JEE MAIN - 2016

PHYSICS

General Instructions :

1. Immediately fill in the particulars on this page of the test booklet with blue/black ball point pen.

2. This Test Booklet consists of three parts - **Part I, Part II** and **Part III. Part I** has **30** objective type questions of Mathematics Test consisting of **FOUR(4)** marks for each correct response. **Part II** Aptitude Test has **50** objective type questions consisting of **FOUR(4)** marks for each correct response. Mark your answers for these questions in the appropriate space against the number corresponding to the question in the Answer Sheet placed inside this Test Booklet. Use Blue/Black Ball Point Pen only for writing particulars/marking responses of **Side-1** and **Side-2** of the Answer Sheet. **Part III** consists of 2 questions carrying **70** marks which are to be attempted on a separate Drawing Sheet which is also placed inside the Test Booklet. Marks allotted to each question are written against each question. Use colour **pencils or crayons** only on the Drawing Sheet. Do not use water colours. For each incorrect response in **Part I** and **Part II**, **one-fourth (¼)** of the total marks allotted to the question from the total score. **No deduction** from the total score, however, will be made if no response is indicated for an item in the Answer Sheet.

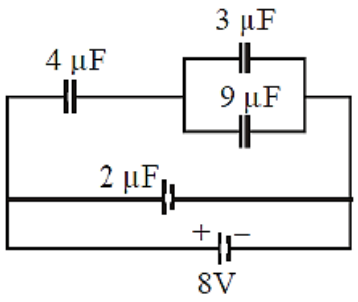
3. There is only one correct response for each question in **Part I** and **Part II**. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 2 above.

4. The test is of 3 hours duration. The maximum marks are 390.

5. On completion of the test, the candidates must hand over the Answer Sheet of Mathematics and **Aptitude Test Part- I & II** and the Drawing Sheet of Aptitude **Test-Part III** along with Test Booklet for Part III to the Invigilator in the Room/Hall. Candidates are allowed to take away with them the Test Booklet of **Aptitude Test -Part I & II**

6. The CODE for this Booklet is S. Make sure that the **CODE** printed on **Side – 2** of the Answer Sheet and on the Drawing Sheet (Part III) is the same as that on this booklet. Also tally the Serial Number of the Test Booklet, Answer Sheet and Drawing Sheet and en sure that they are same. In case of discrepancy in Code or Serial Number, the candidate should immediately report the matter to the Invigilator for replacement of the Test Booklet, Answer Sheet and the Drawing Sheet.

Q31. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the $4\ \mu F$ and $9\ \mu F$ capacitors), at a point $30\,m$ from it, would equal:



(A) $480\,N/C$

(B) $240\,N/C$

(C) $360\,N/C$

(D) $420\,N/C$

Q32. An observer looks at a distant tree of height $10\,m$ with a telescope of magnifying power of 20. To the observer the tree appears:

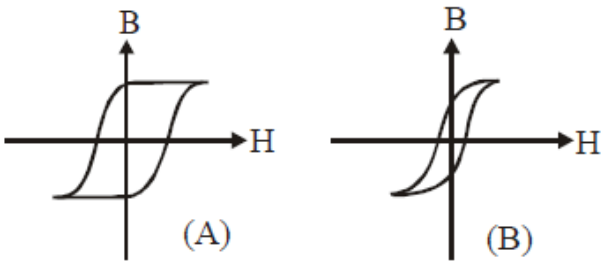
(A) 20 times nearer

(B) 10 times taller

(C) 10 times nearer

(D) 20 times taller

Q33.



These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use;

(A) B for electromagnets and transformers.

(B) A for electric generators and transformers.

(C) A for electromagnets and B for electric transformers.

(D) A for transformers and B for electric generators.

Q34. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively. Initially, the samples have equal number of nuclei. After 80 minutes, the ratio of decayed numbers of A and B nuclei will be:-

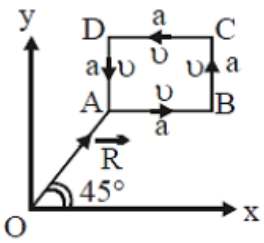
(A) $5:4$

(B) $1:16$

(C) $4:1$

(D) $1:4$

Q35. A particle of mass m is moving along the side of a square of side 'a' , with a uniform speed v in the $x-y$ plane as shown in the figure:



Which of the following statement is false for the angular momentum $\vec{L}$ about the origin?

(A) $\vec{L}=\frac{mv}{\sqrt{2}}Rk$ when the particle is moving from D to A

(B) $\vec{L}=-\frac{mv}{\sqrt{2}}Rk$ when the particle is moving from A to B

(C) $\vec{L}=mv\left[\frac{R}{\sqrt{2}}-a\right]k$ When the particle is moving from C to D

(D) $\vec{L}=mv\left[\frac{R}{\sqrt{2}}+a\right]k$ When the particle is moving from B to C

Q36. Choose the correct statement:

(A) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the frequency of the audio signal.

(B) In amplitude modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio

(C) In amplitude modulation the frequency of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.

(D) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.

Q37. In an experiment for determination of refractive index of glass of a prism by $i-e$, plot, it was found that a ray incident at angle $35°$, suffers a deviation of $40°$ and that it emerges at angle $79°$. In that case which of the following is closest to the maximum possible value of the refractive index?

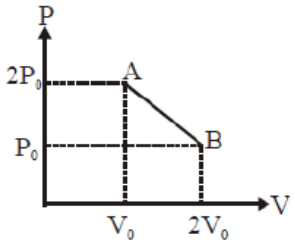
(A) 1.8

(B) 1.5

(C) 1.6

(D) 1.7

Q38. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be:



(A) $\frac{9P_0V_0}{nR}$

(B) $\frac{9P_0V_0}{4nR}$

(C) $\frac{3P_0V_0}{2nR}$

(D) $\frac{9P_0V_0}{2nR}$

Q39. Two identical wires A and B, each of length 'l', carry the same current I. Wire A is bent into a circle of radius R and wire B is bent to form a square of side 'a'. If BA and BB are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is:

(A) $\frac{\pi^2}{8\sqrt{2}}$

(B) $\frac{\pi^2}{8}$

(C) $\frac{\pi^2}{16\sqrt{2}}$

(D) $\frac{\pi^2}{16}$

Q40. A screw gauge with a pitch of $0.5\,\text{mm}$ and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that when the two jaws of the screw gauge are brought in contact, the $45th$ division coincides with the main scale line and that the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is $0.5\,\text{mm}$ and the 25^{th} division coincides with the main scale line?

(A) $0.50\,\text{mm}$

(B) 0.75mm

(C) $0.80\,\text{mm}$

(D) $0.70\,\text{mm}$

Q41. For a common emitter configuration, if α and β have their usual meanings, the **incorrect** relationship between α and β is

(A) $\alpha + \frac{\beta^2}{1+\beta^2}$

(B) $\frac{1}{\alpha} = \frac{1}{\beta} + 1$

(C) $\alpha = \frac{\beta}{1-\beta}$

(D) $\alpha = \frac{\beta}{1+\beta}$

Q42. The box of a pin hole camera, of length L, has a hole of radius a. It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say b min) when:-

(A) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \sqrt{4\lambda L}$

(B) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$

(C) $a = \sqrt{\lambda L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$

(D) $a = \sqrt{\lambda L}$ and $b_{\min} = \sqrt{4\lambda L}$

Q43. A person trying to lose weight by burning fat lifts a mass of $10\,\text{kg}$ up to a height of 1m 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat ill he use up considering the work done only when the weight is lifted up? Fat supplies $3.8\times107\,\text{J}$ of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g=9.8\,\text{ms}-2$:-

(A) $12.89\times10^{-3}\,\text{kg}$

(B) $2.45\times10^{-3}\,\text{kg}$

(C) $6.45\times10^{-3}\,\text{kg}$

(D) $9.89\times10^{-3}\,\text{kg}$

Q44. Arrange the following electromagnetic radiations per quantum in the order of increasing energy:-

(1) Blue light

(2) Yellow light

(3) X-ray

(4) Radiowave

(A) B, A, D, C

(B) D, B, A, C

(C) A, B, D, C

(D) C, A, B, D

Q45. An ideal gas undergoes a quasi static, reversible process in which its molar heat capacity C remains constant. If during this process the relation of pressure P and volume V is given by $PV_n = constant$, then n is given by (Here CP and CV are molar specific heat at constant pressure and constant volume, respectively):-

(A) $n = \frac{C - C_v}{C - C_P}$

(B) $n = \frac{C_P}{C_V}$

(C) $n = \frac{C - C_P}{C - C_V}$

(D) $n = \frac{C_P - C}{C - C_V}$

Q46. A satellite is resolving in a circular orbit at a height 'h' from the earth's surface (radius of earth R; h << R). The minimum increase in its orbital velocity required, so that the satellite could escape from the earth's gravitational field, is close to: (Neglect the effect of atmosphere).

(A) $\sqrt{gR}\left(\sqrt{2}-1\right)$

(B) $\sqrt{2gR}$

(C) $\sqrt{gR}$

(D) $\sqrt{gR/2}$

Q47. A galvanometer having a coil resistance of 100Ω gives a full scale deflection, when a current of 1mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of $10\,\text{A}$, is:-

(A) $3\,\Omega$

(B) 0.01Ω

(C) $2\,\Omega$

(D) 0.1Ω

Q48. Radiation of wavelength λ, is incident on a photocell. The fastest emitted electron has speed v. If the wavelength of changed to $3\lambda/4$ the speed of the fastest emitted electron will be:-

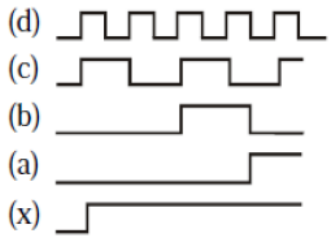
(A) $= v\left(\frac{3}{5}\right)^{1/2}$

(B) $> v\left(\frac{4}{3}\right)^{1/2}$

(C) $< v\left(\frac{4}{3}\right)^{1/2}$

(D) $= v\left(\frac{4}{3}\right)^{1/2}$

Q49. If a, b, c, d are inputs to a gate and x is its output, then as per the following time graph, the gate is



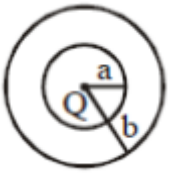
(A) NAND

(B) NOT

(C) AND

(D) OR

Q50. The region between two concentric spheres of radii 'a' and 'b', respectively (see figure), has volume charge density $\rho = A/r$ where A is a constant and r is the distance from the centre. At the centre of the spheres is a point charge Q. The value of A such that the electric field in the region between the spheres will be constant, is:-



(A) $\frac{2Q}{\pi a^2}$

(B) $\frac{Q}{2\pi a^2}$

(C) $\frac{Q}{2\pi\left(b^2 - a^2\right)}$

(D) $\frac{2Q}{\pi\left(a^2 - b^2\right)}$

Q51. A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is $90s, 91s, 95s$ and $92s$. If the minimum division in the measuring clock is $1s$, then the reported mean time should be:-

(A) 92 ± 3 s

(B) $92 \pm 2s$

(C) 92 ± 5.0 s

(D) 92 ± 1.8 s

Q52. The temperature dependence of resistances of Cu and undoped Si in the temperature range $300 - 400K$, is best described by:-

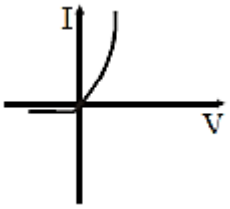
(A) Linear decrease for Cu, linear decrease for Si.

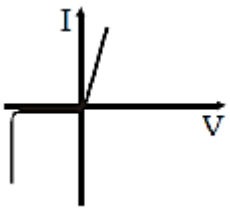
(B) Linear increase for Cu, linear increase for Si.

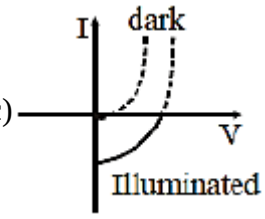
(C) Linear increase for Cu, exponential increase for Si

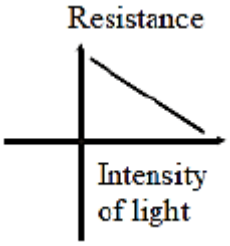
(D) Linear increase for Cu, exponential decrease for Si

Q53. Identify the semiconductor devices whose characteristics are given below, in the order (a),(b),(c), (d):-

(a) 

(b) 

(c) 

(d) 

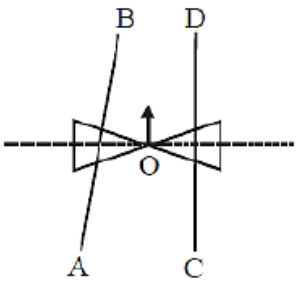
(A) Zener diode, Solar cell, Simple diode, Light dependent resistance

(B) Simple diode, Zener diode, Solar cell, Light dependent resistance

(C) Zener diode, Simple diode, Light dependent resistance, Solar cell

(D) Solar cell, Light dependent resistance, Zener diode, Simple diode

Q54. A roller is made by joining together two cones at their vertices O. It is kept on two rails AB and CD which are placed asymmetrically (see figure), with its axis perpendicular to CD and its centre O at the centre of line joining AB and CD (see figure). It is given a light push so that it starts rolling with its centre O moving parallel to CD in the direction shown. As it moves, the roller will tend to:-



(A) turn left and right alternately.

(B) turn left.

(C) turn right.

(D) go straight.

Q55. A pendulume clock loses $12\,s$ a day if the temperature is $40°C$ and gains $4s$ a day if the temperature is $20°C$. The temperature at which the clock will show correct time, and the coefficient of linear expansion (α) of the metal of the pendulum shaft are respectively:-

(A) $55°C;\ \alpha = 1.85\times10^{-2}/°C$

(B) $25°C;\ \alpha = 1.85\times10^{-5}/°C$

(C) $60°C;\ \alpha = 1.85\times10^{-4}/°C$

(D) $30°C;\ \alpha = 1.85\times10^{-3}/°C$

Q56. A uniform string of length $20\,m$ is suspended from a rigid support. A short wave pulse is introduced at its lowest end. It starts moving up the string. The time taken to reach the support is:- (take $g = 10\,ms^{-2}$)

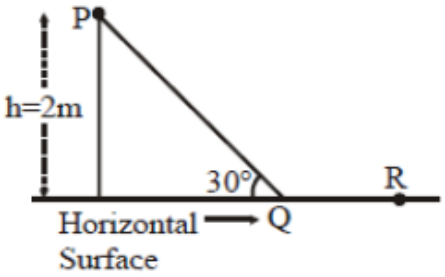
(A) $\sqrt{2}\,s$

(B) $2\pi\sqrt{2}\,s$

(C) $2\,s$

(D) $2\sqrt{2}\,s$

Q57. A point particle of mass, moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest, from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and PR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR. The values of the coefficient of friction μ and the distance $x(=QR)$ are, respectively close to:-



(A) 0.29 and 6.5m

(B) 0.2 and 6.5m

(C) 0.2 and 3.5m

(D) 0.29 and 3.5m

Q58. A pipe open at both ends has a fundamental frequency f in air. The pipe is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now:-

(A) f

(B) $\frac{f}{2}$

(C) $\frac{3f}{4}$

(D) $2f$

Q59. A particle performs simple harmonic motion with amplitude A. Its speed is trebled at the instant that it is at a distance $2A/3$ from equilibrium position. The new amplitude of the motion is:-

(A) $7A/3$

(B) $\frac{A}{3}\sqrt{41}$

(C) $3A$

(D) $A\sqrt{3}$

Q60. An arc lamp requires a direct current of 10A at 80V to function. If it is connected to a 220V (rms), $50\,\text{Hz}$ AC supply, the series inductor needed for it to work is close to:-

(A) 0.065 H

(B) 80 H

(C) 0.08H

(D) 0.044 H