Thus, a metre ruler has a small division of 1 mm. It can measure a length correct up to 1 mm.

Measurement of length of an object with a metre ruler : To measure the length of an object with a metre ruler, the ruler is placed with its markings close to the object. Then the zero mark on the ruler is made to coincide with one end of the object. Now the position of the other end of the object is read on the ruler. This reading gives the length of the object. But a ruler has some thickness, so while looking at the reading on the scale, we get different readings when the eye is kept at different positions. *This is called error of parallax. To avoid it, the correct reading is obtained when the eye is kept in front of and in line with the reading to be taken.*

Fig. 2.2 illustrates the measuring of length of a rod *PQ*. The end *P* of the rod coincides with the zero mark on the ruler. If the end *Q* of the rod is read by keeping the eye at the position *A*, the reading is 4·2 cm. If the eye is at the position *C*, the reading is 4·4 cm. Both these readings are wrong. The correct position of the eye is *B*, vertically above the end *Q*. When the eye is at the position *B*, the reading is 4·3 cm. So the correct length of the rod is 4·3 cm.

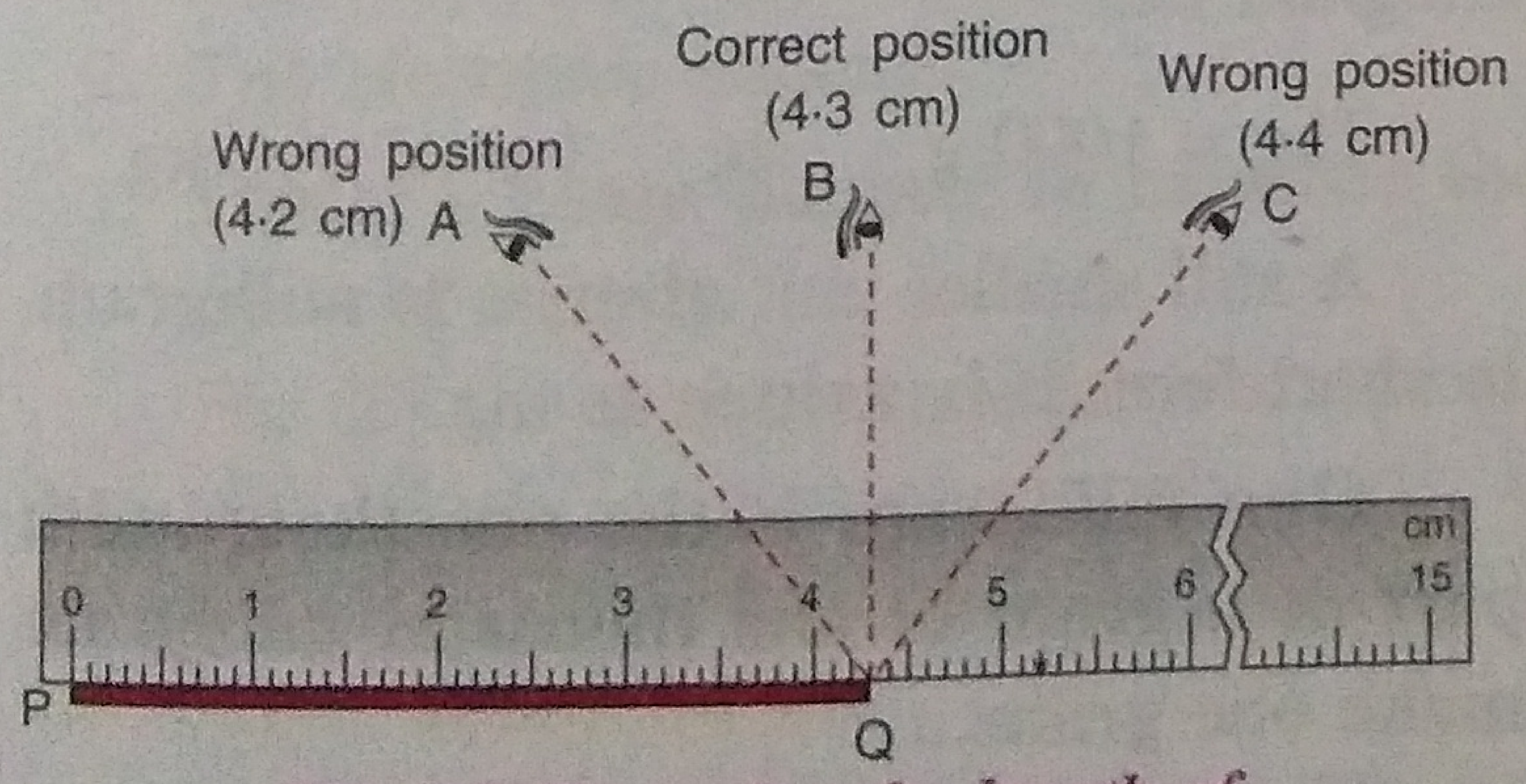

Fig. 2.2 Measuring the length of a rod PQ with a metre ruler

Note : Sometimes, the ends of the ruler get damaged with use and its zero mark may not be visible. To measure the length of an object with such a ruler, the object is placed close to a specific marking on the ruler and positions of both ends of the object are read on the ruler. The difference of the two readings gives the length of the object. In Fig. 2.3, the reading on ruler at the end *X* is 1·0 cm and at the end *Y* it is 4·3 cm. So the length of the rod *XY* is 4·3 – 1·0 = 3·3 cm.

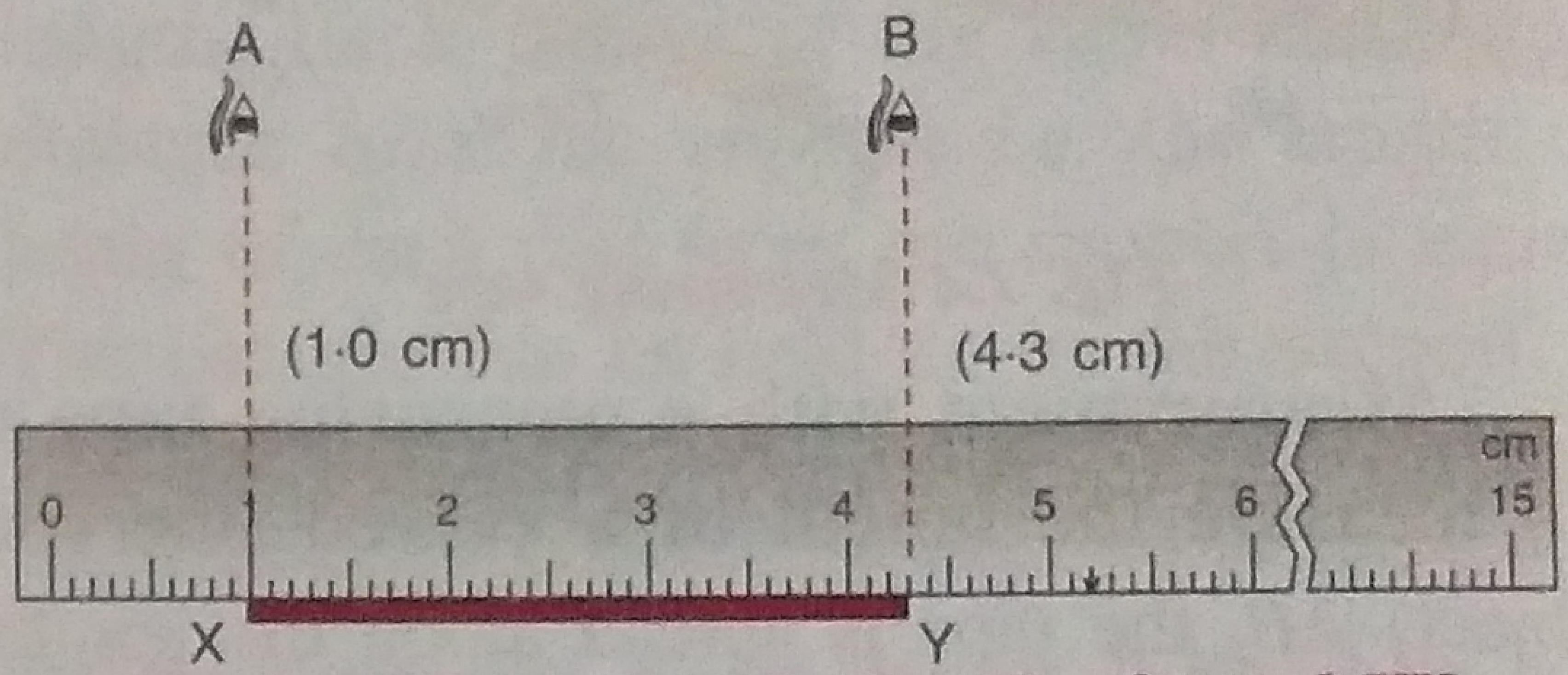

Fig. 2.3 Measuring the length of a rod XY with a damaged metre ruler

Thus, a metre ruler can measure a length up to 1 mm. A metre ruler can only be used to measure the length of straight objects.

Do You Know ?

1. A metre ruler can be used to measure the thickness of a coin even if it is less than 1 mm. For this, the height of a stack of few number of coins (say 10) is measured by using the metre rule and then the thickness of a coin is obtained by dividing the height with the number of coins in the stack.

2. To measure a length smaller than 1 mm, vernier callipers is used to measure lengths up to 0·1 mm and screw gauge is used to measure lengths up to 0·01 mm.

2. Use of measuring tape to measure length

Description of a measuring tape : A measuring tape is a flexible ruler. It consists

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of a ribbon of cloth, plastic, fiber glass or metal strip with lines as markings in cm and mm in it. It can be easily carried in your pocket or tool-kit. It is available in various lengths say 1 m, 5 m, 10 m, 50 m and 100 m. Surveyors use a tape of length 100 m. Fig. 2.4 shows a measuring tape.

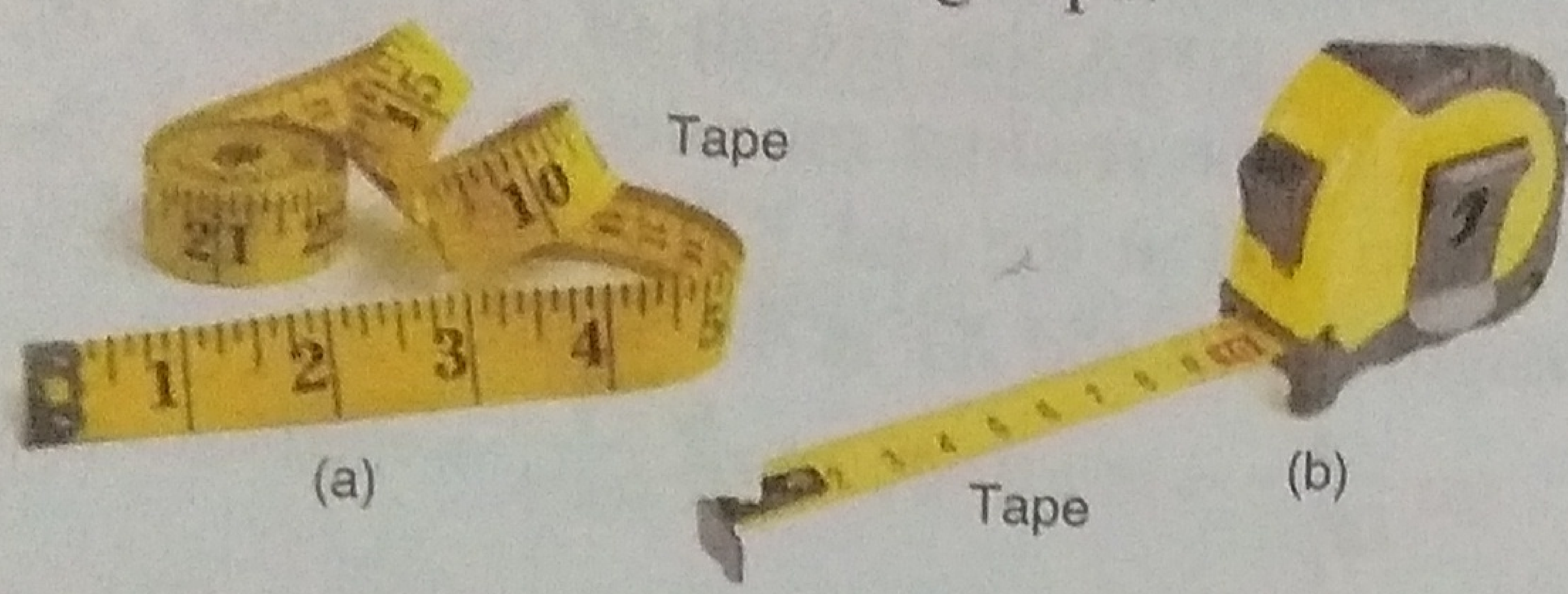

Fig. 2.4 Measuring tape

Measurement with a measuring tape : To measure the length of a curved line (or object) *AB*, the tape is spread along the length of the curved line as shown in Fig. 2.5. The ends of the line *A* and *B* are read on the tape. The difference of these readings gives the length of the curved line. In Fig. 2.5, the length of curved line *AB* is 8·2 cm – 5·0 cm = 3·2 cm.

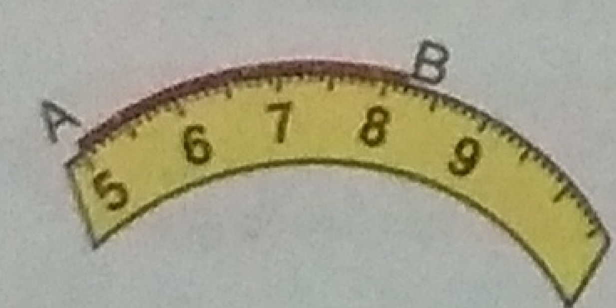

Fig. 2.5 Measuring the length of a curved line by a measuring tape

Fig. 2.6 Measuring the length of a trouser by a tailor using a measuring tape.

MEASUREMENT OF MASS

The mass of a body is the quantity of matter contained in it.

Unit of mass

The S.I. unit of mass is kilogram. In short form, it is written as kg.

In 1889, one kilogram was defined as the mass of a cylinder of platinum-iridium alloy kept at the International Bureau of Weights and Measures at Sevres near Paris.

However, at present, the mass of 1 litre (= 1000 ml) of water at 4°C is taken as 1 kilogram.

Multiple and submultiple units of mass

A bigger unit of mass is **quintal**.

One hundred kilogram make one quintal *i.e.* 1 quintal = 100 kg

A still bigger unit of mass is **metric tonne**.

Ten quintal make one metric tonne *i.e.*

1 metric tonne = 10 quintal = 1000 kg

The mass of a light body is expressed in a smaller unit of mass called **gram**. The short form of it is **'g'**.

One gram is the one-thousandth part of a kilogram or one thousand gram make one kilogram *i.e.*

$$1 \text{kg} = 1000 \text{ g} \quad \text{or} \quad 1 \text{ g} = \frac{1}{1000} \text{ kg}$$

A still smaller unit of mass is **milligram**. In short form it is written as mg.

One milligram is the one thousandth part of a gram or **one thousand milligram make one gram,** *i.e.*

$$1 \text{ g} = 1000 \text{ mg} \quad \text{or} \quad 1 \text{ mg} = \frac{1}{1000} \text{ g}$$

The table below gives the different multiple and submultiple units of mass.

Multiple and submultiple units of mass :

Multiples :

(1) *Quintal* : 1 quintal = 100 kg

(2) *metric tonne* :

1 metric tonne = 10 quintal = 1000 kg

Submultiples :

(1) *Gram* (symbol g)

$1\ g = \frac{1}{1000}\ kg = 10^{-3}\ kg$

(2) *Milligram* (symbol mg)

$1\ mg = \frac{1}{1000}\ g = 10^{-3}\ g = 10^{-6}\ kg$

In F.P.S. system, the unit of mass is pound (symbol 1b).

In C.G.S. system, the unit of mass is gram (symbol g).

Relationship between gram, kilogram and pound :

$$1\ g = \frac{1}{1000}\ kg = 10^{-3}\ kg$$

$$1\ lb = 453{\cdot}59\ g$$

Devices for measuring mass

For measuring the mass of a body, we generally use the following *two* balances :

1. The beam balance, and
2. The electronic balance.

1. Use of a beam balance to measure the mass of a body.

Fig. 2.7 shows the simple form of a beam balance, which is most commonly used. It consists of a straight beam of wood (or metal) of length about 50 cm. The beam has a support just at its middle, having a pointer. Two identical pans are suspended at the ends

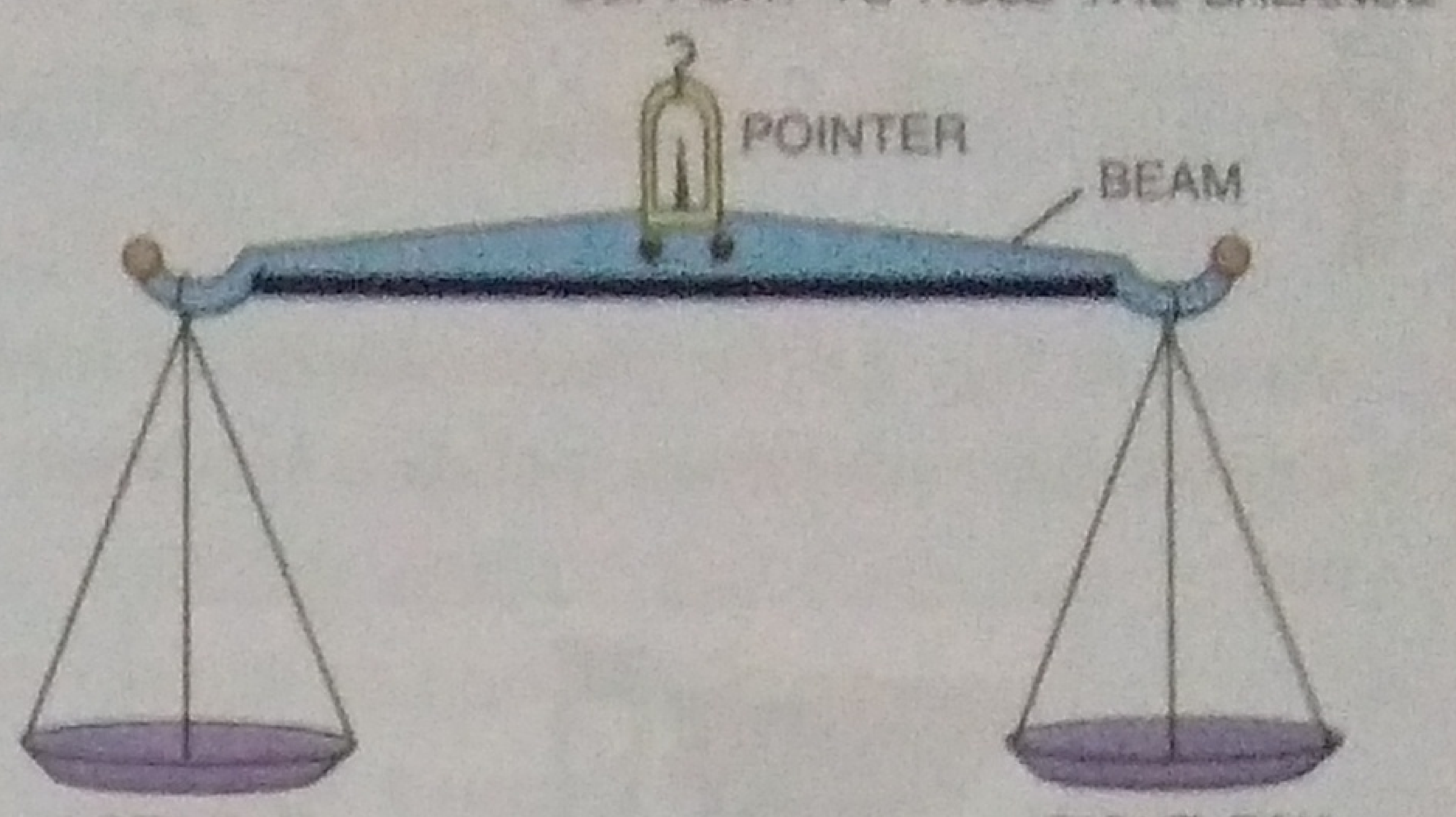

Fig. 2.7 A beam balance

of the beam by means of strings of equal length. Each pan is at the same horizontal distance from the support *i.e.* the length of beam of each pan from the support is equal. The balance can be held up by the support.

To measure the mass of an object, standard weights are used. Fig. 2.8 shows some standard weights 20 kg, 10 kg, 5 kg, 2 kg and 1 kg. However, smaller weights of 500 g, 200 g, 100 g, 50 g, 20 g, 10 g and 5 g are also available.

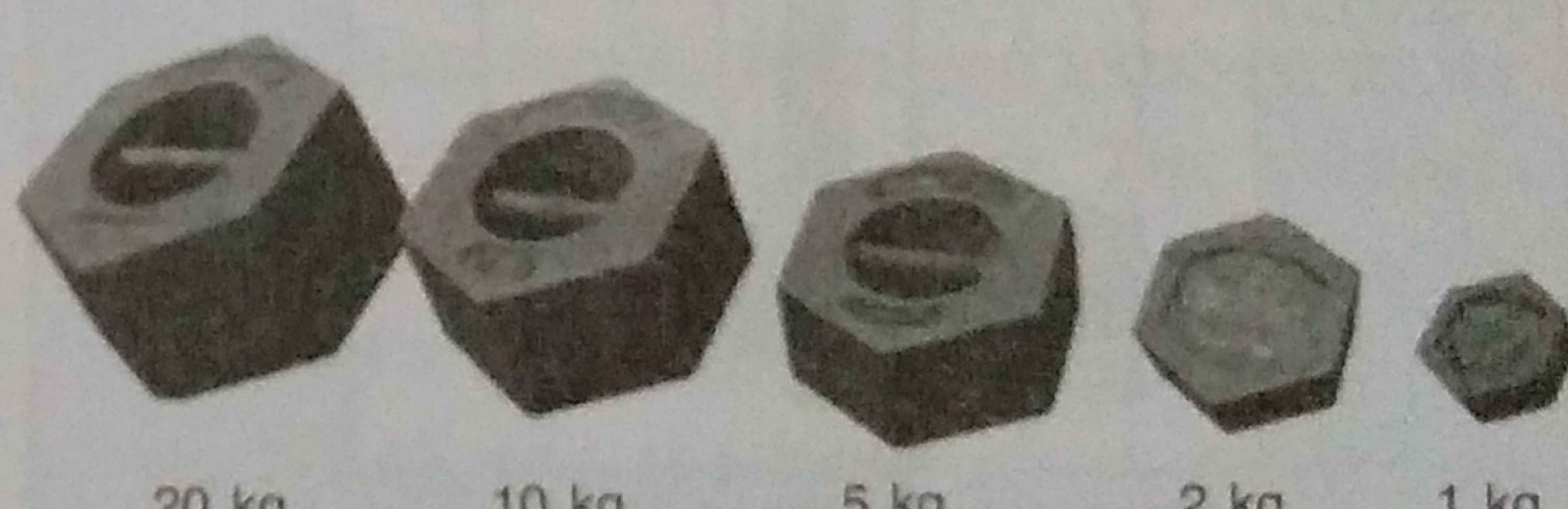

Fig. 2.8 Some standard weights used to measure mass

For measuring, the beam balance is first held up. On holding up the balance, it is ensured that when there is nothing on either pan, the beam is horizontal. The body whose mass is to be measured is placed on the left pan. The standard weights are placed on the right pan. They are so adjusted that the beam is again horizontal on holding the balance up. The total of the standard weights gives the mass of the given body.

Do You Know ?

Some shopkeepers use the grocer's balance shown in Fig. 2.9 for measurement of mass of objects like vegetables, pulses, rice, sugar, salt etc.

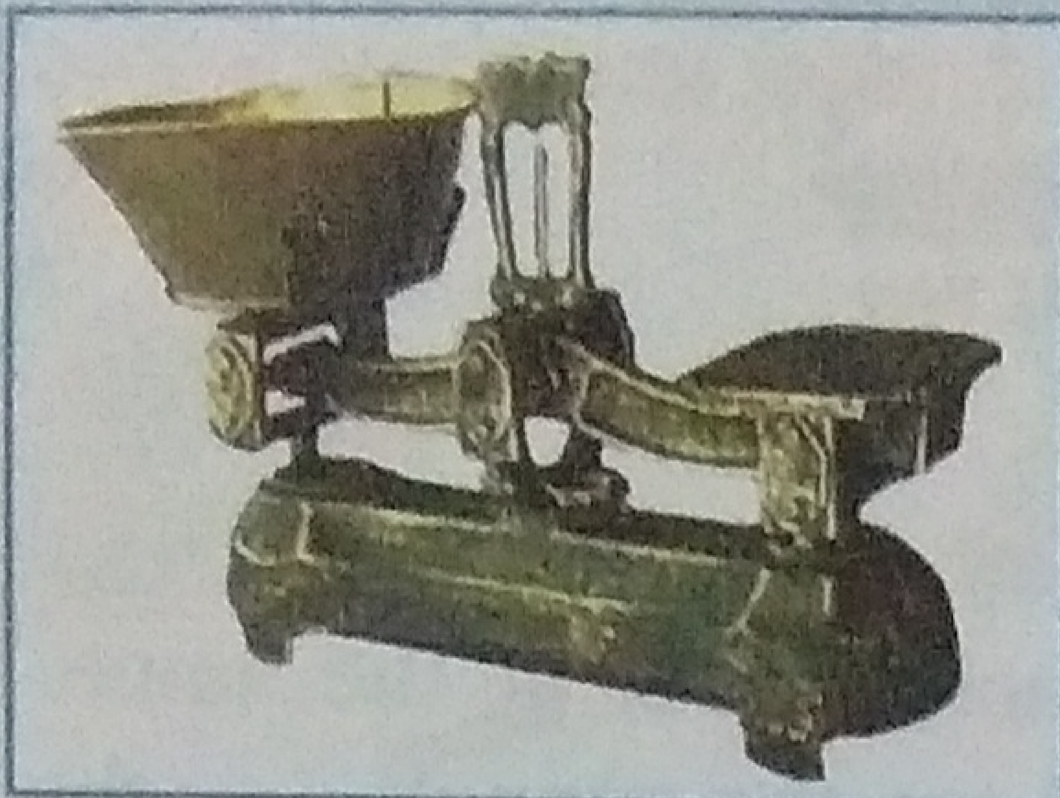

Fig. 2.9 Grocer's balance

A goldsmith requires an accurate and sensitive balance, so he uses a physical balance shown in Fig. 2.10. This balance is also used in the laboratory.

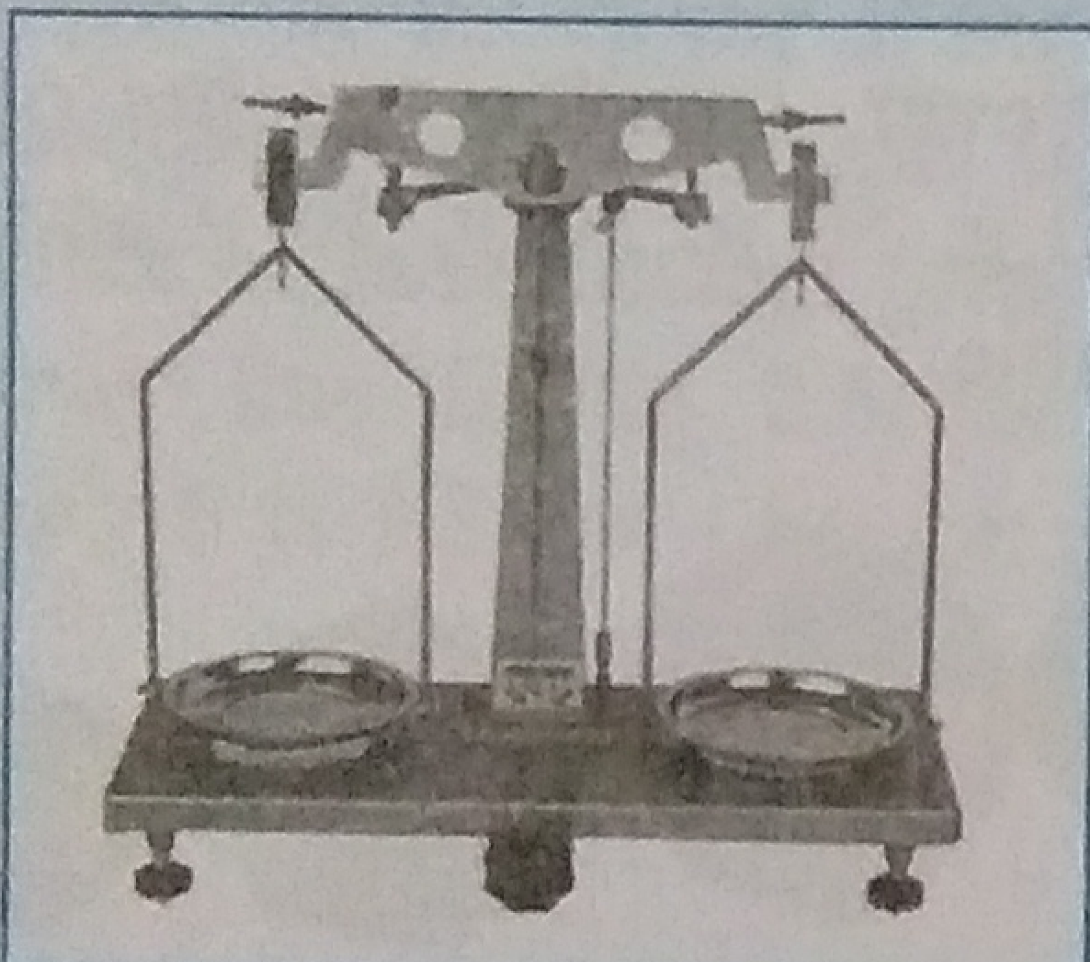

Fig. 2.10 A physical balance

2. Use of electronic balance to measure the mass of an object.

Nowadays, for the precise and accurate measurement of mass of an object, electronic balance is used. They are available to measure a small mass of 1 mg, as well as a large mass of the order of quintal. Small electronic balances are portable while big electronic balances are fixed at a place.

Fig. 2.11 shows a simple electronic balance.

An electronic balance has the following *three* parts :

1. **The structure** : It is the load bearing part which transfers the load of the object to the load cell.
2. **The load cell** : It converts the load (*i.e.* force) into electrical signals.
3. **The signal conditioner** : It is the electronic part which processes the electrical signal and displays the mass.

Fig. 2.11 Electronic balance

Electronic balances measure the mass automatically without any prior setting or using a separate weight box. They directly measure the mass of the object and display it in the digital form on the screen.

MEASUREMENT OF TIME

The interval between two instances or events is called time. We measure time in terms of the **mean solar day**. A solar day is the time taken by the earth to complete one rotation about its own axis. The mean of 365 solar days in a year is called the mean solar day.

Units of time

The S.I. unit of time is second. In short form, it is written by the letter **s**.

One second is defined as $\frac{1}{86400}$ part of a mean solar day. *i.e.*,

$$1 \text{ s} = \frac{1}{86400} \times \text{one mean solar day.}$$

Work-sheet

Q.1. What is parallax error ?
Q.2. How will you measure length of an object with a metre rule ?
Q.3. Describe a measuring tape.
Q.4. What is mass
Q.5 What is the S.I unit of mass?
Q.6. Two bigger units of mass are ____ and ____.
Q.7. 1 g = ______ mg.
Q.8. 1 Lb = ______ g.
Q.9. What is a beam balance.
Q.10. What are the parts of an electronic balance.

—x—

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