

SEAL

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Invigilator's signature

Question Booklet No.

670004

2018

PGT — PAPER - I : PHYSICS

Time : 2 Hours

Maximum Marks : 100

ROLL NO.

INSTRUCTIONS FOR CANDIDATES

1. This Question Booklet contains 50 optional questions. Each question comprises four responses (answers). You will select ONLY ONE response which you consider the best and darken the bubble on the OMR RESPONSE SHEET.
2. DO NOT write your Name or anything else except Roll No. and the actual answers to the question, anywhere on the OMR RESPONSE SHEET.
3. DO NOT handle your OMR RESPONSE SHEET in such a manner as to mutilate, fold, etc.
4. No candidate shall be admitted to the Examination Hall 20 minutes after commencement of distribution of the Test Booklet. The invigilator of the Examination Hall will be the time-keeper and his decision in this regard is final.
5. No candidate shall have in his/her possession inside the Examination Hall any book, notebook or loose paper, calculator, mobile phone, etc., except his/her admit card and other things paper permitted by the Commission.
6. Immediately after the final bell indicating the closure of the examination, stop bubbling. Be seated till the OMR RESPONSE SHEET is collected by the invigilator, thereafter you may leave the Examination Hall.
7. Violation of any of the above rules will render the candidate liable to expulsion from the examination and disqualification from the examination, and according to the nature and gravity of his/her offence, he/she may be debarred from future examinations and interviews to be conducted by the Commission and other such organization (i.e., UPSC, SSC and SPSCs).

NB : CANDIDATES ARE ALLOWED TO TAKE THIS QUESTION BOOKLET ONLY AFTER COMPLETION OF 2 (TWO) HOURS OF EXAMINATION TIME.

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1. According to quantum theory, the energy E of a photon of frequency ν is given by $E = h\nu$, where h is Planck's constant. What is the dimensional formula of h ?
- (A) ML^2T^{-2}
 (B) ML^2T^{-1}
 (C) ML^2T
 (D) ML^2T^2
2. The given dimensional formula $M^{-1}L^3T^{-2}$ is true for which one of the following?
- (A) Torque
 (B) Surface tension
 (C) Gravitational constant
 (D) None of the above
3. A force \vec{F} is represented by $2\vec{i} + 3\vec{j} + 6\vec{k}$. The magnitude of the force is
- (A) 5 units
 (B) 11 units
 (C) 7 units
 (D) 9 units
4. A car changes its speed from 18 km/h to 54 km/h in 5 s. What is its (assumed constant) acceleration?
- (A) 3 ms^{-2}
 (B) 2 ms^{-2}
 (C) 4 ms^{-2}
 (D) 5 ms^{-2}
5. The initial velocity of a particle is $\vec{u} = (4\vec{i} + 3\vec{j}) \text{ ms}^{-1}$. It is moving with uniform acceleration $\vec{a} = (0.4\vec{i} + 0.3\vec{j}) \text{ ms}^{-2}$. The magnitude of its velocity after 10 s is
- (A) 3 ms^{-1}
 (B) 4 ms^{-1}
 (C) 5 ms^{-1}
 (D) 10 ms^{-1}
6. A 0.1 kg bullet acquires a speed of 840 ms^{-1} in a gun barrel 1.5 m long. The average force exerted on the bullet is
- (A) 840 N
 (B) 1680 N
 (C) 22520 N
 (D) 23520 N
7. A constant force $\vec{F} = (2\vec{i} + 3\vec{j}) \text{ N}$ displaces a body from position $\vec{r}_1 = (4\vec{i} - 5\vec{j}) \text{ m}$ to $\vec{r}_2 = (\vec{i} + 3\vec{j}) \text{ m}$. The work done by the force is
- (A) 22 J
 (B) 20 J
 (C) 18 J
 (D) 16 J

8. A car of mass m moving at a speed v is stopped in a distance x by the friction between the tyres and the road. If the K.E. of the car is doubled its stopping distance will be
- (A) $8x$
 (B) $4x$
 (C) $2x$
 (D) x
9. The moment of inertia of a solid sphere of mass M and radius R about an axis through its centre is $\frac{2}{5}MR^2$. The moment of inertia about an axis tangential to the surface of the sphere will be
- (A) $\frac{4}{5}MR^2$
 (B) MR^2
 (C) $\frac{6}{5}MR^2$
 (D) $\frac{7}{5}MR^2$
10. If both the mass and radius of the earth decreases by 1%, the value of the acceleration due to gravity will
- (A) decrease by 1%
 (B) increase by 1%
 (C) increase by 2%
 (D) remain unchanged
11. The escape velocity of the earth is 11.2 kms^{-1} . For a planet whose mass and radius are twice those of the earth, the escape velocity will be
- (A) 44.8 kms^{-1}
 (B) 22.4 kms^{-1}
 (C) 11.2 kms^{-1}
 (D) 2.8 kms^{-1}
12. The radius of the earth is R and g is the acceleration due to gravity on its surface. What should be the angular speed of the earth so that the bodies lying on the equator may appear weightless?
- (A) $\sqrt{\frac{g}{R}}$
 (B) $\sqrt{\frac{2g}{R}}$
 (C) $\sqrt{\frac{g}{2R}}$
 (D) $2\sqrt{\frac{g}{R}}$
13. Two satellites of masses $3M$ and M orbit the earth in circular orbits of radius r and $3r$ respectively. The ratio of their speed is
- (A) 1 : 1
 (B) $\sqrt{3} : 1$
 (C) 3 : 1
 (D) 9 : 1
14. The dimensional formula of the coefficient of viscosity η is
- (A) $ML^{-2}T^{-1}$
 (B) $ML^{-1}T^{-1}$
 (C) $M^2L^2T^{-1}$
 (D) M^2LT^{-2}
15. What is the dimensional formula of stress?
- (A) MLT^{-2}
 (B) $ML^{-1}T^{-1}$
 (C) $ML^{-1}T^{-2}$
 (D) ML^0T^{-1}

16. Water rises to a height h in a capillary tube held vertically in a beaker containing water. If the capillary tube is inclined at an angle of 30° with the water surface, the height to which water rises will be
- (A) $\frac{h}{2}$
 (B) h
 (C) $\frac{2h}{\sqrt{3}}$
 (D) $2h$
17. If T_1 represents the period of a planet about the sun and r_1 its mean distance, then as per Kepler's third law
- (A) $T_1^2 \propto r_1^2$
 (B) $T_1^2 \propto r_1^3$
 (C) $T_1^3 \propto r_1^2$
 (D) $T_1^3 \propto r_1^3$
18. If L is the Lagrangian of the system, then which of the following statements is true?
- (A) $L = T + V$
 (B) $L = T + 2V$
 (C) $L = T - V$
 (D) $L = 2T - V$
19. If α , β and γ are the coefficients of linear expansion, coefficients of area expansion and coefficients of volume expansion respectively, they are related by
- (A) $\gamma = 3\beta = 2\alpha$
 (B) $\gamma = 2\beta = 3\alpha$
 (C) $\gamma = 2\alpha = 4\beta$
 (D) $\gamma = 3\alpha = 4\beta$
20. When a metallic bar is heated from 0°C to 100°C , its length increases by 0.05%. What is the coefficient of linear expansion of the metal?
- (A) $5 \times 10^{-3} \text{ }^\circ\text{C}^{-1}$
 (B) $5 \times 10^{-4} \text{ }^\circ\text{C}^{-1}$
 (C) $5 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$
 (D) $5 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$
21. The average kinetic energy of a molecule of a gas at absolute temperature T is proportional to
- (A) $\frac{1}{T}$
 (B) \sqrt{T}
 (C) T
 (D) T^2
22. The temperature of an ideal gas is increased from 120 K to 480 K. If at 120 K, the root mean square speed of the gas molecule is v_1 , then at 480 K it will be
- (A) $4v_1$
 (B) $2v_1$
 (C) $v_1/2$
 (D) $v_1/4$
23. The dimension of the coefficient of thermal conductivity is
- (A) $ML^{-1}T^2K^{-1}$
 (B) $ML^{-2}T^{-3}K^{-1}$
 (C) $M^{-1}L^{-1}T^{-1}K^{-1}$
 (D) $MLT^{-3}K^{-1}$
24. When two moles of oxygen is heated from 0°C to 10°C at constant volume, its internal energy changes 420 J. The molar specific heat of oxygen at constant volume will be
- (A) $5.75 \text{ JK}^{-1}\text{mol}^{-1}$
 (B) $10.5 \text{ JK}^{-1}\text{mol}^{-1}$
 (C) $21 \text{ JK}^{-1}\text{mol}^{-1}$
 (D) $42 \text{ JK}^{-1}\text{mol}^{-1}$

25. A Carnot's engine working between 27°C and 127°C takes up 800 J of heat. The work done by the engine is

- (A) 100 J
- (B) 200 J
- (C) 300 J
- (D) 400 J

26. When a plane travels in medium, the displacement of the particles is given by $y = 0.01\sin[2\pi(2t - 0.01x)]$, where x and y are in metre and t in second. The frequency of the wave will be

- (A) 4 Hz
- (B) 3 Hz
- (C) 2 Hz
- (D) 1 Hz

27. Which of the following represents Heisenberg's uncertainty relation?

- (A) $\Delta_x \Delta p_x \geq \frac{\hbar}{2}$
- (B) $\Delta_x \Delta p_x \geq 2\hbar$
- (C) $\Delta_x \Delta p_x \geq 4\hbar$
- (D) $\Delta_x \Delta p_x \geq 3\hbar$

28. The time dependent wave function of a particle has to be

- (A) real
- (B) imaginary
- (C) complex
- (D) square integrable

29. For two operators A and B

$$A = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \text{ and } B = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$$

what will be the value of $(AB)^\dagger$?

- (A) $\begin{pmatrix} -i & 0 \\ 0 & i \end{pmatrix}$
- (B) $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
- (C) $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
- (D) $\begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix}$

30. An electron of rest mass $9.1 \times 10^{-31}\text{ kg}$ is moving with a speed $0.99c$. Its total energy will be

- (A) $6.81 \times 10^{-13}\text{ J}$
- (B) $5.81 \times 10^{-13}\text{ J}$
- (C) $4.81 \times 10^{-13}\text{ J}$
- (D) $3.81 \times 10^{-13}\text{ J}$

31. A person with defective eyesight is unable to see objects clearly nearer to 1.5 m . He wants to read a book placed at a distance of 30 cm from his eyes. The power of the lens he requires for his spectacles will be

- (A) $+2.67\text{ D}$
- (B) -2.67 D
- (C) $+2.5\text{ D}$
- (D) -2.5 D

32. A telescope has an objective of focal length 100 cm and an eyepiece of focal length 5 cm. What is the magnifying power of the telescope when it is in normal adjustment?
- (A) 0.2
(B) 2.0
(C) 20
(D) 200
33. When a ray of light is incident on a glass slab at an angle of 60° , the angle between the reflected and refracted rays is 90° . The refractive index of glass is
- (A) 1.5
(B) $\sqrt{2}$
(C) $\sqrt{3}$
(D) 2.0
34. The electric potential V (in volt) varies with x (in metre) according to the relation $V = 5 + 4x^2$, the force experienced by a negative charge of 2×10^{-6} C located at $x = 0.5$ m is
- (A) 2×10^{-6} N
(B) 4×10^{-6} N
(C) 6×10^{-6} N
(D) 8×10^{-6} N
35. A charge q is given to a hollow metallic sphere of radius R . The electric potential at the surface of the sphere is
- (A) zero
(B) $\frac{1}{4\pi\epsilon_0} \frac{q}{R}$
(C) $\frac{1}{4\pi\epsilon_0} \frac{q}{R^2}$
(D) $4\pi\epsilon_0 \frac{q}{R}$
36. A heater draws a current of 2 A when connected to a 250 V source. The rate of energy dissipation is
- (A) 500 W
(B) 1000 W
(C) 125 W
(D) 250 W
37. Five bulbs each of 100 W are used daily for 5 hours for one month of 30 days. The no. of units of electric energy consumption is
- (A) 7.5 kWh
(B) 75 kWh
(C) 2.5 kWh
(D) 25 kWh
38. A bulb rated at (100 W-220 V) is connected to a 110 V d.c. source. The current in the bulb will be nearly
- (A) 0.46 A
(B) 0.92 A
(C) 0.23 A
(D) 0.11 A
39. The peak voltage of an AC is 100 volt. The RMS voltage is
- (A) $50\sqrt{2}$ V
(B) 50 V
(C) $100\sqrt{2}$ V
(D) 100 V
40. A metal whose work function is 3.31 eV is illuminated by light of wavelength 3×10^{-7} m. What is the threshold frequency for the photoelectric emission?
- (A) 0.8×10^{15} Hz
(B) 1.6×10^{15} Hz
(C) 2.4×10^{15} Hz
(D) 3.2×10^{15} Hz

41. The de Broglie wavelength at 927°C is λ . What will be its wavelength at 27°C ?
- (A) $\frac{\lambda}{2}$
 (B) λ
 (C) 2λ
 (D) 4λ
42. The ionization energy of hydrogen atom is 13.6 eV. What is the ionization energy of the helium atom?
- (A) 3.4 eV
 (B) 13.6 eV
 (C) 54.4 eV
 (D) 108.8 eV
43. In the equation
- $${}_{13}\text{Al}^{27} + {}_2\text{He}^4 \rightarrow {}_{15}\text{P}^{30} + X$$
- the correct symbol of X is
- (A) ${}_{-1}\text{e}^0$
 (B) ${}_1\text{H}^1$
 (C) ${}_2\text{He}^4$
 (D) ${}_0n^1$
44. If M be the mass of a nucleus and A its atomic mass, the packing fraction is
- (A) $\frac{M - A}{M + A}$
 (B) $\frac{M - A}{M}$
 (C) $\frac{M - A}{A}$
 (D) $\frac{M + A}{M - A}$
45. In a germanium crystal, the valence and conduction bands are separated by a forbidden band of energy
- (A) 0.074 eV
 (B) 0.74 eV
 (C) 7.4 eV
 (D) 74 eV
46. Which of the following gates serves as the building blocks of digital circuits?
- (A) OR and NAND gates
 (B) AND and NOT gates
 (C) OR and NOT gates
 (D) NAND and NOR gates
47. In a NOT gate, if the input signal is 0, the output signal is
- (A) 0
 (B) either 0 or 1
 (C) 1
 (D) both 0 and 1
48. A TV tower has a height of 50 m. The maximum distance up to which TV transmission can be received is approximately equal to (radius of earth = 6.4×10^6 m)
- (A) 5.5 km
 (B) 25.3 km
 (C) 100 km
 (D) 250 km
49. In the fax and e-mail, the information signal is in the form of
- (A) analog signal
 (B) digital signal
 (C) both analog and digital signals
 (D) neither analog nor digital signals
50. The process of superposition of audio signal on a high frequency carrier wave is called
- (A) demodulation
 (B) communication
 (C) modulation
 (D) mixed modulation.