CBSE CLASS X

Mathematics Standard (041)

ANSWER KEY

From previous CBSE Board Exam questions

Code: MLAJRZ	Questions: 70	Maximum Marks: 120	Generated: 2026-06-15 12:52

SELECTIONS USED

Source	Previous-year board
Subject	Mathematics
Lessons	Real Numbers
Year	2022-2026
Questions selected	70

Composition — Types: 33 MCQ · 16 Short · 15 Very short · 6 Assertion–reason · 1 Case-based

Q1. § 1.1 Introduction **[2]**

Find the greatest number which divides 85 and 72 leaving remainders 1 and 2 respectively.

Previously asked in: 2023 30/1/1 Q24

◆ **Real Numbers** HCF / Euclid's Division Lemma – Greatest number leaving given remainders

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Model Answer

The required number divides (85 − 1) = 84 and (72 − 2) = 70.

So, the required number = HCF(84, 70).

$84 = 2^2 \times 3 \times 7$

$70 = 2 \times 5 \times 7$

HCF(84, 70) = $2 \times 7 = \mathbf{14}$

∴ The greatest required number is **14**.

Explanation

When a number divides 85 leaving remainder 1, it exactly divides 85 − 1 = 84. Similarly, it exactly divides 72 − 2 = 70. The *greatest* such number is the HCF of 84 and 70. Examiners expect you to show the subtraction step clearly, then find HCF by prime factorisation (or Euclid's division). Both steps carry marks.

Q2. § 1.2 The Fundamental Theorem of Arithmetic **[1]**

Which of the following cannot be the unit digit of 8^n, where n is a natural number ?

A 4
B 2
C 0
D 6

Previously asked in: 2025 30/6/1 Q2

◆ **Real Numbers** Cyclicity of Unit Digits of Powers of Natural Numbers

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Model Answer

Answer: C (0)

The powers of 8 cycle through unit digits 8, 4, 2, 6 (for n = 1, 2, 3, 4) and repeat. Since $8^n = 2^{3n}$, its prime factorisation contains only 2, never 5, so the unit digit 0 is impossible.

Explanation

The unit digits of powers of 8 follow a cycle of 4: **8 → 4 → 2 → 6 → 8...** So digits 2, 4, and 6 all appear. For a number to end in 0, it must be divisible by both 2 and 5; since $8^n = 2^{3n}$ has no factor of 5 (by FTA, prime factorisation is unique), it can never end in 0.

Q3. § 1.4 Summary **[1]**

For any prime number p, if p divides a^2, where a is any real number then p also divides

A a
B $a^{\frac{1}{2}}$
C $a^{\frac{3}{2}}$
D $a^{\frac{1}{8}}$

Previously asked in: 2025 30/5/1 Q3

◆ **Real Numbers** 1.2 The Fundamental Theorem of Arithmetic

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Model Answer

Option A: a

By Theorem 1.2, if p is a prime and p divides a^2, then p divides a, where a is a positive integer.

Source: Chapter 1, Section 1.3 (Theorem 1.2)

Explanation

This is a direct application of **Theorem 1.2** from the textbook. The theorem states specifically that if a prime p divides a^2, it must divide a itself (not any fractional power of a). The other options involve fractional indices which are not integers, so the theorem does not apply to them. For MCQs like this, simply recall the exact theorem statement.

Q4. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[1]**

In question number 19 and 20, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.

Assertion (A): 4^n ends with digit 0 for some natural number n.
Reason (R): For a number 'x' having 2 and 5 as its prime factors, x^n always ends with digit 0 for every natural number n.

(a) Both, Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).
(b) Both, Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true but Reason (R) is false.
(d) Assertion (A) is false but Reason (R) is true.

Previously asked in: 2025 30/4/1 Q19

◆ **Real Numbers** 1.2 The Fundamental Theorem of Arithmetic

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Model Answer

(d) Assertion (A) is false but Reason (R) is true.

Since $4^n = 2^{2n}$, its only prime factor is 2, never 5. So 4^n never ends with 0 — Assertion is **false**. Reason is **true**: if x has both 2 and 5 as prime factors, then x^n is divisible by 10, so it always ends with 0.

Source: Chapter 1, Section 1.2 (Example 1)

Explanation

The textbook (Example 1, Section 1.2) explicitly states that $4^n = (2)^{2n}$ contains only the prime 2, so it can never end in 0. This makes Assertion (A) false. The Reason correctly states a general principle — a number with both 2 and 5 as factors will always produce a multiple of 10 when raised to any natural number power — so Reason (R) is true. When A is false and R is true, the answer is option (d).

Q5. § 1.1 Introduction § 1.2 The Fundamental Theorem of Arithmetic § 1.3 Revisiting Irrational Numbers **[1]**

The natural number 1 is :

A a prime number.
B a composite number.
C prime as well as composite.
D neither prime nor composite.

Previously asked in: 2026 30/2/1 Q2

◆ **Real Numbers** 1.1 Introduction

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Model Answer

Answer: D — neither prime nor composite.

The number 1 has only one factor (itself), so it is neither a prime (which requires exactly two distinct factors) nor a composite number.

Source: Chapter 1, Section 1.2 — Real Numbers

Explanation

- A **prime** number has exactly **two** distinct factors: 1 and itself. Since 1 has only one factor, it does not qualify.
- A **composite** number has **more than two** factors. 1 does not qualify here either.
- The Fundamental Theorem of Arithmetic treats 1 separately — it is neither prime nor composite. Examiners expect students to know this standard definition precisely.

Q6. § 1.4 Summary **[1]**

The HCF of 960 and 432 is :

(a) 48
(b) 54
(c) 72
(d) 36

Previously asked in: 2026 30/1/1 Q1

◆ **Real Numbers** HCF using Euclid's Division Algorithm / Prime Factorisation

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Model Answer

(a) 48

$960 = 2^6 \times 3 \times 5$; $432 = 2^4 \times 3^3$. HCF = $2^4 \times 3 = 48$.

Explanation

Use prime factorisation: HCF = product of the **smallest powers** of **common** prime factors. Both share 2^4 and 3^1, giving $16 \times 3 = 48$. Always write the factorisation step in board exams for full credit.

Q7. § 1.2 The Fundamental Theorem of Arithmetic § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[1]**

Assertion (A) : The number 5^n cannot end with the digit 0, where n is a natural number.
Reason (R) : Prime factorisation of 5 has only two factors, 1 and 5.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2023 30/5/1 Q20

◆ **Real Numbers** 1.2 The Fundamental Theorem of Arithmetic

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Model Answer

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

Explanation

A is true: $5^n = 5 \times 5 \times \ldots$ has only 5 as its prime factor; for a number to end in 0 it must be divisible by both 2 and 5, but 2 is absent from the prime factorisation of 5^n, so it can never end in 0.

R is true: 1 and 5 are indeed the only factors of 5 (definition of a prime).

Why R does NOT explain A: The correct explanation uses the Fundamental Theorem of Arithmetic — 5^n lacks the prime factor 2, so it cannot be divisible by 10. The statement about 5 having only two factors (1 and 5) is a general property of primes and does not directly explain why 5^n cannot end in 0. Hence option **(b)**.

Q8. **[1]**

If $(-1)^n + (-1)^8 = 0$, then n is:

A any positive integer
B any negative integer
C any odd number
D any even number

Previously asked in: 2025 30/1/1 Q9

◆ **Real Numbers** Properties of Odd and Even Integers (Powers of -1)

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Model Answer

Answer: (C) any odd number

Since $(-1)^8 = 1$, the equation becomes $(-1)^n + 1 = 0$, so $(-1)^n = -1$, which holds when n is any odd number.

Explanation

$(-1)^{\text{even}} = +1$ and $(-1)^{\text{odd}} = -1$. Since $(-1)^8 = 1$, we need $(-1)^n = -1$, which requires n to be odd. Note: n need not be positive or negative specifically — any odd integer works, making (C) the correct and most precise option.

Q9. § 1.4 Summary **[1]**

If $\mathrm{HCF}(98, 28) = m$ and $\mathrm{LCM}(98, 28) = n$, then the value of $n - 7m$ is:

A 0
B 28
C 98
D 198

Previously asked in: 2025 30/1/1 Q6

◆ **Real Numbers** | 1.2 The Fundamental Theorem of Arithmetic

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Model Answer

Option (A) 0

$98 = 2 \times 7^2$, $28 = 2^2 \times 7$, so $m = \mathrm{HCF} = 2 \times 7 = 14$ and $n = \mathrm{LCM} = 2^2 \times 7^2 = 196$.
Therefore, $n - 7m = 196 - 7(14) = 196 - 98 = 98$...

Wait — recalculating: $n - 7m = 196 - 98 = 98$. → **(C) 98**

Explanation

- $98 = 2 \times 7^2$; $28 = 2^2 \times 7$
- HCF = product of **lowest** powers of common primes = $2^1 \times 7^1 = 14 = m$
- LCM = product of **highest** powers = $2^2 \times 7^2 = 196 = n$
- $n - 7m = 196 - 98 = \mathbf{98}$

The correct answer is **C**. A common slip is miscalculating LCM or forgetting to multiply 7 by m (not just subtract 7). Always verify using HCF × LCM = product of the two numbers: $14 \times 196 = 2744 = 98 \times 28$ ✓

Q10. **[2]**

If the HCF of 210 and 55 is expressed as $210 \times 5 + 55m$, then find the value of m.

Previously asked in: 2026 30/4/1 Q24 (OR-2)

◆ **Real Numbers** | Euclid's Division Algorithm / HCF as linear combination

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Model Answer

HCF of 210 and 55:

$210 = 55 \times 3 + 45$
$55 = 45 \times 1 + 10$
$45 = 10 \times 4 + 5$
$10 = 5 \times 2 + 0$

∴ HCF(210, 55) = **5**

Given: $210 \times 5 + 55m = 5$

$1050 + 55m = 5$

$55m = 5 - 1050 = -1045$

$$m = \frac{-1045}{55} = -19$$

∴ **m = −19**

Source: Chapter 1, Euclid's Division Algorithm

Explanation

The examiner expects you to first find HCF(210, 55) using Euclid's Division Algorithm (step-by-step), then substitute it into the given expression and solve for m. Both steps carry marks — don't skip the division steps. The negative value of m is correct and expected.

Q11. **[1]**

For any natural number n, 5^n ends with the digit :

A 0
B 5
C 3
D 2

Previously asked in: 2026 30/2/1 Q3

◆ **Real Numbers** Units digit / last digit of powers of natural numbers

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Model Answer

Answer: B — 5

Since $5^1 = 5,\ 5^2 = 25,\ 5^3 = 125, \ldots$, every power of 5 ends with the digit **5** for any natural number n.

Explanation

The units digit of powers of 5 follows a fixed pattern: it is always 5. This is because 5×5 always gives a product ending in 5. The prime factorisation of 5^n contains only the prime 5, so it can never end in 0 (which would require factors of both 2 and 5). Source: Chapter 1, Section 1.2 (Fundamental Theorem of Arithmetic).

Q12. **[1]**

For any natural number n, 6^n ends with the digit :

(a) 0
(b) 6
(c) 3
(d) 2

Previously asked in: 2026 30/1/1 Q3

◆ **Real Numbers** Properties of powers of natural numbers / last digit of 6^n

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Model Answer

(b) 6

Since $6 = 2 \times 3$, we have $6^n = 2^n \times 3^n$. The prime factorisation contains no factor of 5, so 6^n never ends in 0; it always ends with the digit **6** (e.g., $6^1 = 6,\ 6^2 = 36,\ 6^3 = 216$).

Source: Chapter 1, Section 1.2 (Exercise 1.1, Q5)

Explanation

- The key reasoning mirrors Exercise 1.1 Q5: for 6^n to end in 0, it must be divisible by both 2 and 5. Since $6^n = 2^n \times 3^n$ has no factor of 5, it can never end in 0.
- A quick pattern check (6, 36, 216, 1296...) confirms the units digit is always 6.
- Examiners expect you to cite the prime factorisation argument, not just pattern observation.

Q13. § 1.2 The Fundamental Theorem of Arithmetic **[4]**

> Teaching Mathematics through activities is a powerful approach that enhances students' understanding and engagement. Keeping this in mind, Ms. Mukta planned a prime number game for class 5 students. She announces the number 2 in her class and asked the first student to multiply it by a prime number and then pass it to second student. Second student also multiplied it by a prime number and passed it to third student. In this way by multiplying to a prime number, the last student got 173250.

Now, Mukta asked some questions as given below to the students :

- **(i)** What is the least prime number used by students ? [1]
- **(ii)** How many students are in the class ? [2]
- **(iii)** Which prime number has been used maximum times ? [1]

Previously asked in: 2024 30/3/1 Q38

◆ **Real Numbers** | Prime Numbers and Factorization

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Model Answer

First, find the prime factorisation of 173250:

$173250 = 2 \times 86625 = 2 \times 3 \times 28875 = 2 \times 3 \times 3 \times 9625 = 2 \times 3 \times 3 \times 5 \times 1925 = 2 \times 3 \times 3 \times 5 \times 5 \times 385 = 2 \times 3 \times 3 \times 5 \times 5 \times 5 \times 77 = 2 \times 3 \times 3 \times 5 \times 5 \times 5 \times 7 \times 11$

So, $173250 = \mathbf{2 \times 3^2 \times 5^3 \times 7 \times 11}$

The game starts with 2 (announced by Ms. Mukta), so students multiply by the remaining prime factors: **3, 3, 5, 5, 5, 7, 11**.

(i) The least prime number used by students = **3**
(2 was the starting number announced by the teacher, not multiplied by a student.)

(ii) The prime factors multiplied by students are: 3, 3, 5, 5, 5, 7, 11 → **7 students** are in the class.

(iii) 5 appears 3 times, which is the maximum. The prime number used maximum times = **5**.

Explanation

- Start with prime factorisation of 173250 — this is the key step.
- Since Ms. Mukta *announced* 2 (she didn't multiply), students only multiply the remaining factors. Count those factors = number of students.
- "Least prime used by students" excludes 2 (the teacher's starting number), so the answer is 3, not 2. Some students miss this nuance — read the passage carefully.
- "Maximum times" means the factor with the highest frequency → 5 (appears 3 times).

Q14. § 1.2 The Fundamental Theorem of Arithmetic **[1]**

The natural number 2 is :

(a) a prime number
(b) a composite number
(c) prime as well as composite
(d) neither prime nor composite

Previously asked in: 2026 30/1/1 Q2

◆ **Real Numbers** | Least composite and least prime number identification

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Model Answer

(a) a prime number

2 is a prime number because it has exactly two distinct factors: 1 and itself, and it is listed among the collection of prime numbers in the Fundamental Theorem of Arithmetic.

Source: Chapter 1, Section 1.2

Explanation

2 is the smallest and the only even prime number. A prime number has exactly two factors — 1 and itself. 2 satisfies this condition. It is neither composite (which requires more than two factors) nor both. Examiners expect the correct option with a brief justification for MCQs.

Q15. § 1.4 Summary **[1]**

If $p^2 = \frac{32}{50}$, then p is a/an

A whole number
B integer
C rational number
D irrational number

Previously asked in: 2023 30/6/1 Q1

◆ **Real Numbers** | Rational and Irrational Numbers

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Model Answer

Answer: C — Rational number

$p^2 = \dfrac{32}{50} = \dfrac{16}{25}$, so $p = \pm\dfrac{4}{5}$, which can be written in the form $\dfrac{p}{q}$ $(q \neq 0)$, hence p is a **rational number**.

Explanation

Simplify 32/50 to 16/25 first, then take the square root to get ±4/5. Since this is expressible as a ratio of two integers with non-zero denominator, it is rational — not irrational. It is not a whole number or integer because 4/5 is a fraction. Examiners expect you to simplify before concluding.

Q16. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[1]**

Assertion (A): The perimeter of $\triangle ABC$ is a rational number. Reason (R): The sum of the squares of two rational numbers is always rational.

A Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
B Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
C Assertion (A) is true but Reason (R) is false.
D Assertion (A) is false but Reason (R) is true.

Previously asked in: 2023 30/1/1 Q20

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers

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Model Answer

Option (D): Assertion (A) is false but Reason (R) is true.

AC = $\sqrt{AB^2 + BC^2} = \sqrt{4+9} = \sqrt{13}$ (irrational). So perimeter = $2 + 3 + \sqrt{13}$ is irrational, making A false. R is true since sum of squares of two rationals is always rational.

Explanation

- Check AC using Pythagoras: $\sqrt{2^2 + 3^2} = \sqrt{13}$, which is irrational (13 is not a perfect square).
- Perimeter = rational + irrational = irrational → Assertion is **false**.
- Reason: $\left(\frac{p}{q}\right)^2 + \left(\frac{a}{b}\right)^2$ is always rational → Reason is **true**.
- R does not explain A (since A itself is false), so answer is **(D)**.

Q17. **[1]**

$\sqrt{0.4}$ is a/an

A natural number
B integer
C rational number
D irrational number

Previously asked in: 2025 30/6/1 Q1

◆ **Real Numbers** Irrational Numbers

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Model Answer

Answer: D — Irrational number

$\sqrt{0.4} = \sqrt{\frac{2}{5}} = \frac{\sqrt{2}}{\sqrt{5}}$, which cannot be expressed as $\frac{p}{q}$ (integers), so it is an irrational number.

Explanation

$0.4 = \frac{2}{5}$, and since 2 and 5 are primes, $\sqrt{2}$ and $\sqrt{5}$ are both irrational. The quotient of two irrationals here does not simplify to a rational — the result is still irrational. The key rule from the chapter: $\sqrt{p}$ is irrational when p is prime, and products/quotients involving irrationals (with non-zero rationals) remain irrational. Examiners expect you to simplify $\sqrt{0.4}$ first, then identify its nature.

Q18. **[1]**

$\left(\sqrt{3}+2\right)^2 + \left(\sqrt{3}-2\right)^2$ is a/an

A positive rational number
B negative rational number
C positive irrational number
D negative irrational number

Previously asked in: 2025 30/5/1 Q1

◆ **Real Numbers** | Rational and Irrational Numbers – Identifying nature of expressions

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Model Answer

$(\sqrt{3}+2)^2 + (\sqrt{3}-2)^2 = (3+4\sqrt{3}+4) + (3-4\sqrt{3}+4) = 14$, which is a **positive rational number**.

Answer: A

Explanation

Using $(a+b)^2 + (a-b)^2 = 2(a^2+b^2)$, the irrational terms ($4\sqrt{3}$) cancel out, leaving $2(3+4) = 14$. Examiners expect the calculation shown briefly to justify the choice.

Q19. **[1]**

$\left(1+\sqrt{3}\right)^2 - \left(1-\sqrt{3}\right)^2$ is :

(a) a positive rational number.
(b) a negative integer.
(c) a positive irrational number.
(d) a negative irrational number.

Previously asked in: 2025 30/4/1 Q2

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers

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Model Answer

$(1+\sqrt{3})^2 - (1-\sqrt{3})^2 = (1+3+2\sqrt{3}) - (1+3-2\sqrt{3}) = 4\sqrt{3}$, which is a positive irrational number.

(c) a positive irrational number.

Explanation

Use the identity $a^2 - b^2 = (a+b)(a-b)$ or expand directly. The rational parts cancel, leaving $4\sqrt{3}$ — a positive irrational (product of a non-zero rational and an irrational).

Q20. § 1.4 Summary **[1]**

A pair of irrational numbers whose product is a rational number is :

A $(\sqrt{16},\ \sqrt{4})$
B $(\sqrt{5},\ \sqrt{2})$
C $(\sqrt{3},\ \sqrt{27})$
D $(\sqrt{36},\ \sqrt{2})$

Previously asked in: 2024 30/3/1 Q14

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers

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Model Answer

Answer: C — $(\sqrt{3},\ \sqrt{27})$

$\sqrt{3} \times \sqrt{27} = \sqrt{81} = 9$, which is rational. Both $\sqrt{3}$ and $\sqrt{27}$ are irrational numbers whose product is rational.

Explanation

- Options A and D: $\sqrt{16} = 4$ and $\sqrt{36} = 6$ are rational, so those pairs don't qualify.
- Option B: $\sqrt{5} \times \sqrt{2} = \sqrt{10}$, which is irrational.
- Option C: $\sqrt{3} \times \sqrt{27} = \sqrt{3 \times 27} = \sqrt{81} = 9$ ✓ — both factors are irrational, product is rational. This is the key check examiners expect you to perform quickly.

Q21. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[1]**

Which of the following is a rational number between $\sqrt{3}$ and $\sqrt{5}$?

A $1{\cdot}4142387954012\ldots$
B $\sqrt{4}$
C $\sqrt{\dfrac{15}{4}}$
D $1{\cdot}857142\ldots$

Previously asked in: 2025 30/1/1 Q14

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers

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Model Answer

Option B: $\sqrt{4}$

$\sqrt{4} = 2$, which is a rational number. Since $\sqrt{3} \approx 1.732$ and $\sqrt{5} \approx 2.236$, the value 2 lies between them.

Explanation

- $\sqrt{4} = 2$ is a perfect square, hence rational (can be written as $\frac{2}{1}$).
- Options A and D are non-terminating, non-repeating decimals → irrational.
- Option C: $\sqrt{\frac{15}{4}} = \frac{\sqrt{15}}{2}$, which is irrational since $\sqrt{15}$ is irrational.
- Always check: is the number rational **and** does it fall between $\sqrt{3} \approx 1.732$ and $\sqrt{5} \approx 2.236$? Only $\sqrt{4} = 2$ satisfies both conditions.

Q22. § 1.3 Revisiting Irrational Numbers **[2]**

Prove that $2 + 3\sqrt{5}$ is an irrational number given that $\sqrt{5}$ is irrational.

Previously asked in: 2026 30/4/1 Q24 (OR-1)

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers

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Model Answer

Proof: Assume, to the contrary, that $2 + 3\sqrt{5}$ is rational.

Then we can find coprime integers a and b ($b \neq 0$) such that:

$$2 + 3\sqrt{5} = \frac{a}{b}$$

$$3\sqrt{5} = \frac{a}{b} - 2 = \frac{a - 2b}{b}$$

$$\sqrt{5} = \frac{a - 2b}{3b}$$

Since a and b are integers, $\frac{a - 2b}{3b}$ is rational, which means $\sqrt{5}$ is rational.

But this **contradicts** the given fact that $\sqrt{5}$ is irrational.

Therefore, our assumption is wrong, and $2 + 3\sqrt{5}$ is **irrational**. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- This is a **proof by contradiction** question. Always start by assuming the opposite of what you want to prove.
- The key step is **isolating** $\sqrt{5}$ on one side, showing it equals a ratio of integers — which contradicts the given condition.
- Always state clearly: "this contradicts the fact that $\sqrt{5}$ is irrational" — examiners award a mark specifically for this contradiction statement.
- The phrase "given that $\sqrt{5}$ is irrational" means you do **not** need to prove $\sqrt{5}$'s irrationality; just use it as a fact.

Q23. § 1.3 Revisiting Irrational Numbers **[1]**

Assertion (A): $(\sqrt{3}+\sqrt{5})$ is an irrational number.

Reason (R): Sum of any two irrational numbers is always irrational.

Select the correct answer from the options (A), (B), (C) and (D) as given below:

A Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
B Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
C Assertion (A) is true, but Reason (R) is false.
D Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 30/4/1 Q20

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers

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Model Answer

(C) Assertion (A) is true, but Reason (R) is false.

Assertion is true: $\sqrt{3}$ and $\sqrt{5}$ are both irrational, and their sum $(\sqrt{3}+\sqrt{5})$ is irrational. Reason is false: for example, $(\sqrt{3})+(-\sqrt{3})=0$, which is rational. So the sum of two irrationals is **not always** irrational.

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- **A is true** because $\sqrt{3}$ and $\sqrt{5}$ are proven irrationals (Section 1.3), and their sum cannot be rational (provable by contradiction).
- **R is false** because the statement "sum of any two irrationals is always irrational" has a counterexample: $\sqrt{3}+(-\sqrt{3})=0$ (rational). Examiners specifically look for this counterexample to disprove R.
- Since A is true but R is false, the answer is **(C)** — a very common trap in Assertion-Reason questions.

Q24. [3]

In a teachers' workshop, the number of teachers teaching French, Hindi and English are 48, 80 and 144 respectively. Find the minimum number of rooms required if in each room the same number of teachers are seated and all of them are of the same subject.

Previously asked in: 2024 30/1/1 Q27

◆ **Real Numbers** | HCF Application – Grouping/Minimum Rooms Problems

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Model Answer

To find the minimum number of rooms, we need the HCF of 48, 80 and 144 (maximum teachers per room, same subject).

Prime factorisation:

- $48 = 2^4 \times 3$
- $80 = 2^4 \times 5$
- $144 = 2^4 \times 3^2$

HCF(48, 80, 144) = 2^4 = **16**

So, 16 teachers can be seated in each room.

Number of rooms required:

- French: $48 \div 16 = 3$
- Hindi: $80 \div 16 = 5$
- English: $144 \div 16 = 9$

Total minimum rooms = 3 + 5 + 9 = 17

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key insight is that the **number of teachers per room must divide all three numbers exactly** → this is the HCF.
- HCF gives the **maximum** number per room, which gives the **minimum** number of rooms — examiners specifically check this logic.
- Show prime factorisation clearly; take the **lowest power of common prime factors** for HCF.
- Don't forget to add the rooms for all three subjects at the end — that single addition step carries a mark.

Q25. § 1.4 Summary **[1]**

If two positive integers p and q can be expressed as $p = 18\,a^2b^4$ and $q = 20\,a^3b^2$, where a and b are prime numbers, then LCM (p, q) is :

(a) $2\,a^2b^2$
(b) $180\,a^2b^2$
(c) $12\,a^2b^2$
(d) $180\,a^3b^4$

Previously asked in: 2024 30/1/1 Q5

◆ **Real Numbers** LCM of numbers expressed in prime factorisation form

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Model Answer

(d) $180\,a^3b^4$

LCM = product of greatest powers of all prime factors: $18 = 2 \times 3^2$, $20 = 2^2 \times 5$, so LCM$(p, q) = 2^2 \times 3^2 \times 5 \times a^3 \times b^4 = 180\,a^3b^4$.

Explanation

LCM takes the **highest power** of every prime factor present in either number. For the numerical part: $18 = 2 \times 3^2$ and $20 = 2^2 \times 5$, giving $2^2 \times 3^2 \times 5 = 180$. For the variable part: highest power of a is a^3 (from q) and highest power of b is b^4 (from p). This directly applies the Fundamental Theorem of Arithmetic (Chapter 1, Section 1.2).

Q26. **[3]**

The dimensions of a window are 156 cm $\times$ 216 cm. Arjun wants to put grill on the window creating complete squares of maximum size. Determine the side length of the square and hence find the number of squares formed.

Previously asked in: 2026 30/5/1 Q31

◆ **Real Numbers** | HCF / GCD Application – Maximum size of square tiles/grills

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Model Answer

The side of the largest square must divide both dimensions exactly, so we need **HCF(156, 216)**.

Prime factorisation:

$$156 = 2^2 \times 3 \times 13$$

$$216 = 2^3 \times 3^3$$

HCF(156, 216) = $2^2 \times 3 = 12$ cm

Side length of each square = 12 cm

Number of squares along length = $156 \div 12 = 13$

Number of squares along breadth = $216 \div 12 = 18$

Total number of squares = $13 \times 18 = 234$

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key insight: "maximum size" of a complete square that fits both dimensions → HCF of the two dimensions.
- Always show prime factorisation clearly; examiners award 1 mark for it.
- Finding HCF gets 1 mark; computing the number of squares gets the final mark.
- Don't forget to multiply both directions to get total squares — a common omission.

Q27. § 1.4 Summary **[1]**

Directions: Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.

Assertion (A) : H.C.F. $(36m^2, 18m) = 18m$, where m is a prime number.

Reason (R) : H.C.F. of two numbers is always less than or equal to the smaller number.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 30/5/1 Q20

◆ **Real Numbers** | HCF of algebraic expressions / monomials | Properties of HCF (HCF ≤ smaller number)

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Model Answer

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A). $36m^2 = 2^2 \times 3^2 \times m^2$ and $18m = 2 \times 3^2 \times m$. HCF $= 2 \times 3^2 \times m = 18m$ ✓. Reason (R) is also true (HCF ≤ smaller number), but it does not explain *why* HCF equals 18m specifically.

Explanation

- **Check A:** Use prime factorisation. $36m^2 = 2^2 \cdot 3^2 \cdot m^2$; $18m = 2 \cdot 3^2 \cdot m$. HCF = lowest powers of common factors = $2^1 \cdot 3^2 \cdot m^1 = 18m$. ✓
- **Check R:** HCF of any two numbers is always ≤ the smaller number — this is a standard true property. Here HCF $= 18m =$ the smaller number, consistent.
- **Why (B) not (A):** R explains a general inequality property, not the specific calculation that gives HCF $= 18m$. So R is true but **not** the correct explanation of A. Choose **(B)**.

Q28. § 1.4 Summary **[3]**

Find the HCF and LCM of 26, 65 and 117, using prime factorisation.

Previously asked in: 2023 30/6/1 Q27(A)

◆ **Real Numbers** HCF and LCM using Prime Factorisation

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Model Answer

Prime Factorisation:

$26 = 2 \times 13$

$65 = 5 \times 13$

$117 = 3 \times 3 \times 13 = 3^2 \times 13$

HCF = Product of the **smallest powers of common prime factors**

Common prime factor = 13

$\therefore \text{HCF}(26, 65, 117) = 13$

LCM = Product of the **greatest powers of all prime factors**

$\therefore \text{LCM}(26, 65, 117) = 2^1 \times 3^2 \times 5^1 \times 13^1 = 2 \times 9 \times 5 \times 13 = \mathbf{1170}$

Source: Chapter 1, Section 1.2 (The Fundamental Theorem of Arithmetic)

Explanation

- **HCF**: Take only the prime factors **common to all** three numbers, each raised to the **lowest** power present. Here only 13 is common to all three → HCF = 13.
- **LCM**: Take **every** prime factor that appears in any of the numbers, each raised to its **highest** power → LCM = $2 \times 3^2 \times 5 \times 13 = 1170$.
- Show the factorisation step clearly — examiners award marks for the working, not just the final answer.
- Note: For three numbers, HCF × LCM ≠ product of the three numbers, so don't try to verify using that shortcut.

Q29. § 1.4 Summary **[2]**

Find the HCF and LCM of 72 and 120.

Previously asked in: 2023 30/6/1 Q21(B)

◆ **Real Numbers** HCF and LCM using Prime Factorisation

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Model Answer

Prime factorisation:
$72 = 2^3 \times 3^2$
$120 = 2^3 \times 3 \times 5$

HCF = Product of smallest powers of common prime factors $= 2^3 \times 3^1 = **24**$

LCM = Product of greatest powers of all prime factors $= 2^3 \times 3^2 \times 5 = **360**$

Verification: HCF × LCM $= 24 \times 360 = 8640 = 72 \times 120$ ✓

Source: Chapter 1, Section 1.2 — The Fundamental Theorem of Arithmetic

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Explanation

- **What examiners look for:** Write prime factorisations clearly, then state the rule for HCF (smallest powers of *common* factors) and LCM (greatest powers of *all* factors). Both values must be correct for full marks.
- The verification step (HCF × LCM = product of numbers) is a good 2-mark habit — it shows understanding and catches arithmetic errors.
- These exact numbers (72 and 120) appear as part of Example 4 in the textbook (with a third number, 6), so the factorisations are directly from the source.

Q30. [2]

Show that 6^n can not end with digit 0 for any natural number 'n'.

Previously asked in: 2023 30/6/1 Q21(A)

◆ **Real Numbers** | Fundamental Theorem of Arithmetic – prime factorisation of 6^n and divisibility by 10

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Model Answer

If 6^n ends with digit 0, it must be divisible by 10, so its prime factorisation must contain both 2 and 5 as factors.

Now, $6^n = (2 \times 3)^n = 2^n \times 3^n$.

The only prime factors of 6^n are 2 and 3. The prime 5 does not appear in its factorisation.

By the uniqueness of the Fundamental Theorem of Arithmetic, 5 can never be a factor of 6^n. Hence, 6^n cannot end with digit 0 for any natural number n.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key idea: a number ends in 0 only if it is divisible by **both 2 and 5** (since $10 = 2 \times 5$).
- Show that the prime factorisation of 6^n contains **only 2 and 3**, never 5.
- Invoke the **uniqueness part** of the Fundamental Theorem of Arithmetic — this is what examiners want to see explicitly stated.
- Don't forget to write the conclusion clearly. Many students lose the final half-mark by not stating it.

Q31. § 1.4 Summary **[3]**

Let p, q and r be three distinct prime numbers. Check whether $p \cdot q \cdot r + q$ is a composite number or not. Further, give an example for 3 distinct primes p, q, r such that

(i) $p \cdot q \cdot r + 1$ is a composite number.

(ii) $p \cdot q \cdot r + 1$ is a prime number.

Previously asked in: 2025 30/6/1 Q26(b)

◆ **Real Numbers** | Composite numbers and prime factorisation arguments | Examples involving products of distinct primes ± 1 being prime or composite

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Model Answer

Checking p·q·r + q:

$p \cdot q \cdot r + q = q(pr + 1)$

Since q > 1 and (pr + 1) > 1, this expression has factors other than 1 and itself. Hence, **p·q·r + q is always a composite number**.

(i) p·q·r + 1 is composite:

Let p = 2, q = 3, r = 5.

$2 \times 3 \times 5 + 1 = 31$ — this is prime. Try p = 2, q = 7, r = 11:

$2 \times 7 \times 11 + 1 = 155 = 5 \times 31$ → **composite**. ✓

(So p = 2, q = 7, r = 11 works.)

(ii) p·q·r + 1 is prime:

Let p = 2, q = 3, r = 5.

$2 \times 3 \times 5 + 1 = 31$, which is **prime**. ✓

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key step for the first part is **factoring out q**: $q(pr + 1)$ immediately shows two factors both greater than 1, proving it composite. Examiners want this algebraic step shown clearly.
- For part (i) and (ii), you just need **one valid example each** with verification. The examiner checks that you compute the product, add 1, and confirm composite/prime. Don't overcomplicate — one correct example with the calculation shown is full marks.
- Note: the same set of primes (2, 3, 5) gives a prime in (ii), so use a different set for (i).

Q32. § 1.4 Summary **[1]**

Directions: A statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.
Assertion (A): For any two prime numbers p and q, their HCF is 1 and LCM is p + q.
Reason (R): For any two natural numbers, HCF × LCM = product of numbers.

A Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).
B Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
C Assertion (A) is true, but Reason (R) is false.
D Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2025 30/6/1 Q19

◆ **Real Numbers** | HCF and LCM of prime numbers | Relationship between HCF, LCM and product of two natural numbers

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Model Answer

Option D: Assertion (A) is false, but Reason (R) is true.

The LCM of two primes p and q is p × q, not p + q. So Assertion is false. Reason (R) is a standard correct result: HCF × LCM = product of two numbers.

Explanation

- **Assertion is FALSE**: For two distinct primes p and q, HCF = 1 (correct), but LCM = p × q (not p + q). E.g., primes 2 and 3: LCM = 6, not 5.
- **Reason is TRUE**: HCF(a, b) × LCM(a, b) = a × b holds for any two positive integers — this is explicitly stated in the textbook (Chapter 1, Section 1.2).
- Since A is false and R is true, the answer is **D**.

Q33. § 1.2 The Fundamental Theorem of Arithmetic | § 1.4 Summary **[3]**

State true or false for each of the following statements and justify in each case :

- **(i)** $2 \times 3 \times 5 \times 7 + 7$ is a composite number.
- **(ii)** $2 \times 3 \times 5 \times 7 + 1$ is a composite number.

Previously asked in: 2025 30/5/1 Q26(b)

◆ **Real Numbers** | Composite Numbers and Prime Factorization

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Model Answer

(i) True.

$2 \times 3 \times 5 \times 7 + 7 = 210 + 7 = 217$

Taking 7 as common: $= 7(2 \times 3 \times 5 + 1) = 7 \times 31$

Since 217 has factors other than 1 and itself (7 and 31), it is a **composite number**.

(ii) True.

$2 \times 3 \times 5 \times 7 + 1 = 210 + 1 = 211$

Wait — 211 is actually a **prime** number (not divisible by 2, 3, 5, 7, 11, 13; and $\sqrt{211} < 15$).

Correction: (ii) is FALSE. $2 \times 3 \times 5 \times 7 + 1 = 211$, which is a prime number, not composite.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- For (i), factoring out 7 immediately shows it is composite — this is the key step examiners look for.
- For (ii), many students carelessly mark it True assuming any such expression must be composite. You must actually compute: 211 is prime (check divisibility by all primes up to $\sqrt{211} \approx 14.5$, i.e., 2, 3, 5, 7, 11, 13 — none divide 211). The answer is **False**.
- Always compute the value and verify; do not assume.

Q34. § 1.4 Summary **[1]**

Let $x = a^2b^3c^n$ and $y = a^3b^mc^2$, where a, b, c are prime numbers. If LCM of x and y is $a^3b^4c^3$, then the value of m + n is

A 10
B 7
C 6
D 5

Previously asked in: 2025 30/5/1 Q2

◆ **Real Numbers** LCM of numbers expressed as prime factorizations

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Model Answer

(B) 7

LCM takes the highest power of each prime. For prime b: max$(3, m) = 4 \Rightarrow m = 4$. For prime c: max $(n, 2) = 3 \Rightarrow n = 3$. So $m + n = 4 + 3 = \mathbf{7}$.

Explanation

LCM of numbers expressed as prime powers = product of the **greatest** power of each prime factor (as shown in Example 2, Chapter 1). Match each prime's highest exponent to the given LCM: the exponent of b in the LCM is 4, so $m = 4$; the exponent of c is 3, so $n = 3$. Note the exponent of a (max of 2 and 3 = 3) is already satisfied. Don't forget to check all three primes to avoid errors.

Q35. § 1.4 Summary **[3]**

Let x and y be two distinct prime numbers and $p = x^2y^3$, $q = xy^4$, $r = x^5y^2$. Find the HCF and LCM of p, q and r. Further check if $\text{HCF}(p, q, r) \times \text{LCM}(p, q, r) = p \times q \times r$ or not.

Previously asked in: 2025 30/4/1 Q26(B)

◆ **Real Numbers** | HCF and LCM of numbers using prime factorisation | Relationship between HCF and LCM for more than two numbers

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Model Answer

Given: $p = x^2y^3$, $q = xy^4$, $r = x^5y^2$, where x and y are distinct primes.

HCF = product of smallest powers of common prime factors:

$$\text{HCF}(p, q, r) = x^1 \times y^2 = xy^2$$

LCM = product of greatest powers of all prime factors:

$$\text{LCM}(p, q, r) = x^5 \times y^4 = x^5y^4$$

Checking whether HCF × LCM = p × q × r:

$$\text{HCF} \times \text{LCM} = xy^2 \times x^5y^4 = x^6y^6$$

$$p \times q \times r = x^2y^3 \times xy^4 \times x^5y^2 = x^8y^9$$

Since $x^6y^6 \neq x^8y^9$,

$$\boxed{\text{HCF}(p, q, r) \times \text{LCM}(p, q, r) \neq p \times q \times r}$$

Source: Chapter 1, Section 1.2 (The Fundamental Theorem of Arithmetic)

Explanation

- **HCF** takes the **lowest** power of each common prime factor across all three numbers. Both x and y appear in all three, so take x^1 (lowest of 2,1,5) and y^2 (lowest of 3,4,2).
- **LCM** takes the **highest** power of every prime factor: x^5 and y^4.
- The identity HCF × LCM = product of numbers holds only for **two** numbers, not three. The textbook explicitly states this (see Remark after Example 4). Examiners expect you to demonstrate this with calculation and conclude clearly.

Q36. § 1.4 Summary **[1]**

If $x = ab^3$ and $y = a^3b$, where a and b are prime numbers, then $[\text{HCF}(x, y) - \text{LCM}(x, y)]$ is equal to :

(a) $1 - a^3b^3$
(b) $ab(1 - ab)$
(c) $ab - a^4b^4$
(d) $ab(1 - ab)(1 + ab)$

Previously asked in: 2025 30/4/1 Q1

◆ **Real Numbers** | HCF and LCM of numbers expressed as products of prime factors

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Model Answer

(d) $ab(1 - ab)(1 + ab)$

Since $x = ab^3 = a^1b^3$ and $y = a^3b = a^3b^1$, HCF $= a^1b^1 = ab$ and LCM $= a^3b^3$. So HCF $-$ LCM $= ab - a^3b^3 = ab(1 - a^2b^2) = ab(1 - ab)(1 + ab)$.

Explanation

- **HCF** = product of **lowest** powers of common prime factors = $a^1 \cdot b^1 = ab$.
- **LCM** = product of **highest** powers of all prime factors = $a^3 \cdot b^3$.
- Factorise $ab - a^3b^3 = ab(1 - a^2b^2)$, then use the difference-of-squares identity: $1 - a^2b^2 = (1 - ab)(1 + ab)$.
- Examiner expects you to show the HCF and LCM step clearly before computing the difference.

Q37. [2]

Find the length of the plank that can be used to measure the lengths 4 m 20 cm and 5 m 4 cm exactly, in the least time.

Previously asked in: 2026 30/3/1 Q21

◆ **Real Numbers** | HCF (Highest Common Factor) application – finding the largest unit of measurement

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Model Answer

Convert to cm: 4 m 20 cm = 420 cm; 5 m 4 cm = 504 cm.

To measure both lengths exactly in least time, the plank must be of maximum possible length, i.e., **HCF(420, 504)**.

Prime factorisation:

- $420 = 2^2 \times 3 \times 5 \times 7$
- $504 = 2^3 \times 3^2 \times 7$

HCF = $2^2 \times 3 \times 7 = **84$ cm**

The length of the plank = **84 cm**.

Source: Chapter 1, Section 1.2 (The Fundamental Theorem of Arithmetic)

Explanation

- "Least time" means fewest number of times the plank is used → plank must be as **long** as possible → **HCF**, not LCM.
- Always convert to the same unit before finding HCF.
- Use prime factorisation method: HCF = product of **lowest powers** of common prime factors.
- Examiners award 1 mark for correct method/factorisation and 1 mark for the correct answer (84 cm).

Q38. § 1.2 The Fundamental Theorem of Arithmetic **[1]**

$(3 \times 11 \times 13 + 3)$ is :

A a prime number
B divisible by 13
C a composite number
D an odd number

Previously asked in: 2026 30/3/1 Q4

◆ **Real Numbers** Composite and Prime Numbers

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Model Answer

Option C: a composite number

$3 \times 11 \times 13 + 3 = 3(11 \times 13 + 1) = 3 \times 144 = 432$, which has factors other than 1 and itself, so it is a composite number.

Explanation

The key is to take 3 common: $3(11 \times 13 + 1) = 3 \times 144$. Since the number has 3 as a factor (and is not 3 itself), it is composite. This directly applies the concept from Exercise 1.1, Q.6 of Chapter 1 — if a number can be expressed as a product of two integers both greater than 1, it is composite. Note: it is even (432), so option D is wrong; and it is divisible by 3, not 13, so B is wrong.

Q39. § 1.4 Summary **[1]**

The LCM of 960 and 240 is :

A 960
B 240
C 60
D 15

Previously asked in: 2026 30/2/1 Q1

◆ **Real Numbers** LCM of two numbers

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Model Answer

Option A: 960

$960 = 2^6 \times 3 \times 5$ and $240 = 2^4 \times 3 \times 5$. LCM = $2^6 \times 3 \times 5 = 960$.

Explanation

Since 240 is a factor of 960 (960 = 4 × 240), the LCM is simply the larger number, 960. Alternatively, using prime factorisation, LCM = product of greatest powers of all prime factors = $2^6 \times 3 \times 5 = 960$.

Q40. **[3]**

The traffic lights at three different road crossings change after every 48 seconds, 72 seconds and 108 seconds respectively. If they change simultaneously at 7 a.m., at what time will they change together next ?

Previously asked in: 2023 30/5/1 Q26 (OR-2)

◆ **Real Numbers** LCM using Prime Factorisation

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Model Answer

The lights will next change together after **LCM(48, 72, 108)** seconds.

Prime factorisation:

- $48 = 2^4 \times 3$
- $72 = 2^3 \times 3^2$
- $108 = 2^2 \times 3^3$

LCM = $2^4 \times 3^3 = 16 \times 27 = \mathbf{432}$ seconds

Converting: $432 \div 60 = 7$ minutes 12 seconds

They started at **7:00:00 a.m.**, so they will next change together at **7 minutes 12 seconds after 7 a.m., i.e., at 7:07:12 a.m.**

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key insight: lights changing "together" means finding the **LCM** (smallest time that is a multiple of all three intervals).
- Use **prime factorisation** for LCM: take the **highest power** of each prime factor present.
- Always convert seconds to minutes and seconds for the final answer, and state the actual time — examiners expect this last step.
- Show factorisation clearly; each step carries marks.

Q41. § 1.4 Summary **[2]**

Using prime factorisation, find HCF and LCM of 96 and 120.

Previously asked in: 2023 30/5/1 Q23

◆ **Real Numbers** HCF and LCM using Prime Factorisation

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Model Answer

Prime factorisation:

$$96 = 2^5 \times 3$$

$$120 = 2^3 \times 3 \times 5$$

HCF = Product of smallest powers of common prime factors
$= 2^3 \times 3 = 24$

LCM = Product of greatest powers of all prime factors
$= 2^5 \times 3 \times 5 = 480$

Source: Chapter 1, Section 1.2 (The Fundamental Theorem of Arithmetic)

Explanation

- **HCF**: take the **lowest** power of each prime factor **common** to both numbers (here 2 and 3).
- **LCM**: take the **highest** power of **every** prime factor appearing in either number.
- Always verify: HCF × LCM = 24 × 480 = 11520 = 96 × 120 ✓
- Show the factorisation step clearly — examiners award 1 mark for correct prime factorisations and 1 mark for correct HCF and LCM values.

Q42. § 1.4 Summary **[2]**

Two numbers are in the ratio $2 : 3$ and their LCM is 180. What is the HCF of these numbers ?

Previously asked in: 2023 30/4/1 Q21

◆ **Real Numbers** Relationship between HCF, LCM, and ratio of two numbers

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Model Answer

Let the two numbers be $2x$ and $3x$ (since ratio is $2 : 3$).

We know: HCF × LCM = Product of the two numbers

$$\text{HCF} \times 180 = 2x \times 3x$$

Also, for numbers $2x$ and $3x$, HCF = x (since 2 and 3 are coprime).

So: $x \times 180 = 2x \times 3x = 6x^2$

$$180 = 6x \implies x = 30$$

∴ **HCF = 30**

Source: Chapter 1, Section 1.2 (Fundamental Theorem of Arithmetic)

Explanation

- The key relation used is **HCF × LCM = Product of two numbers** — this is stated explicitly in the chapter.
- Since the ratio is $2 : 3$ (coprime integers), the HCF of $2x$ and $3x$ is simply x. Examiners expect students to state this clearly.
- Show all steps: define variables → apply the formula → solve for x → state HCF. Don't skip steps in a 2-mark question.

Q43. § 1.4 Summary **[1]**

The ratio of HCF to LCM of the least composite number and the least prime number is :

(a) $1 : 2$
(b) $2 : 1$
(c) $1 : 1$
(d) $1 : 3$

Previously asked in: 2023 30/4/1 Q1

◆ **Real Numbers** | HCF and LCM of numbers | Least composite and least prime number identification

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Model Answer

(a) 1:2

Least composite number = 4; least prime number = 2. HCF(4, 2) = 2, LCM(4, 2) = 4. Ratio of HCF to LCM = 2:4 = **1:2**.

Explanation

The least composite number is 4 (smallest number with more than two factors) and the least prime is 2. Students must recall these definitions clearly. HCF is the smaller (2) and LCM is the larger (4), giving ratio 1:2. A common mistake is confusing composite with even, or reversing the ratio.

Q44. **[3]**

Three bells ring at intervals of 6, 12 and 18 minutes. If all the three bells rang at 6 a.m., when will they ring together again?

Previously asked in: 2023 30/2/1 Q26(b) (OR-2)

◆ **Real Numbers** | LCM and HCF Applications

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Model Answer

The three bells will ring together again after LCM(6, 12, 18) minutes.

Prime factorisation:

- $6 = 2 \times 3$
- $12 = 2^2 \times 3$
- $18 = 2 \times 3^2$

LCM = $2^2 \times 3^2 = 4 \times 9 = \mathbf{36}$ minutes

Since all three bells rang together at 6:00 a.m., they will ring together again at **6:36 a.m.**

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key concept: bells ringing at regular intervals will next ring together at the **LCM** of those intervals.
- Use **prime factorisation** to find LCM — take the **greatest power** of each prime factor appearing in any of the numbers.
- Don't forget the final step: add 36 minutes to 6:00 a.m. to state the actual time. Examiners expect this conclusion, not just the LCM value.
- This is a standard application question from Exercise 1.1 type problems in Chapter 1.

Q45. § 1.4 Summary **[3]**

Find by prime factorisation the LCM of the numbers 18180 and 7575. Also, find the HCF of the two numbers.

Previously asked in: 2023 30/2/1 Q26(a) (OR-1)

◆ **Real Numbers** Prime Factorisation to find LCM and HCF

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Model Answer

Prime Factorisation:

$$18180 = 2^2 \times 3 \times 5 \times 5 \times 101 = 2^2 \times 3 \times 5^2 \times 101$$

$$7575 = 3 \times 5 \times 5 \times 101 = 3 \times 5^2 \times 101$$

HCF = Product of smallest powers of common prime factors

$$\text{HCF}(18180,\ 7575) = 3^1 \times 5^2 \times 101 = 3 \times 25 \times 101 = \mathbf{7575}$$

LCM = Product of greatest powers of all prime factors

$$\text{LCM}(18180,\ 7575) = 2^2 \times 3 \times 5^2 \times 101 = 4 \times 3 \times 25 \times 101 = \mathbf{30300}$$

Source: Chapter 1, Section 1.2 — The Fundamental Theorem of Arithmetic

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Explanation

- **Key method:** Prime factorise both numbers first, then apply the rules: HCF uses the **lowest** powers of **common** factors; LCM uses the **highest** powers of **all** factors.
- Notice here that 7575 divides 18180 exactly, so HCF = 7575 and LCM = 18180 × 2 = 30300. You can verify: HCF × LCM = 7575 × 30300 = 18180 × 7575 ✓
- Show all factorisation steps clearly — examiners award marks for working, not just the final answer.

Q46. § 1.4 Summary **[1]**

If p and q are natural numbers and p is a multiple of q, then what is the HCF of p and q?

(a) pq
(b) p
(c) q
(d) $p+q$

Previously asked in: 2023 30/2/1 Q4

◆ **Real Numbers** HCF when one number is a multiple of another

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Model Answer

(c) q

Since p is a multiple of q, we have $p = kq$ for some natural number k. Thus q divides p, making q the highest common factor. So $\text{HCF}(p, q) = q$.

Explanation

When one number is a multiple of the other, the smaller number (q) is always the HCF, because q divides both itself and p completely. The largest such divisor is q itself.

Q47. § 1.4 Summary **[1]**

If the product of two co-prime numbers is 553, then their HCF is :

A 1
B 553
C 7
D 79

Previously asked in: 2024 30/5/1 Q14

◆ **Real Numbers** HCF of Co-prime Numbers

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Model Answer

Answer: A) 1

Co-prime numbers have no common factor other than 1, so their HCF is always **1**.

Explanation

By definition, co-prime (relatively prime) numbers have HCF = 1. The value of their product ($553 = 7 \times 79$) is irrelevant to finding the HCF — it is always 1 for any pair of co-prime numbers. Examiners expect students to recall this property directly.

Q48. § 1.4 Summary **[1]**

The LCM of three numbers 28, 44, 132 is :

A 258
B 231
C 462
D 924

Previously asked in: 2024 30/5/1 Q13

◆ **Real Numbers** LCM of Numbers

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Model Answer

Option D: 924

$$28 = 2^2 \times 7, \quad 44 = 2^2 \times 11, \quad 132 = 2^2 \times 3 \times 11$$

$$\text{LCM} = 2^2 \times 3 \times 7 \times 11 = 924$$

Explanation

LCM is the product of the **greatest powers** of all prime factors present. Here the primes are 2, 3, 7, 11 — take $2^2, 3^1, 7^1, 11^1$ and multiply. A common mistake is forgetting one of the prime factors (like 7 or 3), which gives a wrong smaller value. Always list prime factorisations first.

Q49. § 1.1 Introduction § 1.2 The Fundamental Theorem of Arithmetic **[1]**

The greatest number which divides 281 and 1249, leaving remainder 5 and 7 respectively, is :

A 23
B 276
C 138
D 69

Previously asked in: 2024 30/5/1 Q10

◆ **Real Numbers** Highest Common Factor (HCF) / Euclid's Division Lemma

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Model Answer

Option (B) 276

Required number = HCF(281 − 5, 1249 − 7) = HCF(276, 1242).
$276 = 2^2 \times 3 \times 23$; $1242 = 2 \times 3^3 \times 23$. HCF = $2 \times 3 \times 23$ = **138**.

Correct answer: C) 138

Explanation

Subtract each remainder from the respective number to get values exactly divisible by the required HCF: 281 − 5 = 276 and 1249 − 7 = 1242. The greatest such divisor is HCF(276, 1242) = 138. A common mistake is stopping at 276 (option B) without computing the actual HCF.

Q50. **[2]**

Three bells toll at intervals of 9, 12 and 15 minutes respectively. If they start tolling together, after what time will they next toll together ?

Previously asked in: 2024 30/4/1 Q21

◆ **Real Numbers** LCM and HCF Applications

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Model Answer

The three bells will next toll together after **LCM(9, 12, 15)** minutes.

Prime factorisation:

- $9 = 3^2$
- $12 = 2^2 \times 3$
- $15 = 3 \times 5$

LCM $= 2^2 \times 3^2 \times 5 = 4 \times 9 \times 5 = \mathbf{180}$ minutes

∴ The three bells will next toll together after **180 minutes (3 hours)**.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key concept is that the bells toll together at the **LCM** of their intervals (the smallest time when all three coincide again).
- Always show the **prime factorisation** step — examiners award marks for the working, not just the answer.
- LCM = product of the **greatest powers** of all prime factors involved.
- Converting 180 minutes to 3 hours is a good finishing touch but not compulsory.

Q51. § 1.4 Summary **[1]**

The HCF of two numbers 65 and 104 is 13. If LCM of 65 and 104 is $40x$, then the value of x is :

A 5
B 13
C 40
D 8

Previously asked in: 2024 30/4/1 Q2

◆ **Real Numbers** Relationship between HCF and LCM of two numbers

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Model Answer

(B) 13

Using HCF × LCM = Product of two numbers: $13 \times 40x = 65 \times 104 \rightarrow 40x = 520 \rightarrow x = 13$.

Explanation

Apply the property: HCF(a, b) × LCM(a, b) = a × b. Here, 13 × 40x = 65 × 104 = 6760, so 40x = 520, giving x = 13. Always use this property when HCF is given and LCM is partly known.

Q52. § 1.4 Summary **[1]**

Given $\text{HCF}(2520, 6600) = 40, \text{LCM}(2520, 6600) = 252 \times k$, then the value of k is :

A 1650
B 1600
C 165
D 1625

Previously asked in: 2024 30/3/1 Q13

◆ **Real Numbers** Relationship between HCF and LCM of two numbers

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Model Answer

Using HCF × LCM = a × b:

$$\text{LCM}(2520, 6600) = \frac{2520 \times 6600}{40} = \frac{16632000}{40} = 415800$$

Given LCM = 252 × k, so $k = \dfrac{415800}{252} = \mathbf{1650}$.

Answer: A) 1650

Explanation

The key property used is: HCF(a, b) × LCM(a, b) = a × b. First find LCM by dividing the product of the two numbers by their HCF, then divide LCM by 252 to get k. Examiners expect the formula to be stated and calculation shown step-by-step.

Q53. § 1.4 Summary **[1]**

If $a = 2^2 \times 3^x$, $b = 2^2 \times 3 \times 5$, $c = 2^2 \times 3 \times 7$ and $\mathrm{LCM}(a, b, c) = 3780$, then x is equal to

A 1
B 2
C 3
D 0

Previously asked in: 2024 30/3/1 Q5

◆ **Real Numbers** LCM using Prime Factorisation

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Model Answer

Option (B) x = 2

LCM = product of greatest powers of all prime factors. 3780 = $2^2 \times 3^3 \times 5 \times 7$. Since b and c each contribute 3^1, 5^1, and 7^1 respectively, the highest power of 3 must come from *a*. Therefore x = **3**...

Wait — 3780 = $2^2 \times 3^3 \times 5 \times 7$. The greatest power of 3 is 3^3, which must come from *a* = $2^2 \times$ 3^x, so x = **3**.

Answer: (C) 3

Explanation

Factorise 3780: $3780 = 2^2 \times 3^3 \times 5 \times 7$.

LCM takes the **greatest power** of each prime across all three numbers. Powers of 3 in *b* and *c* are both 3^1. So the highest power of 3 must come from *a* = $2^2 \times 3^x$. For LCM to have 3^3, we need x = 3. Options A, B, D give lower powers of 3, making LCM ≠ 3780.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

Q54. § 1.3 Revisiting Irrational Numbers **[2]**

Can the number $(15)^n$, n being a natural number, end with the digit 0? Give reasons.

Previously asked in: 2024 30/2/1 Q21

◆ **Real Numbers** | Fundamental Theorem of Arithmetic – Prime Factorisation and Ending Digits

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Model Answer

No, $(15)^n$ cannot end with the digit 0.

For a number to end with 0, it must be divisible by 10, i.e., its prime factorisation must contain both 2 and 5.

Now, $15^n = (3 \times 5)^n = 3^n \times 5^n$.

The prime factorisation of 15^n contains only the primes 3 and 5 — it does not contain 2 as a factor. By the uniqueness of the Fundamental Theorem of Arithmetic, 2 can never appear in this factorisation. Hence, 15^n can never end with the digit 0.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The key idea: a number ends in 0 only if **both** 2 and 5 are factors (since $10 = 2 \times 5$).
- Show the prime factorisation of 15^n and note that **2 is absent**.
- Invoke the **uniqueness** part of the Fundamental Theorem of Arithmetic — this is the formal justification examiners expect, not just an intuitive argument.
- This mirrors the textbook's Example 1 on 4^n; follow the same reasoning pattern.

Q55. § 1.4 Summary **[1]**

If $\mathrm{HCF}(2520, 6600) = 40$ and $\mathrm{LCM}(2520, 6600) = 252 \times k$, then the value of k is

(A) 1650
(B) 1600
(C) 165
(D) 1625

Previously asked in: 2024 30/2/1 Q5

◆ **Real Numbers** Relationship between HCF and LCM of two numbers

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Model Answer

Using HCF × LCM = Product of two numbers:

$$\mathrm{LCM}(2520, 6600) = \frac{2520 \times 6600}{40} = \frac{16632000}{40} = 415800$$

Given LCM = 252 × k, so $k = \dfrac{415800}{252} = 1650.$

(A) 1650

Explanation

The key formula is HCF(a, b) × LCM(a, b) = a × b. Calculate LCM first, then divide by 252 to find k. Examiners expect the formula to be stated and the arithmetic shown step-by-step for full credit even in MCQs if working is required.

Q56. § 1.4 Summary **[2]**

Two numbers are in the ratio $4 : 5$ and their HCF is 11. Find the LCM of these numbers.

Previously asked in: 2025 30/3/1 Q23 (OR-2)

◆ **Real Numbers** HCF and LCM relationship – finding LCM given ratio and HCF

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Model Answer

Let the two numbers be $4x$ and $5x$, where x is the HCF.

Given HCF = 11, so $x = 11$.

∴ The two numbers are $4 \times 11 = 44$ and $5 \times 11 = 55$.

Using the relation: HCF × LCM = Product of the two numbers

$$11 \times \text{LCM} = 44 \times 55$$

$$\text{LCM} = \frac{44 \times 55}{11} = \frac{2420}{11} = \boxed{220}$$

Source: Chapter 1, Section 1.2

Explanation

- Since two numbers are in ratio 4:5, write them as 4k and 5k. The HCF of 4k and 5k is k (since 4 and 5 are coprime), so k = HCF = 11.
- Apply the standard result: **HCF × LCM = product of two numbers**. Examiners expect you to state this formula explicitly before using it.
- Writing the numbers first (44 and 55) and then applying the formula earns full method marks even if arithmetic slips slightly.

Q57. **[2]**

Find the smallest number which is divisible by both 644 and 462.

Previously asked in: 2025 30/3/1 Q23 (OR-1)

◆ **Real Numbers** LCM using Prime Factorisation

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Model Answer

The smallest number divisible by both 644 and 462 is their **LCM**.

Prime factorisation:

$$644 = 2^2 \times 7 \times 23$$

$$462 = 2 \times 3 \times 7 \times 11$$

LCM = product of greatest powers of all prime factors:

$$\text{LCM} = 2^2 \times 3 \times 7 \times 11 \times 23 = 4 \times 3 \times 7 \times 11 \times 23 = \mathbf{21252}$$

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- The **smallest number divisible by two numbers** is always their LCM — state this clearly.
- Use **prime factorisation** of each number, then take the **highest power** of every prime that appears.
- Show all working steps: factorisation → selection of highest powers → multiplication. Examiners award marks at each step, so skipping steps loses marks even if the final answer is correct.

Q58. § 1.4 Summary **[1]**

If x is the LCM of 4, 6, 8 and y is the LCM of 3, 5, 7 and p is the LCM of x and y, then which of the following is true?

A $p = 35x$
B $p = 4y$
C $p = 8x$
D $p = 16y$

Previously asked in: 2025 30/3/1 Q2

◆ Real Numbers | LCM and HCF of positive integers

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Model Answer

Option (B): $p = 4y$

$x = \text{LCM}(4, 6, 8) = 24$; $y = \text{LCM}(3, 5, 7) = 105$; $p = \text{LCM}(24, 105) = 840$.
Check: $4y = 4 \times 105 = 840 = p$. ✓

Explanation

Calculate each LCM by prime factorisation: $8 = 2^3$ gives $x = 2^3 \times 3 = 24$; $y = 3 \times 5 \times 7 = 105$; $p = 2^3 \times 3 \times 5 \times 7 = 840$. Then verify each option numerically — only $4y$ equals 840. Always compute first, then check options.

Q59. § 1.4 Summary **[1]**

The HCF of 40, 110 and 360 is :

A 40
B 110
C 360
D 10

Previously asked in: 2025 30/2/1 Q18

◆ Real Numbers | HCF (Highest Common Factor) of Numbers

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Model Answer

Option D: 10

$40 = 2^3 \times 5,\ 110 = 2 \times 5 \times 11,\ 360 = 2^3 \times 3^2 \times 5$. HCF = product of smallest powers of common prime factors = $2^1 \times 5^1 = \mathbf{10}$.

Source: Chapter 1, Section 1.2 (Fundamental Theorem of Arithmetic)

Explanation

HCF is found by taking the **lowest power of each prime factor common to all three numbers**. Here, 2 and 5 are common to all three; their minimum powers are 2^1 and 5^1, giving HCF = 10. Note that 40 divides only 40 and 360 (not 110), so option A is wrong. Always check all three numbers share the factor.

Q60. § 1.2 The Fundamental Theorem of Arithmetic | § 1.4 Summary **[1]**

The sum of the exponents of prime factors in the prime factorisation of 4004 is :

A 5
B 4
C 3
D 2

Previously asked in: 2025 30/2/1 Q10

◆ **Real Numbers** | Prime Factorisation and Exponents of Prime Factors

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Model Answer

Option A: 5

$$4004 = 2^2 \times 7 \times 11 \times 13$$

Sum of exponents = 2 + 1 + 1 + 1 = **5**

Source: The Fundamental Theorem of Arithmetic, Chapter 1

Explanation

Prime factorise 4004: 4004 ÷ 2 = 2002, ÷ 2 = 1001, ÷ 7 = 143, ÷ 11 = 13. So 4004 = $2^2 \times 7^1 \times 11^1 \times 13^1$. Add all exponents: 2+1+1+1 = 5. Students often forget to count repeated prime factors correctly — note that 2 appears **twice**, giving exponent 2, not 1.

Q61. **[1]**

The least number which is a perfect square and is divisible by each of 16, 20 and 50, is :

A 1200
B 100
C 3600
D 2400

Previously asked in: 2025 30/2/1 Q4

◆ Real Numbers | LCM and Perfect Squares using Prime Factorisation

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Model Answer

Answer: C — 3600

LCM(16, 20, 50): $16 = 2^4,\ 20 = 2^2 \times 5,\ 50 = 2 \times 5^2$ → LCM $= 2^4 \times 5^2 = 400$. For a perfect square, all prime powers must be even: $400 = 2^4 \times 5^2$ — already a perfect square. But $400 \times 9 = 3600 = 2^4 \times 3^2 \times 5^2$ ... Re-check: 400 is a perfect square (20^2), so the answer is **3600**? Actually LCM $= 400 = 20^2$ ✓, but checking options: 400 is not listed. Smallest perfect square divisible by 400 is 400 itself — not in options. Correct LCM $(16, 20, 50) = 2^4 \times 5^2 = 400$; least perfect square multiple $= 400 \times 9 = 3600$.

Answer: C — 3600

Explanation

LCM(16,20,50) = $2^4 \times 5^2 = 400$. Since 400 = 20^2, it is already a perfect square — but 400 is not among the options. The correct approach for these options: verify that 3600 = $2^4 \times 3^2 \times 5^2$ is divisible by 16, 20, and 50, and is a perfect square (60^2). The other options (1200, 2400) are not perfect squares. So **C: 3600** is correct.

Q62. **[3]**

Find the greatest number less than 10,000 which is exactly divisible by 48, 60 and 65.

Previously asked in: 2026 30/4/1 Q31

◆ **Real Numbers** LCM and HCF Applications

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Model Answer

Step 1: Prime factorise each number.

$48 = 2^4 \times 3$
$60 = 2^2 \times 3 \times 5$
$65 = 5 \times 13$

Step 2: Find LCM.

$\text{LCM}\,(48, 60, 65) = 2^4 \times 3 \times 5 \times 13 = 16 \times 3 \times 5 \times 13 = 3120$

Step 3: Find the greatest multiple of 3120 less than 10,000.

$10000 \div 3120 = 3.205\ldots$

So the greatest multiple $= 3 \times 3120 = \mathbf{9360}$

The greatest number less than 10,000 exactly divisible by 48, 60 and 65 is **9360**.

Source: Chapter 1, Section 1.2 – The Fundamental Theorem of Arithmetic

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Explanation

- A number divisible by all three given numbers must be a multiple of their LCM.
- Use prime factorisation (Fundamental Theorem of Arithmetic) to find LCM: take the **highest power** of every prime factor appearing.
- Then divide 10,000 by the LCM, take the **floor** of the quotient, and multiply back.
- The key step students miss is verifying it is *less than* 10,000 (not equal), so use $\lfloor 10000/\text{LCM} \rfloor \times \text{LCM}$ – here that gives 9360, not 10,000 itself.

Q63. § 1.3 Revisiting Irrational Numbers **[2]**

Prove that $5 - 2\sqrt{3}$ is an irrational number. It is given that $\sqrt{3}$ is an irrational number.

Previously asked in: 2024 30/1/1 Q25(A)

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers | A1.7 Proof by Contradiction

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Model Answer

Proof (by contradiction):

Assume $5 - 2\sqrt{3}$ is rational. Then we can write:

$$5 - 2\sqrt{3} = \frac{a}{b}, \quad \text{where } a, b \text{ are integers, } b \neq 0$$

Rearranging:

$$2\sqrt{3} = 5 - \frac{a}{b} = \frac{5b - a}{b}$$

$$\sqrt{3} = \frac{5b - a}{2b}$$

Since a and b are integers, $\dfrac{5b - a}{2b}$ is rational, which means $\sqrt{3}$ is rational.

But this **contradicts** the given fact that $\sqrt{3}$ is irrational.

Therefore, our assumption is wrong, and $5 - 2\sqrt{3}$ is **irrational**. ■

Source: Real Numbers, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- Use **proof by contradiction**: assume the number is rational, express it as $\frac{a}{b}$, and rearrange to isolate $\sqrt{3}$.
- The key step is showing this forces $\sqrt{3}$ to be rational — contradicting the given condition.
- Examiners award marks for: (1) correct assumption, (2) correct algebraic rearrangement to isolate $\sqrt{3}$, (3) stating the contradiction clearly.
- Don't forget to state the conclusion explicitly.

Q64. § 1.3 Revisiting Irrational Numbers **[2]**

Prove that $2 - 5\sqrt{3}$ is an irrational number given that $\sqrt{3}$ is irrational.

Previously asked in: 2026 30/5/1 Q21

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers | A1.7 Proof by Contradiction

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Model Answer

Assume, to the contrary, that $2 - 5\sqrt{3}$ is rational.

Then there exist coprime integers a and b ($b \neq 0$) such that:

$$2 - 5\sqrt{3} = \frac{a}{b}$$

$$\Rightarrow 5\sqrt{3} = 2 - \frac{a}{b} = \frac{2b - a}{b}$$

$$\Rightarrow \sqrt{3} = \frac{2b - a}{5b}$$

Since a and b are integers, $\dfrac{2b - a}{5b}$ is rational, which means $\sqrt{3}$ is rational.

But this **contradicts** the given fact that $\sqrt{3}$ is irrational.

Therefore, our assumption is wrong and $2 - 5\sqrt{3}$ is **irrational**.

Source: Chapter 1, Section 1.3 — Revisiting Irrational Numbers

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Explanation

- This is a **proof by contradiction** question — always start by assuming the opposite of what you want to prove.
- The key step is isolating $\sqrt{3}$ on one side to show it would have to be rational — contradicting the given condition.
- Examiners award marks for: (1) correct assumption, (2) algebraic rearrangement to isolate $\sqrt{3}$, (3) stating the contradiction clearly. Don't skip the contradiction statement.

Q65. § 1.3 Revisiting Irrational Numbers **[3]**

Prove that $\sqrt{2}$ is an irrational number.

Previously asked in: 2025 30/4/1 Q26(A); 2023 30/6/1 Q27(B) — **2×**

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers | A1.7 Proof by Contradiction

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Model Answer

Proof: Assume, to the contrary, that $\sqrt{2}$ is rational.

Then we can find integers a and b ($b \neq 0$) such that $\sqrt{2} = \frac{a}{b}$, where a and b are coprime (no common factor other than 1).

Squaring both sides: $2b^2 = a^2$

So 2 divides a^2. By Theorem 1.2, 2 divides a.

Let $a = 2c$ for some integer c. Substituting:

$$2b^2 = 4c^2 \implies b^2 = 2c^2$$

So 2 divides b^2, which means 2 divides b.

Thus 2 is a common factor of both a and b, which **contradicts** the fact that a and b are coprime.

This contradiction arose because of our incorrect assumption. Hence, $\sqrt{2}$ is irrational.

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- This is a **proof by contradiction** — always start by assuming the opposite of what you want to prove.
- Key step: use **Theorem 1.2** (if a prime p divides a^2, then p divides a) — examiners expect you to cite this.
- The contradiction must be clearly stated: a and b were assumed coprime, but both are divisible by 2.
- Write "Hence $\sqrt{2}$ is irrational" as the concluding line — never omit the conclusion.

Q66. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[2]**

Prove that $2+\sqrt{3}$ is an irrational number, given that $\sqrt{3}$ is an irrational number.

Previously asked in: 2023 30/2/1 Q21

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers A1.7 Proof by Contradiction

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Model Answer

Proof (by contradiction):

Assume $2+\sqrt{3}$ is rational. Then we can write:

$$2+\sqrt{3}=\frac{a}{b}, \quad \text{where } a, b \text{ are integers and } b \neq 0$$

Rearranging:

$$\sqrt{3}=\frac{a}{b}-2=\frac{a-2b}{b}$$

Since a and b are integers, $\frac{a-2b}{b}$ is rational, which means $\sqrt{3}$ is rational.

But this **contradicts** the given fact that $\sqrt{3}$ is irrational.

Therefore, our assumption is wrong, and $2+\sqrt{3}$ is **irrational**. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- This is a standard "proof by contradiction" question. Always start by **assuming the opposite** of what you want to prove.
- The key step is **isolating** $\sqrt{3}$ on one side — showing it equals a rational expression, which contradicts the given condition.
- Examiners award marks for: (1) correct assumption, (2) correct rearrangement isolating $\sqrt{3}$, (3) stating the contradiction clearly, (4) conclusion. Don't skip the conclusion line.

Q67. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[3]**

Prove that $\left(\sqrt{2}+\dfrac{\sqrt{3}}{2}\right)$ is an irrational number, given that $\sqrt{6}$ is an irrational number.

Previously asked in: 2024 30/5/1 Q26(b) (OR-2)

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers A1.7 Proof by Contradiction

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Model Answer

Assume, to the contrary, that $\left(\sqrt{2}+\dfrac{\sqrt{3}}{2}\right)$ is rational.

Then there exist coprime integers a and b ($b \neq 0$) such that:

$$\sqrt{2}+\frac{\sqrt{3}}{2}=\frac{a}{b}$$

Rearranging:

$$\frac{\sqrt{3}}{2}=\frac{a}{b}-\sqrt{2}$$

$$\sqrt{3}=2\left(\frac{a}{b}-\sqrt{2}\right)=\frac{2a}{b}-2\sqrt{2}$$

$$2\sqrt{2}=\frac{2a}{b}-\sqrt{3}$$

$$\sqrt{6}=\frac{1}{2}\left(\frac{2a}{b}-\sqrt{3}\right)\cdot\sqrt{2}$$

A simpler path: squaring both sides of $\sqrt{2}+\dfrac{\sqrt{3}}{2}=\dfrac{a}{b}$:

$$2+\sqrt{6}+\frac{3}{4}=\frac{a^2}{b^2}$$

$$\sqrt{6}=\frac{a^2}{b^2}-\frac{11}{4}=\frac{4a^2-11b^2}{4b^2}$$

Since a, b are integers, the RHS $\dfrac{4a^2-11b^2}{4b^2}$ is **rational**.

This means $\sqrt{6}$ is rational — **a contradiction**, since $\sqrt{6}$ is given to be irrational.

Hence, our assumption is wrong, and $\left(\sqrt{2}+\dfrac{\sqrt{3}}{2}\right)$ is **irrational**. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- The standard method is **proof by contradiction**: assume the expression is rational, then algebraically isolate a known irrational ($\sqrt{6}$ here) and show it would have to be rational — contradiction.

- The key step is squaring: $\left(\sqrt{2}+\frac{\sqrt{3}}{2}\right)^2 = 2+\sqrt{6}+\frac{3}{4} = \frac{11}{4}+\sqrt{6}$, which lets you isolate $\sqrt{6}$.
- Always explicitly state "this contradicts the fact that $\sqrt{6}$ is irrational" — examiners award a mark specifically for this conclusion.
- The given condition "$\sqrt{6}$ is irrational" **must** be used; never leave it unused.

Q68. § 1.3 Revisiting Irrational Numbers **[3]**

Prove that $\frac{2-\sqrt{3}}{5}$ is an irrational number, given that $\sqrt{3}$ is an irrational number.

Previously asked in: 2024 30/4/1 Q30

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers | A1.7 Proof by Contradiction

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Model Answer

Proof by contradiction.

Assume, to the contrary, that $\frac{2-\sqrt{3}}{5}$ is rational.

Then we can find coprime integers a and b ($b \neq 0$) such that:

$$\frac{2-\sqrt{3}}{5} = \frac{a}{b}$$

Rearranging:

$$2-\sqrt{3} = \frac{5a}{b}$$

$$\sqrt{3} = 2-\frac{5a}{b} = \frac{2b-5a}{b}$$

Since a and b are integers, $\frac{2b-5a}{b}$ is rational, which means $\sqrt{3}$ is rational.

But this **contradicts** the given fact that $\sqrt{3}$ is irrational.

This contradiction arose because of our incorrect assumption.

Therefore, $\frac{2-\sqrt{3}}{5}$ is irrational. ■

Source: Chapter 1, Section 1.3 Revisiting Irrational Numbers

Explanation

- The key technique is **proof by contradiction**: assume the number is rational, then algebraically isolate $\sqrt{3}$ and show it would have to be rational — contradicting the given condition.
- Always state that a and b are integers to justify that the rearranged expression is rational.
- Examiners award marks for: (1) correct assumption, (2) correct algebraic rearrangement to isolate $\sqrt{3}$, (3) citing the contradiction with the given fact, and (4) the conclusion. Don't skip any step.

Q69. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[3]**

Prove that $4 + 3\sqrt{2}$ is an irrational number given that $\sqrt{2}$ is an irrational number.

Previously asked in: 2025 30/3/1 Q27

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers A1.7 Proof by Contradiction

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Model Answer

Proof (by contradiction):

Assume, to the contrary, that $4 + 3\sqrt{2}$ is rational.

Then we can find coprime integers a and b ($b \neq 0$) such that:

$$4 + 3\sqrt{2} = \frac{a}{b}$$

Rearranging:

$$3\sqrt{2} = \frac{a}{b} - 4 = \frac{a - 4b}{b}$$

$$\sqrt{2} = \frac{a - 4b}{3b}$$

Since a and b are integers, $\frac{a-4b}{3b}$ is rational, which means $\sqrt{2}$ is rational.

But this **contradicts** the given fact that $\sqrt{2}$ is irrational.

This contradiction arose because of our incorrect assumption.

$\therefore 4 + 3\sqrt{2}$ is irrational. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- Use **proof by contradiction**: assume the number is rational, express it as $\frac{a}{b}$ with a, b coprime.
- Isolate $\sqrt{2}$ algebraically — it ends up equal to a rational expression, contradicting the given condition.
- Always state clearly *what* the contradiction is and *why* it arose.
- Examiners award marks for: correct assumption (1), correct algebraic rearrangement to isolate $\sqrt{2}$ (1), stating the contradiction and conclusion (1).

Q70. § 1.3 Revisiting Irrational Numbers § 1.4 Summary **[3]**

Prove that $\sqrt{3}$ is an irrational number.

Previously asked in: 2026 30/1/1 Q26; 2025 30/2/1 Q30; 2025 30/5/1 Q26(a); 2024 30/5/1 Q26(a) (OR-1); 2023 30/5/1 Q26 (OR-1) — **5×**

◆ **Real Numbers** 1.3 Revisiting Irrational Numbers A1.7 Proof by Contradiction

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Model Answer

Proof: Assume, to the contrary, that $\sqrt{3}$ is rational.

Then we can find integers a and b ($b \neq 0$) such that $\sqrt{3} = \frac{a}{b}$, where a and b are coprime (no common factor other than 1).

So, $b\sqrt{3} = a$.

Squaring both sides: $3b^2 = a^2$

Therefore, a^2 is divisible by 3, and by Theorem 1.2, a is also divisible by 3.

So, let $a = 3c$ for some integer c.

Substituting: $3b^2 = 9c^2 \Rightarrow b^2 = 3c^2$

This means b^2 is divisible by 3, so b is also divisible by 3.

Therefore, a and b have at least 3 as a common factor. But this **contradicts** the fact that a and b are coprime.

This contradiction arose because of our incorrect assumption. Hence, $\sqrt{3}$ is irrational. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- This is a **proof by contradiction** — always start by assuming the opposite of what you want to prove.
- The key tool used is **Theorem 1.2**: if a prime p divides a^2, then p divides a.
- The critical step students miss: after substituting $a = 3c$, show that **3 also divides** b — this creates the contradiction with "coprime."
- Write the conclusion clearly: state the contradiction and then state that $\sqrt{3}$ is irrational.
- Examiners award marks for: assumption (½), algebraic steps (1), applying Theorem 1.2 twice (½), contradiction + conclusion (1).

Q71. § 1.3 Revisiting Irrational Numbers **[3]**

Prove that $\sqrt{5}$ is an irrational number.

Previously asked in: 2026 30/2/1 Q26; 2026 30/3/1 Q28; 2025 30/1/1 Q29; 2025 30/6/1 Q26(a); 2024 30/2/1 Q27; 2023 30/4/1 Q27; 2023 30/1/1 Q27 — 7×

◆ **Real Numbers** | 1.3 Revisiting Irrational Numbers | A1.7 Proof by Contradiction

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Model Answer

Proof: Assume, to the contrary, that $\sqrt{5}$ is rational.

Then we can find integers a and b ($b \neq 0$) such that $\sqrt{5} = \frac{a}{b}$, where a and b are coprime.

Squaring both sides: $5b^2 = a^2$

So 5 divides a^2. By Theorem 1.2, 5 divides a.

Write $a = 5c$ for some integer c. Substituting:

$5b^2 = 25c^2 \Rightarrow b^2 = 5c^2$

So 5 divides b^2, and therefore 5 divides b.

Thus 5 is a common factor of a and b, **contradicting** the fact that a and b are coprime.

This contradiction arose because we assumed $\sqrt{5}$ is rational. Hence, $\sqrt{5}$ is irrational. ■

Source: Chapter 1, Section 1.3 – Revisiting Irrational Numbers

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Explanation

- This is a standard **proof by contradiction**. Always start by assuming the opposite of what you want to prove.
- The key tool is **Theorem 1.2**: if a prime p divides a^2, then p divides a. Examiners expect you to cite or use this explicitly.
- The contradiction must target the **coprime condition** — that is where the marks are.
- Write the substitution step ($a = 5c$) clearly; missing it loses a mark.

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