JEE Main 2023 Jan 30 Shift 2 Physics Question Paper

Time Allowed :3 Hours	**Maximum Marks :**300	**Total Questions :**90

General Instructions

Read the following instructions very carefully and strictly follow them:

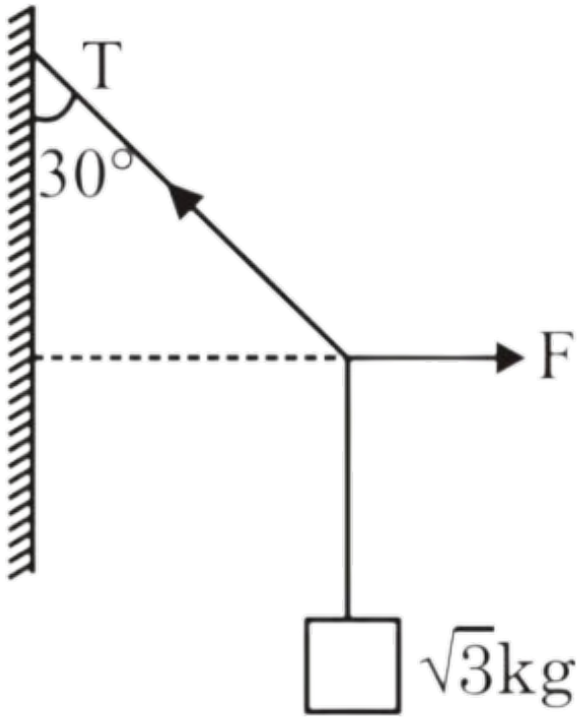
1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

Physics

Section-A

1. A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is:

(Given $g = 10\,\text{ms}^{-2}$)



(1) 20 N

(2) 25 N

(3) 10 N

(4) 15 N

---

2. A flask contains hydrogen and oxygen in the ratio of 2 : 1 by mass at temperature 27°C. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is:

(1) 2 : 1

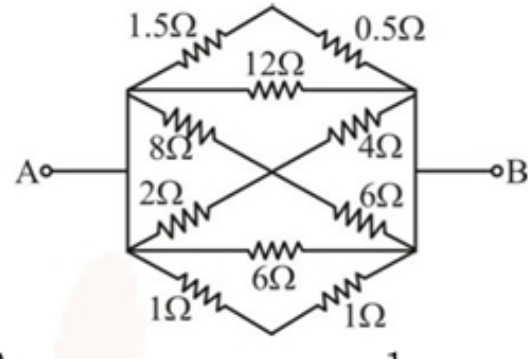
(2) 1 : 1

(3) 1 : 4

(4) 4 : 1

---

3. The equivalent resistance between A and B is .....



(1) $\frac{2}{3}\,\Omega$

(2) $\frac{1}{2}\,\Omega$

(3) $\frac{3}{2}\,\Omega$

(4) $\frac{1}{3}\,\Omega$

---

4. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The nuclear density of nuclides ${}^{10}_{5}B$, ${}^{6}_{3}Li$, ${}^{56}_{26}Fe$, ${}^{20}_{1}0Ne$ and ${}^{209}_{83}Bi$ can be arranged as

$$N_{Bi} > N_{Fe} > N_{Ne} > N_{Pb}.$$

Reason R: The radius R of the nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.

In the light of the above statement, choose the correct answer from the options given below:

(1) Both A and R are true and R is the correct explanation of A

(2) A is false but R is true

(3) A is true but R is false

(4) Both A and R are true but R is NOT the correct explanation of A

---

5. A thin prism P_1 with an angle of 6° and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is:

(1) 6°

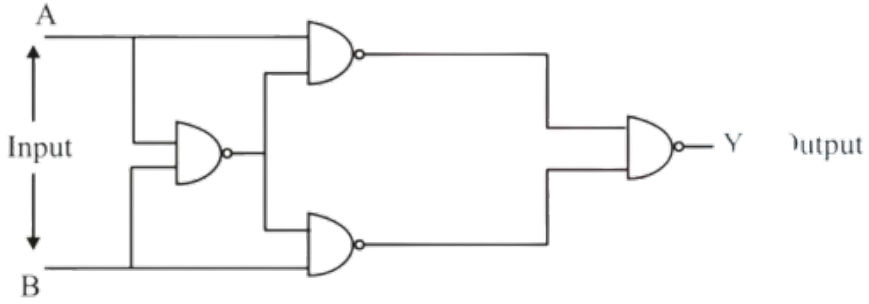
(2) 1.3°

(3) 7.8°

(4) 4.5°

---

6. The output Y for the inputs A and B of the circuit is given by:



Truth table of the shown circuit is :

(1)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(3)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(4)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

---

7. A vehicle travels 4 km with a speed of 3 km/h and another 4 km with a speed of 5 km/h, then its average speed is:

(1) 4.25 km/h

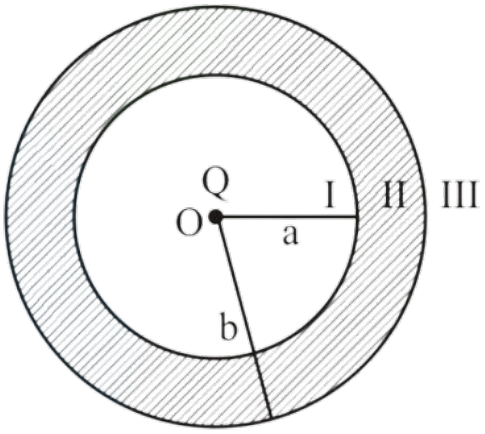
(2) 3.50 km/h

(3) 4.00 km/h

(4) 3.75 km/h

---

8. As shown in the figure, a point charge Q is placed at the centre of a conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II, and III is given by: (I : r ¡ a, II : a ¡ r ¡ b, III : r ¿ b)



(1) $E_I = 0, E_{II} = 0, E_{III} \neq 0$

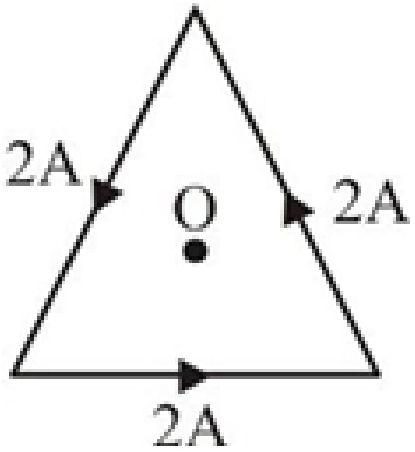
(2) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

(3) $E_I = 0, E_{II} = 0, E_{III} = 0$

(4) $E_I = 0, E_{II} \neq 0, E_{III} = 0$

---

9. As shown in the figure, a current of 2A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid O of the triangle is:



(1) $4\sqrt{3} \times 10^{-4}$ T

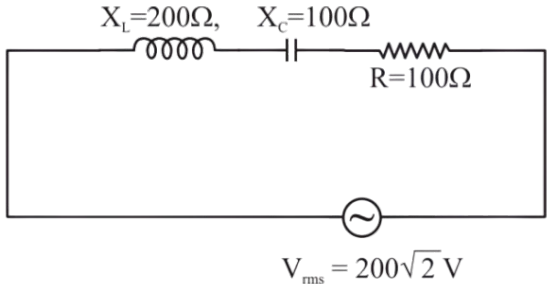
(2) $4\sqrt{3} \times 10^{-5}$ T

(3) $\sqrt{3} \times 10^{-4}$ T

(4) $3\sqrt{3} \times 10^{-5}$ T

---

10. In the given circuit, rms value of current (I_{rms}) through the resistor R is:



(1) $2A$

(2) $\frac{1}{2}A$

(3) $20A$

(4) $2\sqrt{2}A$

---

11. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m/s each. The recoil velocity of the gun is:

(1) 0.02 m/s

(2) 2.5 m/s

(3) 1.5 m/s

(4) 0.6 m/s

---

12. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R. Assertion A: Efficiency of a reversible heat engine will be highest at –273°C temperature of cold reservoir.

Reason R: The efficiency of Carnot's engine depends not only on the temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as:

$$\eta = \left(1 - \frac{T_2}{T_1}\right)$$

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is false but R is true

(4) Both A and R are true and R is the correct explanation of A

---

13. Match List I with List II.

	List I		**List II**
A	Torque	I.	$kg\ m^{-1}\ s^{-2}$
B	Energy density	II.	$kg\ ms^{-1}$
C	Pressure gradient	III.	$kg\ m^{-2}\ s^{-2}$
D	Impulse	IV.	$kg\ m^{2}\ s^{-2}$

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-I, D-II

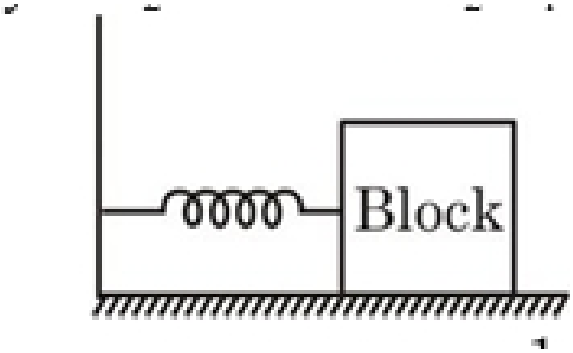
(2) A-I, B-IV, C-III, D-II

(3) A-IV, B-I, C-II, D-III

(4) A-IV, B-I, C-III, D-II

---

14. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio $\frac{\omega_2}{\omega_1}$ is:



(1) $\sqrt{2}$

(2) $\frac{1}{\sqrt{2}}$

(3) 2

(4) $\frac{1}{2}$

---

15. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\frac{V_1}{V_2}$ is equal to :

(1) 3

(2) $\frac{9}{4}$

(3) $\frac{3}{2}$

(4) 4

---

16. Match List I with List II:

	List I		List II
A.	Attenuation	I	Combination of a receiver and transmitter.
B.	Transducer	II	Process of retrieval of information from the carrier wave at received
C.	Demodulation	III	Converts one form of energy into another
D.	Repeater	IV	Loss of strength of a signal while propagating through a medium

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV

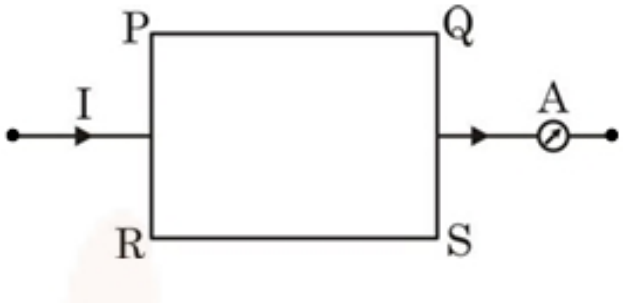
(2) A-II, B-III, C-IV, D-I

(3) A-IV, B-III, C-I, D-II

(4) A-IV, B-III, C-II, D-I

---

17. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively is :



(1) 1 : 2

(2) 1 : 4

(3) 1 : 5

(4) 1 : 3

---

18. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result, elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire 'B' will be (wires having uniform circular cross sections):

(1) 6.06×10^{-2} mm

(2) 2.77×10^{-2} mm

(3) 3.0×10^{-2} mm

(4) 6.9×10^{-2} mm

---

19. An object is allowed to fall from a height R above the earth, where R is the radius of the earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be:

(1) $2\sqrt{gR}$

(2) $\sqrt{gR}$

(3) $\frac{\sqrt{gR}}{2}$

(4) $\sqrt{2gR}$

---

20. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is:

(1) $\frac{1}{2\pi}$ W/m^2

(2) $\frac{1}{40\pi}$ W/m^2

(3) $\frac{1}{10\pi}$ W/m^2

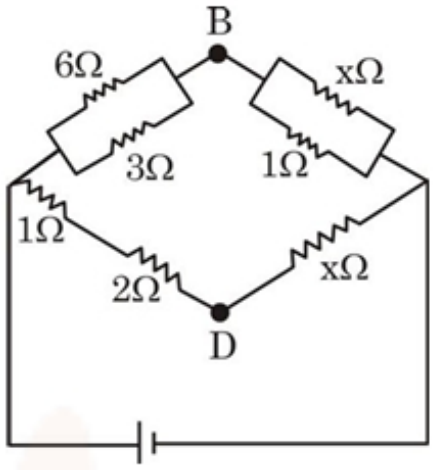
(4) $\frac{1}{20\pi}$ W/m^2

SECTION-B

21. A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temperature on absolute scale will be ..... K when the faulty thermometer reads 41°C.

---

22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is .....



---

23. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{x}{7}$. The value of x is .....

---

24. In a Young's double slit experiment, the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (where λ is the wavelength of light used), are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each of the individual slits, then

$$\frac{I_1 + I_2}{I_0} = \ldots$$

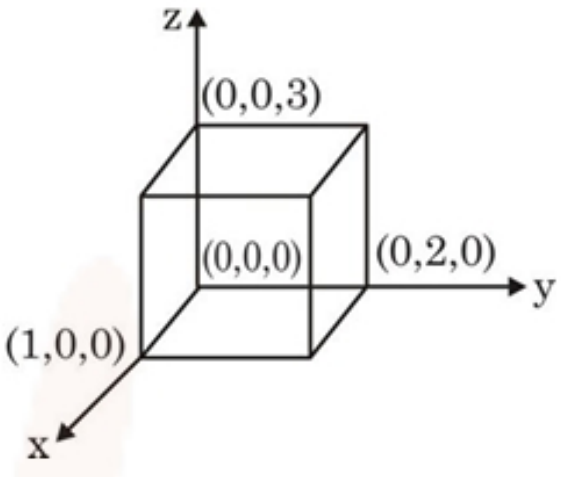
---

25. A radioactive nucleus decays by two different processes. The half-life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ seconds. The value of α is .....

---

26. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4s is $\frac{1}{3}\alpha^2\sqrt{P}$ meters. The value of α will be .....

27. As shown in figure, a cuboid lies in a region with electric field $\mathbf{E} = 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$ **N/C. The magnitude of charge within the cuboid is** $n\epsilon_0$ **C. The value of** n **is ..... (if dimensions of cuboid are** $1 \times 2 \times 3\,\mathbf{m}^3$**)**



---

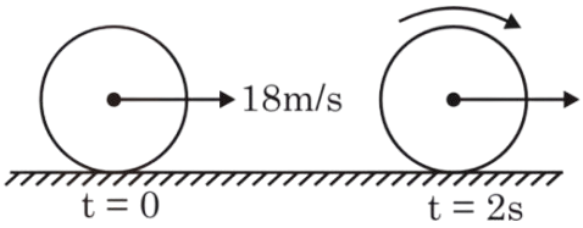
28. In an ac generator, a rectangular coil of 100 turns each having area $14 \times 10^{-2}\,\mathbf{m}^2$ **is rotated at 360 rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be ..... V. (Take** $\pi = \frac{22}{7}$**)**

---

29. A stone tied to 180 cm long string at its end is making 28 revolutions in a horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x}$ **m/s**^{2}**. The value of** x **is .....**

---

30. A uniform disc of mass 0.5 kg and radius r **is projected with velocity 18 m/s at** $t = 0$ **on a rough horizontal surface. It starts off with a purely sliding motion at** $t = 0$**. After 2s, it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2s will be ..... J (given, coefficient of friction is 0.3 and** $g = 10\,\mathbf{m/s}^2$**).**


18m/s
t = 0
t = 2s