Biology - Section A

1.

Transpiration is affected by several external factors: temperature, light, humidity, wind speed [NCERT page 187, Para 4]. If we plot temperature [X-axis] and the rate of transpiration [Y-axis], the expected shape of the graph would be:
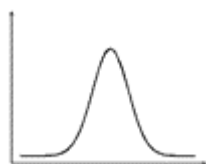
1.

2.

3.

4.

2.

Select the correct match of the essential elements given in Column I with enzyme activated by them in Column II and with important roles they play in plants in Column III:

	Column I	Column II	Column III
I.	Magnesium	Both RuBisCO and PEPcase	Maintenance of ribosome structure
II.	Zinc	Both alcohol dehydrogenase and carboxylases	Synthesis of auxin
III.	Molybdenum	Both nitrogenase and nitrate reductase	Splitting of water during photosynthesis

1. Only I
2. Only I and II
3. Only II
4. I, II and III

3.

Excess of certain essential elements in plants may induce deficiency of other essential elements [NCERT page 199; para 4]. Look at the leaves of a plant shown below. You can see brown necrotic spots and chlorosis. This may be due to:

1. Toxicity of Boron and induced toxicity of Nitrogen
2. Toxicity of Magnesium and induced deficiency of Manganese
3. Toxicity of Manganese and induced deficiency of Iron
4. Deficiency of Calcium and induced deficiency of Magnesium

4.

Ammonia is first oxidized to nitrite by the bacteria Nitrosomonas and/or Nitrococcus. The nitrite is further oxidized to nitrate with the help of the bacterium Nitrobacter. These steps are called nitrification [NCERT page 201, para 1]. Which of the following is/are true regarding this?
I. It is an aerobic process.
II. Nitrifying bacteria are chemoautotrophs.
III. Nitrification is important in agricultural systems, where fertilizer is often applied as ammonia.
1. Only II
2. Only I and II
3. Only II and III
4. I, II and III

5.

Substances that have a hydrophilic moiety find it difficult to pass through the membrane; their movement has to be facilitated [NCERT page 176, para 3]. The membrane proteins involved in this facilitated diffusion:
 1. make such substances lipid-soluble
2. establish a concentration gradient
3. provide sites at which substances can cross the membrane
4. catalyse ATP hydrolysis providing energy for such transport

6.

Though chlorophyll a is the major pigment responsible for trapping light, other thylakoid pigments called accessory pigments are also involved [NCERT page 211; para 1]. The accessory pigments:
I. Include xanthophylls and carotenoids but not chlorophyll b
II. Absorb light and transfer electrons to chlorophyll a
III. Enable a wider range of wavelength of incoming light to be reflected by green leaves
IV. Make Chlorophyll a more prone to photo-oxidation
The incorrect statements include:
1. Only I and II
2. Only III and IV
3. Only I, III and IV
4. I, II, III and IV

7.

Immediately after light becomes unavailable, the biosynthetic phase of photosynthesis continues for some time and then stops. If then, light is made available, the synthesis starts again [NCERT page 215, para 3]. A logical conclusion of these observations will include:
I. Biosynthetic phase does not directly depend on the presence of light.
II. Biosynthetic phase depends on the products of light reactions.
III. Biosynthesis phase occurs only in the dark or in the absence of light.
1. Only I and II
2. Only III
3. Only II
4. I, II and III

8.

Current availability of carbon dioxide is limiting to C_3 plants [NCERT page 223; para 2]. This means that:
1. At low light intensity, C_3 plants respond to high CO_2 concentrations
2. Growing plants like tomatoes in carbon dioxide-rich environment is unlikely to increase yield
3. They show saturation in the rates of photosynthesis at carbon dioxide concentration higher than the current level
4. They have better water use efficiency and thus, adapted to warm tropical climates

9.

While studying the steps of glycolysis, please note the steps at which utilization or synthesis of ATP or NADH takes place [NCERT page 229; para 1]. Identify the incorrect match:

1.	Production of ATP	BPGA to 3-PGA
2.	Utilization of ATP	Fructose-6-phosphate to Fructose-1,6-biphosphate
3.	Production of NADH	PGAL to BPGA
4.	Utilization of NADH	3-PGA to 2-PGA

10.

[NCERT page 233 Figure 14.4]. Identify the correct statements regarding the mitochondrial electron transport system.
I. Electrons from NADH in mitochondrial matrix are first transferred to [Fe-S] and then to FMN in complex I
II. Complex II is not a proton pump
III. Cytochrome c is located on the outer surface of the inner membrane
IV. Ubiquinone, located within the inner mitochondrial membrane, is oxidized with the transfer of electrons to cytochrome c via complex III.
1. Only II and III
2. Only II, III and IV
3. Only IV
4. Only I and III

11.

There can be a net gain of 38 ATP molecules during aerobic respiration of one molecule of glucose [NCERT page 234, para3]. The corresponding number for when one molecule of glucose undergoes fermentation will be:
1. 0
2. 2
3. 4
4. 30

12.

Consider the given two statements:

I. 2,4-D [2,4-Dichlorophenoxyacetic acid] is widely used as a herbicide. [NCERT page 249; Para 1]

II. 2,4-D acts by mimicking the action of the plant growth hormone auxin, which results in uncontrolled growth and eventually death in susceptible plants.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

13.

Consider the given two statements:

I. Generally, phenotypic plasticity is more important for immobile organisms (e.g. plants) than mobile organisms (e.g. most animals).

II. Plants follow different pathways in response to environment or phases of life to form different kinds of structures. [NCERT page 246; para 1]

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

14.

There are certain seeds that fail to germinate even when external conditions are favourable. [NCERT page 252, para 3]. Some of the chemical inhibitors present in such seeds can be all of the following except:

1. Abscisic acids

2. Phenolic acid

3. Para-ascorbic acid

4. Gibberellic acid

15.

An oblique muscle layer may be present in some regions of the human alimentary canal [NCERT page 259; para2]. If you are asked to enumerate the correct sequence of layers of smooth muscle in the wall of stomach beginning from the serosa, your answer will be:

1. longitudinal → circular

2. circular → longitudinal

3. longitudinal → circular → oblique

4. circular → longitudinal → oblique

16.

Hormonal control of the secretion of digestive juices is carried out by local hormones produced by the gastric mucosa and intestinal mucosa. [NCERT page 264; para 2]. Which of the following hormones stimulates gall bladder to contract?

1. gastrin

2. cholecystokinin

3. secretin

4. gastric inhibitory peptide

17.

PEM affects infants and children to produce Marasmus and Kwashiorkor. [NCERT page 266; para 1]. A feature unlikely to be present in a child with marasmus would be:

1. Severe emaciation

2. Impaired mental development

3. Dry, thin and wrinkled skin

4. Extensive oedema

18.

The lungs are situated in the thoracic chamber which is anatomically an air-tight chamber. [NCERT page 270; para 2]. If it is not so then,

1. pulmonary blood flow pattern will be changed

2. pulmonary ventilation will be compromised

3. abdominal breathing will take over the thoracic breathing

4. gradients of gases will be abolished across the respiratory membrane

19.

Consider the two statements:

I. About 97 percent of oxygen and 20-25 percent of carbon dioxide is transported by RBC. [NCERT page 274, para 1]

II. Oxygen is more soluble in water than carbon dioxide.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

20.

Another centre present in the pons region of the brain can moderate the functions of the respiratory rhythm centre. [NCERT page 275; para 3] What is incorrect regarding this centre?

1. It is called the pneumotaxic centre

2. It stimulates/prolongs inspiration

3. Its action can lead to the alteration of the respiratory rate

4. Signals from this centre can reduce the duration of inspiration

21.

Consider the given two statements:

I. Group O blood can be donated to persons with any other blood group and hence O group individuals are called universal donors.

II. Both anti-A and anti-B antibodies are present in the plasma of a person with blood group O.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

22.

The stroke volume multiplied by the heart rate gives the cardiac output. [NCERT page 285, para 2]. If the stroke volume is doubled, the cardiac output will remain the same if the heart rate:

1. remains the same

2. is halved

3. is doubled

4. is reduced to ¼ of the original rate

23.

Match terms in Column I with their correct meaning in Column II and select the correct match as your answer from the codes given: [NCERT page 288; para 3]

	COLUMN I		COLUMN II
A	Cardiac arrest	P	When the heart stops beating
B.	Heart block	Q	when the heart beats more slowly or with an abnormal rhythm
C.	Heart attack	R	When the heart muscle is suddenly damaged by an inadequate blood supply
D.	Heart failure	S	When heart is not pumping blood effectively enough to meet the needs of the body

Codes

	A	B	C	D
1	P	Q	R	S
2	Q	P	R	S
3	R	S	Q	P
4	R	S	P	Q

24.

Ammonia produced by metabolism is converted into urea in the liver and released into the blood which is filtered and excreted out by the kidneys. [NCERT Page 291; para 2]. The urea produced by the liver will be first released into:

1. Hepatic portal vein

2. Renal vein

3. Inferior vena cava

4. Hepatic vein

25.

Consider the given two statements:

I. Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed [NCERT page 297; para 1].

II. About 85% of the nephrons in the human kidney are juxtamedullary nephrons.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

26.

An increase in blood flow to the atria of the heart can cause the release of ANF. ANF:

I. is a potent vasoconstrictor

II. can cause a decrease in blood pressure

III. acts as a check on RAAS

1. Only I and II are correct

2. Only III is correct

3. Only II and III are correct

4. Only I is correct

27.

Cells of human body exhibit three main types of movements [NCERT page 302; para 3]. Cytoskeleton elements called microfilaments play an important role in:

A. Amoeboid movements

B. Ciliary movements

C. Muscular movements

1. Only A

2. Only A and B

3. Only A and C

4. A, B and C

28.

Pelvic girdle consists of two coxal bones [page 311; para 3]. Each coxal bone articulates with:

A. Sacrum

B. Head of femur

C. Other coxal bone

1. Only A

2. Only A and B

3. Only A and C

4. A, B and C

29.

Osteoporosis is an age-related disorder characterized by decreased bone mass and increased chances of fractures. [NCERT page 312; para 4] It can be treated by HRT [Hormone replacement therapy]. The hormone is:

1. Oestrogen

2. Progesterone

3. hCG

4. DHEA

30.

When a neuron is resting, the axonal membrane is relatively more permeable to potassium ions and nearly impermeable to sodium ions. [NCERT page 317; para 2] This would mean that:

1. in resting conditions, all sodium channels in the axonal membrane are closed while few potassium channels are open

2. in resting conditions, the electrogenic sodium-potassium pump will pump only the sodium ions

3. in resting conditions, the electrogenic sodium-potassium pump will pump only the potassium ions

4. in resting conditions, the outer surface of the axonal membrane will carry a negative charge

31.

When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards the membrane. [NCERT page 319; para 2]. This activation of the synaptic vesicle is directly due to:

1. Sodium ions

2. Calcium ions

3. Potassium ions

4. Chloride ions

32.

A canal called the cerebral aqueduct passes through the midbrain [NCERT page 321; para 2]. This canal connects:

1. The two lateral ventricle

2. The lateral ventricles and the third ventricle

3. The third and the fourth ventricle

4. The fourth ventricle and the central canal of the spinal cord

33.

The neurons of the olfactory epithelium extend from the outside environment directly into olfactory lobes [NCERT page 323; para 3]. The olfactory lobes are the extensions of:

1. Pre-frontal cortex

2. Corpus callosum

3. Corpora quadrigemina

4. Limbic system

34.

Hormones that interact with membrane-bound receptors, do not enter the target cell but generate second messengers which in turn regulate cellular metabolism. An example of such a hormone would be:

1. Adrenocorticotrophic hormone

2. Triiodothyronine

3. Progesterone

4. Cortisol

35.

Glucagon is a hyperglycaemic hormone [NCERT page 337; para 4]. All the following are effects of this hormone except:

1. Gluconeogenesis

2. Glycogenesis

3. reduced cellular glucose uptake and utilization

4. glycogenolysis

Biology - Section B

36.

In the mitochondrial electron transport system, if complex IV were non-functional, could chemiosmosis still produce any ATP?

1. No

2. Yes, at the same rate as before

3. Yes, in larger amounts than before

4. Yes, only some and that too for only a small duration

37.

Consider the two statements:

I. A poison that inhibits an enzyme of the Calvin cycle will also inhibit light reactions.

II. The light reactions require ADP and NADP+ which would not be produced in sufficient quantities if the Calvin cycle stopped.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

38.

You add a water-soluble inhibitor of photosynthesis to the roots of a plant. The plant is actively transpiring. You are surprised that photosynthesis is not reduced. This is most likely due to:

1. Xylem vessels being dead at maturity

2. Inability of roots to take up water-soluble chemical

3. Endodermis

4. Transport of the inhibitor by phloem

39.

Consider the two statements:

I. Hydroponically grown plants would grow much slower if they were not sufficiently aerated.

II. Oxygen is not soluble in water.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

40.

The ratio of cytokinins to auxin controls cell differentiation in a callus, if:

I. Auxin levels increase shoot buds develop from the callus

II. Cytokinins level increase, roots form

1. Only I is correct

2. Only II is correct

3. Both I and II are correct

4. Both I and II are incorrect

41.

Blue light photoreceptors in plants are not involved in mediating:

1. Phototropism

2. Light-induced opening of stomata

3. Light-induced slowing of hypocotyls elongation that occurs when a seedling breaks ground

4. Seed germination

42.

In a cardiac cycle, both AV valves and the semilunar valves remain closed during

A: Beginning of ventricular systole

B: Beginning of ventricular diastole

1. Only A

2. Only B

3. Both A and B

4. Neither A nor B

43.

An increase in carbon dioxide concentration in the blood would:

A: lead to an increase in the pH of CSF

B: stimulate respiration

1. Only A

2. Only B

3. Both A and B

4. Neither A nor B

44.

Identify the correct statement:

1. Sympathetic neural system is excitatory to the heart and inhibitory to the gut

2. Sympathetic neural system is inhibitory to the heart and excitatory to the gut

3. Sympathetic neural system is excitatory to the heart and to the gut

4. Sympathetic neural system is inhibitory to the heart and to the gut

45.

Our lungs remove large amounts of carbon dioxide [approximately 200 mL/minute]. This translates to about:

1. 156 L/day

2. 288 L/day

3. 412 L/day

4. 504 L/day

46.

Human physiology is regulated mainly by the neural and the endocrine system. The 'interface' between the two systems is the:

1. Hypothalamus

2. Thalamus

3. Cerebellum

4. Cerebrum

47.

In its actions on carbohydrate, fat, and protein metabolism, which of the following hormones can be described as antagonistic to insulin?

1. Glucagon

2. Cortisol

3. Thyroxin

4. Growth hormone

48.

An excessive loss of both salt and body fluids caused for example, by a major wound, will lead to:

I. Increased secretion of ADH in the body

II. Activation of the Renin-Angiotensin-Aldosterone mechanism

1. Only I

2. Only II

3. Both I and II

4. Neither I nor II

49.

The transducing organ in the human ear is located on the:

1. Reissener's membrane

2. Cupula

3. Macula

4. Basilar membrane

50.

Consider the given two statements:

I. Catecholamines, Adrenaline, and Noradrenaline, are called emergency hormones or hormones of Fight or Flight.

II. They are rapidly secreted in response to stress of any kind and during emergency situations.

1. Both I and II are correct and II explains I

2. Both I and II are correct but II does not explain I

3. I is correct but II is incorrect

4. Both I and II are incorrect

Chemistry - Section A

51.

The ionization energy of the hydrogen atom is 13.6 eV and the first ionization energy of the sodium atom is 5.1 eV. The effective nuclear charge experienced by the valence electron of the sodium atom is -

(Round off to one decimal place)

1. 2.8

2. 1.8

3. 1.2

4. 2.2

52.

The potential energy of an electron present in Li^{+2} is :

1. $\dfrac{e^2}{2\pi\varepsilon_0 r}$

2. $\dfrac{3e^2}{4\pi\varepsilon_0 r}$

3. $\dfrac{-2e^2}{4\pi\varepsilon_0 r}$

4. $\dfrac{-3e^2}{4\pi\varepsilon_0 r}$

53.

Ammonia evolved due to complete conversion of nitrogen from 2.24 g sample of protein was absorbed in 50 mL of 0.5 M HNO_3. The excess acid required 40mL of 0.2 M NaOH. The percentage of nitrogen in the sample is

1. 10

2. 16

3. 20

4. 25

54.

The volume occupied by ten molecule of water (density 1g cm^{-3}) is :

1. 18 cm^3

2. 22400 cm^3

3. 6.023 $\times$ 10^{-23} cm^3
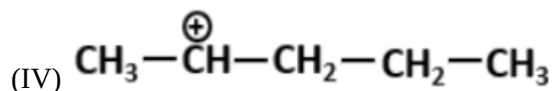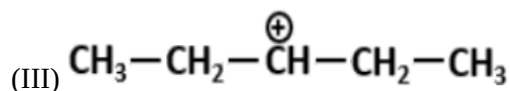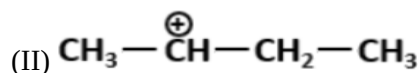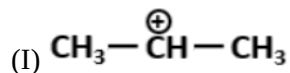
4. 3.0 $\times$ 10^{-22} cm^3

55.

The correct order of reactivity of the following compounds towards electrophilic substitution reaction will be

NH₂

(I)

OCH₃

(II)

Cl

(III)

OH

(IV)

CH₃

(V)
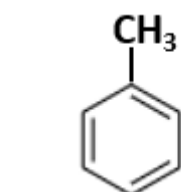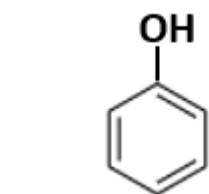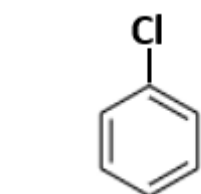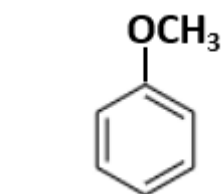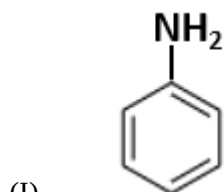
1. I > II > III > IV > V

2. I > II > IV > V > III

3. I > IV > II > V > III

4. I > II > IV > III > V

56.

The correct order of stability of following carbocations is

(I) $CH_3-\overset{\oplus}{C}H-CH_3$

(II) $CH_3-\overset{\oplus}{C}H-CH_2-CH_3$

(III) $CH_3-CH_2-\overset{\oplus}{C}H-CH_2-CH_3$

(IV) $CH_3-\overset{\oplus}{C}H-CH_2-CH_2-CH_3$

1. I > II > III > IV

2. IV > III > II > I

3. I > IV > III > II

4. I > IV > II > III

57.

2.5 litre mixture of CO and CO_2 is passed through red hot charcoal in a tube. The new volume becomes 3.5 litre. All measurements are made at same temperature and pressure. Percentage composition of original mixture by volume will be

1. CO = 50%, CO_2 = 50%

2. CO = 60%, CO_2 = 40%

3. CO = 40%, CO_2 = 60%

4. CO = 20%, CO_2 = 80%

58.

Case Study Question:
The relative location of the bond pair and the lone pair is decided by Bent's rule. The rule states that the more electronegative atom prefers to stay in the orbital having less s character while the lone pair prefers to stay in the orbital having more s character. In molecules with trigonal bipyramidal (TBP) geometry, the more electronegative atom prefers the axial position while the lone pair prefers the equatorial position.

Which molecule, among the following, has non-zero dipole moment?

1. PCl_3F_2

2. PCl_3Br_2

3. $PCl_3(CH_3)_2$

4. Both (2) and (3)

59.

Case Study Question:
The relative location of the bond pair and the lone pair is decided by Bent's rule. The rule states that the more electronegative atom prefers to stay in the orbital having less s character while the lone pair prefers to stay in the orbital having more s character. In molecules with trigonal bipyramidal (TBP) geometry, more electronegative atom prefers axial position while the lone pais prefers equatorial position.

The hybridised state of Br in $CsBr_3$ and shape of Br_3^- are, respectively:

1. sp^3d and Linear

2. No hybridisation and Linear

3. sp^3d and Trigonal bipyramidal

4. No hybridisation and Trigonal bipyramidal

60.

The bond order in B_2 molecule is one. The type of bond and magnetic behaviour of B_2 molecule are, respectively:

1. σ and paramagnetic

2. π and diamagnetic

3. σ and diamagnetic

4. π and paramagnetic

61.

Assertion : To detect presence of halogens in an organic compound, some dilute nitric acid is added.

Reason : Dilute HNO_3 destroys Na_2S and $NaCN$ by oxidation

1. Both assertion and reason are true, and reason is the correct explanation of the assertion

2. Both assertion and reason are true, but reason is not correct explanation of the assertion

3. Assertion is true but reason is false

4. Both assertion and reason are false

62.

Formal charges of central atom in SO_3 , NO_3^- and NH_4^+ are, respectively:

1. 0 , +1 , +1

2. +2 , +1 , +1

3. +2 , -1 , +1

4. 0, -1 , +1

63.

Number of moles of $K_2Cr_2O_7$ required to oxidise 1 mole of ferrous oxalate in acidic medium are:

1. $\dfrac{1}{2}$

2. $\dfrac{1}{3}$

3. $\dfrac{1}{6}$

4. 2

64.

The oxidation number of sulphur in Caro's Acid (H_2SO_5) is

1. +8

2. +7

3. +6

4. +5

65.

Element which has the lowest ionisation potential among the following is:

1. C

2. Si

3. Sn

4. Pb

67.

A single electron in an ion has ionization energy equal to 340 eV. What is the total number of neutrons present in one ion of it?

1. 2

2. 4

3. 6

4. 9

68.

In the following reaction carried out at 500K, 18 moles of N_2 gas is mixed with 24 moles of H_2 gas. What is the percentage yield of NH_3 if the reaction produces 13.5 moles of NH_3?

$N_2(g) + 3\,H_2\,(g) \;\rightarrow\; 2NH_3\,(g)$

1. 16%
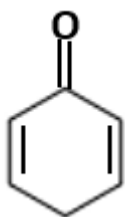
2. 66%

3. 72%

4. 84%

Chemistry - Section B

66.

Two sets of quantum numbers with the same number of radial nodes are -

1. $n = 3, l = 0, m_l = 0$ and $n = 2, l = 0, m_l = 0$

2. $n = 3, l = 2, m_l = 0$ and $n = 2, l = 1, m_l = 0$

3. $n = 3, l = 1, m_l = -1$ and $n = 2, l = 1, m_l = 0$

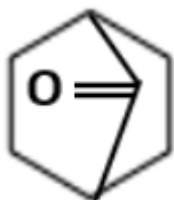4. $n = 3, l = 1, m_l = 1$ and $n = 2, l = 1, m_l = 0$

69.

Which of the following compounds can show tautomerism?
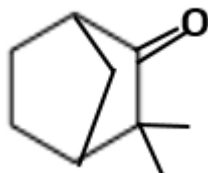

(I)

(II)

(III)

(IV)

1. I, II, III, IV

2. I and II

3. III and IV

4. Only II

70.

Compound, among the following, which has the highest lattice energy is:

1. LiF

2. MgO

3. NaF

4. CaO

71.

Which one of the following species has the highest ionisation potential?

1. F^-

2. Cl^-

3. O^-

4. S^-

72.

Incorrect statement is/are

1. When CO is converted into CO^+ then bond length of CO decreases

2. When O_2 is converted into O_2^+ then bond length of O_2 increases

3. When N_2 is converted into N_2^+ then bond length of N_2 increases

4. Both (1) and (2)

73.

Consider the reaction,

$$3Cl_2 + 6NaOH \; \rightarrow \; 5NaCl + NaClO_3 + 3H_2O$$

In this reaction, the equivalent weight of NaOH will be
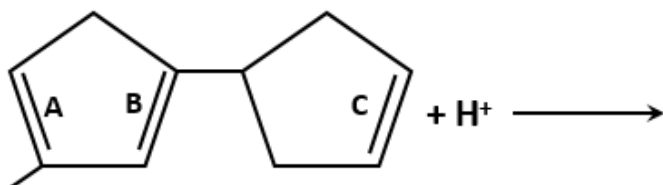
1. 40

2. 48

3. 60

4. 80

74.

When Fe_2S_3 is reacted with O_2 then $FeSO_4$ and SO_2 is formed. In this reaction, equivalent weight of Fe_2S_3 will be (M = Molecular weight of Fe_2S_3)

1. $\frac{M}{2}$

2. $\frac{M}{12}$

3. $\frac{M}{16}$

4. $\frac{M}{20}$

75.

Which π bond is most reactive towards the attack of H^+ ?

1. A

2. B

3. C

4. All π bonds have same reactivity

Physics - Section A

76.

Let ABCDEF be a regular hexagon, with the vertices taken in order. The resultant of the vectors:
$\overrightarrow{AB}, \overrightarrow{BC}, \overrightarrow{CD}, \overrightarrow{DE}$ equals, in magnitude, the vector

1. $\overrightarrow{AB}$

2. $\overrightarrow{AD}$

3. $\sqrt{2}\overrightarrow{AB}$

4. $\sqrt{3}\overrightarrow{AB}$

77.

The magnitude of the vector

$\hat{i} + \hat{i} \times \hat{j} + (\hat{i} \times \hat{j}) \times \hat{i} + ((\hat{i} \times \hat{j}) \times \hat{i}) \times \hat{j}$

1. 1

2. $\sqrt{2}$

3. $\sqrt{3}$

4. 2

78.

A man (A) has to throw a ball vertically up to a partner (B) who is standing up, above his level by 15m. The partner (B) can catch the ball only when it comes downwards with a maximum speed of 10 m/s (take acceleration due to gravity as 10 m/s^2)
The minimum and maximum speed of throw are (nearly)

1. 10 m/s and 20 m/s

2. 10 m/s and 30 m/s

3. 20 m/s and 20$\sqrt{3}$ m/s

4. 10$\sqrt{3}$ m/s and 20 m/s

79.

A ball is thrown vertically upward and it reaches the highest point in 4 s. Immediately, a second ball is thrown upwards with an initial speed that is twice that of the first. The second ball meets the first after a time

1. 1s

2. 2s

3. 3s

4. 4s

80.

The average velocity component in the horizontal direction, for a projectile projected with an initial speed u, at an angle of θ with the horizontal is v, when the average is calculated between the point of projection and the topmost point of the trajectory.
Then, the maximum height reached (H) is related to these quantities by

1. $u^2 = \dfrac{v^2}{2} + gH$

2. $u^2 = \dfrac{v^2}{2} - gH$

3. $u^2 = v^2 + 2gH$

4. $u^2 = v^2 - 2gH$

81.

A particle moves in a circle of radius R with a constant speed v. The average acceleration of the particle in during $\left(\dfrac{1}{6}\right)^{th}$ revolution is

1. $\dfrac{v^2}{R}$

2. $\dfrac{2\pi v^2}{6R}$

3. $\dfrac{\pi v^2}{6R}$

4. $\dfrac{3v^2}{\pi R}$

82.

A particle sits on the periphery of the wheel of a car, which is being driven along a straight road at a speed v. The radius of the wheel of the car is R.
The instantaneous acceleration of the particle, as observed by a passenger, is
(Hint: The periphery of the wheel also rotates with a speed v, in the passenger's frame)

1. $\dfrac{4v^2}{R}$

2. $\dfrac{2v^2}{R}$

3. $\dfrac{v^2}{R}$

4. $\dfrac{v^2}{2R}$

83.

Assume that a space shuttle flies in a circular orbit very close to the earth's surface. Taking the radius of the space shuttle's orbit to be equal to the radius of the earth (R) and the acceleration due to gravity to be g, the time period of one revolution of the space shuttle is (nearly)

1. $\sqrt{\dfrac{2R}{g}}$

2. $\sqrt{\dfrac{\pi R}{g}}$

3. $\sqrt{\dfrac{2\pi R}{g}}$

4. $\sqrt{\dfrac{4\pi^2 R}{g}}$

84.

A block of mass m slides down a smooth plane inclined at an angle of 60° with the horizontal. The normal reaction of the incline acting on the block equals

1. mg sin 60°

2. mg cos 60°

3. mg tan 60°

4. mg cot 60°

85.

A block of mass m, placed on a rough incline (as shown) – is observed to remain at rest. The coefficient of friction is μ. The net force exerted by the incline on the block equals (in magnitude)

1. mg cosθ + μmg cosθ

2. mg cos$\theta\sqrt{1 + \mu^2}$

3. mg sinθ
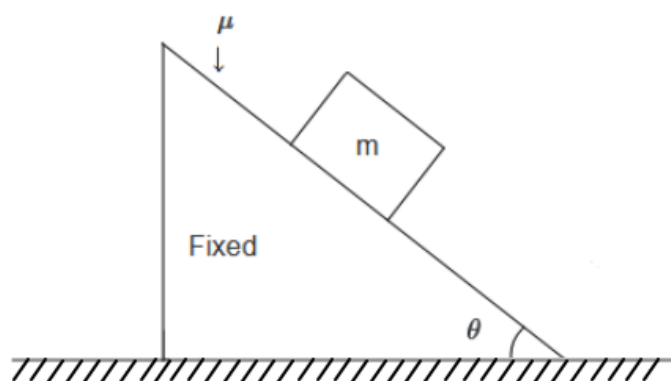
4. mg

86.

The kinetic energy of a particle continuously increases with time. It follows that

1. its potential energy must decrease with time

2. the net force acting on it cannot be perpendicular to its path

3. the net force acting on it is along the velocity

4. friction cannot act on it

87.

When a fan is switched on and it begins to rotate,

1. Its K.E. increases

2. Work is done by centrifugal force

3. Work is done by centripetal forces

4. Mechanical forces do not do any work

88.

Two identical masses are connected to a spring of spring constant k. The two masses are slowly moved symmetrically so that the spring is stretched by x. The work done by the spring on each mass is

1. $\frac{1}{2}kx^2$

2. $\frac{1}{4}kx^2$

3. $-\frac{1}{2}kx^2$

4. $-\frac{1}{4}kx^2$

89.

A block of mass M lies at rest on a horizontal table.

Statement I: (Newton's 3rd Law) To every action, there is an equal and opposite reaction. Action and reaction forces act on different bodies and in opposite directions.

Statement II: The normal reaction is the reaction force, while the weight is the action.

1. Statement I is true, Statement II is true and Statement I is the correct reason for Statement II.

2. Statement I is true, Statement II is true, Statement I is not the correct reason for Statement II.

3. Statement I is true, Statement II is false.

4. Statement I is false, Statement II is true.

90.

Statement I: (Newton's 1st Law of Motion) Every body continues in its state of rest or of uniform motion in a straight line except in so far as it be compelled by an externally impressed force to act otherwise.

Statement II: It is observed that when a car brakes suddenly, the passengers are thrown forward.

1. Statement I is true, Statement II is true and Statement I is the correct explanation for Statement II.

2. Statement I is true, Statement II is true, Statement I is not the correct reason for Statement II.

3. Statement I is true, Statement II is false.

4. Statement I is false, Statement II is true.

Physics - Section B

91.

A boat is rowed across a river so that its velocity w.r.t. water is directed perpendicular to the river's flow. The speed of the boat w.r.t. the water is 2 km/h and the speed of the river's flow is 3 km/h. If the river is 1 km wide, how far down the river will the passengers have to disembark, with respect to their starting point?

1. $\frac{2}{3}$ km

2. 1 km

3. $\frac{3}{2}$ km

4. none of the above is correct

92.

Two guns, mounted along the forward and rear directions of a moving railroad car, are firing at the same angle (relative to the car). The shells rise to a height of 500 m. The forward range of the shells is more than the backward gun's range by 200m. The speed of the railroad car is (take g = 10 m/s^2)

Hint: The range is increased/decreased due to the movement of the car by $V_{car} \cdot T_{shell}$.

1. 5 m/s

2. 10 m/s

3. 20 m/s

4. 40 m/s

93.

A particle projected vertically under gravity passes a certain level on the way up at a time T_1 and on the way down at a time T_2 – after it was projected. The speed of projection is

1. $\frac{1}{2}g\left(T_1 + T_2\right)$

2. $\frac{1}{2}g\left(T_1 - T_2\right)$

3. $g\sqrt{T_1 T_2}$

4. $\frac{1}{2}g\frac{T_1 T_2}{T_1 + T_2}$

94.

The net force acting on a projectile at the highest point of its trajectory, moving with a speed v, at a height H is (m is the mass of the projectile)

1. Zero

2. mg

3. mg+$\frac{mv^2}{H}$

4. mg-$\frac{mv^2}{H}$

95.

A block of mass m is suspended by means of a string, which passes over a massless pulley and is connected to a second block of mass, 2m, sitting on a smooth horizontal table as shown. The system is released. The acceleration of the blocks (acceleration due to gravity is g) is
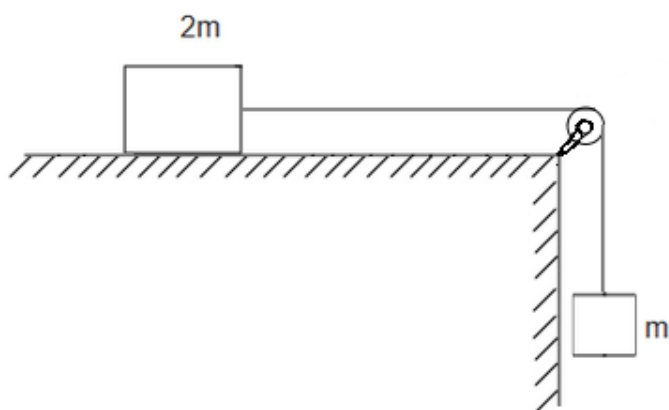
1. $\frac{g}{3}$

2. $\frac{2g}{3}$

3. $\frac{g}{2}$

4. g

96.

Two blocks of masses 2m, m are placed on a smooth horizontal table and they are in contact on their smooth slanted surfaces. A horizontal force F, equal to mg, is applied to the system from the left, which causes them to accelerate. Let N_A be the normal reaction from the table on A, and N_B on B. Then
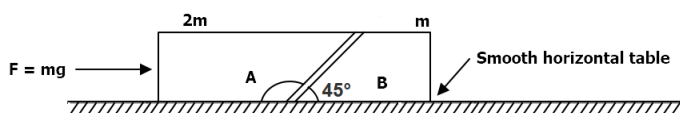
1. N_A = 2 mg, N_B = mg

2. N_A > 2mg, N_B < mg

3. N_A < 2mg, N_B > mg

4. N_A < 2mg, N_B < mg

97.

At the moment of projection of a projectile (mass: m, initial speed: u, angle of projection: θ) the power due to the force of gravity is

1. -mg u

2. mg u $\cos\theta$

3. -mg u $\cos^2\theta$

4. -mg u $\sin\theta$

98.

A force $2x\hat{i} - 3y^2\hat{j}$ acts on a particle when it is at the location (x, y). This force is

1. Non-conservative

2. Conservative and the potential energy is (x^2 - y^3)

3. Conservative and the potential energy is (y^3 - x^2)

4. Conservative, but it cannot have a potential energy

99.

A water pump lifts water from a well which is 20 m deep at a rate of 60 kg/min – with negligible K.E. Take g = 10 m/s^2. The losses in the pump are 20%. The power of the pump is

1. 200 W

2. 250 W

3. 2000 W

4. 500 W

100.

A force F is applied to a system of two blocks: as shown in the figure. There is no friction between the lower block and the table. Due to friction between the blocks of masses m and M, they move together through a distance x.

Then work done by F on m is
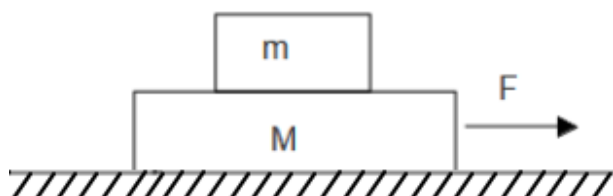
1. $\dfrac{Fx}{2}$

2. $\dfrac{m}{m+M}Fx$

3. $\dfrac{M}{M+m}Fx$

4. none of the above

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