

SCIENCE LABORATORIES

Fixtures & Furniture



Physical and Biological Sciences Sections
Advisory Inspectorate
Education Department
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I. INTRODUCTION

In recent years, science teaching has undergone rapid changes towards a much greater emphasis on the experimental approach. There is an increasing demand for better laboratory facilities and services. The new standard design (flexi-design) secondary school with 26 classrooms and 14 special rooms is now provided with five science laboratories instead of four in the standard estate secondary school to cater for the need of the increased number of practical periods. On the other hand, some existing schools have undergone either room conversion or laboratory renovation to improve their laboratory facilities.

The Science Subjects Section of the Education Department published its first version of “Science Laboratories: Fixtures and Furniture” in 1992. The booklet aims at providing some general information on laboratory design and facilities for the reference of science teachers, school architects and others concerned with science accommodation in schools. Over the past few years, modifications to facilities provided in science laboratories have occurred. There is thus a need to revise the content of the booklet. The present publication represents an effort to update the information provided. However, the information and advice offered in this revised booklet are still neither exhaustive nor prescriptive, and do not preclude the need for modification to suit individual and particular school setting.

It must be emphasized that this booklet is not a policy document of the Education Department on laboratory design or the size and number of the various science laboratories. The content included here is just for reference only.

Comments and suggestions are welcome and should be directed to the Physical Sciences Section of the Advisory Inspectorate, Education Department, Room 1208, Wu Chung House, 213 Queen’s Road East, Wan Chai, Hong Kong.

II. NOTES ON SIZE AND LOCATION OF SCIENCE LABORATORIES

Size

1. A square or rectangular science laboratory with minimum width of about 7 m is desirable.
2. The laboratory should preferably have no pillars inside.
3. A preparation room is to be provided for each science laboratory or to be shared by two adjacent laboratories.
4. The size of each science laboratory scheduled for the new standard design secondary schools (with 26 classrooms and 14 special rooms) is about 120 m^2 , while that of each preparation room is about 45 m^2 .

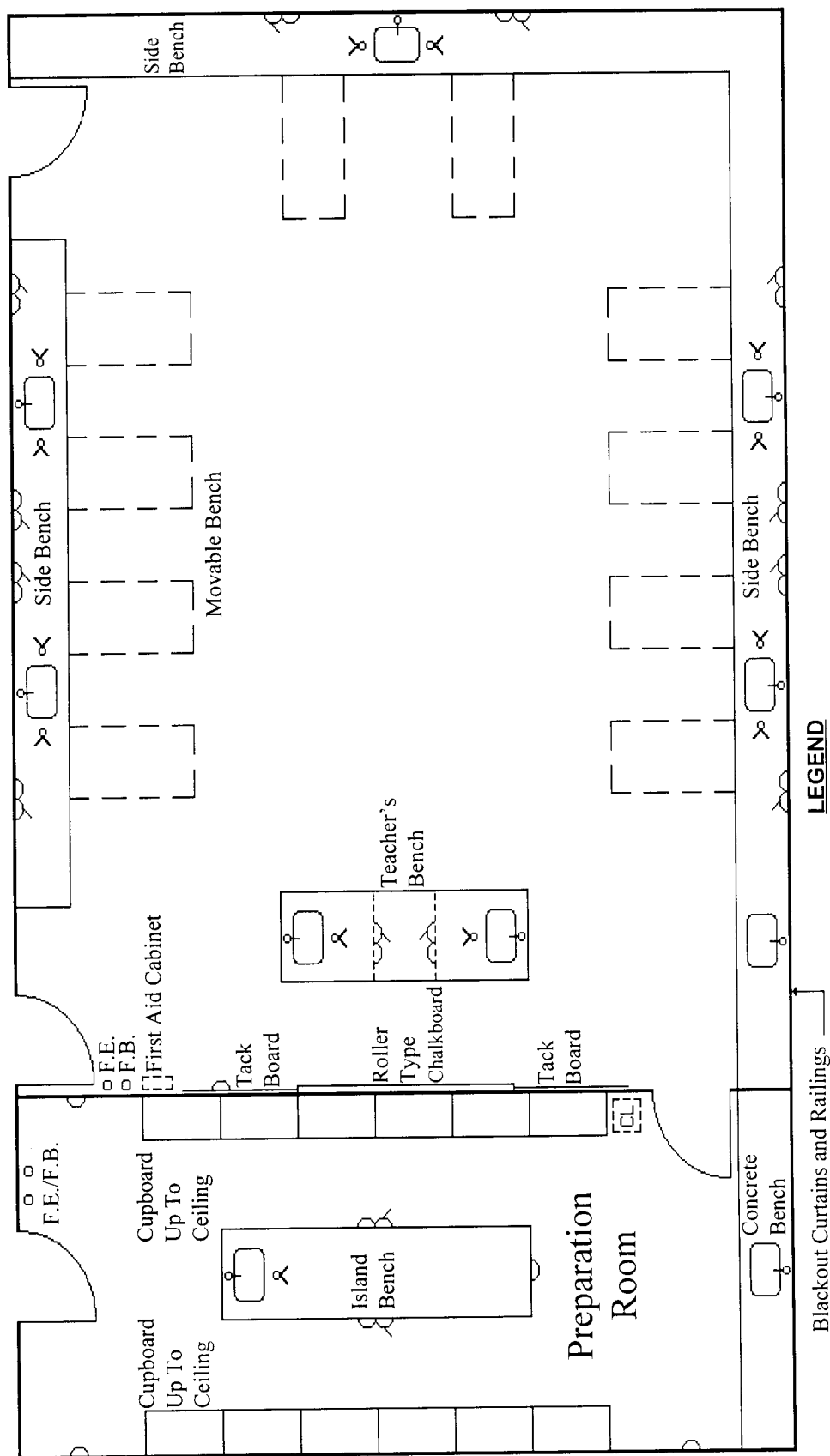
Location

1. The Chemistry laboratory is to be located on the top floor to facilitate the routing of the exhaust duct of the fume cupboard to the roof top for more efficient discharge of fumes/gases that may be generated during the preparation/course of some experiments.
2. The Integrated Science laboratory, also provided with a fume cupboard, is to be located preferably on the top floor, or as near to the top floor as possible.
3. The science laboratories should be as near to one another as possible for ease of management.
4. Preparation rooms should be adjacent to science laboratories, or as near to them as possible.

III. GENERAL LAYOUT PLANS OF THE SCIENCE LABORATORIES

1. Each laboratory should have two exits, located as far apart as possible. If only one exit could be provided, a double-leaf door is preferred.
2. Platform at teacher's bench is not recommended as it may pose potential hazard to the teachers and students who may stumble over it.
3. The general layout plans of the Physics, Chemistry, Biology and Integrated Science laboratories are shown on the following pages.

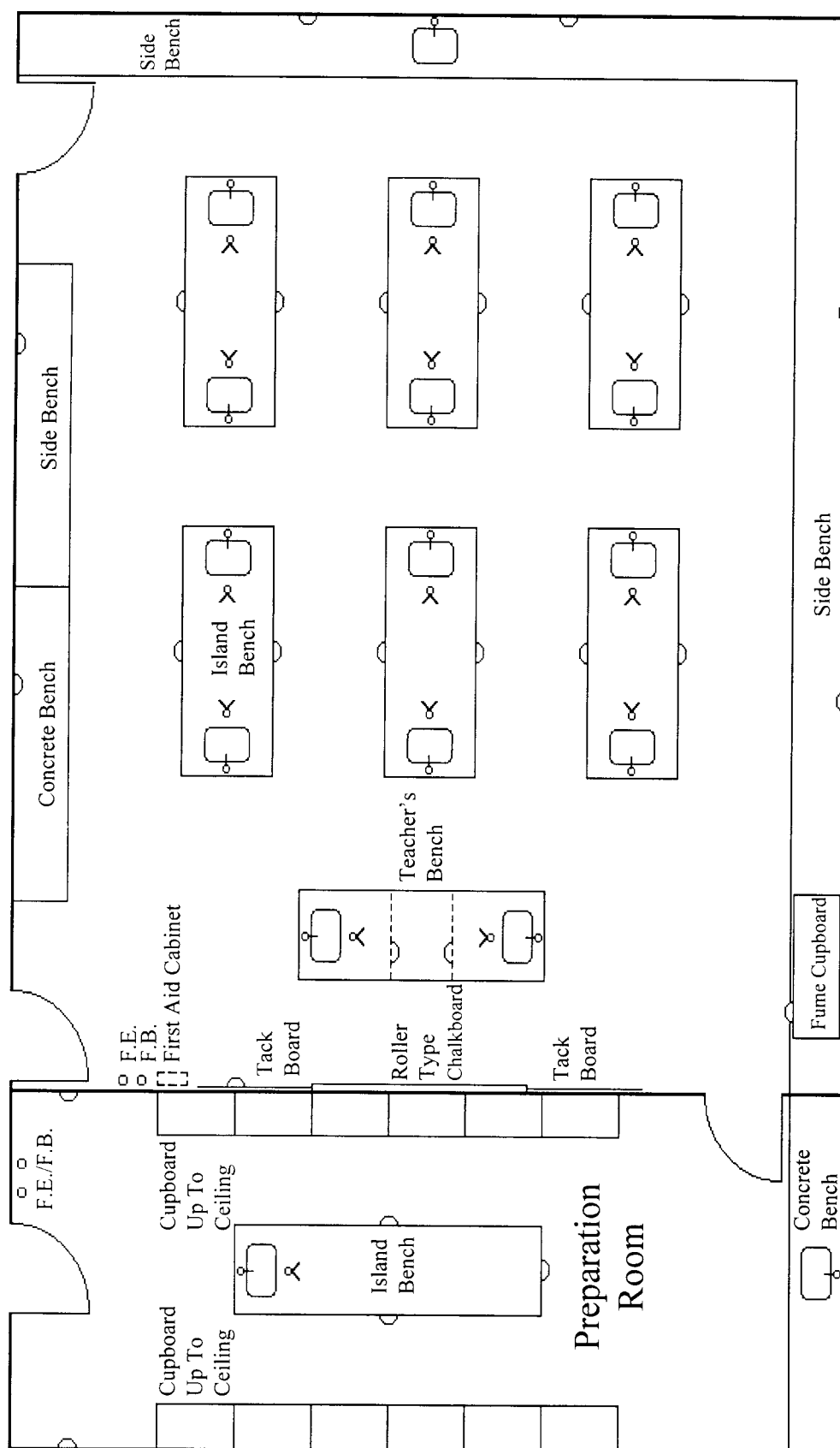
General Layout Plan of Physics Laboratory



LEGEND

- 13-A power socket c/w switch & pilot light
- ⋈ 2-way outlet gas tap c/w safety valve
- 3-way water tap c/w swan-neck outlet
- ⌵ Low voltage power point
- ⌈⌋ Centralized low voltage power supply unit
- F.E. Fire extinguisher
- F.B. Fire blanket

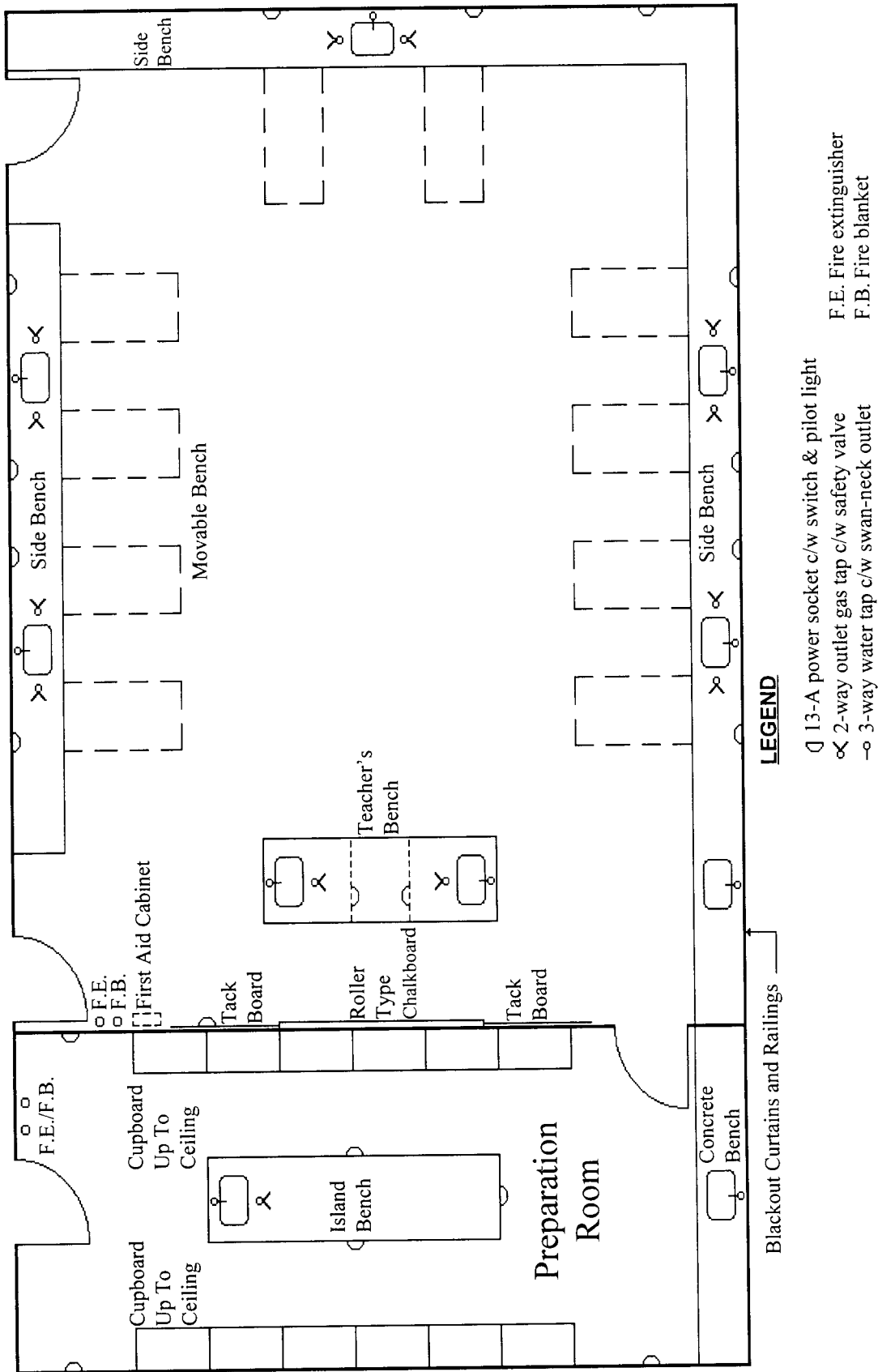
General Layout Plan of Chemistry Laboratory



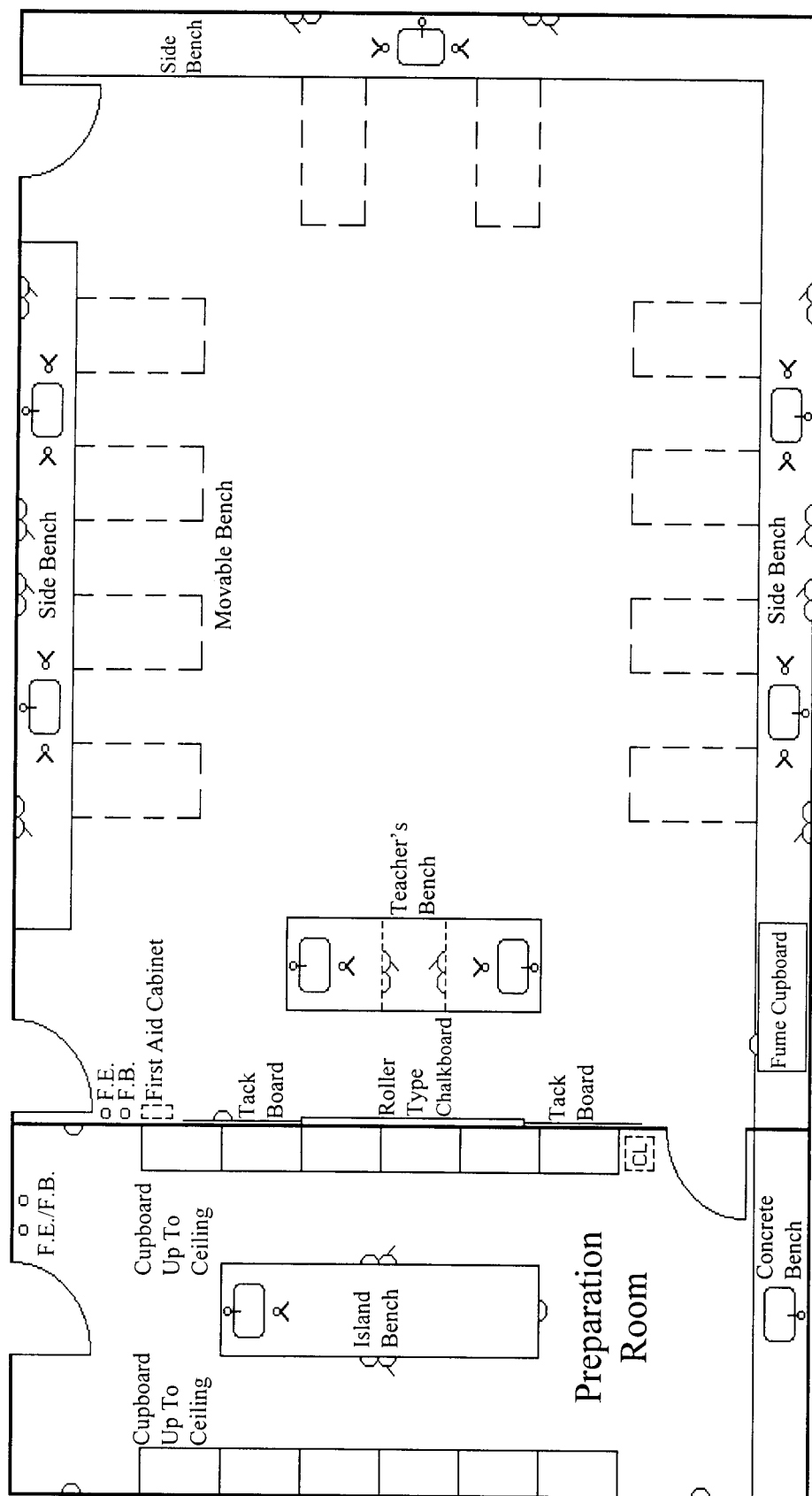
LEGEND

- ⌂ 13-A power socket c/w switch & pilot light
- ⌘ 2-way outlet gas tap c/w safety valve
- ⌘ 3-way water tap c/w swan-neck outlet
- F.E. Fire extinguisher
- F.B. Fire blanket

General Layout Plan of Biology Laboratory



General Layout Plan of Integrated Science Laboratory



LEGEND

- 13-A power socket c/w switch & pilot light
- ⋈ 2-way outlet gas tap c/w safety valve
- 3-way water tap c/w swan-neck outlet
- ⋈ Low voltage power point
- Centralized low voltage power supply unit
- F.E. Fire extinguisher
- F.B. Fire blanket

IV. LABORATORY FACILITIES

The following laboratory facilities are recommended for the science laboratories. The given provisions and quantities are recommended *for use with the layout design given in previous pages*, and will cater for science laboratories normally accommodating 10 groups of pupils.

Facility	Provision	Location and quantity				
		Phy	Chem	Bio	I.S.	Prep. Room
Electricity at mains	13 A power socket with switch & pilot light	13	22	14	14	5
Electricity at low voltage	centralized low voltage power supply unit	yes	no	no	yes	-
	terminal connector (low voltage power point) with maximum output 24 V 15 A and with fuse carrier	12	-	-	12	2*
Gas supply	2-way outlet gas tap with safety lock	12	14	12	12	1
Water supply and drainage	3-way water tap with swan-neck outlet, rectangular sink with catchpot recovery trap underneath	8	15	8	7	2
Fume exhaust	fume cupboard	-	1-2	-	1	-
Ventilation	ventilation fans	3	3	3	3	1-2
Blackout facilities	blackout curtain	yes	no	yes	no	no
Chalkboard	roller type chalkboard	1	1	1	1	-
First aid facilities	first aid box	1	1	1	1	-
Fire-fighting facilities	non-asbestos type fire blanket	1	1	1	1	1
	CO ₂ /dry powder type fire extinguisher	1	1	1	1	1
	sand bucket	2	2	2	2	-

* For preparation rooms of Physics and Integrated Science laboratories.

Facility	Provision	Location and quantity				
		Phy	Chem	Bio	I.S.	Prep. Room
Furniture	movable bench	10	-	10	10	-
	stool	40	40	40	40	-
	storage cupboard for chemical wastes	-	2	-	-	-
Fixtures	teacher's bench	1	1	1	1	-
	island bench	-	6	-	-	1
	side bench	yes	yes	yes	yes	no
	concrete side bench	no	yes	no	no	yes
	cupboard up to ceiling	no	no	no	no	yes

Electricity at Mains

Mains electricity is distributed via 13 A power sockets which should be positioned to minimize risk of penetration by water. The use of Residual Current Device with tripping current of 30 mA in 30 ms is recommended.

Electricity at Low Voltage

Low voltage electricity for the Physics and Integrated Science laboratories is provided by centralized low voltage power supply units (*see Appendix A*), and distributed via low voltage terminal connectors/low voltage power points (*see Appendix B*).

Gas Supply

For distribution of fuel gas in science laboratories, two-way outlet gas taps with safety locks are recommended (*see Appendix C for the type of gas taps commonly used in school laboratories*). It is important that they cannot be opened by an accidental knock. Furthermore, all gas taps not to be used should be properly secured in order to avoid pupils' accidental opening (e.g. the type of gas taps in Appendix C can be secured by fixing a hose clip under the knobs of the gas taps).

The master gas switch should be positioned at a readily accessible location, and the ON/OFF positions be clearly indicated.

The rubber tubings connecting the gas taps to Bunsen burners should be of a type suitable for use with the gas being supplied and should be obtained from the gas suppliers. Both ends of the tubings should be held in position by hose clips to prevent loosening.

For laboratories using LPG cylinders, measures given in *Appendix D* should be observed.

Water Supply and Drainage

3-way water taps with swan-neck outlet, and glazed ceramic rectangular sinks are recommended. Catchpot recovery traps of capacity 0.78L (*see Appendix E*) are to be used for drainage below the sinks. The catchpots serve two purposes:

- (i) To act as a dilution tank for corrosive liquid before being discharged so as to protect the piping.
- (ii) To trap insoluble solids flowing down from the sink so as to prevent the piping from being blocked. The catchpot can be easily removed to dispose of the trapped solids.

The catchpots should be properly supported underneath. The supporting devices should be removable for the ease of dispose of the trapped solids inside the catchpots.

Fume Exhaust

Fume exhaust in the Chemistry and Integrated Science laboratories is provided by fume cupboards, details of which are given in *Appendix F*.

Ventilation

Ventilation is provided by ventilation fans of xpelair type.

Blackout Facilities

Blackout in Biology and Physics laboratories is provided by blackout curtains, which should conform to the following specifications:

Blackout curtains, made of flameproofing, preshrunk, thick, black, cotton drill material, in set of 2 pieces, with rufflette tape and hook to fit window unit of overall dimensions (*re new standard plans*) 3160 mm wide and 1910 mm high and curtain rail 3600 mm long installed above the window unit.

Chalkboard

Roller type chalkboard is recommended. It is designed to stand on the floor and to be fixed to the wall. *(See Appendix G.)*

First Aid Facilities

Every laboratory should have a first aid box *(see Appendix H)* with the following contents:

Antiseptics, e.g. Savlon, tincture of iodine	Forceps
Cotton wool	Safety pins
Disposable plastic/vinyl gloves	Scissors
Sterile dressings/gauze	Sterile adhesive dressings (of different sizes)
Adhesive plaster	Sterile eye pad
Bandages (of different sizes)	Triangular bandages

Fire-fighting Facilities

Every laboratory must be equipped with at least one appropriate fire extinguisher, which should normally be installed near an exit and be easily accessible, i.e. not more than 900 mm above the floor. The following types of fire extinguisher are suitable for laboratory use:

Carbon dioxide type
'Dry powder' type

Each laboratory should also be provided with a non-asbestos type fire-blanket and two buckets of sand.

Furniture

- (i) *Movable Benches*
Wooden movable bench of overall dimensions 1525 mm x 760 mm x 840 mm (high) is recommended for Physics, Biology and Integrated Science laboratories. The bench top should be covered with acid and heat resistant plastic laminate. *(See Appendix I.)*
- (ii) *Stools*
Wooden stools of dimensions 300 mm x 300 mm x 530 mm (high) are recommended for all laboratories. *(See Appendix J.)*

(iii) *Storage cupboard for chemical wastes*

Two storage cupboards, together with 4 stainless steel spill catcher trays and 4 heavy-duty plastic spill catcher trays, should be provided for the science laboratories for storage of chemical wastes prior to collection for disposal by the Chemical Waste Treatment Centre. The cupboards should conform to the specifications shown below:

	<i>Quantity</i>
1. Steel cupboard Double door, fitted with 3 point locking espagnolette bolt, controlled by 6-lever lock with one adjustable shelf, and with words "Chemical Waste 化學廢物" printed in white on left door. Overall dimension: 910 mm (W) x 1830 mm (H) x 460 mm (D)	2
2. Stainless steel spill catcher tray Overall dimension: 380 mm x 380 mm x 145 mm	4
3. Heavy-duty plastic spill catcher tray Overall dimension: 380 mm x 380 mm x 362 mm Material dimension: Top 360 mm x 360 mm x 355 mm Bottom 351 mm x 351 mm x 355 mm	4

(See Appendix K for diagrams.)

Fixtures

Fixtures in laboratories may include the following:

<i>Fixture</i>	<i>Location</i>	<i>Appendix</i>
Teacher's bench	all laboratories	L
Island bench	Chemistry laboratory	M
	all preparation rooms	N
Side bench	all laboratories	O
Concrete side bench	Chemistry laboratory	P
	all preparation rooms	Q
Cupboard up to ceiling	all preparation rooms	R
	Chemistry store room	S
	store/dark room	T
Concrete cupboard	Chemistry store room	U
Concrete bench	store/dark room	V

CENTRALIZED LOW VOLTAGE POWER SUPPLY UNIT

General Description:

This equipment is designed to provide a source of low voltage a.c. or d.c. power supplies simultaneously to distribution points with output controlled from the unit; for general use in school laboratories with provision for charging secondary batteries.

A single phase a.c. supply is taken from an outlet with fused plug and is connected to the double pole *isolator* which disconnects the supply immediately when the panel is opened. From the isolator, power is taken through the *input circuit breaker* to the *variable ratio auto-transformer*. The input circuit is protected against both surge or steady overload by the input circuit breaker. Input current and voltage are indicated by the *input ammeter* and *input voltmeter* at the top of the front panel. The output from the variable ratio auto-transformer is taken to the primary of a fixed ratio, step down, double wound, main transformer. The secondary of this main transformer is taken to the *rotatory selector switch*. To provide a.c. sources, the secondary output is fed via the *output ammeter*, *output voltmeter* and *output circuit breaker* to the *output terminals*. The output circuit breaker designed to withstand heavy current arcs safeguards the output circuit. To provide d.c. sources, the low voltage alternating current is fed into the selenium cell full wave bridge connected rectifier and then via the output terminals. The d.c. output is unsmoothed and the polarity being indicated by terminal colour.

All the measuring instruments are of the moving iron type. The input and output circuit breakers are both of the magnetic terminal release type and are adjusted to trip at 5 and 50 amperes respectively.

For inspection purposes, the front panel is hinged at the bottom to allow it to be opened through 140°. The internal wiring is colour coded, with green for a.c. and red/black for d.c. When opening, the supply is automatically disconnected making the wiring 'dead' and perfectly safe to touch.

For Laboratory Use

The output from the unit is taken via a ring main circuit to at most 13 distribution points in the laboratory. The output voltage and/or current may be kept constant or varied by adjustment of the auto-transformer.

Maximum outputs are:

0-14 V at 40 A	a.c. or d.c.
14-18 V at 32 A	a.c. or d.c.

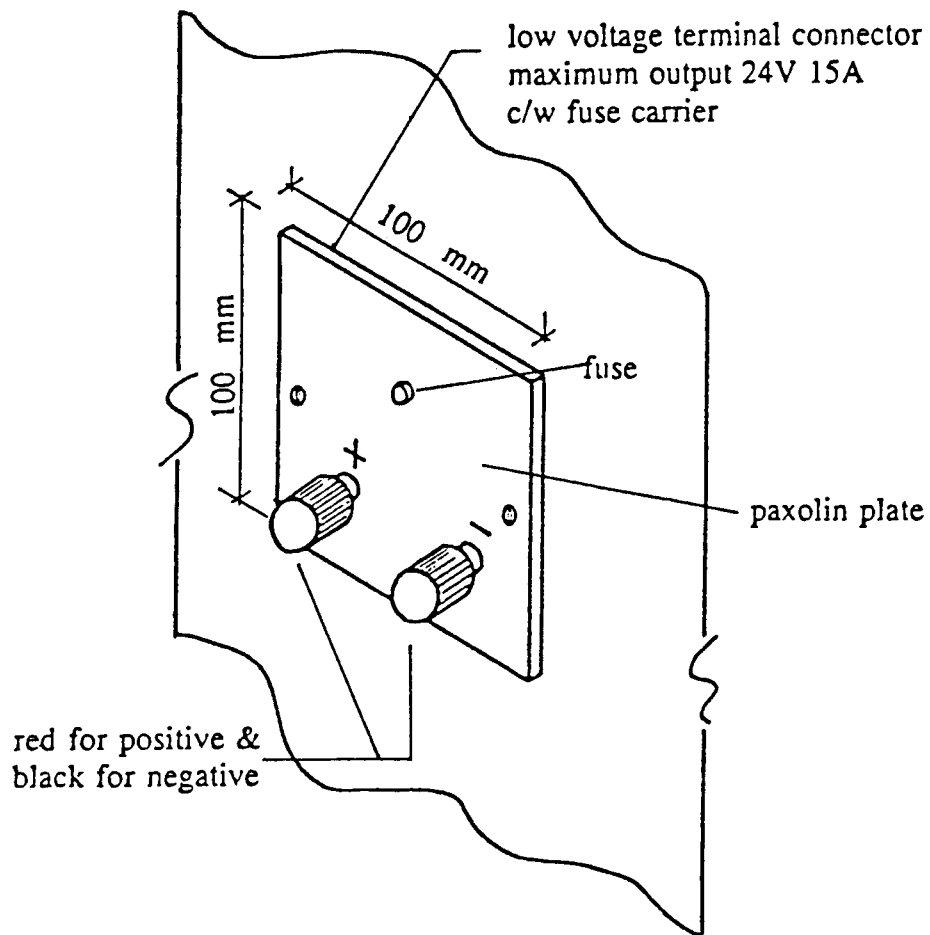
For battery charging, the cells should be connected in series with the positive and negative terminals connected to the output terminals of like polarity. The maximum number of 2 volt cells that can be charged is 6 and the maximum charging current advised by the battery manufacturer should not be exceeded.

The unit is rated at 580 VA.

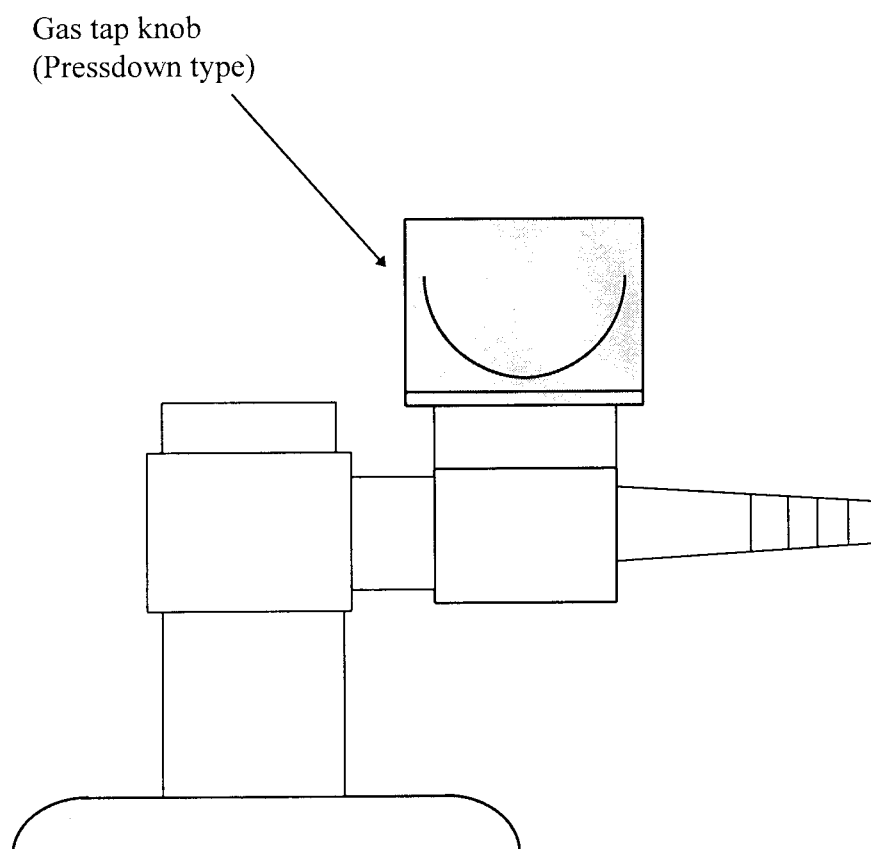
Overall dimensions approximately 310 mm x 540 mm x 740 mm.

For use on 200 - 220 V, 50 Hz, single phase, a.c. supplies. Bonded to earth through 3 core supply cable and 3 rectangular pin appropriately fused B.S.S. plug.

LOW VOLTAGE TERMINAL CONNECTOR



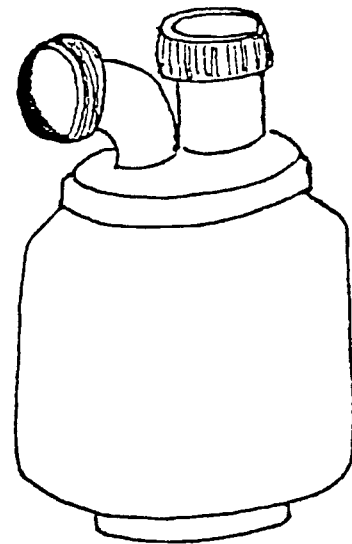
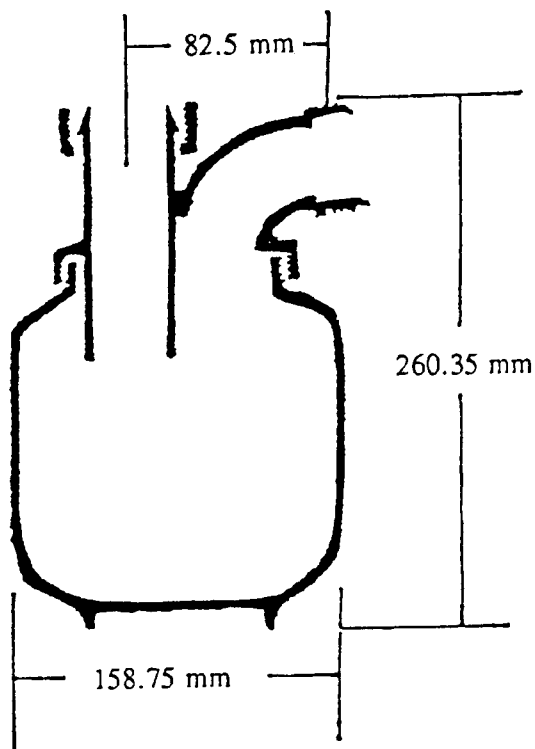
GAS COCK



**MEASURES TO BE TAKEN WHEN USING
LIQUEFIED PETROLEUM GAS CYLINDERS IN SCIENCE LABORATORIES**

1. Formal approval must be obtained from the Director of Fire Services.
2. An aggregate of not exceeding 50 kg liquefied petroleum gas will be permitted in cylinders inside a fire resisting chamber for use in the laboratory.
3. The chamber should be constructed of concrete and brick which is not less than 75 mm thick, fitted with a steel door of not less than 6 mm thick and, provided with high and low level ventilation. The letters 'L.P.G.' in English and Chinese characters are to be painted on the door.
4. Liquefied petroleum gas cylinders are to be secured onto the wall within the L.P.G. chamber.
5. The door(s) of the chamber should be kept locked except when cylinder changing is carried out.
6. 'Shut-off' valves indicated in Chinese and English characters shall be provided on the gas supply pipe immediately outside the chamber.
7. The pipework from the cylinders in the chamber to the supply outlet of the burners is to be constructed of metal and securely fixed to the wall and table top. A small length of flexible tubing will be permitted within the chamber between cylinder and the manifold to facilitate cylinder changing, and, between the supply outlet to the burners.
8. The chamber is not permitted to be alongside or adjacent to any doorway situated on an escape route.
9. The chamber is not permitted in any room or space not provided with adequate low level ventilation.
10. The chamber is not permitted in any position which is subject to wide extremes of temperature.
11. No liquefied petroleum gas cylinders are to be installed or kept in proximity to any corrosive or readily combustible substances.

CATCHPOT RECOVERY TRAP



Approximate dilution capacity 0.78 litres
Outlet and loose nut inlet are threaded polythene

FUME CUPBOARD

1. *Construction and lining materials*

The body of the fume cupboard is usually constructed with wood or plywood with teak edge (varnished). The interior lining of the fume cupboard and the working surface should be resistant to chemicals and heat, e.g. arborite or formica. Light coloured lining material is recommended.

2. *Service*

The services to be installed should include

- (a) one 13A a.c. socket with switch and pilot light (to be installed outside the fume cupboard as shown in the drawings).
- (b) one swan-neck type water tap with remote control.
- (c) one 2-way gas point with safety valve and remote control.
- (d) one drip cup of diameter about 255 mm with catchpot recovery trap (recovery trap of 0.78 L capacity is recommended).

3. *Exhaust fan*

An appropriate fume cupboard axial (cylindrical) fan should be installed to give an average face velocity of about 0.5 ms^{-1} when the sliding window (sash) is fully open.

4. *Sash*

The sash should be operated with a pulley counterweight system. The pulleys and counterweights should be made accessible for servicing and repair, e.g. by the provision of press-open doors or doors with magnetic catches on the side of hollow pillars containing the counterweights.

5. *Exhaust ducts*

Exhaust ducts should be made of PVC. The routing of exhaust ducts to the roof top should be as direct as possible, with horizontal runs and right angle bends kept to a minimum. The outlet of the exhaust duct should be at least 2-3 metres above the roof top and fitted with a weather cap or trap device to prevent entry of rainwater or birds into the exhaust duct.

6. *Wired glass*

Wired glass or tempered glass should be provided on the sash, the side panels and the back of the fume cupboard.

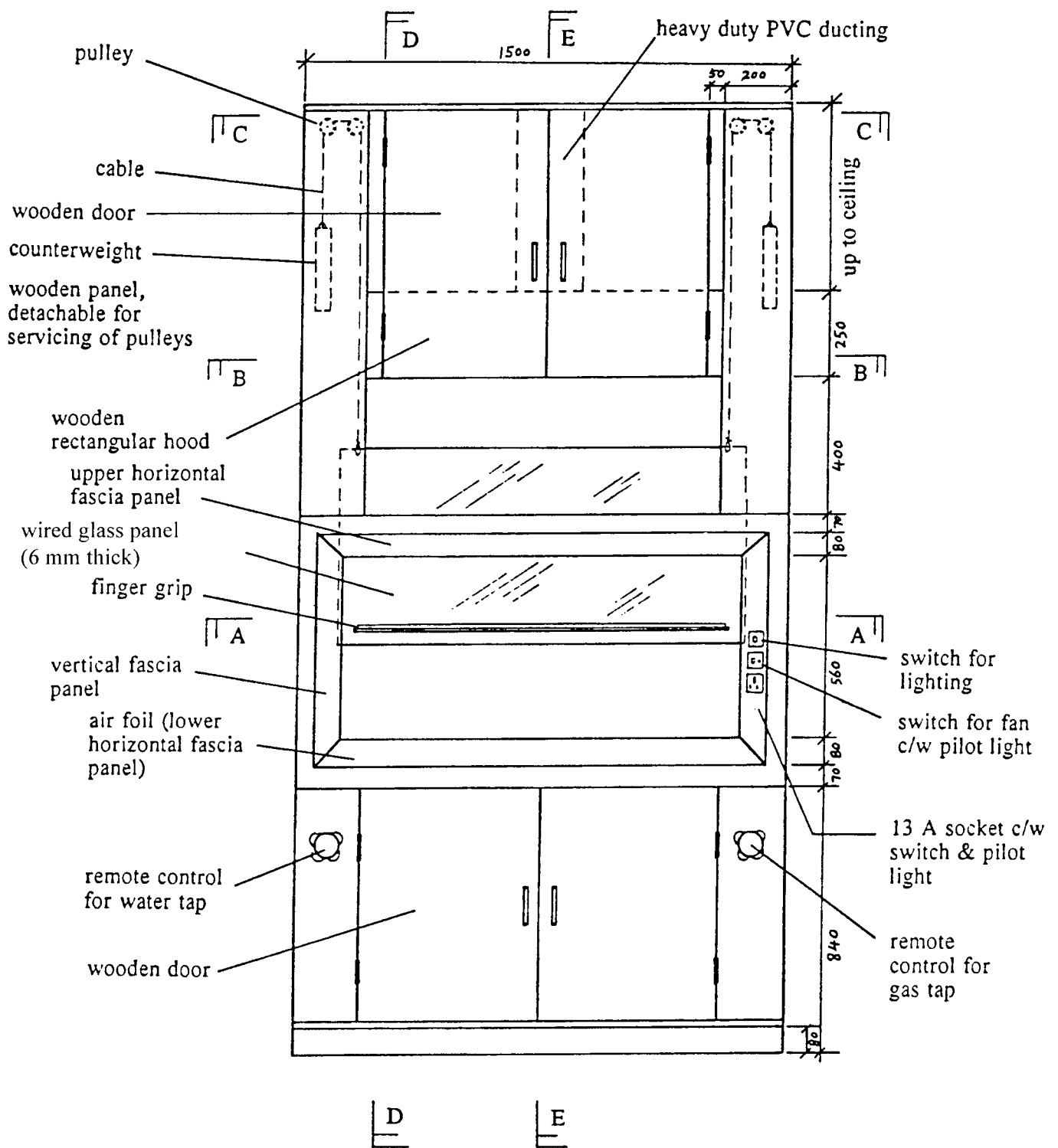


Diagram 1: Front View

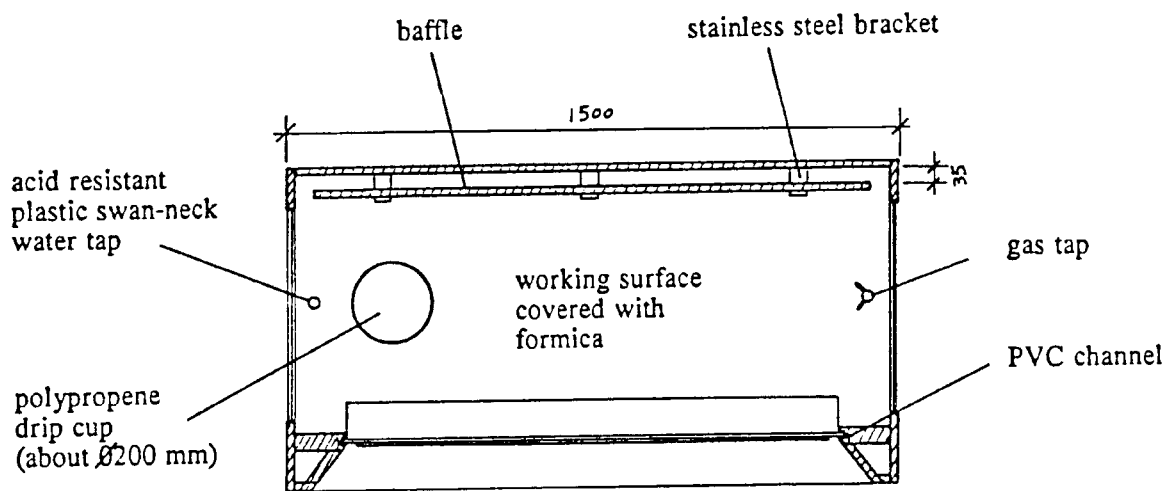


Diagram 2: Section A-A

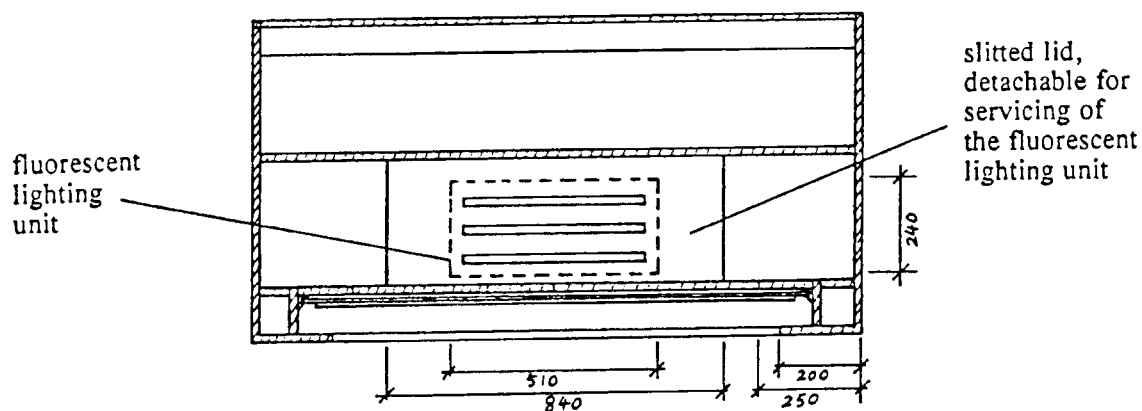


Diagram 3: Section B-B

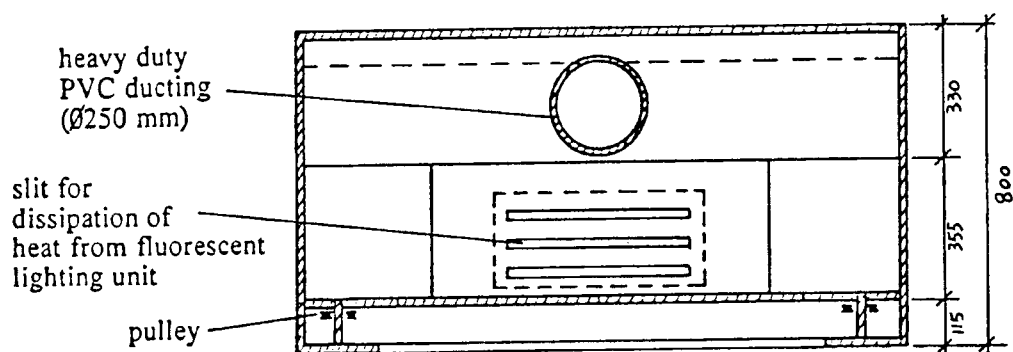


Diagram 4: Section C-C

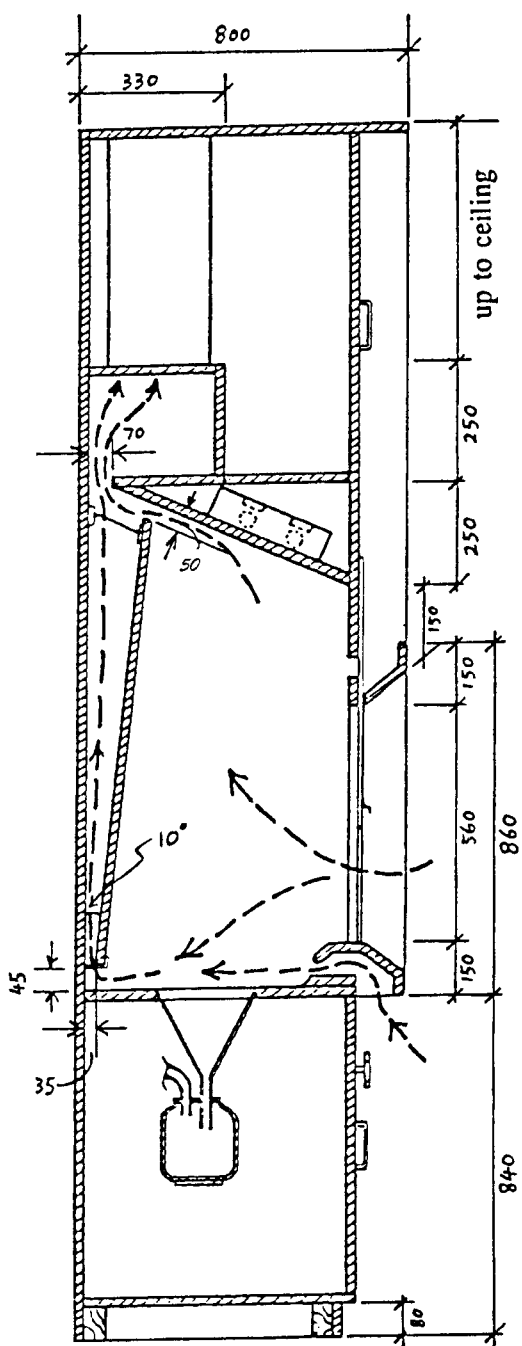


Diagram 5: Section D-D
(with sash half-opened)

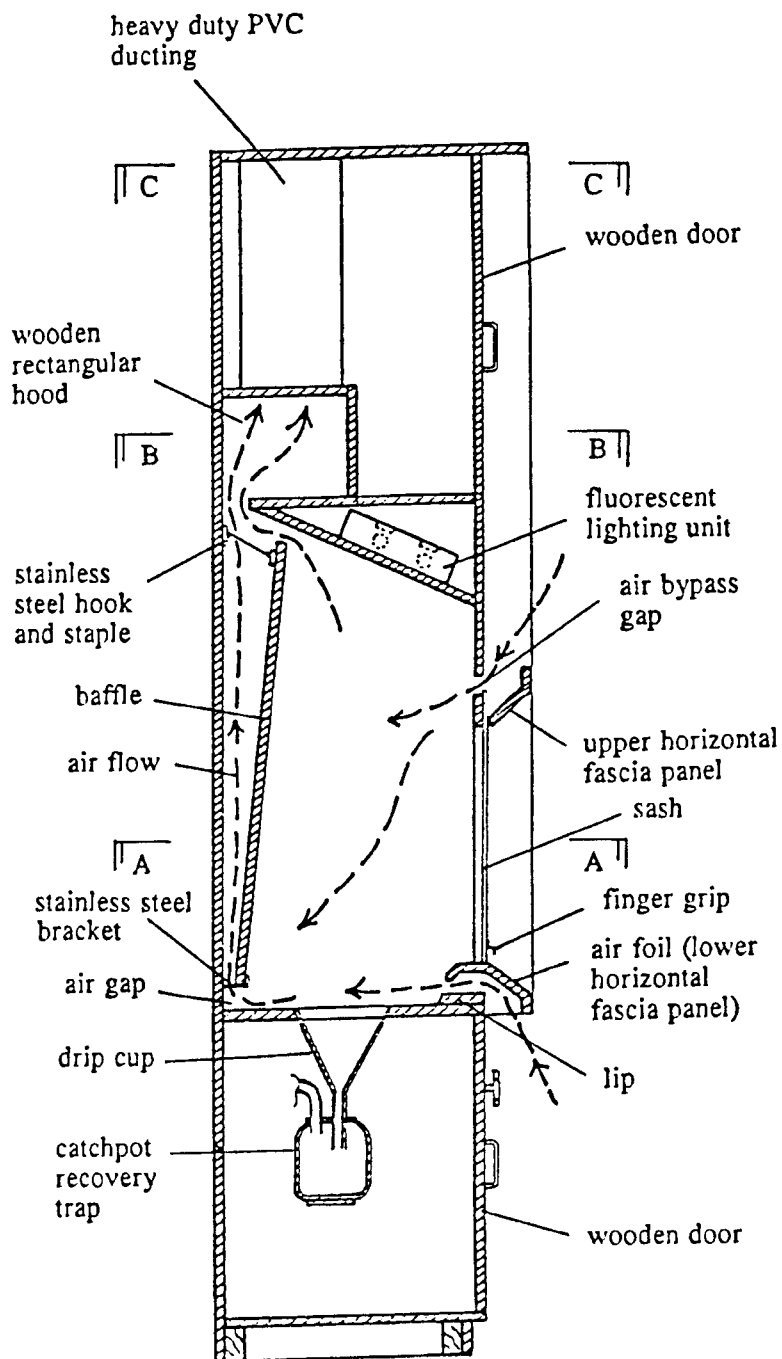


Diagram 6: Section D-D
(with sash closed)

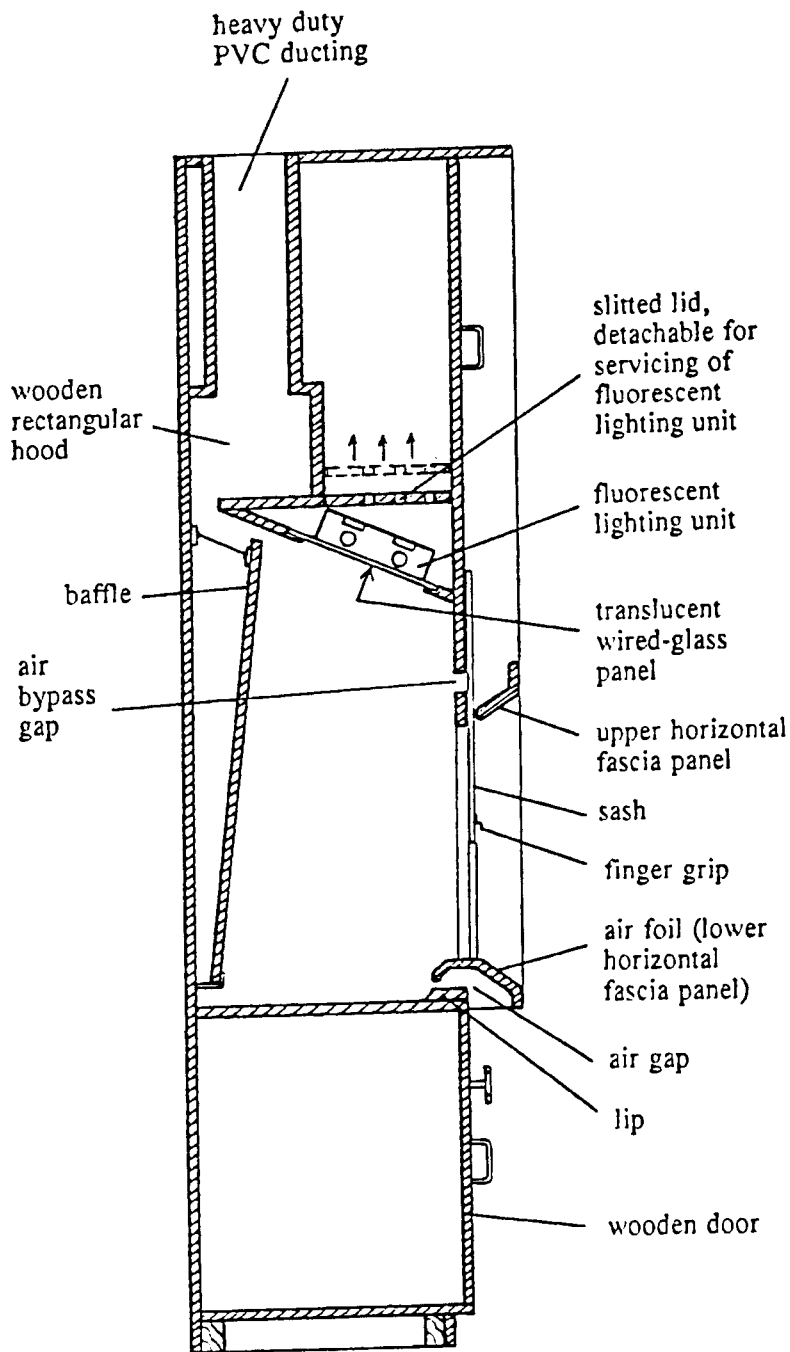


Diagram 7: Section E-E
(with sash half-opened)

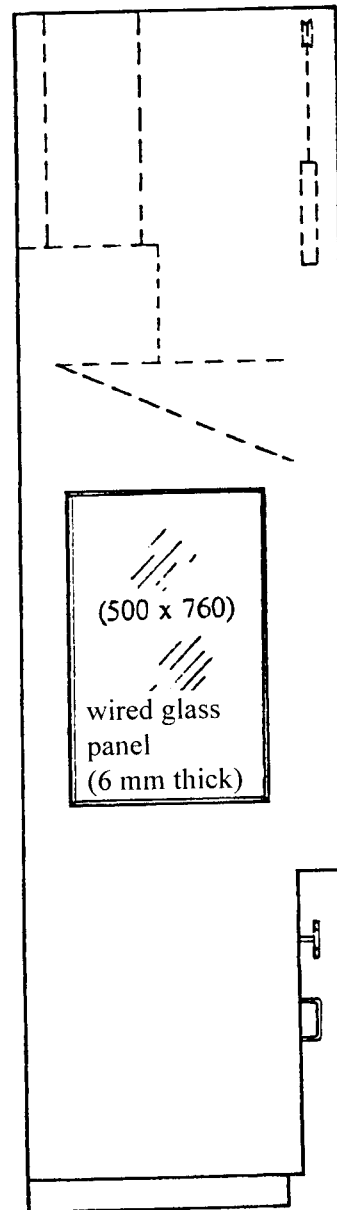


Diagram 8: Side View

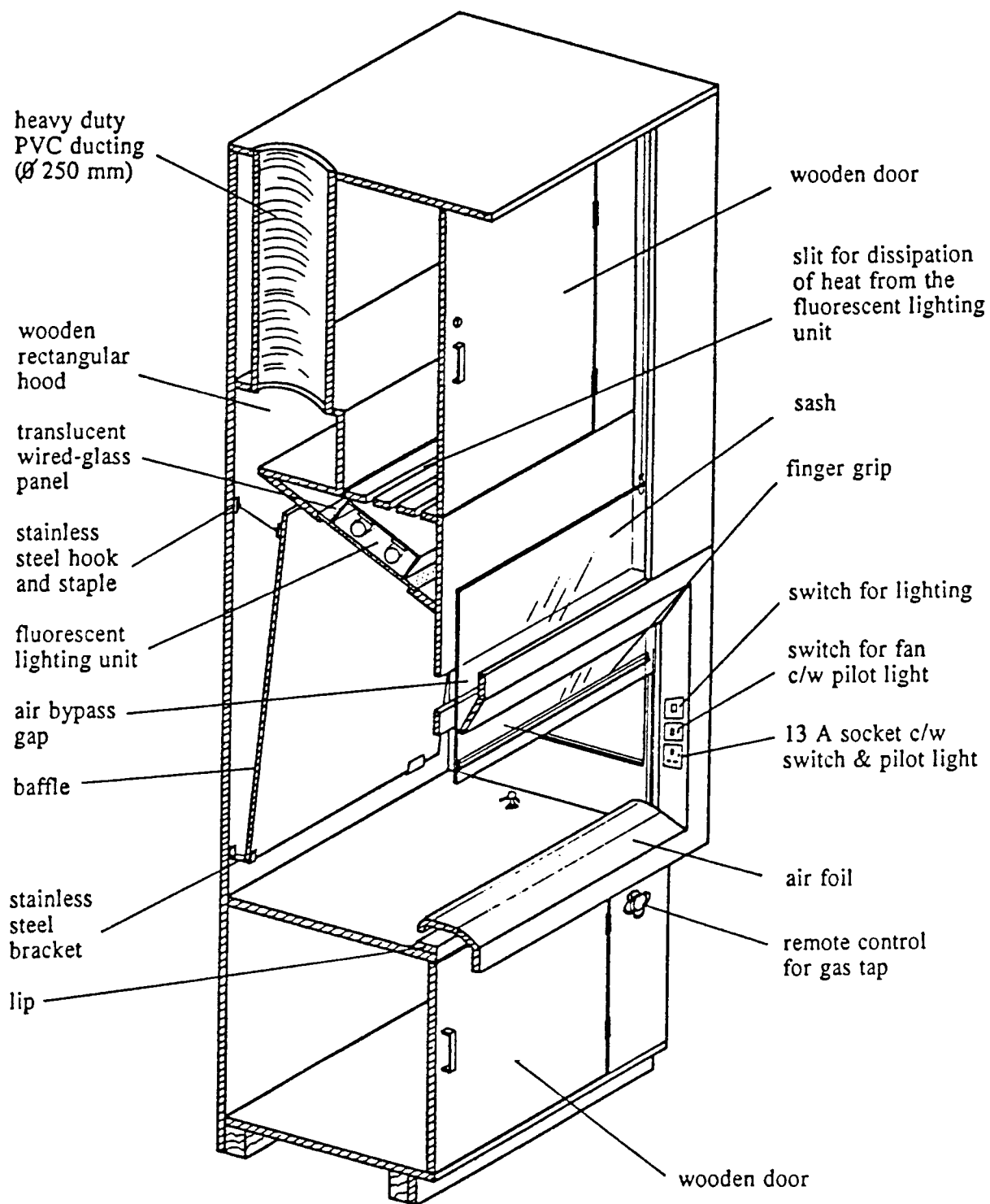
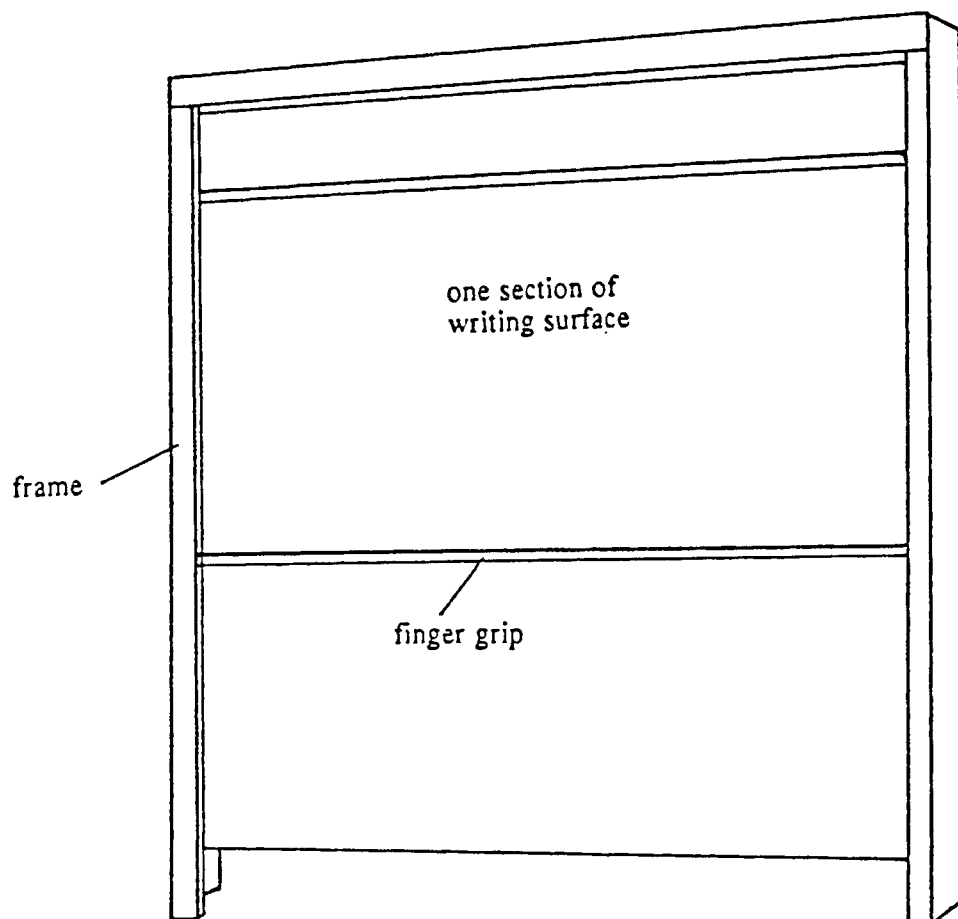


Diagram 9: Isometric View at Section E-E

ROLLER TYPE CHALKBOARD



Frame

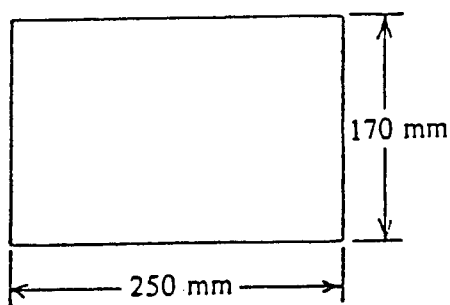
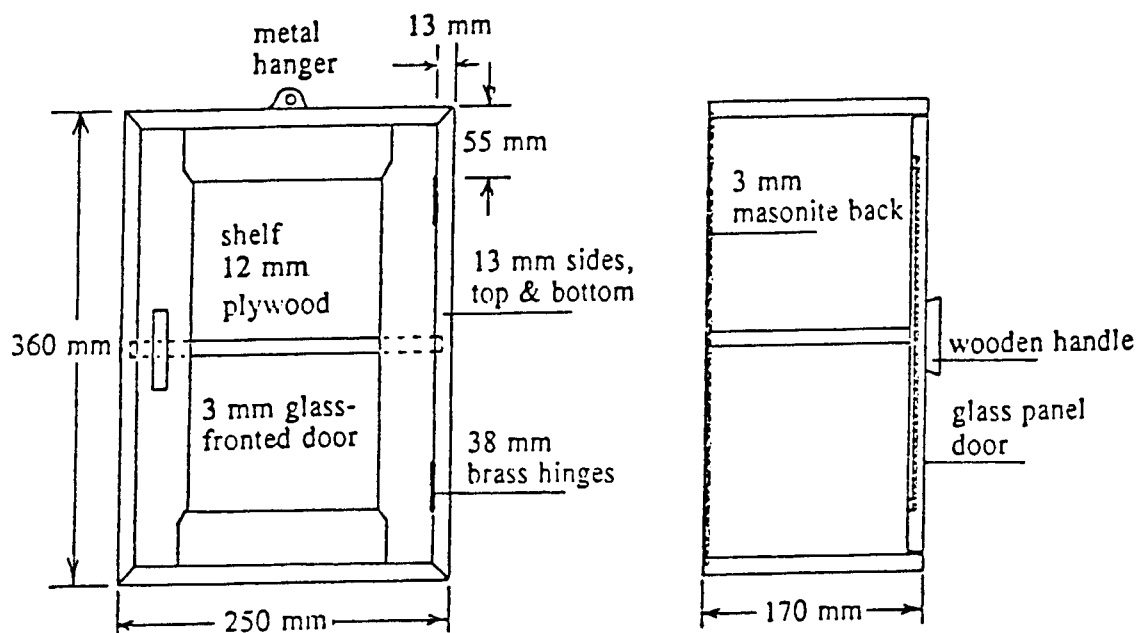
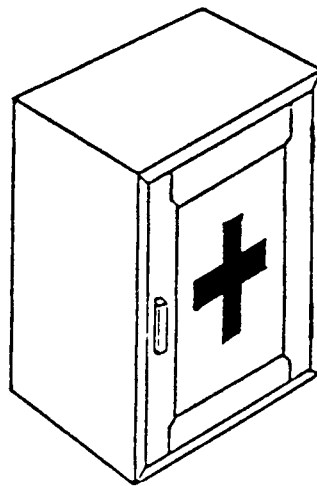
height: 2740 mm
width: 2500 mm

Writing surface

no. of sections: 4 (all plane)
section depth: 1240 mm
section width: 2430 mm

The board is designed to stand on the floor and to be fixed to the wall.

FIRST-AID BOX



Specification

To be made of hardwood and plywood painted in white.

MOVABLE BENCH

OVERALL DIMENSIONS

1525 mm x 760 mm x 840 mm

MATERIALS

(a) *Legs and rails*

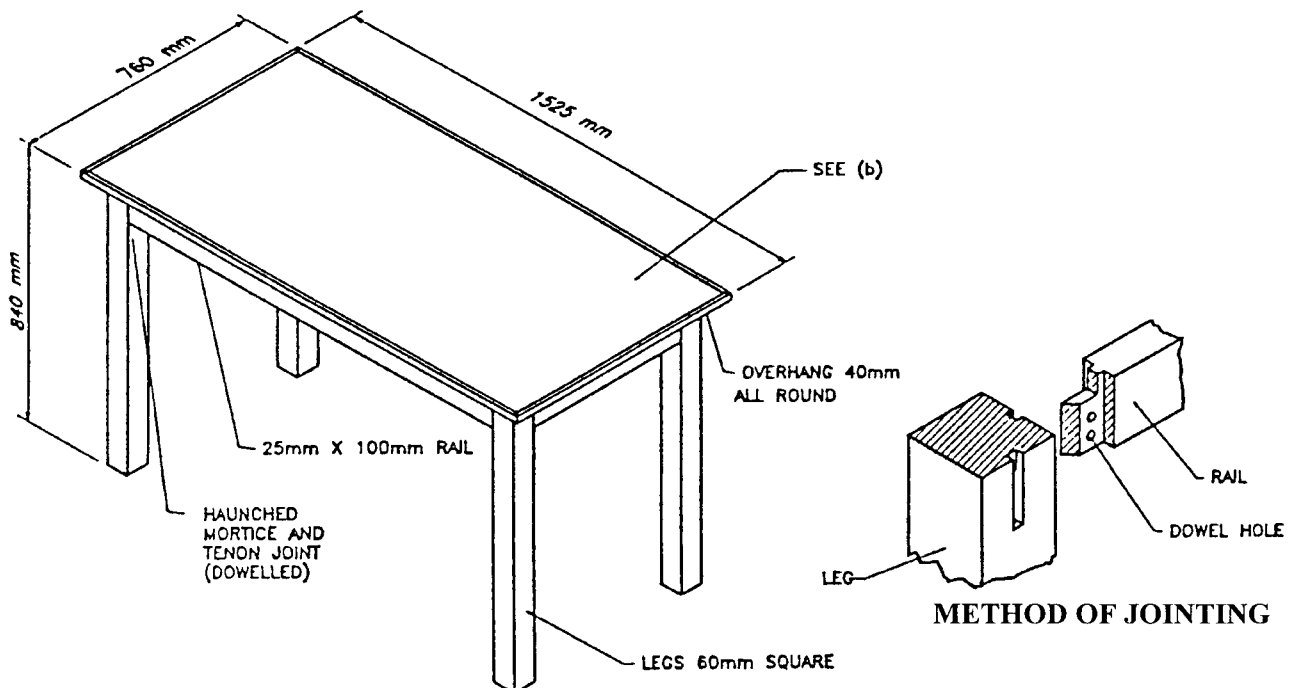
Teakwood, seasoned and straight-grained and free from shakes.

(b) *Top*

20 mm thick plywood top faced with acid and heat resistant plastic laminate, lipped with 12 mm thick teakwood edge all round. Colour and material of plastic same as that of side bench and teacher's bench.

FINISH

All surfaces should be sanded, filled and polished in natural lacquer finish. All arris-edges should be chamfered.



STOOL

MATERIAL

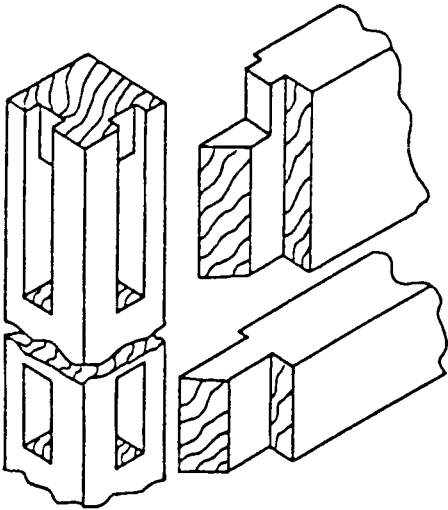
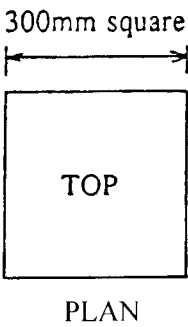
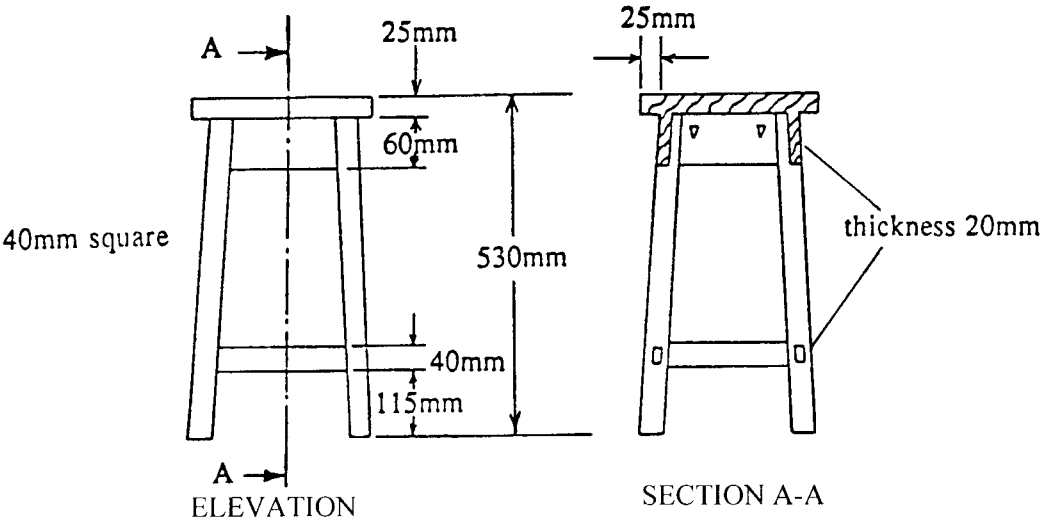
Teakwood, seasoned and straight-grained and free from shakes.

TOP

Stool top to be secured by pocketed screws.

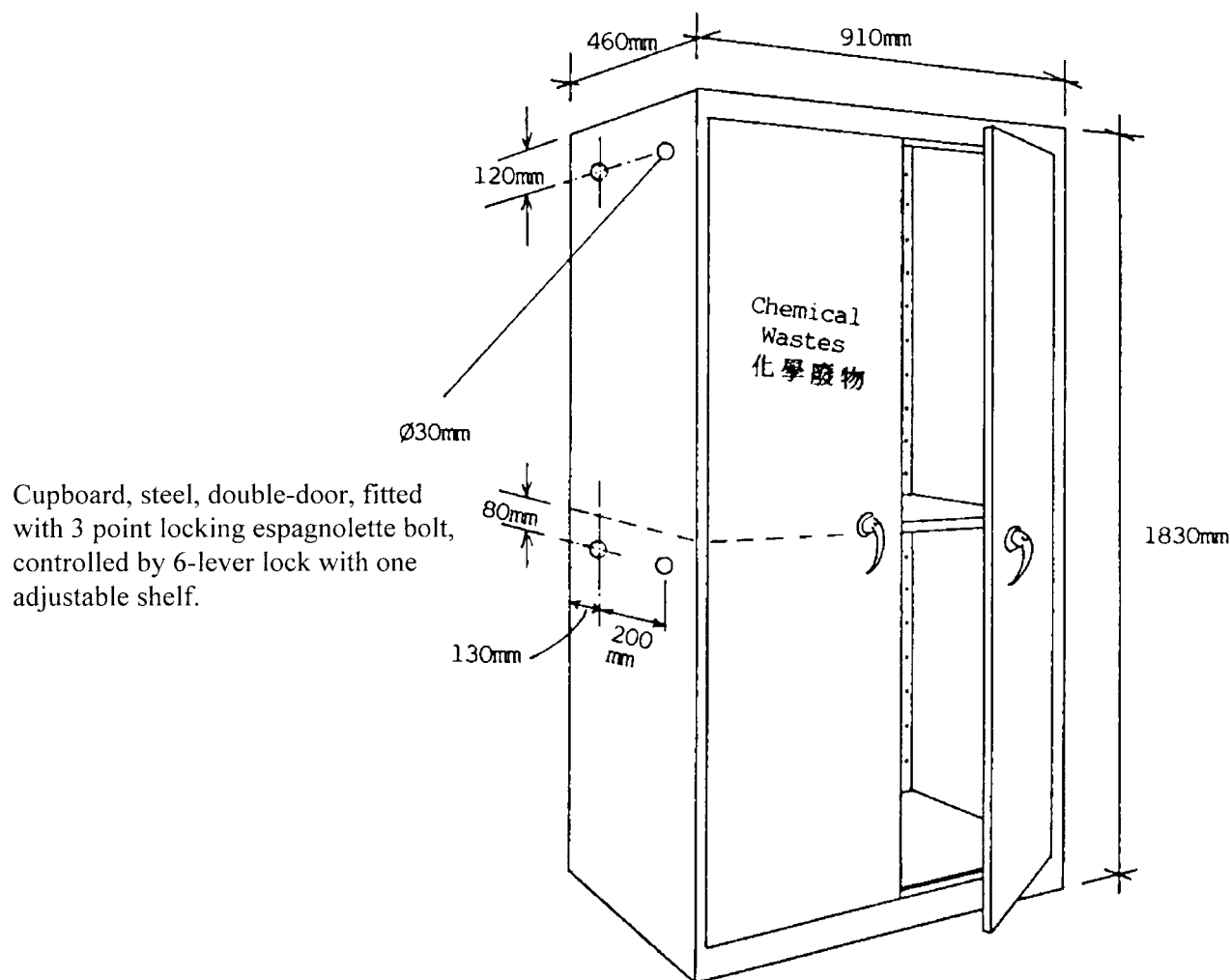
FINISH

All surfaces should be sanded, filled and polished in natural lacquer finish. All arris-edges should be chamfered.



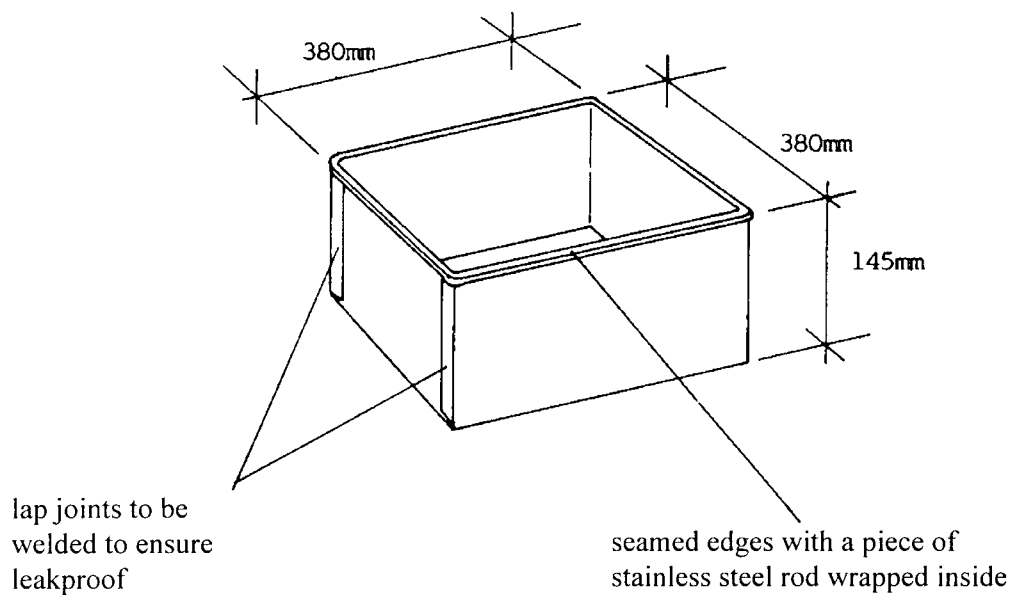
METHOD OF JOINTING

STORAGE CUPBOARD FOR CHEMICAL WASTES



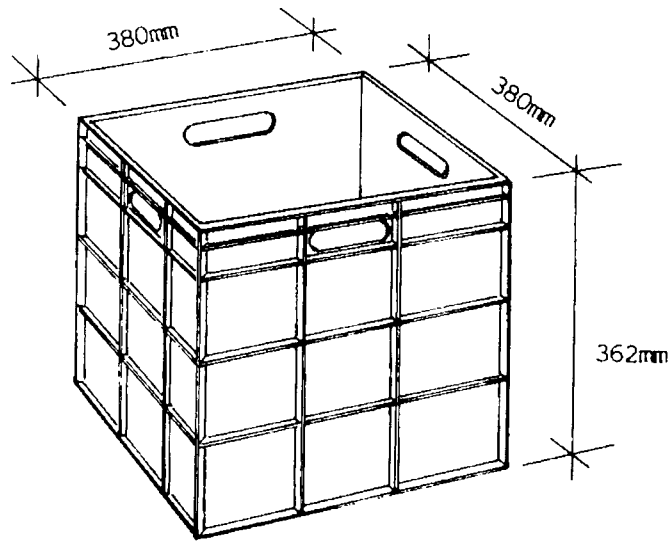
Steel Cupboard

External Dimension	:	910 mm wide x 1830 mm high x 460 mm deep
Doors and Slides	:	1.2 mm (minimum) thickness of steel
Ventilation Holes	:	4 holes of diameter 30 mm on <u>each</u> side as shown
Marking	:	Words "Chemical Waste 化學廢物" (about 6 cm in height) should be printed in white on the left door as shown
Adjustable Shelf and Bottom	:	1.2 mm (minimum) thickness of steel, strengthened with two U-shape ribs welded along the width underneath the adjustable shelf and bottom of the cupboard, stiff and strong enough to stand the weight of about 70 kilograms
Top and Back	:	0.7 - 0.8 mm thickness of steel
Lock	:	Union or Yale
Finish	:	Rust proof with "FOSCOTE" or equivalent preparation and sprayed with three coats of cellulose lacquer
Colour	:	Olive brown



Stainless Steel Spill Catcher Tray

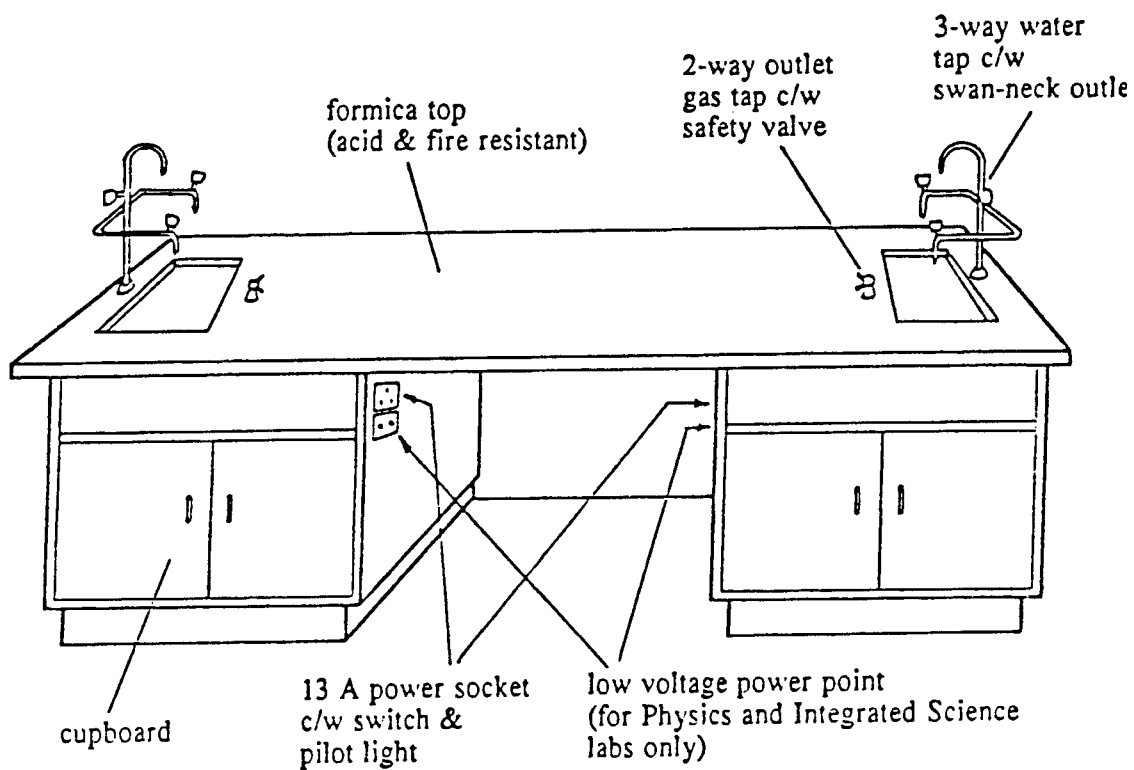
Overall dimension 380 mm x 380 mm x 145 mm, to be made of a SWG 24 stainless steel (type 316) sheet. All edges should be seamed with a piece of stainless steel rod (dia. 5 mm) to stiffen and avoid sharp edges. The lap joints should be welded to ensure that the whole tray is leakproof.



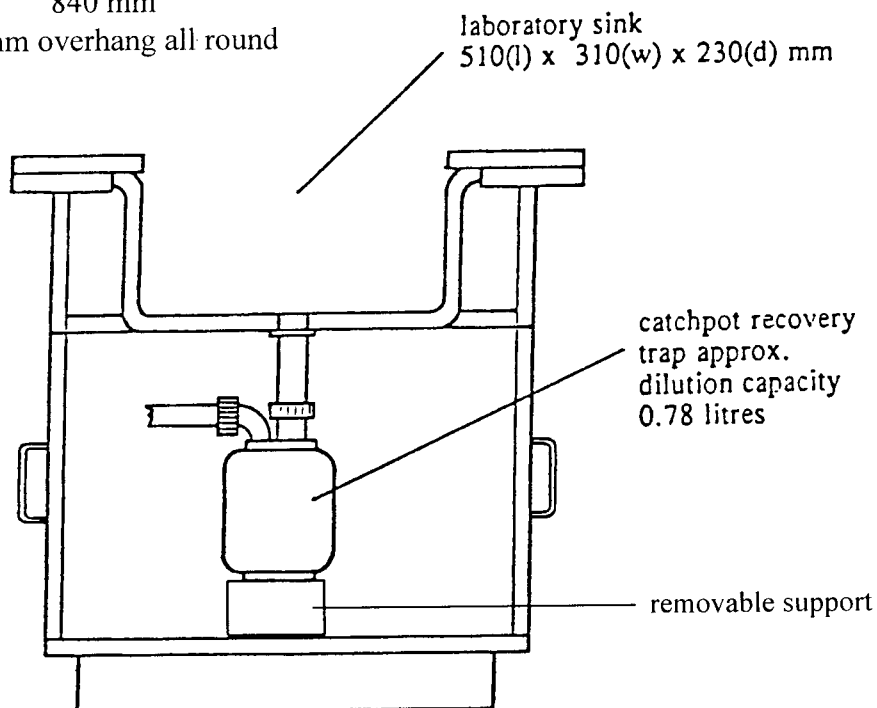
Heavy-duty Plastic Spill Catcher Tray

Overall dimension	:	380 x 380 x 362 mm
Material dimension	:	Top 360 x 360 x 355 mm
	:	Bottom 351 x 351 x 355 mm

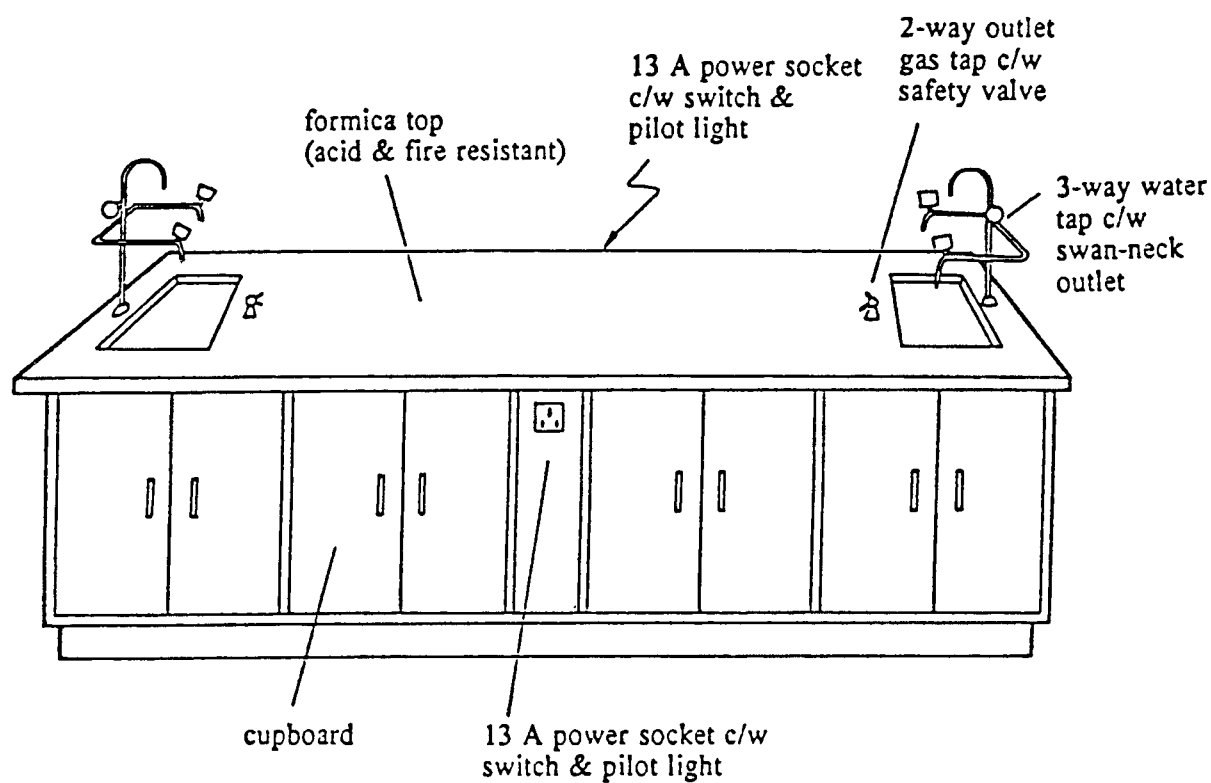
TEACHER'S BENCH



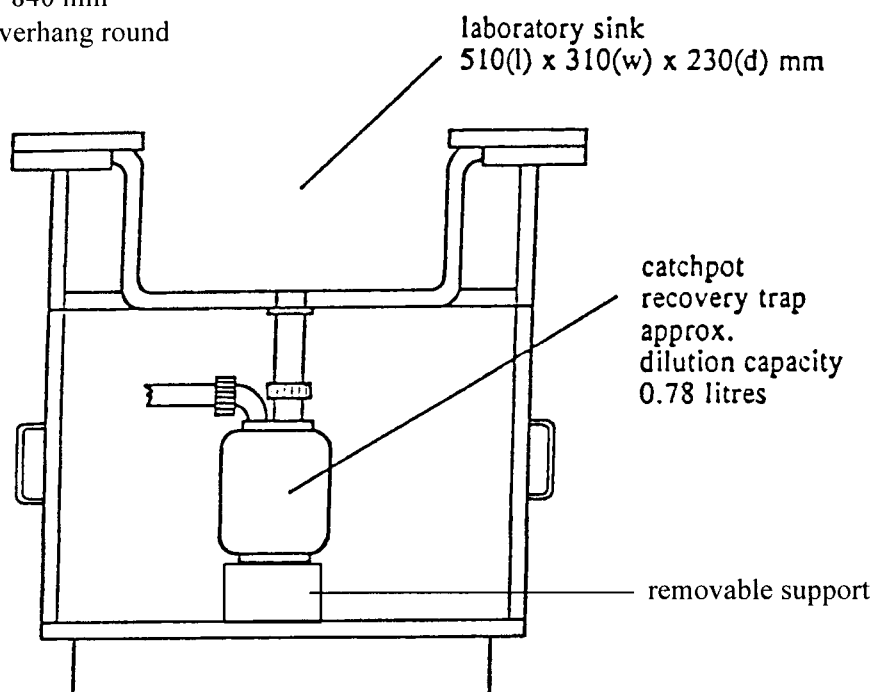
length : 3000 mm
 width : 900 mm
 height : 840 mm
 with 160 mm overhang all round



ISLAND BENCH FOR CHEMISTRY LABORATORY

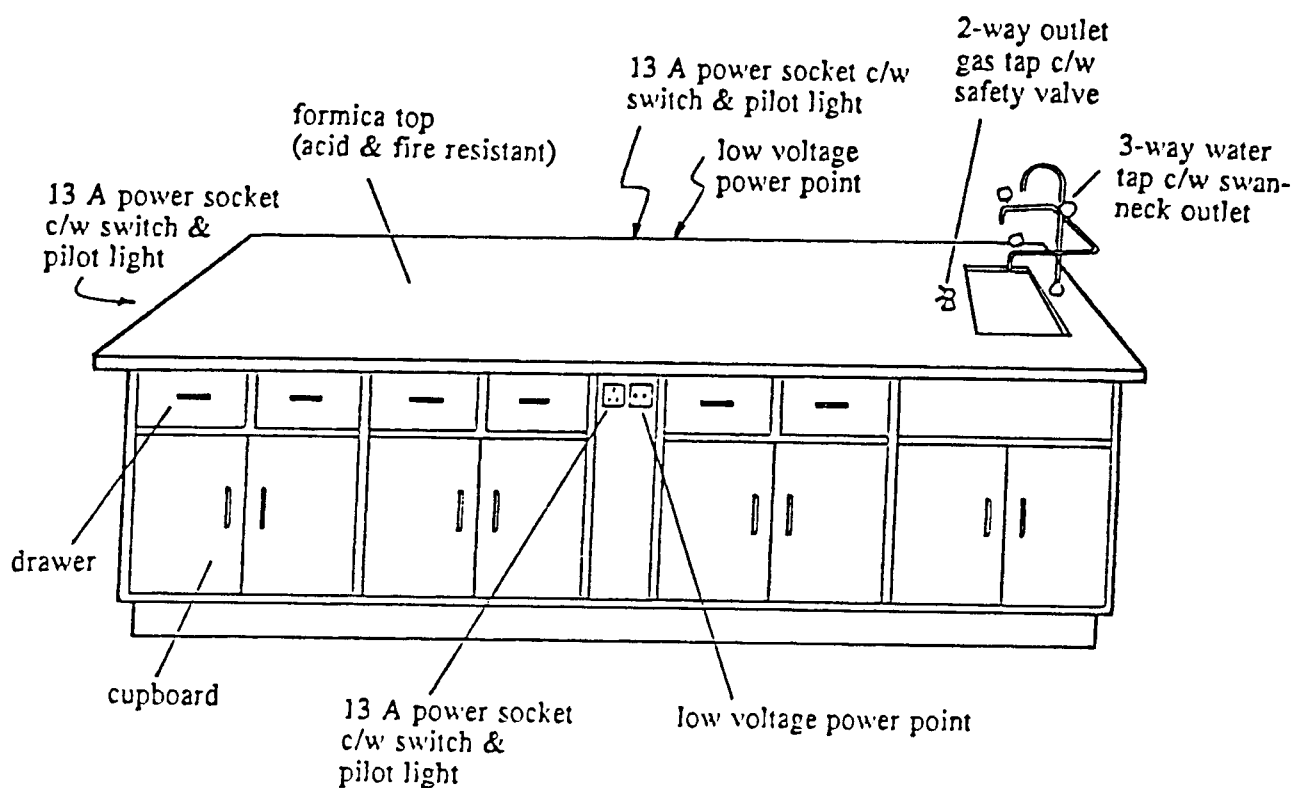


length : 2750 mm
width : 1100 mm
height : 840 mm
with 160 mm overhang round

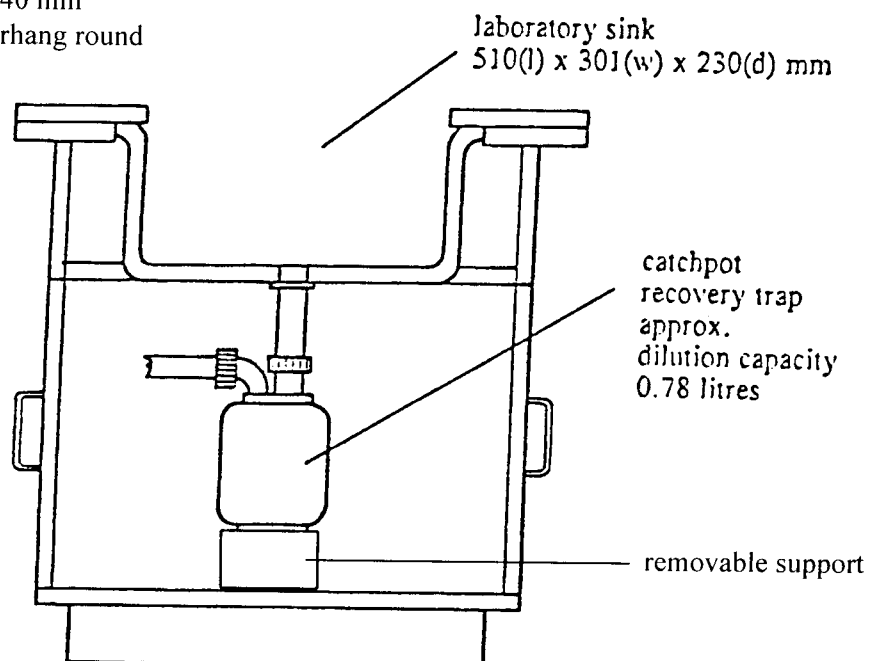


Note: There should be a shelf inside the cupboard dividing the latter into two halves.

ISLAND BENCH FOR PREPARATION ROOM

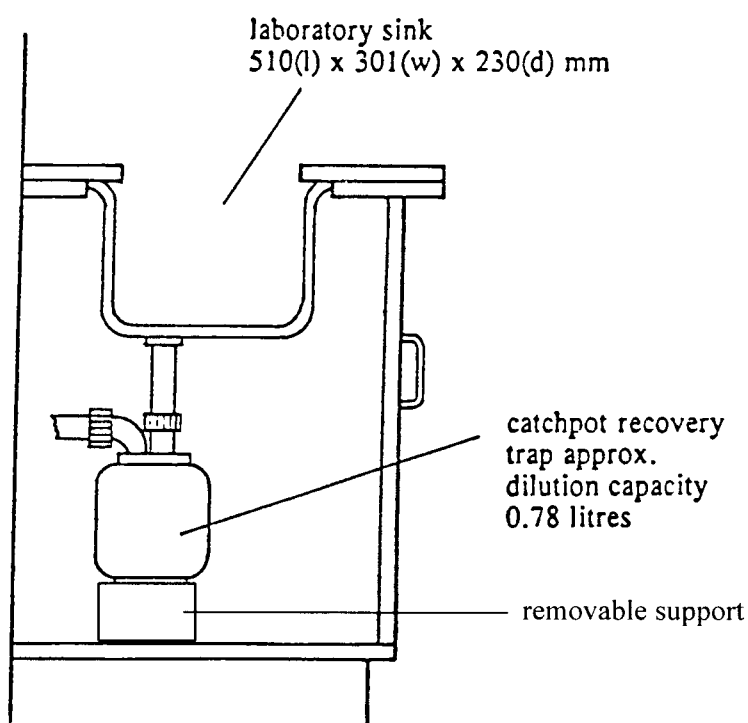
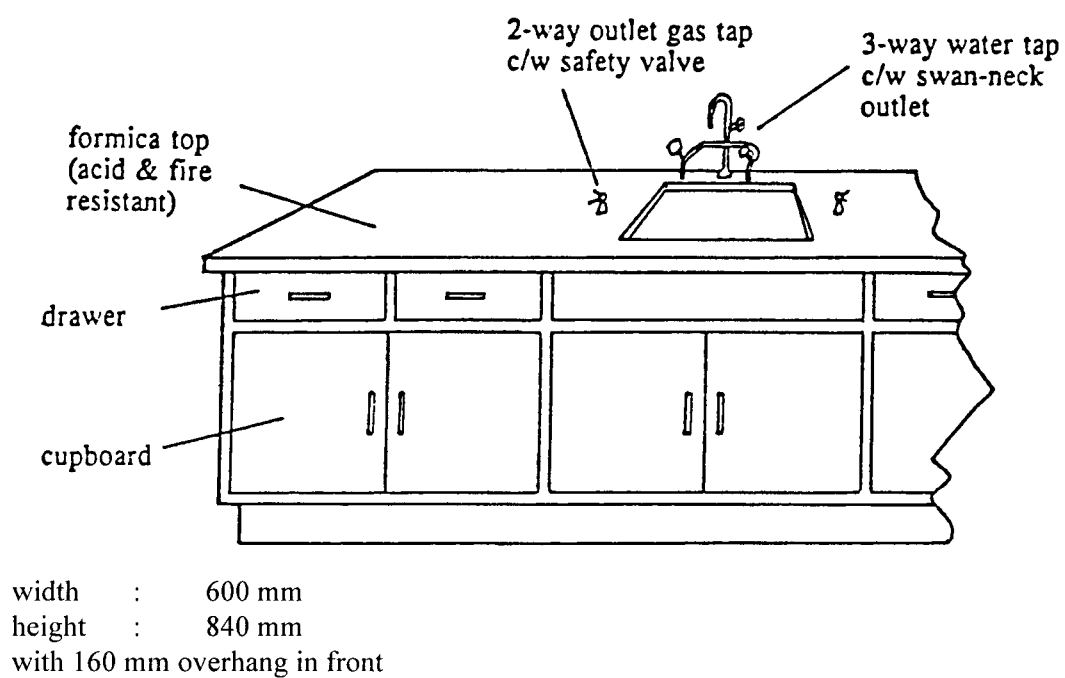


length : 4500 mm
 width : 900 mm
 height : 840 mm
 with 160 mm overhang round



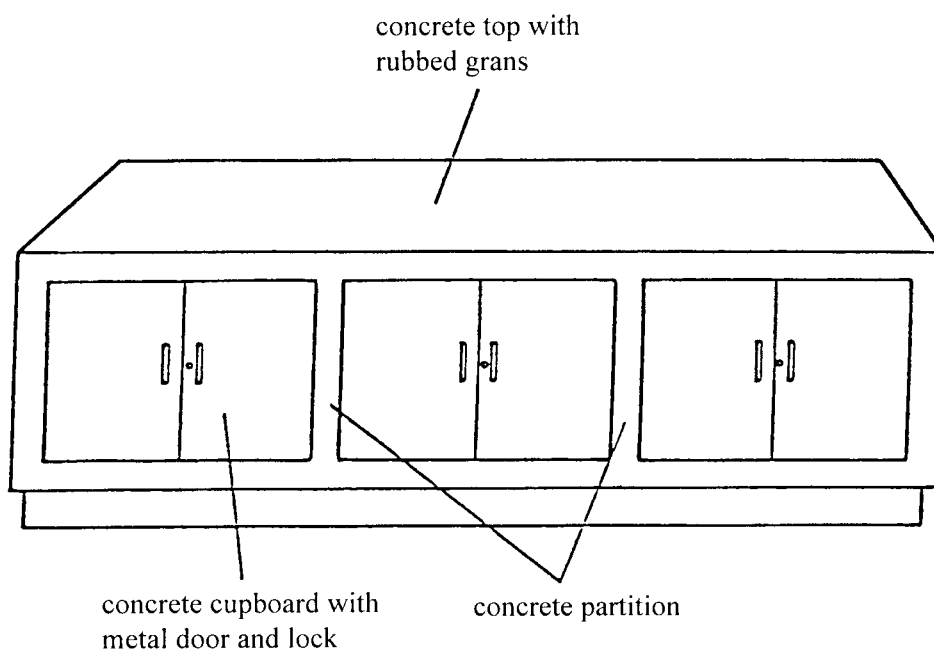
- Note: (1) The low voltage power points are for the preparation rooms of Physics and Integrated Science laboratories only.
 (2) There should be a shelf inside the cupboard dividing the latter into two halves.

SIDE BENCH



Note: There should be a shelf inside the cupboard dividing the latter into two halves.

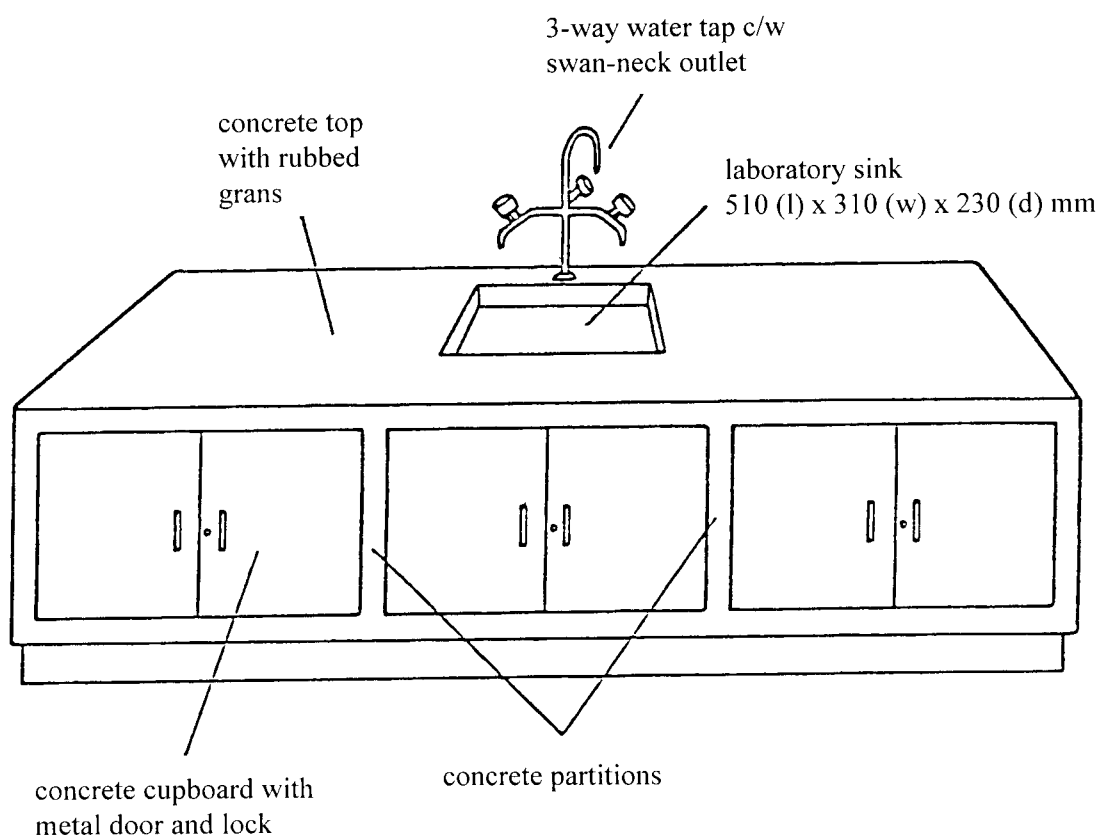
CONCRETE SIDE BENCH FOR CHEMISTRY LABORATORY



length	:	half of the length of the room
width	:	600 mm
height	:	840 mm

Note: The interior of each concrete cupboard should be lined with white ceramic tiles.

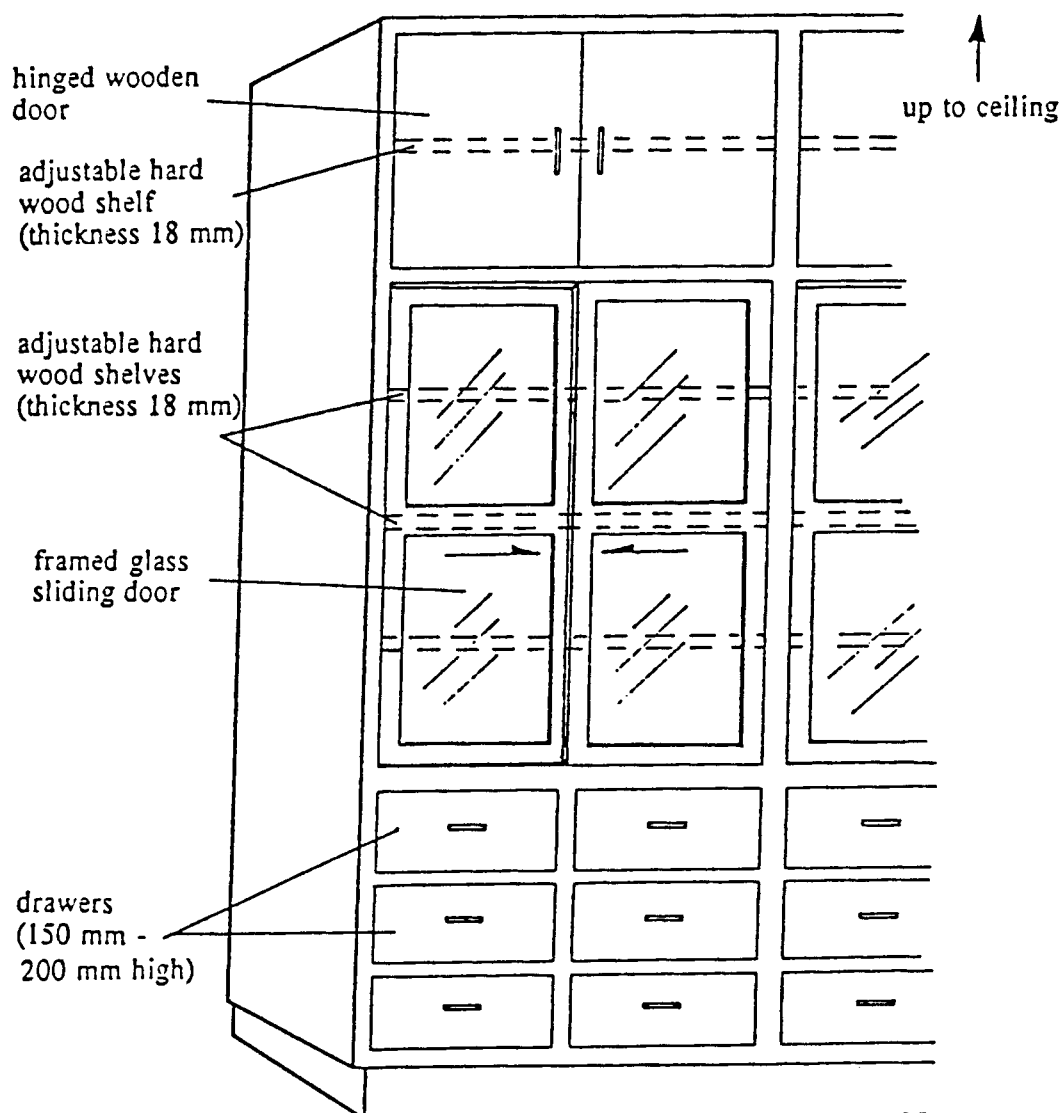
CONCRETE SIDE BENCH FOR PREPARATION ROOM



length	:	width of the preparation room
width	:	600 mm
height	:	840 mm

- Note: (1) There should be a catchpot recovery trap (dilution capacity of about 0.78 litres) below the sink.
- (2) The interior of each concrete cupboard should be lined with white ceramic tiles.

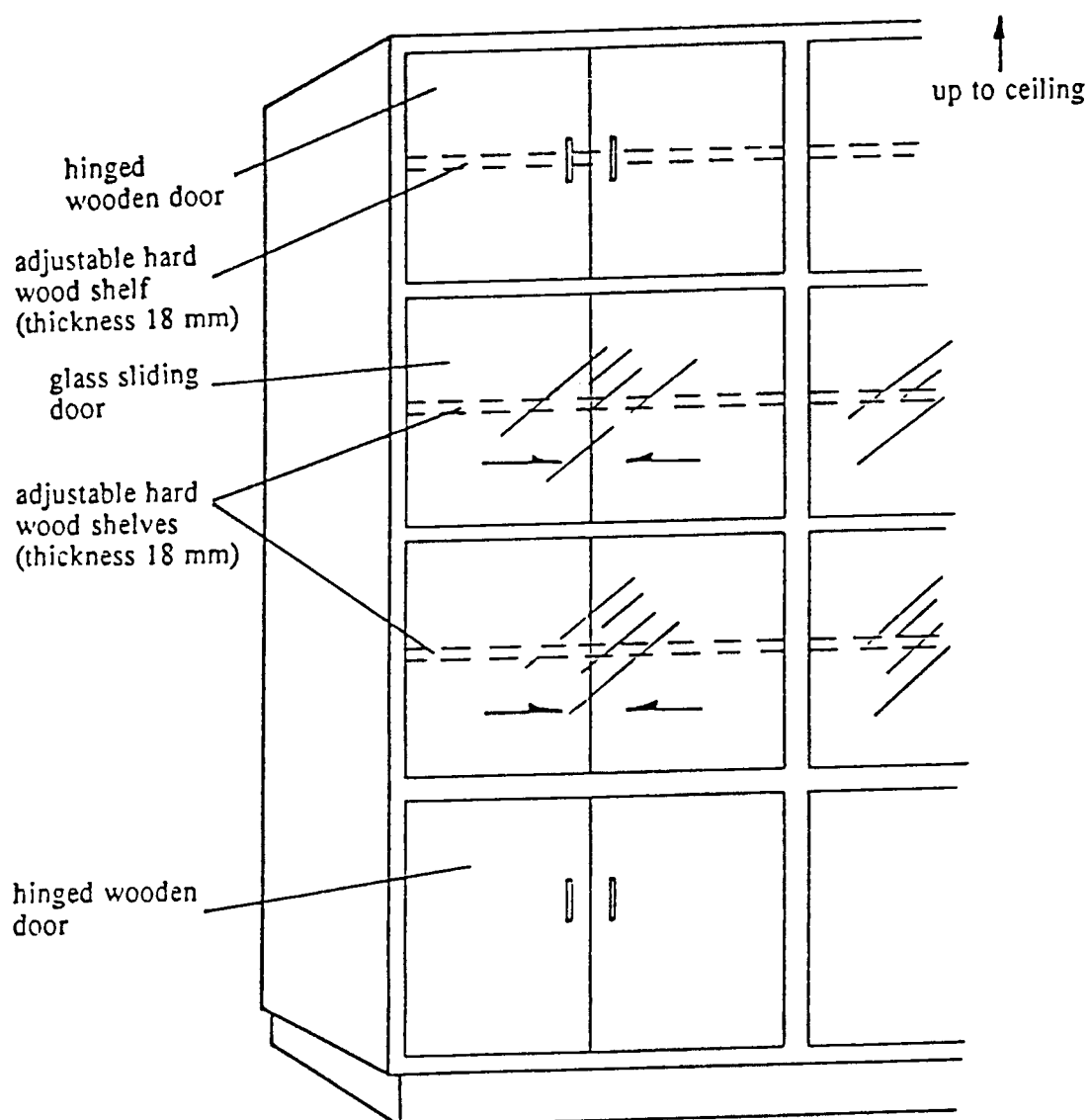
CUPBOARD FOR PREPARATION ROOM



width : 450 mm
height : up to ceiling

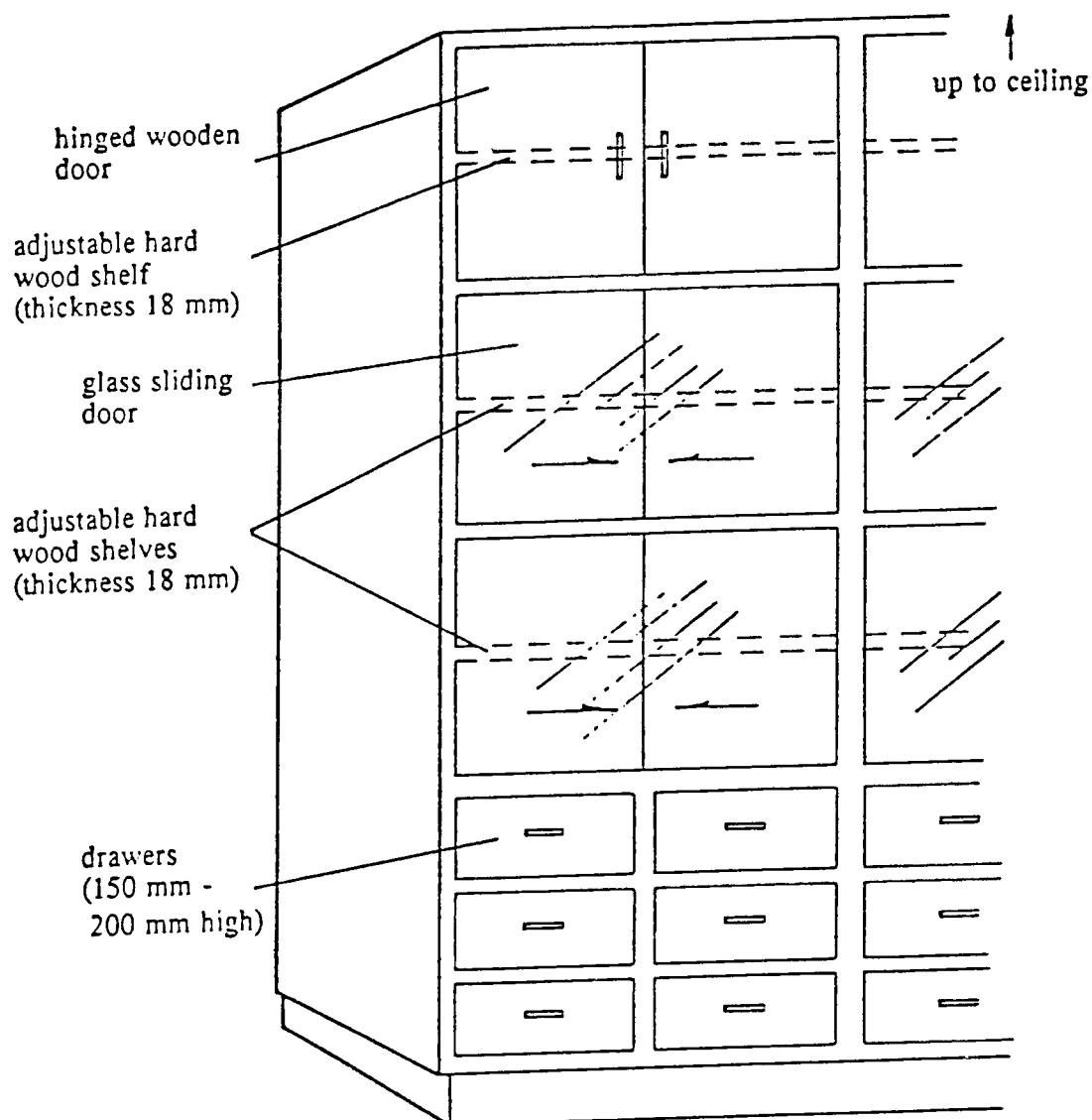
Note: Each framed glass sliding door should have a height 1200 - 1400 mm and a width about 500 mm.

CUPBOARD FOR CHEMISTRY STORE ROOM



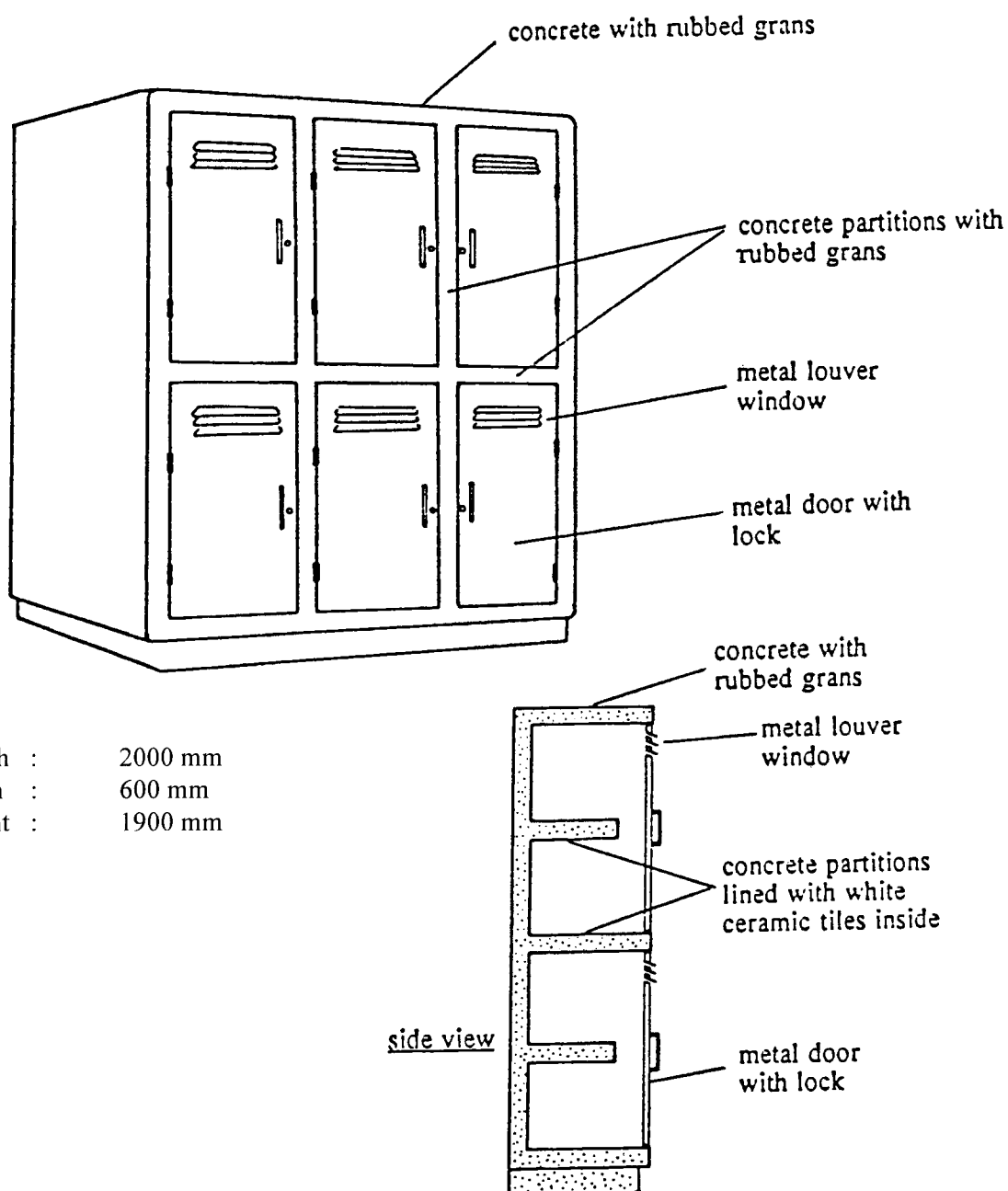
length : 5000 mm
width : 450 mm
height : up to ceiling

CUPBOARD FOR STORE/DARK ROOM



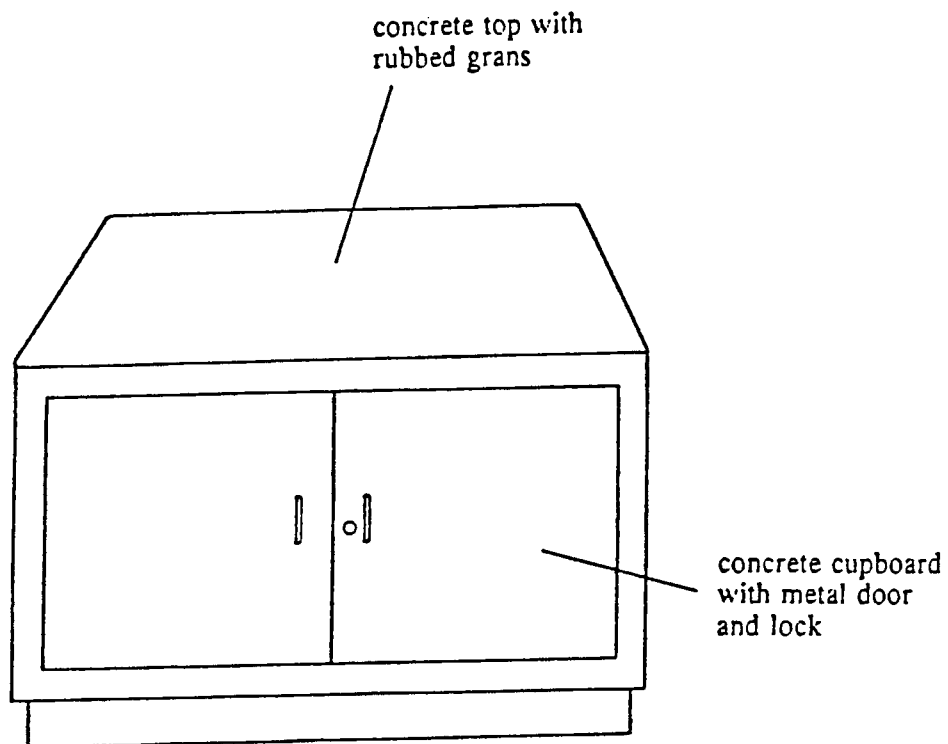
length : 1750 mm
width : 600 mm
height : up to ceiling

CONCRETE CUPBOARD FOR CHEMISTRY STORE ROOM



- Note: (1) There should be one concrete shelf for each of the six concrete cupboards. The shelf should divide the cupboard into two halves.
- (2) The interior of each concrete cupboard should be lined with white ceramic tiles.

CONCRETE BENCH FOR STORE/DARK ROOM



length : 1000 mm
width : 600 mm
height : 840 mm