(17) $((q \wedge p) \wedge \sim(p \wedge q)) \vee (p \wedge p)$

$\Leftrightarrow ((p \wedge q) \wedge \sim(p \wedge q)) \vee (p \wedge p)$ Commutative

$\Leftrightarrow 0 \vee (p \wedge p)$ Complement

$\Leftrightarrow p \wedge p$ Identity

$\Leftrightarrow p$ Idempotent

(18) $(BA + \overline{CB}\,CB) + \overline{\overline{AB}}$

$\Leftrightarrow (BA + 0) + \overline{\overline{AB}}$ Complement

$\Leftrightarrow (BA + 0) + AB$ Complement

$\Leftrightarrow BA + AB$ Identity

$\Leftrightarrow AB + AB$ Commutative

$\Leftrightarrow AB$ Idempotent

(19) $\sim(p \vee q) \wedge (q \vee (q \wedge \sim r))$

$\Leftrightarrow \sim(p \vee q) \wedge q$ Absorption

$\Leftrightarrow (\sim p \wedge \sim q) \wedge q$ De Morgan's

$\Leftrightarrow \sim p \wedge (\sim q \wedge q)$ Associative

$\Leftrightarrow \sim p \wedge 0$ Complement

$\Leftrightarrow 0$ Identity

(20) $\overline{A\,\overline{B}}\,(\bar{A} + \overline{B}) + \bar{A}C$

$\Leftrightarrow (\overline{A} + \overline{\overline{B}})(\bar{A} + \overline{B}) + \bar{A}C$ De Morgan's

$\Leftrightarrow (\bar{A} + B)(\bar{A} + \overline{B}) + \bar{A}C$ Complement

$\Leftrightarrow \bar{A} + B\overline{B} + \bar{A}C$ Distributive

$\Leftrightarrow \bar{A} + 0 + \bar{A}C$ Complement

$\Leftrightarrow \overline{A} + \bar{A}C$ Identity

$\Leftrightarrow \overline{A}$ Absorption

(21) a) MAYBE

b) YES

c) No

d) MAYBE

(22) a) Converse of original.
Not logically equivalent to original.

b) Contrapositive of original.
Logically equivalent to original.

c) Inverse of original.
Not logically equivalent to original.

(23) a) No

b) YES

c) YES

d) No

(24) a) $a_n = \frac{n+1}{n}$ for $1 \leq n \leq 9$

Alternatively:

$$a_n = \frac{n}{n-1} \quad \text{for} \quad 2 \leq n \leq 10$$

b) Each term is the previous term -3

$$\begin{cases} a_1 = 4 \\ a_n = a_{n-1} - 3 & \text{for } n \geq 2 \end{cases}$$

Alternatively:

$$\begin{cases} a_0 = 4 \\ a_n = a_{n-1} - 3 & \text{for } n \geq 1 \end{cases}$$

(25) $\frac{2}{5} + \frac{2}{6} + \frac{2}{7} + \ldots + \frac{2}{13}$

$$= \sum_{n=5}^{13} \frac{2}{n}$$

Some alternative answers:

$$\sum_{i=5}^{13} \frac{2}{i} \quad \text{OR} \quad \sum_{i=0}^{8} \frac{2}{i+5} \quad \text{OR} \quad \sum_{n=0}^{8} \frac{2}{n+5}$$

(26) Arithmetic sequence with $a_1 = 23$ and $d = 8$

$$a_n = a_m + (n-m)d \quad \text{for } n \geq m$$

Sub $m=1$: $a_n = a_1 + (n-1)d$ for $n \geq 1$

$a_n = 23 + (n-1)(8)$

$a_n = 23 + 8n - 8$

$$\boxed{a_n = 15 + 8n \quad \text{for } n \geq 1}$$

(27) a) $a_n = a_m + (n-m)d$ for $n \geq m$

Sub $m=1$:

$a_n = a_1 + (n-1)d$ for $n \geq 1$

$a_n = 19 + (n-1)6$

Sub $n=35$: $a_{35} = 19 + 34(6)$

$a_{35} = 223$

b) From above:

$a_n = 19 + (n-1)6$ for $n \geq 1$

Sub $a_n = 1243$: $1243 = 19 + (n-1)6$

$1224 = (n-1)6$

$204 = n-1$

$205 = n$

$\boxed{a_{205} = 1243}$

(28) $\sum_{j=12}^{59} (7j-2)$

$= 82 + 89 + 96 + \dots + 411$

Arithmetic Series

a_m a_n

$k =$ # of terms

$= n - m + 1$

$= 59 - 12 + 1$

$= 48$

$S_k = \frac{k}{2}(a_m + a_n)$

$= \frac{48}{2}(82 + 411)$

$= 11832$

(29) Geometric Sequence with $a_1 = 4$ and $r = -2$

$$\begin{cases} a_1 = 4 \\ a_n = -2\, a_{n-1} & \text{for } n \geq 2 \end{cases}$$

(30) Geometric sequence with $a_1 = 3^{16}$ $r = \frac{1}{3}$

$$a_n = a_m r^{n-m} \quad \text{for } n \geq m$$

Sub $n = 12$, $m = 1$:

$$a_{12} = a_1 r^{11}$$
$$= 3^{16}\left(\frac{1}{3}\right)^{11}$$
$$= 243$$

(31) Geometric series with $a_1 = -6$ $r = \frac{-1}{2}$

a) $$S_k = \frac{a_m(1-r^k)}{1-r}$$

Sub $k = 8$, $m = 1$:

$$S_8 = \frac{a_1(1-r^8)}{1-r}$$
$$= \frac{-6\left(1-\left(\frac{-1}{2}\right)^8\right)}{\left(1+\frac{1}{2}\right)}$$
$$\approx -3.98$$

b) $-1 < r < 1$ ✓

$$S_\infty = \frac{a_n}{1-r}$$

$$= \frac{a_1}{1-r}$$

$$= \frac{-6}{(1+\frac{1}{2})}$$

$$= -4$$

(32) a) Program 1
b) Program 2
c) 50,000

(33) a) $O(n)$ b) $O(n^2)$ c) $O(1)$
d) $O(n!)$ e) $O(2^n)$ f) $O(n!)$
g) $O(\log n)$ h) $O(n \log n)$ i) $O(n)$

(34) $O(n!)$, $O(2^n)$, $O(n^2)$,
$O(n \log n)$, $O(n)$, $O(\log n)$, $O(1)$

(35) a) Each user is an experimental unit.

b) Country — QUALITATIVE

Number of logins — DISCRETE

Time Spent Playing — CONTINUOUS

(36) a) Unimodal symmetrical

b) There are no outliers.

c) The range 1-1.5 kg is the mode.

d) $\frac{30}{100} = 30\%$

(37) The vertical axis does not begin at 0.