(SOLUTION)

Physics

1. Soln.: (3)

$F\frac{\Delta p}{\Delta t}$ $\{\Rightarrow \Delta p$ area under force vs time graph

$\Delta p = \left(\frac{1}{2}\times 4\times 20\right)+(4\times 20)+\left(\frac{1}{2}\times 2\times 20\right)$

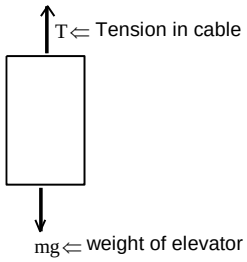
= 40 + 80 + 20

Δp = 140 Ns

2. Soln.: (2)

Total change in momentum = force $\times$ time = mgt

3. Soln.: (1)



$\Rightarrow$ Tension = mg

$\Rightarrow$ $F_{net} = 0$

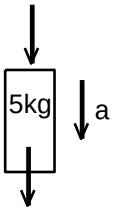
$\Rightarrow$ a = 0

$\Rightarrow$ speed of elevator is constant

$\Rightarrow$ uniform speed motion

4. Soln.: (3)

$\Rightarrow$ free body diagram of 5 kg



5a = 5g – T ……(1)

$\Rightarrow$ free body diagram of 4 kg

$\Rightarrow$ $\xrightarrow{a}$ 4a = T

4 Kg $\rightarrow$ T

$\Rightarrow$ from (1) and (2)

5a = 5g – 4a $\}$ $\Rightarrow$ $a = \frac{5g}{9} ms^{-2}$

5. Soln.: (3)

$\langle Force\rangle = \frac{\text{change in momentum}}{\text{total time}}$

$\langle F\rangle = \frac{\Delta P}{\Delta t} = \frac{50}{0.01} = 5000N$

6. Soln.: (4)

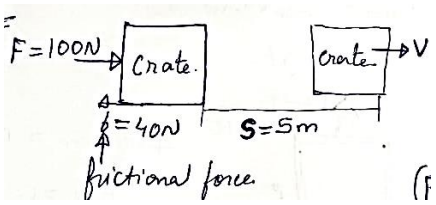
Work done by force F + work done by friction (f)
= change in kinetic energy

$(F \cdot S) + (= f \cdot s) = \Delta KE$

$\Delta KE = 100 \times 5 - 40 \times 5$

$= 60 \times 5$

$= 300$ J



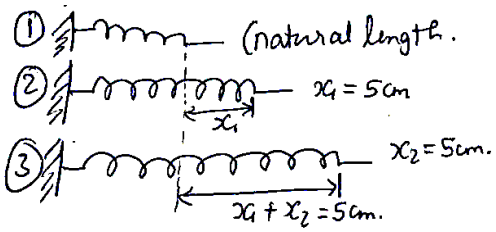
7. Soln.: (4)

$\Rightarrow$ energy stored in **case 1** = **0**

$\Rightarrow$ energy stored in **case 2** $= \frac{1}{2}kx_1^2$

$$E_2 = \frac{1}{2} \times 5 \times 10^3 \times \left(\frac{5 \times 5}{100 \times 100} \right)$$

= 6.25 J



$\Rightarrow$ energy store in **case 3** $E_3 = \frac{1}{2}K(x_1 + x_2)^2$

$$E_3 = \frac{1}{2} \times 5 \times 10^3 \times \left(\frac{10 \times 10}{100 \times 100} \right)$$

= 25 J

$\Rightarrow$ work required to $= (E_1 - E_2)$

Stretch it further by = (25 – 6.25) J

Another 5 cm = 18.75 J

8. Soln.: (4)

Machine gun fires n bullets per second each with kinetic energy K

Power of the machine gun = P

$$P = \frac{\text{kinetic energy of n bullets}}{\text{time}}$$

$$P = \frac{nk}{1} = nk \text{ watt}$$

9. Soln.: (2)

Force $\vec{F} = (5\hat{i} + 3\hat{j} + 2k)n$

Displacement $\vec{r} = (2\hat{i} - \hat{j})m$

Work done on the particle = (force in x × displacement in x)
+ (force in y × displacement in y)
+ (force in z × displacement in z)

$= (5 \times 2) + (3 \times (-1)) + (2 \times (0))$

$= 10 - 3 + 0$

$= 7$ J

10. Soln.: (4)

Work done by friction = change in KE

$$f \times S = \frac{1}{2}mv^2 - 0$$

$$f \times S = \frac{1}{2}mv^2$$

$$S = \frac{1}{2}\frac{mv^2}{f}$$

$$S \propto v^2$$

$$\Rightarrow S_1 = 20\,m \text{ for } v_1 = 60 \text{ km/h}$$

$$\Rightarrow S_2 = ? \quad \text{for } v_2 = 120 \text{ km/h}$$

$$\frac{S_1}{S_2} = \frac{20}{S_2} = \frac{60^2}{4\times 60^2} \quad \{\Rightarrow S_2 = 80m$$

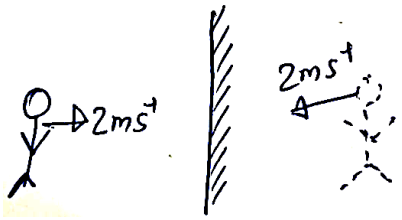
11. Soln.: (2)

$$V_{man} = 2\uparrow$$

$$V_{image} = -2\uparrow$$

$$\Rightarrow V_{image/man} = V_{image} - V_{man} = -4\uparrow$$

$\Rightarrow$ Speed of image = $4ms^{-1}$



12. Soln.: (3)

$\Rightarrow$ The image formed is same size as the object

$\Rightarrow$ The position of object is at center of curvature

$\Rightarrow$ R = 12 cm

$$f = \frac{R}{2} = 6\,cm$$

13. Soln.: (4)

Concave mirror $\Rightarrow$ Real image

$$\Rightarrow |m_1| = 4$$

$$m = -4 = -\frac{v}{u} \{\Rightarrow v = 4u$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \left\{\Rightarrow \frac{1}{f} = \frac{-1}{4u} \quad \frac{-1}{u} = \frac{-5}{4u}\right.$$

$$f = \frac{-4u}{5}$$

$$\Rightarrow |m_2| = 3$$

$$m_2 = -3 = \frac{-v_2}{u_2} \{v_2 = 3u_2$$

$$\frac{1}{f} = \frac{-1}{3u_2} - \frac{1}{u_2} \left\{\Rightarrow \quad \frac{1}{f} = \frac{-4}{3u_2} = \frac{-4}{3(u+3)}\right.$$

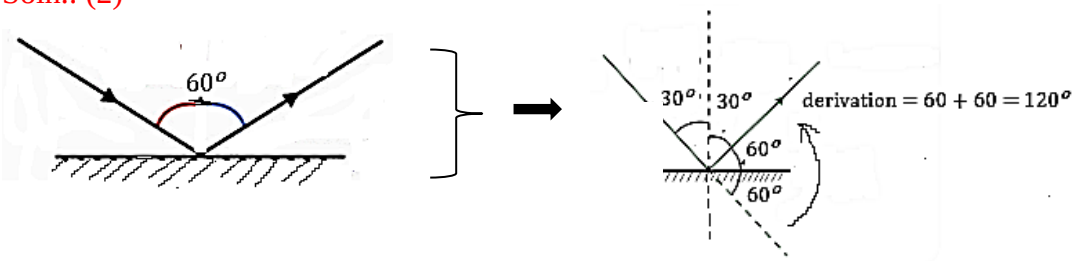
$$f = \frac{-3(u+3)}{4}$$

$$16u = 15u + 15\times 3$$

$$u = 15\times 3 = 45$$

$$|f| = \frac{4 \times 45}{5} = 36\,\text{cm}$$

14. Soln.: (2)



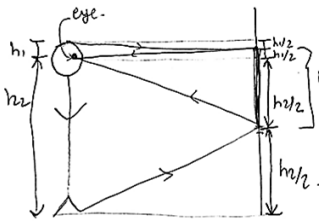
15. Soln.: (2)

Height (h) = $h_1 + h_2 = 2m$

Size of mirror = $\frac{h_1}{2} + \frac{h_2}{2}$

$= \frac{h_1 + h_2}{2}$

$= \frac{2}{2} = m \quad = 1m$



Chemistry

16. Soln.: (1)

Three shells → period 3; three valence electrons → group 13; such elements (like Al) are metals.

17. Soln.: (1)

B, Si, Ge show properties intermediate between metals and non-metals and are classic metalloids.

18. Soln.: (4)

Ionisation energy increases across a period and is maximum for the noble gas Ne among second-period elements.

19. Soln.: (2)

Effective nuclear charge increases, so radius shrinks and more energy is needed to remove electrons, raising ionisation energy.

20. Soln.: (3)

Ca is a reactive metal; metallic oxides like CaO are basic, while non-metal oxides are generally acidic

21. Soln.: (4)

All three are group-1 alkali metals; metallic character increases down the group, so A < B < C.

22. Soln.: (3)

Group elements have the same valence electron count, so valency pattern remains constant down that group (e.g. all group-1 have valency 1).

23. Soln.: (2)

Al is trivalent; to conserve atoms, $2Al + 3Cl_2$ gives $2AlCl_3$ (2 Al and 6 Cl each side).

24. Soln.: (3)

In C, Na^+ exchanges with H^+ (double displacement); carbonic acid decomposes to CO_2 gas and water

25. Soln.: (2)
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$; CO_2 turns limewater milky due to formation of $CaCO_3$.

26. Soln.: (1)
Thermal decomposition of limestone absorbs heat to break $CaCO_3$ into CaO and CO_2

27. Soln.: (2)
H^+ ions in HCl gain electrons to form H_2 (reduction), so HCl acts as the oxidising agent and causes oxidation of Zn.

28. Soln.: (1)
Fe displaces Cu from $CuSO_4$, giving $FeSO_4$ (pale green, making solution lighter) and depositing reddish-brown Cu on the nail.

29. Soln.: (2)
Diprotic acid H_2SO_4 needs two moles of NaOH for complete neutralisation: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

30. Soln.: (2)
Balanced decomposition is $2KClO_3 \rightarrow 2KCl + 3O_2$ (K and Cl_2 each side, O: 6 each side).

Biology

31. Soln.: (2)
The point of contact, or functional junction, between the terminal branches of the axon of one neuron and the dendrites of another neuron is called a synapse. This connection allows for the transmission of nerve impulses, typically via chemical messengers called neurotransmitters that cross a tiny gap known as the synaptic cleft.

32. Soln.: (2)
Sieve tubes (sieve tube elements) are living cells at maturity, though they lack a nucleus, ribosomes, and some other organelles. Their functions are controlled by the adjacent companion cells. They are the main conducting elements for food in the phloem tissue.

33. Soln.: (4)
The filtration units of the kidneys are called (4) Nephrons, as each kidney contains millions of these microscopic structures responsible for filtering blood, removing waste, and forming urine, working as the kidney's fundamental functional units. They filter blood, reabsorb necessary substances, and secrete waste.

34. Soln.: (1)
As blood flows through the capillaries of body tissues, cells perform cellular respiration, consuming **oxygen** and producing **carbon dioxide** as a waste product. This carbon dioxide diffuses from the high concentration area in the cells into the lower concentration area in the blood, making the blood leaving the tissues richer in **carbon dioxide** and lower in oxygen

35. Soln.: (2)
- The term **heterodont** refers to the condition in which an organism possesses more than one type of tooth morphology.

- Humans and most mammals have four distinct types of teeth, specialized for different functions: **incisors** for cutting, **canines** for tearing, and **premolars** and **molars** for crushing and grinding food.
- This specialization allows for efficient processing of a varied diet.

36. Soln.: (4)
The total number of ATP molecules obtained through the anaerobic respiration of three molecules of glucose is 6

37. Soln.: (4)
Hydrochloric acid (HCl) in the stomach performs all the mentioned functions as part of the digestive process.
(1) **Activation of gastric enzymes**: HCl provides the essential acidic environment (pH 1.5-3.5) needed to convert the inactive enzyme pepsinogen into its active form, **pepsin,** which is responsible for protein digestion.
(2) **Killing harmful pathogens in ingested food**: The high acidity of the stomach acts as a primary defense mechanism, destroying most **bacteria** and other harmful **microorganisms** that enter with the food, thus preventing infections.
(3) **Softening food**: HCl helps to break down and **denature proteins,** essentially "unfolding" them and breaking down the food into a semi-liquid mixture called chyme, making it easier for enzymes to act and for further digestion and nutrient absorption to occur.

38. Soln.: (3)
Spore formation, as Rhizopus (bread mould) reproduces asexually by producing tiny, airborne spores within specialized sacs called sporangia, which germinate to form new mold colonies under favorable conditions, making spore formation the primary method of dispersal and reproduction

39. Soln.: (3)
A potato tuber is a modified underground **stem** that is used for food storage (mainly starch) and vegetative propagation. The key characteristic that identifies it as a stem and not a root is the presence of "eyes," which are **axillary buds** or nodes where new shoots and leaves can sprout, leading to the growth of a new, genetically identical plant.

40. Soln.: (1)
Hydrochloric acid (HCl) creates a highly acidic environment in the stomach, which is essential for two key reasons related to pepsin
- It converts the inactive precursor enzyme pepsinogen into its active form, pepsin.
- Pepsin functions optimally at this low pH (around 1.8-3.5) to begin the digestion of proteins.

Without HCl, pepsinogen would not be activated, and the enzyme would not function, severely impairing protein digestion

41. Soln.: (3)
Photophosphorylation is the process in which light energy is used to convert adenosine diphosphate (ADP) and inorganic phosphate (Pi) into **ATP** (adenosine triphosphate). This process occurs during the light-dependent reactions of photosynthesis in the chloroplasts of plant cells and cyanobacteria. The ATP produced serves as the primary energy currency for the subsequent dark reaction (Calvin cycle), where carbon dioxide is converted into carbohydrates

42. Soln.: (3)
The **epiglottis** is a leaf-shaped flap of elastic cartilage located at the top of the larynx (voice box/windpipe entrance). During swallowing, the larynx moves upward, and the epiglottis folds down

to cover the glottis (the opening of the trachea), thereby preventing food or liquids from entering the respiratory passage and directing them into the esophagus instead.

43. Soln.: (1)
The deficiency of **(1) Ca** ions (calcium ions) will delay blood clotting [1, 2]. Calcium ions (Ca^{2+}) are essential cofactors in the coagulation cascade, necessary for the activation of several clotting factors [2, 3].

44. Soln.: (4)
Ethylene is a gaseous plant hormone that is naturally produced by fruits and triggers the complex process of ripening. This process involves changes like softening of the flesh (due to the dissolution of pectin), the conversion of starches into sugars, and the development of color, aroma, and flavor.

45. Soln.: (1)
Phototropism, which is the plant's directional growth response to light, driven by hormones like auxin to maximize light absorption for photosynthesis.

46. Soln.: (3)
Emasculation is the process of removing the stamens (male reproductive parts) or anthers from a bisexual flower to prevent self-pollination, a key step in artificial hybridization for controlled cross-pollination in plant breeding

47. Soln.: (1)
Menopause in a human female refers to the time when menstruation permanently stops, marking the end of reproductive years, typically between ages 45-55, as ovaries cease releasing eggs and hormone production declines
This is the definition of menopause—the cessation of menstrual periods for 12 consecutive months.

48. Soln.: (3)
The sequence of events in sexual reproduction in plants is as follows:

- **Pollination** is the transfer of pollen from the anther (male part) to the stigma (female part) of the flower.
- **Fertilization** occurs after the pollen reaches the stigma and grows a pollen tube to the ovule, where the male gamete fuses with the female egg cell to form a zygote.
- **Embryo** development follows, as the zygote undergoes cell division to develop into a multicellular embryo within the seed.
- **Seedling** growth is the final stage, where the embryo in the seed germinates under suitable conditions to grow into a new plant (seedling).

49. Soln.: (3)
The **larynx**, or voice box, is a part of the respiratory system and is involved in producing sound and protecting the trachea (windpipe) from food aspiration. It is not a continuous part of the digestive tract through which food passes

50. Soln.: (2)

- **Aerobic respiration** is the process cells use to break down food (primarily glucose) to produce a large amount of energy, stored as **ATP**, using oxygen.
- While the initial stage, **glycolysis,** occurs in the **cytoplasm**, the key, energy-producing stages (Krebs cycle and the electron transport chain) take place in the **mitochondria.**
- Because the vast majority of the ATP is generated within the mitochondria, it is considered the primary site and is often referred to as the "**powerhouse of the cell**".