Note: “Option (a)” is the correct answer for all the questions in all the subjects

Biology

1. Question 1

Match the entries in column I and column II.

Column I		Column II	
P.	Notochord and hollow nerve cord present	i.	Cyclostomata
Q.	Ectoparasite with 6-15 pairs of gills and closed circulation	ii.	Chondrichthyes
R.	Marine animals with persistent notochord and placoid scales	iii.	Hemichordata
S.	Animals with open circulatory systems, and stomochord	iv.	Chordata

Which one of the following combinations is correct?

(a) P - iv; Q - i; R - ii; S - iii

(b) P - iv; Q - ii; R - i; S - iii

(c) P - i; Q - iii; R - ii; S - iv

(d) P - iii; Q - i; R - ii; S - iv

2. Question 2

Chromosomes are classified as metacentric, sub-metacentric, acrocentric and telocentric. This classification is based on the position of which one of the following structures?

(a) Centromere

(b) Centrosome

(c) Centriole

(d) Telomere

3. Question 3

Which one of the following options describes a triglyceride?

(a) Three fatty acid chains linked to a molecule of glycerol

(b) Three glycerol molecules linked to a fatty acid chain

(c) Three saturated fatty acid chains linked to a molecule of cholesterol

(d) Three glyceride molecules linked to a molecule of phospholipid

4. Question 4

Which one of the following statements about a plant carotenoid is FALSE?

(a) It is an accessory pigment which absorbs light at 600 - 700 nm.

(b) It protects chlorophyll *a* from photo-oxidation.

(c) It provides precursor for the synthesis of stress hormone in plants.

(d) It accumulates in chromoplasts during fruit ripening.

5. Question 5

A cell suspension of actively respiring mitochondria is treated with either chemical X (experiment 1) or chemical Y (experiment 2), or left untreated (experiment 3).

Chemical X selectively inhibits electron transport from Complex I to ubiquinone, while chemical Y selectively inhibits electron transport from Complex III to cytochrome C.

Which one of the following options represents the correct order of relative number of ATP synthesised in mitochondria?

(a) Experiment 2 < Experiment 1 < Experiment 3

(b) Experiment 1 < Experiment 2 < Experiment 3

(c) Experiment 1 = Experiment 2 = Experiment 3

(d) Experiment 2 < Experiment 1 = Experiment 3

6. Question 6

Which one of the following autoregulatory mechanisms is employed by the kidney when glomerular filtration rate is reduced?

(a) Levels of renin, angiotensin I and II and aldosterone are increased.

(b) Levels of renin and aldosterone are reduced.

(c) Levels of renin are increased, while those of angiotensin I and II and aldosterone are reduced.

(d) Levels of angiotensin I and II are increased, while that of aldosterone are reduced.

7. Question 7

Which one of the following conditions will favour maximum dissociation of oxygen from the oxyhaemoglobin in the tissues?

(a) higher $[H^+]$; higher temperature

(b) higher $[H^+]$; lower temperature

(c) lower $[H^+]$; higher temperature

(d) lower $[H^+]$; lower temperature

8. Question 8

Which one of the following statements is correct?

(a) Red muscle fibres produce ATP aerobically under normal oxygen conditions.

(b) Mitochondria are more in white than in red muscle fibres.

(c) Lactic acid accumulates more in red than in white muscle fibres under similar conditions.

(d) All muscle fibres primarily produce ATP anaerobically.

9. Question 9

Which one of the following organisms produces the female gamete by mitosis of haploid cells?

(a) Garden pea

(b) Honey bee

(c) Fruit fly

(d) Chicken

10. Question 10

Which amino acid will be charged on the tRNA with anticodon 5′-GUU-3′?

(a) Asparagine (codon AAC)

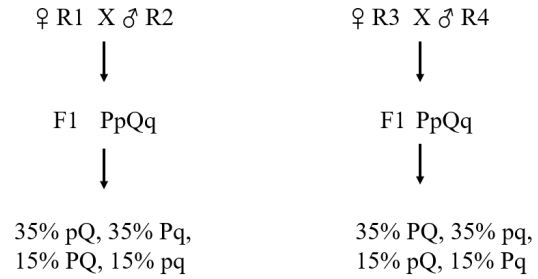
(b) Valine (codon GUU)

(c) Leucine (codon UUG)

(d) Glutamine (codon CAA)

11. Question 11

Two double heterozygous plants (PpQq), derived from two different pairs of true-breeding parents of unknown genotype, produce gametes in the proportions as given below.



Which one of the following options correctly represents the genotype of the parents?

(a) R1 = ppQQ ; R2 = PPqq ; R3 = PPQQ ; R4 = ppqq

(b) R1 = PPQQ ; R2 = ppqq ; R3 = ppQQ ; R4 = PPqq

(c) R1 = ppQQ ; R2 = PPqq ; R3 = PPqq ; R4 = ppQQ

(d) R1 = PPQQ ; R2 = ppqq ; R3 = ppqq ; R4 = PPQQ

12. Question 12

What are retroviruses?

(a) A group of viruses with RNA genome and reverse transcriptase activity

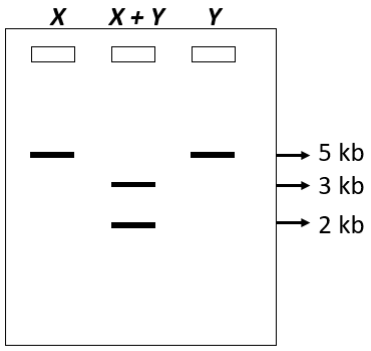
(b) A group of viruses with DNA genome and no reverse transcriptase activity

(c) A group of viruses with DNA genome and reverse transcriptase activity

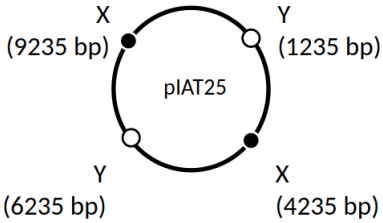
(d) A group of viruses with RNA genome and no reverse transcriptase activity

13. Question 13

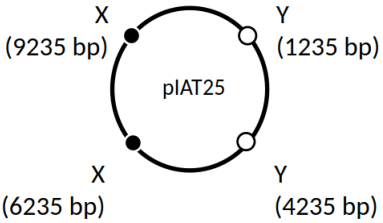
The given picture was obtained from an agarose gel electrophoresis of a plasmid after digestion with restriction enzymes either X, Y or both X and Y.



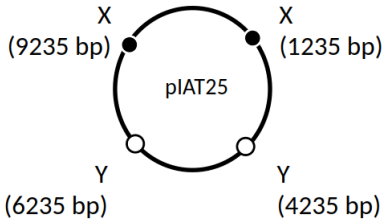
Which one of the following diagrams correctly represents the position of the restriction enzyme sites (X, Y) on the 10,000 bp plasmid?



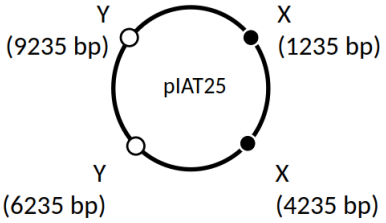
(a)



(b)


X
(9235 bp)
X
(1235 bp)
pIAT25
Y
(6235 bp)
Y
(4235 bp)

(c)


Y
(9235 bp)
X
(1235 bp)
pIAT25
Y
(6235 bp)
X
(4235 bp)

(d)

14. Question 14

Honey bee males are haploid and females are diploid. Which one of the following statements is INCORRECT about honey bees?

(a) Honey bee males cannot have daughters but can have sons.

(b) Honey bee males are produced from unfertilized eggs and females are produced from fertilized eggs.

(c) A honey bee male does not have a father but has a grandfather.

(d) Honey bee males form gametes by mitosis and females form gametes by meiosis.

15. Question 15

Which one of the following statements is FALSE?

(a) More than 80% of the solar energy incident on earth is captured by plants and photosynthetic bacteria.

(b) Only 10% of energy is transferred to each of the higher trophic levels in grazing food chain.

(c) All organisms of a trophic level should be included for estimation of energy content of that trophic level.

(d) The movement of energy is unidirectional in the ecological pyramid of energy.

Chemistry

1. Question 1

   Which one of the following statements best describes the acidic/basic/amphoteric nature of ZnO and CaO?

   (a) ZnO is amphoteric, while CaO is basic.

   (b) ZnO is basic, while CaO is amphoteric.

   (c) Both ZnO and CaO are amphoteric.

   (d) ZnO is acidic, while CaO is basic.

2. Question 2

Which among the following processes is/are associated with increasing bond order but no change in diamagnetic/paramagnetic behaviour?

(i) $N_2 \rightarrow {N_2}^+ + e^-$
(ii) $O_2 \rightarrow {O_2}^+ + e^-$
(iii) $O_2 + e^- \rightarrow {O_2}^-$

(a) (ii) only

(b) (i) and (ii)

(c) (ii) and (iii)

(d) (iii) only

3. Question 3

What is the value of $E^{\circ}(Fe^{3+}/Fe^{0})$?

[The standard reduction potential values are
$E^{\circ}(Fe^{3+}/Fe^{2+}) = 0.77$ V, and $E^{\circ}(Fe^{2+}/Fe^{0}) = -0.44$ V]

(a) -0.04 V

(b) 0.33 V

(c) 0.11 V

(d) -0.11 V

4. Question 4

What are the correct orders of stability for the following compounds?

(a) $VF_5 > VCl_5$; $CuCl_2 > CuI_2$

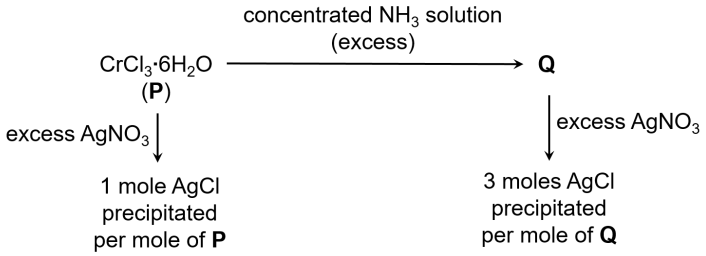
(b) $VCl_5 > VF_5$; $CuCl_2 > CuI_2$

(c) $VCl_5 > VF_5$; $CuI_2 > CuCl_2$

(d) $VF_5 > VCl_5$; $CuI_2 > CuCl_2$

5. Question 5

Consider the following reaction scheme:



Which among the following statements is correct?

(a) **P** shows geometrical isomerism and absorbs light of higher wavelength than that of **Q**.

(b) Both **P** and **Q** show geometrical isomerism and **P** absorbs light of higher wavelength than that of **Q**.

(c) **Q** shows geometrical isomerism and absorbs light of higher wavelength than that of **P**.

(d) **P** shows geometrical isomerism and absorbs light of lower wavelength than that of **Q**.

6. Question 6

How many β-hydrogen is/are present in 2-methyl-3-phenyl-pentan-1-al?

(a) 4

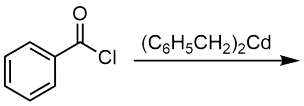
(b) 1

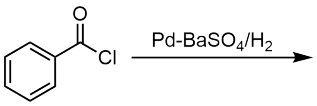
(c) 3

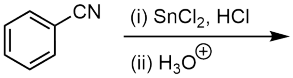
(d) 2

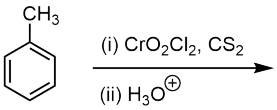
7. Question 7

Which of the following reactions do NOT provide an aldehyde as a product?

(a) 

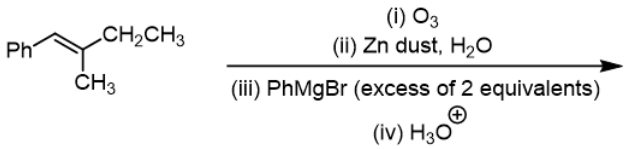
(b) 

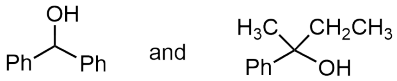
(c) 

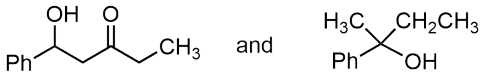
(d) 

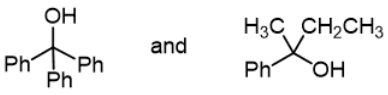
8. Question 8

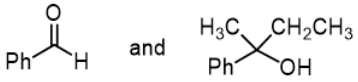
What are the major products formed in the following reaction sequence?



(a) 

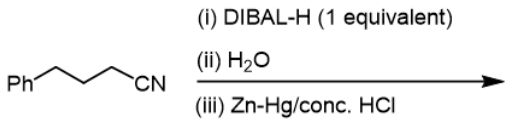
(b) 

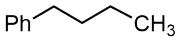
(c) 

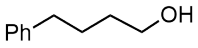
(d) 

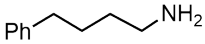
9. Question 9

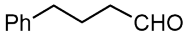
What is the major product in the reaction sequence given below?



(a) 

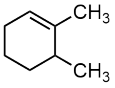
(b) 

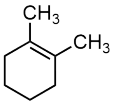
(c) 

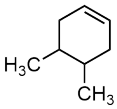
(d) 

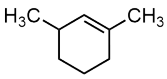
10. Question 10

Compound **I** undergoes hydroboration-oxidation reaction with $(BH_3)_2$ followed by treatment with H_2O_2 and aqueous NaOH to produce another compound **II**, which upon oxidation with CrO_3 gives 2,3-dimethyl-cyclohexanone as the product. What is the structure of **I**?

(a) 

(b) 

(c) 

(d) 

11. Question 11

The work done when one mole of an ideal gas expands at constant temperature T from volume V to $2V$ (in two equal steps of volume in a linear fashion) is $\frac{7}{12}\mathrm{R}T$. How much more work would be done by the gas if it expands in three equal steps?
[R is the universal gas constant]

(a) $\frac{1}{30}\mathrm{R}T$

(b) $\frac{3}{8}\mathrm{R}T$

(c) $\frac{3}{4}\ \mathrm{R}T$

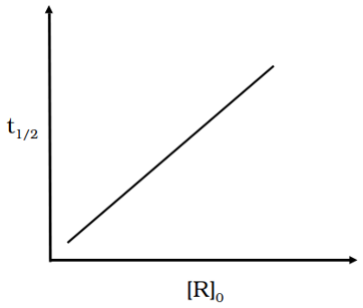
(d) $-\mathrm{R}T\ln\left(\frac{1}{15}\right)$

12. Question 12

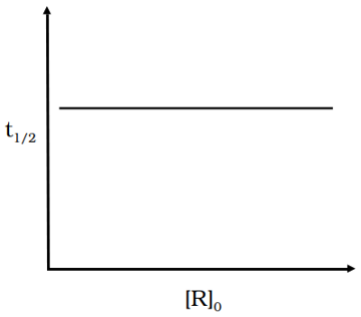
At a particular temperature, the magnitude of the rate constant of a reaction is 5×10^{-5} and the unit of the pre-exponential factor of the Arrhenius equation for this reaction is mol L^{-1} min^{-1}. Which of the following plots is correct for this reaction?

[Note: $[R]_0$ is the initial concentration and $t_{1/2}$ is the half-life of the reaction]

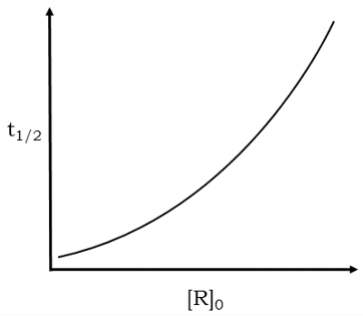
(a)

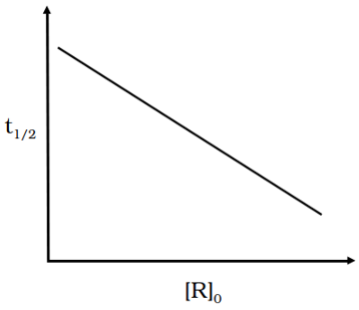


(b)



(c)





(d)

13. Question 13

What is the time period of revolution of an electron in the fourth Bohr orbit of He^+?

[Bohr radius = 52.9 picometers, mass of an electron = 9.11×10^{-31} kg, Planck's constant = 6.626×10^{-34} Js]

(a) 2.4 femtoseconds

(b) 4.8 femtoseconds

(c) 24 femtoseconds

(d) 0.24 femtoseconds

14. Question 14

The dipole moments of three AB_3-type molecules **I**, **II**, and **III** are measured to be 0.0 D, 0.2 D, and 1.5 D, respectively. Which one of the following options is correct regarding the identity of **I**, **II**, and **III**?

(a) **I**: BF_3, **II**: NF_3, **III**: NH_3

(b) **I**: BF_3, **II**: NH_3, **III**: NF_3

(c) **I**: ClF_3, **II**: NF_3, **III**: NH_3

(d) **I**: BCl_3, **II**: NH_3, **III**: NF_3

15. Question 15

During the charging and discharging of a lead-acid battery (a Pb anode, a grid of Pb packed with PbO_2 as cathode, and an aqueous solution of H_2SO_4 as an electrolyte), which of the following redox reactions does NOT occur?

(a) $Pb^{4+} + 4e^- \rightarrow Pb$

(b) $Pb^{2+} \rightarrow Pb^{4+} + 2e^-$

(c) $Pb \rightarrow Pb^{2+} + 2e^-$

(d) $2Pb^{2+} \rightarrow Pb^{4+} + Pb$

Mathematics

1. Question 1

   How many three digit numbers divisible by 5 are there in which **no** digits are repeated?

   (a) 136

   (b) 128

   (c) 144

   (d) 162

2. Question 2

Let A be a 3×3 matrix with real entries such that

$$A = \begin{bmatrix} 4 & -1 & \cos x \\ -1 & 5x & 25 \\ x^2+1 & 25 & 7 \end{bmatrix}.$$

For how many values of x, the matrix A is symmetric?

(a) 1

(b) 2

(c) 4

(d) infinitely many

3. Question 3

Let $n = \sum_{r=0}^{10} (-1)^r \ {}^{10}C_r \left(\frac{2}{3}\right)^{2r} 3^{20}$. Which one of the following statements is TRUE?

(a) n is divisible by 5

(b) n is divisible by 6

(c) n is divisible by 8

(d) n is divisible by 9

4. Question 4

Let $f : \mathbf{R} \to \mathbf{R}$ be the function given by $f(x) = \cos(\tan^{-1} x)$. Which one of the following statements is TRUE?

(a) f is decreasing for $x > 0$

(b) f is decreasing for $x < 0$

(c) f is decreasing on $\mathbf{R}$

(d) f is decreasing on the interval $(-1, 1)$

5. Question 5

Let

$$A = \left\{ x \in \mathbf{R} \;\middle|\; -31 < \det \begin{bmatrix} 3x-1 & 2 \\ -2 & 5 \end{bmatrix} \leq 29 \right\}.$$

Which one of the following statements is TRUE?

(a) $A = (-2, 2]$

(b) $A = (-2, 2)$

(c) $A = [-2, 2)$

(d) $A = [-2, 2]$

6. Question 6

Let z_1, z_2, and z_3 be complex numbers satisfying the following conditions

$$2 = |2z_1| = |z_2 - 1| = |z_3 + 1| = \left| \frac{1}{z_1} + \frac{1}{z_2 - 1} + \frac{1}{z_3 + 1} \right|.$$

What is the value of $|4z_1 + z_2 + z_3|$?

(a) 8

(b) 4

(c) $\frac{1}{4}$

(d) $\frac{1}{8}$

7. Question 7

Let $f\colon \mathbf{R} \to \mathbf{R}$ be defined as $f(x) = |x^3 - 3x|[x]$, where $[x]$ denotes the greatest integer less than or equal to x. Which one of the following statements is TRUE?

(a) Every non-zero integer is a point of discontinuity of f

(b) f is continuous at every real number

(c) Every integer is a point of discontinuity of f

(d) f is continuous at every real number except for $0, \pm\sqrt{3}$

8. Question 8

Let ℓ be the tangent line to the ellipse $x^2 + 16y^2 = 4$ at $\left(1, \frac{\sqrt{3}}{4}\right)$. What is the equation of the line perpendicular to ℓ passing through $(2, 0)$?

(a) $y = 4\sqrt{3}(x - 2)$

(b) $y = 2\sqrt{3}(x - 2)$

(c) $y = \sqrt{3}(x - 2)$

(d) $4\sqrt{3}y = (x - 2)$

9. Question 9

Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{a}+\vec{b}| = 15$ and

$$\vec{a} \times (3\hat{i} - 4\hat{j} + 5\hat{k}) = (3\hat{i} - 4\hat{j} + 5\hat{k}) \times \vec{b}.$$

What is the value of $|(\vec{a}+\vec{b}) \cdot (2\hat{i} + 3\hat{j} + \hat{k})|$?

(a) $\dfrac{3}{\sqrt{2}}$

(b) 0

(c) $\sqrt{2}$

(d) 3

10. Question 10

What is the derivative of $\log(\sin^2 x)$ with respect to $\sin x$?

(a) $2 \operatorname{cosec} x$

(b) $\sin 2x$

(c) $4 \operatorname{cosec} x$

(d) $\cot x \operatorname{cosec} 2x$

11. Question 11

Let S_n denote the sum of the first n terms of a sequence $a_1, a_2, a_3, \ldots$. If $S_{n+3} - S_n = 13n + 7$ for all n, what is the value of $a_{13} - a_{10}$?

(a) 13

(b) 137

(c) 46

(d) 12

12. Question 12

Five fair coins are tossed independently. What is the probability that at least two heads appear?

(a) $\frac{13}{16}$

(b) $\frac{7}{16}$

(c) $\frac{5}{16}$

(d) $\frac{11}{16}$

13. Question 13

Let $f : \mathbf{R} \to \mathbf{R}$ be the function defined by

$$f(x) = \begin{cases} x^2 - 4x - 5 & \text{if } x \geq 1, \\ 2x & \text{if } x < 1. \end{cases}$$

Which one of the following statements is TRUE?

(a) f is onto but not one-one

(b) f is one-one but not onto

(c) f is neither one-one nor onto

(d) f is one-one and onto

14. Question 14

Which one of the following is the solution of the differential equation

$$x^2 \frac{dy}{dx} + 9xy = x^4 \text{ (for } x > 0),$$

given that $y = 0$ when $x = 1$?

(a) $12y = x^3 - \dfrac{1}{x^9}$

(b) $12y = x^9 - \dfrac{1}{x^3}$

(c) $9y = x^{21} - \dfrac{1}{x^3}$

(d) $9y = x^3 - \dfrac{1}{x^{21}}$

15. Question 15

What is the value of $\int_0^{\pi} x|\cos x|\sin x \; dx$?

(a) $\frac{\pi}{2}$

(b) $\frac{\pi}{4}$

(c) π

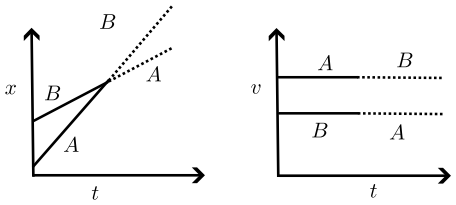
(d) $\frac{\pi}{6}$

Physics

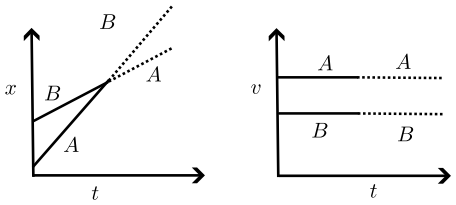
1. Question 1

Consider an elastic collision between two particles A and B of same mass, moving in the same direction. Particle A is moving at speed v_A and particle B is moving at speed v_B. In the figures shown, the solid lines represent the motion before the collision and the dotted lines represent the motion after the collision. Which of the following describes the motion of these two particles most accurately?

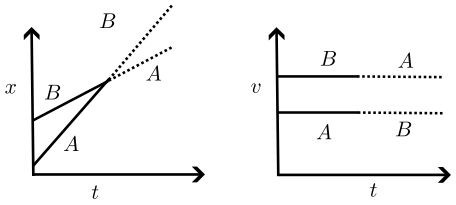
(a)



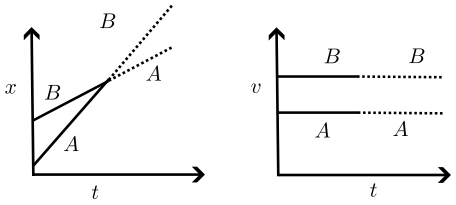
(b)



(c)

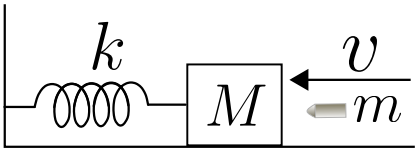


(d)



2. Question 2

A block of mass M lies at rest connected to a massless spring of spring constant k on a frictionless surface. A bullet of mass m hits the block horizontally with speed v as shown in the figure and is completely stuck to the block. What is the maximum compression in the spring resulting from this impact (assuming that at this point the spring is still not fully compressed)?



(a) $\sqrt{\dfrac{m^2v^2}{k(M+m)}}$

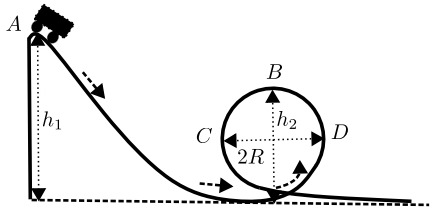
(b) $\sqrt{\dfrac{mv^2}{k}}$

(c) $\sqrt{\dfrac{Mv^2}{k}}$

(d) $\sqrt{\dfrac{mMv^2}{k(M+m)}}$

3. Question 3

A cart of mass M is released from A, the highest point of a frictionless track, as shown in the figure. The cart travels along the track and enters the semicircular arc DBC of radius R. The heights of the points A and B are h_1 and h_2 from the ground, respectively. Which of the following quantities does not play any role in ensuring that the cart does not leave the track?



(a) M

(b) h_1

(c) h_2

(d) R

4. Question 4

A circular disk of mass M and radius R is rotating clockwise with a uniform angular velocity ω about an axis passing through the centre, normal to the disk. At time $t = 0$, a torque T is applied along the same axis to oppose the rotation of the disk. What is the angular displacement θ (measured from $t = 0$ in the clockwise direction) that the disk attains before it starts rotating counterclockwise?

(a) $\theta = \dfrac{\omega^2 MR^2}{4T}$

(b) $\theta = \dfrac{\omega^2 MR^2}{8T}$

(c) $\theta = -\dfrac{\omega^2 MR^2}{4T}$

(d) $\theta = -\dfrac{\omega^2 MR^2}{8T}$

5. Question 5

A metallic cube initially kept at a temperature T is emitting black body radiation with a power P (energy emitted per unit time). If T is increased by 1 %, the power being radiated increases by 4.5 %. What is the approximate percentage increase in the volume of the cube in this process?

(a) 0.75 %

(b) 0.50 %

(c) 1.56×10^{-6} %

(d) 6.25×10^{-6} %

6. Question 6

Consider two pipes A and B of identical length. A has one end closed and one end open. B has both ends open. Each tube is immersed in a closed chamber of ideal gas having volume V. The chamber containing tube A is at temperature T_A and the chamber containing tube B is at temperature T_B. The sound frequencies corresponding to the n_A-th harmonic in tube A and the n_B-th harmonic in tube B are the same. What is the relation between the temperatures T_A and T_B?

(a) $T_A = \left(\frac{4n_B^2}{n_A^2}\right) T_B$

(b) $T_A = \left(\frac{4n_A^2}{n_B^2}\right) T_B$

(c) $T_A = \left(\frac{n_A^2}{4n_B^2}\right) T_B$

(d) $T_A = \left(\frac{n_B^2}{4n_A^2}\right) T_B$

7. Question 7

Consider two waves, which are given by $y_1(x,t) = A\sin(kx - \omega t)$ and $y_2(x,t) = \sqrt{3}A\cos(kx - \omega t)$, where k is the wave number and ω is the angular frequency. The amplitude of the resultant waveform obtained by the superposition of the two waves is A_s and its phase difference with y_1 is ϕ_s. What are A_s and ϕ_s?

(a) $A_s = 2A$ and $\phi_s = \dfrac{\pi}{3}$

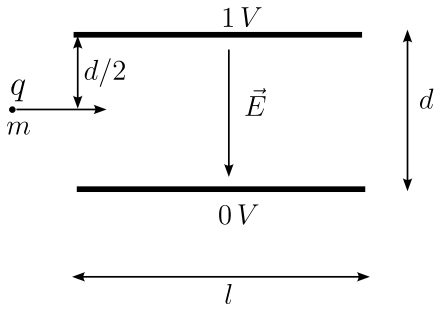
(b) $A_s = 2A$ and $\phi_s = \dfrac{\pi}{6}$

(c) $A_s = \dfrac{A}{2}$ and $\phi_s = \dfrac{\pi}{3}$

(d) $A_s = \dfrac{A}{2}$ and $\phi_s = \dfrac{\pi}{6}$

8. Question 8

A particle of charge $q = 1e$ and mass m with kinetic energy K enters an electric field set up by two parallel plates of length l as illustrated in the figure. The potential difference between the two plates is 1 V and their separation is d. What is the minimum value of K (in eV) for which the particle will not hit either of the plates?
[e is the charge of the electron.]



(a) $\dfrac{l^2}{2d^2}$

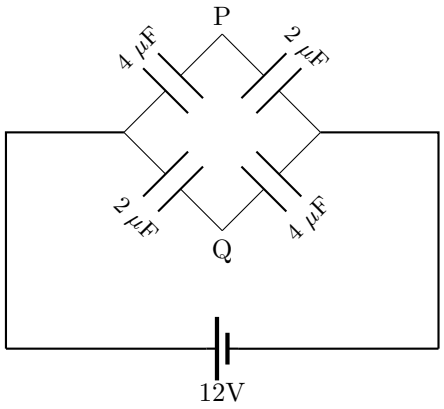
(b) $\dfrac{d^2}{2l^2}$

(c) $\dfrac{l^2}{d^2}$

(d) $\dfrac{d^2}{l^2}$

9. Question 9

What is the potential difference between the points P and Q in the circuit shown below, once the capacitors are fully charged?



(a) 4 V

(b) 0 V

(c) 8 V

(d) 12 V

10. Question 10

A particle of mass m and charge q moving with a velocity $\vec{v} = v_0(\hat{i} + \hat{j} - \hat{k})$ is placed in a uniform magnetic field $\vec{B} = B_0(\hat{i} + \hat{j} + \hat{k})$. It executes a helical trajectory of radius r and pitch p. Which of the following options is correct?

(a) $r = \dfrac{2\sqrt{2}mv_0}{3qB_0}$ and $p = \dfrac{2\pi mv_0}{3qB_0}$

(b) $r = \dfrac{mv_0}{3qB_0}$ and $p = \dfrac{2\pi mv_0}{3qB_0}$

(c) $r = \dfrac{2\sqrt{2}mv_0}{3qB_0}$ and $p = \dfrac{4\sqrt{2}\pi mv_0}{3qB_0}$

(d) $r = \dfrac{2\pi mv_0}{3qB_0}$ and $p = \dfrac{2\sqrt{2}mv_0}{3qB_0}$

11. Question 11

A charged particle is moving in a circular orbit with radius r and orbital angular frequency ω in the presence of a magnetic field. The orbit is enclosed within a larger circular metallic frame. The frame is concentric and coplanar with the orbit. The radius of the frame is now gradually decreased. Assuming that the particle remains within the frame at all times, what changes to the trajectory of the particle will occur as the frame is being shrunk?

(a) The radius of the orbit will gradually decrease and the frequency will gradually increase.

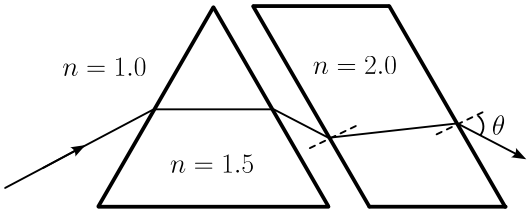
(b) The radius of the orbit will gradually increase and the frequency will gradually decrease.

(c) The radius of the orbit will remain the same but the frequency will gradually increase.

(d) Both the radius of the orbit and the frequency will remain unchanged.

12. Question 12

Consider an equilateral prism of refractive index 1.5 and a parallelepiped block of refractive index 2.0 arranged as shown in the figure such that their adjacent faces are parallel. A light ray enters the prism from air at an angle of incidence such that the ray travels through the prism parallel to its base. What is the angle of emergence θ?



(a) $\sin^{-1}(3/4)$

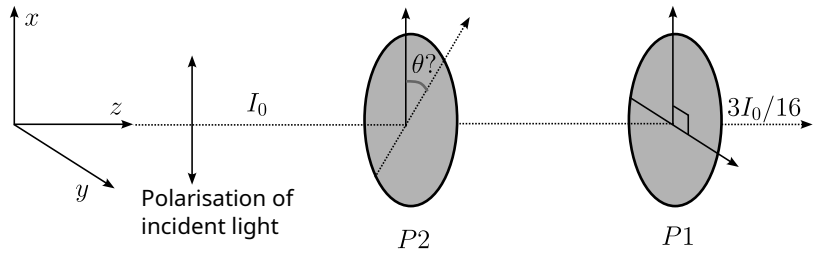
(b) $\sin^{-1}(1/3)$

(c) $\sin^{-1}(1/2)$

(d) $\sin^{-1}(\sqrt{3}/2)$

13. Question 13

A source produces a light beam of intensity I_0 polarized along the x-direction. The beam is sent along the z-direction. It enters a polaroid $P1$ with its polaroid axis aligned along the y-direction so that no light exits the polaroid. When another polaroid $P2$ is placed in between the source and $P1$, the intensity measured after $P1$ is $3I_0/16$. Which among the following is a possible value of θ, the angle of the polaroid axis measured from the x-axis?



(a) $60°$

(b) $15°$

(c) $45°$

(d) $75°$

14. Question 14

An electron in the ground state (with energy E_1) of a hydrogen atom, absorbs a photon of energy E_a, and gets excited to a higher energy level of principal quantum number n. What is the value of n?

(a) $\sqrt{\dfrac{E_1}{E_1 + E_a}}$

(b) $\sqrt{\dfrac{E_1}{E_1 - E_a}}$

(c) $\sqrt{\dfrac{E_a}{E_1 - E_a}}$

(d) $\sqrt{\dfrac{E_a}{E_1 + E_a}}$

15. Question 15

A particle of mass m and charge q is accelerated through a distance d_1 by an electric field $\vec{E}$. Another particle of mass M and charge q is accelerated by the same electric field through a distance d_2. Both the particles emerge with the same de Broglie wavelength λ_B. What is the ratio of the distances d_2/d_1?

(a) $\frac{m}{M}$

(b) $\frac{M}{m}$

(c) $\sqrt{\frac{m}{M}}$

(d) $\sqrt{\frac{M}{m}}$