Indian Association of Physics Teachers

NATIONAL STANDARD EXAMINATION IN ASTRONOMY 2012-2013

Date of Examination 24th November 2012

Time 15.00 to 17.00 Hrs

Q. P. Code No. 4 FOUR | 3 THREE | 4 FOUR

INSTRUCTIONS TO CANDIDATES

1. In addition to this question paper, you are given a separate answer sheet.
2. On the answer sheet fill up all the entries carefully in the space provided, **ONLY IN BLOCK CAPITALS.**
   Incomplete / incorrect / carelessly filled information may disqualify your candidature.
3. On the answer sheet, use only **BLUE or BLACK BALL PEN** for making entries and marking answers.
4. The question paper contains 80 multiple-choice questions. Each question has 4 options, out of which only one is correct. Choose the correct answer and mark a **cross** in the corresponding box on the answer sheet as shown below :

Q.	a	b	c	d
22			X	

5. Any rough work should be done only on the sheet provided at the end of question paper.
6. A correct answer carries 3 marks and 1 mark will be deducted for each wrong answer.
7. Use of nonprogrammable calculator is allowed.
8. No candidate should leave the examination hall before the completion of the examination.
9. The answers / solutions to this question paper will be available on our website - **www.iapt.org.in** by 3 rd December 2012.
10. Result sheets and the "centre top 10%" certificates of NSEA are dispatched to the Professor in charge of the centre. Thus you will get your marks from the Professor in charge of your centre by January 2013 end.
11. TOP 300 (or so) students are called for the next examination-Indian National Astronomy Olympiads (INAO). Individual letters are sent to these students ONLY.
12. No querries will be entertained in this regard.

PLEASE DO NOT MAKE ANY MARK OTHER THAN (X) IN THE SPACE PROVIDED ON THE ANSWER SHEET.

Answer sheets are evaluated with the help of a machine. Due to this, **CHANGE OF ENTRY IS NOT ALLOWED.**

Scratching or overwriting may result in wrong score.

DO NOT WRITE ANYTHING ON BACK SIDE OF ANSWER SHEET.

CERTIFICATES & AWARDS

Following certificates are awarded by the I.A.P.T. to students successful in NSEA.

i) Certificate for "Centre Top 10%" students.

ii) Merit certificates to statewise Top 1% students.

iii) Merit certificate and a prize in the form of a book to Nationwise Top 1% students.

TO TAKE THIS EXAMINATION YOU HAVE TO BE BORN ON OR AFTER JANUARY 1, 1994

1) A particle having initial velocity of $10ms^{-1}$ travels in a straight line. It experiences a retardation of $2ms^{-2}$. The distance traveled by the particle after 8s is

a) 16m b) 8m c) 34m d) 32m

2) A spring has an unstretched length l and has force constant k, It is cut into two pieces of force contacts k_1 and k_2 such that the length of first piece l_1 is n times the length of second piece $l_2 (n > 1)$

a) $k_1 = nk_2$ b) $k_2 = nk_1$ (c) $k_2 = (n+1)k$ d) $k_1 l_1 = k_2 l_2 = kl$

3) A wire of length L_0 is supplied heat to raise its temperature by T. If γ is the coefficient of volume expansion of the wire and Y is the Young's modulus of the wire then the energy density stored in the wire is

a) $\frac{1}{2}\gamma^2 T^2 Y$ (b) $\frac{1}{3}\gamma^2 T^2 Y$ (c) $\frac{1}{18}\frac{\gamma^2 T^2}{Y}$ (d) $\frac{1}{18}\gamma^2 T^2 Y$

4) $\int \left(1+\frac{1}{x}\right)\left(1+\frac{1}{x+1}\right)\left(1+\frac{1}{x+2}\right)\left(1+\frac{1}{x+3}\right) - - - - - - \left(1+\frac{1}{x+n}\right) dx =$

a) $log e^x x^{n+1} + C$ b) $log(x+n)^{n+1} + C$

c) $1 + (n+1) log x + C$ d) $x + (n+1)\log(x+n) + C$

5) In a grocery shop, there is a stock of 440kg of rice and 605 kg of dhal. They are to be packed in bags separately containing same quantity (weights) of rice or dhal. The minimum number of bags required to pack is

a) 19 b) 24 c) 22 d) 18

6) If all nuclear reactions in the sun now were to suddenly stop for ever, then

a) Distances between planets and sun would decrease.
b) Angular momentum of planets would increase.
c) Inner planets will be engulfed by the sun.
d) Speed of rotation of the sun would increase

7) If 6 points out of 12 in a plane are in the same straight line then the number of triangles formed by joining these points is

a) 185 b) 200 c) 205 d) 180

8) The second person to put his feet on the moon is

a) Neil Armstrong b) Edwin Aldrin c) Michael Collins d) Lyndon Johnson

9) The number of divisors of 58212 (excluding 1 and the number itself) is

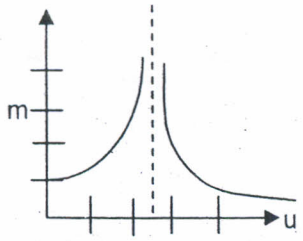
a) 70 b)72 c)74 d) 84

10) Distance of the moon from the earth is about

a) 1.3 light year b) 3.8 light minute c) 1.3 light second d) 4.6 light minute

11) The variation of the magnitude of the magnification *m* with respect to the distance of a linear object placed perpendicular to the axis of a Convex lens is best represented by the diagram

a)



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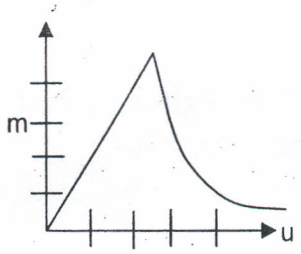

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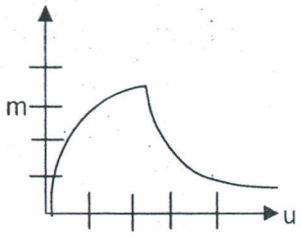

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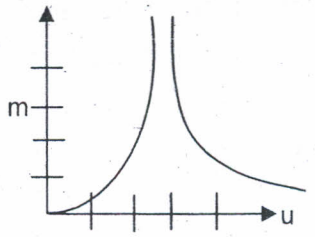


12) If x, 2x+2, 3x+3--------- are in geometric progression then the fifth term is

a) -9 b) $-\frac{27}{2}$ c) $-\frac{81}{4}$ d) $-\frac{36}{5}$

13) The areal velocity of the earth in the orbit around the sun is about (one astronomical unit is $1.5X10^{11}m$).

a) $2.8X10^{11}m^2s^{-1}$ b) $2.2X10^{15}m^2s^{-1}$ c) $1.1X10^{18}m^2s^{-1}$ d)$2.8X10^{13}m^2s^{-1}$

14) Two stars A and B are assigned apparent magnitude of +3.5 and -1.5 respectively. If observed from the earth,

a) Star A is 5 times brighter than B b) Star B is 5 times brighter than A

c) Star A is 2^5 times brighter than B d) Star B is 100 times brighter than B

15) The number of vectors of unit length perpendicular to $\vec{a} = (1,1,0)$ and $\vec{b} = (1,1,1)$ is

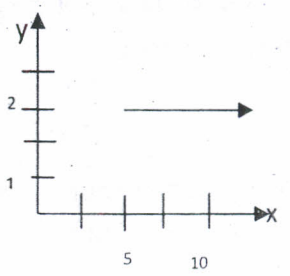
a) None b) 0 c) two d) Infinite

16) A particle of mass *m* is moving with a uniform velocity *v* along the line *y*=2 in the x-y plane. The angular momentum of the particle about the origin

a) Is zero b) steadily increases from its initial value of 2*mv*

c) steadily increases from its initial value of $\sqrt{29}mv$

d) remains constant equal to 2mv throughout its motion



17) Three well known stars (a) Sirius (b) Betelgeuse and (c)Pole star are in respectively in the constellation

a) Orion, Sagittarius and Scorpios b) Orion, Taurus and Ursa major c) Canis major, Orion and Ursa minor d) Scorpios, Canes minor and Leo

18) If (1-tanx)(1+sin2x)=1+tanx, then

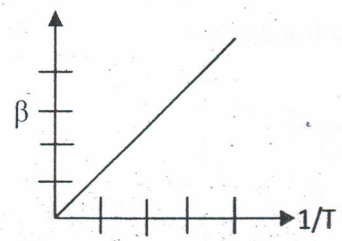
a) $x = n\frac{\pi}{4}, \frac{\pi}{4}$ b) $x = n\pi - \frac{\pi}{4}, n\pi$ c) $x = n\pi + \frac{\pi}{4}, \frac{\pi}{4}$ d) $x = 2n\pi + \frac{\pi}{4}, 2n\pi$

19) If a five digit number 4368x is divisible by 11, then x is

a) 1 b) 2 c) 3 d) 5

20) An ideal gas is at an initial temperature T and pressure P. If the pressure changes from P to P+dP when the temperature changes to T +dT at constant volume, the value of the pressure coefficient $\beta = \frac{1}{P}\frac{dP}{dT}$ varies with T as shown in the graph,

a)



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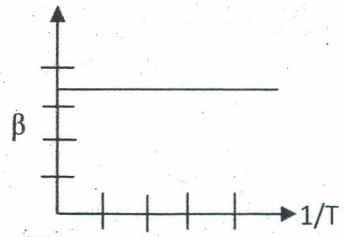

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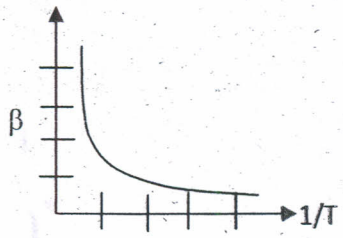

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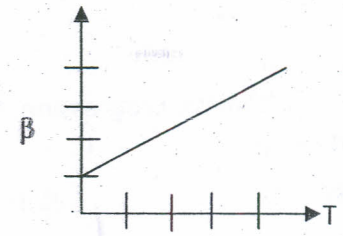


21) The number of ways of arranging 8 men and 8 women around a table so that men and women sit alternatively is

a) $(8!)^2$ b) $(7!)^2$ c) (7!)(8!) d) 8!

22) The wave length of H_α line from hydrogen discharge tube in a laboratory is 656 nm. The corresponding radiation received from two galaxies A and B have wavelengths of 648nm and 688nm respectively. Then

a) A is approaching the earth with a speed of $2.4X10^4$ kms^{-1}
b) B is approaching the earth with a speed of $1X10^4$ kms^{-1}
c) A is receding from the earth with a speed of $3.6X10^4$ kms^{-1}
d) B is receding the earth with a speed of $1.5X10^4$ kms^{-1}

23) On a full moon day spring tides (maximum rise of sea level) are observed at two places Chennai (P) and New York (Q) then the height of the sea level attains a

a) maximum at P and minimum at Q
b) minimum at Q and maximum at P
c) minimum at both Q and P
d) maximum at both Q and P

24) One liter of water of density 1gcm^{-3} is mixed with certain amount of milk of density 1.05gcm^{-3}. If the mass of the mixture is 5.0Kg, the volume of pure milk is

a) 3.5 liter b)3.8 liter c)3.0 liter d) 3.2 liter

25) The center of the circle passing through (0,0) and (4,0) and touching $x^2+y^2=16$

a) (2,0) b) (0,2) c) (2,2) d) (2,4)

26) When $n!$ written in decimal system ends with exactly four zeroes, then the maximum value of n is

a) 20 b) 23 c) 24 d) 29

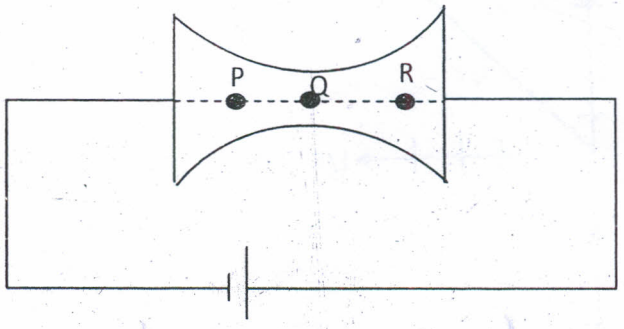
27) A conductor connected across the terminal of a cell of emf V is shown in the figure. I, J, v_d and μ represent the current, current density, drift velocity and mobility of the electron respectively then

a) $I_P = I_Q > I_R$

b) $J_Q > J_P > J_R$

c) $(v_d)_R < (v_d)_P < (v_d)_Q$

d) $\mu_p = \mu_Q > \mu_R$



28) If a,b and c are in arithmetic progression, then the roots of the equation $ax^2 + 2bx + c = 0$ are

a) real and equal b) rational c) real and may be irrational also d) imaginary.

29) A satellite moving in a circular orbit at a height of 200km above the surface of the earth. If it is raised to an orbit at a height of 800 km above the surface of the earth, the correct statement is

a) Kinetic energy increases

b) Potential energy increases

c) Total mechanical energy decreases

d) Angular velocity increases

30) The number of 4 digit numbers that are divisible by 6 which can be formed by using the digits 1,3,4,6 and 7, no digit being used more than once in any number is

a) 18 b) 24 c) 36 d) 60

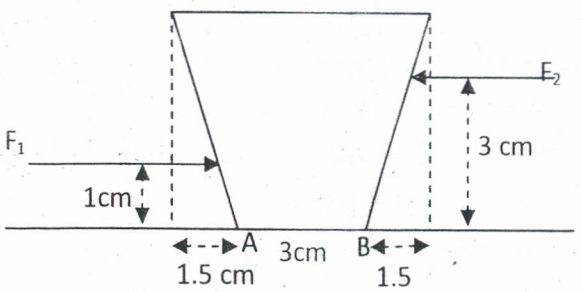
31) A solid of mass 6kg is kept on rough floor as shown in the figure. The coefficient of friction is 0.2. Indentify the correct statement. (Take g = 10 ms^{-2})

a) F_2=32N acting alone, can tilt the object

b) F_2=10N acting alone can translate the object

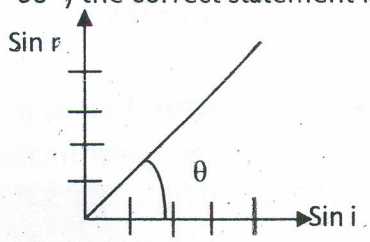
c) F_1=40N acting alone can tilt the object

d) F_1=40N and F_2=30N acting together can translate the object



32) A ray of light incident on the surface of a medium *X* at an angle i gets refracted into the other medium *Y* at an angle of refraction *r*. From the graph shown,($\theta = 60^0$) the correct statement is

a) Speed of light in X is $\sqrt{3}$ times greater than in Y
b) Speed of light in Y is $\sqrt{3}$ times greater than in X
c) Total internal reflection will take place.
d) Refractive index increases with angle of incidence.



33) If $x = 3 - 2i$, then $x^2 - 7x + 13 =$

a) 0 b) $2i - 3$ c) $3 + 2i$ d) $-3 - 2i$

34) The locus of the point (x,y) which moves such that $\sin^{-1} 2x + \sin^{-1} y = \frac{\pi}{2}$ is

a) a circle b) a hyperbola c) a straight line d) an ellipse

35) If $f(x) = (x+1)(x^2+2)(x^3+3)(x^4+4)(x^5+5)(x^6+6)$, then $f'(-1) =$

a) 720 b) 540 c) 840 d) 360

36) If $A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & -1 & -1 \\ 1 & 2 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$ then $A^{-1}B =$

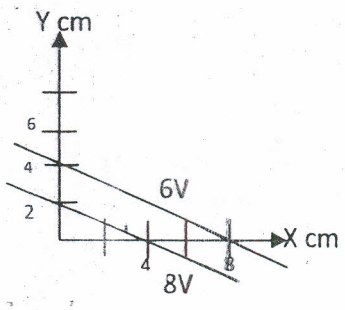
a) $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ b) $\begin{bmatrix} 1 \\ 2 \\ -3 \end{bmatrix}$ c) $\begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$ d) $\begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$

37) A polar satellite at a height of about 600km above the earth makes 15 revolutions per day. It crosses a place P on the equator of longitude 80^0E at 9 am, it is moving from north to south. The time at which it crosses a place Q on the equator at 8^0E is

a) 1.48 pm IST
b) 10:0 am local time at Q
c) 11:24 am IST
d) 10:36 local time at Q

38) Equipotential lines in a uniform electric field in the x-y plane at a certain place are shown in the diagram. Then

a) magnitude of the electric field is $\sqrt{2}X10^2 Vm^{-1}$
b) magnitude of the electric field is $500 Vm^{-1}$
c) electric field vector is $\vec{E} = (0.5\hat{\imath} + 1.0\hat{\jmath})Vm^{-1}$
d) electric field is along y axis



39) If $\log_4 5 = a$, $\log_5 6 = b$, *then* $\log_3 2 =$

a) $\frac{1}{2ab-1}$ b) $\frac{1}{2b+a}$ c) $2ab - 1$ d) $\frac{1}{2ab+1}$

40) A block is projected up a frictionless inclined plane with an initial speed of $v_0 = 3.5ms^{-1}$ Angle of incline is 30^0. Time taken by the block to go up the maximum distance on the inclined plane is

a) 1.25s b) 0.355 s c) 3.5s d) 2.8

41) A 70 kg box is dragged across floor by pulling on a rope attached to box inclined at 15^0 above horizontal. If coefficient of kinetic friction is 0.35, magnitude of initial acceleration is (take tension along the rope to be 300 N)

a) $0.64\ ms^{-2}$ b) $1.1\ ms^{-2}$ c) $9.8\ ms^{-2}$ d) 0

42) A solid sphere of radius 60cm is melted and recast into a solid cylinder of height 7.2m. The diameter of this cylinder in cm is

a) 20 b) 40 c) 15 d) 80

43) If Q is the image of the point P (2,-3) in the line 3x-4y+2=0, then the length of PQ=

a) 8 units b) 4 units c) 12 units d) $4\sqrt{3}$ units

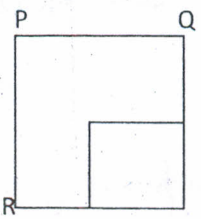
44) Four particles are moving with the velocities (i) $\boldsymbol{v=4i+3j}$ (ii) $\boldsymbol{v=-3i+4j}$ (iii) $\boldsymbol{v=5i}$ (iv) 5m/s at 30^0 with horizontal respectively. Then the particle with highest kinetic energy is

a) particle 1 b)particle 2 c) particle 3 d) all have same kinetic energy

45) A football player kicks a ball of mass 0.45kg initially at rest with a force $(6x10^6t-2x10^9t^2)$ N for $0 \le t \le 3x10^{-3}$s average force on the ball is

a) 9N b) $4.5x10^3$N c) $3x10^3$N d) 20 N

46) For a square uniform metal plate 25% of it was cut. Rotational inertia of the plate through perpendicular axis about the three points shown in figure is



a) equal at point *P,Q and R* b) equal at point *P and R*
c) equal at point *R and Q* d) equal at point P and Q

47) Which one of the following triplets CANNOT be the angles made by a line in space with the three coordinate axes?

a) $\left(\frac{\pi}{4}, \frac{3\pi}{4}, \frac{\pi}{2}\right)$ b) $\left(\frac{\pi}{4}, \frac{\pi}{3}, \frac{2\pi}{3}\right)$ c) $\left(\frac{\pi}{3}, \frac{3\pi}{4}, \frac{\pi}{3}\right)$ d) $\left(\frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{4}\right)$

48) In a small village with a population of 2000 people, 950 take coffee, 825 take tea and 225 take both coffee and tea. The number of persons who take neither coffee nor tea is

a) 350 b) 450 c) 550 d) 650

49) The range of the function $f(x) = {}^{8-x}C_{x-3}$ is

a) {3,4,5} b) {1,2,3,4} c) {1,3,4} d) {2,3,4}

50) Mean diameter of Mars and Earth are 6900 km and 13000km respectively. Mass of Mars is 0.11 times earth mass. Then the ratio of the mean density of Mars to that of earth is

a) 0.53 b) 0.74 c) 1 d) 0.81

51) The equation $y^2 = 4a(x + a)$ represents different parabolas for different values of a. All these parabolas have same

a) Vertex and focus b) focus and directrix

c) axis and vertex d) focus and axis

52) A loud speaker produces a musical sound by means of oscillations of a diaphragm whose amplitude is limited to 1.0 micrometer. The frequency at which magnitude of acceleration of diaphragm becomes equal to acceleration due to gravity is

a) 3127 Hz b) 399 hz c) 498 Hz d) 271 Hz

53) A system is taken from initial state (i) to final state (f) along two paths. For path one heat supplied Q = 50 J and W = 20 J what is the work along path two if Q = 36J.

a) 36J b) 30 J c) 6 J d) 70 J

54) A particle of charge 1C and another particle of charge 4C are held at separation of 9 cm on X- axis. Position of third particle of charge - 0.44C to be located on the same line if all three particles have to remain in same place is

a) 6cm from first particle b) 3cm from first particle c) 3cm from second particle

d) any position between the two particles

55) A 100 pF capacitor is charged to potential difference of 50 V and battery is disconnected. Now the capacitor is connected to an uncharged capacitor. If potential difference of first capacitor drops to 35 V, capacitance of second capacitor is

a) 50 pF b) 35 pF c) 40 pF d) 43 pF

56) The function $f(x) = (x - 3) + |x + 4|$ is differentiable

a) Every where b) Every where except at x=-4

c) Every where except at x=3 and x=-4 d) at x=3 and x=-4 only

57) If $\cos 40^0 - \sin 40^0 = b$, then $\cos 80^0 =$

a) $b\sqrt{2 - b^2}$ b) $b\sqrt{2 + b^2}$ c) $b + \sqrt{2 - b^2}$ d) $b^2\sqrt{2 - b}$

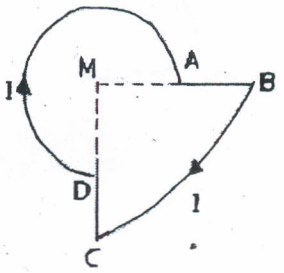
58) A current I is flowing through the loop. The direction of the current and the shape of the loop are as shown in the figure. The magnetic field at the centre of the loop is— times. (MA=R, MB=2R, angle DMA:90°)

a) —, but out of the plane of the paper.

b) —, but into the plane of the paper.

c) —, but out of the plane of the paper.

d) —, but into the plane of the paper.



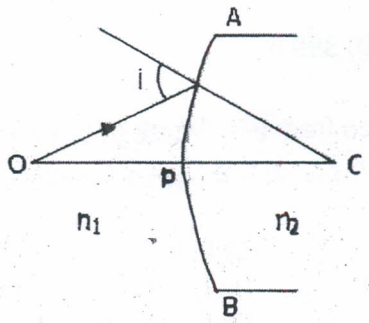
59) A point object O is kept at a distance of $OP = u$. The radius of curvature of the spherical surface APB is $CP = R$. The refractive indices of the two medium are n_1 and n_2 which are as shown in the diagram. Then,

1) if $n_1 > n_2$, image is virtual for all values of u.
2) if $n_2 = 2n_1$, image is virtual when $R > u$.
3) the image is real for all values of u, n_1 and n_2.

Here, the correct statement/s is/are.

a) only 1 b) 1, 2 and 3

c) only 2 d) both 1 and 2



60) –

a) e b) √e c) e^2 d) 2e

61) If and then

a) b) c) d)

62) The solution of the differential equation — with is

a) — b) ——

c) — d) ——

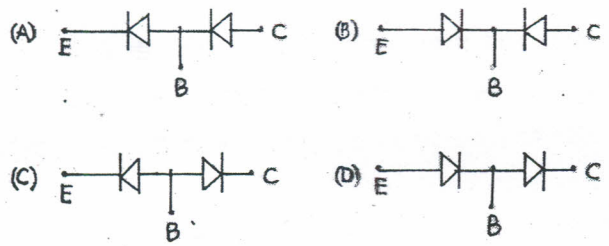
63) A variable capacitor in LC circuit has a range from 10 to 365pF. Ratio of the maximum frequency to minimum frequency is

a) 1.65 b) 6.0 c) √5 d)1.8

64) The kinetic energy of electron at which its de Broglie wavelength becomes equal to 590 nm is.

a) 4.33eV b) 33.5eV c) 4.33 eV d)4.36μeV

65) An n-p-n transistor can be considered to be equivalent to two diodes, connected. Which of the following figures is the correct one?



66) Aldebaron the brightest star in the constellation Taurus rises at local time 7:00 pm on 1st of October. On November 1st the star will rise at

a) 5:00 pm b) 6:00 pm c) 9:00 pm d) 8:34 pm

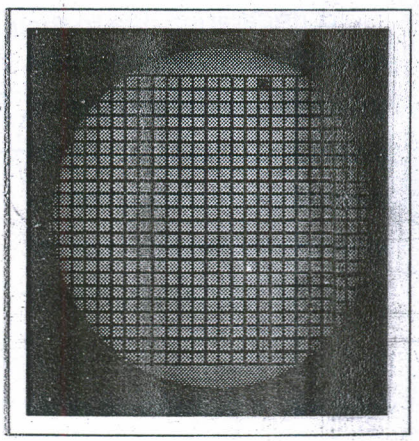
67) When astronaut observes Earth from moon he will see

a) Earth rising in the west and setting in the east.
b) Earth neither setting nor rising but stays at one position through out.
c) Earth rising in the east and setting in the west.
d) Earth will have a complex motion, sometime rising in the east and sometime in the west.

68) In neutron star the pressure (P) and volume (V) can be assumed to obey the relation . Where a is constant. Specific heat capacity (C) of a medium can be calculated using first law of thermodynamics. Assuming that medium behaves as mono atomic, the correct expression for C is

a) — b) - c) — d) —

69) The photograph of the Venus transit (seen as small dot) on June 6th 2012 is shown in the adjacent figure. Gridlines are drawn in front of the sun disc to measure the relative size of Venus with respect to Sun. If the mean distance to Earth and Venus from Sun are 1 AU and 0.72 AU respectively. An approximate value of the radius of Venus is (radius of sun is $6.9X10^8$m)



a) $12.8X10^6$ m b) $8.05X10^6$ m
c) $2.38\ X10^6$ m d) $18.98\ X10^6$ m

70) The value of depends on

a) a,b and c b) a and b and not on c
c) b and c and not on a d) none of a, b and c

71) The minimum value of $|cosec\ x\ secx|\ is$

a) 1 b) 3 c) 4 d) 2

72) Solar constant is the amount of solar radiation incident on earth per unit area per second. Its mean value is given by $1.38kWm^{-2}$. An important property of a star called Luminosity is defined as the amount of radiation emitted by star in one second. If the mean distance between earth and sun is $1.49X10^{11}$ km, the luminosity of sun is given by

a) $3.85X10^{26}$ W b) $4.85X10^{26}$ W c) $3.85X10^{25}$ W d) $6.56X10^{24}$ W

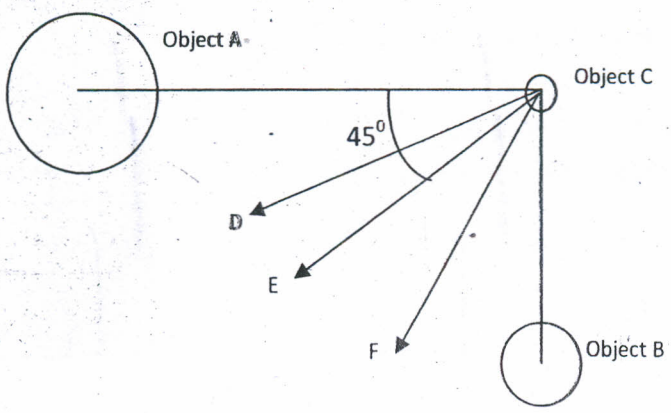
73) An acceleration vector

a) Tells us how fast an object is going.
b) Is constructed from two velocity vectors.
c) Points in the direction of motion.
d) Is parallel or opposite to the direction of motion.

74) Ram and his skate board have a combined mass of 50kg. Krishna and his skate board total to 100kg. Both of them are pushed with the same force. Ram is pushed for 2 seconds and Krishna for 1 second. After the pushes

a) Ram is moving twice as faster than Krishna.
b) Krishna is moving four times faster than Ram.
c) Both have the same speed.
d) Ram is moving four times faster than Krishna.

75) Object **A** has four times the mass of object **B.** The objects A and B are fixed in space and cannot move. The small object 'C' is located as shown in the figure at an instant of time t. Which arrow in the diagram best shows the direction in which 'C' would be accelerated by A and B at the instant under consideration due to their gravitational force?

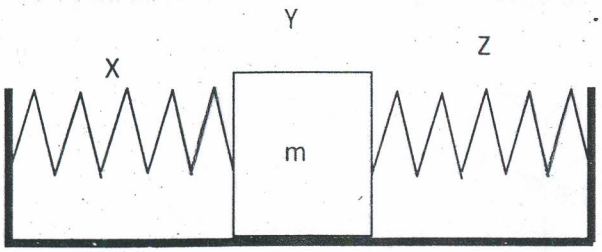


a) Arrow D
b) Arrow E
c) Arrow F
d) Arrow D, E, F, depending on whether A/or B are also free to move.

76) If the distance S travelled by a particle in time t is proportional to the square root of its velocity, then its acceleration is

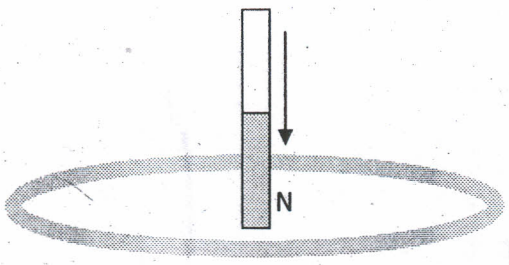
a) a constant b) proportional to S^3 c) b) proportional to S^2 d) proportional to $\frac{1}{S^3}$

77) A frictionless puck of mass m mounted between identical springs as shown, can slide back and forth on the level frictionless surface. The springs have negligible mass relative to the mass of the puck. The puck is displaced by hand from its equilibrium position at Y to position X , at which point it is released from rest. It is then oscillates back and forth between positions X and Z. choose the correct statement about the oscillatory motion.



a) The puck has its largest value of kinetic energy at position Z
b) The puck has its largest value of kinetic energy at position Y
c) The system has its largest potential energy when the puck is at position Y
d) The potential energy of the system when the puck at position Z is not same as the work that was done in displacing the puck from Y to X.

78) If the north pole of a magnet is thrust downward into a horizontally oriented copper ring as shown in the following figure. The ring will experience



a) A downward force
b) An upward force
c) Zero force
d) A clock wise torque as seen from above

79) Which of the following mathematical expressions would most conveniently describe the standing wave pressure variation in an open pipe with respect to x and t as independent variables.

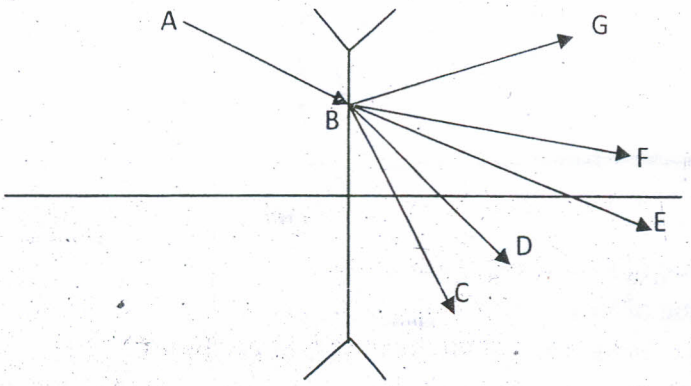
a) $\Delta P = \Delta P_m cos\left(\frac{2\pi x}{\lambda} + \omega t\right)$

b) $\Delta P = \Delta P_m sin\frac{2\pi x}{\lambda} sin\omega t$

c) $\Delta P = \Delta P_m cos\frac{2\pi x}{\lambda} sin\omega t$

d) $\Delta P = \Delta P_m sin\frac{2\pi x}{\lambda}$

80) A ray of light AB is incident on a diverging lens from left at point B on the lens. The emerging ray is best represented by



a) May be Ray BC or BF
b) May be Ray BF or BG
c) May be Ray BE or BD
d) May Ray BG or BC