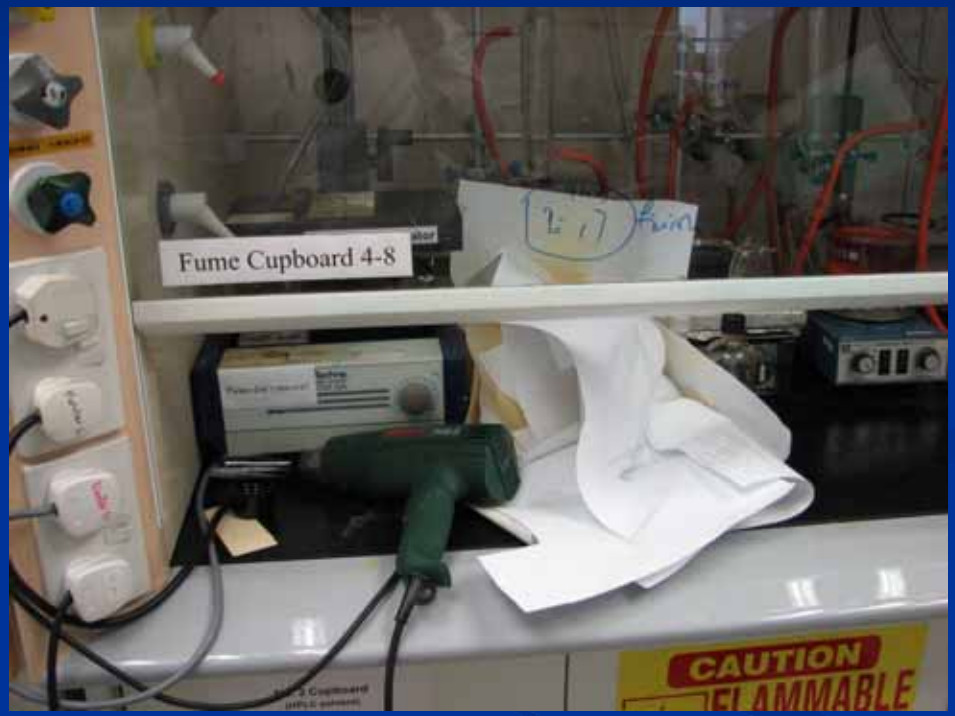
Safety in the Laboratory

- House keeping
- Mechanical hazards
- Laser hazards
- Electrical hazards

Cluttered workplace is unsafe!

Clean up your workplace for a safe and efficient work environment.



No food or drinks in the laboratory.

- You can poison yourself if you eat in the laboratory.
- You will also invite rats into your laboratory if you store food in the laboratory.

Do not block open fire doors and laboratory doors.

NO

YES

The double fire doors close automatically once the fire alarm is triggered.

Smoke doors

Other improper practice

- Wearing gloves and lab coat outside of the laboratory.
- Chemicals / gases in the passenger lift.
- Unattended experiments.
- Running in the corridor and laboratory.

Mechanical hazards

Vacuum system

Compressed gas cylinder

- Unsecured / improperly secured cylinders may fall down and crush people nearby.
- High pressure gas (>1000 psi) may rush out if the main valve is severed during the fall – mechanical hazard and suffocation hazard.

Always secure your gas cylinders properly – one chain for one cylinder. Free standing cylinders are dangerous.

Mechanical hazards

Equipment with moving parts

Equipments in the machine shop

- Lab coat and long hair may get caught by the pump or other rotating machines.
- Use cutting and drilling machines only if you have proper training and instruction.

Laser Hazards

- Serious burns to the skin and outer layers of the eyes (cornea).
- Serious damage to interior tissues of the eyes (especially the retinal layer) even at exposure levels harmless to skin and the front of the eyes.
- Other hazards: electric shock, fire, ionizing radiation.

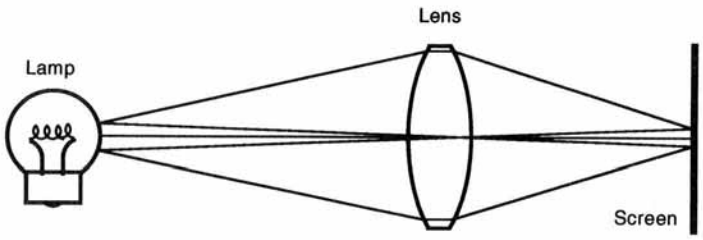


Figure 1.6 The focusing of light emitted by a lamp. The smallest patch of light that can be produced on a screen corresponds to the geometrical image of the lamp.

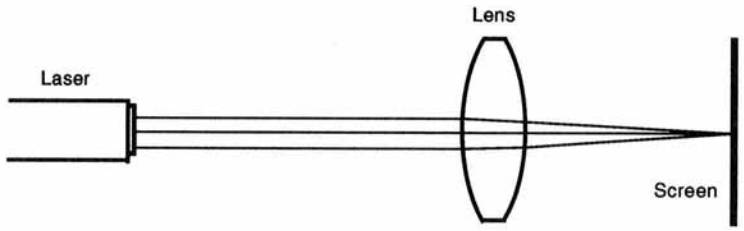


Figure 1.8 The focusing of light emitted by a laser. All of the radiation produced by the laser can be collected by the lens and brought to a focus at a point.

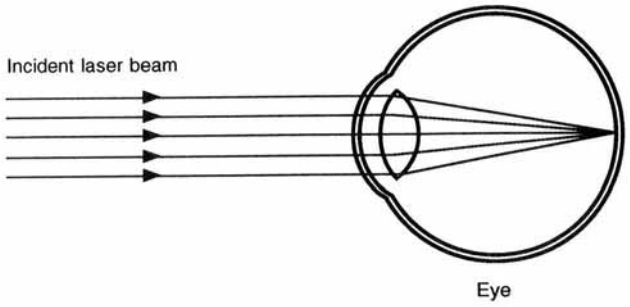
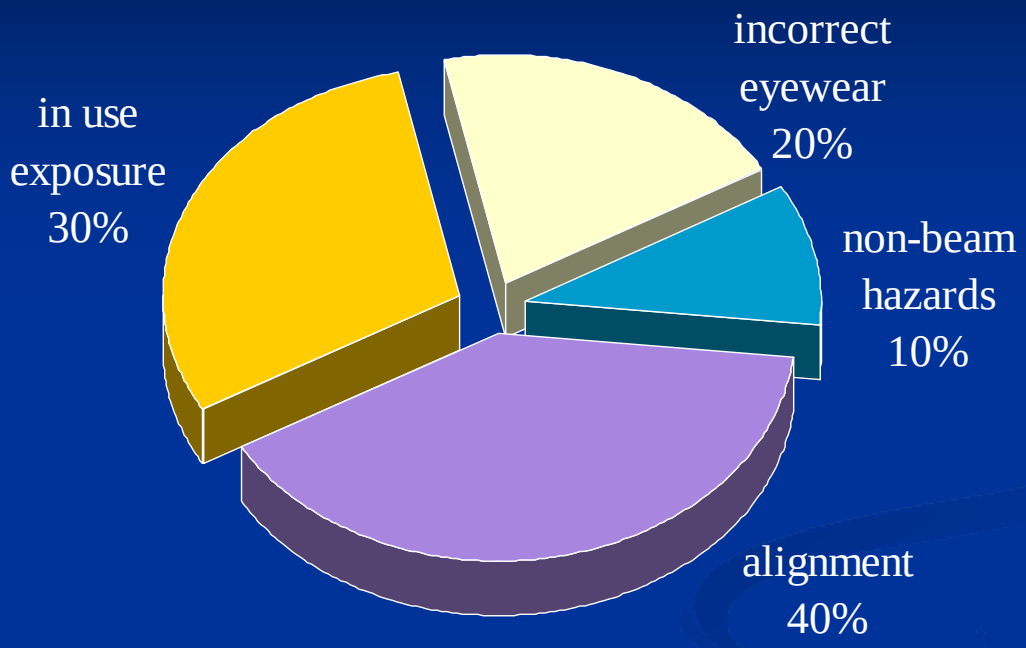


Figure 1.9 Focusing of laser radiation by the eye. The radiation entering the eye can be brought to a point-focus on the retina, at the back of the eye.

Small spot size : power density at the focus of the laser can be very high, especially for pulsed lasers (ns-laser can produce $10^9\,W/cm^2$ readily).

Major Causes of Laser Accidents



- You must have proper training by your supervisor before operating a laser.
- Never walk into a laser laboratory without proper eye protection.

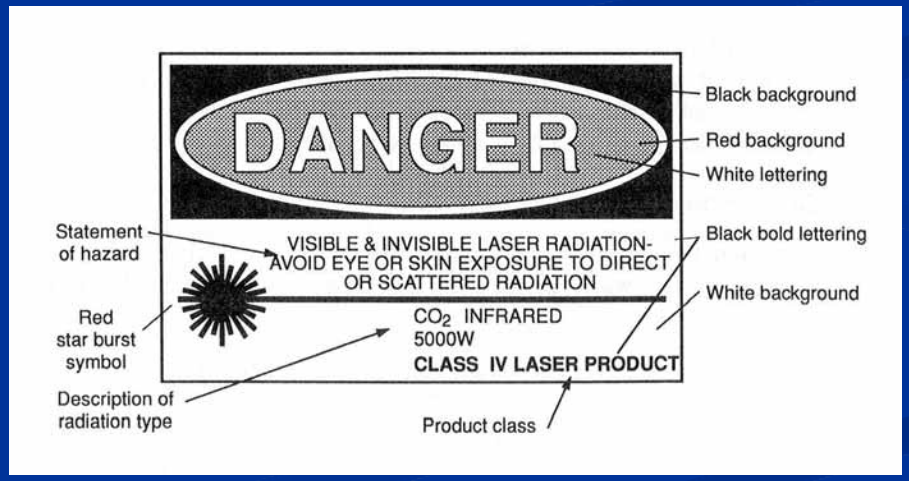
Warning signs are posted outside of laser laboratories.

International laser hazard warning symbol

Signs in Department

Know your laser hazard before entering a laser laboratory.

- Class of the laser
- Wavelength of the laser
- Pulse energy and duration of the laser
- Warning light outside of the laboratory



U.S. Department of Labor, Occupational Safety & Health Administration, OSHA Technical Manual, Chapter 6: Laser Hazards
http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html

Beware of Class 3B and 4 lasers.

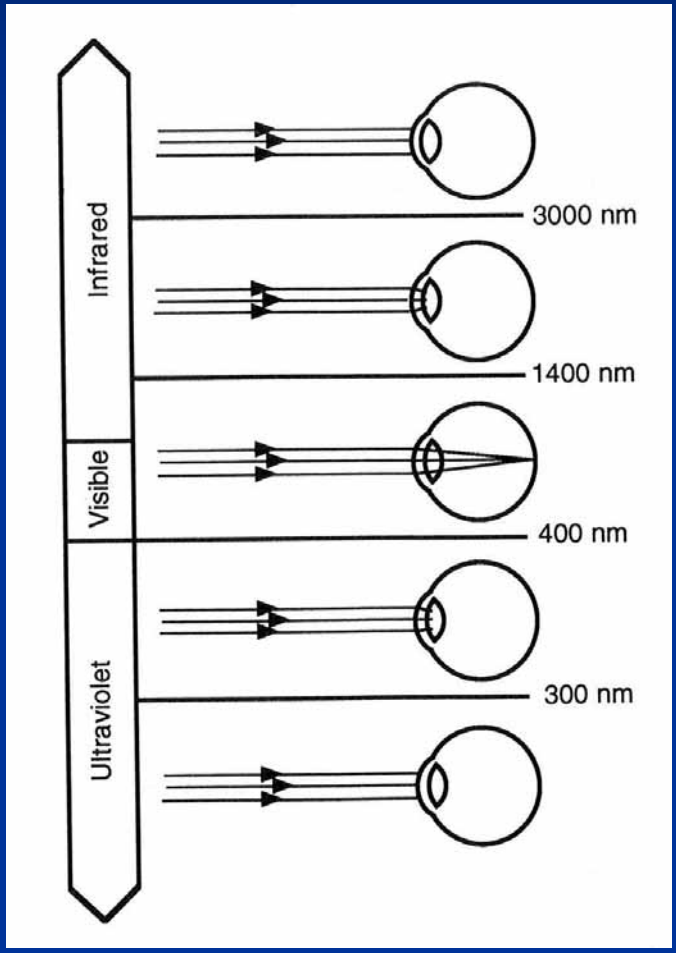
Table 1.5 Principal laser radiation hazards according to the laser class

Class 1	Safe, due to very low radiant emission
Class 2	(Covers visible emission only) Possible eye hazard other than for accidental momentary viewing
Class 3A	Eye hazard if magnifying viewing instruments are used to view or intercept the beam
Class 3B	Hazard to the unaided eye. The viewing of diffuse reflections is normally safe. Can also exceed the skin safety threshold, but would not be expected to cause serious harm to the skin
Class 4	Eye and skin hazard. Diffuse reflections may also be hazardous. Possible fire and fume hazard by interaction with target material

References:

1. **ANSI Z136.1 (2000) Standard "Safe Use of Lasers",** American National Standards Institute, Inc.
2. **OSHA Technical Manual, SECTION III: CHAPTER 6 LASER HAZARDS**
   http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html

The point of interactions with human tissue depends on laser wavelength.



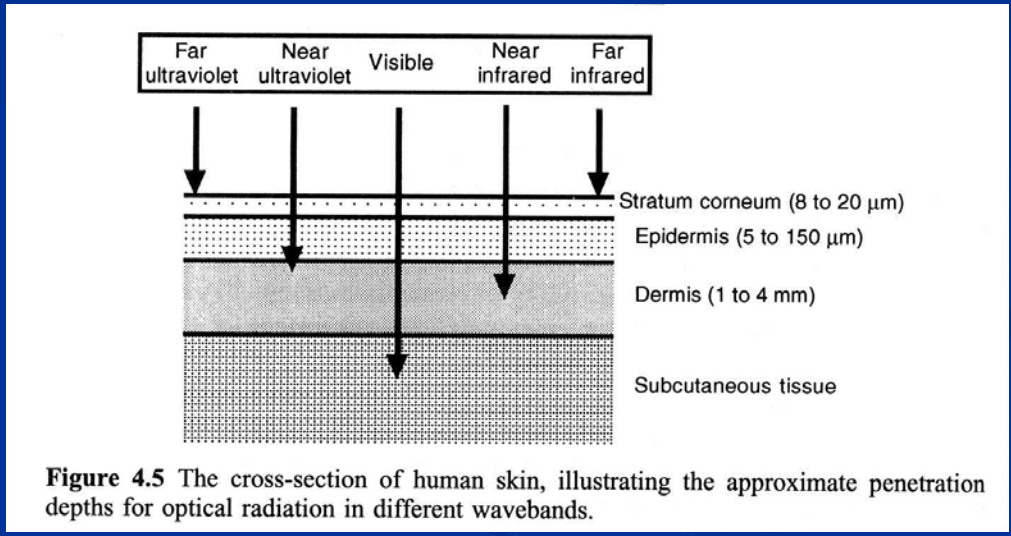


Figure 4.5 The cross-section of human skin, illustrating the approximate penetration depths for optical radiation in different wavebands.

Laser Goggles

Use the correct type!

Check:

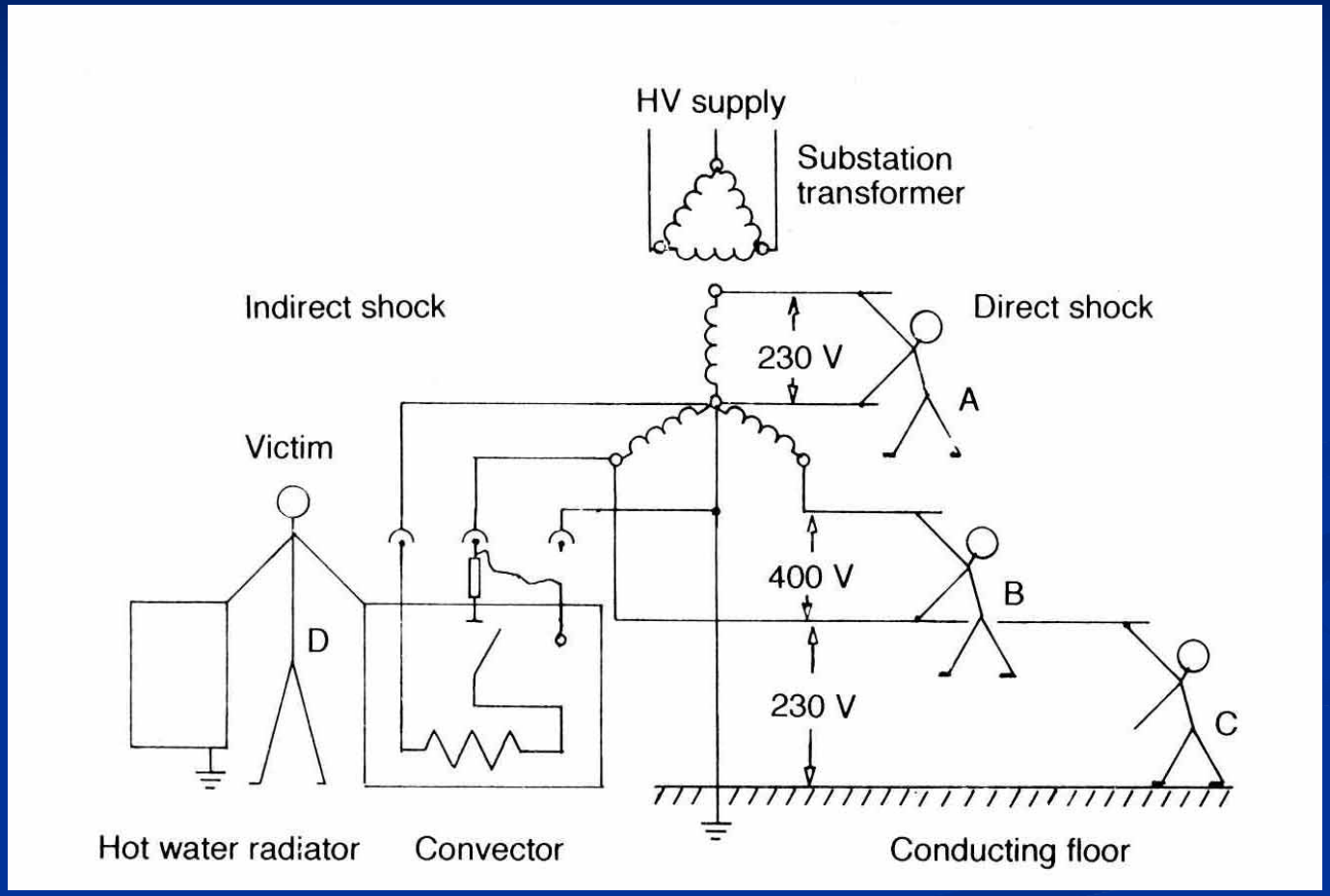
1. Wavelength
2. Optical Density (OD)

$$OD = \log \frac{I_o}{I_t}$$

General Rules of Laser Safety

- Turn the laser on only when required.
- Always be aware where the beam is shining.
- Never allow the laser beam to fall on the naked eye.
- Never allow the beam to scatter off reflecting objects, e.g., glass face of a watch, rings, metal stands.
- Wear suitable protective goggles or glasses - make sure everybody in the laboratory does the same.
- Use the correct laser goggles - each laser type will require different goggles.
- Know the NOHD (nominal ocular hazard distance - the distance you can work without wearing goggles) of your laser.

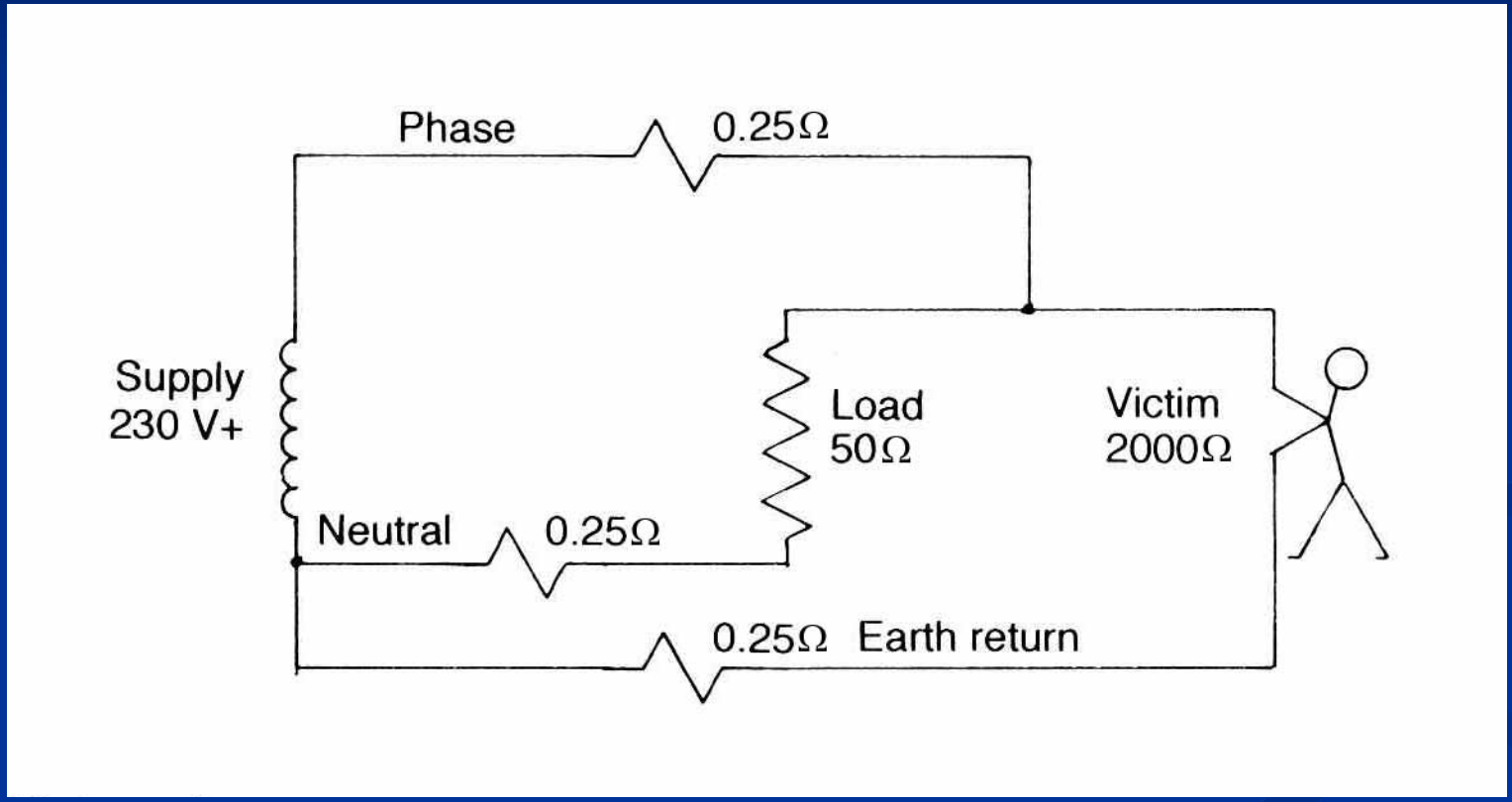
Electrical Safety



Water pipe (grounded)

Instrument of faulty wiring

Electrical Safety



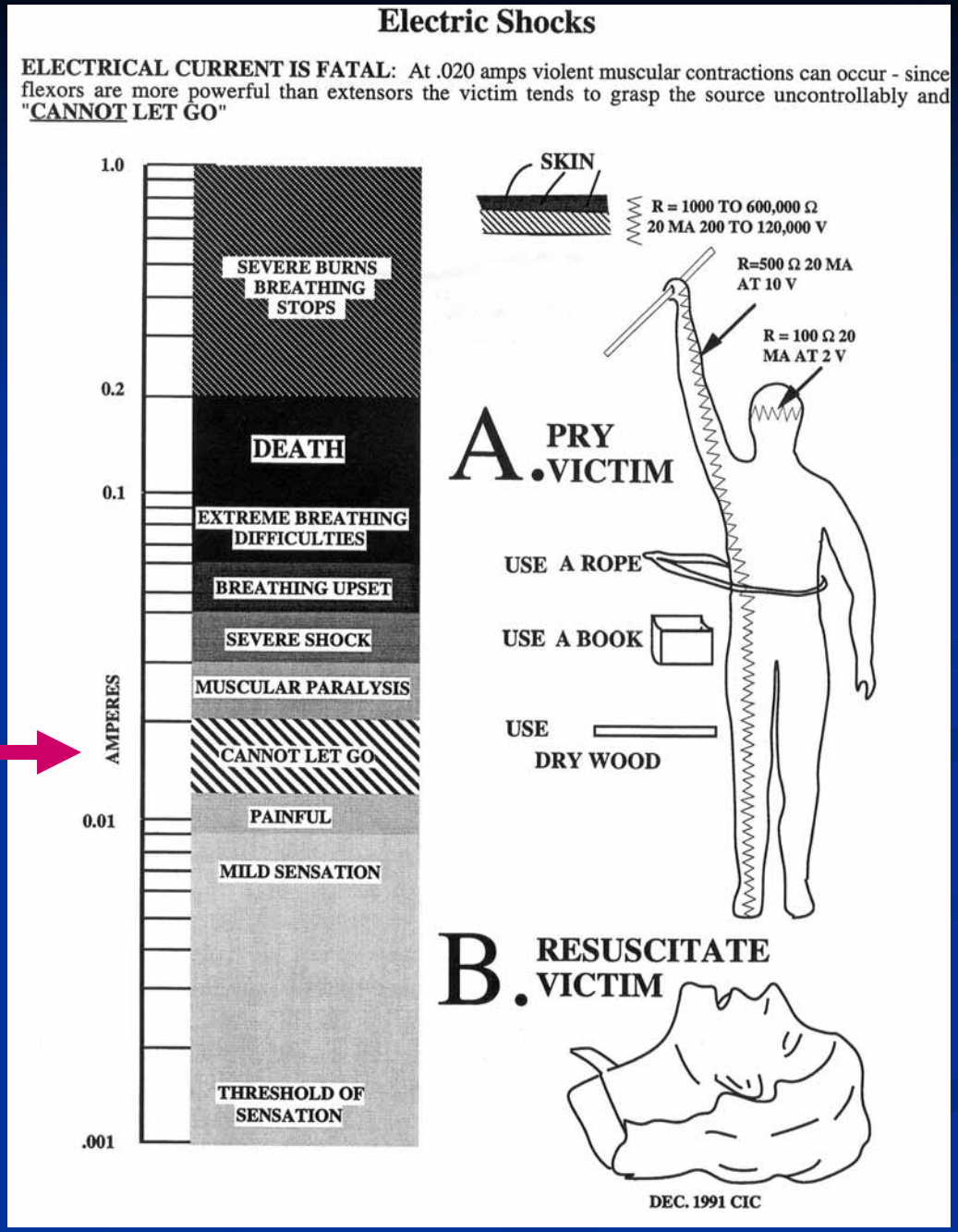
$$i = \frac{V}{R} = \frac{230}{2000} = 0.115\ A = 115\ mA$$

It is the current that kills. 20 mA through the body is dangerous.

Table 7.1 The effect of passing a shock current through the body from hand-held electrodes.

Current in mA	Effect
0.5–2	Threshold of perception.
2–10	Painful sensation, increasing with current.
10–25	Cramp and inability to 'let go'. Increase in blood pressure. Dangers of asphyxiation from respiratory muscular contraction.
25–80	Severe muscular contraction, sometimes involving bone fractures. Increased blood pressure. Loss of consciousness from heart and/or respiratory failure.
Over 80	Burns at points of contact. Death from ventricular fibrillation (uncoordinated contractions of the heart muscles so that it ceases to pump).

20 mA:
Cannot let go,
Suffocation.

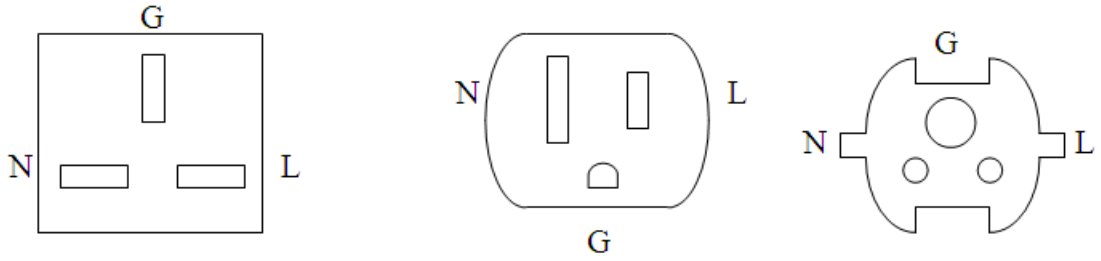


General Rules of Electrical Safety

- Be alert: check and remove exposed contacts, damaged wire, etc.
- Be tidy: label wires and plugs.
- Keep your hands dry and keep water away from equipment.
- Observe the one hand rule.
- No power cable on the floor.
- Be careful of capacitors because they may remain charged long after disconnected from power supply.

- Current trips and fuses should be used for all equipment.
- Good grounding for all instruments.

Power Sockets and Power Plugs



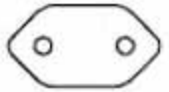
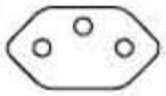
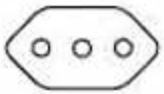
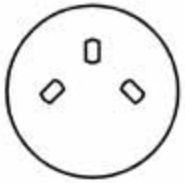
G: Ground; N: Neutral; L: Live

Department Safety Handbook

The following table gives the characteristic of each pin and the colour code of the wire that is connected to it:

	Live	Neutral	Ground
Voltage	~220 V rms	~0 V	~0 V
Current Europe	Brown	Blue	Green-yellow
Old UK	Red	Black	Green
US/Canada	Black	White	Green-yellow
Japan/Korea	White	Black	Green

Where practical, all plugs should be 5, 13 or 15 Amp plugs with 3 pins and made to British Standard BS546 or BS1363.

plug type					
description	**category A** 125V~, 2 flat blades	**category B** 2 flat blades with round ground pin	**category C** oblique flat blades	**category D** oblique flat blades - grounded	**category E** 2 round pins
		discontinued			
category F 2 round pins	**category G** 2 round pins with ground receptacle	category H Midle East type plug	**category I** 3 flat blades UK type plug	**category J** 220V~, 2 flat blades	**category K** 3 round pins plug in triangle pattern (6A)
					
category L 3 round pins plug in triangle pattern (16A)	**category M** Swiss type plug	**category N** Italy type plug	**category O** Denmark type plug	**category P** Israel type plug	

http://www.yung-li.com.tw/EN/info/ww_specifications.htm

Web resources

http://chem.hku.hk/~safety