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# Chain Rule

## Formulas & Shortcut Tricks

Every important formula, shortcut and exam trick for Chain Rule in one place – with solved examples, common mistakes and a one-page revision sheet.

### WHAT'S INSIDE


1. Topic introduction
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### USEFUL FOR

- Bank PO & Clerk (IBPS, SBI, RBI)
- SSC CGL / CHSL / MTS
- Railways (RRB NTPC, Group D)
- Campus placements (TCS, Infosys, Wipro, Accenture)
- UPSC CSAT & state PSC exams

Practise **Chain Rule** free on LearnFrenzy – questions with instant explanations →

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# 1 Topic introduction

What it is, why it matters and how it is asked

The chain rule connects several quantities that change together – men, days, hours per day, work done, food, wages, machines and output. Each pair is either in direct proportion (more workers → more work) or inverse proportion (more workers → fewer days). Linking all of them in one equation is the “chain”.

The master formula $M_1D_1H_1/W_1 = M_2D_2H_2/W_2$ solves most questions in one line. Garrisons running out of food, contractors falling behind schedule and “3 men = 5 women” equivalences are all special cases of the same idea: total effort stays in proportion to the job.

**Why it matters in exams**

- Bank, SSC and railway papers ask chain-rule questions both alone and inside time-and-work sets.
- Garrison (provision) and contractor problems are favourites in SSC and placement tests.
- The same reasoning is used for wages, fuel, machines and production.

**Where it is used**

- Planning labour and time on construction and factory jobs.
- Food and supply planning for camps, hostels and armies.
- Costing: wages, fuel use and machine output.

## Common question patterns

**Men–days–hours**
Find days, men or hours for a different amount of work.

**Provisions**
Food for M men for D days; men join or leave midway.

**Ration change**
Daily ration cut – how long does the food last?

**Equivalences**
3 men = 5 women = 10 boys – convert and solve.

**Behind schedule**
Extra men needed (or men released) to finish on time.

**Wages and output**
Wages, machines, fuel and production chains.

**Price chains**
x apples = y mangoes, … – value of one item in another.

**Growing grass**
Cows grazing a field that keeps growing.

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# 2 Important formulas

Cards marked MOST USED are the ones to revise first

## Direct and inverse proportion

### Direct and inverse

MOST USED

**Direct: $x_1/y_1 = x_2/y_2$ (more → more). Inverse: $x_1y_1 = x_2y_2$ (more → less)**

Ask: if this goes up, does the answer go up (direct) or down (inverse)?

**EXAMPLE** 15 workers take 12 days → 20 workers take 15 × 12 ÷ 20 = **9 days** (inverse).

### The chain formula

MOST USED

**$M_1 \times D_1 \times H_1/W_1 = M_2 \times D_2 \times H_2/W_2$ (add efficiency E if workers differ)**

Effort (men × days × hours) per unit of work is the same in both situations.

**M** – men **D** – days **H** – hours per day **W** – work done

**EXAMPLE** 12 men, 8 days, 6 h build 24 m; 16 men at 6 h build 32 m in D days → 12·8·6/24 = 16·D·6/32 → D = **8**.

## Provisions and rations

### Men join or leave midway

MOST USED

**Days left = $M \times (D - t)/(M \pm R)$**

Food left after t days feeds M men for D – t days; share it among the new number.

**M** – men at the start **D** – days the food was meant to last **t** – days already passed
**R** – men who joined (+) or left (–)

**EXAMPLE** 1,200 soldiers, food for 40 days; after 10 days 300 more join → 1,200 × 30 ÷ 1,500 = **24 days**.

### Ration change

**Days $\propto$ 1/daily ration: new days = old days × old ration/new ration**

Eating less each day makes the food last longer.

**EXAMPLE** Food for 30 days; ration cut to 3/4 → 30 × 4/3 = **40 days**.

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## Workers of different strength

### Work equivalence

MOST USED

**If a men = b women, then 1 man = b/a women; convert everyone to one kind**

Turn a mixed team into one type of worker, then use the chain formula.

**EXAMPLE** 2 men = 3 women; 4 men + 6 women finish in 10 days → 12 women × 10 = 120 → 8 women take **15 days**.

### Efficiency in the chain

$$M_1D_1H_1E_1/W_1 = M_2D_2H_2E_2/W_2$$

A machine twice as fast counts as E = 2.

**EXAMPLE** 6 old machines finish in 10 h; new machines are 1.5 times as fast → 4 new ones take 6 × 10 ÷ (4 × 1.5) = **10 h**.

## Schedules, wages and output

### Contractor behind schedule

MOST USED

**Total job = (men × days) ÷ fraction done; men needed = remaining man-days ÷ remaining days**

Measure the job in man-days from the progress so far.

**EXAMPLE** Road due in 100 days; 60 men do 1/3 in 40 days → job = 7,200 man-days → 4,800 left in 60 days → 80 men → **20 more**.

### Wages

**Wages ∝ men × days (× hours)**

Find the rate per man-day first.

**EXAMPLE** 15 men earn ₹1,26,000 in 12 days → ₹700 per man-day → 18 men for 10 days earn **₹1,26,000**.

### Machines and output

**Output ∝ machines × time**

Find output per machine per minute (or hour).

**EXAMPLE** 6 machines fill 270 bottles a minute → 10 machines fill 270/6 × 10 × 4 = **1,800** bottles in 4 minutes.

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# 3 Shortcut tricks & smart techniques

Each trick says when to use it – that matters as much as the trick

## Arrow method for any chain

MOST USED

**USE WHEN** Several quantities change at once.

| Quantity | Change | Effect on days | Multiply by |
|---|---|---|---|
| **Men** | 12 → 16 | fewer (inverse) | 12/16 |
| **Hours per day** | 6 → 6 | no change | 1 |
| **Work** | 24 m → 32 m | more (direct) | 32/24 |

1. Put the unknown on the right and write the given value of the same kind.
2. For each other quantity, ask “more or less answer?” and multiply by the ratio that makes the answer bigger or smaller accordingly.

**EXAMPLE** Days = 8 × 12/16 × 32/24 = **8**.

## Keep the units the same

**USE WHEN** Hours per day, days and weeks are mixed.

1. Convert everything to one unit (usually hours) before using the chain formula.

**EXAMPLE** 5 days of 8 h = **40 hours** of work for each worker.

## Provision shortcut

MOST USED

**USE WHEN** Garrison food questions with reinforcements or departures.

1. Food left = M × (D − t) man-days.
2. Divide by the new number of men.

**EXAMPLE** 500 men, food for 27 days; after 3 days 100 leave → 500 × 24 ÷ 400 = **30 days**.

## Growing grass (cows and pasture)

**USE WHEN** The field keeps growing while animals eat it.

1. Let G = grass at the start and r = growth per day (in cow-days).
2. Use two cases: $G + D_1r = C_1D_1$ and $G + D_2r = C_2D_2$.
3. Solve for r and G, then use $G + d{\cdot}r = C{\cdot}d$.

**EXAMPLE** 10 cows: 20 days; 15 cows: 10 days → r = 5, G = 100 → 25 cows: 100 = 20d → **5 days**.

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# 4 Solved examples

The full method on the left, the exam shortcut on the right

## 1 MEN–DAYS–HOURS

**10 men working 8 hours a day build a 48 m wall in 12 days. In how many days will 15 men working 8 hours a day build a 60 m wall?**

### STEP BY STEP

1. $10 \times 12 \times 8/48 = 15 \times D \times 8/60$.
2. $20 = 2D$.
3. $D = 10$ days.

### SHORTCUT

$12 \times 10/15$ (more men → fewer days) $\times 60/48$ (more wall → more days) $= 10$.

**Why it works:** Effort per metre of wall is the same in both cases.

**Answer: 10 days**

## 2 PROVISIONS

**A camp has food for 800 men for 60 days. After 15 days, 200 men leave. How long will the rest of the food last for those who remain?**

### STEP BY STEP

1. Food left $= 800 \times 45$ man-days.
2. Men left $= 600$.
3. Days $= 800 \times 45 \div 600 = 60$.

### SHORTCUT

$M(D - t) \div (M - R) = 800 \times 45 \div 600 = 60$.

**Why it works:** Fewer people share the same food, so it lasts longer than the 45 days planned.

**Answer: 60 days**

## 3 RATION CHANGE

**A fort has food for 450 men for 35 days. After 5 days the daily ration is reduced to 5/6 of the normal amount. How many more days will the food last?**

### STEP BY STEP

1. At full ration the food left lasts 30 days.
2. At 5/6 ration it lasts $30 \times 6/5 = 36$ days.

### SHORTCUT

Remaining days × old ration ÷ new ration $= 30 \times 6/5 = 36$.

**Why it works:** Days and daily ration are in inverse proportion.

**Answer: 36 days**

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**4** EQUIVALENCE

**3 men = 4 women = 6 boys in work. A team of 6 men, 8 women and 12 boys finishes a job in 10 days. How many days will 15 boys take?**

STEP BY STEP

1. Convert to boys: 6 men = 12 boys, 8 women = 12 boys.
2. Team = 12 + 12 + 12 = 36 boys → 360 boy-days.
3. 15 boys: 360 ÷ 15 = 24 days.

SHORTCUT

36 boys × 10 = 15 boys × D → D = 24.

**Why it works:** Once everyone is in boy-units, it is a simple inverse proportion.

**Answer: 24 days**

**5** AHEAD OF SCHEDULE

**A contractor plans to finish a job in 75 days with 120 men. After 25 days, 2/5 of the work is done. How many men can he release and still finish on time?**

STEP BY STEP

1. 120 × 25 = 3,000 man-days did 2/5 → whole job = 7,500 man-days.
2. Remaining 4,500 man-days in 50 days → 90 men needed.
3. He can release 120 − 90 = 30 men.

SHORTCUT

Remaining work 3/5 needs 120 × 25 × (3/5)/(2/5) = 4,500 man-days ÷ 50 = 90.

**Why it works:** Progress so far fixes the size of the job in man-days.

**Answer: 30 men**

**6** WAGES

**12 men earn ₹50,400 in 7 days. How much will 18 men earn in 5 days at the same rate?**

STEP BY STEP

1. Rate = 50,400 ÷ (12 × 7) = ₹600 per man-day.
2. 18 × 5 × 600 = ₹54,000.

SHORTCUT

50,400 × 18/12 × 5/7 = 54,000.

**Why it works:** Wages are proportional to men × days.

**Answer: ₹54,000**

**7** MACHINES

**8 machines make 1,200 units in 6 hours. How many hours will 12 machines take to make 2,700 units?**

STEP BY STEP

1. Rate = 1,200 ÷ (8 × 6) = 25 units per machine-hour.
2. Hours = 2,700 ÷ (12 × 25) = 9.

SHORTCUT

6 × 8/12 × 2,700/1,200 = 9.

**Why it works:** More machines → fewer hours; more units → more hours.

**Answer: 9 hours**

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8 FUEL

**A car uses 30 litres of petrol for 450 km. Petrol costs ₹100 a litre. What does petrol cost for a 1,200 km trip?**

STEP BY STEP

1. Mileage = 450 ÷ 30 = 15 km per litre.
2. Petrol for 1,200 km = 80 L.
3. Cost = 80 × 100 = ₹8,000.

SHORTCUT

30 × 1,200/450 = 80 L → ₹8,000.

**Why it works:** Fuel used is directly proportional to distance.

**Answer: ₹8,000**

9 PRICE CHAIN

**The cost of 8 pens equals that of 5 notebooks, and 3 notebooks cost as much as 2 bags. A bag costs ₹480. What does one pen cost?**

STEP BY STEP

1. 2 bags = ₹960 = 3 notebooks → notebook = ₹320.
2. 5 notebooks = ₹1,600 = 8 pens → pen = ₹200.

SHORTCUT

Pen = 480 × 2/3 × 5/8 = 200.

**Why it works:** Each equal-cost statement is a conversion rate; multiply them along the chain.

**Answer: ₹200**

10 NEW TEAM JOINS

**20 men can finish a job in 15 days. They work for 6 days, and then 10 more men join. In how many more days is the job finished?**

STEP BY STEP

1. Job = 20 × 15 = 300 man-days; done = 120.
2. Remaining 180 man-days with 30 men.
3. 180 ÷ 30 = 6 days.

SHORTCUT

20 × (15 − 6) ÷ 30 = 6.

**Why it works:** The work left equals what 20 men would do in the remaining 9 days.

**Answer: 6 days**

11 GROWING GRASS

**A field with growing grass feeds 12 cows for 15 days or 16 cows for 9 days. How many days will it feed 21 cows?**

STEP BY STEP

1. Let G = initial grass, r = daily growth (in cow-days).
2. G + 15r = 180 and G + 9r = 144 → r = 6, G = 90.
3. 21 cows: 90 + 6d = 21d → d = 6.

SHORTCUT

r = (180 − 144) ÷ (15 − 9) = 6; d = G ÷ (cows − r) = 90 ÷ 15 = 6.

**Why it works:** Each day 6 cows' worth of grass grows back, so effectively only 15 cows eat the original grass.

**Answer: 6 days**

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# 5 Important exam tips

Patterns, traps and habits that save marks

### Frequently asked question patterns

- Men, days and hours with a different amount of work.
- Garrison food with men joining or leaving, or rations reduced.
- Mixed teams of men, women and boys.
- Contractors behind or ahead of schedule.
- Wages, machines, fuel and production chains.
- Exchange chains (x of one item = y of another).
- Growing-grass pasture questions.

### Common mistakes to avoid

- Treating an inverse relation as direct (more men → more days).
- Mixing hours and days without converting.
- Forgetting the days already passed in provision questions.
- Not converting a mixed team into one type of worker.
- Answering “men needed” when the question asks “extra men” or “men released”.
- Using the whole job instead of the remaining work after a change.

### Points to remember

- $M_1D_1H_1/W_1 = M_2D_2H_2/W_2$.
- Food left = $M(D - t)$ man-days.
- Days $\propto$ 1/daily ration.
- Convert a men = b women before calculating.
- Growing grass: effective eaters = cows – daily growth.
- Price chains: multiply the exchange rates (5 apples = 3 mangoes, 4 mangoes = 10 bananas → 1 apple = 1.5 bananas).

### Speed and accuracy

- Use the arrow method – one multiplication line, no equation.
- Cancel numbers before multiplying.
- Find the rate per man-day or per machine-hour once.
- Re-read what is asked: total, extra or released.

### Preparation strategy

- Master the chain formula first; provisions and equivalences follow from it.
- Practise on LearnFrenzy in order: Easy → Medium → Hard → Exam Pattern Mix → Data Sufficiency.
- Aim for 45 seconds per chain-rule question.
- Keep an error log of direct/inverse mix-ups.
- Read the Quick Revision Sheet (next page) the night before the exam.

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# 6 Quick revision sheet

Everything on one page for the night before the exam

## Formulas

| | | | |
|---|---|---|---|
| Direct | $x_1/y_1 = x_2/y_2$ | Inverse | $x_1y_1 = x_2y_2$ |
| Chain | $M_1D_1H_1/W_1 = M_2D_2H_2/W_2$ | With efficiency | **M D H E/W** |
| Food left | **M(D – t) man-days** | Men join / leave | **M(D – t)/(M ± R)** |
| Ration cut | **days × old/new ration** | a men = b women | **1 man = b/a women** |
| Job size | **man-days ÷ fraction done** | Men needed | **remaining man-days ÷ days left** |
| Wages | **∝ men × days** | Output | **∝ machines × time** |
| Price chain | **multiply exchange rates** | Growing grass | **G + d·r = C·d** |

## Shortcut tricks

- Arrow method: more or less?
- Same units before the formula.
- Rate per unit first.
- Convert mixed teams to one kind.
- Provisions: subtract days passed.
- Read: total, extra or released?

## Must-know numbers

| | |
|---|---|
| **Units** | 1 day = 24 h · 1 week = 7 days · 1 h = 60 min |
| **Typical equivalences** | 2 men = 3 women · 3 men = 4 women = 6 boys · 1 man = 2 boys |

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# 7 A message from LearnFrenzy

For everyone preparing for placements, competitive and government exams

## Keep going – you are closer than you think

Success in examinations is not just about how many hours you study. It is about how effectively you understand concepts, practise questions, and improve yourself every day.

Every formula you learn, every problem you solve, and every mistake you correct brings you one step closer to your goal.

Whether you are preparing for campus placements, competitive examinations, or government jobs, remember that consistency, confidence, and smart preparation make a real difference.

Don’t just memorize formulas. Understand the concepts, practise smart techniques, and develop the confidence to solve problems independently.

Your hard work today can create the opportunities you dream of tomorrow.

**— Team LearnFrenzy**

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