(SOLUTION)

Physics

1. Soln.: (3)

$$F = \frac{\text{change in Momentum}}{\text{Time of Contact}} = \frac{\Delta p}{\Delta t}$$

$$\Delta p = m(v = u)$$

$$\Delta p = 2\,\text{kg}\,[(-100\text{ m/s}) - (100\text{m/s})]$$

$$\Delta p = 2\,\text{kg}\,(-200\text{ m/s}) = -400\text{ N . s}$$

$$F = \frac{|\Delta p|}{\Delta t} = \frac{400\,\text{N.s}}{\frac{1}{50}\,\text{s}}$$

$$F = 400 \times 50\,\text{N} = 20,000\text{N}$$

$$F = 2 \times 10^4\text{ N}$$

2. Soln.: (2)

$$3a = T - 3g \Leftarrow 3\text{kg block}$$

$$4a = 4g - T \Leftarrow 4\text{kg block}$$

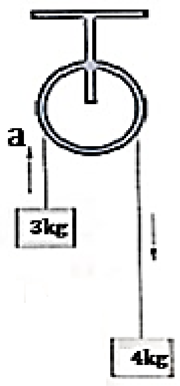
$\Rightarrow$ Tension calculation

$$\frac{4}{3}(T - 3g) = 4g - T$$

$$4T - 12g = 12g - 3T$$

$$7\,T = 240$$

$$T = \frac{240}{7}$$



3. Soln.: (4)

The change in linear momentum (Δp) is equal to the net area under the Force versus Time (F– t) graph (impulse)

$$\Delta p = \text{Net Area} = \sum(\text{Force} \times \text{Time Interval})$$

4. Soln.: (2)

Since the force is constant, the acceleration is constant, allowing us to use the kinematic equation that relates initial velocity (u), final velocity (v), acceleration (a), and distance (s);

$$v^2 = u^2 + 2as$$

The body starts as rest, so u = 0 :

$$v^2 = 0 + 2as$$

$$v^2 = 2as$$

Substitute the expression for acceleration $a = \frac{F}{m}$ into the equation for v^2 :

$$v^2 = 2\left(\frac{F}{m}\right)s$$

$$v \propto \frac{1}{\sqrt{m}}$$

5. Soln.: (2)

$$F = \frac{\Delta p}{\Delta t} = \frac{m(v-u)}{t}$$

$$F = \frac{2kg \times (30m/s - 20m/s)}{2s}$$

F = 10 N

6. Soln.: (1)

The problem asks which bullet, P or Q will pierce a greater distance through a target. Both bullets are stopped by the target, meaning the **work done** by the resistive force of the target equals the initial **kinetic energy** (KE) of the bullet.

- Work – Energy Theorem: Work done by resistive force (W_{res}) = Change in KE (ΔKE). Since the final KE is zero, W_{res} = Initial KE.
- **Work done**: $W_{res} = F_{avg} \times d$, where F_{avg} is the average resistive force and d is the piercing distance.
- **Assumption:** For the same target, the **average resistive force** (F_{avg}) **is constant** for both bullets.

Therefore, the distance pierced (d) is directly proportional to the initial kinetic energy (K.E) ;

$$d \propto KE = \frac{1}{2}mv^2$$

Since KE_P (2.0J) is greater than KE_Q (1.0J), bullet P must do more work against the constant resistive force and will therefore pierce a greater distance.

7. Soln.: (4)

1 k Wh = 1 × 1000 W × 1 h
1 k Wh = (1000 W) × (3600 s)
1 k Wh = (1000 J/s) × (3600 s)
1 k Wh = 3, 600, 000 J

8. Soln.: (4)

Kinetic Energy in terms of Momentum: $K = \frac{P^2}{2m}$

Final Momentum: $p_2 = p_1 + 10\% \text{ of } p_1 = p_1(1+0.10) = 1.10p_1$

$$K_2 = \frac{(1.10p_1)^2}{2m} = \frac{(1.10)^2 p_1^2}{2m}$$

$$K_2 = (1.21)\frac{p_1^2}{2m}$$

Since $K_1 = \frac{p_1^2}{2m}$, we have :

$$K_2 = 1.21K_1$$

Percentage Increase = $\frac{K_2 - K_1}{K_1} \times 100\% = \frac{0.21K_1}{K_1} \times 100\%$

Percentage Increase = $0.21 \times 100\% = 21\%$

9. Soln.: (4)

Kinetic Energy in terms of Momentum $K = \frac{p^2}{2m}$

$$p_2 = p_1 - 0.10p_1 = 0.90p_1$$

The final K.E., K_2 will be :

$$K_2 = \frac{p_2^2}{2m} = \frac{(0.90p_1)^2}{2m} = (0.90)^2\frac{p_1^2}{2m}$$

$$K_2 = 0.81K_1$$

The percentage decrease in K.E. is :

$$\text{Percentage Decrease} = \frac{K_1 - K_2}{K_1}\times 100\% = \frac{K_1 - 0.81K_1}{K_1}\times 100\%$$

$$\text{Percentage Decrease} = \frac{0.19K_1}{K_1}\times 100\% = 0.19\times 100\% = 19\%$$

10. Soln.: (4)

The formula for work done (W) by a constant force (F) acting at an angle θ to the direction of displacement (S) is:

$$W = F.S.\cos\theta$$

Since the force (F) and the displacement (S) are the same in all four cases, the work done(W) will be maximum when $\cos\theta$ is maximum.

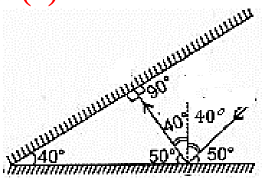
Since cos 0^o = 1 is the maximum value, the work done is maximum in case (d).

In case (d) : $W_{max} = F.S.\cos 0^0 = F\cdot S$

The correct option is (d).

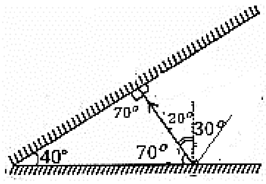
11. Soln.: (1)

(1)



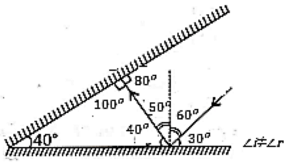
$\angle i = \angle r$ ✓

(2)



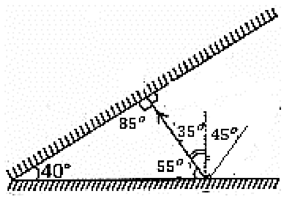
$\angle i \neq \angle r$ ✗

(3)



$\angle i \neq \angle r$ ✗

(4)



$\angle i \neq \angle r$ ✗

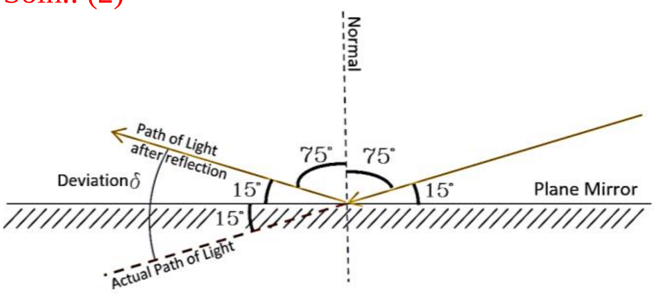
12. Soln.: (1)

When a ray of light passes through the centre of curvature (C) of a spherical mirror (Concave or convex),it strikes the mirror along the normal at the point of incidence

Therefore, the angle of incidence (*i*) is :

$$i = 0^o$$

13. Soln.: (2)



14. Soln.: (3)
⇒ **(a)** Shows a ray parallel to the principal axis reflecting as if coming from the focus (F). This is the rule for a **convex mirror**, not a concave mirror (which is depicted). This is incorrect
⇒ **(b)** Shows a ray parallel to the principal axis reflecting and **passing directly through the principal focus (F).** This is the correct rule for the **concave mirror**, not a convex mirror as shown. This is incorrect
⇒ **(c)** Shows a ray parallel to the principal axis reflecting away from the principal axis, passes through the focus (F) for a concave mirror as shown. This is correct.
⇒ **(d)** Shows a ray parallel to the principal axis continuing parallel after reflection. This is incorrect.

15. Soln.: (2)
When light travels from a **denser** medium (D) into a **rarer** medium (R), its speed **increases,** and the refracted ray bends **away from the normal**.

- **Denser** $\rightarrow$ **Rarer** (D $\rightarrow$R): Ray bends away from the normal.
- **Rarer** $\rightarrow$ **Denser** (R $\rightarrow$D): Ray bends towards the normal.

The **normal** is the dashed line drawn perpendicular to the boundary between the two media at the point where the light ray strikes it.

Chemistry

16. Soln.: (2)
Z = 19 → 2,8,8,1 (4 shells → period 4; 1 valence electron → group 1; valency = 1).

17. Soln.: (2)
MCl_2 implies M^{2+}; among given metals, Mg (2,8,2) loses 2 electrons to form Mg^{2+}, giving $MgCl_2$-type compound.

18. Soln.: (1)
P has electronic configuration 2,8,6 (group 16), so its valency is 2 (P^{2-}). Q has configuration 2,8,2 (group 2), so its valency is 2 (Q^{2+}). Cross-combination gives P_2Q_2, which simplifies to a 1:1 ratio, so the simplest formula is PQ.

19. Soln.: (4)
Across a period left to right, atomic radius decreases; in 3rd period order of size is Na > Mg > Al > Si, so decreasing order is Na, Mg, Al, Si; hence smallest-to-largest is Si < Al < Mg < Na (option D).

20. Soln.: (1)
In a period, metallic character decreases from left to right; Na is the left-most metal in the third period, so it is most metallic.

21. Soln.: (3)
Z = 10 (Ne) and 18 (Ar) are noble gases with complete octet → very low reactivity

22. Soln.: (3)
As valence electrons go from 1 to 8, combining capacity (valency) rises from 1 to 4 (groups 1–14) then falls from 3 to 0 (groups 15–18).

23. Soln.: (2)
$CaO + CO_2 \rightarrow CaCO_3$ shows two substances combining to form one compound (combination) and is already balanced; A and C are decomposition, D is displacement

24. Soln.: (1)
Fe is oxidised ($Fe \rightarrow Fe^{2+}$), causing Cu^{2+} to be reduced to Cu, so Fe is the reducing agent.

25. Soln.: (3)
$CaCO_3(s) \rightarrow CaO$(s, white solid) + CO_2 (g, colourless gas). The evolved CO_2 gas passes through limewater and turns it milky white due to formation of $CaCO_3$ precipitate:
$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 \downarrow$ (white precipitate) + H_2O This reaction represents thermal decomposition of limestone.

26. Soln.: (3)
Heating lead nitrate forms NO_2 (brown gas) and new substances, so composition changes; the others are physical state changes only.

27. Soln.: (1)
$Mg(0) \rightarrow Mg^{2+}$ (loss of electrons = oxidation); O(0) in $O_2 \rightarrow O^{2-}$ in MgO
(gain of electrons = reduction).

28. Soln.: (2)
Electrolysis breaks molten $PbBr_2$ into Pb and Br_2, an example of electrolytic decomposition

29. Soln.: (2)
Copper develops green basic copper carbonate in moist air via oxidation by oxygen and CO_2; this slow surface attack is corrosion, involving redox.

30. Soln.: (2)
Start with Fe: 2 Fe on LHS in Fe_2O_3, so put 2 Fe on RHS. For O: Fe_2O_3 has 3 O; to make Al_2O_3 with 3 O atoms need 1 Al_2O_3. That uses 2 Al atoms, so put 2 Al on LHS. Balanced:
$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$ (coefficients 2,1,1,2).

Biology

31. Soln.: (1)
Intestinal juice (succus entericus) contains a variety of enzymes, such as disaccharidases (maltase, lactase, sucrase), lipases, and peptidases (dipeptidases, aminopeptidases), which break down carbohydrates, fats, and proteins into simple sugars (glucose, fructose, galactose), fatty acids, glycerol, and amino acids, respectively. These final products are then absorbed through the intestinal walls into the bloodstream and lymphatic system

32. Soln.: (2)
Lipase acts on **Fats**, breaking them down into fatty acids and glycerol for energy, a key process in fat digestion in the small intestine, making it essential for lipid metabolism.

33. Soln.: (2)
In human males, the testes are in the scrotum because it provides a lower temperature (2-3°C below body temp), which is crucial for the formation of sperms (spermatogenesis), as higher internal body heat inhibits sperm production, making the scrotum essential for fertility.

34. Soln.: (2)
A is False, and R is true
Reason - The pulmonary artery does not pump oxygenated blood. In fact, it pumps deoxygenated blood from the right ventricle to the lungs for oxygenation. After oxygenation, the oxygenated blood returns to the heart through the pulmonary veins.

35. Soln.: (3)
Reason - Dialysis is a medical process used to remove waste products like urea from the blood when the kidneys are not functioning properly. Urea is a waste product produced in the body and its accumulation can lead to toxicity if not removed

36. Soln.: (2)
Pancreas
Reason — The pancreas is an exoendocrine gland because it has both exocrine and endocrine functions. It secretes digestive enzymes into the small intestine via ducts (exocrine activity) and produces hormones like insulin and glucagon, which are released directly into the bloodstream to regulate blood sugar levels (endocrine activity).

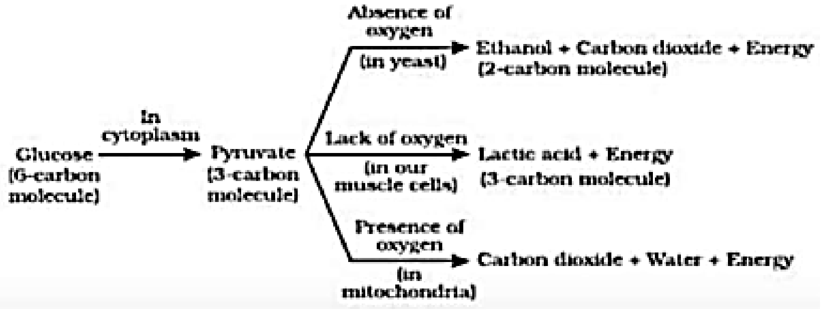
37. Soln.: (1)
Kidney → ureter → bladder → urethra → outside the body
Urine is produced in the kidneys through the filtration of blood. From the kidneys, the urine travels down through two tubes called ureters to the urinary bladder, where it is stored temporarily. When the bladder is full, the urine is expelled from the body through another tube called the urethra.

38. Soln.: (3)
Regulating body temperature
While the nervous system plays a critical role in sensing temperature changes and coordinating responses to maintain body temperature (thermoregulation), it is not the only system involved, and some of the broader, long-term regulation of internal environments (homeostasis) is a cooperative effort with the endocrine system. The other options are core, primary, and direct functions of the nervous system

39. Soln.: (4)
Syphilis is a well-known sexually transmitted disease (STD) caused by the bacterium Treponema pallidum. It is primarily spread through sexual contact, including vaginal, anal, and oral sex.

40. Soln.: (3)
Darwin's theory of evolution by natural selection includes the concepts of natural **selection, survival of the fittest,** and the **struggle for existence.** However, while he recognized that traits are inherited, Darwin did not understand the specific mechanism of how this occurred. The concept of genetic inheritance was not understood at the time; it was later clarified by Gregor Mendel's work on genetics, which contributed to the modern synthesis of evolutionary theory (Neo-Darwinism).

41. Soln.: (4)
Cytoplasm and Mitochondria In aerobic **respiration, glucose** is first broken down into **pyruvate in the cytoplasm,** and then **pyruvate** is further broken down into **carbon dioxide and water in the mitochondria, releasing energy.**



42. Soln.: (2)
Hydrochloric acid, Pepsin, Mucus **Gastric Glands Secretions:**
- Hydrochloric acid (HCl): Creates an acidic environment (pH 1.5-3.5) to activate pepsin and kill pathogens.
- Pepsin: Digests proteins into peptides (activated from pepsinogen by HCl).
- Mucus: Protects the stomach lining from acid and pepsin damage.

43. Soln.: (1)
The **nephron** is the **basic structural and functional unit** of the human kidney. It is responsible for the **filtration of blood** and the **formation of urine.**

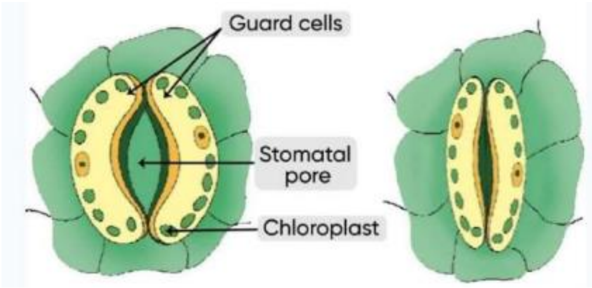
44. Soln.: (2)
Starch is a **stored form of carbohydrate** in plants, not an excretory product. Plants excrete substances like **CO_2, resins, gums**, and **dead cells** as waste materials.

45. Soln.: (3)
A is true, but R is false.
The xylem indeed transports **water and minerals** from the roots to other parts of the plant, but it is **not found only in the roots** - it is present throughout the plant, including the **stems and leaves.**

46. Soln.: (3)
Cuscuta (also known as Amarbel) shows a **parasitic mode of nutrition**, as it obtains food from the host plant on which it climbs by absorbing nutrients through specialized structures called **haustoria.**

47. Soln.: (1)
Nitrogen is an essential element required by plants for the **synthesis of proteins** and other important compounds like nucleic acids.

48. Soln.: (4)
The **guard cells** control the **opening and closing of stomata**. When they are full of water (turgid), the stomata open; when they lose water (flaccid), the stomata close.



49. Soln.: (3)
Starch into simple sugars Saliva in the mouth contains the enzyme **salivary amylase**, which helps in the **breakdown of starch into simple sugars**. If less saliva is secreted, this conversion will be affected.

50. Soln.: (4)
Cytoplasm and Oxygen deficient muscle cells
Reason — Glycolysis (Glucose → Pyruvate + energy) takes place in the cytoplasm of the cell and when oxygen is scarce, pyruvate is converted to lactic acid in oxygen-deficient (anaerobic) muscle cells, releasing a small amount of energy.
Hence the sites for (a) and (b) are cytoplasm and oxygen-deficient muscle cells respectively.