INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN PHYSICS 2014-15

Date of Examination: 23rd November, 2014

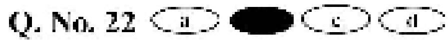
Time: 0930 to 1130 Hrs

Q. Paper Code: P 160

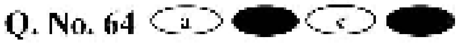
Write the question paper code mentioned above on YOUR answer sheet (in the space provided), otherwise your answer sheet will NOT be assessed. Note that the same Q. P. Code appears on each page of the question paper.

Instructions to Candidates –

1. Use of mobile phones, smartphones, ipads during examination is **STRICTLY PROHIBITED**.
2. In addition to this question paper, you are given answer sheet along with Candidate's copy.
3. On the answer sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/carelessly filled information may disqualify your candidature.
4. On the answer sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Question paper has two parts. In Part A1(Q. Nos 1 to 60) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

   In Part A2 (Q. Nos. 61 to 70) each question has four alternatives out of which **any number of alternatives** (1, 2, 3 or 4) may be correct. You have to choose ALL correct alternatives and fill the appropriate bubbles, as shown.

6. For **Part A1**, each correct answer gets 3 marks. A wrong one gets a penalty of 1 mark. **Part A2** full marks are 6 for each question, you get them when **ALL** correct answers are marked.
7. Any rough work should be done only in the space provided.
8. Use of **non-programmable** calculator is allowed.
9. No candidate should leave the examination hall before the completion of the examination.
10. After submitting your answerpaper, take away the Candidate's copy for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet.

Answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED.

Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE ANSWER SHEET.

Instructions to Candidates (continued)–

Read the following instructions after submitting the answer sheet.

11. **Comments regarding this question paper, if any, may be sent by email only to iaptpune@gmail.com till 25th November, 2014.**
12. **The answers/solutions to this question paper will be available on our website – www.iapt.org.in by 3rd December, 2014.**
13. **CERTIFICATES and AWARDS –**

    Following certificates are awarded by the IAPT to students successful in NSEs

    (i)Certificates to "Centre Top 10%" students

    (ii)Merit Certificates to "Statewise Top 1%" students

    (iii)Merit Certificates and a book prize to "National Top 1%" students
14. Result sheets and the "Centre Top 10%" certificates will be dispatched to the Prof-in-charge of the centre by January, 2015.
15. List of students (with centre number and roll number only) having score above MAS will be displayed on our website (**www.iapt.org.in**) by **22nd December, 2014.** See the **Eligibility Clause** in the Student's brochure on our website.
16. Students eligible for the INO Examination on the basis of selection criteria mentioned in Student's brochure will be informed accordingly.
17. Gold medals will be awarded to TOP 35 students in the entire process.

Q.P. Code -P 160

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN PHYSICS 2014-15

Total Time : 120 minutes (A-1 and A-2)

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT.

N. B. – Physical constants are given at the end.

1. If the threshold of hearing is assumed to be the reference (0 dB), then the threshold of pain is taken to be 120 dB. Let the corresponding sound intensities be I_0 and I respectively. Then, $\frac{I_0}{I}$ is
(a) 120 (b) 10^{12} (c) 10^{-12} (d) $10^{1.2}$

2. If E denotes the intensity of electric field, the dimensions of a quantity $\epsilon_0 \frac{dE}{dt}$ are those of
(a) current (b) current density (c) electric potential (d) electric flux

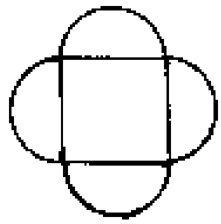
3. Two stars of masses m_1 and m_2 distance r apart revolve about their centre of mass. The period of revolution is
(a) $2\pi\sqrt{\frac{r^3}{2G(m_1+m_2)}}$ (b) $2\pi\sqrt{\frac{r^3(m_1+m_2)}{2G(m_1m_2)}}$ (c) $2\pi\sqrt{\frac{2r^3}{G(m_1+m_2)}}$ (d) $2\pi\sqrt{\frac{r^3}{G(m_1+m_2)}}$

4. Let a body be placed at a point on the earth's surface at a latitude λ where the radius of the earth is R. Then, the body experiences an effective acceleration
(a) $g - R\omega^2 cos\,\lambda$ (b) $g + R\omega^2 sin\,\lambda$ (c) $g - R\omega^2 cos^2\lambda$ (d) $g - \frac{R\omega^2}{cos^2\lambda}$

5. A particle moves in a plane with a constant speed along a path $y = 2x^2 + 3x - 4$. When the particle is at (0, – 4) the direction along which it is moving is inclined to the X axis at an angle
(a) 63^0 (b) 72^0 (c) 27^0 (d) 0^0

6. Two particles A and B are moving in XY plane. Particle A moves along a line with equation $y = x$ while B moves along X axis such that their X coordinates are always equal. If B moves with a uniform speed 3 m/s, the speed of A is
(a) 3 m/s (b) $\frac{1}{3}$ m/s (c) $3\sqrt{2}$ m/s (d) $\frac{3}{\sqrt{2}}$ m/s

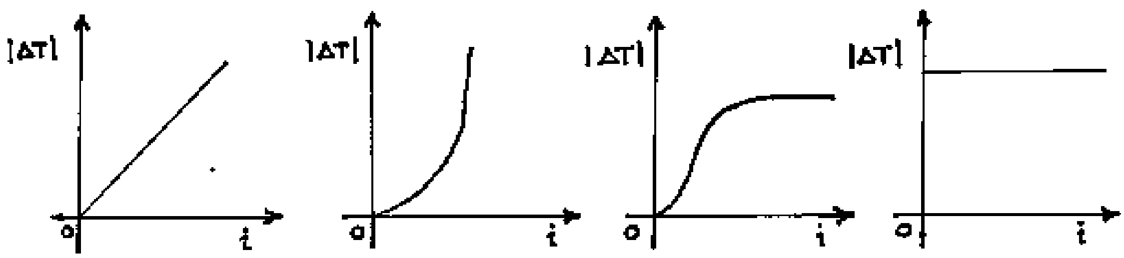
7. A uniform thin rod of length ($4a + 2\pi a$) and of mass ($4m + 2\pi m$) is bent and fabricated to form a square surrounded by semicircles as shown in the figure. The moment of inertia of this frame about an axis passing through its centre and perpendicular to its plane is



(a) $\frac{(4+2\pi)}{3}ma^2$ (b) $\frac{(4+\pi)}{2}ma^2$ (c) $\frac{(4+3\pi)}{3}ma^2$ (d) $\frac{(3+\pi)}{2}ma^2$

8. A ball is dropped onto a horizontal surface from a height of 36 cm. After bouncing several times it comes to rest covering a total distance of 100 cm measured in a vertical direction. The percentage loss in its kinetic energy after its first impact is
(a) 36 (b) 64 (c) 53 (d) 96

9. A simple pendulum has a small disc shaped magnet as the bob whose magnetic moment is along vertical. Just beneath the bob a current carrying coil is placed on a horizontal table. The coil produces a uniform magnetic field. The dependence of the change in time period $|\Delta T|$ on current i can be graphically shown as



(a) (b) (c) (d)

10. Two coupled simple pendulums have nearly the same period. One of them is excited while the other is at rest. Now energy keeps on transferring from one pendulum to the other alternately. This periodic transfer of energy continues almost indefinitely with a time period of 10 s. Then the difference of frequencies between the two pendulums is
(a) zero Hz (b) 0.1 Hz (c) 0.01 Hz (d) infinite

11. A large cylindrical vessel contains water to a height of 10 m. It is found that the thrust acting on the curved surface is equal to that at the bottom. If atmospheric pressure can support a water column of 10 m, the radius of the vessel is
(a) 10 m (b) 15m (c) 5 m (d) 25 m

12. A thin annular metal disc of inner and outer radii R_1 and R_2respectively, is freely suspended from a point on its outer circumference. The length of the corresponding equivalent simple pendulum is
(a) $\frac{R_1^2+R_2^2}{2R_2}$ (b) $\frac{R_1^2+3R_2^2}{2R_2}$ (c) $\frac{3R_1^2+R_2^2}{R_2}$ (d) $\frac{R_1^2+3R_2^2}{R_2}$

13. Two identical thin metal strips, one of aluminum and the other of iron are riveted together to form a bimetallic strip. The temperature is raised by 50^o C. If the central planes of the two strips are separated by 2 mm and the coefficients of thermal expansion for aluminum and iron are respectively 30×10^{-6} / ^{0}C and 10×10^{-6} / ^{0}C, the average radius of curvature of the bimetallic strip is about
(a) 50 cm (b) 100 cm (c) 150 cm (d) 200 cm

14. Standing waves are generated on a string loaded with a cylindrical body. If the cylinder is immersed in water, the length of the loops changes by a factor of 2.2. The specific gravity of the material of the cylinder is
(a) 1.11 (b) 2.15 (c) 2.50 (d) 1.26

15. A curved road with radius of curvature 200 m is banked with an angle of banking equal to $\tan^{-1}$ (0.2). Now, if the traffic is at double the speed for which the road is designed, the minimum value of the frictional coefficient needed is (g = 10 m/s^2)
(a) 0.52 (b) 0.35 (c) 0.94 (d) 0.80

16. A plastic pipe filled with iron wires forms a soft iron core. Two identical coils that can just slide over the pipe are placed on this soft iron core. Initially the pipe is kept horizontal and a current is passed through the coils connected in series. The fields are in opposition and the coils remain stationary with a separation of 5 cm. The system is now made vertical and the separation between the coils reduces to 4 cm. Then the coefficient of friction between the coils and the pipe is
(a) 0.41 (b) 0.02 (c) 0.5 (d) 0.3

17. A long straight wire carries a charge with linear density λ. A particle of mass m and a charge q is released at a distance r from the wire. The speed of the particle as it crosses a point distance $2r$ is
(a) $\sqrt{\frac{q\lambda \ln r}{\pi m \epsilon_o}}$ (b) $\sqrt{\frac{q\lambda \ln 2}{\pi m \epsilon_o}}$ (c) $\sqrt{\frac{q\lambda \ln 2}{2\pi m \epsilon_o}}$ (d) $\sqrt{\frac{2q\lambda \ln r}{\pi m \epsilon_o}}$

18. A uniform meter scale is supported from its 20 cm mark. A body suspended from 10 cm mark keeps the scale horizontal. However, the scale gets unbalanced if the body is completely immersed in water. To regain the balance the body is shifted to the 8 cm mark. Therefore, the specific gravity of the material of the body is
(a) 5 (b) 6 (c) 7 (d) 4

19. Temperature of 100 g of water in a thermoflask remains fixed for a pretty long time at 50°C. An equal mass of sand at 20°C is poured in the flask and shaken for some time so that the temperature of the mixture is 40°C. Now the experiment is repeated with 100 g of a liquid at 50°C and an equal amount of sand at 20°C when the temperature of the mixture is found to be 30°C. The specific heat of the liquid (in kJ $kg^{-1}K^{-1}$) is
(a) 1.05 (b) 2.01 (c) 1.55 (d) 1.95

20. Let v_{avg}, v_p and v_{rms} be respectively the average, the most probable and the root mean square speeds of gas molecules according to Maxwell's distribution. Then,
(a) $v_{avg}<v_p<v_{rms}$ (b) $v_p<v_{rms}<v_{avg}$ (c) $v_{rms}<v_p<v_{avg}$ (d) $v_p<v_{avg}<v_{rms}$

21. A coal-based thermal power plant producing electricity operates between the temperatures 27°C and 227°C. The plant works at 80% of its maximum theoretical efficiency. Complete burning of 1 kg of coal yields 36000 kJ of heat. A house needs 10 units of electricity each day. Coal used for supplying the amount of energy for the house in one year is
(a) 1141 kg (b) 580 kg (c) 605 kg (d) 765 kg

22. A copper-constantan thermocouple has thermoelectric power 40 μV/°C. One junction is at 0°C while the other is at 50°C. The thermocouple is connected to a 30-0-30 galvanometer to produce a full scale deflection. If a 100 ohm resistance is connected in series with the galvanometer, the galvanometer gives a deflection of 10 divisions. The figure of merit of the galvanometer is
(a) 1.3 μA/div (b) 2.0 μA/div (c) 2.3 μA/div (d) 4.0 μA/div

23. A fresh dry cell of 1.5 volt and two resistors of 10 kΩ each are connected in series. An analog voltmeter measures a voltage of 0.5 volt across each of the resistors. A 1000 μF capacitor is fully charged using the same source. the same voltmeter is now used to measure the voltage across it. The initial value of the current and the time in which the voltmeter reading falls to 0.5 volt are respectively
(a) 60 μA, 11 s (b) 120 μA, 15 s (c) 150 μA, 15 s (d) 150 μA, 11 s

24. A charge of + 2 μC is situated off-centre of a hollow spherical metallic shell. Then,
(a) – 2μC charge gets uniformly distributed on the inner surface of the shell.
(b) + 2μC charge gets non-uniformly distributed on the outer surface of the shell.
(c) – 2μC charge gets non-uniformly distributed on the inner surface of the shell.
(d) no charge appears on the outer surface of the shell.

25. Two simple pendulums with heavy bobs – one using iron wire and the other aluminium wire are excited simultaneously. It is found that when the first pendulum completes 1000 oscillations the other completes 1001. When the temperature is raised by t^{o}C, it is found that the two pendulums now oscillate together. If the coefficients of thermal expansion of iron and aluminium are 10×10^{-6} /^{o}C and 30×10^{-6} /^{o}C, the value of $t$is
(a) 77.2^{o}C (b) 123.2^{o}C (c) 100.1^{o}C (d) 105.2^{o}C

26. Consider a body moving through air at a speed greater than that of sound. Out of the following terms that one which is NOT connected with this event is
(a) sonic boom (b) ultrasonic (c) Mach number (d) conical wavefront

27. A short bar magnet is placed along N-S direction with N pole pointing north. The neutral points are located 20 cm away from the bar magnet. If $B_H$is the horizontal component of earth's magnetic field, then the magnetic field due to the bar magnet at a distance of 40 cm along its axis is

(a) $\frac{B_H}{2}$ (b) $\frac{B_H}{4}$ (c) $\frac{B_H}{8}$ (d) $\frac{B_H}{16}$

28. A plane mirror coincides with a plane having equation $x = 3$. A particle is moving along a line with direction ratios 3,4,5. If speed of the particle is $\sqrt{2}$, the velocity of its image is

(a) $\frac{3}{5}\hat{\imath} + \frac{4}{5}\hat{\jmath} + \frac{1}{5}\hat{k}$ (b) $-\frac{3}{5}\hat{\imath} - \frac{4}{5}\hat{\jmath} - \hat{k}$ (c) $\frac{3}{5}\hat{\imath} + \frac{4}{5}\hat{\jmath} - \frac{1}{5}\hat{k}$ (d) $-\frac{3}{5}\hat{\imath} + \frac{4}{5}\hat{\jmath} + \hat{k}$

29. An unpolarized light is travelling along Z axis through three polarizing sheets. The polarizing directions of the first and the third sheet are respectively parallel to X axis and Y axis whereas that of the second one is at 60^{o}to the Y axis. Then, the fraction of the initial light intensity that emerges from the system is about
(a) zero (b) 0.093 (c) 0.031 (d) 0.28

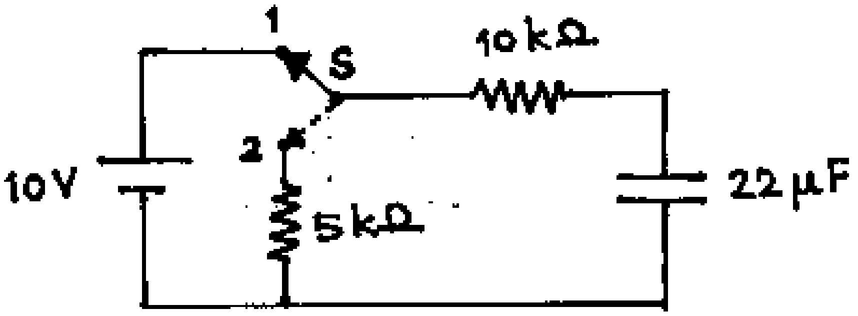
30. One face of a glass (μ = 1.50) lens is coated with a thin film of magnesium fluoride MgF_2 (μ = 1.38) to reduce reflection from the lens surface. Assuming the incident light to be perpendicular to the lens surface, the least coating thickness that eliminates the reflection at the centre of the visible spectrum (λ = 550 nm) is about
(a) 0.05 µm (b) 0.10 µm (c) 1.38 µm (d) 2.80 µm

31. Consider the analogy between an oscillating spring-body system and an oscillating LCR circuit. Then, the correspondence between the two systems that is NOT correct is
(a) charge$q$ corresponds to displacement x of the body.
(b) inductance$L$ corresponds to mass m of the body.
(c) capacitance$C$ corresponds to spring constant k .
(d) magnetic energy corresponds to kinetic energy of the body.

32. A 50 Hz ac source is connected to a capacitor C in series with a resistance 1 kΩ. The rms voltages measured across them are 5 volt and 2 volt respectively. Assume the capacitor to be ideal. The peak value of the source voltage and the capacitance are respectively

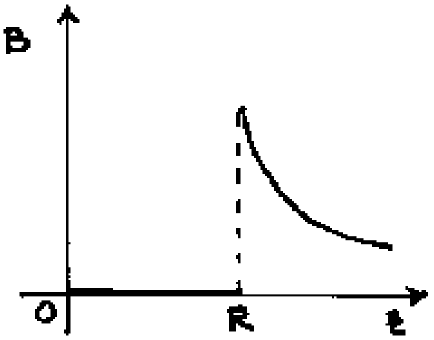
(a) 7 V, 1.27 μF (b) 5.3 V, 2.3 μF (c) 7.62 V, 1.27 μF (d) 3 V, 2.3 μF

33. Refer to the circuit given below. Initially the switch S is in position 1 for 1.5 s. Then the switch is changed to position 2. After a time *t* (measured from the change-over of the switch) the voltage across 5 kΩ resistance is found to be about 1.226 volt. Then, *t* is

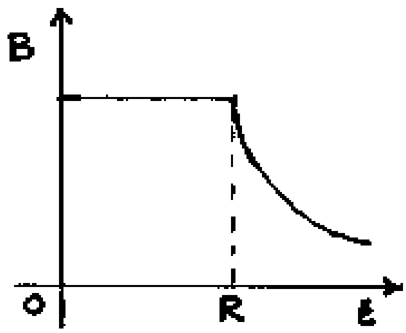


(a) 330 ms (b) 500 ms (c) 33 ms (d) data insufficient

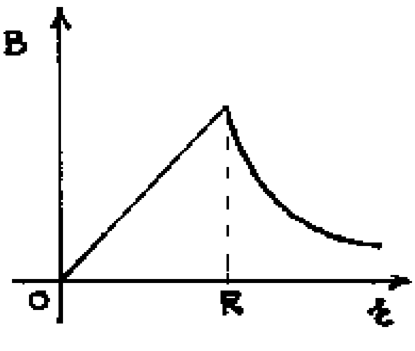
34. A long straight wire of radius *R* carries a uniformly distributed current *i*. The variation of magnetic field *B* from the axis of the wire is correctly represented by the graph

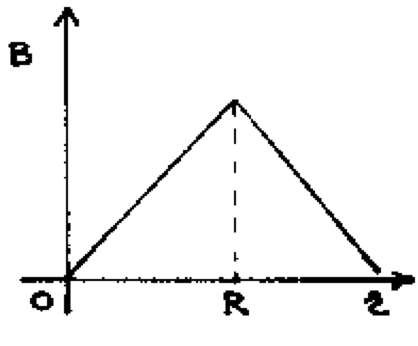


(a)



(b)

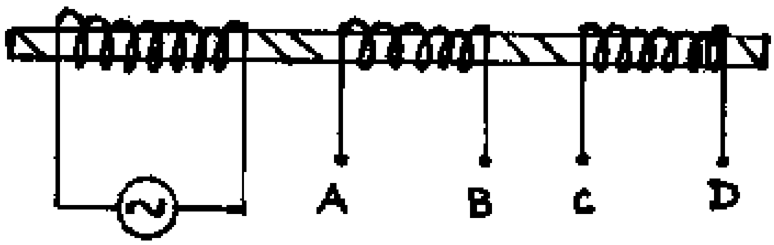




(c) (d)

35. Two copper coils A and B are wound over a plastic pipe. Coil A is connected to a sinusoidal voltage source of frequency 50 Hz so that a current of 100 mA passes through it. The voltage across coil B is 5 volt. Now if coil B is short circuited, there is a change of current of 2 mA in coil A. Then, the mutual inductance between the two coils and the percentage change in the impedance of coil A are respectively
(a) 160 mH, 2% (b) 16 mH, 0% (c) 1.6 mH, 2% (d) 0.16 mH, 0%

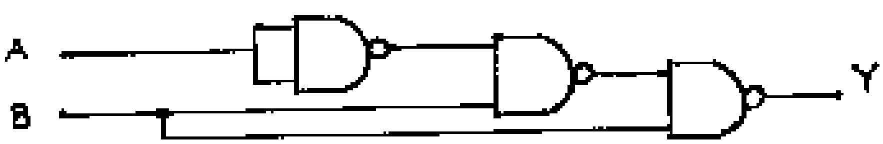
36. A coil is wound on an iron rod and connected to an ac source as shown in the figure. Two more coils AB and CD are also wound on the same rod. If ends B and C are joined, a filament bulb connected between ends A and D glows well. However, if B and D are joined and the bulb is connected between A and C, it glows feebly. This shows that



(a) coils AB and CD are in series in the first case while they are in parallel in the second case.
(b) in the second case the two coils are in phase addition and they have unequal number of turns.
(c) in the second case the two coils are in phase opposition and they have equal number of turns.
(d) in the second case the two coils are in phase opposition and they have unequal number of turns.

37. The age of an organic material is usually determined by measuring its ^{14}C content (carbon dating). The ratio of the number of stable isotope of ^{14}C atoms present to the number of radioactive ^{14}C atoms in a certain material is found to be 3:1. If the half life of ^{14}C atoms is 5730 years, the age of the material under investigation is
(a) 7944 years (b) 17190 years (c) 11460 years (d) 13972 years

38. The arrangement of NAND gates shown below effectively works as

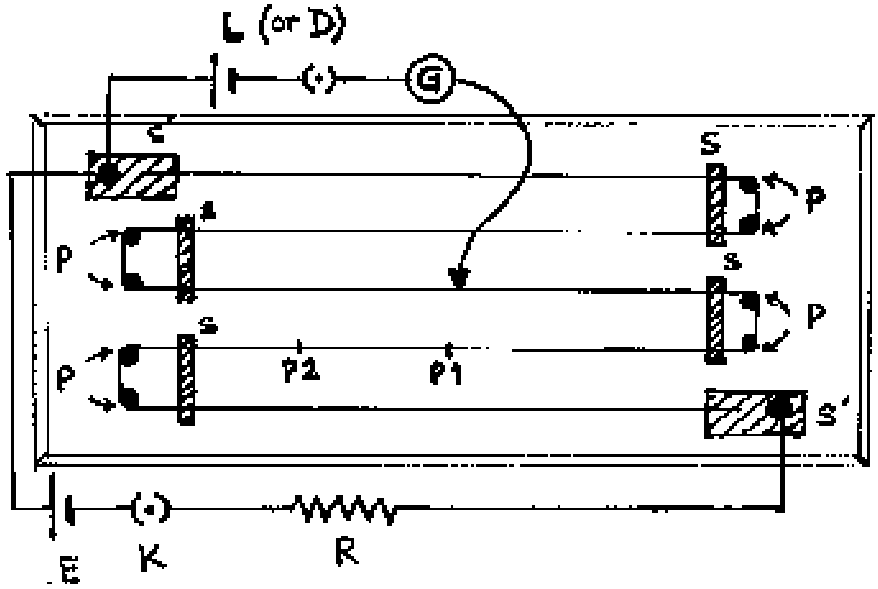


(a) AND gate (b) OR gate (c) NAND gate (d) NOR gate

39. A beam of 28 keV electrons strikes a target generating X rays. The minimum wave length λ_{min} (called cutoff wavelength) of the X rays generated is
(a) 4.4 nm (b) 44 nm (c) 0.044 nm (d) 0.44 nm

Group of Q. Nos. 40 to 47 are based on the following paragraph.

A potentiometer is made using a resistance wire about 5 m long and having a resistance of 8 Ω/m. The diagram shows the arrangement on a wooden board. The wire is turned round brass screws (P) used as pegs giving 5 parallel segments 1.0 m each. The wire remains taut under moderate tension. It is held in place by strips 3 mm thick marked as S and S'. The experimental circuit shows the labeled electrical components. L is Leclanche cell (emfe_1 = 1.40 volt) and D is Daniel cell (emfe_2 = 1.08 volt). ***Note that answers obtained in any earlier question/s may be needed in further questions and such answers should be used wherever needed.***



40. It is required to decide the ratio (e_1 / e_2) by sum and difference method ALSO. Four cells with different values of emfs$E$ are available. One must use a cell with emf$E$ equal to
(a) 1.40 volt (b) 2.0 volt (c) 4.50 volt (d) 1.08 volt

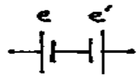
41. The best material for strips marked S and S' is
(a) plastic (b) aluminium (c) cast iron (d) plated brass

42. Assuming that due to stretching of wire while preparing the potentiometer, its resistance has increased by 2% and a potential gradient of 0.6 mV/mm is needed, then R must be
(a) 13.5 ohm (b) 40.8 ohm (c) 20.4 ohm (d) 135 ohm

43. It is claimed that the strips S and S' serve two purposes – (I) to decide the end points of the wire, and (II) to keep the wire in its place. Then,
(a) both (I) and (II) are important.
(b) (I) is more important than (II).
(c) (II) is more important than (I).
(d) both are unimportant.

44. The length of wire between the adjoining pegs carries current
(a) equal to that in the potentiometer wire.
(b) equal to half the current in the potentiometer wire.
(c) nearly zero.
(d) equal to zero.

45. Two new and different cells having emf'sv_1 and v_2 have their balance points P_1 and P_2 respectively. Then,
(a) $v_1 > v_2$ (b) $v_1 < v_2$ (c) $v_1 = v_2$ (d) information is not sufficient.

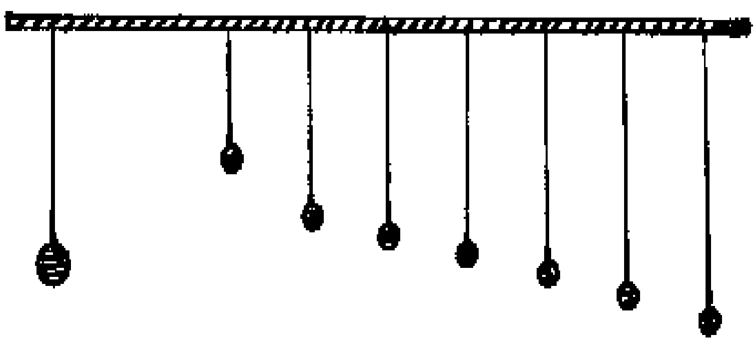
46. The 'emf under test' contains an arrangement as 

connected in the circuit. It is observed that wherever the jockey is touched to wire the galvanometer shows full scale deflection only on one side. The possible causes (considered one at a time) are (I) *e* is D and *e*' is L, (II) *e* is L and *e*' is D, (III) key K is not inserted, (IV) value of *R* is much larger than that set as per Q. No. 42, (V) value of R is very small. The possible causes are
(a) (I), (II) and (III) (b) (II), (III) and (IV)
(c) (I), (III) and (IV) (d) (II), (III) and (V)

47. If the jockey is touched at a point on the wire 1.0 cm away from the balance point, then the galvanometer (G = 1 kΩ) will show a current equal to
(a) 2 μA (b) 4 μA (c) 6 μA (d) 8 μA

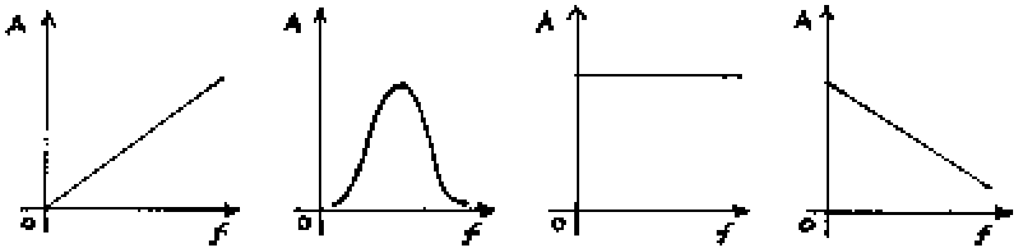
Group of Q. Nos. 48 to 55 are based on the following paragraph.

A large number of pendulums with identical bobs (mass *m*) but varying lengths are suspended from a thick thread. Another pendulum of a heavier bob (mass *M*) is also suspended from the same thread as shown.



This pendulum with the heavier bob is used as a 'driver' to drive the other pendulums called as 'driven' pendulums. Assume that the amplitude of the driver is maintained constant (by some suitable mechanism). Let the frequency of the driver be f_0.

48. The time periods – hence the frequencies (f) and the amplitudes (A) of the driven pendulums in steady state are measured. The variation of A with f is correctly shown by the graph



(a) (b) (c) (d)

49. It is observed that
   (a) all the pendulums except one are at rest.
   (b) all the pendulums oscillate in phase with the 'driver'.
   (c) one of the pendulums oscillates with maximum amplitude.
   (d) the pendulum with maximum amplitude oscillates in phase with the 'driver'.

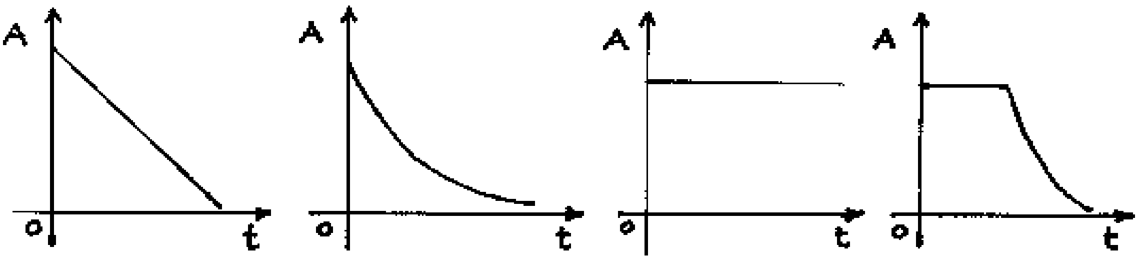
50. The frequency of the pendulum having maximum amplitude is
   (a) $f_0 / 2$ (b) f_0 (c) $2 f_0$ (d) not related to f_0

51. The pendulum in Q. No. 50 above is set into oscillation with an initial amplitude of 10.0 cm. Soon this pendulum comes to rest momentarily and the driver is seen to oscillate with an amplitude of 8.16 cm. Then, mass M equals
   (a) 1.5 m (b) 2 m (c) 2.5 m (d) 3 m

Now only one of the driven pendulums is oscillated. The driver and all other driven pendulums are clamped.

52. A simple pendulum of length L has a period T. If length is changed by ΔL, the change in period ΔT is proportional to
   (a) T (b) T^2 (c) $\frac{1}{T}$ (d) $\frac{1}{\sqrt{T}}$

53. The variation of amplitude A with respect to time t is shown as



(a) (b) (c) (d)

54. Which of the following will give a straight line graph?
(a) log A against t (b) log A against $1/t$ (c) A against t^2 (d) A^2 against t

55. If v is the velocity of the bob the force that is responsible for decrease of amplitude is proportional to
(a) v^2 (b) v (c) $\frac{1}{v}$ (d) $\frac{1}{v^2}$

Q. Nos. 56 to 60are to be solved as group questions.

Note that answers obtained in any earlier question/s may be needed in further questions and such answers should be used wherever needed.

56. An object is placed 30 cm away from a symmetric convex lens and an image two thirds of the size of the object is produced. The object is moved by a distance of 20 cm so as to get a magnified image. Now we get

(a) a real image of magnification $\frac{17}{6}$.
(b) a virtual image of magnification 5.
(c) a real image at a distance of 40 cm.
(d) a virtual image at a distance of 60 cm.

57. A symmetric concave lens of focal length 24 cm is now placed in contact with the convex lens and the object is brought back to its original position. The image formed will be

(a) a real one with a magnification 4.
(b) a real one at a distance of 40 cm.
(c) a virtual one at a distance of 120 cm.
(d) a virtual one with a magnification 2.5.

58. The concave lens is moved away from the object through a distance of 10 cm. We get an image that is
    (a) virtual and at a distance of about 17 cm from the concave lens.
    (b) real and at a distance of about 47 cm from the object.
    (c) virtual, diminished and at a distance of 10 cm from the concave lens.
    (d) real and at a distance of 57 cm from the object.

59. Now consider again the lenses to be in contact with each other but made of material of refractive index 1.2. The system is immersed in a medium of refractive index μ and it is found that the focal length of the system remains numerically the same as when in air. Therefore, μ is
    (a) less than 1.2 (b) between 1.2 and 1.5
    (c) greater than 1.5 (d) equal to 1.5

60. The given convex lens (refractive index $\frac{3}{2}$) is made to rest on the surface of a lake such that its upper surface is in air while the lower one is in water (refractive index $\frac{4}{3}$). Rays from the sun overhead converge at a distance 'a' inside the water, while rays from a luminescent anglerfish beneath at the bottom of the lake converge at a distance 'b' in air. Therefore,
    (a) a = 12 cm, b = 12 cm (b) a = 24 cm, b = 12 cm
    (c) a = 18 cm, b = 12 cm (d) a = 24 cm, b = 18 cm

A 2

In Q. Nos. 61 to 70 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 marks.

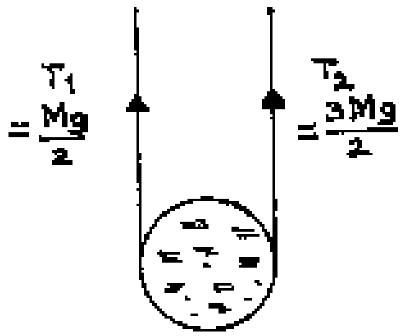
61. Four point masses are placed in a plane so that their centre of mass is at (1,1). Three of them are of mass m each and are placed at (0,0), (2,0) and (0,2) respectively. The fourth point of mass $2m$ is displaced from its initial position such that centre of mass of the system moves to (2,1). Then, the displacement of the fourth point mass is

(a) parallel to X axis. (b) inclined at an angle 45^o with X axis.

(c) of magnitude $\frac{5}{2}$ units. (d) of magnitude 5 units.

62. A block A of mass 2 kg rests on a horizontal surface. Another block B of mass 1 kg moving at a speed of 1 m/s when at a distance of 16 cm from A, collides elastically with A. The coefficient of friction between the horizontal surface and each of the blocks is 0.2. Then, (g = 10 m/s^2),
(a) after collision block B rebounds.
(b) after collision block B comes to rest.
(c) final separation between the blocks is 3 cm.
(d) final separation between the blocks is 5 cm.

63. A uniform disc of mass M and radius R is lifted using a string as shown in the figure. Then,



(a) its linear acceleration is g upward. (b) its linear acceleration is g downward.

(c) its angular acceleration is $\frac{2g}{R}$. (d) its rate of change of angular momentum is MgR.

64. Four thin straight long wires are all parallel to Z axis. They pass through the points A(3,0,0), B(0,3,0), C(-3,0,0) and D(0,-3,0). They all carry currents in $\hat{k}$ direction of magnitudes 0.3 A, 0.6 A, 0.3 A and 0.3 A respectively. The magnitude of magnetic field at the origin O due to

(a) wires at A and C is zero.

(b) wires at A and B is $2\sqrt{2} \times 10^{-8}$ T

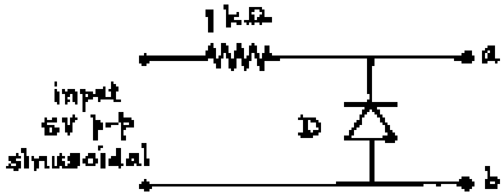
(c) wires at A and D is $2\sqrt{2} \times 10^{-8}$ T

(d) all wires is 2×10^{-8} T

65. In a drip irrigation system water flows at 0.4 m/s through a 25 mm diameter pipe. At each of the plants in the field water is expected to be delivered at 0.02 m/s through a 2 mm opening. The drip works for 2 hours a day. Then,

(a) the system feeds 2250 plants.
(b) a plant gets about 3.2 litres of water a day.
(c) the system feeds 3125 plants.
(d) a plant gets about 1.8 litres of water a day.

66. Refer to the circuit given below. Output voltage V_0 is measured between points **a** and**b**. Then,



(a) the peak value of V_0 is 2.5 volt above the minimum if the diode is assumed to be ideal.
(b) the positive half cycle of the input is clipped.
(c) the circuit acts as a rectifier.
(d) the peak value of V_0 is about 3.2 volt above the minimum if D is silicon diode (non-ideal).

67. Two constant volume gas thermometers – one containing helium and the other containing oxygen are used to measure the boiling point of liquid nitrogen. For calibrating the He thermometer first it is dipped in boiling water and afterwards in boiling liquid nitrogen and the pressure was found to change by a factor of 5. The process is repeated with oxygen thermometer. Then, which of the following statement/s is/are true?

(a) According to He thermometer liquid nitrogen boils at 74.6 K.
(b) Oxygen gas thermometer also gives the same result.
(c) Oxygen gas thermometer cannot be used in this situation.
(d) Helium gas thermometer cannot give the linear variation of pressure with temperature.

68. A hollow prism filled with hot water is used with usual arrangement to obtain a spectrum. The water prism is set in minimum deviation position. It is observed that the spectrum shifts so that deviation increases. Indicate the correct statement/s.
(a) Refractive index of water increases with decrease of temperature.
(b) Refractive index of water increases with increase of temperature.
(c) Speed of light decreases with decrease of temperature.
(d) Speed of light increases with decrease of temperature.

69. A vertical narrow wire is illuminated with laser. Alternate dark and bright bands are formed on a graph paper pasted on a distant wall. Indicate the correct statement/s.
(a) Making appropriate measurements it is possible to determine the diameter of the wire.
(b) This phenomenon exhibits that light does not follow rectilinear paths.
(c) This is a case of Fraunhoffer diffraction.
(d) This is a case of interference of an infinitely large number of Huygens' secondary waves leading to a diffraction pattern.

70. Consider an element of a stretched string along which a wave travels. During its transverse oscillatory motion, the element passes through a point at $y = 0$ and reaches its maximum at $y = y_m$. Then, the string element has its maximum
(a) kinetic energy at $y = y_m$.
(b) elastic potential energy at $y = y_m$.
(c) kinetic energy at $y = 0$.
(d) elastic potential energy at $y = 0$.

-x-x-x-x-x-x-x-x-x-

Physical constants you may need…

Charge on electron $e = 1.6 \times 10^{-19}$ C Mass of electron $m_e = 9.1 \times 10^{-31}$ kg

Universal gravitational constant $G = 6.67 \times 10^{-11}$ Nm^2/kg^2

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2

Universal gas constant $R = 8.31$ J/mol K Planck constant $h = 6.62 \times 10^{-34}$Js

Stefan constant $\sigma = 5.67 \times 10^{-8}$ W/m^2K^4 Boltzmann constant $k = 1.38 \times 10^{-23}$ J/K

Mass of proton $m_p = 1.67 \times 10^{-27}$ kg

Boiling point of nitrogen = 77.4 K Boiling point of oxygen = 90.19 K

Boiling point of hydrogen =20.3 KBoiling point of helium = 4.2 K

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN PHYSICS 2014-15
ANSWERS / SOLUTIONS
Q. P. Code 160

A 1

1. **(c)** Use the definition of dB scale: 120 = 10 $\log_{10}\left(\frac{I}{I_0}\right)$, which gives $\left(\frac{I_0}{I}\right)$ = 10^{-12}.
2. **(b)** Use Gauss law where $E = \frac{\varphi}{A} = \frac{1}{A}\frac{Q}{\epsilon_0}$ so that $\epsilon_0 E = \frac{Q}{A}$ and $\frac{dQ}{dt} = I$.
3. **(d)** Let the distances of the stars with masses m_1 and m_2 from their centre of mass be r_1 and r_2 respectively so that $(r_1 + r_2) = r$, say. The necessary centripetal force is provided by the gravitational force between them, so that $G\frac{m_1 m_2}{r^2} = m_1 r_1 \omega^2 = m_2 r_2 \omega^2$. This gives $\omega^2 = \frac{Gm_2}{r^2 r_1} = \frac{Gm_1}{r^2 r_2} = \frac{G(m_1+m_2)}{r^2(r_1+r_2)} = \frac{G(m_1+m_2)}{r^3}$. From this one can write the expression for T.
4. **(c)** Effective acceleration $\boldsymbol{g'}$ is the vector sum of $\boldsymbol{g}$ and acceleration due to rotation of the earth $\boldsymbol{r\omega^2}$ where r is the distance from the axis of rotation. Also one can neglect $r\omega^2$compared to g while determining the magnitude g'. Therefore, $g' = (g^2 - 2gr\omega^2 cos\lambda)^{\frac{1}{2}}$. Also r can be written as $Rcos\lambda$ where λ is the latitude.
5. **(b)** The direction along which the particle moves is the direction of velocity which in turn, is the slope of the trajectory. This is $\left[\frac{dy}{dx}\right]_{(0,-4)} = \tan(\theta) = 3$ and hence the answer.
6. **(c)** If the particle A is at (x, y), particle B will be at (x, 0). The speed of B is given to be $\frac{dx}{dt} = v_x = 3$ m/s which is also the x component of the velocity of A. Since for particle B, the equation of trajectory is $y = x$, $v_y = \frac{dy}{dt} = \frac{dx}{dt} = v_x$ = 3 m/s. Therefore, speed of A is $\sqrt{{v_x}^2 + {v_x}^2} = 3\sqrt{2}$.
7. **(c)** Moment of inertia = $4\left[\left\{\frac{ma^2}{12} + \frac{ma^2}{4}\right\} + \left\{\frac{\pi m}{2}\frac{a^2}{4} + \frac{\pi m}{2}\frac{a^2}{4}\right\}\right] = ma^2\left(\frac{4+3\pi}{3}\right)$
8. **(c)** One can write the series 100 = 36 + $2 \times 36(e^2 + e^4 + e^6 + \cdots)$ giving $e^2 = \frac{8}{17}$ where e is the coefficient of restitution. Now, the percentage loss of kinetic energy = $\frac{change\ in\ kinetic\ energy}{original\ kinetic\ energy} \times 100$. Note that the speed after impact is e times the initial speed. This gives the percentage loss as 52.94 which is almost 53%.
9. **(a)** The magnetic force exerted and hence the corresponding acceleration is proportional to the current. Consider the expression for the period of a simple pendulum in which the effective acceleration due to gravity can be written as $g' = g + ai$ where a is a constant. Then, $T = 2\pi\sqrt{\frac{l}{g+ai}} = 2\pi\sqrt{\frac{l}{g\left(1+\frac{ai}{g}\right)}} =$

$2\pi\sqrt{\frac{l}{g}}\left(1+\frac{ai}{g}\right)^{-\frac{1}{2}} = T_0\left(1-\frac{1}{2}\frac{ai}{g}\right)$ where T_0 is the original period. Therefore, the change in period $|\Delta T|$ is linearly proportional to the current *i*.

10. (b) The beat frequency is the difference in frequencies which is the reciprocal of the beat period *T* which is given to be 10 s.

11. (b) Thrust on the curved surface $= 2\pi Rh\left(P_0+\frac{h}{2}\right) = 300\pi R$ whereas the thrust on the bottom $= \pi R^2(P_0+h) = 20\pi R^2$. The atmospheric pressure in terms of column of water is 10 m. equating the two thrusts gives R = 15 m.

12. (b) Moment of inertia of annular disc about the axis under consideration can be written as $\frac{m}{2}(R_1^2+R_2^2)+mR_2^2$. Comparing the expression for the periodic time of this oscillating disc as a compound pendulum with that of a simple pendulum, we get the equivalent length.

13. (d) For aluminum one can write $L_{Al} = L_0[1+\alpha_{Al}t] = R_2\theta$ where R_2 is the radius of the arc of aluminum strip and *t* is the temperature. Note that θ is the angular width of the strips. A similar expression can be written for iron strip. The difference between the radii, say *d*, for aluminum and iron is the distance between the central planes of the two strips. The expression for *d* can be obtained from the above two expressions as $= \frac{L_0t[\alpha_{Al}-\alpha_{Fe}]}{d}$. Also ($R_1$ + R_2) can be approximated as 2i and the value of *R* can be determined.

14. (d) In this case $\frac{\sqrt{T}}{\lambda}$ is constant. If wavelength is λ (when the cylinder is in air), that when the cylinder is immersed in water will be $\frac{\lambda}{2.2}$.

15. (a) As per road design, the rated speed is $\sqrt{gRtan\theta} = 20$ m/s. Now, the speed is to be 40 m/s which will be helped by friction. With the help of free body diagram, one can write $mg+\mu_sNsin\theta = Ncos\theta$ and $Nsin\theta+\mu_sNcos\theta = \frac{mv^2}{R}$. Simplifying this one gets $\mu_s = \frac{v^2cos\theta - gRsin\theta}{gRcos\theta+v^2sin\theta}$. Using tanθ = 0.2, one gets $\mu_s = 0.517 = 0.52$ approximately.

16. (a) Each of the coils acts as a magnetic dipole. The force of interaction between them varies inversely as the fourth power of the distance of separation. When the coils are placed vertically only the weight *mg* of the coil balances this force. However, when they are placed horizontally a force equal to *μmg* balances this force. Thus, $\frac{\mu mg}{mg} = \frac{(0.04)^4}{(0.05)^4} = 0.4096$ which is almost 0.41.

17. (b) The electric field at a distance *x* from the wire is $E = \frac{\lambda}{2\pi\epsilon_0x}$ so that the force on a charge *q* would be $\frac{q\lambda}{2\pi\epsilon_0x}$. Writing the force as $\frac{dv}{dx}$, the speed can be determined by integrating the expression.

18. (b) Let w_1 be the weight of the body in air and w_2 be its weight in water. Using law of moments, one gets $w_1 = 3mg$ and $w_2 = 2.5\ mg$ where mg is the weight of the meter scale. The specific gravity is then $\frac{w_1}{w_1-w_2}$ = 6.

19. (a) Let s_1 be the specific heat of sand and *s* be that of the liquid. Using the principle of calorimetry, one gets 4200 = 2 s_1 and s_1 = 2 *s* and hence the answer.

20. (d) Consider the expressions for the different speeds, $v_{avg} = \sqrt{\frac{8RT}{\pi M}}$, $v_{rms} = \sqrt{\frac{3RT}{M}}$ and $v_p = \sqrt{\frac{2RT}{M}}$, where symbols carry their usual meanings. Now determine their inter-relation.

21. (a) Ideal efficiency is 40% whereas the actual efficiency is 40 × 0.8 = 32%. In a year the number of units required is 10 × 365 = 3650 units. One unit corresponds to 3600 kJ of energy, so that in a year the actual output is required to be 36000 × 365 kJ, which is (equivalent of 1 kg of coal) × 365. With 32% efficiency this gives the amount of coal required throughout a year is 1140.625 kg of coal.

22. (a) The thermoemf e = 40 (50 – 0) = 2000 μV. If G is the resistance of the galvanometer, the current through it is $\frac{2000}{G}$ μA which produces full scale deflection of 30 divisions. Therefore, $\frac{2000}{G} = 30C$ where C is the figure of merit of the galvanometer. After connecting 100 ohm resistance in series with the galvanometer, the equation becomes $\frac{2000}{G+100} = 10C$. Solving these equations one gets G = 50 ohm and $C = 1.33$ μA/div.

23. (d) Let the resistance of the voltmeter be R (in kΩ, for convenience). Considering the voltage drops, one gets R = 10 kΩ. Initial current is then obviously 150 μA. The time required for the voltage across the capacitor to fall from V_0 to V is given by $t = RC\, ln\left(\frac{V_0}{V}\right)$. Using this one gets t = 11 s.

24. (c) A charge – 2 μC is non-uniformly distributed on the inner surface of the spherical shell whereas an equal positive charge is uniformly distributed on the outer surface.

25. (c) If T_1 and T_2 are the periodic times of the two pendulums, $\frac{T_1}{T_2} = 1.001$ and hence the ratio of lengths is $\frac{L_1}{L_2} = \left(\frac{T_1}{L_2}\right)^2 = 1.002$. This gives $L_1 = 1.002\, L_2$. Now, one can write the expressions for the increased lengths after the temperature is raised by t^0 C and equate the two. Solving this one gets the temperature t.

26. (b) Ultrasonic has to do with the frequency and not the speed.

27. (b) Clearly the neutral point is on the equator of the magnet and the magnetic field at that point is $B_H = \frac{\mu_0 M}{4\pi r^3}$. Writing a similar expression for the field at a point on the axis, the ratio can be taken to give the answer.

28. (d) Knowing the direction ratios, one can write the unit vector in the direction in which the object is moving. Therefore, the velocity of the object can be written as $v = \sqrt{2}\left(\frac{3}{5\sqrt{2}}\hat{\imath} + \frac{4}{5\sqrt{2}}\hat{\jmath} + \frac{5}{5\sqrt{2}}\hat{k}\right)$. Since, the mirror is along the plane x = 3, the velocity will have its x component only inverted.

29. (b) If I_0 is the initial intensity of light entering the first polarizing sheet, the intensity after this sheet is $I_1 = \frac{I_0}{2}$. The intensity of light after the second sheet is $I_2 = I_1 cos^2\, 60^o$ and similarly that after the third sheet is $I_3 = I_2 cos^2\, 30^o$. Finally expressing I_3 in terms of I_0 one gets the result.

30. (b) Note that if the rays reflected from the two interfaces (air-film and film-glass) interfere destructively, the reflection will be eliminated. For this the total path difference must be an odd multiple of half the wavelength. If L is the film thickness, $2L = (2n + 1)\frac{1}{2}\left(\frac{\lambda}{1.38}\right)$ where the wavelength in MgF_2 is $\left(\frac{\lambda}{1.38}\right)$. Now for L to be minimum n should be zero. Substituting the values one gets the result.

31. **(c)** The capacitance C corresponds to $\frac{1}{k}$ and NOT k.

32. **(c)** Current through the circuit is obviously 2 mA. Therefore, the capacitive reactance is $\frac{5\,volt}{2\,mA} = 2.5$ kΩ. From this the capacitance turns out to be 1.27 μF. The peak value of the source voltage is $\sqrt{2}$ times the net RMS voltage which is $\sqrt{2} \times \sqrt{5^2 + 2^2} = 7.62$ volt.

33. **(a)** The charging time constant is 220 ms. Since the contact is more than five time constants the capacitor gets fully charged, that is the voltage across the capacitor is 10 volt. Now, the discharging time constant is 330 ms. Therefore, after 330 ms, the voltage across the capacitor and hence across the two resistors together is 3.678 volt. Out of this the voltage across the 5 kΩ resistor is 1.226 volt.

34. **(c)** The variation of B with the distance is linear inside the wire.

35. **(a)** The voltage across coil B is $v_2 = M\frac{dI}{dt}$ where $I = I_0 sin\,\omega t$ is the current in coil A. This gives $v_2 = \omega M I_0 cos\,\omega t$. Taking into account the rms values of current and voltage, M comes out to be 159 mH. Initial current in coil A is, say I_1 = 0.1 A. Therefore, if V is the voltage across it, the impedance of coil A is 10V. After coil B is shorted, the current in coil A increases to 0.102 A, hence its impedance is $\frac{V}{0.102} = 9.804\,V$. Then the percentage change in impedance is 1.96% or about 2%.

36. **(d)** Due to the emf's induced being in phase opposition the net current is small. Also since the number of turns is not the same the current does not drop to zero and hence the bulb glows feebly.

37. **(c)** Let N_2 be the number of atoms of stable isotopes and N_1 be that of radioactive isotopes. If N_0 is the initial number then, $N_2 = N_0 - N_1$. Now, $N_1 = N_0\, e^{-\lambda t} = (N_1 + N_2)\, e^{-\lambda t}$. This gives $t = \frac{ln\left[1+\frac{N_2}{N_1}\right]}{\lambda}$. Writing $\lambda = \frac{ln\,2}{T_{1/2}}$ one gets the answer.

38. **(c)** With the help of truth table for NAND gate write the output at every stage for all possible cases of the input.

39. **(c)** The minimum wavelength λ_{min} corresponds to v_{max} where all the energy carried by the electron is totally transferred to X ray photon. Writing $\lambda_{min} = \frac{hc}{E}$ where E is the energy of the electron, one gets the answer.

40. **(c)** Particularly when the cells assist each other (sum), the driving cell must have an emf E greater than the sum of the emf's [> (1.40 + 1.08)] of the cells under test.

41. **(d)** Electrical conductivity of brass is the greatest among the materials given. Due to plating the strips are free from corrosion.

42. **(c)** Due to stretching the resistance of the potentiometer wire is 40 + 2% = 40.8 ohm. Potential gradient v can be written as $v = \frac{1}{L}\frac{Er}{R+r}$ where r is the resistance of the wire and R is the resistance connected in the circuit. Solving for R gives the answer.

43. (b) Determining the end point is more important than keeping the wire in place.

44. (c) The metal strip S has a very small resistance (close to zero, but NOT zero).

45. (b) Note that point P_1 is closer to the common point (where the positive terminal of E and that of the cell under test are connected) than the point P_2 and the emf is proportional to the balancing length.

46. (c) If $e < e'$, the emf under test will be negative and the current will always pass through the galvanometer. If key is open, current is only due to the emf under test which never becomes zero. If R is too large, the potential difference across the total length of wire may be smaller than the emf under test.

47. (c) The potential difference across 1 cm wire is 6mV and hence the current through the galvanometer is 6 μA.

48. (b) Obviously the amplitude is a maximum for one particular frequency at which a pendulum resonates with the driver pendulum.

49. (c) The pendulum which has the same natural frequency of oscillation as that of the driver pendulum has maximum amplitude.

50. (b) The frequency of the resonating pendulum is obviously the same as f_0 the frequency of the driver pendulum.

51. (a) When one of the coupled pendulums stops, its energy is completely transferred to the driver pendulum. If A and A' are respectively the amplitudes of the coupled pendulum and the driver pendulum, $\frac{1}{2}\omega^2 MA'^2 = \frac{1}{2}\omega^2 mA^2$. This gives $M = 1.5\ m$.

52. (c) Considering the expression for the periodic time T of a simple pendulum, ΔT is proportional to $\frac{1}{T}$.

53. (b) The amplitude of a simple pendulum exponentially decreases with time.

54. (a) The graph of log A against t is a straight line as A varies exponentially with t.

55. (b) The decrease of amplitude is due to a damping force that is proportional to velocity v.

56. (d) Considering the object distance u and the magnification m, the image distance v comes out to be 20 cm and the focal length f to be 12 cm. Now, the object has to be moved closer to the lens so as to get a magnified image. Taking u' = 10 cm, image distance comes out to be 60 cm.

57. (a) Focal length of the combination is + 24 cm. With u = 30 cm, image distance is 120 cm and the magnification is 4, that is the image is real and magnified.

58. (d) Convex lens forms a real inverted image at 20 cm from the lens. This acts as the virtual object for the concave lens forming a final image at $\frac{120}{7}$ or approximately 17 cm from the concave lens. Note that this is a real image of the virtual object formed by the concave lens. Therefore, from the object the final image is at a distance of 57 cm.

59. (d) At first consider the convex lens made of material of refractive index 1.2 and placed in air (μ = 1) and then immersed in a medium of refractive index μ = 1.5. The focal length happens to be numerically 5k where k is a factor decided by the radii of curvature. It is seen that the focal length numerically remains the same. The same argument can be made for the concave lens. Therefore, when the two lenses are in contact, the effective focal length remains numerically the same.

60. **(d)** Use the formula for refraction at a spherical surface. Since the media on the two sides of the lens are different, consider the formation of image by one surface at a time. Consider parallel rays from air and $n_1 = 1$, $n_2 = \frac{3}{2}$, image distance by the first surface is 36 cm. For the second surface $n_1 = \frac{3}{2}$ and $n_2 = \frac{4}{3}$, final image is formed at 24 cm. Thus, a = 24 cm. Using a similar procedure and considering parallel rays incident from water, the final image is formed at b = 18 cm.

A 2

61. **(a), (c)** After displacement of mass $2m$, there is no change in y coordinate of centre of mass. This indicates that the displacement is along X axis. Using the expression for the X coordinate of centre of mass, initially the X coordinate of mass $2m$ comes out to be 1.5 whereas it is 4 when the mass is displaced. Therefore, the displacement is of magnitude 2.5 or $\frac{5}{2}$ units.

62. **(a), (d)** Deceleration due to the frictional force is 2 m/s^2, so that block B collides with a velocity of 0.6 m/s. Using conservation of momentum, $2v_1 + v_2 = 0.6$ where v_1 and v_2 are the velocities of blocks A and B after collision. Also since the collision is elastic (coefficient of restitution = 1), $v_1 - v_2 = 0.6$. This gives $v_1 = 0.4$ m/s and $v_2 = -0.2$ m/s. The negative sign for v_2 indicates that block B rebounds. Displacement of block A after collision is 4 cm to the right whereas that of block B is 1 cm to the left, so that the final separation is 5 cm.

63. **(a), (c), (d)** The net force upward is Mg so that the acceleration is g upwards. The net torque is anticlockwise and is of magnitude MgR which is also the same as the rate of change of angular momentum. Since the moment of inertia is $\frac{MR^2}{2}$, the angular acceleration is $\frac{2g}{R}$.

64. **(a), (c), (d)** Using the expression for the magnetic induction due to a long straight wire and the right hand rule, the magnetic inductions at the origin due to the wires at A, B, C and D are 2×10^{-8} T along OY', 4×10^{-8} T along OX, 2×10^{-8} T along OY and 2×10^{-8} T along OX' respectively. Therefore, the inductions due to wires at A and C cancel out. Using the vector addition, the induction due to wires at A and D is $2\sqrt{2} \times 10^{-8}$ T and that due to all wires is 2×10^{-8} T.

65. **(c), (d)** Using the equation of continuity, a relation can be written as $\pi(25)^2 \times 0.4 = n \times \pi(2)^2 \times 0.02$ where n is the number of plants. This gives n = 3125. Further the flow of water is 0.25 ml per second so that in 2 hours each plant gets 1.8 litre of water.

66. **(a), (c), (d)** During the positive half cycle, the diode remains open and the output is the same as the input and hence 2.5 volt. Since the negative half cycle is clipped, the circuit acts as a rectifier. If the diode happens to be non-ideal the output is 2.5 + 0.7 = 3.2 volt above minimum.

67. **(a), (c)** At constant volume, pressure is directly proportional to temperature. Using this the temperature at which liquid nitrogen boils comes out to be 74.6 K. Also since at this temperature oxygen is not in gaseous state (boiling point of O_2 is 90 K), it cannot be used in gas thermometer.

68. **(a), (c)** On cooling of water, deviation increases indicating that the refractive index of water increases. Considering the expression for refractive index in terms of speed of light, the speed of light decreases with decrease of temperature.

69. **(a), (b), (c), (d)** Knowing the wavelength diameter of wire can always be determined. Obviously in experiments on diffraction light does not follow rectilinear paths. This is a case of Fraunhoffer diffraction. Diffraction is essentially a case of interference of a large number of wavelets.

70. **(c), (d)** The kinetic energy is obviously maximum when the element passes through the mean position. In the mean position the string element happens to be in its maximum stretched and hence its elastic potential energy is also maximum.

-x-x-x-x-x-x-x-x-