# FIITJEE

## INDIAN ASSOCIATION OF PHYSICS TEACHERS
## NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE (NSEJS) 2024 – 25
## Held on: December 22, 2024

**Instructions to Candidates:**

1. Use of mobile phone, smart watch, and ipad during examination is STRICTLY **PROHIBITED**.

2. In addition to this question paper, you are given OMR Answer Sheet along with Candidate's copy.

3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLACK CAPITAL** as well as by properly darkening the appropriate bubbles.

**Incomplete / incorrect / carelessly filled information may disqualify your candidature.**

4. On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.

5. Your **10 – digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in National Standard Examination in Junior Science 2023.

6. Question paper has two parts A1 (Q. No 1 to 48) each question has four alternative, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q.No. 12 (a) (●) (c) (d)

In part A2 (Q. No 49 to 60) each question has four alternatives out of which any number of alternative (s) (1, 2, 3 or 4) may be correct. You have to choose all correct alternatives(s) and fill the appropriate bubble(s), as shown.

Q.No. 52 (a) (●) (c) (●)

7. For **Part A1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2**, you get 6 marks if all the correct alternatives are marked. No negative marks in this part.

8. Rough work may be done in the space provided. There are **11** printed pages in this paper.

9. Calculator is **not** allowed.

10. No candidate should leave the examination hall before the completion of the examination.

11. After submitting answer paper, take away the question paper & Candidate's copy OMR sheet for your reference.

**Please DO NOT make any mark other than filling the appropriate bubbles property in the space provided on the OMR answer sheet.**

**OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.**

**DO NOT WRITE ON THE BACK WISE OF THE OMR ANSWER SHEET.**

1. The mature megagametophyte (Embryo sac) generally has 8 nuclei; 3 egg cells, 1 secondary nucleus and 3 antipodal cells. What kind of embryo sac is found in Polygonum?
   (a) Monosporic
   (b) Bisporic
   (c) Trisporic
   (d) Tetrasporic

1. a

Sol. The embryo sac within the ovule is the female gametophyte in angiosperms. A typical embryo sac is generally of the polygonum type.

A polygonum embryo sac is a monosporic embryo sac which arises from a single haploid megaspore with the help of 3 mitotic nuclear divisions which leads to the formation of 8 nuclei. The two polar nuclei at the centre fuse together to form the central cell. Thus, the polygonum ovary is typically 7 celled and 8nucleate.

A mature polygonum embryo sac contains:
1) Egg apparatus with one egg and two synergid cells,
2) Three antipodal cells
3) A central cell with two polar nuclei.

2. Various plant parts respond to different stimuli e.g., light, gravity, moisture, touch, chemical etc. by growing unequally on the two sides of their organs. A student observed a bottle gourd plant twined around the branches of an adjacent tree while growing close to it. What type of response is it?
   (a) Gravitropism
   (b) Thigmotropism
   (c) Nyctinasty
   (d) Thigmonasty

2. b

Sol. A plant's response to touch, which causes the plant to move toward or away from the stimulus. For example, a climbing plant's tendril will coil around a fence.

3. DNA can exist in various double helical forms. Characteristics of these different forms of DNA are given in the following table under the CODES – Q, R, S and T, respectively.

| Helix Form | Base pairs per turn | Rotation per base pair | Vertical Rise per base pair (h) | Helix Diameter |
|------------|---------------------|------------------------|--------------------------------|----------------|
| Q | 12 | −30.0° | 5.7 Å | 18.4 Å |
| R | 10 | +36.0° | 3.4 Å | 23.7 Å |
| S | 10 | +38.6° | 3.3 Å | 23.7 Å |
| T | 11 | −32.7° | 2.3 Å | 25.5 Å |

Correlate the characteristics with the CODE which shows left-handed helix and which follows the Watson – Crick Model. Choose the correct option.
(a) R & S
(b) S & T
(c) Q & S
(d) Q & R

3. d

Sol. Only Q is left handed and R follows Watson – Crick Model posed the Watson-Crick Structure of DNA in 1953. Robert Wells was the first to discover Z DNA, a non-B structure that DNA can adopt in vivo.

|  | helix sense |
|--------|--------------|
| B-Form | Right handed |
| A-Form | Right handed |
| Z-Form | Left handed |
|  | base pairs per turn |
| B-Form | 10 |
| A-Form | 11 |
| Z-Form | 12 |
|  | vertical rise per bp |
| B-Form | 3.4 Å |

| | |
|---|---|
| A-Form | 2.56 Å |
| Z-Form | 19 Å |
| | rotation per bp |
| B-Form | +36° |
| A-Form | +33° |
| Z-Form | −30° |
| | helical diameter |
| B-Form | 19 Å |
| A-Form | 19 Å |
| Z-Form | 19 Å |

4. Which of the following statements is not correct?
   (a) Two or more species living in common habitats are called allopatric species.
   (b) Two or more species living in common habitats are called sympatric species.
   (c) Species reproducing asexually are called agamo species.
   (d) Species which are morphologically similar but are found in different yet adjacent habitats are called sibling species.

4. a

Sol. Option A is incorrect. Same species that are separated through geographical barriers are called allopatric species.

5. Which of the following is considered a secondary pollutant in the atmosphere?
   (a) Nitrogen oxides (NOx)          (b) Carbon monoxide (CO)
   (c) Ozone ($O_3$)          (d) Particulate matter (PM2.5)

5. c

Sol. Ozone is a harmful air pollutant that forms when other pollutants, like nitrogen oxides (NOx) and volatile organic compounds (VOCs), react with sunlight in the atmosphere.
   (PM2.5) is a secondary pollutant. Particulate matter (PM) is a mixture of solid and liquid particles in the air, and PM2.5 is a type of fine particulate matter.

6. While studying the characteristics of various animals, the character of 'SKELETON', whether external or internal, is started being described with which of the following groups?
   (a) Vertebrata          (b) Arthropoda
   (c) Mollusca          (d) Protozoa

6. b

Sol. Arthropods have an external skeleton, or exoskeleton, made of chitin, a protein that hardens into a protective outer covering:
   The exoskeleton is made of chitin, a protein that's produced by the arthropod's skin. Some arthropods, like crabs and barnacles, also add calcium carbonate to their exoskeletons to make them harder and thicker.

7. Given below are two statements, one labelled as Assertion A and other labelled as Reason R.
   **Assertion (A):** The hypothalamus helps regulate body temperature by acting on the autonomic nervous system are other mechanisms like sweating or shivering.
   **Reason (R):** The hypothalamus plays a key role in regulating the release of hormones from the pituitary gland, which controls various functions like growth, reproduction and metabolism.
   **CODES:**
   (a) Both A and R are true and R is the correct explanation of A
   (b) Both A and R are true but R is not the correct explanation of A
   (c) A is true but R is false
   (d) R is true but A is false

7. b

Sol. Both statements are correct but Reason is not the explanation of Assertion.

8. Some bacteria glide and travel in swarms. Which of the following bacteria conform to these characteristics?
(a) Oscillatoria
(b) Spirulina
(c) Myxobacteria
(d) Chlamydia

8. c

Sol. Myxobacteria are predatory bacteria move in groups called "swarms" by gliding on surfaces and using molecular signals to stay together. The bacteria are long, flexible rods that move in the direction of their long axis. They can spread rapidly over surfaces and form fruiting bodies.

9. The chlorophyll molecules make use of visible radiations by absorbing wavelengths of light which are effective in photosynthesis. When a photon of light collides with chlorophyll molecules, it gets excited and when it comes back to ground state, the released energy is utilized in photosynthetic phosphorylation. Different wavelengths of light give different amount of light reaction products. Following are the absorption spectra of various wavelengths of visible light.
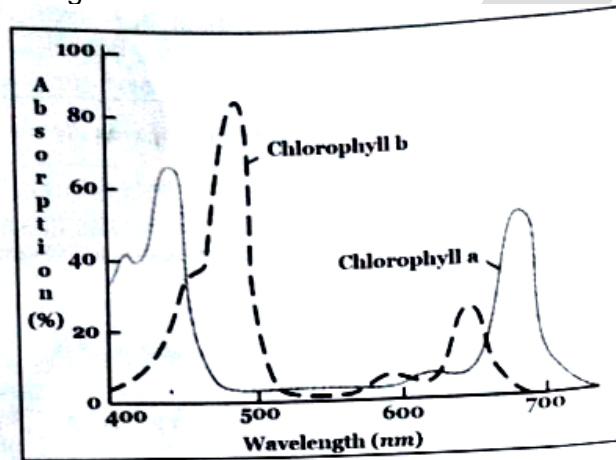


Which of the following lights will yield maximum photosynthesis?
(a) Red
(b) Blue
(c) White
(d) Green

9. a

Sol. Red light yields the maximum photosynthesis. Chlorophyll absorbs light in the red and blue regions of the visible spectrum, which are most effective for photosynthesis. The Emerson enhancement effect states that photosynthesis increases when chloroplasts are exposed to light with a wavelength of 680–700 nanometers.

10. Match the items of Column I with the name of Genus mentioned in Column II.

| Column I | | Column II | |
|---|---|---|---|
| 1. | Smallest fish | (i) | Microcebus |
| 2. | Smallest Toad | (ii) | Mellisuga |
| 3. | Smallest Reptile | (iii) | Paedocypris |
| 4. | Smallest Bird | (iv) | Brachycephalus |
| 5. | Smallest Primate | (v) | Brookesia |

Choose the correct option:
(a) 1-(v), 2-(iv), 3-(ii), 4-(i), 5-(iii)
(b) 1-(iv), 2-(iii), 3-(v), 4-(i), 5-(ii)
(c) 1-(iii), 2-(iv), 3-(v), 4-(ii), 5-(i)
(d) 1-(ii), 2-(i), 3-(iv), 4-(v), 5-(iii)

10. c

Sol. Smallest fish →Paedocypris; Smallest Toad → Brachycephalus; Smallest Reptile → Brookesia; Smallest Bird → Mellisuga; Smallest Primate → Microcebus

11. Based on one of the types of Mendel's hybridization experiments. F2 phenotype number obtained was 8 whereas the genotype number was 27. Which kind of cross it was?
(a) Monohybrid cross
(b) Tetrahybrid cross
(c) Trihybrid cross
(d) Dihybrid cross

11. c
Sol. Number of different F2 genotypes = $3^n$
And phenotypes = $2^n$
It is tri hybrid……. So n = 3
Genotype $3^3 = 27$
Phenotype= $2^3 = 8$

12. Vascular systems are normally regarded as first evolving in Pteridophytes. The central vascular cylinder of it is called as stele.



(1) Plectostele    (2) Solenostele    (3) Dictyostele    (4) Eustele
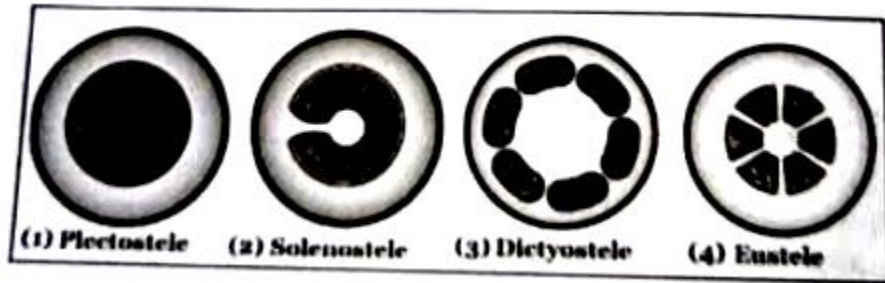
Which of the above steles evolved in Dieotyledons?
(a) (1)                                    (b) (2)
(c) (3)                                    (d) (4)

12. d
Sol. Eustele is the type of stele found in dicotyledons. In a dicot stem, the vascular bundles are arranged in a ring pattern.

13. To achieve an open defecation free India and improve solid waste management, when was Swachh Bharat Mission of Govt. of India launched?
(a) 15th August 2014                     (b) 2nd October 2014
(c) 5th June 2014                        (d) 26th January 2014

13. b
Sol. To accelerate the efforts to achieve universal sanitation coverage and to put focus on sanitation, the Honorable Prime Minister of India, Shri Narendra Modi, launched the Swachh Bharat Mission on 2nd October, 2014.

14. Study the diagram given below. Some anatomically observed parts of this important organ are labeled with numbers 1 to 5. Following structrral or functional characters, numbered (i) to (v), are related to these parts:
(i) Sensitive to a gradient of frequencies
(ii) A membrane called Vastibular of Reissner's membrane
(iii) The tips of the outer hair cells stereocilia are embedded in it
(iv) This part starts at the oval window
(v) Supporting cells include Deiters' cells and pillar cells
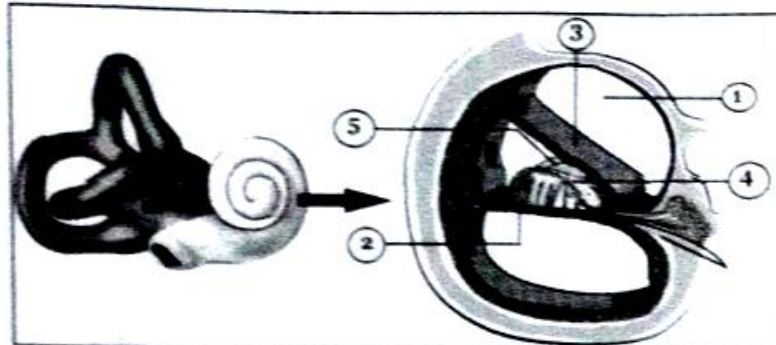


Choose the correct option showing the correct matching of 1 to 5 with (i) and (v).
(a) 1-(ii), 2-(i), 3-(iii), 4-(v), 5-(iv)     (b) 1-(iii), 2-(ii), 3-(i), 4-(iv), 5-(v)
(c) 1-(iv), 2-(i), 3-(ii), 4-(v), 5-(iii)     (d) 1-(v), 2-(iii), 3-(iv), 4-(i), 5-(ii)

14. c
Sol. 1. This part starts at the oval window

2. Sensitive to a gradient of frequencies
3. A membrane called Vastibular of Reissner's membrane
4. Supporting cells include Deiters' cells and pillar cells
5. The tips of the outer hair cells stereocilia are embedded in it

15.    Glyceraldehyde–3–phosphate is oxidized during Glycolysis. What happens to the 'H' atoms and the electrons that are removed during oxidation?
(a) They oxidize NAD$^+$             (b) They are transferred to Pyruvic Acid
(c) They reduce NAD$^+$             (d) They are eliminated in the form of Methane

15.    c
Sol.    G3P is converted to 1,3-bisphosphoglycerate, with the help of the enzyme glyceraldehyde 3-phosphate dehydrogenase, and involves the reduction of NAD+ to NADH.

16.    Both Jean Baptiste de Lamarck and Charles Darwin believed in the idea that particles come together from all parts of the body to form eggs and semen. The concept is popularly known as:
(a) Spontaneous generation             (b) Biogenesis
(c) Pangenesis             (d) Sexual Inheritance

16.    c
Sol.    The concept of particles coming from all parts of the body to form egg and sperm is called pangenesis, a theory proposed by Charles Darwin in 1868.

17.    The molecular formula of a commercial resin used for exchanging ions in water is $C_8H_7SO_3Na$. The maximum uptake of $Ca^{2+}$ ions by the resin expressed in mol/g is

(a) $\dfrac{2}{309}$             (b) $\dfrac{1}{412}$

(c) $\dfrac{1}{103}$             (d) $\dfrac{1}{206}$

17.    b
Sol.    $$\underset{\substack{2\ mol \\ 412\ g}}{C_8H_7SO_3Na} + \underset{\substack{1\ mol \\ 1\ mol}}{Ca^{2+}} \longrightarrow \left(C_8H_7SO_5\right)_2 Ca + Na^+$$
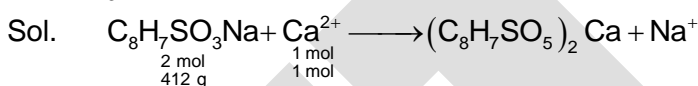
Maximum uptake of $Ca^{2+}$ ion by the resin(mol/gram resin) = $\dfrac{1}{412}$

18.    3g of activated charcoal was added to 50 mL of 0.06 N acetic acid in a flask. After 1 hr, it was filtered and the strength of filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is
(a) 42 mg             (b) 54 mg
(c) 18 mg             (d) 36 mg

18.    c
Sol.    Initial millimoles of $CH_3COOH = 0.06 \times 50$
Final millimoles of $CH_3COOH = 0.042 \times 50$
The mass of $CH_3COOH$ absorbs per gram of charcoal is
$$\dfrac{\left(0.06 - 0.042\right) \times 50 \times 10^{-3} \times 60 \times 10^{-3}}{3} = 18 \text{ mg}$$

19.    At 90°C, for pure water, $\left[H_3O^+\right] = 10^{-6}$. The value of $K_W$ for pure water at 90°C is

(a) $10^{-14}$             (b) $10^{-7}$
(c) $10^{-6}$             (d) $10^{-12}$

19.    d
Sol.    $K_w = [H^+][OH^-]$
$[10^{-6}][10^{-6}]$
$K_w = 10^{-12}$ at 90°C

20. The bond dissociation energy of $H_2$ is 430.53 KJ $mol^{-1}$. If $H_2$ is exposed to radiation of wave length $\lambda$ = 253.7 nm, the percent of radiant energy which will be converted into kinetic energy, is approximately

(a) 22.8%                               (b) 4.34%

(c) 10.5%                               (d) 8.68%

20. d

Sol. $E_{H-H}$ bond dissociation = $\dfrac{430.53 \times 10^3}{6.022 \times 10^{23}}$ per molecule = 7.15 × $10^{-19}$ J per molecule

$E = \dfrac{hc}{\lambda} = 7.83 \times 10^{-19} J$

∴ Energy converted into K.E = (7.83 − 7.15) × $10^{-19}$ J = 0.68 × $10^{-19}$ J

% of energy converted into

$K.E = \dfrac{0.68 \times 10^{-19}}{7.83 \times 10^{-19}} \times 100 = 8.68\%$

21. According to Bohr's atomic model, the approximate quantum number of a circular orbit of diameter 20.6 nm of hydrogen atom is

(a) 10                               (b) 14

(c) 12                               (d) 16

21. b

Sol. The radius of Bohr's orbit is 10.3 nm

also, radius of Bohr's orbit is given by $\dfrac{0.0529 \times n^2}{z}$ z=1,

∴ r = 0.0529 $n^2$ nm

equating the above two, we have,

10.3 nm = (0.0529 $n^2$) nm

$n^2$ = 194

n = 13.9 ≈ 14

Hence, the correct option is B

22. Consider the reaction $C_6H_3CH_3CH(OH)CH(CH_3)_2 \xrightarrow{\text{cons } H_2SO_4} A$. Predominating product A is

(a)
$$\underset{H}{\overset{C_6H_5}{\phantom{.}}} C = C \underset{CH(CH_3)_2}{\overset{H}{\phantom{.}}}$$

(b)
$$\underset{H}{\overset{C_6H_5CH_2}{\phantom{.}}} C = C \underset{CH_3}{\overset{CH_3}{\phantom{.}}}$$

(c)
$$\underset{H}{\overset{C_6H_5}{\phantom{.}}} C = C \underset{H}{\overset{CH(CH_3)_2}{\phantom{.}}}$$

(d)
$$C_6H_5CH_2CH_2$$
$$\underset{H}{\overset{}{\phantom{.}}} C = CH_2$$
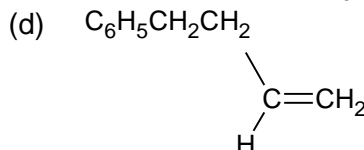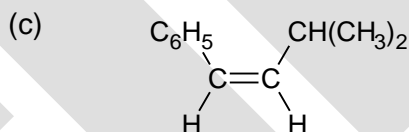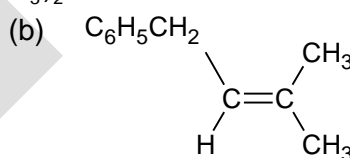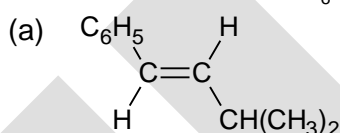
22. a

Sol. Predominating product A is
$$\underset{H}{\overset{C_6H_5}{\phantom{.}}} C = C \underset{CH(CH_3)_2}{\overset{H}{\phantom{.}}}$$
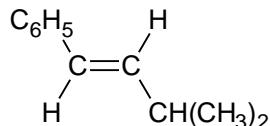
23. The correct order of increasing basic strength of conjugate bases given below is

(a) $RCOO^- < HC \equiv C^- < CH_3^- < NH_2^-$       (b) $CH_3^- < HC \equiv C^- < RCOO^- < NH_2^-$

(c) $RCOO^- < NH_2^- < HC \equiv C < CH_3^-$       (d) $RCOO^- < HC \equiv C^- < NH_2^- < CH_3^-$

23. d

Sol. The correct order of increasing basic strength of conjugate bases is

$RCOO^- < HC \equiv C^- < NH_2^- < CH_3^-$.

24. Quaternary alkyl ammonium ion ($R_4N^+$) may behave as
    (a) $E^+$                     (b) $Nu^-$
    (c) Both                      (d) neither $E^+$ nor $Nu^-$

24. d

Sol. Due to fulfilled octet ammonium ion cannot act as an electrophile and because nitrogen does not have lone pair electron so it can't act as a nucleophile.

25. p-alcohols can be prepared by hydrolysis of monohaloalkanes. Among the reactions mentioned below, which reactant will give least yield of p-alcohol?

$$R - X \xrightarrow{OH^-} ROH + XH^-$$
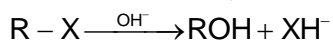
(a)
$$\begin{array}{c} CH_3 \\ | \\ CH_3CH_2CH - CH_2I \end{array}$$

(b) $CH_3CH_2I$

(c)
$$\begin{array}{c} CH_3CH_2CH - I \\ | \\ CH_3 \end{array}$$

(d) $(CH_3CH_2)_3C - I$

25. a

Sol. Option (a) will give least yield of p-alcohol.

26. Carbonyl compounds ($\overset{\diagup}{C} = O$) react with Grignard reagent followed by hydrolysis to produce alcohols. Select the carbonyl compounds which will yield alcohol in this reaction.

(a)
$$\begin{array}{c} NH_2 \\ \diagdown \\ \phantom{xx}C=O \\ \diagup \\ CH_3 \end{array}$$

(b)
$$\begin{array}{c} NO_2 \\ \diagdown \\ \phantom{xx}C=O \\ \diagup \\ CH_3 \end{array}$$

(c)
$$\begin{array}{c} COOH \\ \diagdown \\ \phantom{xx}C=O \\ \diagup \\ CH_3 \end{array}$$

(d)
$$\begin{array}{c} H \\ \diagdown \\ \phantom{xx}C=O \\ \diagup \\ H \end{array}$$

26. d

Sol.
$$H - \overset{\overset{\displaystyle H}{|}}{C} = O + RMgBr \xrightarrow{H^+} H - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle R}{|}}{C}} - OH + Mg(OH)Br$$
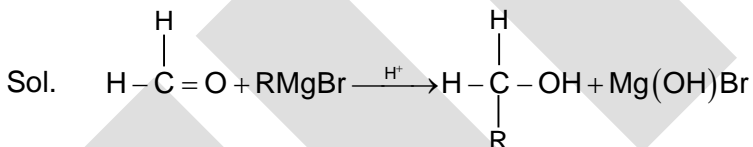
27. Which of the following carboxylic acid is supposed to have highest value of $K_a$?
    (a) $CH_2 = CH - CH_2COOH$          (b) $H \equiv C - CH_2 - COOH$
    (c) $CH_3CH_2CH_2COOH$              (d) $HC \equiv C - COOH$

27. d

Sol. $HC \equiv C - COOH$, have highest value of $K_a$ because the adjacent carbon is sp-hybridized.

28. For Cl-atom $IE_1$ and $\Delta H_{EG_1}$ values are 13.0 eV and 3.60 eV respectively. IF Avogadro number of atoms are converted into $Cl^-$ as $Cl + e^- \longrightarrow Cl^-$ and the energy released is completely used to ionize Cl-atom as $Cl \rightarrow Cl^+ + e^-$, then number of Cl-atom converted into $Cl^+$ are
    (a) $1.667 \times 10^{23}$          (b) $6.023 \times 10^{23}$
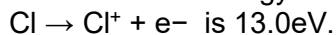    (c) $3.2 \times 10^{23}$            (d) can't be calculated

28. a

Sol. The energy liberated during the addition of electron to neutral isolated gaseous atom is electron affinity. For chlorine

$Cl_g + e^- \longrightarrow Cl_g^-$, $E_A = 3.60$ eV/atom
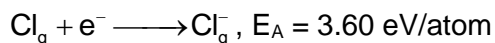
For one mole i.e., Avogadro number of chlorine atoms

$3.60 \times 6 \times 10^{23} = 21.6 \times 10^{23}$ eV.

The ionisation energy of chlorine atom

$Cl \rightarrow Cl^+ + e^-$ is 13.0eV.

The number of Cl atoms that ionise with $21.6 \times 10^{23}$ eV is

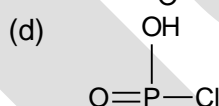$$\frac{21.6 \times 10^{23}}{13.0} = 1.66 \times 10^{23}$$

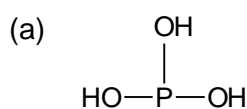29. Which of the following property does not exhibit periodic behaviour in periodic table?
    (a) bonding pattern
    (b) Electron gain enthalpy
    (c) reactivity
    (d) Neutron / proton ratio

29. d

Sol. Neutron to proton ratio is not a periodic property as it is not having any regular trend where as the remaining options have a regular trend in groups as well as periods.

30. Consider the following reaction $PCl_3 \xrightarrow{\text{HOH}} A$. Preferred structure of A is

(a)
```
        OH
        |
  HO—P—OH
```

(b)
```
        H
        |
  HO—P—OH
        ‖
        O
```

(c)
```
  HO
    \
     P=Cl
    /
  HO
```

(d)
```
       OH
        |
  O=P—Cl
```

30. b

Sol. $PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$
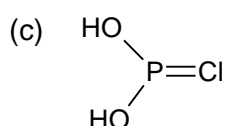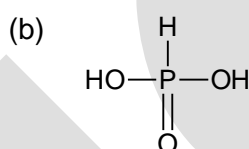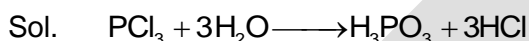
31. Amongst the given oxides, most basic and least basic oxides respectively are

$MgO$, $SrO$, $K_2O$, $NiO$, $Cs_2O$

(a) $K_2O$, $SrO$
(b) $Cs_2O$, $NiO$
(c) $MgO$, $NiO$
(d) $Cs_2O$, $SrO$

31. b

Sol. $Cs_2O$ most basic, $NiO$ least basic.

32. Which of the following minerals are least abundant in nature?
    (a) oxides
    (b) sulphates
    (c) carbonates
    (d) nitrates

32. d

Sol. Nitrates are least abundant in nature.

33. Loudness of sound on decibel scale during normal conservation between two person sis of the order of
    (a) 6 dB
    (b) 12 dB
    (c) 60 dB
    (d) 120 dB

33. c

Sol. Normal talk = 60 dB

34. On a particular day, following electrical appliances were used as per details given below,
A 500 W washing machine for 45 minute
A 1200 W toaster for 30 minute
A 4200 W electric clothes dryer for 20 minute
Six 50 W bulbs for 4 hour
The total cost of electricity consumption at the rate of Rs. 12 per kilowatt hour (kWh) will be (in Rs.)
(a) 45.06                      (b) 42.90
(c) 38.60                      (d) 36.20

34. **b**

Sol. Total power $= \dfrac{500}{1000} Kw \times \dfrac{45}{60} hr + \dfrac{1200}{1000} \times \dfrac{30}{60} kwh$

$+ \dfrac{4200}{1000} kw \times \dfrac{20}{60} hr + \dfrac{6 \times 50}{1000} \times 4$

$= 0.375 kwh + 0.6 kwh + 1.4 kwh + 1.2 kwh$

$= 3.575$ kwh

Cost $= 12 \times 3.575 = 42.90$ Rs.

35. Four identical blocks A, B, C and D, each of mass M = 1.0 kg are connected to one another through massless inextensible strings. The system is lifted vertically upward by applying force F which produces constant acceleration 2.2 m/s². The situation is shown in adjacent figure. Tension in the string connecting block A and B is:
(a) 6.6 N
(b) 12 N
(c) 16.4 N
(d) 36 N



35. **d**

Sol. $F - 4 \times M \times g = 4M \times a$

$\Rightarrow F - 4 \times 1 \times 9.8 = 4 \times 1 \times 2.2$

$\Rightarrow F = 39.2 + 8.8 = 48 N$

Tension in string connecting A and B,

$T - 3Mg = 3 Ma$

$\Rightarrow T = 3M(g + a) = 3 \times 1(9.8 + 2.2) = 3 \times 12 = 36 N$
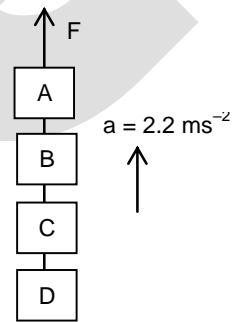
36. A cylindrical vessel contains two immiscible liquids: liquid-1 (density $d_1$ = 1000 kg/m³) over liquid 2 (density $d_2$ = 3000 kg/m³). A cubical block of mass M = 10 kg and density d = 8000 kg/m³ is suspended from a spring balance and dipped into vessel at a position so that one-fourth of its volume immersed in liquid-1 and rest of value in liquid 2, as shown in figure. Density of air is negligible. The reading of spring balance in kg-wt must be
(a) 6.578                      (b) 6.587
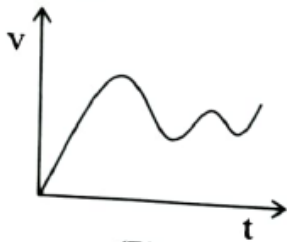(c) 6.785                      (d) 6.875



36. **d**

Sol. $T + B_1 + B_2 = Mg$         …….(1)

$V_0 = $ Volume of object $= \dfrac{M}{d} = \dfrac{10}{8000} m^3 = \dfrac{1}{800} m^3$

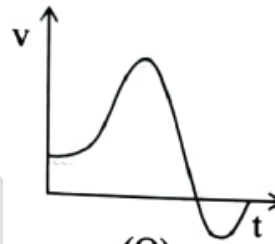From (i) $T + \dfrac{V_0}{4} \times d_1 \times g + \dfrac{3V_0}{4} \times d_2 \times g = Mg$
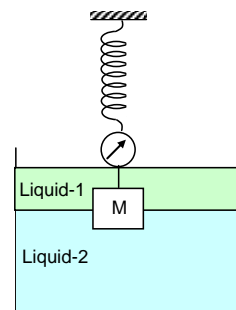
$$\Rightarrow T = Mg - \frac{V_0 g}{4}(d_1 + 3d_2)$$

$$= 10 \times 9.8 - \frac{1}{800} \times \frac{9.8}{4} \times (1000 + 3000 \times 3)$$

$$= 98 - \frac{98 \times 1000}{3200} = 98 - 30.625$$

$$= 67.375$$

Reading of spring balance $= \dfrac{T}{g} = 6.875\,N$
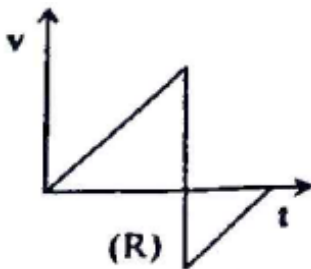
37. Following figures represent few velocity (v) verses time (t) graphs. Choose the graph showing realistic



(P)     (Q)

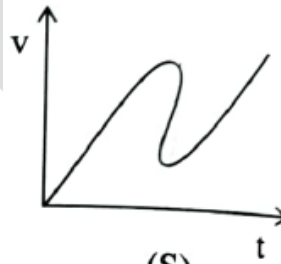(R)     (S)

(a) P only                                  (b) P and Q
(c) P, Q and R                              (d) P, Q, R and S

37.     **c**
Sol.    Last option is incorrect as two velocities are not possible at same time.

38.     Two cells having same emf E but different internal resistances $r_1$ and $r_2$, are connected in series with an external resistor R. an ideal voltmeter V records terminal potential difference of cell-2. The situation is shown in adjacent figure. the value of R for which voltmeter reads zero volt, is:
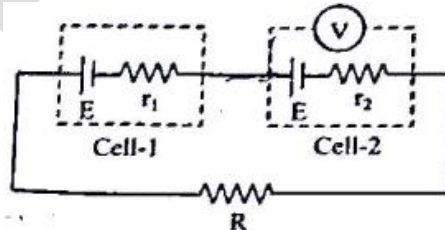


(a) $R = r_2 + r_1$                         (b) $R = r_2 - r_1$

(c) $R = \dfrac{r_2 + r_1}{2}$              (d) $R = \sqrt{r_2 r_1}$

38.     **b**
Sol.    Reading of Voltmeter $= E - Ir_2$

$$\Rightarrow 0 = E - Ir_2 \Rightarrow I = \frac{E}{r_2}$$

By Kirchoff's Voltage Law,

$$E - Ir_2 + E - Ir_1 - IR = 0$$

$$\Rightarrow 2E - I(r_1 + r_2 + R) = 0$$

$$\Rightarrow 2E - \frac{E}{r_2}(r_1 + r_2 + R) = 0$$

$$\Rightarrow 2E = \frac{E}{r_2}(r_1 + r_2 + R) \Rightarrow 2r_2 = r_1 + r_2 + R$$

$$\Rightarrow R = r_2 - r_1$$

39. An engine, moving on straight rails with constant speed 90 km/hr, approaches a hill. When it is at a distance x from hill, it blows a whistle whose echo is heared by the driver after 4 second. If the speed of sound in air is 330 m/s, the value of x is
(a) 9000 m
(b) 750 m
(c) 730 m
(d) 710 m

39. **d**

Sol. $V_0 =$ Velocity of engine = 90 km/hr = 25 m/sec.

Relative velocity of sound with respect to engine $= V_s + V_o = 330 + 25$

$$\Rightarrow V = 355 \text{ m / sec.}$$

Now, $X = \dfrac{vt}{2} = \dfrac{355 \times 4}{2} = 710 \text{ m / sec}$

40. Choose the incorrect statement:
(a) Light travels faster in air than in water.
(b) Value of refractive index for a given pair of medium depends upon speed of light in two media.
(c) When a light ray travelling in water enters obliquely into glass, it bends towards the normal.
(d) An optical denser medium always possess greater mass density.

40. **d**

Sol. Knowledge based.

An optically denser medium may have less mass density.

41. The adjacent figure shows positions of an object O and its image formed by a mirror. This is possible if
(a) a concave mirror is placed between O and I
(b) a concave mirror is placed to the right of I
(c) a convex mirror is placed between O and I
(d) a convex mirror is placed to the right of I



41. **c**

Sol. Only Convex mirror makes smaller and erect image.

42. Read the following Statements $S_1$ and $S_2$

$S_1$: When a rectangular coil of copper wire is rotated in a uniform magnetic filed, the direction of induced current changes once after each half revolution

$S_2$: An electric motor converts electrical energy into mechanical energy.

Now choose the correct option

(a) $S_1$ is true, $S_2$ is false
(b) $S_1$ is false, $S_2$ is true
(c) Both $S_1$ and $S_2$ are true
(d) Both $S_1$ and $S_2$ are false

42. **c**

Sol. When coil rotated in magnetic field, the direction of induced current changes after half cycle.
Motor Converts electrical to mechanical energy.

43. Three identical uniform solid spheres A, B and C, each having mass M and radius R are kept in such a way that centres of spheres A, B and C lie on same straight line and sphere B touches the other tow spheres. If G is universal gravitational constant, the magnitude of resultant gravitational force on the sphere A due to sphere B and C is

(a) $\dfrac{3GM^2}{4R^2}$

(b) $\dfrac{3GM^2}{16R^2}$

(c) $\dfrac{5GM^2}{4R^2}$

(d) $\dfrac{5GM^2}{16R^2}$

43. **d**

Sol.
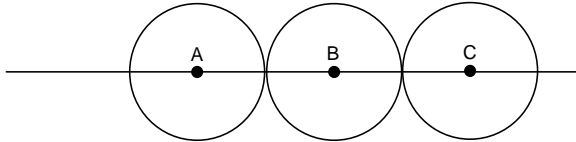


$$F = \dfrac{GM^2}{(2R)^2} + \dfrac{GM^2}{(4R)^2}$$

$$F = \dfrac{GM^2}{R^2}\left[\dfrac{1}{4} + \dfrac{1}{16}\right]$$

$$\dfrac{GM^2}{R^2}\left[\dfrac{4+1}{16}\right]$$

$$= \dfrac{5GM^2}{16R^2}$$

44. A person with long – sightedness (hypermetropia) cannot see objects clearly at a distance less than 100 cm. The power of lens needed to read an object at normal near point (25 cm) is

(a) $+1D$

(b) $-1D$

(c) $+3\,D$

(d) $-3D$

44. **c**

Sol. u = –25 cm, v = –100 cm

Now, $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$ $\Rightarrow$ $\dfrac{1}{-100} + \dfrac{1}{25} = \dfrac{1}{f}$

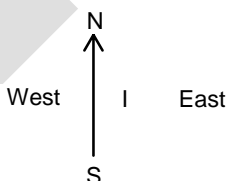$\Rightarrow \dfrac{-1+4}{100} = \dfrac{1}{f}$ $\Rightarrow$ f $= \dfrac{100}{3}$ cm

$= \dfrac{1}{3}$ m

$P = \dfrac{1}{f(\text{in m})} = +3D$

45. A current through a horizontal power line flows in south to north direction. The direction of magnetic field produced by power line at a point directly below the line is towards

(a) Eastward

(b) Westward

(c) Upward

(d) Downward

45. **b**

Sol.



Magnetic field is from east to west, so westwards.

46. Linear momentum of a car moving on a road increases by 20 percent by changing its speed only. In this situation, kinetic energy of car increases by
(a) 20%                                (b) 40%
(c) 36%                                (d) 44%

46. **d**

Sol. $P = \sqrt{2mK}$      …(i)

$P' = 20\%$ of $P + P = \dfrac{6P}{5} = \sqrt{2mK'}$    …(2)
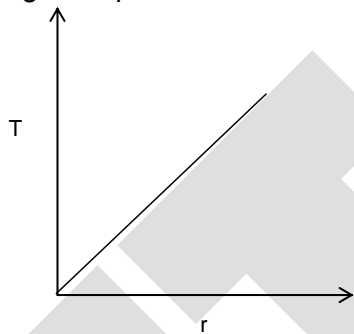
From (1) and (2)

$$\frac{P}{P'} = \sqrt{\frac{2mK}{2mK'}} = \frac{K}{K'}$$

$$\Rightarrow \quad \frac{P \times 5}{6P} = \sqrt{\frac{K}{K'}} \Rightarrow \frac{K}{K'} = \left(\frac{5}{6}\right)^2 \Rightarrow \frac{K'}{K} = \frac{36}{25}$$

$$\Rightarrow \quad \frac{K' - K}{K} = \frac{11}{25}$$

$$\Rightarrow \quad \% \text{ increase in KE} = \frac{11}{25} \times 100 = 44\%.$$

47. For different planets moving around the Sun, if r represents mean distance of a planet from the Sun and T is its orbital period, which of the following graph represents motion of planets according to Kepler's laws.
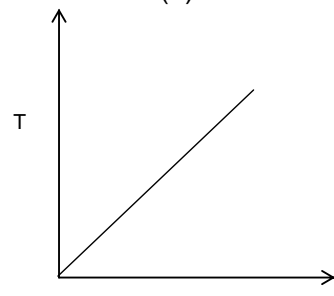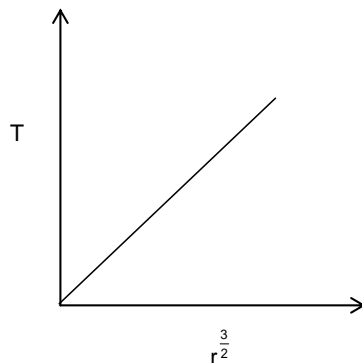


(a)
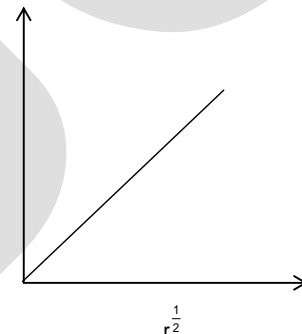


(b)
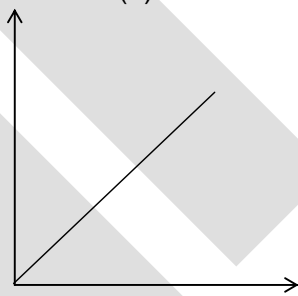


(c)



(d)

47. **c**

Sol. $T^2 \propto r^3$

$T \propto r^{3/2}$

48.  A student has to design a circuit using a d.c. source of emf E = 120V in series with three resistors $R_1 = 1k\Omega, R_2 = 2k\Omega, R_3 = 3k\Omega$. Resistors are available with wattage ratings of 0.5 W, 1W, 2 W and 5W. Higher is the wattage rating, higher is the cost of resistor. To keep the cost of resistors minimum, wattage ratings used for each resistor are:

| | $R_1$ | $R_2$ | $R_3$ |
|---|---|---|---|
| (a) | 0.5 W | 0.5 W | 0.5 W |
| (b) | 0.5 W | 1 W | 1 W |
| (c) | 0.5 W | 1 W | 2 W |
| (d) | 1 W | 2 W | 2 W |
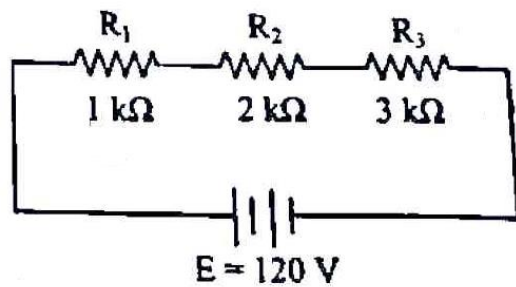


48.  **c**

Sol.  $I = \dfrac{E}{R_1 + R_2 + R_3} = \dfrac{120}{6000} = \dfrac{1}{50} A$

$P_1 = i^2 R_1 = \left(\dfrac{1}{50}\right)^2 \times 1000 = \dfrac{1}{2500} \times 1000 = 0.4\,W$

$P_2 = i^2 R_2 = \dfrac{1}{2500} \times 2000 = 0.8\,W$

$P_3 = i^2 R_3 = \dfrac{1}{2500} \times 3000 = 1.2\,W$

Power of resistors must be greater than $P_1, P_2$ and $P_3$.

49.  Choose the appropriate answer related with components of reproductive organs in mammals:
(a) Corpus Allatum                       (b) Corpus Albicans
(c) Corpus Cardiacum                     (d) Corpus Luteum
49.  bd
Sol.  The corpus albicans is a scar on the ovary that forms after the corpus luteum degenerates.

50.  Find out the correct pair(s):
(a) Parathormone – Metamorphosis        (b) Thyroxine – Calorigenic action
(c) Adenohypophysis – Intermedin        (d) Adrenal Cortex – Fight and Flight Reaction
50.  bc
Sol.  Thyroxine is calorigenic and intermedin (IMD) is present in the adenohypophysis of higher animals, including humans.

51.  Which of the following plant pairs resemble in their inflorescence and fruit types?
(a) Coriander (Coriandrum sativum) and Fennel (Foeniculum vulgare)
(b) Coconut (Cocos nucifera) and Mango(Mangifera indica)
(c) Marigold (Tagetes patula) and Parthenium (Parthenium hysterophorus)
(d) Apple (Malus sylvestris) and Pear (Pyrus communis)
51.  acd
Sol.  a) Both Coriander (Coriandrum sativum) and Fennel (Foeniculum vulgare) belong to the same family (Apiaceae) and have similar:
1. Inflorescence: Both produce umbel type of inflorescence, which is a characteristic feature of the Apiaceae family.
2. Fruit type: Both produce schizocarp type of fruits, which are dry and split into two mericarps.

So, Coriander and Fennel show similarities in their inflorescence and fruit types.

c) Yes, Marigold and Parthenium resemble each other in their inflorescence and fruit types.

Both Marigold (Tagetes spp.) and Parthenium (Parthenium spp.) belong to the same family (Asteraceae) and have similar:

1. Inflorescence: Both produce capitulum (head) type of inflorescence, which is a characteristic feature of the Asteraceae family.
2. Fruit type: Both produce achene type of fruits, which are small, dry, and single-seeded.

So, Marigold and Parthenium show similarities in their inflorescence and fruit types.

d) Yes, Apple and Pear resemble each other in their inflorescence and fruit types.

Both Apple (Malus domestica) and Pear (Pyrus communis) belong to the same family (Rosaceae) and have similar:

1. Inflorescence: Both produce corymb type of inflorescence, which is a characteristic feature of the Rosaceae family.
2. Fruit type: Both produce pome type of fruits, which are fleshy, juicy, and have a leathery rind.

So, Apple and Pear show similarities in their inflorescence and fruit types. Yes, Coriander and Fennel resemble each other in their inflorescence and fruit types.

52.     Which of the following statements is/are true regarding the differences between Algae and Fungi?
        (a) Parenchyma cells in algae and pseudoparenchyma in fungi
        (b) Algal cell wall of cellulose and fungal cell wall of chitin and $\beta$-1, 3 glucan
        (c) Algae produce sporangia and sporangospores while Fungi do not produce them
        (d) Algae have autotrophic nutrition while Fungi are heterotrophic
52.     abd
Sol.    Pseudoparenchyma cells are primarily found in fungi, where they appear as a tissue made up of interwoven hyphae that superficially resemble the parenchyma cells of higher plants. Parenchyma is a type of simple permanent tissue that makes a major part of ground tissues in plants, where other tissues like vascular tissues are embedded. Algal cell wall is made up of cellulose and fungal cell wall is made up of chitin. Algae have autotrophic and fungi are heterotrophic.

53.     Which of the following species has/have five unpaired electrons?
        (a) $V^{3+}$                        (b) $Cr^{3+}$
        (c) $Mn^{2+}$                       (d) $Fe^{3+}$
53.     cd
Sol.    $V^{3+} \rightarrow 3d^3$
        $Cr^{3+} \rightarrow 3d^3$
        $Mn^{2+} \rightarrow 3d^5$
        $Fe^{3+} \rightarrow 3d^5$

54.     Assuming complete dissociation, select the solution having pH = 13
        (a) 2 g NaOH/500 mL solution          (b) 0.05 M/100 mL $Ca(OH)_2$ solution
        (c) 0.1 N/100 mL $Ca(OH)_2$ solution  (d) 1 g NaOH/1000 mL solution
54.     abc
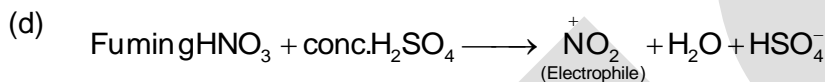Sol.    (a) $\left[ OH^- \right] = \dfrac{2}{40} \times \dfrac{1000}{500} = 10^{-1}$
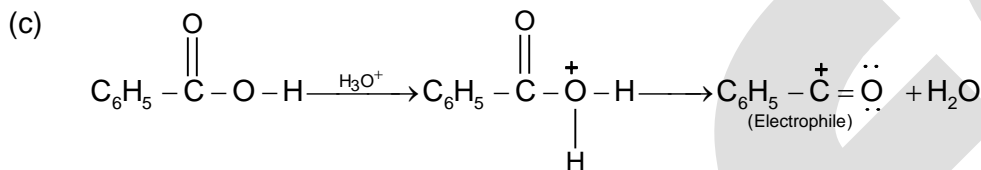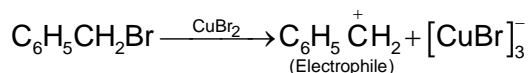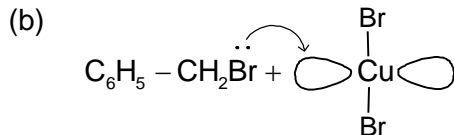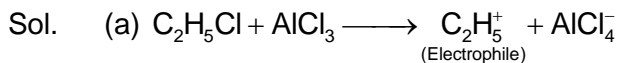
        (b) $[OH^-] = 0.05 \times 2 = 10^{-1}$
        (c) $[OH^-] = 10^{-1}$
        pH + pOH = 14

55. Which of the following reaction(s) will generate an electrophile?

(a) $C_2H_5Cl \xrightarrow{AlCl_3}$             (b) $C_6H_5CH_2Br \xrightarrow{CuBr_2}$

(c) $C_6H_5COOH \xrightarrow{H_3O^+}$          (d) $Fuming\, HNO_3 + conc.H_2SO_4 \longrightarrow$

55. abcd

Sol. (a) $C_2H_5Cl + AlCl_3 \longrightarrow \underset{(Electrophile)}{C_2H_5^+} + AlCl_4^-$

(b)



$C_6H_5CH_2Br \xrightarrow{CuBr_2} \underset{(Electrophile)}{C_6H_5\overset{+}{C}H_2} + [CuBr]_3^-$

(c)



(d)

$Fuming\, HNO_3 + conc.H_2SO_4 \longrightarrow \underset{(Electrophile)}{\overset{+}{N}O_2} + H_2O + HSO_4^-$

56. Which of the following compounds can't be used to synthesize Grignard reagent?

(a) $CH_3\underset{\underset{NH_2}{|}}{CH} - CH_2CH_2Br$             (b)



(c)



(d)
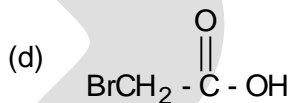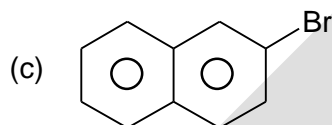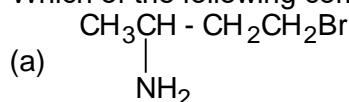


56. ad

Sol. Alkyl bromide & Aryl bromide are used to synthesize Grignard reagent. So option (b) & (c) are used to synthesize Grignard reagent whereas option (a) & (d) contain acidic hydrogen.

57. A ray of light traveling in a uniform transparent medium is incident on plane interface separating medium from air at angle of incidence 47°. The ray undergoes total internal reflection. Which of following can be possible value of refractive index of the medium? [Given Cos 43° = 0.73]

(a) 1.33          (b) 1.42

(c) 1.5           (d) 1.6

57. bcd

Sol. For I = 47°, ray goes T.I.R.

So, I = critical angle = C

Sin c = sin I = sin 47° = cos 43° = 0.73

$\Rightarrow \quad \dfrac{1}{\mu} = 0.73$

$\Rightarrow \quad \mu = \dfrac{1}{0.73} = 1.369$

58. In the following figure, a battery of emf E = 90 V and internal resistance r = 10Ω is supplying current to a resistor network connected between points P and Q. Choose the correct option(s)



(a) potential difference between points P and Q is 60 volt

(b) current passing through 15Ω resistor is $\frac{4}{3}$ amp

(c) Electric current passing through 60Ω resistor is $\frac{2}{3}$ amp

(d) Electric power delivered from batter to resistor network between point P and Q is 180 Watt
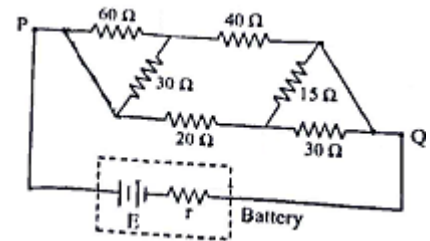
58. abd

Sol.
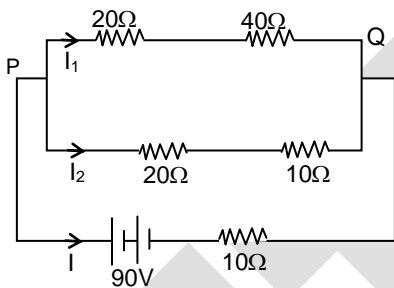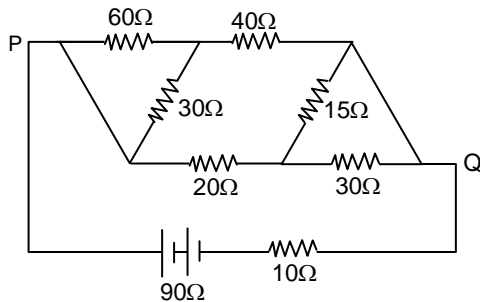


$$R_{eq} = \frac{60 \times 30}{60 + 30} + 10$$

$$= 20\ \Omega + 10\Omega$$

$$= 30\ \Omega$$

$$I = \frac{90}{30} = 3\ A$$

$V_P - V_Q = I \times 20\ \Omega = 3 \times 20\ \Omega = 60\ V$

$$I_2 = \left(\frac{60}{60 + 30}\right) I = \frac{60}{90} \times 3 = 2\ A$$

Current through $15\Omega = \left(\frac{30}{30 + 15}\right) 2 = \frac{2 \times 2}{3} = \frac{4}{3}\ A$

Current through $60\ \Omega = \left(\frac{20}{60}\right) A$

$$= \frac{1}{3}\ A.$$

Power = $I^2 \times 20$

$$= 3 \times 3 \times 20 = 180\ W.$$

59. A uniform copper wire of mass $2.23 \times 10^{-3}$ kg carries 1.0 A current when potential difference across the wire is 1.7 volt. If the density of copper is $8.92 \times 10^3$ kg/m$^3$ and its resistivity is $1.7 \times 10^{-8}$ ohm-meter. Choose the correct option(s)

(a) length of wire, L = 5 meter

(b) Area of cross section of wire, A = $5 \times 10^{-6}$ m$^2$

(c) Electric power dissipated in wire = 1.7 watt

(d) Resistance of wire is 1.7 ohm

59. acd

Sol. m = $2.23 \times 10^{-3}$ kg

I = 1A, V = 1.7 V, d = 8.92 × 10$^3$ kg/m$^3$

f = 1.7 × 10$^{-8}$ ohm-meter.

$$R = \frac{V}{I} = 1.7\,\Omega$$

$$\rho\frac{L}{A} = 1.7 \Rightarrow \rho \times \frac{1}{\left(\dfrac{Vol.}{L}\right)} = 1.7 \Rightarrow \frac{\rho L^2}{Vol.} = 1.7$$

$$\Rightarrow L^2 = \frac{1.7 \times \dfrac{m}{d}}{\rho} = \frac{1.7 \times 2.23 \times 10^{-3}}{1.7 \times 10^{-8} \times 8.92 \times 10^3}$$

$$L = \sqrt{\frac{100}{4}} = 5\,m$$

Area of cross section = $\dfrac{Vol.}{L} = \dfrac{m}{dL} = \dfrac{2.23 \times 10^{-3}}{8.92 \times 10^3 \times 5}$

$$= 5 \times 10^{-8}\,m^2$$

Power dissipated = VI = 1.7 Watt.

Resistance = $\dfrac{V}{I} = 1.7\,\Omega$

60. At the instant the traffic signal turns green, a car starts moving with constant acceleration 2 m/s$^2$. At the same instant, a truck traveling in the same direction with constant speed 72 km/hr overtakes and passes the car. Assume that both car and truck continue to travel in straight line in different lanes of the road. Now choose the correct option(s).
   (a) car will overtake the truck after 20 sec of start of its motion
   (b) car will overtake the truck after traveling through distance 400 meter from starting point
   (c) speed of car when it overtakes the truck will be twice of speed of truck
   (d) the distance time graph for the motion of car will be a straight line

60. abc

Sol. $u_1 = 0\,m/s, a = 2\,m/s^2$

$u_2 = 72\,km/hr = 20\,m/sec$

$s_1 = s_2$

$\Rightarrow u_1 t + \dfrac{1}{2}at^2 = u_2 t$

$\Rightarrow \dfrac{1}{2} \times 2 \times t^2 = 20 \times t \Rightarrow t = 20\,sec$

$s_1 = s_2 = u_2 t = 20 \times 20 = 400\,m$

$v_1 = u_1 + at = 0 + 2 \times 20 = 40\,m/sec.$

For accelerated motion, distance – time graph is parabolic.