INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN ASTRONOMY 2007 - 2008

Date of examination: 25th November 2007

SENIOR LEVEL

Time 15.00 to 17.00 Hrs.

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. This paper has two part. In part A1 (Q. Nos. 1 to 40) each question has **FOUR** alternatives, out of which only **one** is correct. Choose the correct alternative and mark a cross **(X)** in the corresponding box on the answer sheet.

For example,

Q.No.	a	b	c	d
22		X		

Part A2 (Q. Nos. 41 to 50) has four alternatives in each question, but any number of these (4, 3, 2, or 1) may be correct. You have to mark **ALL** correct alternatives and mark a cross **(X)** for each, like

Q.No.	a	b	c	d
42		X		X

5. Any rough work should be done only on the sheet provided at the end of question paper.
6. **For Part A1,** each correct answer gets 3 marks; wrong answer gets a penaltyof 1 mark. **For Part A2** full marks are 6 for each question, you get them when **ALL** correct answers only are marked.
7. Use of nonprogrammable calculator is allowed.
8. No candidate should leave the examination hall before the completion of the examination.
9. You are requested to collect a copy of solutions of this question paper from the professor in charge of the centre (at which you are appearing for this exam.) In the 1st week of January 2008.
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 2008 end.
11. TOP 250 (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.

YOU HAVE TO BE BORN BETWEEN JANUARY 1, 1991 AND DECEMBER 31, 1992

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN ASTRONOMY
SENIOR LEVEL
2007 – 2008

Total time: 120 minutes (A-1, A-2) **Marks: 180**

PART A – 1: ONLY ONE OUT OF FOUR OPTIONS IS CORRECT

1) The physical quantity 'electrical resistance' has the dimensions

(a) $[M^1 L^1 T^{-2} I^{-2}]$
(b) $[M^1 L^2 T^{-3} I^{-2}]$
(c) $[M^1 L^2 T^{-1} I^{-2}]$
(d) $[M^1 L^2 T^{-3} I^{-1}]$

2) As one goes from the surface of the earth to its centre, the acceleration due to gravity

(a) increases
(b) decreases and becomes zero at the centre
(c) remains constant
(d) first increases and then decreases

3) Starting from rest, a particle moves along a circle of radius $\sqrt{2}$ m with an angular acceleration of $(\pi / 4)$ rad s^{-2}. During the time the particle covers a quarter of the circle, the magnitude of average velocity is

(a) 1.50 m/s
(b) 2.00 m/s
(c) 1.00 m/s
(d) 1.25 m/s

4) The ratio of minimum kinetic energies of two projectiles of the same mass is 2 : 1. The ratio of maximum heights attained by them is 3 : 1. Then, the ratio of their ranges is

(a) 1/6
(b) $\sqrt{6}$
(c) $\sqrt{(2/3)}$
(d) $\sqrt{(3/2)}$

5) A ball X collides with an identical ball Y initially at rest. After collision the velocity of Y is observed to be twice that of X. Then, the coefficient of restitution is

(a) 1 / 2
(b) 1 / 4
(c) 1 / 5
(d) 1 / 3

6) A ball of mass 100 g thrown from a point A on the ground returns to a point B on the ground distance 30 m from A. The work done by gravity on the ball is

(a) 29.4 J
(b) 2.94 J
(c) 0.294 J
(d) zero

7) A vector $A = a_x\, i + a_y j + a_z\, k$ has zero magnitude. Then,

(a) $a_x + a_y = -a_z$
(b) $a_x + a_z = 0,\ a_y = 0$
(c) $a_x + a_y = 0,\ a_z = 0$
(d) $a_x = a_y = a_z = 0$

8) A body of mass 10 g moves with constant speed 2 m/s along a regular hexagon. The magnitude of change in momentum when the body crosses a corner is

(a) 0.04 kg-m/s
(b) zero
(c) 0.02 kg-m/s
(d) 0.4 kg-m/s

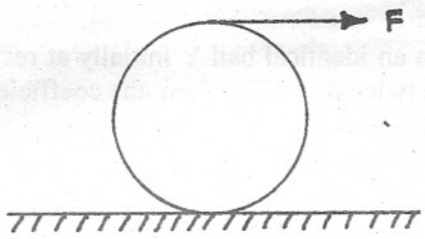
9) A particle executes simple harmonic motion. If the particle passes the mean position with speed v, its average speed is

(a) $v / 2$
(b) $2v / \pi$
(c) $\pi v / 2$
(d) v / π

10) A particle moves along a straight line with constant acceleration a. Let u be the speed at t = 0. The average speed for first t second is

(a) $u/2$
(b) $u + at$
(c) $u + at/2$
(d) $(u + at)/2$

11) A heavy roller is being pulled along a rough road, as shown in the figure. The frictional force at the point of contact is

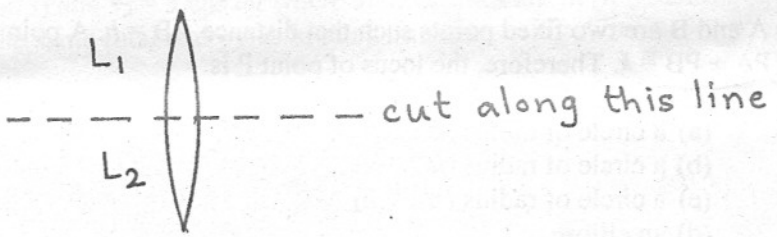


(a) parallel to F
(b) opposite to F
(c) perpendicular to F
(d) zero

12) A boy runs towards a convex mirror with a speed v. His image is seen to move towards the mirror at a speed v'. Then,

(a) $v < v'$
(b) $v > v'$
(c) $v = v'$
(d) nothing can be said as data are insufficient

13) A convex lens of focal length f is cut into two halves as shown. Light rays parallel to the principal axis are incident on one half of the lens (say L_1). This will form an image at



(a) f
(b) $f/2$
(c) $2f$
(d) $f/4$

14) A bouncing tennis ball rebounds each time to a height one half that of the previous one. If it is dropped from a height of 3 m, the total distance traveled by the ball before coming to rest will be

(a) 6 m
(b) 12 m
(c) 20 m
(d) 30 m

15) It is required to decide if 1107 is a prime number or not. The number of trials of division necessary is

(a) 10
(b) 11
(c) 12
(d) 235

16) Let $(x^2 - 15) / (2x - 8) = A$. If x is real, then

(a) $A \geq 3$
(b) $A \leq 5$
(c) $A \leq 3$ or $A \geq 5$
(d) $3 < A < 5$

17) Four gentlemen and four ladies are to sit at a round table so that no two gentlemen sit together. Then, the number of ways in which this can be done is

(a) $(4!)^2$
(b) $(4!)(3!)$
(c) $7!$
(d) $8!$

18) The adjacent sides of a parallelogram are 15 cm and 10 cm. If length of one diagonal of this parallelogram is 20 cm, the length of other diagonal will be

(a) 30 cm
(b) $5\sqrt{10}$ cm
(c) $10\sqrt{5}$ cm
(d) $4\sqrt{30}$ cm

19) A and B are two fixed points such that distance AB = h. A point P moves such that PA + PB = k. Therefore, the locus of point P is

(a) a circle of radius $(k/2)$
(b) a circle of radius $(h/2 + k)$
(c) a circle of radius $(k/2 + h)$
(d) an ellipse

20) The number of ways in which 1440 can be expressed as a product of two positive integers is

(a) 17
(b) 18
(c) 35
(d) 36

21) If $8 \sin\theta \cos^5\theta - 8 \sin^5\theta \cos\theta = \sqrt{3}$, then

(a) $\theta = [n\pi/4] + (-1)^n [\pi/24]$
(b) $\theta = [n\pi/4] + (-1)^n [\pi/12]$
(c) $\theta = [2n\pi \pm \pi/4]$
(d) $\theta = [n\pi + \pi/4]$

22) Consider the circles represented by $x^2 + y^2 = 16$ and $x^2 + y^2 - 24x - 10y + 88 = 0$. The number of common tangents to these two circles is

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

23) A weight is supported by two strings 1.3 m and 2.0 m long fastened to two points on a horizontal beam 2.0 m apart. The depth of this weight below the beam is

(a) 1.0 m
(b) 1.23 m
(c) 0.77 m
(d) 0.89 m

24) Let R and H be the horizontal range and the maximum height reached in case of a projectile. If a constant horizontal acceleration of $g/4$ is imparted to the projectile due to wind, then its range and the maximum height will be

(a) $(R + 2H)$, $2H$
(b) $(R + H/2)$, H
(c) $(R + H)$, H
(d) $(R + 2H)$, H

25) Two identical particles perform simple harmonic motions represented by equations $x_1 = 6 \sin (4t + \pi/3)$ and $x_2 = 5 \cos \omega t$ where all quantities are in SI units. If both the particles have the same total energy, ω in rad/s must be

(a) 4
(b) 24/5
(c) 16/5
(d) 12/5

26) A rubber balloon of negligible mass is filled with 500 g of water. Its weight in water will be

(a) 250 g
(b) 500 g
(c) zero
(d) 100 g

27) A gas at pressure p_o is enclosed in a container. If the masses of all particles were halved and their rms speed doubled, the pressure would be

(a) p_o
(b) $4\, p_o$
(c) $2\, p_o$
(d) $p_o / 2$

28) If T represents the absolute temperature of an ideal gas, the volume coefficient of thermal expansion at constant pressure, is

(a) T
(b) T^2
(c) $1/T$
(d) $1/T^2$

29) An aluminium measuring tape which is correct at 10° C measures the length of a line as 80 cm at 50°. If thermal coefficient of linear expansion of aluminium is 2.50×10^{-5} per $^\circ$C, the correct length of the line is

(a) 79.92 cm
(b) 79.68 cm
(c) 80.08 cm
(d) 80.32 cm

30) A ray of light passing through an equilateral triangular prism gets deviated at least by 30°. Then, the refractive index of the material of the prism must be

(a) $\leq \sqrt{2}$
(b) $\geq \sqrt{2}$
(c) $\leq \sqrt{3}$
(d) $\geq \sqrt{3}$

31) Critical angle for glass is θ_1 and that for water is θ_2. The critical angle θ at the water-glass interface is such that

(a) $\theta < (\theta_1 + \theta_2)/2$
(b) $\theta_1 < \theta < \theta_2$
(c) $\theta > \theta_2$
(d) $\theta < \theta_1$

32) An object is placed in front of a concave mirror of focal length f. An erect image is formed with a magnification of 2. To obtain real image with the same magnification, the object has to be moved through a distance of

(a) $f/2$
(b) f
(c) $3f/2$
(d) $2f/3$

33) A metallic sphere of radius a is charged to a potential V volt. The electric field at a distance r ($> a$) from the centre of the sphere is

(a) V/r
(b) a^2V/r^3
(c) aV/r^2
(d) V/a

34) The power of a pump that drives water through a horizontal pipe with speed v is proportional to

(a) v^3
(b) v^2
(c) v
(d) $v^{3/2}$

35) A charged particle enters a uniform magnetic field with its velocity vector at an angle of 45° with the magnetic field. Let the pitch of the helical path followed by the particle be p. Then, the radius of the helix will be

(a) $p / \sqrt{(2\pi)}$
(b) $p\sqrt{2}$
(c) $p / \pi\sqrt{2}$
(d) $p / 2\pi$

36) A pipe initially open at both ends is later closed at one of the ends. The ratio of the frequencies of respective n th overtones is

(a) $(n+1) / (2n+1)$
(b) $2(n+1) / (2n+1)$
(c) $n / (n+1)$
(d) $2n / (2n+1)$

37) The direction of electric field at a point on the equator of an electric dipole of moment p is

(a) parallel to p
(b) antiparallel to p
(c) perpendicular to p
(d) inclined at an angle of 45° to p

38) Similar to the earth, total solar eclipse can also be observed from

(a) Mercury
(b) Venus
(c) Jupiter
(d) Mars

39) Consider a total lunar eclipse being observed from the earth. At the same time, if we imagine an observer on the moon at a suitable location, he will observe

(a) total earth eclipse
(b) partial earth eclipse
(c) total solar eclipse
(d) partial solar eclipse

40) In case of the moon, the ratio of average distance from the earth to its diameter is a. The ratio of average distance of the sun from the earth to its diameter is close to

(a) a
(b) $0.03\,a$
(c) $15\,a$
(d) $377\,a$

PART A - 2

In question 41 to 50 any number of options (1 or 2 or 3 or all 4) may be correct. You are to identify all of them correctly to get 6 marks. Even if one answer identified is incorrect or one correct answer is missed, you get zero score.

41) If $\sqrt{x} = a + \sqrt{y}$, which of the following statements is / are possible?

(a) $x = y$ and $a = 0$
(b) $\sqrt{x}$ is irrational and $a \neq 0$
(c) $\sqrt{x}$, $\sqrt{y}$ are irrational and $x \neq y$
(d) $\sqrt{x}$, $\sqrt{y}$ are rational

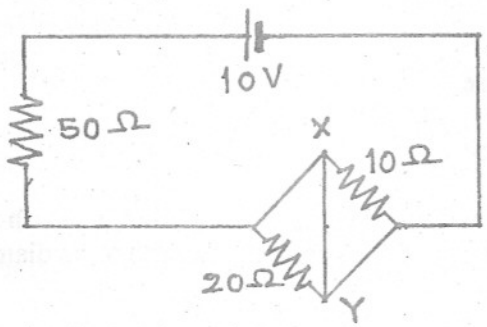
42) For any angle θ

(a) $\sin 3\theta = 3 \sin\theta - 4 \sin^3\theta$
(b) $\sin 3\theta = \cos^3\theta [3 \tan\theta - \tan^3\theta]$
(c) $\sin 3\theta = \sin^3\theta [3 \tan\theta - \tan^3\theta]$
(d) $\cos 3\theta = \cos^3\theta [1 - 3 \tan^2\theta]$

43) A current i reaching at a point X in a circuit gets branched and flows through two resistors R_1 and R_2. Then, the current through R_1 varies as

(a) R_1
(b) R_2
(c) $(R_1 + R_2)$
(d) $1/(R_1 + R_2)$

44) In the circuit shown below,



(a) current flowing in the circuit is 200 mA
(b) power supplied by the battery is 2 watt
(c) current from X to Y is zero
(d) potential difference across 10 Ω is equal to zero

45) The correct statement / statements in case of magnetic lines of induction is / are

(a) they originate from north pole and terminate on south pole
(b) their number per unit area is a measure of strength of magnetic field
(c) a tangent to a line of magnetic induction gives the direction of magnetic field
(d) they never cross each other

46) The quantity / quantities having the dimensions $[L^1 T^{-1}]$ is / are

(a) speed
(b) ratio of electric flux to magnetic flux
(c) ratio of electric field to magnetic field
(d) $1 / (\varepsilon \mu)^{1/2}$ where ε is permittivity and μ is permeability

47) A radioactive nucleus X transforms into a nucleus Y. Then, X and Y can be

(a) isotopes
(b) isotones
(c) isobars
(d) isotones but never isobars

48) Neutrinos are particles that

(a) can penetrate the entire earth
(b) exist everywhere in the universe
(c) can have energies in a very wide range such as 10^{-5} eV to 10^{25} eV
(d) are massless

49) The ancient Indian system assumes nine planets;

(a) one of these nine celestial bodies is a star.
(b) one of these nine celestial bodies is a satellite.
(c) some of these are NOT real bodies at all.
(d) one of these nine *planets* is Earth.

50) The spaceship launched on Mars in search of life on it was

(a) Viking
(b) Sputnik
(c) Mariner
(d) Voyager

-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-