(SOLUTION)

Physics

1. Soln.: (1)

Option	Effect Produced by a Force?	Explanation
(A)Changing the mass of an object	**NO**	**Mass** is the amount of matter in an object and it an intrinsic property. A force (push, pull, gravity, etc.) can change motion or shape, but it **cannot** change the amount of matter in an object.
(B) Changing the shape of an object	Yes	Forces like compression, stretching, or bending can easily change an object's shape
(C) Changing the position of an object	Yes	A force causes motion (or a change in motion), thus changing its position.
(D Changing the direction of movement of an object	Yes	This is change in velocity (acceleration), which is a direct effect of a force.

2. Soln.: (1)

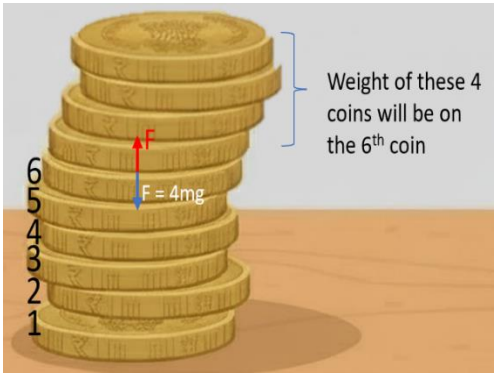
$$PE_{top} = KE_{bottom}$$

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

The mass (m) cancels out from both sides of the equation, leaving:

$$v = \sqrt{2gh}$$

3. Soln.: (1)



4. Soln.: (3)

$$W_{net} = \Delta K$$

$$W_{resistive} = -F_{\alpha vg} \cdot s$$

$$-F_{\alpha vg} \cdot s = K_f - K_i$$

$$-F_{\alpha vg} \cdot s = 0 - \frac{1}{2}mv_i^2$$

$$F_{\alpha vg} = \frac{mv_i^2}{2s}$$

5. Soln.: (3)

An astronaut feels weightless because they and the spacecraft are in a state of **continuous free – fall** around the Earth.

1. **Gravity is present:** The Earth's gravity is still pulling the spacecraft and the astronaut.
2. **Equal Acceleration**: Both the astronaut and the spacecraft are accelerating towards the Earth at the **same rate** ($\alpha_{spacecraft} = g$)
3. **Result:** Since everything inside is accelerating together, the astronaut does not push against the floor, leading to the sensation of **weightlessness** (microgravity).

6. Soln.: (4)

The **work done** (W) by a force (F) to move an object through a displacement (s) is fundamentally defined by the product of force and displacement.

- The area under a **Force – Displacement curve** is the integral of force with respect to displacement:
- This integral is the exact definition of the **work done** in physics, especially when the force is not constant (a variable force) $W = \int F \cdot ds$

7. Soln.: (4)

$$E_i = KE_i + PE_i \qquad E_f = KE_f + PE_f$$

$$E_i = \frac{1}{2}mv^2 + mgh \qquad E_f = \frac{1}{2}mv_f^2 + 0$$

$$E_i = E_f$$

$$\frac{1}{2}mv^2 + mgh = \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{v^2 + 2gh}$$

The final speed (v_f) is determined solely by the initial speed (v) and the height (h) and is **independent of the initial direction** (upward downward or horizontal)

8. Soln.: (2)

$$KE_f = 10\% \times KE_i$$

$$KE_f = 0.1 \times KE_i$$

$$\frac{1}{2}mv_f^2 = 0.1 \times \left(\frac{1}{2}mv_i^2\right)$$

$$v_f^2 = 0.1 \times v_i^2$$

$$v_f = \sqrt{0.1 \times v_i^2}$$

$$v_f = v_i\sqrt{0.1}$$

$$v_f = 20\sqrt{10}\ \text{m s}^{-1}$$

9. Soln.: (3)

The work done by the centripetal force on a body moving in a circular path at a **uniform speed** is **zero** because the centripetal force is always perpendicular (90^0) to the direction of displacement (velocity). Therefore since Work = Force $\times$ Displacement $\times$ $\cos(90^0)$, the result is zero. **OR**

$$W_{net} = K_{final} - K_{initial}$$

$$= \frac{1}{2}mV^2 - \frac{1}{2}mV^2$$

$$= 0$$

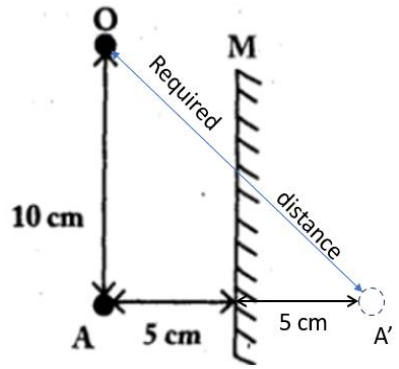
Therefore, the work done by the net force in one complete turn is **Zero**

10. Soln.: (4)

The work done is given by W = Fd cos θ . For **negative work** (W< 0), the term $\cos\theta$ must be negative, which occurs when the angle θ is between 90^0 and 180^o. Since 110^o is the only option in this range, it is the correct angle

11. Soln.: (1)

$10\sqrt{2}$ cm



12. Soln.: (2)

For a **real image** formed by a concave mirror, the image is always **inverted**. For an inverted image, the magnification (m) is **negative**

$m = -3$

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

$$-3 = -\frac{v}{(-20\,cm)}$$

$$v = -60 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

Substitute the values for $u = -20$ cm and $v = -60$ cm

$$\frac{1}{f} = \frac{1}{(-60\,cm)} + \frac{1}{(-20\,cm)}$$

$$\frac{1}{f} = \frac{1}{60} - \frac{1}{20}$$

$$f = -15$$

13. Soln.: (3)

The correct observation is A) **From the point R, the source cannot be seen**. Point R lies in the region of the **umbra** (the darkest part of the shadow), where the light rays from the source are completely blocked by the opaque object.

14. Soln.: (2)

The focal length spherical mirror depends only on its **radius of curvature (R)** where *f* = R/2. Cutting the mirror along the line XY does not change the **radius of curvature** of the curved surface, so the focal length of each piece remains *f*.

15. Soln.: (2)

The absolute magnification, $|m|$, is the ratio of image size (h_i) to object size (h_o)

$$|m_A| = \frac{|h_{iA}|}{h_{oA}}$$

From, the mirror formula, the magnification is also given by:

$$m_A = \frac{f}{f - u_A}$$

Substitute the values for f and u_A:

$$m_A = \frac{-7.5}{-7.5-(-30)} = \frac{-7.5}{-7.5+30} = \frac{-7.5}{22.5}$$

$$m_A = -\frac{1}{3}$$

We use the relationship for the image and object sizes:

$$\frac{|h_{iB}|}{h_{0B}} = |m_B|$$

Since $h_{iA} = h_{iB}$ and $h_{oA} = 3h_{oB}$, we can substitute these into the magnification for A :

$$|m_A| = \frac{|h_{iA}|}{h_{oA}} = \frac{|h_{iB}|}{3h_{oB}} = \frac{1}{3}\left(\frac{|h_{iB}|}{h_{oB}}\right)$$

$$|m_A| = \frac{1}{3}|m_B|$$

Now substitute the calculated value for $|m_A| = 1/3$:

$$\frac{1}{3} = \frac{1}{3}|m_B|$$

$$\Rightarrow |m_B| = 1$$

The distance to the Centre of Curvature is twice the focal length:

$$|u_B| = R = 2|f|$$

$$|u_B| = 2 \times 7.5 \text{ cm} = 15 \text{ cm}$$

Since the object is in front of the mirror, the object distance is negative:

$$u_B = -15 \text{ cm}$$

Chemistry

16. Soln.: 3

Electronegativity values (Pauling scale) for the elements in each pair are used to determine the difference:

17. Soln.: 3

elements like aluminum (Al_2O_3) form amphoteric oxides, meaning they can react with both acids and bases [1].

18. Soln.: 3

Here are the general trends for the properties listed:

Property	**Trend down a Group**	**Trend across a Period (L to R)**
Ionisation potential	Decreases	Increases
Electronegativity	Decreases	Increases
Atomic radius	Increases	Decreases
Electron affinity	Decreases(Generally)	Increases(more negative, generally)

19. Soln.: (1)

An element with 6 valence electrons will most likely be found in **Group 16** of the periodic table [1]. The period cannot be determined solely by the number of valence electrons. However, among the given options, the most likely answer is (1) **Period 3, Group 16**.

Elements in Group 16, also known as the chalcogens, are characterized by having six valence electrons in their outermost shell [1]. Key elements in this group include oxygen, sulfur, and selenium

20. Soln.: (2)

This is a single displacement reaction because the more reactive element, zinc (Zn), displaces the hydrogen (H) from the hydrochloric acid (HCl) to form zinc chloride ($ZnCl_2$) and hydrogen gas (H_2).

21. Soln.: (2)

Endothermic: A reaction that absorbs heat

22. Soln.: (3)

Group 17 elements, also known as halogens, have seven valence electrons in their outermost shell. This electronic configuration makes them highly reactive and eager to gain one more electron to achieve a stable noble gas configuration. Because of this high electron affinity, they act as strong oxidizing agents. They readily oxidize other substances by accepting electrons from them

23. Soln.: (4)

Should be $4Na + O_2 \rightarrow 2Na_2O$

24. Soln.: (2)

The balanced chemical equation for this reaction is $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

25. Soln.: (3)

The true statement about the modern periodic table is (4) Properties of elements vary periodically with their atomic number

26. Soln.: (3)

Mg^{2+} and $Cl^- \rightarrow MgCl_2$

27. Soln.: (1)

Reducing agent: A reducing agent is a substance that causes another substance to gain electrons (be reduced) by losing electrons itself. In this reaction, hydrogen (H_2) loses electrons to copper oxide (CuO), causing CuO to be reduced to copper (Cu) while H_2 is oxidized to water (H_2O).

28. Soln.: (1)

Stability in ionic compounds like chlorides is largely determined by the strength of the electrostatic attraction between the cation (positively charged ion) and the anion (negatively charged ion). A smaller cation has a stronger electrostatic attraction to the anion, making the bond more stable.

Among the alkali metals (Li, Na, K, Cs), lithium has the smallest ionic radius. Therefore, it will exert the strongest electrostatic attraction towards the chloride ion (Cl-), forming the most stable chloride compound (LiCl).

29. Soln.: (3)
The correct answer is AgCl. When a solution containing chloride ions is tested with silver nitrate, a white precipitate of silver chloride (AgCl) is formed. This white precipitate is insoluble in dilute nitric acid but soluble in excess ammonium hydroxide.
Forms a white precipitate with chloride ions that is insoluble in dilute acids like nitric acid but soluble in ammonium hydroxide.

30. Soln.: (1)
Thermal decomposition is a type of chemical reaction where a single compound breaks down into two or more simpler substances upon heating.
In the reaction $CaCO_3 \rightarrow CaO + CO_2$ calcium carbonate ($CaCO_3$) decomposes into calcium oxide (CaO) and carbon dioxide (CO_2) when subjected to heat.

Biology

31. Soln.: (2)
The nephron is the structural and functional unit of the kidney. If filters blood, removes waste products, and regulates water and slat balance, forming urine

32. Soln.: (1)
Red blood cells (RBCs) contain hemoglobin, a protein that binds oxygen in the lungs and delivers it to tissues throughout the body, enduring cells receive energy to function.

33. Soln.: (1)

34. Soln.: (1)
Chlorophyll is the green pigment in plant cells, primarily located in chloroplasts. It captures sunlight energy for photosynthesis, enabling the plant to produce food.

35. Soln.: (3)
Insulin, secreted by the pancreas, helps regulate blood sugar levels by enabling cells to absorb glucose for energy or storage, thereby reducing glucose levels in the blood.

36. Soln.: (4)
Producers, like green plants, synthesize their own food using sunlight through the process of photosynthesis, forming the base of the food chain.

37. Soln.: (2)
Ethylene is a gaseous plant hormone that regulates several processes, including the ripening of fruits by breaking down cell walls and converting starches to sugars.

38. Soln.: (4)
DNA has double helix structure formed by two strands coiled around each other

39. Soln.: (3)
Sunlight is the primary source of energy for all ecosystems, driving photosynthesis in plants.

40. Soln.: (4)
Human sex is determined at the moment of conception by the chromosomes contributed by the sperm cell from the father [1].
The mother's egg always provides an X chromosome [1].
The father's sperm can provide either an X or a Y chromosome [1].
If the sperm contributes an X chromosome, the baby will have an XX combination and be female [1].
If the sperm contributes a Y chromosome, the baby will have an XY combination and be male [1].

41. Soln.: (1)
positively geotropic

42. Soln.: (1)
Starch breaking down into sugars

43. Soln.: (4)
Guard cells

44. Soln.: (3)
Valves in heart

45. Soln.: (1)
Villi are finger-like projections in the small intestine that increase the surface area for maximum absorption of nutrients from digested food into the bloodstream

46. Soln.: (2)
A food chain represents the flow of energy in an ecosystem, where one organism eats another, transferring energy form producers to consumers and finally to decomposers.

47. Soln.: (1)
A synapse is the small gap between two neurons where signals are transmitted from one neuron to the next. The junction between two neurons that allows for the transmission of electrical and chemical signals

48. Soln.: (4)

49. Soln.: (3)

50. Soln.: (2)