Unit - 1.

Scientific study

1. Select the best answer from the given alternatives.

a. What is the name given for the factors, traits, or conditions that are considered during an experiment?

II) → variables

b. Which variable can be changed by the scientist during his experiment?

II) → ~~Indep~~ Independent variable

c. With the help of units, check the correct one from the given equations

→ (iii) $s = ut + \frac{1}{2}at^2$

d. Based on units, $v^2 = u^2 + 2as$ is called.....

i) → ~~hom~~ homogenous

e. Identify the unit analysis for $v^2 = u^2 + 2as$

IV) → m^2s^{-2} & $m^2s^{-2} + m^2s^{-2}$

2. Define the following terms with required examples.

a. Variables : The factors that affect the scientific study is called variable. For example : temperature, light, height, weight, etc.

b. Independent variables : Those variables which can be changed by scientist / researcher is called Independent variables. ~~For example~~ : Let's take the example of 'Test scores'. "Studying" or "sleeping" is the independent variables.

c. Dependent variables : Those variables which depend upon other variables is called dependent variables.

d. Controlled variables : Those variables which are kept constant during research is called controlled variable.

e. Unit : The standard known quantity which is used to measure the unknown quantity of the same kind is called unit. The units of measuring length are milimeter (mm), centimeter (cm), meter (m) and kilometer (km).

f. Fundamental unit : The unit which donot depend upon other unit. Fundamental units are single and independent. Length, mass, time, temperature, electric-current, amount of substance and luminous intensity are the seven fundamental units.

g. Derived unit : The unit which is formed by two or more than two fundamental units is called derived unit. Example : Area, Volume, velocity, etc.

h. Physical quantity : The quantities which can be measured by using different kinds of physical devices are called physical quantities. Example : Mass, time, force, etc.

3. Answer it :

a. What is the independent variable if a scientist is turning bulb on and off to check behavior of the earthworm?

→ The independent variable is amount of light.

b. What is the type of variable of its magnitude is constant throughout the experiment?

→ Controlled variable is the type of variable of its magnitude is constant throughout the experiment.

c) What are the quantities that can be measured called?
→ Physical quantities are the quantities that can be measured.

d) What is the standard reference quantity of a physical quantity called?
→ The standard reference quantity of a physical quantity is called a unit.

e) What type of physical quantity is area?
→ Area is derived physical quantity

f) Write down the basic units involved in Newton(N), Watt(W), Joule(J) and Pascal(Pa)
→ The basic units involved are:
Newton(N) → kgm/(s x s)
Watt (W) → kg x m x m/(s x s x s)
Joule (J) = kg x m x m/(s x s)
Pascal(P) = kg/(m x s x s)

g) Write down the formula and basic units involved in density, velocity, weight, work, acceleration, force, pressure and speed.
→ The formula of Density is:
$\text{Density} = \frac{\text{mass}}{\text{volume}}$ and the basic units involve

in density are: $\frac{kg}{m \times m \times m} = \frac{kg}{m^3} = kg/m^3$

The formula of velocity is: $V = \frac{\text{Displacement}}{\text{Time}}$ and the units involved in velocity are: $\frac{m}{s} = m/s$

The formula of weight is: $W = mg$ and the units are: $kg \times ms^{-2} = kgms^{-2}$

The formula of work is: $W = F \times D$ and the units are: $ma \times m = kgms^{-2} \times m$
$= kgm^2s^{-2}$

The formula of acceleration is: $a = \frac{V}{t}$ and the units are: $\frac{ms^{-1}}{s} = ms^{-2}$

The formula of force is: $F = ma$ and the units are: $kg \times ms^{-2} = kgms^{-2}$

The formula of pressure is: $P = \frac{F}{A}$ and the units are: $\frac{mg}{m^2} = \frac{kgms^{-2}}{m^2} = kgm^{-1}s^{-2}$

The formula of speed is: $S = \frac{d}{t}$ and the units are: $\frac{m}{s} = ms^{-1}$

4 Give reasons.

a The magnitude of kilogram is same all over the world
→ Kilogram is SI unit of mass and unit must be same all over the world.

b. Unit of the temperature is called fundamental unit.
→ Unit of the temperature is called fundamental unit because the unit of temperature donot depends upon other unit.

c Unit of work is called derived unit.
→ Unit of work is formed by two fundamental units so, it is called derived unit.

d Unit-wise analysis is broadly used to test the physical equation.
→ It helps to check the correctness of a physical equation. So, unit-wise analysis is broadly used to test the physical equation.

5 Differentiate between the following:

a. Dependent variables and Independent variables

→ The differences between dependent and Independent variables are as follows :-

Dependent variables	Independent variabl
i) Those variables which depend upon other variables are called dependent variables	i) These variables which can be changed by scie are called Independen variables.
ii) It is an effect.	ii) It is a cause

b. Controlled variables and dependent variables

→ The differences between controlled variables and dependent variables are :-

Controlled variables	Dependent variables
(i) The variables which is kept constant during research is called controlled variables.	i) These variables whi depend upon other va are called dependent variables.
(ii) For example : Temperature, sunlight, etc. while observing plant.	ii) For example : Growth plant while observin plant.

c. Fundamental units and derived units

→ The differences between fundamental units and derived units are as follows :-

Fundamental units	Derived units
i) Fundamental units are those units which are independent of each other	i) Derived units are those units which is formed by the combination of two or more than two fundamental units.
ii) Examples : mass, time, length, etc.	ii) Examples : Area, volume, velocity, etc.

6 Answer the following :

a Examine the physical equation $s = ut + at$ where 'a' is acceleration, 'u' is initial velocity, 's' is distance and 't' is time.

→ Soln,

In this equation 'a' is acceleration, its SI unit is m/s^2. 'u' is initial velocity, its SI unit is m/s. 's' is distance, its SI unit is m. 't' is time, its SI unit is second (s).

L.H.S

distance = m

Right hand side = u + at = m/s + m/s^2 × s

= m/s + m/s

Hence, L.H.S is not equal to R.H.S. This equation incorrect.

b. Is time a physical quantity ? Support your answer with a suitable reason.

→ Time is a physical quantity because they it not derived from each other or we can say they are independent of each other

c. What do you mean by principle of homogeneity of equations ?

→ The principle of homogeneity states that an equation is unit-wise correct if the units of various terms on either side of the equation same.

d. Write down the applications of unit-wise analysis

→ The applications of unit-wise analysis are

i) It is used to check the reliability of a physical equation.
ii) It is used to derive the relation between physical quantities in physical equation.
iii) It is used to change units from one system to another.

c. Explain the limitation of unit-wise analysis.
→ The limitations of unit-wise analysis are:

i) It doesn't give information about the equational constant.
ii) It doesn't give information about the coefficient of the equation.
iii) It gives no information about whether a physical quantity is a scalar or vector.

Q Answer the following questions:

a) Explain independent variable, dependent variable and control variables with examples.
→ Independent variables are those variables which can be changed by scientist/researcher.
Dependent variables are the variables which are depend upon other variables.
Controlled variables are the variables which are kept constant during research.

Example :

The different variables when a plant is grown in different amount of a fertilizer.

Independent var.	Dependent var.	Controlled var.
Amount of fertilizer	Growth of plant	Light, Temperature, Humidity, Altitude ...

b. ~~What kinds of variables are~~

b. What kinds of variables are called controlled variables? Write down the importance.

→ Those variables which are kept constant during research are called controlled variables.

Importance of controlled variables is that recording controlled variables makes it easier to establish the relationship between the independent and dependent variables.

c. State principle of homogenity of equation. Check the correctness of physical equation $s = ut + \frac{1}{2}at^2$

→ The principle of homogeneity states that an equation is unit-wise correct if the units of the various terms on either side of the equation are same.

Checking the correctness of physical equations

$s = ut + \frac{1}{2}at$

→ In this equation s is distance, u is initial velocity, t is time, a is acceleration

Taking L.H.S

s = distance = m

$R.HS = ut + \frac{1}{2}at = ms^{-1}s + ms^{-2}s^2$

$= m + ms^{-1}$

Hence, L.HS ≠ R.HS. So, it is not correct equation

d. Write any two differences between fundamental and derived units. Which units are involved in joule and watt?

→ Any two differences between fundamental and derived units are:

Fundamental units	Derived units
(i) Fundamental units are those units which are independent of each other.	(i) Derived units are those units which are formed by combining two or more than two fundamental units.

ii) Mass, time, length, etc | iii) Area, volume, velocity, etc

The joule has base unit of kgm^2s^{-2}.
The watt has base unit of kgm^2s^{-3}

e. Based on units, check whether the following equations are correct or not ?

(i) $v^2 = u^2 + 2as$

→ In this equation, v is final velocity. u is initial velocity. a is acceleration. s is distance

L·H·S

$$v^2 = (ms^{-1})^2 = m^2s^{-2}$$

R·H·S $= u^2 + 2as = (ms^{-1})^2 + ms^{-2}m$ (2 is unitless)

$$= m^2s^{-2} + m^2s^{-2}$$

L·H·S = R·H·S So, it is correct equation.

ii) $v = u + at$

→ In this equation v is final velocity. u is initial velocity. a is acceleration. t is time

L·H·S

$$v = ms^{-1}$$

R.H.S = $ut + at = ms^{-1} + ms^{-2} s$

$= ms^{-1} + m^2 s^{-2} ms^{-1}$

∴ L.H.S = R.H.S so, it is correct equation.

iii. $s^2 = ut + \frac{1}{2} at^2$

→ In this equation s is distance, u is initial velocity a is acceleration t is time

L.H.S

$s^2 = m^2$

R.H.S = $ut + \frac{1}{2} at^2 = ms^{-1} s + ms^{-2} s^2$ ($\frac{1}{2}$ is unitless)

$= m + m$

Here, L.H.S ≠ R.H.S. so, it is incorrect equation

iv. $P = mv^2$

→ In this equation P is momentum. m is mass. V is velocity.

L.H.S $P = kgms^{-1}$

R.H.S : $mv^2 = kg(ms^{-1})^2$

$= kgm^2s^{-2}$

$\therefore$ L.H.S $\neq$ R.H.S. So, it is incorrect equation.

v. $P = I^2R$

$\longrightarrow$ In this equation P is power. I is the electric current and R is resistance

L.H.S

unit involved in power = kgm^2s^{-3}

R.H.S = I^2R = $[A]^2 \times \frac{P}{I^2}$

$R = \frac{P}{I^2} = \frac{kgm^2s^{-3}}{A^2} = kgm^2s^{-3}A^{-2}$

unit of I^2R = $A^2 \times kgm^2s^{-3}A^{-2}$

$= kgm^2s^{-3}$

$\therefore$ L.H.S = R.H.S. So it is correct equation

vi) $S = ut + at$

$\longrightarrow$ In this equation s is distance. u is initial velocity. a is acceleration. t is time

L.H.S $S = m$

R.H.S = $ut + at = ms^{-1} + ms^{-2}s$

$= ms^{-1} + ms^{-1}$

L.H.S $\neq$ R.H.S. so, it is incorrect equation

vii) $s = ut + \frac{1}{2}at^2$

→ In this equation s is distance. u is initial velocity t is time. a is acceleration.

L.H.S

$s = m$

R.H.S $= ut + \frac{1}{2}at^2$

$= ms^{-1}s + ms^{-2}s^2$ ($\frac{1}{2}$ is unitless)

$= m + m$

∴ L.H.S = R.H.S. so it is correct equation

viii) $v = ut + \frac{1}{2}at^2$

→ In this equation v is final velocity. u is initial velocity t is time. a is acceleration ~~and t~~

L.H.S $v = ms^{-1}$

R.H.S $= ut + \frac{1}{2}at^2$ ($\frac{1}{2}$ is unitless)

$= ms^{-1}s + ms^{-2}s^2$

$= m + m$

L.H.S ≠ R.H.S so, it is incorrect equation

5. Alish wants to observe the growth of plants in different fertilizers like urea, compost fertilizer and wooden ash. He brought three vases and kept equal amount of urea, compost fertilizer and wooden ash in each. He sown seeds of same plant and kept them in open place. After germination of seeds, he measured their height each day and maintain record. Based on this experiment answer the following questions.

i. What are independent variable, dependent variable and controlled variables in this experiment?

→

Independent variables
Urea, compost fertilizer and wooden ash

Dependent variable
growth of plants

Controlled variables
light, moisture, temperature

ii. Why did he brought vases of equal size and kept equ amount of fertilizers?

→ He brought vases of equal size and kept equal amount of fertilizers because he wants to wanted

observe the growth of plants in different fertilizer

g. Lokeshwor has a cow farm. He increased the food to one group of cow and kept constant for others. The group that ate more food gave more milk than the others. Enlist dependent and independent variables in this experiment along with their reason.

→

Independent variable	Dependent variable
The food for cow	Milk of cow

The food for cow is independent variable because it can be changed by the owner of the cow farm.

Milk of cow is dependent variable because it is depend upon the food eaten by the cow.

h. Munal says the formula of power $P = mv^2$ and Rohan says $P = \frac{mv}{A}$. Which one is correct? Check using unit-analysis.

→ Let's check which equation is correct.

(1) First equation is $P = mv^2$

~~we know that L.H.S P = R.H~~

We know that L.H.S = P and R.H.S = mv^2

Unit of P(momentum) = $kgms^{-1}$ ... (i)

R.H.S = mv^2

= $kg(ms^{-1})^2$

= kgm^2s^{-2} ... (ii)

Putting eqn (i) and (ii) together, we have,

$kgms^{-1} \neq kgm^2s^{-2}$

From eqn (i) and (ii), we donot have L.HS = R.HS
Hence, by the principle of homogeneity, the given equation is incorrect.

(2) Second equation is $P = \frac{mv}{A}$

→ We know that L.H.S = P and R.HS = $\frac{mv}{A}$

Unit of P = $kgms^{-1}$ ... (i)

R.HS = $\frac{mv}{A}$ = $\frac{kgms^{-1}}{m^2}$ = $kgm^{-1}s^{-1}$ ... (ii)

Putting eqn (I) and (II) together, we have,

$$kgms^{-1} \neq kgm^{-1}s^{-1}$$

L.H.S ≠ R.H.S. Hence, it is also incorrect.

∴ Munal and Rohan both of ~~them~~ their ~~answer~~ formula is wrong.

9. Design an activity where we can identify independent variable, dependent variable and controlled variables.

→ Activity : a car going down different surface

Independent variable : the surface of the slope rug, bubble wrap and wood.

Dependent variable : the time it takes for the car to go down the slope.

Controlled variable : the height of the slope, the car, the unit of time eg. minutes and the length of the slope.

5. Write down the formula and show that the unit analysis of electric resistance (R) is $kgm^2A^{-2}s^{-3}$

→ $R = \frac{P}{I^2} = \frac{kgm^2s^{-3}}{A^2}$

$= kgm^2s^{-3}A^{-2}$

$\therefore R = kgm^2A^{-2}s^{-3}$

k) Complete the given table using independent variable, dependent variable and controlled variable

Experiment 1) Relation between distance covered and time taken

Independent variable
→ Time

Dependent variable
→ Velocity Distance

Controlled variable
→ Velocity

Experiment 2) Relation between hunger and eating time

Independent