

JEE Main 2024 Question Paper with Solution

Jan 29 Shift 2 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. An electromagnetic wave has electric field given by

$$\vec{E} = (9.6\hat{j})\sin\left[2\pi\left\{30\times 10^6t - \frac{1}{10}x\right\}\right], \text{ x and t are in SI units. The maximum magnetic field is}$$

- A. 3.2×10^{-8}
- B. 9.6×10^{-8}
- C. 1.7×10^{-8}
- D. 10^{-7}

Ans. A

Ques 2. A planet at distance r from the sun takes 200 days to complete one revolution around the sun. What will be the time period for a planet at distance $r/4$ from the sun?

- A. 50 days
- B. 25 days
- C. 100 days
- D. 12.5 days

Ans. B

Solution: The time period of a planet's revolution around the sun is proportional to the square root of the cube of its mean distance from the sun (Kepler's third law).

Let's denote:

- T as the time period of revolution,
- R as the mean distance of the planet from the sun.

According to Kepler's third law:

$$T^2 \propto R^3$$

So, if the distance is reduced to $\frac{1}{4}$ of the original distance, the time period T' will become:

$$T'^2 \propto \left(\frac{R}{4}\right)^3$$

$$T'^2 \propto \frac{R^3}{64}$$

Since the proportionality constant remains the same, we have:

$$T'^2 = \frac{1}{64}T^2$$

$$T' = \frac{1}{8}T$$

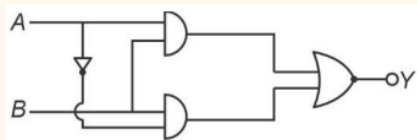
Given that the original time period T is 200 days:

$$T' = \frac{1}{8} \times 200$$

$$T' = 25 \text{ days}$$

So, the time period for a planet at a distance $\frac{1}{4}$ from the sun is 25 days. Therefore, the correct answer is option B) 25 days.

Ques 3. The truth table for the combination of logical gates



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

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

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

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

Ans. C

Ques 4. A uniform wire has length L and radius r . It is acted on by a force F as shown. The elongation is l . If F and r are both halved, the new elongation will be :

- A. $\Delta l/2$
- B. Δl
- C. $4\Delta l$
- D. $2\Delta l$

Ans. D

Ques 5. Two forces F_1 and F_2 are applied on two rods P and Q of same materials such that elongation in rods are same. If ratio of their radii is $x : y$ and ratio of length is $m : n$, then ratio of $F_1 : F_2$ is

- A. $(y/x)^2 n/m$
- B. $(x/y)^2 n/m$
- C. $(y/x)^2 m/n$
- D. $(y/x)^2 m/n$

Ans. B

Ques 6. In a simple pendulum of length 10 m, the string is initially kept horizontal and the bob is released. 10% of energy is lost till the bob reaches the lowest position. Then find the speed of the bob at the lowest position.

- A. 6 m/s
- B. $6\sqrt{5}$ m/s
- C. $7\sqrt{5}$ m/s
- D. $4\sqrt{2}$ m/s

Ans. B

Ques 7. The intensity at each slit is equal for a YDSE and it is maximum I_{\max} at 7π central maxima. If I is intensity for phase difference $7\pi/2$ between two waves on screen. Then I/I_{\max} is?

- A. $\frac{1}{2}$
- B. $\frac{1}{4}$
- C. $\frac{3}{8}$
- D. $1/\sqrt{2}$

Ans. A

Ques 8. Two charged particles A and B have charge q each while masses are m_1 & m_2 . Both have the same velocity v and enter into a transverse magnetic field B such that their radii are r_1 & r_2 . Then the ratio $m_1 : m_2$ is

- A. r_2/r_1
- B. $(r_1/r_2)^2$
- C. r_1/r_2
- D. $(r_2/r_1)^2$

Ans. C

Ques 9. A liquid drop of radius R is divided into 27 identical drops. If the surface tension of the drops is T , then find work done in this process.

- A. $4\pi R^2 T$
- B. $3\pi R^2 T$
- C. $8\pi R^2 T$
- D. $1/8\pi R^2 T$

Ans. C

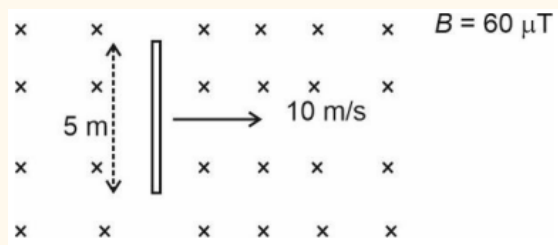
Ques 10. Alternating voltage and current in circuit is given as $V = (100 \sin \omega t)$ volt $I = 100 \sin(\omega t + \pi/3)$ mA

Find average power dissipated in circuit.

- A. 2.5 w
- B. 5 w
- C. 10 w
- D. 20 w

Ans. A

Ques 11. Consider a rod moving in a magnetic field as shown:



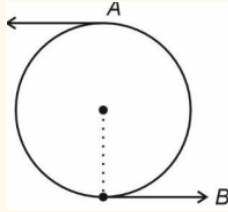
The induced emf across the ends of the

rod is

- A. 3 mV
- B. 6 mV
- C. 0 V
- D. 1 mV

Ans. A

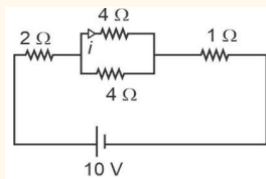
Ques 12. A particle connected with light thread is performing vertical circular motion. Speed at point B (Lowermost point) is sufficient, so that it is able to complete its circular motion. Ignoring air friction, find the ratio of kinetic energy at A to that at B. (A being top-most point)



- A. 1 : 5
- B. 5 : 1
- C. 1 : $7\sqrt{2}$
- D. 1 : $5\sqrt{2}$

Ans. A

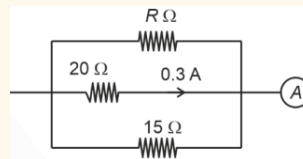
Ques 13. In a given circuit, an ideal battery is connected with four resistances as shown. Find current i as mentioned in the diagram.



- A. 2 A
- B. 1 A
- C. 4 A
- D. 0.5 A

Ans. B

Ques 14. Consider the circuit shown :



. The ammeter reads 0.9 A. Value of R is

Ans. 30

Ques 15. Distance between a twice-magnified virtual image of an object placed in front of the mirror is 15 cm. Find focal length of spherical mirror in cm.

Ans. 10

JEE Main Chemistry Questions

Ques 1. Which of the following elements has the highest 1st ionization energy ?

- A. N**
- B. C**
- C. Si**
- D. Al**

Ans. A

Ques 2. Which reagent gives bright red ppt. With Ni^{2+} in basic medium?

- A. DMG**
- B. Nessler's Reagent**
- C. KCNS**
- D. $\text{K}_4[\text{Fe}(\text{CN})_6]$**

Ans. A

Ques 3. Match the following:

- (A) Lyman (i) IR**
- (B) Balmer (ii) IR**
- (C) Paschen (iii) Visible**
- (D) p-fund (iv) UV**

- A. A → (iv), B → (iii), C → (i), D → (ii)
- B. A → (iv), B → (i), C → (iii), D → (ii)
- C. A → (i), B → (iii), C → (ii), D → (iv)
- D. A → (i), B → (ii), C → (iii), D → (iv)

Ans. A

Ques 4. IUPAC name of K_2MnO_4 is

- A. Potassium tetraoxomanganate(VI)
- B. Potassium tetraoxomanganate(III)
- C. Potassium tetraoxomanganate(VI)
- D. Tetraoxomanganate(VI) potassium

Ans. A

Ques 5. If standard enthalpy of vaporization of CCl_4 is 30.5 kJ/mol, find heat absorbed for vaporization of 294 gm of CCl_4 . [Nearest integer] [in kJ/mol]

Ans. 57

Ques 6. Best reducing agent among the given ions are:

- A. Ce^{4+}
- B. Gd^{2+}
- C. Lu^{3+}
- D. Nd^{3+}

Ans. B

Ques 7. Oxidation state of Fe(iron) in complex formed in brown ring test

Ans. +3

Solution: In the brown ring test, the complex formed is the $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$ complex ion, also known as the nitrosyl ion. The oxidation state of iron (Fe) in this complex can be determined by examining the overall charge and the charges of the ligands.

The nitrosyl ion has the formula $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$. In this complex:

Each water molecule (H_2O) is a neutral ligand, contributing no charge.

The nitric oxide ligand (NO) has a charge of -1.

Since the complex has an overall charge of +2, the iron ion (Fe) must have an oxidation state that balances out the negative charges of the ligands.

Let's denote the oxidation state of iron as x .

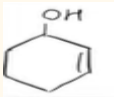
The overall charge of the complex is equal to the sum of the charges contributed by each ligand and the oxidation state of iron:

$$(+2) = 5(0) + (-1) + x$$

$$2 = -1 + x$$

$$x = +3$$

So, the oxidation state of iron (Fe) in the $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$ complex formed in the brown ring test is +3.

Ques 8. IUPAC Name of the compound  **is**

- A. Hex-2-en-1-ol
- B. Cyclohex-2-en-1-ol
- C. 3-Hydroxycyclohexane
- D. Cyclohex-1-en-3-ol

Ans. B

Ques 9 . Why does oxygen show anomalous behavior

- A. Large size, high electronegativity**
- B. Small size, small electronegativity**
- C. Small size, high electronegativity, absence of vacant d- orbital**
- D. Large size high electronegativity presence of vacant d orbital**

Ans. C

Solution: Oxygen exhibits anomalous behavior due to its small size, high electronegativity, and the absence of vacant d orbitals.

Option C: "Small size, high electronegativity, absence of vacant d orbital" accurately captures these factors.

Small size: Oxygen is a small atom, which affects its bonding characteristics and influences its reactivity compared to other elements in the same period of the periodic table.

High electronegativity: Oxygen is highly electronegative, meaning it has a strong tendency to attract electrons towards itself when it forms chemical bonds.

Absence of vacant d orbitals: Oxygen, like other second-row elements, lacks vacant d orbitals in its valence shell. This affects its ability to expand its valence shell and participate in d orbital-based hybridization and bonding, unlike heavier elements in the same group.

These factors contribute to oxygen's unique behavior in various chemical reactions and compound formations, leading to what is often termed as "anomalous behavior." Therefore, option C is the most appropriate explanation for why oxygen shows anomalous behavior.

Ques 10. How many of the following compounds have zero dipole moment.

NH₃, H₂O, HF, CO₂, SO₂, BF₃, CH₄

Ans. 3

Solution: To determine whether a molecule has a zero dipole moment, we need to consider its molecular geometry and the individual bond dipoles.

1. NH₃ (Ammonia):

- NH₃ has a trigonal pyramidal molecular geometry.
- The N-H bonds are polar due to the electronegativity difference between N and H.
- However, the dipole moments of the N-H bonds do not cancel each other out, resulting in a net dipole moment for NH₃.
- Conclusion: NH₃ has a nonzero dipole moment.

2. H₂O (Water):

- H₂O has a bent molecular geometry.
- The O-H bonds are polar due to the electronegativity difference between O and H.
- The dipole moments of the O-H bonds do not cancel each other out, resulting in a net dipole moment for H₂O.
- Conclusion: H₂O has a nonzero dipole moment.

3. HF (Hydrogen fluoride):

- HF has a linear molecular geometry.
- The H-F bond is highly polar due to the electronegativity difference between H and F.
- The dipole moment of the H-F bond does not cancel out with any other bond dipole, resulting in a nonzero dipole moment for HF.
- Conclusion: HF has a nonzero dipole moment.

4. CO₂ (Carbon dioxide):

- CO₂ has a linear molecular geometry.

- The C=O bonds are polar due to the electronegativity difference between C and O.

- However, the dipole moments of the C=O bonds cancel each other out perfectly, resulting in a zero dipole moment for CO₂.

- Conclusion: CO₂ has a zero dipole moment.

5. SO₂ (Sulfur dioxide):

- SO₂ has a bent molecular geometry.

- The S=O bonds are polar due to the electronegativity difference between S and O.

- The dipole moments of the S=O bonds do not cancel each other out, resulting in a nonzero dipole moment for SO₂.

- Conclusion: SO₂ has a nonzero dipole moment.

6. BF₃ (Boron trifluoride):

- BF₃ has a trigonal planar molecular geometry.

- The B-F bonds are polar due to the electronegativity difference between B and F.

- However, the molecule is symmetrical, and the dipole moments of the B-F bonds cancel each other out perfectly, resulting in a zero dipole moment for BF₃.

- Conclusion: BF₃ has a zero dipole moment.

7. CH₄ (Methane):

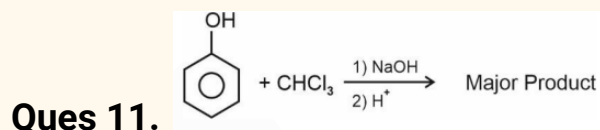
- CH₄ has a tetrahedral molecular geometry.

- The C-H bonds are polar due to the electronegativity difference between C and H.

- However, the molecule is symmetrical, and the dipole moments of the C-H bonds cancel each other out perfectly, resulting in a zero dipole moment for CH₄.

- Conclusion: CH₄ has a zero dipole moment.

Therefore, out of the given compounds, CO₂, BF₃, and CH₄ have zero dipole moments. So, 3 of the compounds have zero dipole moment.



The major product in the above reaction is

- A. 2-hydroxybenzaldehyde
- B. 2-hydroxybenzoic acid
- C. 4-hydroxybenzaldehyde
- D. 3-hydroxybenzaldehyde

Ans. A

Ques 12. The correct statement about Zn, Cd, Hg are

- A. All are solid metals at room temperature
- B. They have high enthalpy of atomization
- C. All are paramagnetic
- D. Zn, Cd cannot show variable oxidation state but Hg can show variable oxidation state

Ans. D

Solution: The correct statement about Zn (zinc), Cd (cadmium), and Hg (mercury) is:

D. Zn, Cd cannot show variable oxidation states but Hg can show variable oxidation states.

Explanation:

- Zn and Cd are transition metals with filled d orbitals in their most stable oxidation states. Zn predominantly exists in the +2 oxidation state, while Cd mainly exists in the +2 oxidation state. They do not commonly exhibit variable oxidation states.

- On the other hand, Hg is also a transition metal but can exhibit variable oxidation states, including +1 and +2. This ability to exhibit variable oxidation states is due to the presence of a partially filled d orbital in its electronic configuration.
- None of these metals are paramagnetic at room temperature; they exhibit diamagnetic behavior due to completely filled or nearly filled d orbitals in their most stable oxidation states.
- While Zn and Cd are typically solid metals at room temperature, Hg is a liquid metal at room temperature.

Therefore, option D is the correct statement about Zn, Cd, and Hg.

Ques 13. In chromatographic techniques, which of the following follows preferential adsorption?

- (A) Column chromatography**
- (B) Thin layer chromatography**
- (C) Paper chromatography**
- A. A only**
- B. B only**
- C. C only**
- D. A and B both**

Ans. D

Solution: In chromatographic techniques, preferential adsorption refers to the phenomenon where certain components in a mixture have a stronger affinity for the stationary phase (adsorbent) compared to others, resulting in their slower movement through the system.

Among the given options:

- Column chromatography involves the separation of components based on their differential adsorption to the stationary phase packed in a column. It commonly follows preferential adsorption.

- Thin layer chromatography (TLC) also relies on differential adsorption of components to a thin layer of adsorbent coated on a solid support. It is another technique that typically follows preferential adsorption.
- Paper chromatography involves the separation of components using a piece of paper as the stationary phase. While it also relies on adsorption, it may not always exhibit preferential adsorption to the same extent as column chromatography or TLC.

Based on this analysis, the correct option is:

D. A and B both
(Column chromatography and Thin layer chromatography)

Ques 14. Find the total number of sigma and pi bonds in 2-formyl hex-4-enoic acid.

- A. 20
- B. 22
- C. 18
- D. 24

Ans. B

Ques 15. A gas 'X' is added to Nessler's reagent then brown precipitate is formed, gas X is

- A. NH_3
- B. SO_2
- C. Cl_2
- D. Br_2

Ans.

Solution: When a gas is added to Nessler's reagent (a solution of potassium tetraiodomercurate(II)), and a brown precipitate is formed, it indicates the presence of ammonia gas (NH_3).

Therefore, the correct answer is:

A) NH3

JEE Main Mathematics Questions

Ques 1. Given set = $\{1, 2, 3, \dots, 50\}$ one number is selected randomly from the set. Find the probability that number is multiple of 4 or 6 or 7.

- A. $21/50$
- B. $18/50$
- C. $8/25$
- D. $21/25$

Ans. A

Solution: To find the probability that a number selected randomly from the set $\{1, 2, 3, \dots, 50\}$ is a multiple of 4 or 6 or 7, we first need to count the total number of elements in the set that are multiples of each of these numbers. Then, we'll add up these counts and divide by the total number of elements in the set.

1. Multiples of 4:
There are $\left\lfloor \frac{50}{4} \right\rfloor = 12$ multiples of 4 in the set.
2. Multiples of 6:
There are $\left\lfloor \frac{50}{6} \right\rfloor = 8$ multiples of 6 in the set.
3. Multiples of 7:
There are $\left\lfloor \frac{50}{7} \right\rfloor = 7$ multiples of 7 in the set.

However, we need to be careful about overcounting the common multiples. For example, 12 is a multiple of both 4 and 6. We must ensure that such numbers are counted only once.

We can use the principle of inclusion-exclusion to adjust for overcounting:

Total number of multiples of 4 or 6 or 7 = (Multiples of 4) + (Multiples of 6) + (Multiples of 7) - (Multiples of both 4 and 6) - (Multiples of both 4 and 7) - (Multiples of both 6 and 7) + (Multiples of 4, 6, and 7)

1. Multiples of both 4 and 6:

There are $\left\lfloor \frac{50}{12} \right\rfloor = 4$ multiples of both 4 and 6.

2. Multiples of both 4 and 7:

There are $\left\lfloor \frac{50}{28} \right\rfloor = 1$ multiples of both 4 and 7.

3. Multiples of both 6 and 7:

There are $\left\lfloor \frac{50}{42} \right\rfloor = 1$ multiples of both 6 and 7.

4. Multiples of 4, 6, and 7:

There are $\left\lfloor \frac{50}{84} \right\rfloor = 0$ multiples of 4, 6, and 7 in the set.

Now, we can calculate the total number of multiples of 4 or 6 or 7:

$$\text{Total} = 12 + 8 + 7 - 4 - 1 - 1 + 0 = 21$$

The probability that a number selected randomly from the set is a multiple of 4 or 6 or 7 is given by:

$$\text{Probability} = \frac{\text{Total}}{\text{Total number of elements in the set}} = \frac{21}{50}$$

So, the correct answer is option A) 21/50

Ques 2. The value of $\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \sqrt{1 - \sin 2x} \, dx$ is

- A. $\sqrt{2} - \sqrt{3} + 1$
- B. $2\sqrt{2} - \sqrt{3} - 1$
- C. $2\sqrt{2} + \sqrt{3} - 1$
- D. $\sqrt{2} + \sqrt{3} - 1$

Ans. B

Ques 3. The remainder when $64^{32^{32}}$ is divided by 9 is

Ans. 1

Ques 4. Area bounded by $0 \leq y \leq \min\{x^2 + 2, 2x + 2\}$, $x \in [0, 3]$ then 12A is

Ans. 164

Solution: To find the area bounded by the curves

$y = \min(x^2 + 2, 2x + 2)$ and x in the interval $[0, 3]$, we need to determine the points of intersection of these curves and then integrate the minimum function over the given interval.

First, let's find the points of intersection by setting the two expressions equal to each other:

$$x^2 + 2 = 2x + 2$$

Solving this equation gives us:

$$x^2 - 2x = 0$$

$$x(x - 2) = 0$$

So, $x = 0$ and $x = 2$ are the points of intersection.

Now, we'll integrate the minimum function over the interval $[0, 2]$ and $[2, 3]$, separately, to find the area.

For $x \in [0, 2]$:

$$\text{Area} = \int_0^2 \min(x^2 + 2, 2x + 2) dx$$

For $x \in [2, 3]$:

$$\text{Area} = \int_2^3 \min(x^2 + 2, 2x + 2) dx$$

Let's calculate these integrals:

For $x \in [0, 2]$:

$$\text{Area} = \int_0^2 (x^2 + 2) dx$$

$$\begin{aligned} &= \left[\frac{x^3}{3} + 2x \right]_0^2 \\ &= \left(\frac{2^3}{3} + 2 \cdot 2 \right) - \left(\frac{0^3}{3} + 2 \cdot 0 \right) \\ &= \left(\frac{8}{3} + 4 \right) - (0 + 0) \\ &= \frac{8}{3} + 4 \\ &= \frac{20}{3} \end{aligned}$$

For $x \in [2, 3]$:

$$\text{Area} = \int_2^3 (2x + 2) dx$$

$$\begin{aligned} &= [x^2 + 2x]_2^3 \\ &= (3^2 + 2 \cdot 3) - (2^2 + 2 \cdot 2) \\ &= (9 + 6) - (4 + 4) \\ &= 15 - 8 \\ &= 7 \end{aligned}$$

Now, let's add these areas together to find the total area:

$$\begin{aligned}\text{Total Area} &= \frac{20}{3} + 7 \\ &= \frac{20}{3} + \frac{21}{3} \\ &= \frac{41}{3}\end{aligned}$$

So, the area bounded by the curves is $41/3$

Now, if $12A$ represents twelve times this area, then $12A = 12 \times 41/3 = 492/3 = 164$

Ques 5. $A = \{1, 2, 3, 4\}$ minimum number of elements added to make an equivalence relation on set A containing $(1, 3)$ & $(1, 2)$ in it.

- A. 8
- B. 9
- C. 12
- D. 16

Ans. A

Ques 6. If $\ln a, \ln b, \ln c$ are in AP and $\ln a - \ln 2b, \ln 2b - \ln 3c, \ln 3c - \ln a$ are in AP then $a : b : c$ is

- A. 1 : 2 : 3
- B. 7 : 7 : 4
- C. 9 : 9 : 4
- D. 4 : 4 : 9

Ans. C

Ques 7. If $r = |z|$, $\theta = \arg(z)$ and $z = 2 - 2i \sqrt{5} \tan(5\pi/8)$ then find (r, θ)

- A. $(2\sec((5\pi)/8), (3\pi)/8)$
- B. $(2\sec((3\pi)/8), (3\pi)/8)$
- C. $(2\tan((3\pi)/8), (5\pi)/8)$
- D. $(2\tan((3\pi)/8), (3\pi)/8)$

Ans. B

Ques 8. In which interval the function $f(x) = x/(x^2-6x-16)$ is increasing?

- A. φ
- B. $[1, 3/4) \cup (5/4, \infty)$
- C. $(5/4, \infty)$
- D. $(3/4, 5/4)$

Ans. A

Ques 9. (α, β) lie on the parabola $y^2 = 4x$ and (α, β) also lie on chord with midpoint $(1, 5/4)$ of another parabola $x^2 = 8y$, then value of $|(8 - \beta)(\alpha - 28)|$ is

- A. 192
- B. 92
- C. 64
- D. 128

Ans. A

Ques 10. If first term of non-constant GP be $1/8$ and every term is AM of

next two, then $\sum_{r=1}^{20} T_r - \sum_{r=1}^{18} T_r$ is

- A. 2^{15}
- B. -2^{15}
- C. -2^{18}
- D. 2^{18}

Ans. B

Ques 11. The mean of 5 observations is $24/5$ and variance is $194/25$. If the mean of first four observations is $7/2$, then the variance of first four observations is

- A. $3/2$
- B. $5/2$
- C. $5/4$
- D. $2/3$

Ans. C

Ques 12. The number of ways to distribute 8 identical books into 4 distinct bookshelf is (where any bookshelf can be empty)

Ans. 165

Ques 13. If $f(x) = \ln\left(\frac{1-x^2}{1+x^2}\right)$ then value of $225(f'(x) - f''(x))$ at $x = \frac{1}{2}$

Ans. 736

Ques 14. $\frac{3\cos 2x + \cos^3 2x}{\cos^6 x - \sin^6 x} = x^3 - x^2 + 6$ then find sum of roots,

Ans. 1