer any 3 out of the given 5 questions in 50– 80 words each (4 x 3 = 12 marks)					
Q. 20	Explain central air conditioning system. **ANSWER:** In a central air-conditioning system, all the components of the system are grouped together in one central room and conditioned air is distributed from the central room to the required places though extensive duct work. The central air-conditioning system is generally used for the load above 25 TR and 2500cubic meter/min of conditioned air. The central plants require the following components and all the components are assembled on the site:- (A) Cooling and de-humidifying coils (B) Heating coils (C) Blower with motor (D) Sprays for cooling, de humidifying or washing (E) Air-cleaning equipments (F) A control device. The central system serves different rooms through extensive duct work with individual control. The system may use one of the following methods to supply the conditioned air. (a) Air-is conditioned in the center conditioned room and is supplied to the required rooms with controlled air- discharge in each room. (b) The water is chilled in the central conditioned room and is supplied to the required room with individual flow control. Individual evaporator in each room with thermostatic flow control or direct expansion system.	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-6	69	4
Q. 21	Explain the factors which contribute to the heat load (cooling load on apparatus) in an air-conditioned space. **ANSWER:** The total quantity of heat which is required to be pumped out from the air-conditioned space to be maintained at desired temperature level by the refrigerating equipment is known as cooling load. The amount of cooling load determines the capacity of the refrigeration plant to be installed. The cooling load comprises of two components, viz. sensible heat gain and latent heat gain. **FACTORS WHICH ARE RESPONSIBLE FOR SENSIBLE HEAT GAIN:** A gain of sensible heat is said to occur when there is a direct addition of heat to the enclosed space by any one or all of the modes of heat transfer	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-2	17	4

	i.e., conduction, convection and radiation. Sensible heat gain includes the following: 1. Heat transmitted by conduction through structures such as walls, floors and ceilings, due to temperature differential between their two sides. 2. Heat transferred into enclosed space by solar radiation through window panes, doors and ventilators. 3. Heat brought in by leaking (infiltrating) outside air entering the conditioned space through door openings, or cracks around windows, doors etc. 4. Heat liberated by occupants. 5. Heat given off by the products brought in at higher temperature than the conditioned space temperature. 6. Heat given off by lights, fans, computers, motors, cooking and other appliances, installed in the conditioned space.				
Q. 22	Explain shell and tube type condenser with a neat sketch. **ANSWER:** The shell and tube condenser consists of a cylindrical steel shell in which a number of straight tubes are arranged in parallel and held in place at the ends by tube sheets. The condensing water is circulated through the tubes, which may be either steel or copper. The refrigerant is contained in the steel shell between the tube sheets. This is universally used for all high-capacity units. The arrangement of this condenser with two passes of water is shown in the following	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-3	33	4

	 **Fig : Shell and tube condenser** The headers which are provided with both the ends are removable so that the tubes can be perfectly cleaned by removing the headers either mechanically or chemically. These condensers are available from 2 to 1000 TR capacity units.				
Q. 23	Draw layout of a cold storage. **ANSWER:** A typical layout of a cold storage is given here:  Fig: Layout of a cold storage.	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-5	64	4

Q. 24	Explain current type starting relay with a neat sketch. **ANSWER:** The current starting relay is primarily used with fractional horse power motors. It is a magnetic type relay and is actuated by the change in the current flow in the running winding during the starting and running periods. The coil of the relay , which is made up of a relatively few turns of large wire, is connected in series with the running winding. The relay contacts, which are normally open, are connected is series with the starting winding as shown in the given figure.  **Fig: Current Starting Relay** When the motor is energized, the high locked rotor current passing through the running winding and through the relay coil produces a relatively strong magnet around the coil and causes the relay armature to "pull in" and close the starting contacts energizing the starting winding with the starting winding energized. The rotor begins to rotate and a counter e.m.f. is induced in the stator windings which opposes the line voltage and reduces the current through the windings and relay coil. As the current flow through the relay coil diminishes, the coil field becomes too weak to hold the armature, where upon the armature falls out of the coil field by gravity (or by spring-action) and opens the starting contacts. The motor then runs on the running winding alone.	STUDY MATERIAL AIR-CONDITIONING & REFRIGERATION (CODE-827)	UNIT-4	60	4