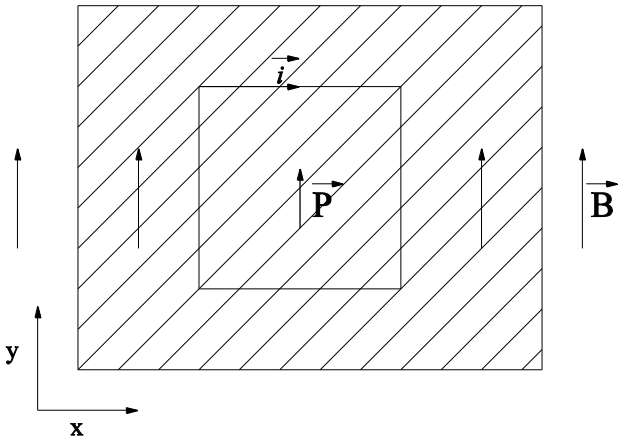
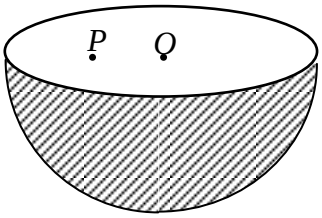
1.A square loop and an electric dipole $\vec{P}$ are fixed on a light plastic plate. The loop carries a current *i* as shown in the figure. A dipole is at the centre of the loop in the direction shown. Electric and magnetic fields exist in the region such that there is no net torque on the plate due to them. If the magnetic field is in the plane of the plate as shown in the figure the electric field must be



(a) Along negative y direction
(b) Along positive y direction
(c) Along negative *z* direction
(d) Along positive z direction

2.Positive electric charge is distributed uniformly on the surface of a thin spherical shell made of a non conducting material. The sphere is cut into two hemispheres and the top hemisphere is removed. *P* is a point that lies in the plane of the rim of the bottom hemisphere, while *O* is the centre of the rim. If $\vec{E}$ is the electric field at *P*, then



(a) $\vec{E}$ is normal to the plane of the rim, pointing downwards
(b) $\vec{E}$ is directed along $\overrightarrow{PO}$
(c) $\vec{E} = 0$
(d) $\vec{E}$ is normal to the plane of the rim, pointing upwards

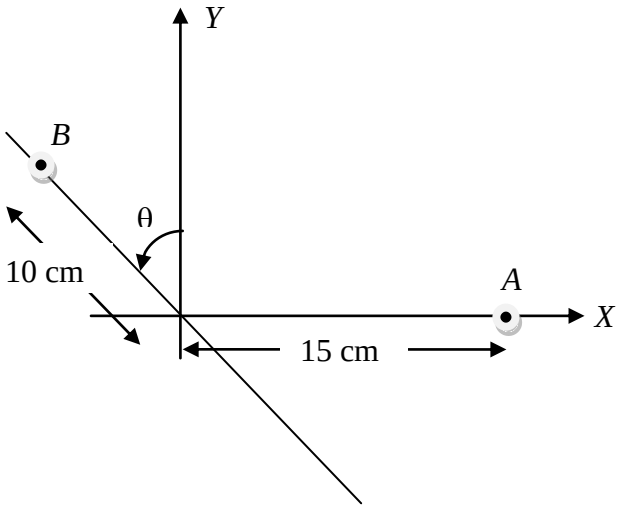
3.Two equal positive charges *A* and *B* are kept fixed at the positions shown in the figure. A negative charge is released from the origin. When θ is equal to a certain angle θ_1, the negative charge starts moving along the *X*-axis, whereas when θ is equal to another angle θ_2, it starts moving along the positive *Y*-axis. The value of θ_1 and θ_2 are,

(a) $\frac{\pi}{2}$, $\sin^{-1}(3/4)$

(b) $\frac{\pi}{2}$, $\sin^{-1}(4/9)$

(c) $\frac{\pi}{4}$, $\sin^{-1}(2/3)$

(d) $\frac{\pi}{2}$, $\sin^{-1}(4/5)$



4.An electric charge *+q* is located at each of the points $\pm a, \pm as^2, \pm as^4 \ldots ad\ infinitium$ on the *x*-axis, and a charge *–q* is located at each of the points $\pm as, \pm as^3, \pm as^5 \ldots ad\ infinitium$ on the same axis. Here *s* is a constant *>1*. The electrostatic potential at the origin due to the array of charges is

(a) $\frac{q}{2\Pi\varepsilon_0 a}\left(\frac{s}{s+1}\right)$

(b) $\frac{q}{2\Pi\varepsilon_0 a}\left(\frac{s}{s-1}\right)$

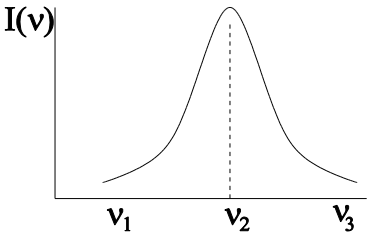
(c) $\frac{q}{2\Pi\varepsilon_0 a}\left(\frac{1}{s+1}\right)$

(d) $\frac{q}{2\Pi\varepsilon_0 a}\left(\frac{1}{s-1}\right)$

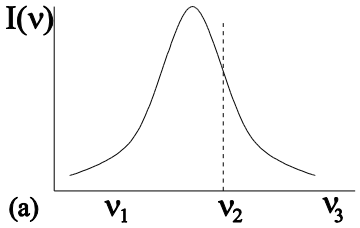
5.An electron (magnitude of charge *e*, mass *m*) is moving in a circular orbit in a magnetic field of magnitude *B*. If the orbit contains an integer number *n* of de Broglie wavelength, the energy of the electron is (*h* = Planck's constant)

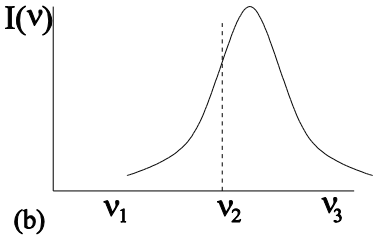
(a) $n^2\left(\frac{he B}{4\pi m}\right)$	(b) $n\left(\frac{he B}{4\pi m}\right)$
(c) $\frac{1}{n}\left(\frac{he B}{4\pi m}\right)$	(d) $\frac{1}{n^2}\left(\frac{he B}{4\pi m}\right)$

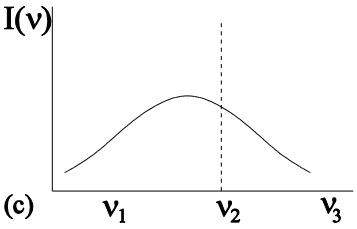
6. A source emits sound having a range of frequencies, the distribution of intensity *I(ν)* sketched in the figure.

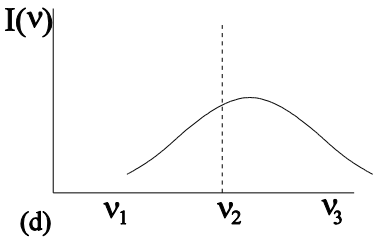


An observer moves with a speed *u* towards the source. Which of the following represents the intensity distribution as determined by the observer?

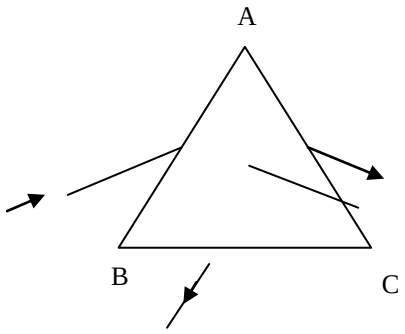








7.An equilateral prism *ABC* is made of a material of refractive index $\sqrt{2}$. A narrow parallel beam of monochromatic light falls on the face *AB.* The beam coming out from the face *AC* has minimum deviation from the original path. A part of the beam also comes out of the face BC after undergoing one reflection at *AC.* The angle between the beams coming out from these two surfaces is



(a) 150° (b) 90°

(c) 135° (d) 120°

8. An ideal gas undergoes two successive processes *A* and *B*. In the process *A*, the values of the increase *ΔU* in internal energy and the work *W* done by the gas are *ΔU= 72J* and *W=-72J*, respectively. For the process *B*, *ΔU=0*.

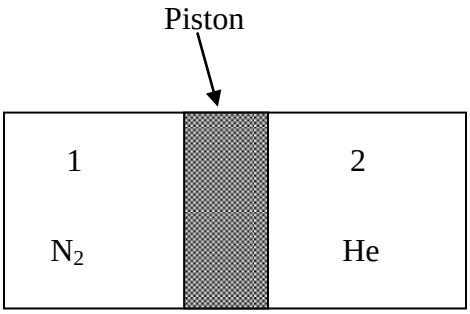
(a) Process *A* is adiabatic, process *B* is isochoric

(b) Process *A* is adiabatic, process *B* is isothermal

(c) Process *A* is isothermal, process *B* is adiabatic

(d) Process *A* is isobaric, process *B* is adiabatic

9.A thermally conducting piston can move freely in a thermally insulated cylindrical vessel, separating two compartments. Compartment 1 contains 14mg of N_2 gas and compartment 2 contains 20mg of He gas. When the piston attains its equilibrium position, the length of compartment 1 becomes L_1 and that of compartment 2 becomes L_2 (see figure). The molecular weight of nitrogen is 28 and that of helium is 4. Then the ratio $\frac{L_1}{L_2}$ is



(a) 10/1 c) 49/10

(b) 1/10 d) 10/49

10. A solid rectangular parallelepiped has sides of lengths X, Y and Z, respectively. The solid is pulled along the Z – direction which produces an extension ΔZ in this direction. The relative lateral contractions in the X and Y directions are given by $\frac{\Delta x}{x} = \frac{\Delta y}{y} = \frac{-\nu \Delta z}{z}$, where ν is a constant. The relative change in the volume of the solid is given by

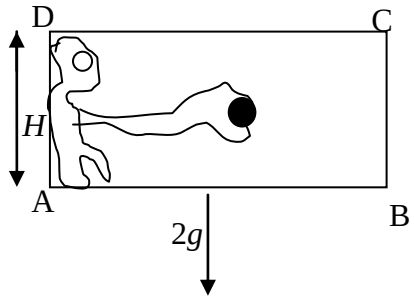
(a) $\frac{(1-2\nu)\Delta z}{z}$ (b) $\frac{(1+\nu)\Delta z}{z}$

(c) $\frac{(1+2\nu)\Delta z}{z}$ (d) $\frac{3\Delta z}{z}$

Comprehensive: Question no.11 - 13

Newton's law, f=ma, for a particle of mass *m* is applicable only in inertial frames. If a frame moves linearly with an acceleration a_0 with respect to the earth (assumed to be an inertial frame), the acceleration of the particle is given by ma $= \vec{F} - m\overrightarrow{a_0}$. The term (-m$\overrightarrow{a_0}$) is known as the pseudoforce acting on the particle in this frame.

Now consider the situation shown in the adjacent figure. A rectangular box ABCD(as shown below in the picture) of mass *M* is made to fall vertically with an acceleration of 2*g*, as seen from the ground. The sides AB and CD remain horizontal. The sides AD and BC are of length *H*. A robot firmly attached to the box holds an object of mass *m* at the center of the box.



11. The pseudoforce on the object as seen from the box frame is

(a) 2*mg* upwards
(b) 2*mg* downwards
(c) 2*Mg* downwards
(d) 2*Mg* upwards

12. The net force (pseudoforce + all real forces) on the object as seen from the box frame is

(a) *mg* downwards
(b) 2*mg* downwards
(c) *0*
(d) *mg* upwards

13. Now the robot releases the object. It will hit

(a) CD in time square root of 2H/g
(b) AB in time square root of H/g
(c) AB in time square root of 2H/g
(d) CD in time square root of H/g

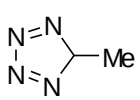
14. The species with metal ion having d^5 configuration is

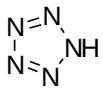
(a) $K_4[Fe(CN)_6]$
(b) $[Co(NH_3)_6]PO_4$
(c) $K_4[Mn(CN)_6]$
(d) $[Co(NH_3)_5(SO_4)]NO_3$

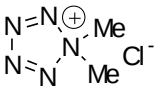
15. The monobasic acid among the following is

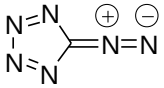
(a) H_3PO_3
(b) $H_2S_2O_7$
(c) H_3PO_2
(d) $H_4P_2O_7$

16. The best explosive among the following is

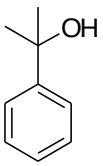

(a)

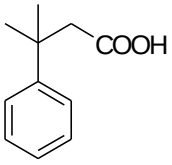

(b)

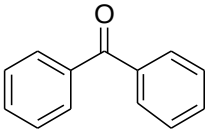

(c)

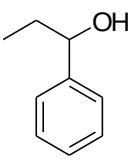

(d)

17. An organic compound on treatment with chromic acid/H_2SO_4 gave a clear orange solution which turned greenish and opaque immediately. The compound is

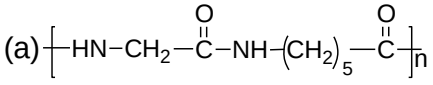

(a)

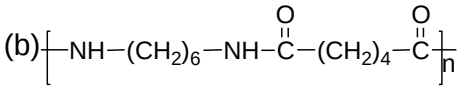

(b)

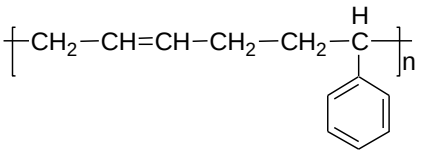

(c)

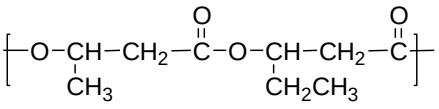

(d)

18. Among the following, the homo polymer is

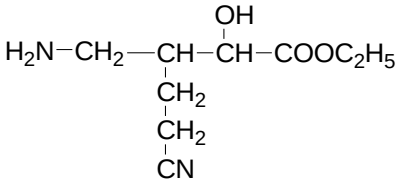
(a) 

(b) 

(c) 

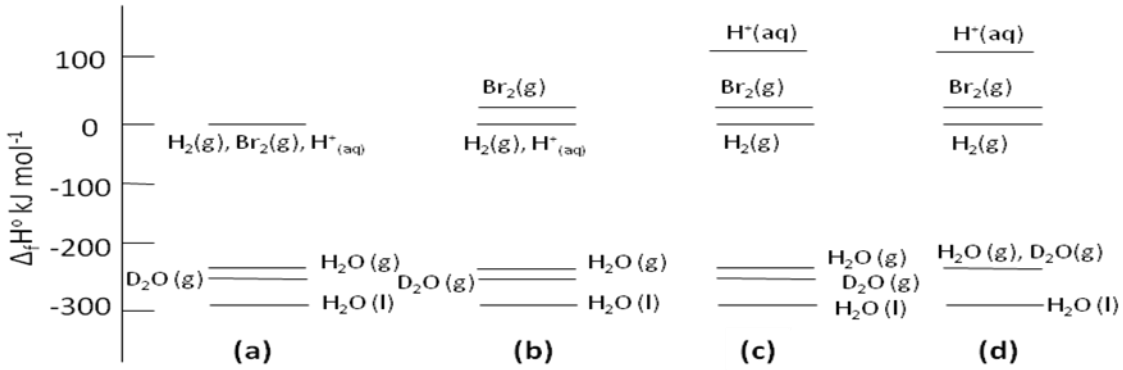
(d) 

19. The correct IUPAC nomenclature of the given compound is



(a) ethyl 3-aminomethyl-5-cyano-2-hydroxypentanoate
(b) 4-aminomethyl-5-ethoxycarbonyl-5-hydroxypentanenitrile
(c) 2-aminomethyl-4-cyano-1-ethoxycarbonylbutanol
(d) Ethyl 4-amino-3-cyanoethyl-2-hydroxybutanoate

20. Standard molar enthalpies of several substances are summarised pictorially below. The correct representation is



21. The observed rate of a chemical reaction is substantially lower than the collision frequency. One or more of the following statements is/are true to account for this fact.

A. the reactants do not have the required energy
B. the partners do not collide in the proper orientation

C. collision complex exists for a very short time

D. collision frequency overestimates the number of effective collisions

(a) A, B & C

(b) A, B & D

(c) B, C & D

(d) A, C & D

22. The correct statement(s) for alkali halides is/are

A. metal excess defects make NaCl yellow

B. metal excess defects make LiCl, NaCl and KCl coloured

C. metal excess defects make NaCl yellow but has no effect on LiCl

D. metal excess defects make both NaCl and KCl coloured

(a) A & B

(b) A & C

(c) A, B & D

(d) A

23. For the cell reaction, $Mg(s) + 2\ Ag^{+}(aq) \rightarrow Mg^{2+}(aq) + 2\ Ag(s)$, $E^{o}_{(cell)}$ is 3.17 V at 298 K. The values of $E_{(cell)}$, ΔG^{o} and Q at Ag^{+} and Mg^{2+} concentrations of 0.001 and 0.02 M, respectively are

(a) 3.04 V, -605.8 kJ mol^{-1}, 20000

(b) 3.04 V, 611.8 kJ mol^{-1}, 20000

(c) 3.13 V, -604.0 kJ mol^{-1}, 20

(d) 3.04 V, -611.8 kJ mol^{-1}, 20000

24. Amongst the following, the most thermally stable polymer is

(a) Polyethylene

(b) polypropylene

(c) polystyrene

(d) poly α- methylstyrene

25. Pick the group which does not contain a neutral oxide

(a) NO_2, P_4O_{10}, Al_2O_3, NO

(b) MgO, N_2O_5, SO_3, N_2O

(c) CO_2, SO_3, CaO, XeO_3

(d) CO, SiO_2, SnO_2, Na_2O_3

26. The three *p*-orbitals, of a *p*-block element E, combine to form p^3 hybrid orbitals in compound EX_3. The X-E-X bond angle in EX_3 is

(a) 109^o
(b) 120^o
(c) 134^o
(d) 90^o

27. Let $f(x) = 3\int_0^x t^2 f(t)dt + 1$, $x \in [0, \infty)$. Then $f(1)$ is

a) 1
b) e
c) e^2
d) e^6

28. The general solution of the differential equation $ydx - (x^2 - 4)dy = 0$ satisfies

a) $y^4 = c\dfrac{x-2}{x+2}$
b) $y^4 = c\dfrac{x+2}{x-2}$
c) $y^2 = c\dfrac{x-2}{x+2}$
d) $y^2 = c\dfrac{x+2}{x-2}$

29. If $f(x) = [x]$ denotes the greatest integer function, then $\int_0^{1.5} ([x^2] - [x]^2)dx$ is

a) $\dfrac{3}{2} - \sqrt{2}$
b) 135/64
c) $\dfrac{3}{2} + \sqrt{2}$
d) 0

30. The value of $\lim_{x\to\infty}(e^x + x)^{1/x}$ is

a) 0
b) 1
c) e

d) ∞

31. Let z_1, z_2, z_3 be complex numbers of modulus 1 satisfying $|z_1 - z_2|^2 + |z_1 - z_3|^2 = 4$. Then,

a) $z_1 + z_2 = 0$

b) $z_2 + z_3 = 0$

c) $z_1 + 2z_3 = 0$

d) $z_1 + z_2 + z_3 = 0$

32. The number of ways in which 7 balls can be put in 7 bags such that atmost 5 bags are empty is

a) 7^7

b) $7^7 - 7$

c) $7^7 - 5$

d) $7^7 - 2$

33. $\tan^{-1}\frac{2}{11} + 2\tan^{-1}\frac{1}{7}$

is

a) $\tan^{-1}\frac{36}{77}$

b) $\tan^{-1}\frac{1}{2}$

c) $\tan^{-1}\frac{1}{7}$

d) $\tan^{-1}\frac{36}{73}$

34. A traffic police reports that 20 percent of the vehicles passing through a check point are from outside the state. Then the probability that more than 8 of the next 10 vehicles are from the state is

a) $1-\frac{14}{5}\left(\frac{4}{5}\right)^9$

b) $\frac{41}{5}\left(\frac{1}{5}\right)^9$

c) $\frac{14}{5}(\frac{4}{5})^9$

d) $1-\frac{41}{5}(\frac{1}{5})^9$

35. Let a,b,c be three non-zero vectors such that c is not orthogonal to b. If r=xi + yj+zk (i,j,k are unit vectors) satisfies r x b = a x b and r.c =0 then r x a is

a) (a.c / b.c) (axb)
b) (a.c / b.c) (bxc)
c) (a.c / b.c) (cxa)
d) (a.c / b.c) (bxa)

36. Let an object be placed at some height $h\ cm$ and let P and Q be two points of observation which are at a distance $10\ cm$ apart on a line inclined at an angle 15° to the horizontal. If the angles of elevation of the object from P and Q are 30° and 60°, respectively, then h is

a) $5\sqrt{2}$
b) $5/\sqrt{2}$
c) $5\sqrt{6}$
d) $5\sqrt{3}$

37. An unbiased die is rolled until two consecutive trials result in even numbered faces. The probability that exactly six trials are required to get two consecutive even numbered faces is

(a) $5(\frac{1}{2})^6$	(b) $6(\frac{1}{2})^6$
(c) $4(\frac{1}{2})^6$	(d) $6(\frac{1}{6})^6$

38. A student is allowed to select at most n books from a collection of $2n+1$ books. If the total number of ways in which a student can select atleast one book is 63, then n is

a) 9
b) 3

c) 8
d) 4

39. The sum of the series 1- (3/2) + (5/4) – (7/8) +…… is

a) 0
b) 2/9
c) 2/3
d) *e*

40. A group of 47 students received 27 medals in football, 26 medals in basket ball and 28 medals in cricket, out of which 8 students got medals in all the three events. Then the number of students who received medals in exactly two of the events is

a) 42
b) 34
c) 26
d) 18

End of questions