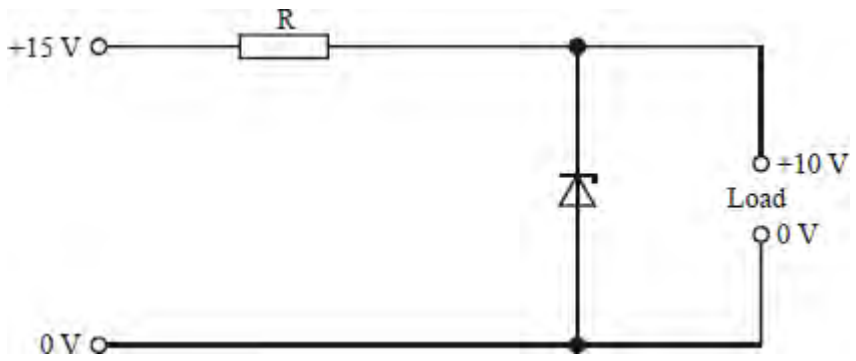
Q1. The diagram below shows a zener diode used to produce a stabilised output of 10 V from a nominal 15 V supply.



The maximum output current supplied to the load is 100 mA. The zener diode must have a minimum current of 10 mA passing through it to maintain its voltage.

(a) Calculate the ideal value of the resistor R.

.....

.....

(2)

(b) Calculate the power dissipated by R under these conditions.

.....

.....

(2)

(c) State, giving a reason, the best value resistor to use from the E24 range.

.....

.....

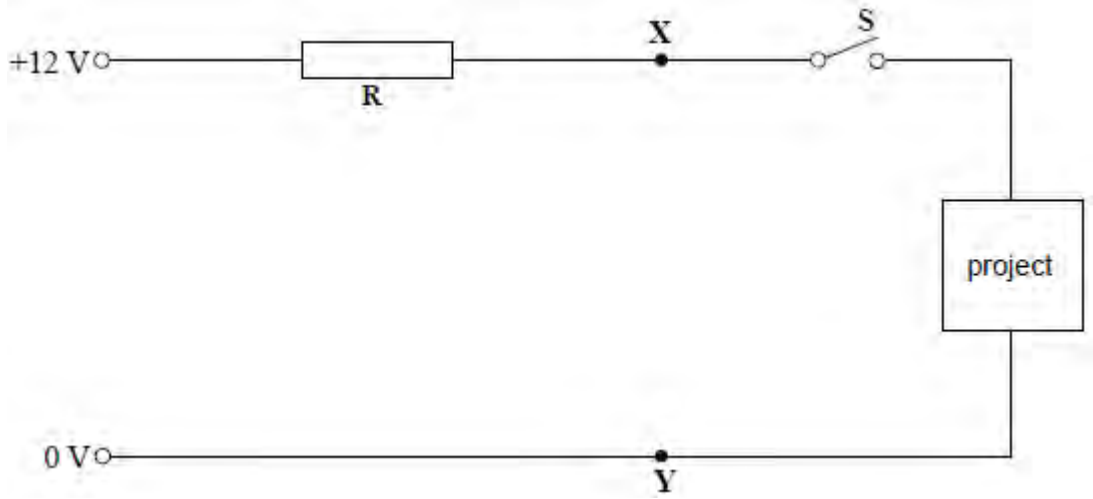
.....

.....

(2)

(Total 6 marks)

Q2. A Zener diode is used to produce a stabilized 5.1 V from an unregulated 12 V supply to power a project that requires 80 mA.
Part of the circuit is shown in the diagram.



(a) Draw on the diagram the Zener diode connected correctly between points **X** and **Y**.

(2)

(b) The Zener diode requires at least 5 mA to maintain its Zener voltage of 5.1 V.

(i) Calculate the minimum current flowing through **R** when switch **S** is closed.

.....

(1)

(ii) Calculate the voltage across resistor **R** under these conditions.

.....

.....

(1)

(iii) Calculate the value of resistor **R**.

.....

.....

.....

(2)

(c) The circuit in the diagram above is now constructed using a value of 75 Ω for resistor **R**.

(i) Show that the power dissipated in the resistor is approximately 0.6 W.

.....

.....

.....

(2)

(ii) The project is disconnected by turning switch **S** off, but the 12 V supply remains connected.

Calculate the current that now flows through the Zener diode.

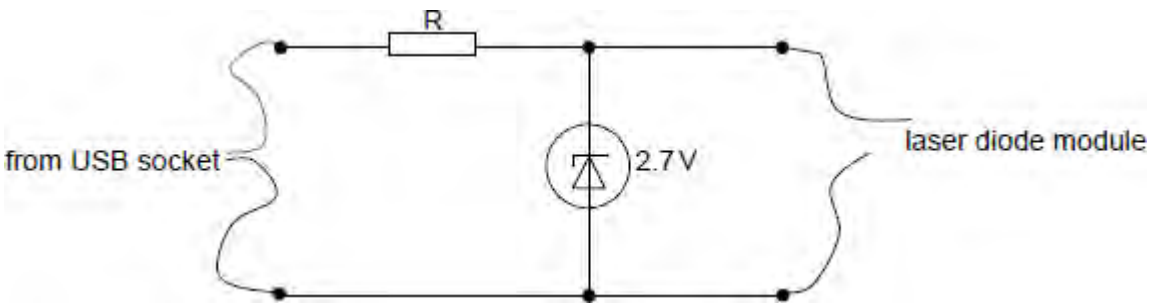
.....

.....

.....

(2)
(Total 10 marks)

Q3. The circuit shown below uses a 2.7 V Zener diode to convert the voltage supply from a USB socket on a PC to power a laser diode module.



Specifications for the laser diode module and the USB output are:

Laser diode module current: 88 mA
USB socket supply output: 4.40 V - 5.25 V

(a) If the voltage from the USB socket is 4.40 V, the current through the Zener diode is 10 mA and the laser diode module is connected, calculate the required value of series resistor, R.

.....

.....

.....

.....

(4)

(b) State what the Zener diode current will be if the laser diode module is now disconnected from the circuit.

.....

(1)

(c) Zener diodes are available with ratings of $\frac{1}{8}$W, $\frac{1}{4}$W and $\frac{1}{2}$W. Using a calculation determine which one should be used.

.....

.....

.....

(3)

(d) Explain, without using calculations, what will happen in the circuit if the USB socket voltage rises to its maximum of 5.25 V.

.....

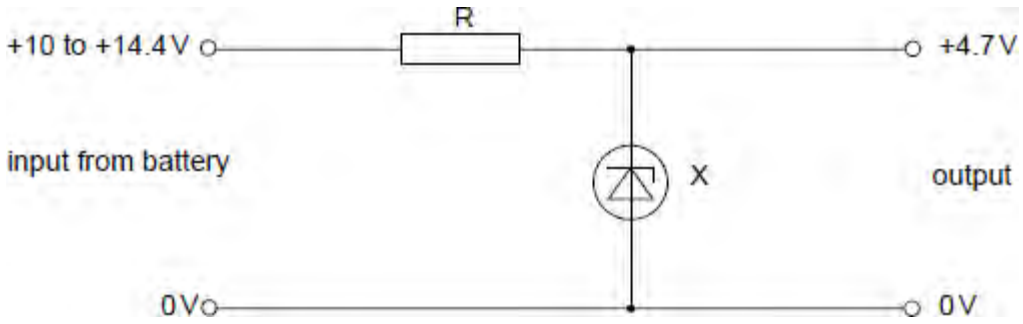
.....

.....

(3)
(Total 11 marks)

Q4.A stable power supply voltage of 4.7 V at a maximum current of 100 mA is needed to power

an MP3 player in a car.
The problem is that the car battery voltage can vary from as low as 10 V when the car is started on a cold day, up to 14.4 V when it is charging as the engine is running. The circuit below is designed to produce a constant 4.7 V output.



(a) (i) What is component X?

.....

(1)

(ii) What voltage rating should be chosen for X?

.....

(1)

(iii) In which bias direction is component X placed?

.....

(1)

(b) The minimum current through component X is 5 mA. The maximum output current from this circuit is 100 mA.
R must be calculated when the value of the input voltage is at its lowest.

Calculate

(i) the total current flow through R under these conditions

.....

(1)

(ii) the voltage across R when the input voltage is at its lowest

.....

(1)

(iii) the required value of R.

.....

(2)

(iv) Which preferred value should be chosen for R if the minimum current through X is not to fall below 5 mA?

.....

(1)

(c) The preferred value of resistor determined in part (b)(iv) is not available, but a 33 Ω resistor is used. With the circuit powered up, and the engine running, the MP3 player is disconnected. Component X is then found to be hot.

(i) Calculate the current through component X.

.....

.....

(2)

(ii) Calculate the power dissipated by component X.

.....

.....

(1)

(Total 11 marks)