Class: 7th

Subject: Physics & Chemistry

Chapters: a) Work, Power & Energy

b) Is Matter Around us Pure.

Chemistry 8

Is matter around us pure

Mixture and its types

Q.1: What is meant by a pure substance? **(T.B.Q.1; Page 116)**

Ans: A pure substance is the one that consists of a single type of particles, i.e., all constituent particles of the substance have the same chemical nature. Pure substances can be classified as elements or compounds.

Q.2: List the points of differences between homogeneous and heterogeneous mixtures. **(T.B.Q.2; Page 116)**

Ans: A homogeneous mixture is a mixture having a uniform composition throughout the mixture. For example: salt in water, sugar in water, copper sulphate in water

A heterogeneous mixture is a mixture having a non-uniform composition throughout the mixture. For example: sodium chloride and iron fillings, salt and sulphur, oil and water

Q.3: Differentiate between homogeneous and heterogeneous mixtures with examples. **(T.B.Q.1; Page 120)**

Ans: A homogeneous mixture is a mixture having a uniform composition throughout the mixture. For example, mixtures of salt in water, sugar in water, copper sulphate in water, iodine in alcohol, alloy, and air have uniform compositions throughout the mixtures.

On the other hand, a heterogeneous mixture is a mixture having a non-uniform composition throughout the mixture. For example, composition of mixtures of sodium chloride and iron fillings, salt and sulphur, oil and water, chalk powder in water, wheat flour in water, milk and water are not uniform throughout the mixtures.

Q.4: Classify each of the following as a homogeneous or heterogeneous mixture. **(T.B.Q.5; Page 132)**
Soda water, wood, air, soil, vinegar, filtered tea

Ans: **Homogeneous mixtures**: Soda water, air, vinegar
Heterogeneous mixtures: Wood, soil, filtered tea

Solution and its properties

Q.5: Write the steps you would use for making tea. Use the words: solution, solvent, solute, dissolve, soluble, insoluble, filtrate and residue. **(T.B.Q.2; Page 132)**

Ans: First, water is taken as a **solvent** in a saucer pan. This water (solvent) is allowed to boil. During heating, milk and tea leaves are added to the solvent as **solutes**. They form a solution. Then, the solution is poured through a strainer. The insoluble part of the solution remains on the strainer as **residue**. Sugar is added tothe **filtrate**, which dissolves in the filtrate. The resulting **solution** is the required tea.

Q.6: Identify the solutions among the following mixtures:
(a) Soil (b) Sea water (c) Air (d) Coal (e) Soda water **(T.B.Q.8: Page 132)**

Ans: The following mixtures are solutions:
(b) Sea water (c) Air (e) Soda water

Concentration of a solution and how it is expressed

Q.7: To make a saturated solution, 36 g of sodium chloride is dissolved in 100 g of water at 293 K. Find its concentration at this temperature. **(T.B.Q.3: Page 120)**

Ans: Mass of solute (sodium chloride) = 36 g (Given)
Mass of solvent (water) = 100 g (Given)
Then, mass of solution = Mass of solute + Mass of solvent
= (36 + 100) g
= 136 g
Therefore, concentration (mass by mass percentage) of the solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solvent}} \times 100\%$$

$$= \frac{36}{136} \times 100\%$$

= 26.47%

Q.8: Pragya tested the solubility of three different substances at different temperatures and collected the data as given below (results are given in the following table, as grams of substance dissolved in 100 grams of water to form a saturated solution).

Substance Dissolved	Temperature in K				
	283	293	313	333	353
Potassium nitrate	21	32	62	106	167
Sodium chloride	36	36	36	37	37
Potassium chloride	35	35	40	46	54
Ammonium chloride	24	37	41	55	66

(a) What mass of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 grams of water at 313 K?
(b) Pragya makes a saturated solution of potassium chloride in water at 353 K and leaves the solution to cool at room temperature. What would she observe as the solution cools? Explain.
(c) Find the solubility of each salt at 293 K. Which salt has the highest solubility at this temperature?
(d) What is the effect of change of temperature on the solubility of a salt? **(T.B.Q.3: Page 132)**

Ans: (a) Solubility of potassium nitrate at 313K = 62/100g of water
100 g of water contains potassium nitrate = 62g
50 g of water will contain potassium nitrate = (62/100) × 50= 31g
∴ 31 g of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50g of water at 313K

(b) On cooling the saturated solution of potassium chloride in water at 352K to room temperature, crystals of potassium chloride will be formed.

(c) Solubility of different salts in 100g water at 293K is:
Potassium Nitrate: 32g, Sodium chloride:36g
Potassium chloride:35g, Ammonium chloride :37g
Ammonium chloride has the highest solubility.

(d) The solubility of salts increases with increase in temperature.

Colloidal solution and its properties

Q.9: Explain the following giving examples:
(a) Saturated solution (b) Pure substance
(c) Colloid (d) Suspension **(T.B.Q.4: Page 132)**

Ans: (a) **Saturated solution:** A saturated solution is a solution in which the maximum amount of solute has been dissolved at a given temperature. The solution cannot dissolve beyond that amount of solute at that temperature. Any more solute added will settle down at the bottom of the container as a precipitate.
Suppose 500 g of a solvent can dissolve a maximum of 150 g of a particular solute at 40°C. Then, the solution obtained by dissolving 150 g of that solute in 500 g of that solvent at 300 K is said to be a saturated solution at 300 K.

(b) **Pure substance:** A pure substance is a substance consisting of a single type of particles i.e., all constituent particles of the substance have the same chemical properties. For example, salt, sugar, water are pure substances.

(c) **Colloid:** A colloid is a heterogeneous mixture. The size of the solutes in this mixture is so small that they cannot be seen individually with naked eyes, and seems to be distributed uniformly throughout the mixture. The solute particles do not settle down when the mixture is left undisturbed. This means that colloids are quite stable. Colloids cannot be separated by the process of filtration. They can be separated by centrifugation. Colloids show the Tyndall effect. For example, milk, butter, foam, fog, smoke, clouds.

(d) **Suspension:** Suspensions are heterogeneous mixtures. The solute particles in this mixture remain suspended throughout the bulk of the medium. The particles can be seen with naked eyes. Suspension shows the Tyndall effect. The solute particles settle down when the mixture is left undisturbed. This means that suspensions are unstable. Suspensions can be separated by the method of filtration. For example, mixtures of chalk powder and water, wheat flour and water.

Suspension and its properties

Q.10: How are sol, solution and suspension different from each other? **(T.B.Q.2: Page 120)**

Ans: **Sol** is a heterogeneous mixture. In this mixture, the solute particles are so small that they cannot be seen with the naked eye. Also, they seem to be spread uniformly throughout the mixture. The Tyndall effect is observed in this mixture. For example: milk of magnesia, mud

Solution is a homogeneous mixture. In this mixture, the solute particles dissolve and spread uniformly throughout the mixture. The Tyndall effect is not observed in this mixture. For example: salt in water, sugar in water, iodine in alcohol, alloy

Suspensions are heterogeneous mixtures. In this mixture, the solute particles are visible to the naked eye, and remain suspended throughout the bulk of the medium. The Tyndall effect is observed in this mixture. For example: chalk powder and water, wheat flour and water.

Q.11: Which of the following will show the "Tyndall effect"?
(a) Salt solution **(b) Milk**
(c) Copper sulphate solution **(d) Starch solution** **(T.B.Q.9; Page 131)**

Ans: Milk and starch solution will show the "Tyndall effect".

Separating the components of a mixture by different methods

Q.12: Name the technique to separate
(i) butter from curd (ii) salt from sea-water
(iii) camphor from salt **(T.B.Q.2; Page 127)**

Ans: (i) Butter can be separated from curd by centrifugation.
(ii) Salt can be separated from sea-water by evaporation.
(iii) Camphor can be separated from salt by sublimation.

Q.13: Which separation techniques will you apply for the separation of the following?
(a) Sodium chloride from its solution in water.
(b) Ammonium chloride from a mixture containing sodium chloride and ammonium chloride.
(c) Small pieces of metal in the engine oil of a car.
(d) Different pigments from an extract of flower petals.
(e) Butter from curd. **(f) Oil from water.**
(g) Tea leaves from tea. **(h) Iron pins from sand.**
(i) Wheat grains from husk.
(j) Fine mud particles suspended in water. **(T.B.Q.1; Page 131)**

Ans: (a) Sodium chloride from its solution in water → Evaporation
(b) Ammonium chloride from a mixture containing sodium chloride and ammonium chloride → Sublimation
(c) Small pieces of metal in the engine oil of a car → Centrifugation or filtration or decantation
(d) Different pigments from an extract of flower petals → Chromatography
(e) Butter from curd → Centrifugation
(f) Oil from water → Using separating funnel
(g) Tea leaves from tea → Filtration
(h) Iron pins from sand → Magnetic separation
(i) Wheat grains from husk → Winnowing
(j) Fine mud particles suspended in water → Centrifugation

Q.14: What type of mixtures is separated by the technique of crystallization? **(T.B.Q.3; Page 127)**

Ans: By the technique of crystallization, pure solids are separated from impurities. For example, salt obtained from sea is separated from impurities; crystals of alum (*Phitkari*) are separated from impure samples.

Evaporation

Q.15: Define Evaporation. Show the process of evaporation experimentally.

Ans: **Evaporation**: The process by which a soluble solid can be obtained from a solution by allowing the solvent to vaporize, is called evaporation. Many of you might be aware, that for preparing salt, seawater near the shore is trapped in large pans and water is allowed to evaporate, by the heat of the sun. In a similar way, salt can be obtained from an aqueous salt solution in the laboratory by undertaking the following procedure:

Experiment: Take the solution of salt and water in evaporating dish. Heat the dish carefully till the entire water in the dish gets evaporated. The white crust that remains as residue after evaporation, is salt.

In a similar manner, sulphur can be separated from a solution of sulphur and carbon disulphide. Keep the solution in a flat dish at room temperature, for some time. The carbon disulphide, being volatile, completely evaporates, leaving behind yellow crystals of sulphur.

Evaporation

Centrifugation

Q.16: What principle is applied in centrifugation? Give examples where this method is applied to separate mixtures.

Ans: Centrifugation works on the principle that that the denser particles are forced to the bottom and the lighter particles stay at the top when spun rapidly.

Examples are:

1. Separating cream from milk (cream comes as top layer)
2. Used in diagnostic laboratories for blood and urine tests.
3. Used in washing machines to squeeze out water from wet clothes.
4. Used in preparing lactic cultures to prepare cheese (paneer) from milk in dairies.

By using separating tunnel

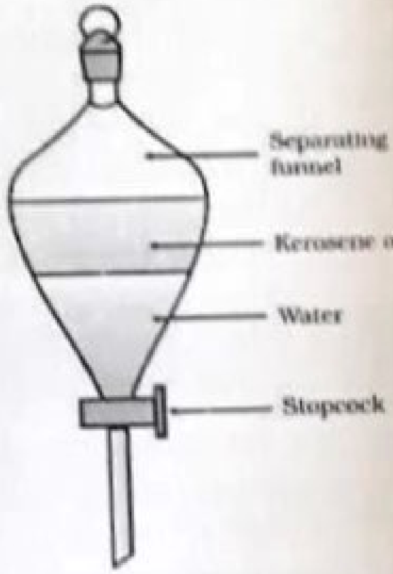
Q.17: Explain the use of separating funnel.

Ans: A separating funnel can be used to separate the components of the mixture of immiscible liquids. How this can be done? To understand this let us perform a following activity.

Let us try to separate kerosene oil from water using a separating funnel.

Pour the mixture of kerosene oil and water in a separating funnel.

Let it stand undisturbed for sometime so that separate layers of oil and water are formed. Open the stopcock of the separating funnel and pour out the lower layer of water carefully. Now close the stopcock of the separating funnel as the oil reaches the stop-cock.



Applications

To separate mixture of oil and water.

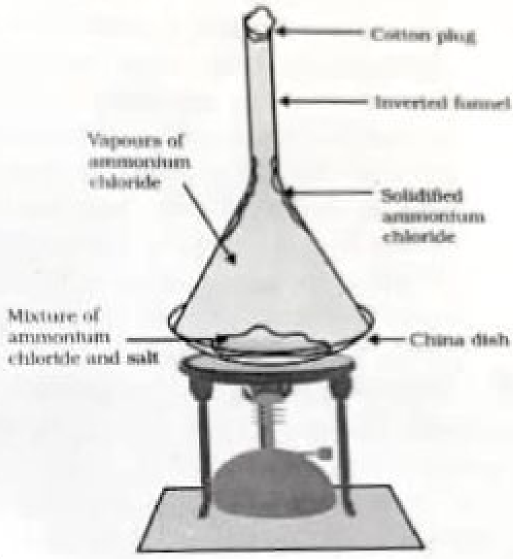
In the extraction of iron from its ore, the lighter slag is removed from the top by this method to leave the molten iron at the bottom in the furnace.

Sublimation

Q.18: Explain sublimation.

Ans: Sublimation is the property of substance in which they are converted directly from solid to gas or vice versa. Such substances are known as sublime. Some examples of solids which sublime are ammonium chloride, camphor, naphthalene and anthracene.

Let us perform an activity to separate a mixture of ammonium chloride and salt. Take a mixture of ammonium chloride and salt in a china dish cover it inverted conical transparent funnel. At the other end of the funnel put a cotton plug so that vapour could not come out. Now place china dish on a burner. As the ammonium chloride is sublime after heating it will directly converted into vapour and this vapour will again condense at the upper colder part of funnel to form solid ammonium chloride. In this way the mixture ammonium chloride and salt can be separated by the sublimation method.



Simple distillation, Fractional distillation

Q.19: Explain the method of simple distillation.

Ans: This method is used to separate the mixture of two miscible liquids where difference between their boiling points is at least 25°C.

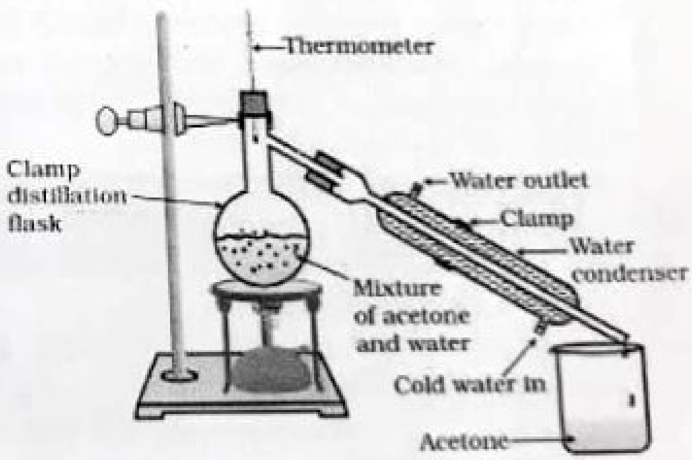
Acetone and water are miscible liquids also the difference between their boiling point is more than 25°C so they can be separated by the method of simple distillation. Follow the steps given below

i) Take a mixture in the distillation flask fit it with the thermometer.

ii) Arrange the apparatus as shown in the given figure.

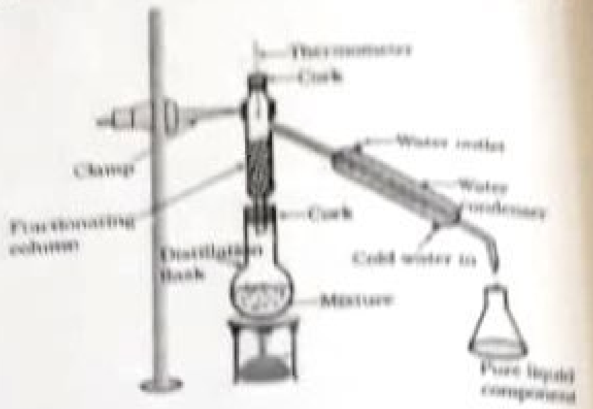
iii) Heat the mixture slowly keeping a close watch on thermometer.

iv) Since the acetone has lower boiling point starts vaporises and condenses in the condenser which is finally collected in the beaker.



Q.20: Explain the method of fractional distillation.

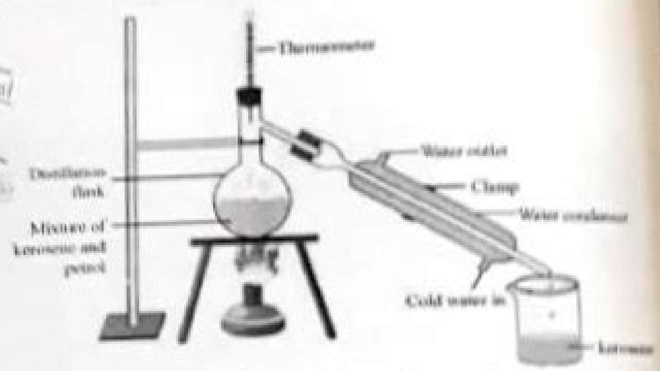
Ans: This method is used to separate the mixture of two miscible liquids where difference between their boiling points is less than 25°C. Also to separate a mixture of two or more miscible liquids for which the difference in boiling points is less than 25 K, fractional distillation process is used, for example, for the separation of different gases from air, different factions from petroleum products etc. The apparatus is similar to that for simple distillation, except that a fractionating column is fitted in between the distillation flask and the condenser. A simple fractionating column is a tube packed with glass beads. The beads provide surface for the vapours to cool and condense repeatedly, as shown in following figure.



Q.21: How will you separate a mixture containing kerosene and petrol (difference in their boiling points is more than 25°C), which are miscible with each other? **(T.B.Q.1; Page 127)**

Ans: A mixture of two miscible liquids having a difference in their boiling points more than 25°C can be separated by the method of distillation. Thus, kerosene and petrol can be separated by distillation.

In this method, the mixture of kerosene and petrol is taken in a distillation flask with a thermometer fitted in it. We also need a beaker, a water condenser, and a Bunsen burner. The apparatus is arranged as shown in the above figure. Then, the mixture is heated slowly. The thermometer should be watched simultaneously. Kerosene will vaporize and condense in the water condenser. The condensed kerosene is collected from the condenser outlet, whereas petrol is left behind in the distillation flask.



Chromatography

Q.22: What is Chromatography?

Ans: Chromatography is a technique used to separate those solutes of a mixture which are soluble in the same solvent. It works on the principle of adsorption. It is used to separate the coloured components (dyes) in black ink.

Separation of components of Air.

Q.23: How can we obtain different gases from air?

Ans: Air is a homogeneous mixture and can be separated into its components by fractional distillation. The flow diagram given under shows the steps of the process.

Air

↓

Compress and cool by increasing pressure and decreasing temperature

↓

Liquid Air

↓

Allow to warm up slowly in fractional distillation column

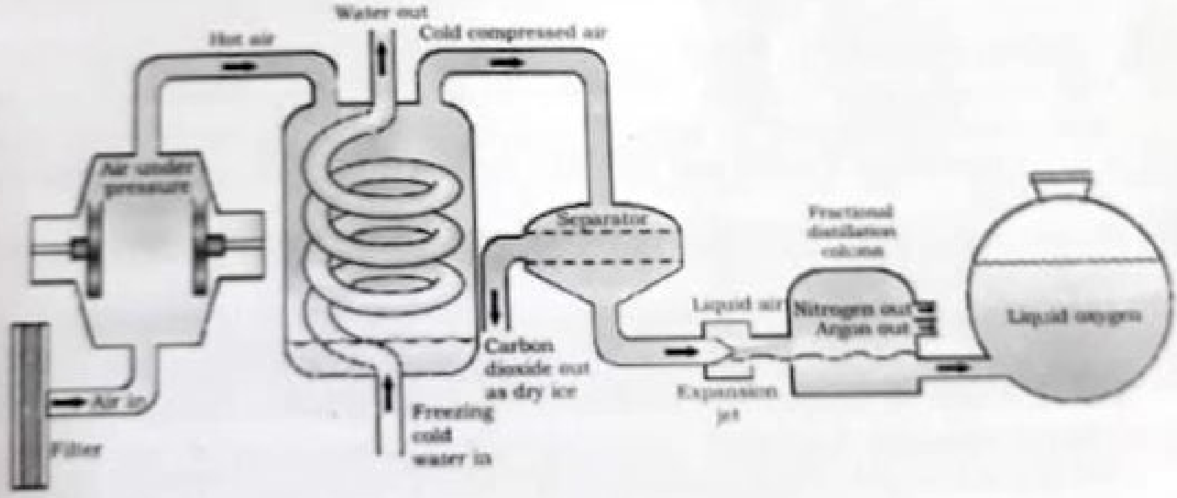
↓

Gases get separated at different heights

↓

	Oxygen	Argon	Nitrogen
Boiling Point (°C)	-183	-186	-196
% Air by Volume	20.9	0.9	78.1

If we want oxygen gas from air, we have to separate out all the other gases present in the air. The air is compressed by increasing the pressure and is then cooled by decreasing the temperature to get liquid air. This liquid air is allowed to warm-up slowly in a fractional distillation column, where gases get separated at different heights depending upon their boiling points.



Physical and Chemical changes.

Q.24: Classify the following as chemical or physical changes:

- **Cutting of trees**
- **Melting of butter in a pan**
- **Rusting of almirah**
- **Boiling of water to form steam**

- Passing of electric current through water, and water breaking down into hydrogen and oxygen gas
- Dissolving common salt in water
- Making a fruit salad with raw fruits (T.B.Q.1; Page128)
- Burning of paper and wood

Ans:
- Cutting of trees → Physical change
- Melting of butter in a pan → Physical change
- Rusting of almirah → Chemical change
- Boiling of water to form steam → Physical change
- Passing of electric current through water, and water breaking down into hydrogen and oxygen gas → Chemical change
- Dissolving common salt in water → Physical change
- Making a fruit salad with raw fruits → Physical change
- Burning of paper and wood → Chemical change

Q.25: Which of the following are chemical changes?
(a) Growth of a plant (b) Rusting of iron (c) Mixing of iron fillings and sand (d) Cooking of food (e) Digestion of food (f) Freezing of water (g) Burning of candle (T.B.Q.11; Page 133)

Ans: The following changes are chemical changes:
(a) Growth of a plant (b) Rusting of iron (d) Cooking of food (e) Digestion of food (g) Burning of candle

Types of Pure substances (Elements and Compounds)

Q.26: What are different categories of pure substance?

Ans: Elements and Compounds.

Q.27: What are elements?

Ans: Elements are substances that cannot be chemically broken down into simpler substances. So an element is made up of only one kind of atoms. For example, silver is an element which is made up of only silver atoms. Eiements are the building blocks of all matter.

Q.28: How elements are further classified?

Ans: Metals, Non-metals, metalloids.

Q.29: What is a compound? Give an example.

Ans: A Compound is u substance made up of two or more elements chemically combined in a fixed ratio by weight. They are homogeneous and exhibit definite physical and chemical properties E.g. water is a compound. It is made up of two elements hydrogen and oxygen, which combine chemically in a fixed ratio of 1:8 by weight. It possesses properties entirely different from the properties of hydrogen and oxygen.

Q.30: How would you confirm that a colourless liquid given to you is pure water? (T.B.Q.6; Page 132)

Ans: Every liquid has a characteristic boiling point. Pure water has a boiling point of 100°C (373 K) at 1 atmospheric pressure. If the given colourless liquid boils at even slightly above or below 100°C, then the given liquid is not pure water. It must boil at sharp 100°C. Thus, by observing the boiling point, we can confirm whether a given colourless liquid is pure water or not.

Q.31: Which of the following materials fall in the category of a "pure substance"?
(a) Ice (b) Milk (c) Iron (d) Hydrochloric Acid (e) Calcium oxide (f) Mercury (g) Brick (h) Wood (i) Air (T.B.Q.7; Page 132)

Ans: The following materials fall in the category of a "pure substance":

(a) Ice (c) Iron (d) Hydrochloric acid (e) Calcium oxide (f) Mercury

Q.32: Classify the following into elements, compounds and mixtures:
(a) Sodium (b) Soil (c) Sugar solution (d) Silver (e) Calcium carbonate (f) Tin (g) Silicon (h) Coal (i) Air (j) Soap (k) Methane (l) Carbon dioxide (m) Blood

(T.B.Q.10:Page 133)

Ans: **Elements:** (a) Sodium (d) Silver (f) Tin (g) Silicon
Compounds: (e) Calcium carbonate (k) Methane (l) Carbon dioxide
Mixtures: (b) Soil (c) Sugar solution (h) Coal (i) Air (j) Soap (m) Blood

Q.33: Try segregating the things around you as pure substances or mixtures.

(T.B.Q.2: Page 128)

Ans: **Pure substance:** Water, salt, sugar
Mixture: Salt water, soil, wood, air, cold drink, rubber, sponge, fog, milk, butter, clothes, food.

Difference between a Compound and a Mixture

Q.34: State the differences between compounds and mixtures.

Ans:

S. No	Compounds	Mixtures
1.	It is made up of two or more elements that are chemically combined.	It is made up of two or more pure substances that are mixed physically.
2.	A compound has definite melting and boiling points and density.	A mixture has no definite melting or boiling points and density.
3.	The properties of a compound are entirely different from those of its constituents.	A mixture retains the properties of the components.
4.	A compound is always homogeneous.	A mixture is heterogeneous, an some are homogeneous.
5.	The constituents of a compound cannot be separated by physical means.	The components of a mixture can separated by simple physi means,(dissolving, magne separation, heating, and filtration)

Physics 3

P-11

Work, Energy and Power

Scientific concept of work

For a layman the term 'work' implies any activity resulting in muscular or mental exertion. In physics, however, the term has a different meaning. It represents a physical quantity.

When a force acts on an object and the object moves in the direction of force, we say that the force has done work on the object.

If you push a book lying on a table you exert force on the book and the book moves in the direction of the force. We say that the force has done work. If you push a wall, the act will definitely tire you, but the wall does not move. Scientifically, no work is done.

Q.1: When do we say that work is done? **(T.B.Q. 1: page 44)**

Ans: Work is done whenever the given conditions are satisfied:

(i) A force acts on the body.

(ii) There is a displacement of the body caused by the applied force along the direction of the applied force.

Q.2: Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

- **Suma is swimming in a pond.**
- **A donkey is carrying a load on its back.**
- **A wind mill is lifting water from a well.**
- **A green plant is carrying out photosynthesis.**
- **An engine is pulling a train.**
- **Food grains are getting dried in the sun.**
- **A sailboat is moving due to wind energy.** **(T.B.Q. 1: page 57)**

Ans: (a) While swimming, Suma applies a force to push the water backwards. Therefore, Suma swims in the forward direction caused by the forward reaction of water. Here, the force causes a displacement. Hence, work is done by Seema while swimming.

(b) While carrying a load, the donkey has to apply a force in the upward direction. But, displacement of the load is in the forward direction. Since, displacement is perpendicular to force, the work done is zero.

(c) A wind mill works against the gravitational force to lift water. Hence, work is done by the wind mill in lifting water from the well.

(d) In this case, there is no displacement of the leaves of the plant. Therefore, the work done is zero.

[illegible]

Work done by constant force

Q. Write an expression for the work done when a force is acting on an object in the direction of its displacement. [illegible]

Ans: When a force F displaces a body through a distance S in the direction of the applied force, then the work done W on the body is given by the expression:

Work done = Force × Displacement

$W = F \times S$

Q. A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force (Fig. 11.3). Let us take it that the force acts on the object through the displacement. What is the work done in this case? [illegible]

Fig 11.3

Ans: When a force F acts on an object to displace it through a distance S in its direction, then the work done W on the body by the force is given by:

Work done = Force × Displacement

$W = F \times S$ Where, $F = 7$ N $S = 8$ m

Therefore, work done, $W = 7 \times 8 = 56$ Nm $= 56$ J

Q. Define 1 J of work. [illegible]

Ans: 1 J is the amount of work done by a force of 1 N on an object that displaces it through a distance of 1 m in the direction of the applied force.

Q. A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field? [illegible]

Ans: Work done by the bullocks is given by the expression:

Work done = Force × Displacement

$W = F \times d$

Where, Applied force, $F = 140$ N Displacement, $d = 15$ m

$W = 140 \times 15 = 2100$ J

Hence, 2100 J of work is done in ploughing the length of the field.

Q. An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object? [illegible]

Ans: Work done by the force of gravity on an object depends only on vertical displacement. Vertical displacement is given by the difference in the initial and final positions/heights of the object, which is zero.

Work done by gravity is given by the expression,

$W = mgh$

Where, h = Vertical displacement = 0 $W = mg \times 0 = 0$ J

Therefore, the work done by gravity on the given object is zero joule.

Q.8: Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her? Why? [illegible]

Ans: Acceleration in an object could be zero even when several forces are acting on it. This happens when all the forces cancel out each other i.e., the net force acting on the object is zero. For a uniformly moving object, the net force acting on the object is zero. Hence, the acceleration of the object is zero. Hence, Soni is right.

Q.9: A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer. [illegible]

Ans: Work done by gravity depends only on the vertical displacement of the body. It does not depend upon the path of the body. Therefore, work done by gravity is given by the expression,

$W = mgh$ Where, Vertical displacement, $h = 0$

$\therefore W = mg \times 0 = 0$

Hence, the work done by gravity on the body is zero.

Concept of positive and negative work

Q.10: What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer. (T.B.Q.11: page 58)

Ans: Work is done whenever the given two conditions are satisfied:

(i) A force acts on the body.

(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.

If the direction of force is perpendicular to displacement, then the work done is zero.

When a satellite moves around the Earth, then the direction of force of gravity on the satellite is perpendicular to its displacement. Hence, the work done on the satellite by the Earth is zero.

Q.11: Can there be displacement of an object in the absence of any force acting on it? Think. Discuss this question with your friends and teacher. (T.B.Q.12: page 58)

Ans: Yes. For a uniformly moving object

Suppose an object is moving with constant velocity. The net force acting on it is zero. But, there is a displacement along the motion of the object. Hence, there can be a displacement without a force.

Q.12: A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer. (T.B.Q.13: page 58)

Ans: Work is done whenever the given two conditions are satisfied:

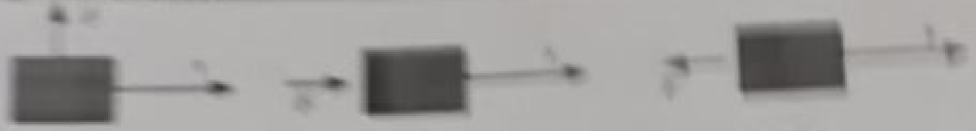
(i) A force acts on the body.

(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.

When a person holds a bundle of hay over his head, then there is no displacement in the bundle of hay. Although, force of gravity is acting on the bundle, the person is not applying any force on it. Hence, in the absence of force, work done by the person on the bundle is zero.

Q.13: In each of the following a force, F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe the

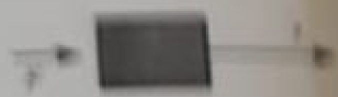
diagrams carefully and state whether the work done by the force is [illegible] positive or zero.



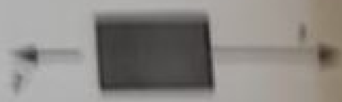
Ans: Work is done whenever the given two conditions are satisfied:
(i) A force acts on the body.
(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.

Case I
In this case, the direction of force acting on the block is perpendicular to the displacement. Therefore, work done by force on the block will be zero.

Case II
In this case, the direction of force acting on the block is in the direction of displacement. Therefore, work done by force on the block will be positive.



Case III
In this case, the direction of force acting on the block is opposite to the direction of displacement. Therefore, work done by force on the block will be negative.



Energy and its various forms

Energy: Anything that is able to do work possesses energy. *Energy is the capacity to do work.* Energy is measured by the amount of work that a body can do. Therefore, SI unit of energy is also joule.

Various Forms of Energy: There are different forms of energy like for example, mechanical energy, heat energy, electrical energy and chemical energy.

Kinetic energy and potential energy are the two types of mechanical energy.

Potential and kinetic energy

Q.14: Define potential energy of a body. Write an expression for potential energy.

Ans: **Potential Energy:** *Potential energy of an object can be defined as the energy possessed by the object by virtue of its position or condition.*

Expression for Potential Energy: Consider an object of mass 'm', raised through height 'h' above the earth's surface. The work done against gravity gets stored in the object as its potential energy (gravitational potential energy).

Therefore, potential energy = work done in raising the object through a height 'h'.

Potential energy = F x S ...(1)

But F = mg [Newton's second law of motion]

S = h

Substituting for F and S in equation (1), we get

Potential energy = mg x h

Potential energy = mgh

From the above relation it is clear that the potential energy of an object depends on the height from the ground.

Q.15: What is the kinetic energy of an object? **(T.B.Q. 1; page 48)**

Ans: Kinetic energy is the energy possessed by a body by the virtue of its motion. Every moving object possesses kinetic energy. A body uses kinetic energy to do work. Kinetic energy of hammer is used in driving a nail into a log of wood, kinetic energy of air is used to run wind mills, etc.

Q.16: Write an expression for the kinetic energy of an object. **(T.B.Q. 3; page 48)**

Ans: If a body of mass m is moving with a velocity v, then its kinetic energy E_k is given by the expression,

$$E_k = \frac{1}{2}mv^2$$

Its SI unit is Joule (J).

Q.17: An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is half-way down. **(T.B.Q.10; page 58)**

Ans: Gravitational potential energy is given by the expression,

$W = mgh$

Where,

h = Vertical displacement = 5 m

m = Mass of the object = 40 kg

g = Acceleration due to gravity = 9.8 m s^{-2}

$\therefore W = 40 \times 5 \times 9.8 = 1960$ J.

At half-way down, the potential energy of the object will be $\frac{1960}{2} = 980$ J.

At this point, the object has an equal amount of potential and kinetic energy. This is due to the law of conservation of energy. Hence, half-way down, the kinetic energy of the object will be 980 J.

Q.18: A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy? **(T.B.Q.21; page 58)**

Ans: When an object falls freely towards the ground, its potential energy decreases and kinetic energy increases. As the object touches the ground, all its potential energy gets converted into kinetic energy. As the object hits the hard ground, all its kinetic energy gets converted into heat energy and sound energy. It can also deform the ground depending upon the nature of the ground and the amount of kinetic energy possessed by the object.

Q.19: The kinetic energy of an object of mass, m moving with a velocity of 5 m s^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times? **(T.B.Q. 3; page 48)**

Ans: Expression for kinetic energy is $E_k = \frac{1}{2}mv^2$

m = Mass of the object

v = Velocity of the object = 5 m s^{-1}

Given that kinetic energy, $E_k = 25$ J

(i) If the velocity of an object is doubled, then $v = 5 \times 2 = 10$ m s^{-1}.

Therefore, its kinetic energy becomes 4 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = $25 \times 4 = 100$ J.

(ii) If velocity is increased three times, then its kinetic energy becomes 9 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = 25 × 9 = 225 J.

Q.20: An object of mass, *m* is moving with a constant velocity, *v*. How much work should be done on the object in order to bring the object to rest? **(T.B.Q.16; page 58)**

Ans: Kinetic energy of an object of mass, *m* moving with a velocity, *v* is given by the expression,

$$E_k = \frac{1}{2}mv^2$$

To bring the object to rest, $\frac{1}{2}mv^2$ amount of work is required to be done on the object.

Q.21: Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h? **(T.B.Q.17; page 58)**

Ans: Kinetic energy, $E_k = \frac{1}{2}mv^2$

Where,

Mass of car, $m = 1500$ kg

Velocity of car, $v = 60$ km/h $= 60 \times \frac{5}{18}\ \text{ms}^{-1}$

$$\therefore E_k = \frac{1}{2} \times 1500 \times \left(60 \times \frac{5}{18}\right)^2 = 20.8 \times 10^4 \text{ J}$$

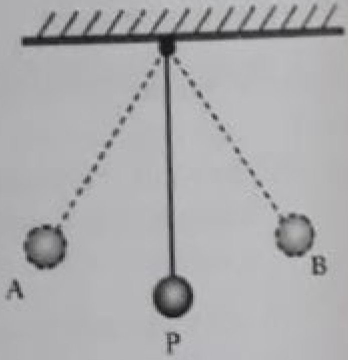
Hence, 20.8×10^4 J of work is required to stop the car.

Law of conservation of energy

Q.22: Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy? **(T.B.Q.15; page 58)**

Ans: The law of conservation of energy states that energy can be neither created nor destroyed. It can only be converted from one form to another.

Consider the case of an oscillating pendulum.



When a pendulum moves from its mean position P to either of its extreme positions A or B, it rises through a height *h* above the mean level P. At this point, the kinetic energy of the bob changes completely into potential energy. The kinetic energy becomes zero, and the bob possesses only potential energy. As it moves towards point P, its potential energy decreases progressively. Accordingly, the kinetic energy increases. As the bob reaches point P, its potential energy becomes zero and the bob possesses only kinetic energy. This process is repeated as long as the pendulum oscillates.

P-17

The bob does not oscillate forever. It comes to rest because air resistance resists its motion. The pendulum loses its kinetic energy to overcome this friction and stops after some time.

The law of conservation of energy is not violated because the energy lost by the pendulum to overcome friction is gained by its surroundings. Hence, the total energy of the pendulum and the surrounding system remain conserved.

Q.23: A battery lights a bulb. Describe the energy changes involved in the process. (T.B.Q. 3; page 57)

Ans: When a bulb is connected to a battery, then the chemical energy of the battery is transferred into electrical energy. When the bulb receives this electrical energy, then it converts it into light and heat energy. Hence, the transformation of energy in the given situation can be shown as:

Chemical Energy → Electrical Energy → Light Energy + Heat energy

Q.24: The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why? (T.B.Q. 6; page 58)

Ans: No. The process does not violate the law of conservation of energy. This is because when the body falls from a height, then its potential energy changes into kinetic energy progressively. A decrease in the potential energy is equal to an increase in the kinetic energy of the body. During the process, total mechanical energy of the body remains conserved. Therefore, the law of conservation of energy is not violated.

Q.25: What are the various energy transformations that occur when you are riding a bicycle? (T.B.Q. 7; page 58)

Ans: While riding a bicycle, the muscular energy of the rider gets transferred into heat energy and kinetic energy of the bicycle. Heat energy heats the rider's body. Kinetic energy provides a velocity to the bicycle. The transformation can be shown as:

Muscular Energy → Kinetic Energy + Heat Energy

During the transformation, the total energy remains conserved.

Q.26: Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going? (T.B.Q. 8; page 58)

Ans: When we push a huge rock, there is no transfer of muscular energy to the stationary rock. Also, there is no loss of energy because muscular energy is transferred into heat energy, which causes our body to become hot.

Definition of Power and its units

Q.27: What is power? (T.B.Q. 1; page 55)

Ans: Power is the rate of doing work or the rate of transfer of energy. If W is the amount of work done in time t, then power is given by the expression,

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Energy}}{\text{Time}}$$

$$P = \frac{W}{T}$$

It is expressed in watt (W).

Q.28: Define 1 watt of power: (T.B.Q. 2; page 55)

Ans: A body is said to have power of 1 watt if it does work at the rate of 1 joule in 1 s, i.e.,

$$1\text{ W} = \frac{1\text{ J}}{1\text{ s}}$$

Q.[illegible] Define average power. (T.B.Q.[illegible]: page [illegible])

Ans: A body can do different amount of work in different time intervals. Hence, it is better to define average power. Average power is obtained by dividing the total amount of work done in the total time taken to do this work.

$$\text{Average Power} = \frac{\text{Total work done}}{\text{Total time taken}}$$

Q.[illegible] A lamp consumes 1000 J of electrical energy in 10 s. What is its power? (T.B.Q.[illegible]: page [illegible])

Ans: Power is given by the expression,

$$\text{Power} = \frac{\text{Work done}}{\text{Time}}$$

Work done = Energy consumed by the lamp = 1000 J

Time = 10 s

$$\text{Power} = \frac{1000}{10} = 100\ \text{J s}^{-1} = 100\ \text{W}$$

Q.[illegible] Find the energy in kW h consumed in 10 hours by four devices of power 500 W each. (T.B.Q.20: page 88)

Ans: Energy consumed by an electric device can be obtained with the help of the expression for power,

$$P = \frac{W}{T}$$

Where,

Power rating of the device, $P = 500\ \text{W} = 0.50\ \text{kW}$

Time for which the device runs, $T = 10$ h

Work done = Energy consumed by the device

Therefore, energy consumed = Power × Time

$= 0.50 \times 10 = 5$ kWh

Hence, the energy consumed by four equal rating devices in 10 h will be 4×5 kWh = 20 kWh = 20 Units.

Q.[illegible] A certain household has consumed 250 units of energy during a month. How much energy is this in joules? (T.B.Q. 9: page 8)

Ans: 1 unit of energy is equal to 1 kilowatt hour (kWh).

1 unit = 1 kWh

1 kWh = 3.6×10^6 J

Therefore, 250 units of energy = $250 \times 3.6 \times 10^6 = 9 \times 10^8$ J

Q.[illegible] An electric heater is rated 1500 W. How much energy does it use in 10 hours? (T.B.Q.14: page)

Ans: Energy consumed by an electric heater can be obtained with the help of the expression,

$$P = \frac{W}{T}$$

Where,

Power rating of the heater, $P = 1500\ W = 1.5$ kW

Time for which the heater has operated, $T = 10$ h

Work done = Energy consumed by the heater

Therefore, energy consumed = Power × Time

$= 1.5 \times 10 = 15$ kWh

Hence, the energy consumed by the heater in 10 h is 15 kWh.