POSSIBLE ANSWERS FOR:

PHYSIOLOGY HG

TIME: 3 hours

MARKS: 300

SECTION A

QUESTION 1.1

1.1.1	A	1.1.16	C
1.1.2	C	1.1.17	C
1.1.3	A	1.1.18	B
1.1.4	A	1.1.19	A
1.1.5	C	1.1.20	B
1.1.6	D	1.1.21	C
1.1.7	D	1.1.22	A
1.1.8	D	1.1.23	B
1.1.9	D	1.1.24	A
1.1.10	A	1.1.25	B
1.1.11	B	1.1.26	B
1.1.12	B	1.1.27	B
1.1.13	B	1.1.28	D
1.1.14	A	1.1.29	C
1.1.15	D	1.1.30	B

30 x 2 = (60)

QUESTION 1.2

1.2.1 Fissure of Rolando
1.2.2 Meissner corpuscles
1.2.3 Prolactin
1.2.4 Oval window
1.2.5 aquous humor
1.2.6 Lachrymal gland
1.2.7 Medulla
1.2.8 Vermis
1.2.9 Acetylcholine
1.2.10 Ceratin

(10)

QUESTION 1.3

1.3.1 A
1.3.2 E
1.3.3 G
1.3.4 K
1.3.5 B
1.3.6 O
1.3.7 M
1.3.8 Q
1.3.9 S
1.3.10 P 10 x 2 = (20)

SECTION B

QUESTION 2

2.1 (a) Blood vessels:
- Provides the skin with oxygen and nutrients.
- Waste products are removed from tissues and some are carried to the sweat glands.
- Constriction and dilation of blood vessels also facilitate temperature regulation.

(b) Lymph vessels:
- Lymph is transported to the deeper-lying layers.

(c) Sense organs:
- free nerve endings – sensitive to pain
- Meissner's corpuscles for touch
- Pacinian corpuscles for pressure
- Organs of Ruffini for warmth
- End-bulbs of Krause for cold

(d) Hairs:
- Erector muscles attached to hair play a role in temperature regulation.

(e) Skin glands:
- Sweat glands – produce sweat to cool down the body. Assist in osmoregulation. Excretes metabolic waste.
- Sebaceous glands – Produce sebum. It opens onto the hair follicle keeping it and the skin soft and pliable. **Any 16**

2.2 Graph (Fig 2.2)

2.2.1 It causes an increase I the concentration of urea in the blood.

2.2.2 The liver is responsible for the deamination (1) of the excess proteins and amino acids (1). It causes the amino group (NH_2) (1) to be removed from the amino acid. The NH_2 then combined with H^+ (1) to form ammonia (1). Ammonia will then react with CO_2 (1) to form urea (1). Urea is excreted into the blood (1) and transported to the kidneys (1) which are responsible for the excretion of metabolic waste (1) including urea (1). If the kidneys are removed, the area can not be excreted (1) and the liver will continue to produce urea (1) and that causes the concentration of urea to increase in the blood (1). **[12]**

2.2.3 In graph M the liver was removed first and the result was a decrease in concentration of ureum (1). Conclusion - the liver produce ureum (1) In graph L the kidneys were removed first that causes the increase in urea (1). Conclusion – the kidneys excrete urea (1) **[4]**

2.3 Blood – could be as a result of an infection, injury, bilharzia or strenuous exercise.
Glucose – Diabetes mellitus. Insulin shortage
Kidney stones – not drinking enough fluids or stagnation of urine due to an injury / over-active parathyroid (6)

QUESTION 3

3.1.1 A reflex action is an autonomic response of a muscle or gland to a stimulus received by a receptor organ. (3)

3.1.2 Sneezing, blinking, coughing or salivation. (2)

3.1.3 (a) The vertebrae are not supported by the disc anymore – therefore the disc don't absorb shock or weight and vertebrae are in close contact. (2)

(b) The pressure can be exerted on the spinal cord. (2)

3.1.4 They relieve the workload of the higher centres of the brain. They speed up reactions by bypassing the higher centres of the brain. The quality of life is enhanced by actions such as playing the piano or reading a book.

3.1.5 Reflex arc

- A stimulus is sensed by the receptor and it causes impulses to be generated.
- These impulses pass along the dendrite of a sensory neuron towards the CNS.
- They are conducted into the dorsal root of the spinal nerve and then into the cell body of the sensory neuron which is situated in the dorsal root ganglion.
- From three they are conducted along the axon of the sensory neuron, into the dorsal horn of gray matter in the CNS.
- The impulse moves across the synapse between the sensory nerve and the connector neuron which acts as a reflex centre.
- The connector neuron passes the impulse along to the appropriate motor neuron and it travels along its axon via the ventral horn of gray matter and out the spinal chord through the ventral root of the spinal nerve.
- They travel to the effector organ (a muscle or gland) which brings about the appropriate response (reflex action). (12)

3.2 Reflex Time

This is the interval between the application of the stimulus and the start of the response.

Factors affecting reflex time

- Alcohol – this retards reflex times as it affects the synapses, slowing down the conduction of impulses.

- Fatigue – this also affects the synaptic junctions, retarding the impulses.

- Certain drugs e.g. atropine

- Types of stimuli – touch, sound, and visual stimuli cause a faster response than smell, taste and pain stimuli.

Inhibition of a reflex action

Inhibition is the slowing down or prevention of a reflex action and is brought about by varying conditions of synapses.

Types of inhibition

(a) Control by higher centres of the brain i.e. by the cerebral cortex and cerebellum.

Certain neurons from these centres are inhibitory and their impulses prevent the normal stimulation of the motor neuron.

Examples:

- Some are under control of the will (cerebral cortex) e.g. deciding to keep one's hand in hot water instead of withdrawing it reflexively.
- Others we are not conscious of e.g. working of antagonistic muscles (cerebellum)

(b) Actions of drugs an poisons

These chemicals, e.g. food poisoning toxins, organophosphates, pesticides, nerve gas, affect the myo-neural junction (nerve end plate) blocking the flow of impulses along the motor neuron and so inhibit the reflex action.

(c) Synaptic fatigue

This occurs when there are too many impulses and there are not enough time for the neurotransmitter at the synapse to be resynthesised and so transmission stops. (16)

QUESTION 4

4.1 Brain is protected by the:

- cranium
- dura mater
- pia mater
- arachnoid
- cerebrospinal fluid
- curvature of the spine
- arches of the feet
- cartlaliginous discs between vertebrae

any (6)

4.2 Respiratory centre controls rate and depth of breathing.

- Vasomotor centre controls calibre of the walls of the blood vessels and influences blood pressure
- Vasomotor centre also controls the vasoconstriction and vasodilatation of peripheral arteriole which aids temperature regulation.
- Cardiovascular centre influences the rate of the heart beat and cardiac output.
- Visceral activities such as peristalsis, swallowing and glandular secretions. (5)

4.3

WHITE MATTER	GRAY MATTER
Made up of a collection of myelinated fibres.	Made up of a collection of cell bodies.
Occurs on the inside of the cerebrum and cerebellum.	It occurs on the outer areas of the cerebrum and cerebellum.
It occurs in the outer areas of the medulla oblongata and spinal cord.	It occurs in the centre of the medulla oblongata and the spinal chord. It resembles an H in the spinal cord

(6)

4.4 4.4.1 Parathormone

4.4.2 Inhibits the excretion of calcium by the kidneys. Improve the absorption of calcium by the small intestines. (4)

4.4.3 Deficiency of Parathormone

- The calcium concentration decreases in the blood.
- Muscular tremors
- Muscular cramps and spasms
- Tetany (4)

4.4.4 Calcitonin (1) is secretaed by the thyroid gland (1) into the blood and targets the bones (1) to inhibits the release of calcium by the bones (1) and causes lowering of blood calcium (1) (5)

4.5 (a) In the sacculus and the urtriculus the otolithis in the macula are sensitive to gravitational pull.

- As the head tilts the otoliths are pulled down and exerts pressure on certain hairs to bend. This sends nerve impulses along the vestibular nerve to the cerebellum.
- In the ampulla of the semi-circular canals, the cristae are sensitive to the movement of the head according to the movement of the endolymph.
- This cause the hair cells to bend which generates nerve impulses which is sent to the cerebellum via the vestibular nerve.
- In the cerebellum the information is interpreted and the muscles are co-ordinated accordingly. (8)

[40]

QUESTION 5

5.1 Multiplying phase

Under the influence of FSH the diploid germ cells are divided repeatedly.

Growth phase

these mature diploid cells grow and mature to form primary spermatocytes

Reduction phase

The first meiotic division occurs with two haploid cells forming. A second meiotic division occurs resulting in four haploid cells.

Maturity phase

The four haploid spermatids mature into spermatozoa. (8)

5.2 Venereal disease
Unwanted pregnancies
HIV - AIDS (3)

5.3 Nutrition

- Food substances diffuse across the placental barrier from the mother's blood to the blood of the foetus.
- Carbohydrates, proteins, calcium and iron can be stored in the placenta until needed.

Respiration

- It provides oxygen and removes the waste product, carbon dioxide from the foetal blood.

Excretion

- The waste nitrogen and carbon dioxide diffuse across the placental barrier into the maternal blood to be excreted with her waste products.

Protection

- The placenta serves as a micro-filter preventing pathogenic organisms from entering the foetus.
- Antibodies can pass from the other to the foetus thus providing passive immunity for the foetus.

Endocrine gland

- The placenta secretes oestrogen and progesterone after three months of pregnancy. These bring about changes in the uterus for the maintenance of the pregnancy.
- It secretes relaxin which relaxes the joints and ligaments to assist in the delivery of the baby. (10)

5.4 5.4.1 tinnitus – ringing in the ears 2 x 2 (4)

5.4.2 two thirds (2)

5.4.3 - High intensity soundwaves cause extreme displacement of the basilar membrane resulting in overstimulation of the hair cells; particularly at the base of the cochlea.

- The sensation of tinnitus may be caused by the inability of the round window to dissipate the sound waves quickly enough.

- The "deadened hearing" effect could be as a result of the tensor tympani and stapedius muscles in the middle ear contracting as a protective measure to dampen the loudness of the sound reaching the inner ear.

- Temporary deafness could also arise from the inability of a nerve fibre to react optimally to an impulse after being subjected to over stimulation (refractory period). any one (2)

5.4.4 leisure pursuits (2)

5.4.5 CN VIII (auditory nerve)

5.4.6 Throughout adult life the ears become less sensitive to high pitched sound. The hair cells sensitive to high frequencies are situated at the base of the basilar membrane, and as this part of the basilar membrane is more rigid, with shorter hairs than the cells towards the more flexible apex, the hair cells in this area experience greater "wear and tear." Also, with aging, cells no longer regenerate as effectively.

Deafness in old age is thus often only loss of the upper range of hearing. The elderly experience noise as acutely as anyone with normal hearing, and can hear that they are being spoken to, but they cannot distinguish high pitched sounds such as consonants, so the sense of what is being said is not understood. (Any explanation along these lines) (13)

5.5 <u>Seminal vesicles</u>

- Secrete a yellow mucous, alkaline substance providing a transport medium for sperm in which to move.
- It is also a source of nourishment (Globulin and fructose)
- Neutralises acid in vagina.

<u>Prostate gland</u>

- Secretions activate the sperm and increases is viability.

<u>Cowper's gland</u>

- Alkaline fluid neutralise the acid environment in the urethra.
- Lubricates the penis during intercourse (gland + any function) (6)

[40]

SECTION C

QUESTION 6

- Once fertilisation has taken place, cell division commences
- mitosis now possible because sperm has contributed centrosome (centriole) and ovum has contributed cytoplasm and there are 46 chromosomes present
- by day 4, a mass of cells is already present (morula) in Fallopian tube
- the morula develops into a hollow, fluid-filled ball of cells, the blastocyst
- this occurs when most of the cells forming the morula migrate to one side
- leaving only a single-celled wall to form most of the structure (trophoblast)
- blastocyst arrives in uterus by day 7, having been slowly moved down the Fallopian tube by means of peristalsis
- a second layer of cells is laid down against the trophoblast
- to form the outermost embryonic membrane the chorion
- further development gives rise to a further two sacs
- the yolk sac and the amnion (forms the innermost embryonic membrane)
- the amnion enlarges to enclose the developing embryo as more amniotic fluid is produced
- the disc-shaped embryonic plate arises from the cells dividing these two sacs
- by the time the embryonic plate is about 2 mm in diameter, the cells have been arranged in two layers separated by a narrow space
- the outer layer is known as the ectoderm
- and the inner layer as the endoderm
- shortly after, a third layer is laid down in the space between the other two
- this middle layer is termed the mesoderm
- it is from these three layers that the embryo will develop by cell division and differentiation
- the ectoderm gives rise to the nervous system and sense organs, among other parts;
- the mesoderm gives rise to the skeletomuscular system and vascular system (blood), among others
- and the endoderm gives rise to the epithelial linings of most of the gastrointestinal tract and of the air passages
- By about day 10 the blastocyst implants itself into the thickened endometrium of the uterus
- at the point at which it comes to rest, small projections known as chorionic (attachment) villi extend into the endometrium
- which becomes thickened to form the deciduas
- attachment villi plus deciduas form the placenta
- umbilical cord attaches embryo / foetus to placenta
- and consists of remnants of yolk sac and allantois, from which 2 umbilical arteries carrying blood from foetus to placenta and 1 umbilical vein carrying blood from placenta to foetus arise
- By the end of the eight weeks of embryonic development, all of the principle adult organs have formed, gill pouches and rudimentary tail have disappeared, and the embryo is now recognizable as a human, at which stage it is termed a foetus.

[50]

QUESTION 7

7.1

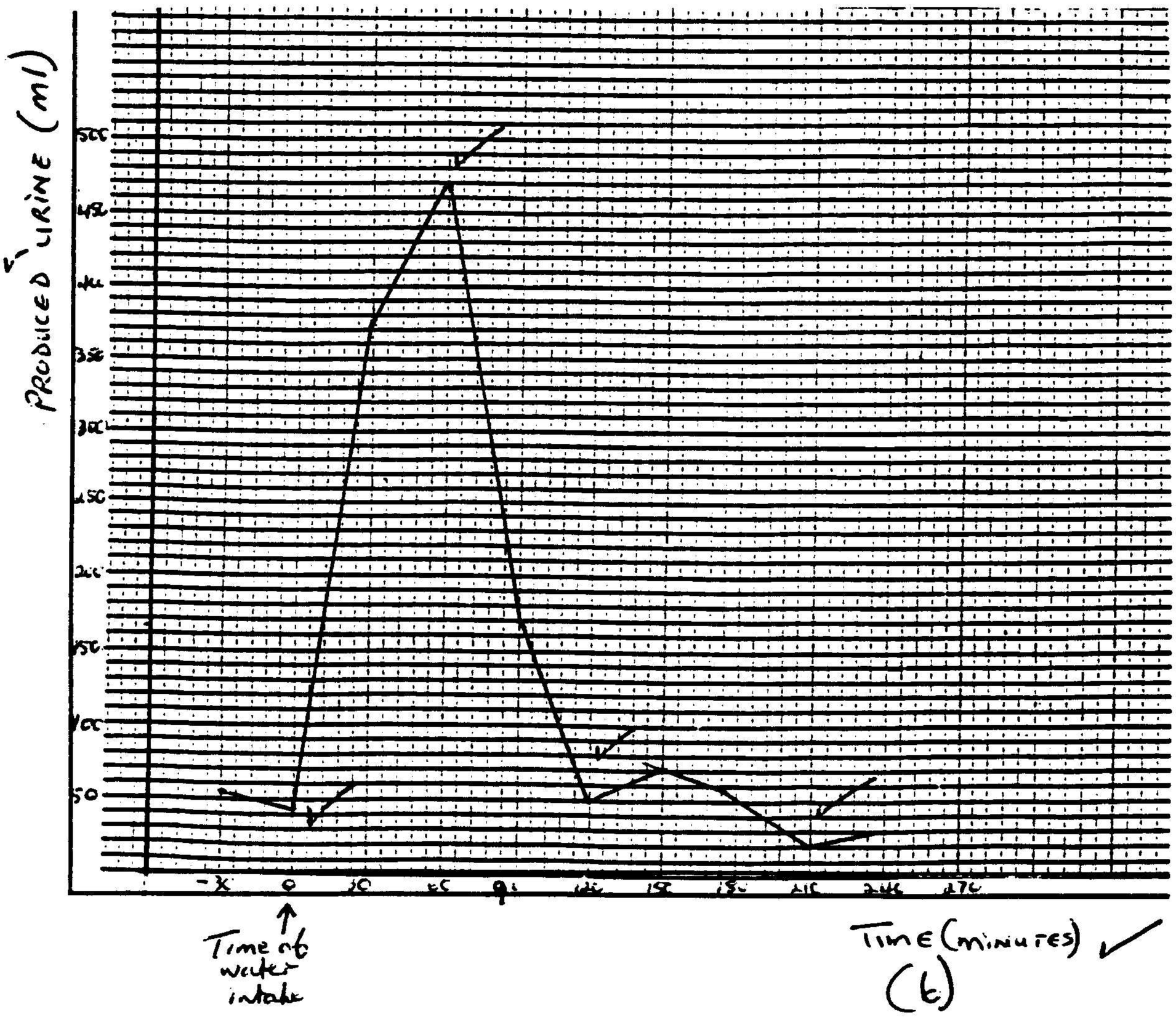

Fig 7.1: Experimental data where the volume of urine is determined in time intervals of 30 minutes. (7)

7.2 60 minutes

7.3 ± 180 minutes (3 hours)

7.4 (a) Hypotonic
(b) The urine at maximum contains large quantities of water (1) and a low salt concentration (2) (27 mg / 100 ml) – hypotonic

7.5 The Anti diuretic hormone (ADH) is promoting the reabsorbtion of water (1) ADH is secreted by the hypothalamus (1) and transported by the nerve fibres (1) to the neuro-hypophysis where it is stored (1). An increase in osmotic pressure stimulates the osmoreseptor (1) in the hypothalamus (1). The impulses (1) are conducted via the nerve fibres and causes the release of ADH (1). ADH is transported by the blood (1) to the kidneys (1) where it dilates the peritubular cappillares (1) and increases the premeability (1) of the membranes of the distal convoluted tubules (1) and the collecting ducts (1) to water. More water (1) will be reabsorbed (1) by osmosis (1) into the blood (1) that will decrease the osmotic pressure (1) returning to normal. (Max 10)

7.6 (a) 125 ml x 30 min = 3 750 ml fillrate is produced in the first 30 minutes

(b) In the first 30 min 375 ml urine is excreted

$\therefore \frac{375}{3750}$ x 100 = 10% of the fillrate is excreted as urine

$\therefore$ 100 – 10% = 90% of the fillrate is reabsorbed

7.7 (a)

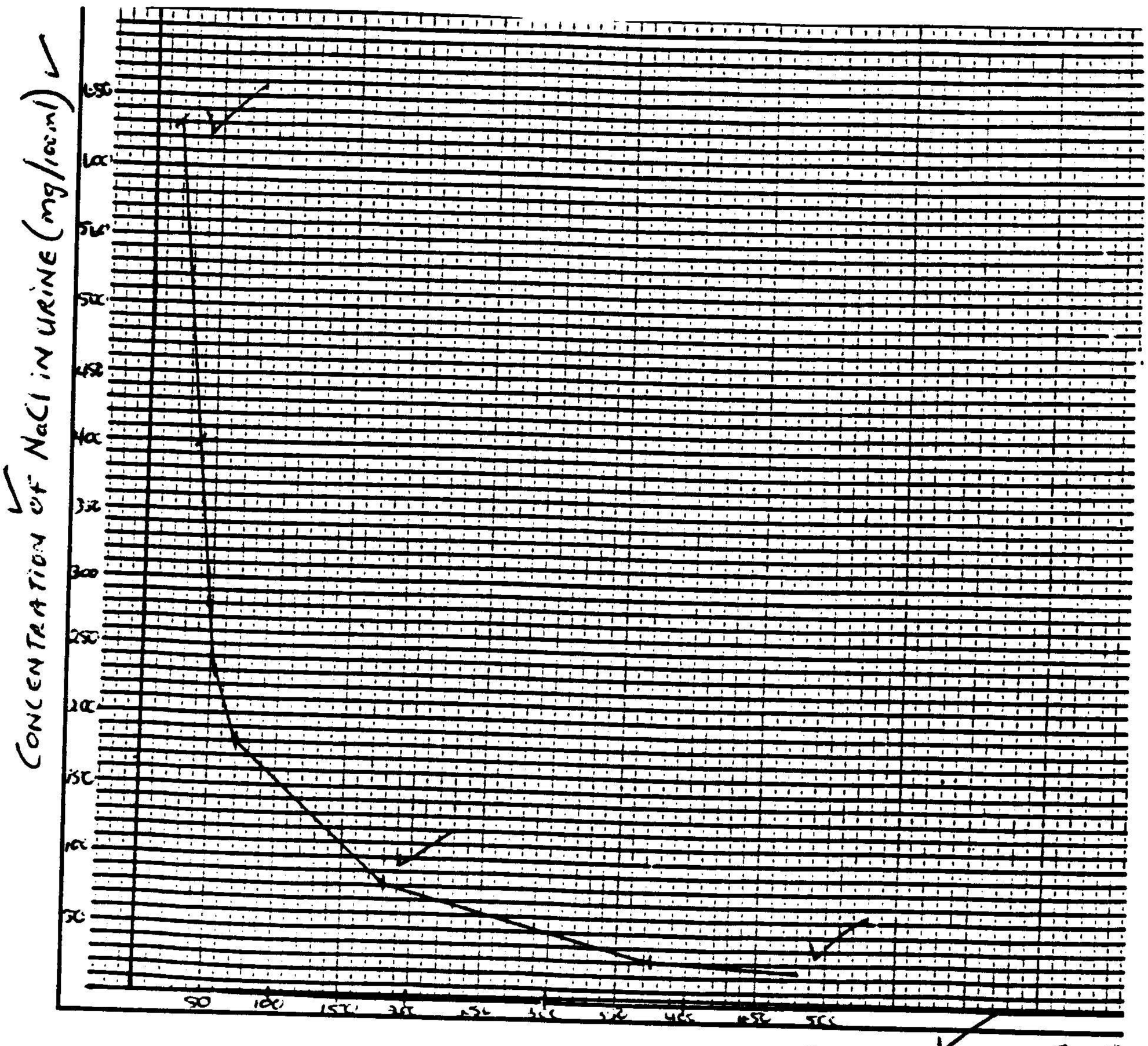

FIG 7.7 — DATA OF NaCl in URINE

7.7 (b) Conclusion

The smaller the volume of urine produced the bigger the concentration of NaCl in the urine (and vice versa)

OR

The amount of NaCl lost in the urine is related to the volume of urine excreted.

7.8 Control of sodium ions (Na+)

The kidney is the only organ that can regulate the extracellular sodium ion concentration.

- 65% of the sodium in the glomerular filtrate is actively reabsorbed from the proximal convoluted tubule.

- 25% is reabsorbed in the ascending limb of Henle as a result of the sodium pump.

- The reabsorption of the remaining sodium ions occurs in the distal convoluted tubule. The amount reabsorbed is variable. Here the sodium reabsorption is regulated by the hormone aldosterone from the adrenal cortex. Aldosterone promotes the reabsorption of sodium ions into the blood.

Sodium reabsorption takes place as follows

- Specialized cells in the afferent arteriole in the kidney respond to a decrease in sodium ion concentration or a drop in the blood pressure (decreased blood flow) by secreting the enzyme rennin.

- Renin causes the production of angiotensin (from serum angiotensinogen).

- Angiotensin stimulates the adrenal cortex to release aldosterone.

- Aldosterone travels in the blood to the distal convoluted tubule where it promotes the reabsorption into the blood of the sodium ions. (Water passively follows the sodium ions so increasing the blood volume. This causes the blood pressure to rise and return to normal).