A1)

$$\frac{81 \times 125 \times 64}{256 \times 729 \times 15}$$

$$= \frac{3^4 \times 5^3 \times 2^6}{2^8 \times 3^6 \times 3 \times 5}$$

$$= \frac{5^2}{2^2 \times 3^3}$$

$$= \frac{25}{4 \times 27} = \frac{25}{108}$$

B1) $x^{2024} + x^{1012} - 1$

$x^{1012} \geq 0$ as 1012 is even

$x^{2024} \geq 0$ as 2024 is also even

So minimum is for $x = 0$

So minimum is for $x=0$

$$f(x)_{min} = -1$$

A2) Chance of 2 sons in a row is 0.25
Chance of 3 sons in a row is 0.125
Chance of 4 sons in a row is 0.0625

Hence chance of not 4 sons in a row (at least 1 daughter) is $1-0.0625 = 0.9375$

4 children

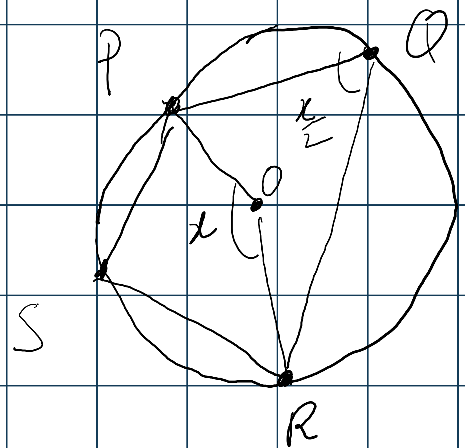
B2)
$$1+2 = 3 = 4-1$$
$$1+2+4 = 7 = 8-1$$
$$1+2+4+8 = 15 = 16-1$$
$$1+2+4+8+16 = 31 = 32-1$$

hence

$$1+2+4+8+16+\ldots+32768 = 32768 \times 2 - 1$$

$= 65536 - 1$
$= 65535$

A3)



Angle at centre is twice angle at circumference

B3)

$$u^2 - u - 1 = 0$$
$$\left(u - \tfrac{1}{2}\right)^2 - \tfrac{1}{4} - 1 = 0$$

$$\left(u - \tfrac{1}{2}\right)^2 = \frac{5}{4}$$

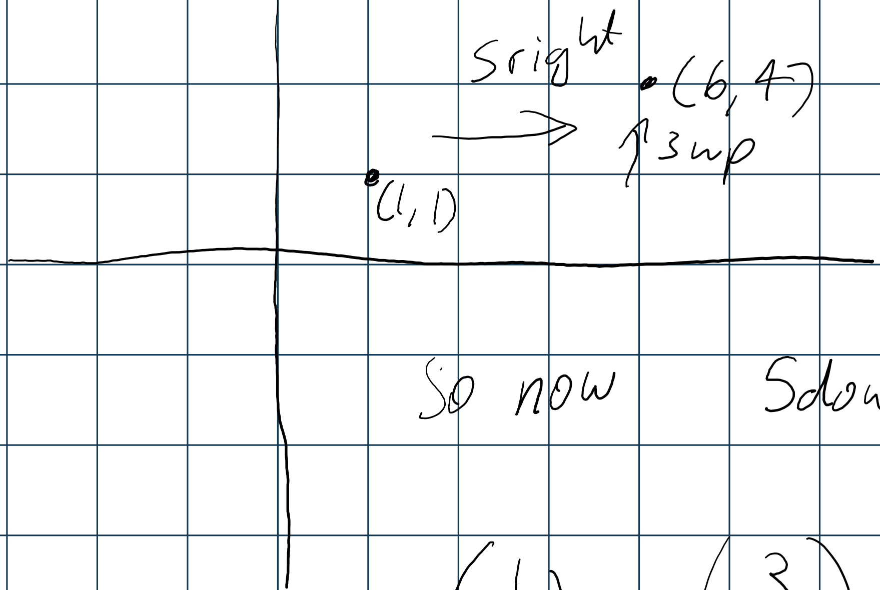
$$u = \frac{1 \pm \sqrt{5}}{2}$$

$$f(x) = x^{2024} - x^{1012} - 1$$
Let $u = x^{1012}$

$$f(x) = u^2 - u - 1$$
$$= \left(u - \tfrac{1}{2}\right)^2 - \frac{5}{4}$$

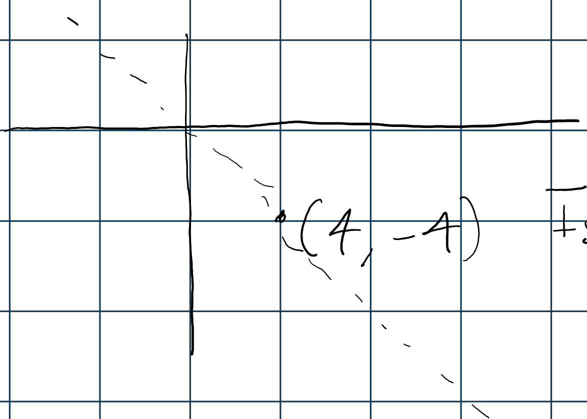
$$f(x)_{min} = -\frac{5}{4}$$

A4)



So now 5down, 3right

$$\begin{pmatrix}1\\1\end{pmatrix} + \begin{pmatrix}3\\-5\end{pmatrix} = \begin{pmatrix}4\\-4\end{pmatrix}$$

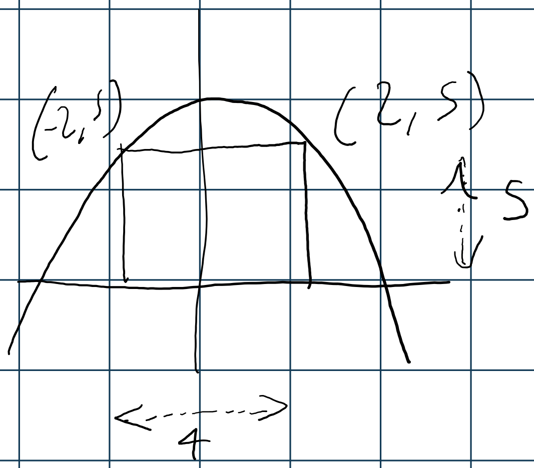


Is on the line $y=-x$ so not reflected

$$\begin{pmatrix}4\\-4\end{pmatrix} + \begin{pmatrix}3\\2\end{pmatrix} = \begin{pmatrix}7\\-2\end{pmatrix}$$

$$\begin{pmatrix}7\\-2\end{pmatrix} \times 3 = \begin{pmatrix}21\\-6\end{pmatrix} \qquad (21, -6)$$

B4)



$5 \times 4 = 20$

20 units^2

A5) $3 \times (£3, 15s, 7p)$

$= £9, 45s, 21p$

$$
\begin{array}{r}
£9, 45s, 21p \\
+ \; £2, 10s, 3\tfrac{1}{2}p \\
\hline
£11, 55s, 24\tfrac{1}{2}p
\end{array}
$$

$24\frac{1}{2}p = 2s \; \frac{1}{2}p$

$55s + 2s = 57s$

$57s = £2 \; 17s$

$£11 + £2 = £13$

$£11 + £2 = £13$

$£13,\ 17s,\ \frac{1}{2}p$

13 £ coins, 3 crowns, 1 florin, and 1 halfpence

18 coins

B5)

$2 \times (£1,\ 18s,\ 4p)$

$= £2,\ 36s,\ 8p$

$$\begin{array}{rl} & £2,\ 36s,\ 8p \\ + & £2,\ 5s,\ 1\tfrac{1}{2}p \\ \hline & £4,\ 41s,\ 9\tfrac{1}{2}p \end{array}$$

$41s = £2,\ 1s$

Total: $£6,\ 1s,\ 9\frac{1}{2}p$

6 £1 coins, 1 shilling, 1 sixpence, 3 pence coins, and 1 half pence

12 coins in total

A6)

V is vertical velocity here

$$\frac{1}{2}mv^2 = mgh$$

$$\frac{1}{2}v^2 = gh$$

$$v = \sqrt{2gh}$$
$$= \sqrt{40g}$$
$$= 2\sqrt{10g}$$

$$s = ut + \frac{1}{2}at^2$$

Final displacement is 0

$$0 = ut - \frac{1}{2}gt^2$$
$$= t\left(u - \frac{1}{2}gt\right)$$

$$u - \frac{1}{2}gt = 0$$

$$\frac{2u}{g} = t$$

$$\frac{4\sqrt{10g}}{g} = t$$

$$4\sqrt{10}\, g^{-\frac{1}{2}} = t$$

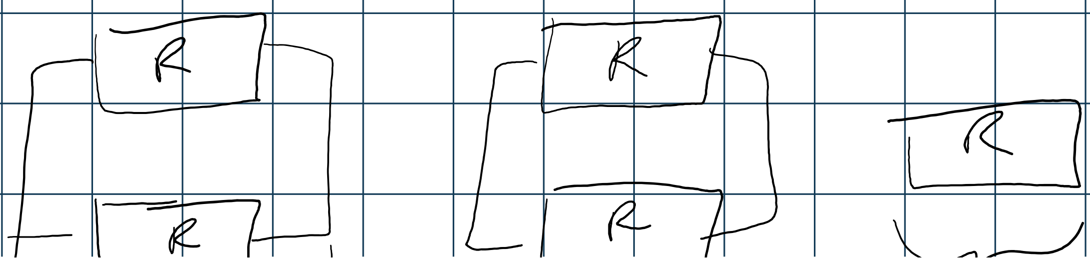
The initial velocity is not needed,
only the maximum height

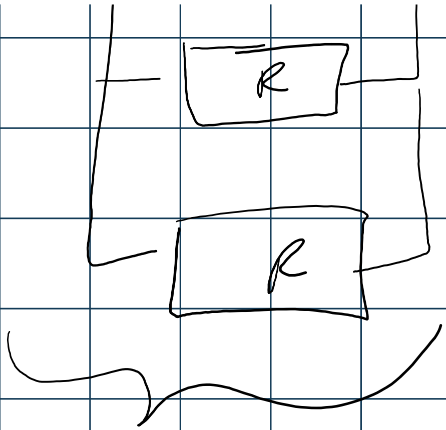
B6)

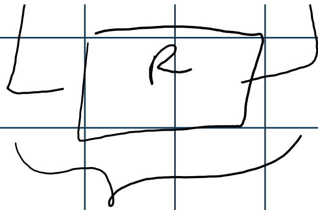
$$\frac{1}{2} m v^2 = 0.9 mgh$$
$$\frac{1}{2} v^2 = 0.9 gh$$
$$v^2 = 1.8 gh$$

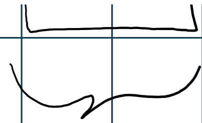
$$v = \sqrt{1.8gh}$$
$$= \sqrt{9g}$$
$$= 3\sqrt{g}$$

A7)









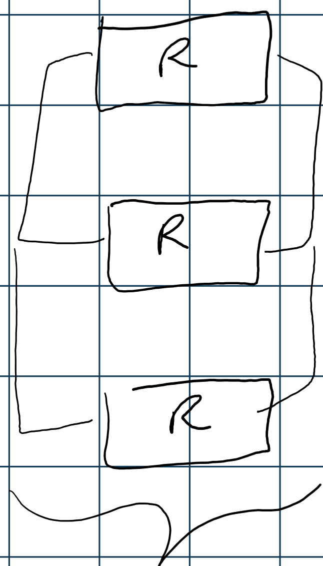
$R_T = R$

$$R_T = \left(\frac{1}{R} + \frac{1}{R}\right)^{-1} = \frac{R}{2}$$

$$R_T = \left(\frac{1}{R} + \frac{1}{R} + \frac{1}{R}\right)^{-1} = \frac{R}{3}$$

$$\frac{R}{3} + \frac{R}{2} + R = \frac{11}{6}R$$

B7)

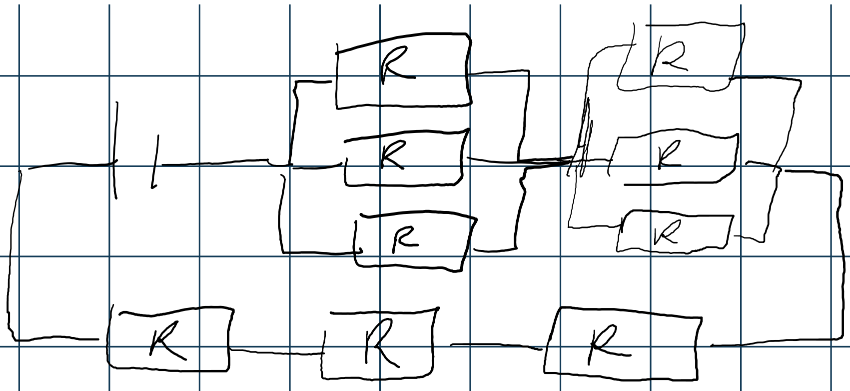


$\frac{R}{3}$

$$\frac{R}{3} \times 2 = \frac{2}{3}R$$

$$\frac{2}{3}R + 3R = \frac{11}{3}R$$

Hence



Is a possible solution