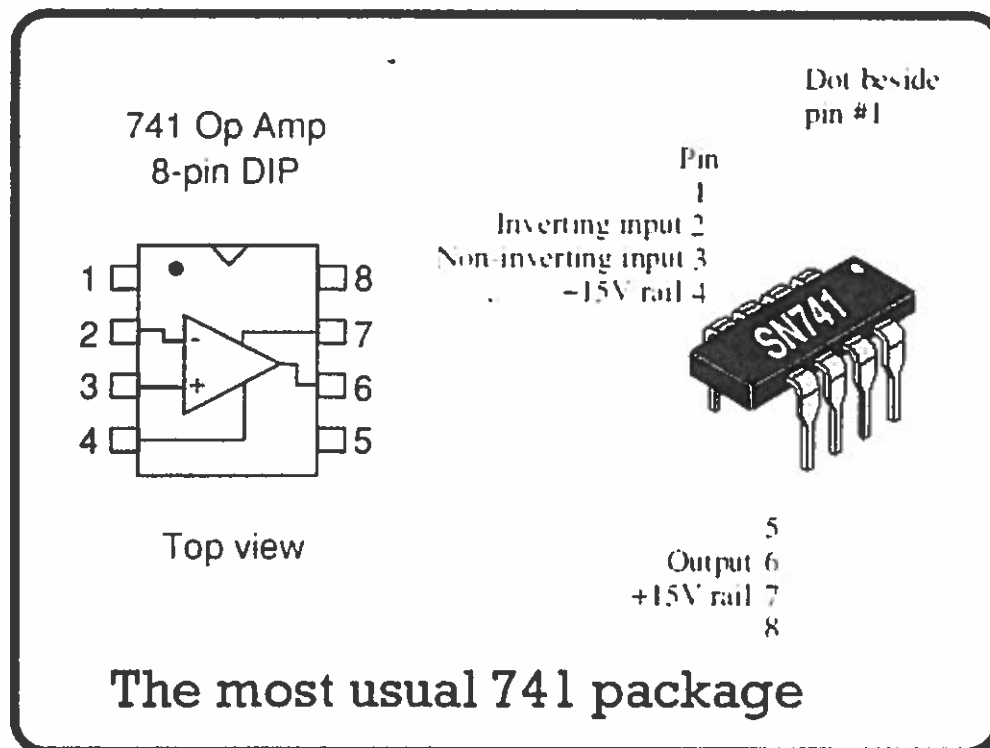


## Experiment 5 — The Op Amp & IC Amplifier

Although transistor amplifiers made with 'discrete' components (i.e. individually packaged) are still used for some special purposes like high-quality 'Hi-Fi', most modern signal processing systems use Integrated Circuits (ICs). The one of the oldest, most commonly used – and cheapest! – IC *Operational Amplifiers* is the SN741. This experiment uses a 741 as a simple audio-frequency amplifier.

741 Op Amps come in a variety of packages. One of the most common is an 8-pin Dual-In-Line (DIL) or Dual In-line Plastic (DIP) package of the kind shown below

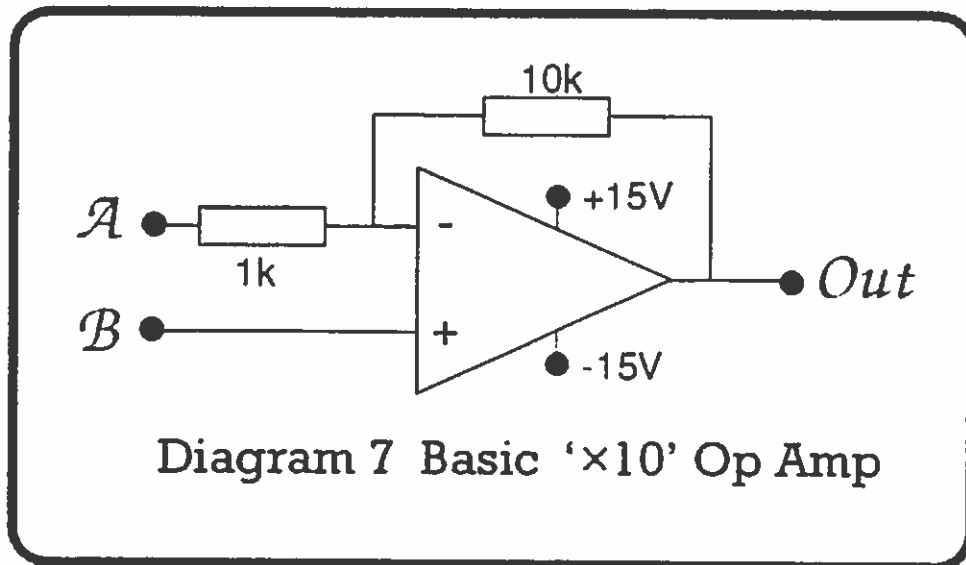


The 741 has *two* signal inputs – called 'inverting' and 'non-inverting'. It also must be powered using two voltage lines that provide  $\pm 15\text{V}$ .

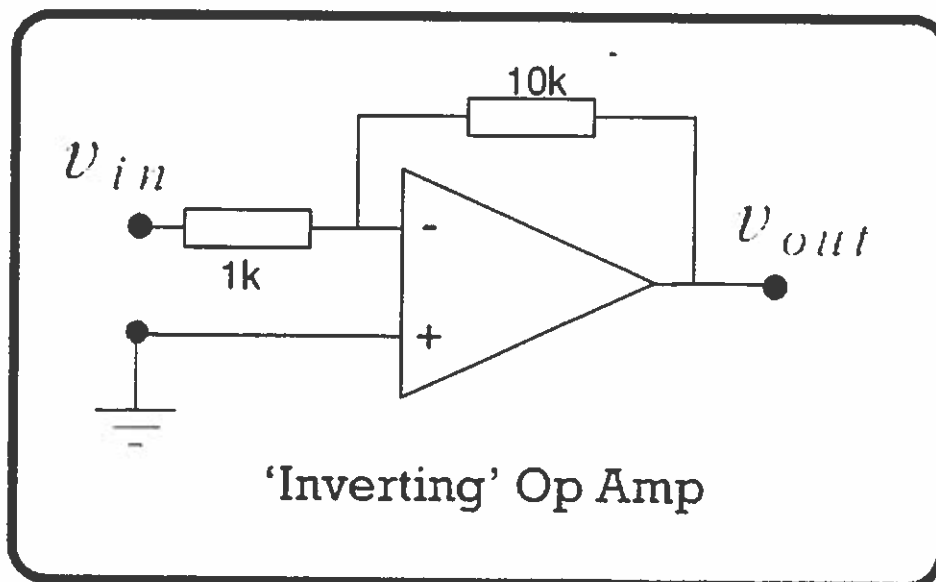


For this experiment, build the circuit shown in figure 7. As with earlier circuits, make your circuit look similar to the one in the photographs. Click on the picture of a camera if you want to see the photos.

Remember to label your circuit and hand it in with your results. You should be able to work out which pin to connect to what by comparing this diagram with those for the 741's package and the wires shown in the photos. If not sure, ask a demonstrator.



The circuit shown in diagram 7 can be used as either an 'inverting' or a 'non-inverting' voltage amplifier depending on how you apply an input signal. This is because the Op Amp has the property that its output depends on the *difference* in the voltages applied to the *pair* of pins, 2 & 3. First, use it as an inverting amplifier by connecting it as shown below.



The earth symbol shows where we connect 0V (earth) from the power supply. We also connect the earth leads (outer wires of the co-axial cables) to this point. The live input lead is connected to the inverting input resistor (shown as 'A' in figure 7).



Measure the voltage gain,  $v_{out} / v_{in}$ , of the inverting Op Amp, using sinewaves at 10Hz, 1kHz, 10kHz, and 100kHz. What value does this gain have at most frequencies?

Remember to check and see if the output is inverted, if so the gain value should be *negative*. Also, as usual when making gain measurements, make sure the output isn't distorted – clipped or bent in any way. If it seems distorted, reduce the amplitude of the signal until the output looks like a sinewave.

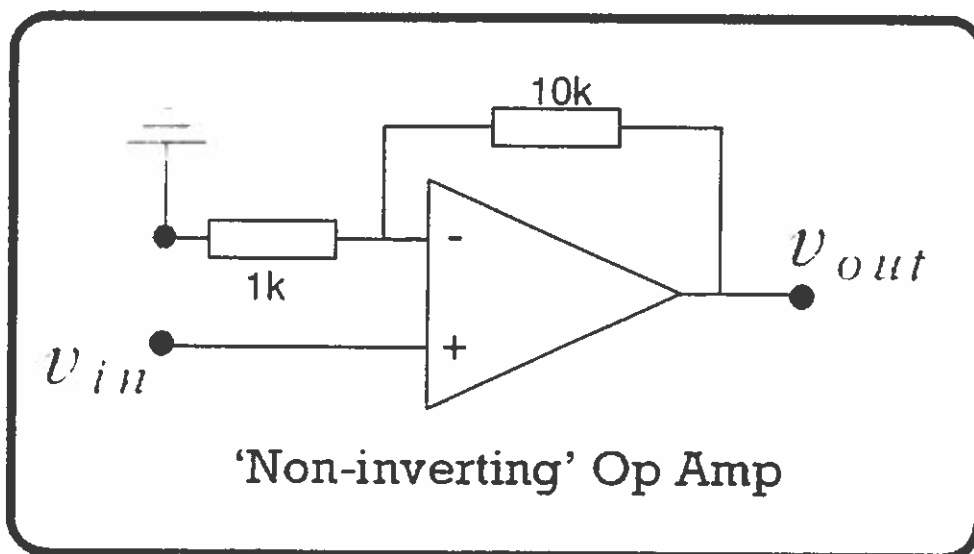


You should find that the gain is fairly uniform at low frequencies, but tends to fall away at high frequencies. At what frequency does the gain fall to 70% of its low-frequency value?



What is the peak to peak voltage of the largest output the amplifier can produce at low frequency (e.g. 300 Hz)? Say why you think the output is limited to the value.

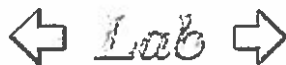
Now change the connections to your Op-Amp so that the 'live' input and the earth connections have been swapped over. Your circuit should now be a non-inverting amplifier as shown below. Repeat the same gain measurements as before and note your results.



You should find that both the sign and the value of the gain of the two types of amplifier differ. Say why you think this is the case. (If unsure, ask a demonstrator.)



Say what change you would make to the circuit you have built if you wanted to increase the voltage gain of the inverting amplifier to  $-22$ .



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