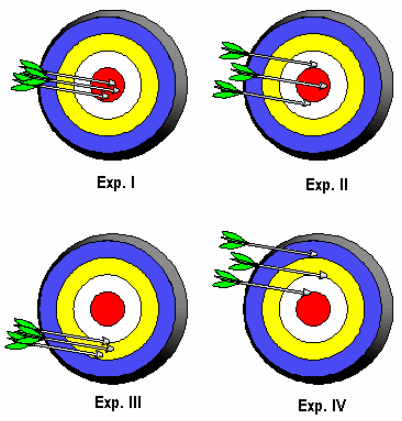
UNCERTAINTY WORKSHEET

1. In the diagram at right, 4 targets are shown.
If the goal is to hit the centre of the bulls-eye,

a) Which show a precise aim?

b) Which show an accurate aim?



2. a) Calculate the average and the uncertainty for each set of data:

	AVG	UNCERT.
SET A: 15.32, 15.37, 15.33, 15.38, 15.35		
SET B: 16.30, 16.19; 16.24 16.29, 16.23		

b) The "true" value that we were attempting to measure was: 16.26

Which set of data is most precise? _____ Which was most accurate? _____

3. In which of the following examples would the precision of a thermometer be more important than its accuracy?

a) Determining, the identity of an unknown compound by comparison of its measured melting point to a reference table

b) Measuring the temperature change when a chemical is added to water

4. In an experiment, you are measuring the mass of water by difference. You use 2 different balances to measure mass, and your data looks like this:

	Balance A	**Balance B**	**Avg. with uncertainty**
Empty Beaker	207.2 g	210.4 g	_____
Beaker + 50mL water	257.2 g	260.4 g	_____
50 mL water alone	_____	_____	_____

Complete the table. Do you think your main source of error is random or systematic? If you believe one of the balances is off, how would you determine which one? What happens to your uncertainty after you've done the calculations? WHY?

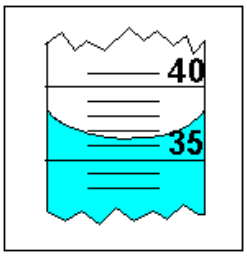
5. In an experiment, you are measuring the mass of water by difference. You use only one balance, but ask 2 friends to help you make measurements. Your data looks like this:

	You	Friend A	Friend B	Avg. with uncertainty
Empty Beaker	207.2 g	207.1 g	207.3 g	_____
Beaker + 50mL water	257.3 g	257.0 g	257.5 g	_____
50 mL water alone	_____	_____	_____	_____

Complete the table.
Might random error be present? What is causing it? If so, how would you correct for it?
Might systematic error be present? What is causing it? How would you find out?

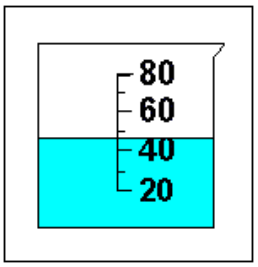
6. Use the following scales to measure the quantities required. Be sure to list the appropriate number of digits, as well as the uncertainty that goes along with each measurement

GRADUATED CYLINDER (mL):



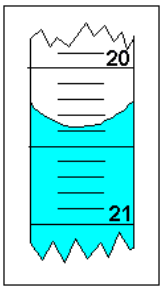
V = _____

BEAKER (mL):



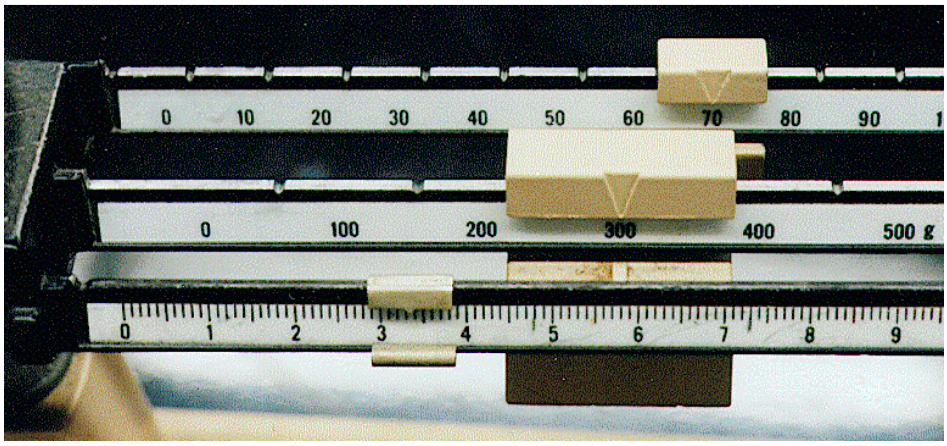
V = _____

BURET(mL):



V = _____

BALANCE (g):



M = _____

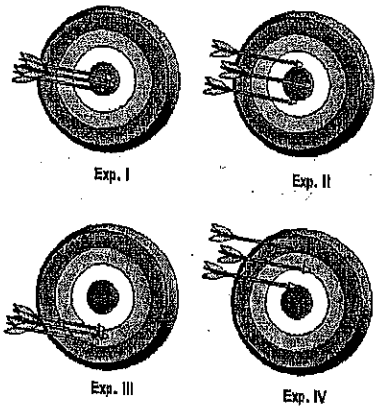
7- You need to measure the length of the table. You can use a metre stick or a 30-cm ruler. Both have the smallest division at 0.5 cm. Will one of the instruments give a greater uncertainty? Explain.

UNCERTAINTY WORKSHEET (KEY)

1. In the diagram at right, 4 targets are shown. If the goal is to hit the centre of the bulls-eye,

a) Which show a precise aim? I, III

b) Which show an accurate aim? I, II, (IV)



2. a) Calculate the average and the uncertainty for each set of data:

	AVG	UNCERT.
SET A: MIN 15.32, 15.37, 15.33, MAX 15.38, 15.35	15.35	± 0.03
SET B: MAX 16.30, 16.19; MIN 16.24 16.29, 16.23	16.25	± 0.06

$\frac{15.38-15.32}{2}$

$\frac{16.30-16.19}{2}$

b) The "true" value that we were attempting to measure was: 16.26

Which set of data is most precise? A Which was most accurate? B

3. In which of the following examples would the precision of a thermometer be more important than its accuracy?

B a) Determining, the identity of an unknown compound by comparison of its measured melting point to a reference table

(b) Measuring the temperature change when a chemical is added to water

4. In an experiment, you are measuring the mass of water by difference. You use 2 different balances to measure mass, and your data looks like this:

	Balance A	Balance B	Avg. with uncertainty
Empty Beaker	207.2 g	210.4 g	208.8 ± 1.6 g → 209 ± 2g
Beaker + 50mL water	257.2 g	260.4 g	258.8 ± 1.6 g → 259 ± 2g
50 mL water alone	50.0g	50.0g	50.0 ± 3.2 g → 50 ± 4g

Complete the table. Do you think your main source of error is random or (systematic)? If you believe one of the balances is off, how would you determine which one? What happens to your uncertainty after you've done the calculations? WHY?

measure with another scale (weigh something with known mass)

absolute uncertainties add

(uncertainty increases due to systematic errors)

5. In an experiment, you are measuring the mass of water by difference. You use only one balance, but ask 2 friends to help you make measurements. Your data looks like this:

	You	Friend A	Friend B	Avg. with uncertainty
Empty Beaker	207.2 g	207.1 g	207.3 g	207.2 ± 0.1 g (if round to nearest even (±0.3 would be better)
Beaker + 50mL water	257.3 g	257.0 g	257.5 g	257.3 ± 0.2 g
50 mL water alone	50.1 g	49.9 g	50.2 g	50.1 ± 0.3 g

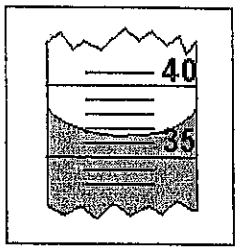
Complete the table.

Might random error be present? What is causing it? If so, how would you correct for it? unpredictable fluctuations, experimenter error, estimate last digit, repeated measurements

Might systematic error be present? What is causing it? How would you find out? poor calibration (not zeroed), compare with different scale (mass of known objects)

6. Use the following scales to measure the quantities required. Be sure to list the appropriate number of digits, as well as the uncertainty that goes along with each measurement

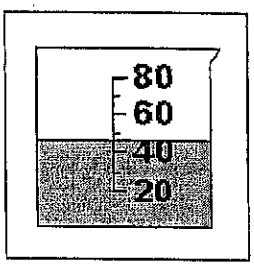
GRADUATED CYLINDER (mL):



± 0.5

V= 36.5 mL

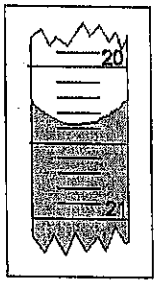
BEAKER (mL):



± 5

V= 48 mL

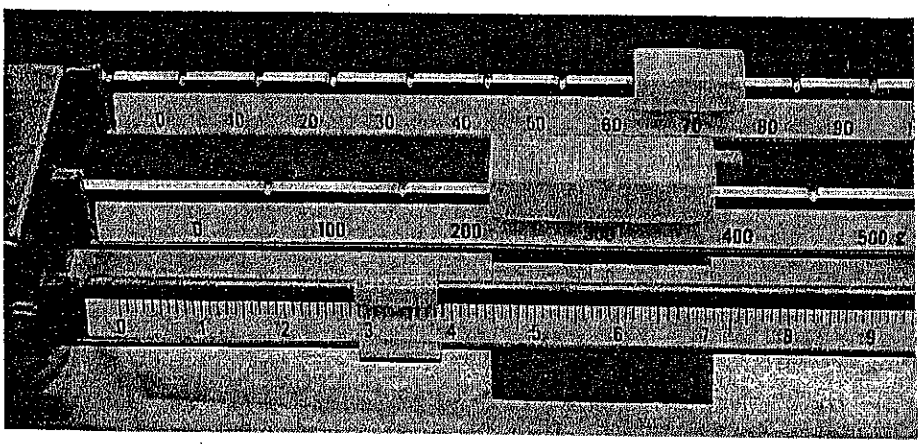
BURET(mL):



± 0.05

V= 23.34mL

BALANCE (g):



M= 373.31 g

± 0.01

7- You need to measure the length of the table. You can use a metre stick or a 30-cm ruler. Both have the smallest division at 0.5 cm. Will one of the instruments give a greater uncertainty? Explain. cm markings

30cm ruler assuming table is longer than ruler, in which absolute uncertainties would be added