CHAPTER TWELVE

CHANGE OF SUBJECT

Introduction:

To make a letter the subject of a given equation is to let it stand alone, on one side of the equal to symbol.

Q1. Given that c = 2πr,

i) make r the subject.
ii) calculate r when c = 20 and π = 3.14 .

Soln.

c = 2πr

Divide through using 2π $\Rightarrow \frac{c}{2\pi} = \frac{2\pi r}{2\pi} \Rightarrow \frac{c}{2\pi} = r \Rightarrow$ r = $\frac{c}{2\pi}$

When c = 20 and π = 3.14

$\Rightarrow$ r = $\frac{c}{2\pi} = \frac{20}{2(3.14)} = \frac{20}{6.28}$

= 3.2 $\Rightarrow$ r = 3.2.

Q2. Given that M = RVL,

i) make V the subject.
ii) Calculate V when M = 50, R = 20 and L = 10.

Soln.

i) M = RVL

Divide through using RL $\Rightarrow \frac{M}{RL} = \frac{RVL}{RL}, \Rightarrow \frac{M}{RL} = V \Rightarrow$ V = $\frac{M}{RL}$.

ii) When M = 50, R = 20 and L = 10 $\Rightarrow$ V = $\frac{M}{RL} = \frac{50}{(20)(10)}$

= $\frac{50}{200} = 0.25$.

Q3. You are given the formula 2RV^2 = mg.

i) Make R the subject.

ii) Calculate R when V = 3, M = 5 and g = 2.

Soln.

i) $2RV^2 = mg$.

Divide through using $2V^2 \Rightarrow \frac{2RV^2}{2V^2} =$ R = $\frac{mg}{2V^2}$

ii) If V = 3, m = 5 and g = 2

$\Rightarrow$ R = $\frac{Mg}{2V^2} = \frac{(5)(2)}{(2)(3)^2} = \frac{10}{(2)(9)} = \frac{10}{18} \Rightarrow$ R = 0.55 .

Q4. If $5b^2r^3v = 2N, make\ v\ the\ subject.$

Soln.

$5b^2r^3v = 2N. Dividethrough\ using\ 5b^2r^3 \Rightarrow \frac{5b^2r^3v}{5b^2r^3} = \frac{2N}{5b^2r^3}$

$\Rightarrow$ v = $\frac{2N}{5b^2r^3}$.

Q5. Given that a + b = 2R,

i) make a the subject.
ii) calculate a, when b = 3 and R = 10.
iii) make R the subject.
iv) calculate R when a = 3 and b = 5.

Soln.

i) a + b = 2R $\Rightarrow$ a = 2R – b
ii) When b = 3 and R = 10 $\Rightarrow$ a = 2R – b, $\Rightarrow$ a = 2(10) – 3
= 20 – 3 = 17.
iii) To make R the subject, a + b = 2R. Divide through using 2 $\Rightarrow \frac{a+b}{2} = \frac{2R}{2} \Rightarrow \frac{a+b}{2} =$ R
$\Rightarrow$ R = $\frac{a+b}{2}$.
When a = 3 and b = 5
$\Rightarrow$ R = $\frac{a+b}{2} = \frac{3+5}{2} = \frac{8}{2} = 4$.

Q6. Given that 2V + 3R = 4b,

i) make V the subject.
ii) calculate V when R = 3 and b = 1.

Soln.

i) 2V + 3R = 4b $\Rightarrow$ 2V = 4b – 3R

Divide through using 2 $\Rightarrow \frac{2v}{2} = \frac{4b-3R}{2} \Rightarrow \mathrm{V} = \frac{4\mathrm{b} - 3\mathrm{R}}{2}$

ii) When R = 3 and b = 1

$\Rightarrow \mathrm{V} = \frac{4(1) - 3(3)}{2} = \frac{4 - 9}{2} = \frac{-5}{2} = -2.5.$

Q7. You are given the formula 2V + 3R = 4b,

(i) make R the subject.

(ii) make b the subject.

Soln.

(i) 2V + 3R = 4b

$\Rightarrow$ 3R = 4b – 2V

Divide through using 3

$\Rightarrow \frac{3R}{3} = \frac{4b-2V}{3} \Rightarrow \mathrm{R} = \frac{4\mathrm{b}-2\mathrm{V}}{3}$

(ii) 2V + 3R = 4b .

Divide through using 4

$\Rightarrow \frac{2V+3R}{4} = \frac{4b}{4} \Rightarrow \frac{2\mathrm{V}+3\mathrm{R}}{4} = \mathrm{b}$

$\Rightarrow \mathrm{b} = \frac{2V+3R}{4}$.

Q8. Given that the three quantities V, u and t are connected by the formula V = 3u + at^2, calculate a when V = 10, t = 1 and u = 3.

N/B: Before you can calculate a, you must first make a the subject.

Soln.

V = 3u + a$t^2 \Rightarrow \mathrm{V} - 3\mathrm{u} = \mathrm{at}^2$

Divide through using $t^2 \Rightarrow \frac{\mathrm{V}-3\mathrm{u}}{\mathrm{t}^2} = \frac{\mathrm{at}^2}{\mathrm{t}^2} \Rightarrow \frac{\mathrm{V}-3\mathrm{u}}{\mathrm{t}^2} = \mathrm{a}$

$\Rightarrow$ a = $\frac{V-3u}{t^2}$.

When V = 10, t = 1 and u = 3

$\Rightarrow \mathrm{a} = \frac{V-3u}{t^2} = \frac{10-3(3)}{1^2} = \frac{10-9}{1} = \frac{1}{1}$

= 1 .

N/B: If $a^2 = 4 \Rightarrow$ a = $\sqrt{4} = 2$.

If $x^2 = 25 \Rightarrow$ x = $\sqrt{25} = 5$.

Q9. If 2V = u – ga^2,

(i) make a the subject.

(ii) calculate a when V = 3, u = 30 and g = 1.

Soln.

(i) 2V = u – g$a^2 \Rightarrow$ 2V + ga^2 = u

$\Rightarrow$ g$a^2 = u - 2V$.

Divide through using g

$\Rightarrow \frac{ga^2}{g} = \frac{u-2v}{g} \Rightarrow$ a^2 = $\frac{u-2V}{g} \Rightarrow$ a = $\sqrt{\frac{u-2v}{g}}$.

(ii) When V = 3, u = 30 and g = 1

$\Rightarrow$ a = $\sqrt{\frac{30-2(3)}{1}} \Rightarrow$ a = $\sqrt{\frac{30-6}{1}}$

$\Rightarrow$ a = $\sqrt{\frac{24}{1}} \Rightarrow a = \sqrt{24} = 4.9$.

Q10. If 2RV^2 = mg, calculate V when m = 50, g = 4 and R = 1.

Soln.

2R$V^2 = mg$.

Dividing through using 2R $\Rightarrow \frac{2RV^2}{2R} = \frac{mg}{2R} \Rightarrow V^2 = \frac{mg}{2R}$

$\Rightarrow$ V = $\sqrt{mg/2R}$.

When m = 50, g = 4 and R = 1

$\Rightarrow$ V = $\sqrt{\frac{(50)(4)}{2(1)}} = \sqrt{\frac{200}{2}} = \sqrt{100}$

$\Rightarrow$ V = 10.

Q11. The movement of a particle is such that its final velocity V, its initial velocity u, its acceleration a and its time t, are connected by the formula V = 3u + at^2 . Calculate the time in seconds when V = $115m/s$, $u = 5m/s$ and a = $4m/s^2$.

Soln.

V = 3u + a$t^2 \Rightarrow V - 3u = at^2$

Divide through using a $\Rightarrow \frac{v-3u}{a} = \frac{at^2}{a}, \Rightarrow \frac{\text{V}-3\text{u}}{\text{a}} = \text{t}^2,$

$\Rightarrow t^2 = \frac{V-3u}{a} \Rightarrow$ t = $\sqrt{\frac{\text{V} - 3\text{u}}{\text{a}}}$.

But V = 115, u = 5 and a = 4

$\Rightarrow$ t = $\sqrt{\frac{115 - 3(5)}{4}} = \sqrt{\frac{100}{4}} = \sqrt{25}$

= 5 $\Rightarrow$ t = 5seconds.

N/B: If the letter we are required to make the subject appears twice, then we must factorize it by bringing it outside the bracket.

Q12. The variables b and v are connected by the formula 5b - v^2 = vb + 2. Make b the subject.

Soln.

5b – $v^2 = vb + 2 \Rightarrow$ 5b = vb + 2 + $\text{v}^2, \Rightarrow$ 5b – vb = 2 + v^2 . Factorize the b

$\Rightarrow \text{b}(5 - \text{v}) = 2 + \text{v}^2$

Divide through using $5 - \text{v} \Rightarrow \frac{b(5-v)}{5-v} = \frac{2+v^2}{5-v}$

$\Rightarrow$ b = $\frac{2 + v^2}{5 - v}$.

Q13. Given that a$v^2 + 2 = 2v^2 - 2c, make\ v\ the\ subject.$

Soln.

a$v^2 + 2 = 2v^2 - 2c$

$\Rightarrow$ a$v^2 + 2 - 2v^2 = -2c,$

$\Rightarrow av^2 - 2v^2 = -2c - 2$

$\Rightarrow v^2(a - 2) = -2c - 2,$

Divide through using a – 2.

$\Rightarrow \frac{v^2(a-2)}{(a-2)} = \frac{-2c-2}{(a-2)}$

$\Rightarrow v^2 = \frac{-2c-2}{(a-2)} \Rightarrow \text{v} = \sqrt{\frac{-2\text{c}-2}{\text{a}-2}}$.

N/B: (1) If $a^2 = b \Rightarrow \text{a} = \sqrt{\text{b}}$