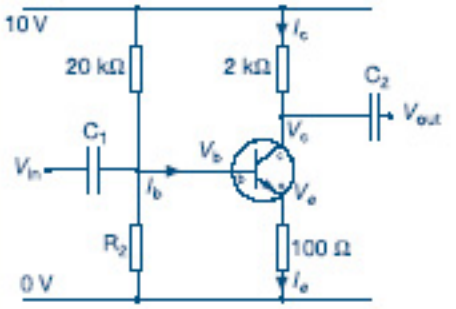
For questions 28 – 31. The circuit below is to be used as a voltage amplifier for a small AC signal. In the no-signal situation V_c is to be 5 V. For a silicon transistor the base-emitter voltage is to be close to 0.7 V for correct bias.



28 For the no-signal situation

- **a** What is the value of Ic the collector current?
- **b** Assuming the transistor has a high current gain (so that I_b is very small compared to Ic) what will be the value of Ve the emitter voltage?
- **c** What is the required value of V_b so that the transistor is correctly biased?
- **d** Determine the required value of R_2.
- **e** What is the current flowing through the $R_1 - R_2$ voltage divider?
- **f** If the current gain of this transistor is 200, what is the value of the base current I_b? Will this affect the value of V_b as calculated above?

29 An AC signal of 4 mV peak-peak (that is from +2 mV to -2mV amplitude) is now fed into the input V_{in}

- **a** If this signal was not fed through the capacitor C_1 but directly to the base of the transistor, what problems could occur with the biasing of the transistor?
- **b** What is the function of capacitor C_1? Describe the voltage at the base of the transistor when the signal is fed through C_1.
- **c** It is found that a decrease in base voltage of 2 mV leads to a change in the collector current Ic of 2μA. Will this be an increase or a decrease of 2μA? How will the output voltage be affected?
- **d** What is the voltage gain of the amplifier? Is this an inverting or non-inverting amplifier?
- **e** One of the 'rules of thumb' of amplifier design says that the voltage gain is approximately equal to the ratio of Rc to Re. Is that rule 'obeyed' in this example?

30 If the input signal to an amplifier of this type is too large the output signal becomes distorted.

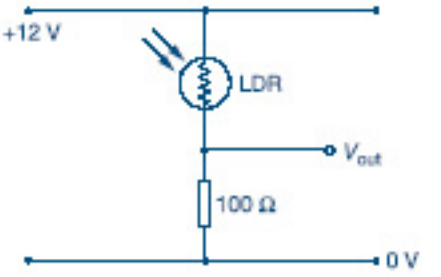
- **a** For an amplifier with a voltage gain of -20, what would be the approximate value of the largest peak-peak signal voltage that could be amplified without distortion?
- **b** Describe the distortion that would result from a signal amplitude that was too large.

31 (Challenge question!)

In amplifier circuits such as this, the emitter resistor (100Ω in this case) is not always used.

- **a** In the circuit above, an increase of 2 mV in the base voltage led to an increase of 2 μA in the collector (and emitter) current and hence a decrease in V_{out}. What change in the emitter voltage V_e will this lead to?
- **b** Qualitatively, what effect will this small change have on the base-emitter voltage of the transistor?
- **c** And so what will be the consequent effect on the collector current IC and hence the output voltage V_{out}? (In qualitative terms only.)
- **d** So what is the effect of using an emitter resistor and what difference would you find in a similar amplifier circuit without an emitter resistor?

32 In the simple LDR light detector circuit shown, V_{out} is to be used to activate an alarm when the ambient light reaches a certain level. At this particular light level the resistance of the LDR is 200Ω. The alarm activates whenever V_{out} is above the trigger level.



- **a** What is the value of V_{out} at which the alarm should activate?
- **b** Will the alarm activate when the light is above or below the particular level of concern? Explain your answer.
- **c** When it is very dark, what would you expect V_{out} to become?

33 The graph shows the characteristics of a LED which is to be used in the circuit shown. For optimum life and light efficiency the current through the LED should be 40 mA. At higher currents the LED will be brighter, but its life is shortened and it will burn out rapidly if the current exceeds 90 mA.