

## THERMODYNAMICS WS 9

### Class 11 - Physics

#### Section A

1. The freezer in a refrigerator is located at the top section so that [1]
  - i. the entire chamber of the refrigerator is cooled quickly due to convection
  - ii. the motor is not heated
  - iii. the heat gained from the environment is high
  - iv. the heat gained from the environment is low
  - a) Option iii
  - b) Option iv
  - c) Option ii
  - d) Option i
2. The inside and outside temperatures of a refrigerator are 273 K and 303 K respectively. Assuming that refrigerator cycle is reversible, for every joule of work done, the heat delivered to the surrounding will be: [1]
  - a) 20 J
  - b) 10 J
  - c) 50 J
  - d) 30 J
3. A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. [1]
 

The power required is [Take 1 cal = 4.2 joules]

  - a) 23.65 W
  - b) 2365 W
  - c) 236.5 W
  - d) 2.365 W
4. The door of a domestic refrigerator is kept open while the switch is on. Then the room will: [1]
  - a) get cooled
  - b) both get heated and get cooled
  - c) get heated
  - d) get neither heated nor cooled
5. A refrigerator is to maintain eatables kept inside at 9°C. If the room temperature is 36°C, calculate the coefficient of performance? [1]
  - a) 11.4
  - b) 12.4
  - c) 11.8
  - d) 10.4
6. The coefficient of performance of a refrigerator is 5. If the temperature inside freezer is -20°C the temperature of the surroundings to which it rejects heat is: [1]
  - a) 41°C
  - b) 11°C
  - c) 21°C
  - d) 31°C
7. **Assertion:** It is impossible for a ship to use the internal energy of sea water to operate its engine. [1]
 

**Reason:** A refrigerator is a heat engine working in the reverse direction.

  - a) Assertion and reason both are correct
  - b) Assertion and reason both are correct

statements and reason is correct explanation for assertion.

statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

8. Refrigerator transfers heat from a cold body to a hot body. Does this not violate the second law of thermodynamics? [1]
9. If a refrigerator's door is kept open, will the room become cool or hot? Explain. [1]
10. Is coefficient of performance of a refrigerator a constant quantity? [1]
11. If the door of a refrigerator is kept open in a room, will it make the room warm or cool? [1]
12. What is a heat pump? Give an example. [1]
13. How a refrigerator can be used as a heat pump to heat a house in winter? [1]
14. Define coefficient of performance of a refrigerator. [1]
15. A refrigerator whose coefficient of performance is 3 extracts heat from the cooling compartment at the rate of 250 J/cycle. How much electric energy is spent per cycle? How much heat per cycle is discharged to the room? [1]
16. Does the working of an electric refrigerator defy second law of thermodynamics? [1]
17. What is meant by a reversible engine? Explain why the efficiency of a reversible engine is maximum? [1]

### Section B

18. An ideal refrigerator is working between the temperature of ice and temperature of atmosphere at 300 K. Find the energy which has been supplied to it to freeze 2 kg of water at 0°C. Given that latent heat of ice  $3.33 \times 10^5$  J/kg. [2]
19. i. Calculate the least amount of work that must be done to freeze one gram of water at 0°C by means of a refrigeration machine. The temperature of the surrounding is 27°C. [2]  
ii. How much heat is passed on to the surroundings in the process?
20. In a refrigerator, heat from inside at 277 K is transferred to a room at 300 K. How many joules of heat shall be delivered to the room for each joule of electrical energy consumed ideally? [2]
21. A refrigerator placed in a room at 300 K has inside temperature 264 K. How many calories of heat shall be delivered to the room for each 1 KCal of energy consumed by the refrigerator, ideally? [2]
22. A refrigerator has to transfer an average of 263 J of heat per second from temperature -10°C to 25°C. Calculate the average power consumed, assuming no energy losses in the process. [2]
23. By using a refrigerator machine, 1 g of water at 0°C is to be frozen. If the temperature of the surrounding is 27°C. Calculate [2]  
i. least amount of work done.  
ii. the heat which is passed to the surroundings in the process.
24. If the co-efficient of performance of a refrigerator is 5 and operates at the room temperature (27 °C), find the temperature inside the refrigerator. [2]
25. In a refrigerator one removes heat from a lower temperature and deposits to the surroundings at a higher temperature. In this process, mechanical work has to be done, which is provided by an electric motor. If the motor is of 1kW power, and heat is transferred -3°C to 27°C, find the heat taken out of the refrigerator per second assuming its efficiency is 50% of a perfect engine. [2]
26. Can a kitchen be cooled by leaving the door of an electric refrigerator opens? [2]
27. A refrigerator freezes 5 kg of water at 0°C into ice at 0°C in a time interval of 20 minutes. Assume that the room [2]

temperature is  $20^{\circ}\text{C}$ . Calculate the minimum power needed to accomplish it.

28. A refrigerator transfers 250 J heat per second from  $-23^{\circ}\text{C}$  to  $25^{\circ}\text{C}$ . Find the power consumed, assuming no loss of energy. [2]
29. A refrigerator is to maintain eatables kept inside at  $9^{\circ}\text{C}$ . If room temperature is  $36^{\circ}\text{C}$ , calculate the coefficient of performance. [2]

### Section C

30. **Fill in the blanks:** [3]
- (a) Lesser the temperature difference between the atmosphere and the cooling chamber \_\_\_\_\_ is the coefficient of performance of the refrigerator. [1]
  - (b) \_\_\_\_\_ is a device that comprises a heat pump and a thermally insulated compartment which is used to store food and drinks. [1]
  - (c) A refrigerator is a Carnot's heat engine working in \_\_\_\_\_. [1]
31. What is a refrigerator? Draw a schematic representation of a refrigerator. [3]
32. In a refrigerator, heat from inside of a refrigerator at 270 K is transferred to a room at 300 K. [3]
- i. What is its coefficient of performance?
  - ii. How much heat will be delivered to the room for each joule of electric energy consumed? Assume the refrigerator to be an ideal one.
33. What is a refrigerator? With the help of a block diagram, explain the working principle of a refrigerator and obtain an expression for its coefficient of performance. [3]
34. An ideal refrigerator runs between  $-23^{\circ}\text{C}$  and  $27^{\circ}\text{C}$  [3]
- i. Find the heat rejected to atmosphere for every joule of work input.
  - ii. Also, find heat extracted from cold body.
  - iii. Find coefficient of performance of the refrigerator.
35. What is a refrigerator? Describe the main steps of a refrigerator cycle. [3]

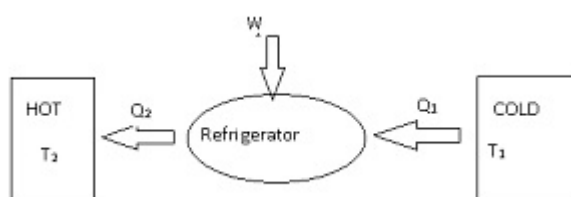
### Section D

36. **State True or False:** [4]
- (a) Coefficient of performance of a refrigerator is same as the efficiency of Carnot cycle on which refrigerator is based. [1]
  - (b) If a refrigerator's door is kept open, the room become cool. [1]
  - (c) A room can be cooled by opening the door of a refrigerator. [1]
  - (d) A kitchen can be cooled by leaving the door of an electric refrigerator open. [1]

### Section E

37. **Read the case study given below and answer any four subparts:** [5]

Refrigerator works on the principle which is reverse of a heat engine. It takes heat from the cold reservoir and then some work is done on the refrigerator and then the amount of heat is transferred to heat reservoir. Let  $Q_2$  be the takes from the cold reservoir,  $W$  is the work done on the system and then releases  $Q_1$  amount of heat to the hot reservoir.



- i. The temperatures of inside and outside of a refrigerator are 273 K and 303 K respectively. Assuming, that the refrigerator cycle is reversible, for every joule of work done, the heat delivered to the surrounding will be nearly:
- a. 10 J
  - b. 20 J
  - c. 30 J
  - d. 40 J
- ii. What does a refrigerant do?
- a. absorbs the heat leakage into the body from surroundings
  - b. evaporates in the evaporator
  - c. both a and b
  - d. none of these
- iii. The coefficient of performance of a refrigerator working between  $30^{\circ}\text{C}$  and  $0^{\circ}\text{C}$  is:
- a. 10
  - b. 9
  - c. 1
  - d. 0
- iv. If the door of the refrigerator is kept open:
- a. Room is cooled
  - b. Room is hot
  - c. Room is neither hot nor cooled
  - d. none of these
- v. The internal energy of an ideal gas depends upon:
- a. temperature only
  - b. volume only
  - c. both a and b
  - d. neither a and b