Stage 1 Physics
Skills and Applications Task 2 A
Complete the two attached tasks – one about resistance in circuits the other about the functioning of diodes – during class time in weeks 9 and 10. Submit on paper (preferably not ripped from a book – see me if you require pad paper), with your name on each page, graphs on graph paper and clearly reference any other sources of information you might have used (yes, I count as a source, so do the videos on edmodo).

		A	B	C	D	E
Investigation	Obtaining, Recording and displaying Tables, graphs.	Obtains, records, and displays findings of investigations, using appropriate conventions and formats accurately and highly effectively	Obtains, records, and displays findings of investigations, using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and displays findings of investigations, using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and displays findings of investigations, using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and display some descriptive information about an investigation, with limited accuracy or effectiveness.
Analysis and Evaluation	Analyse data, make conclusion Q2,3,4 Diodes	Systematically analyses data and their connections with concepts, to formulate logical and perceptive conclusions and make relevant predictions.	Logically analyses data and their connections with concepts, to formulate consistent conclusions and mostly relevant predictions.	Analyses data and their connections with concepts, to formulate generally appropriate conclusions and make simple predictions, with some relevance.	Describes basic connections between some data and concepts, and attempts to formulate a conclusion and make a simple prediction that may be relevant.	Attempts to connect data with concepts, formulate a conclusion, and make a prediction.
Application	Applying concepts Series,parallel, current voltage resistance	Applies physics concepts and evidence from investigations to suggest solutions to complex problems in new and familiar contexts.	Applies physics concepts and evidence from investigations to suggest solutions to problems in new and familiar contexts.	Applies physics concepts and evidence from investigations to suggest some solutions to basic problems in new or familiar contexts.	Applies some evidence to describe some basic problems and identify one or more simple solutions, in familiar contexts.	Identifies a basic problem and attempts to identify a solution in a familiar context.
	Using terms and conventions Across whole	Uses appropriate physics terms, conventions, formulae, and equations highly effectively.	Uses appropriate physics terms, conventions, formulae, and equations effectively.	Uses generally appropriate physics terms, conventions, formulae, and equations, with some general effectiveness.	Attempts to use some physics terms, conventions, formulae, and equations that may be appropriate.	Uses some physics terms or formulae.
	Work skills Use of class time,	Demonstrates **initiative** in applying constructive and focused individual and collaborative work skills.	Applies mostly constructive and focused individual and collaborative work skills.	Applies generally constructive individual and collaborative work skills.	Attempts individual work inconsistently, and contributes superficially to aspects of collaborative work.	Shows emerging skills in individual and collaborative work.
Knowledge and Understa	Demonstrating knowledge and understanding Across whole	Consistently demonstrates a deep and broad knowledge and understanding of a range of physics concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts.	Demonstrates knowledge and understanding of a general range of physics concepts.	Demonstrates some basic knowledge and partial understanding of physics concepts.	Demonstrates some limited recognition and awareness of physics concepts.

Stage 1 Physics
Skills and Applications Task 2 A

Series and parallel circuits

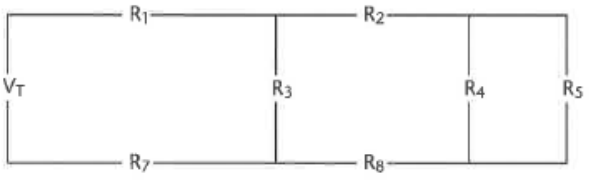
Usually circuits are a combination of series and parallel parts. To find out the characteristics of the components, the circuit has to be dealt with in sections or strings. The basic rules for parallel circuits are followed in those sections so:

P.D. = P.D.1 = P.D.2 = P.D.3 $\qquad$ I = I1 + I2 + I3 $\qquad$ $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$

Similarly, the rules for series circuits are followed in those sections where:

P.D. = P.D.1 + P.D.2 + P.D.3 $\qquad$ I = I1 = I2 = I3 $\qquad$ R = R1 + R2 + R3

Ohm's law ($V = IR$) is used to find potential difference (P.D.) and current for each component and the circuit. The first step is to simplify the parallel sections so that the circuit becomes a series of resistances, then combine these resistances to find the total resistance of the circuit (R_T). The electro motive force (emf) of supply (V_T) is usually known so the total current (I_T) can be found. The resistances in the circuit below are simply numbered against values in the table with other characteristics to be built up as the exercise proceeds.



	R1	R2	R3	R4	R5	R6	R7	T
R	50	8	20	16	16	4	60	
I								
V								240
P								

where R = resistance (ohms),
I = current (amps),
V = P.D. or e.m.f. (volts),
P = power (watts).

1 Draw the circuit and put in the resistance values. Now simplify the parallel section for R4 and R5 and call the new resistance R9.

2 Draw the new simplified circuit. There is now a series section involving resistances R2, R9 and R6. Calculate the resistance (R17) of this section.

3 The circuit you now draw should have R3 and R17 in parallel. Simplify these two resistances and call the resulting value R20.

4 This is the final circuit with R1, R20 and R7 in series. Find the total resistance (R_T) and the total current (I_T) for the final column of the table.
Work from the last diagram to the first, putting in the currents for each section and then each resistance, before filling in the current row in the table.

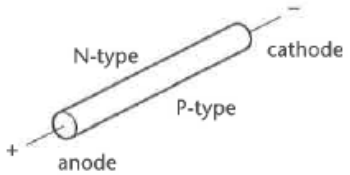
6 Find the P.D. of each component and put the values in the table.

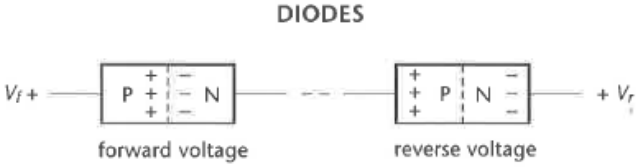
7 Calculate the power for each resistance and the circuit using $P = IV$.

Diodes

Diodes are **semiconductors**, which means they conduct under certain conditions. There is a great variety of uses for diodes, including light-dependent switches, signal lights, logic gates, voltage regulators and as a safety device to prevent polarity being reversed in a circuit. The last example suggests that a diode will permit a current to flow one way but not another, and this is indeed so.

The diode is made of two materials — a **P-type** (positive) and an **N-type** (negative). One combination is silicon doped with boron which produces P-type, while silicon doped with phosphorus results in N-type. When a voltage is applied through the diode in a forward direction with sufficient strength, the electrical barrier between the P and N substances will be overcome and the current is free to flow around the circuit. If a voltage moving in the reverse direction is introduced to the diode, no current will flow across the barrier until either a very high voltage is reached or the diode is destroyed. This is because the positive forward voltage opposes the positive charge of the P-type and repels it towards the barrier where it meets the negative charge of the N-type. This has, in turn, been repelled from the negative voltage at the cathode of the diode. When the voltage is reversed, the P-type is attracted to the negative charge and the N-type to the positive charge, moving each away from the barrier and reducing the ability of the diode to transmit a current. The figures below illustrate these ideas.





The information in the table links a foward voltage to the forward current arising in a silicon power diode. The current rises at an ever increasing rate until the forward voltage neutralises the barrier voltage at a mean value of 0.6V. This is sufficient to turn the diode on, permitting free flow of electricity around the circuit the diode is in. When the reverse voltage is applied, only a minute current is generated, until a high voltage is applied and the electrical barrier of the diode is suddenly overcome.

V_f	0	0.5	0.55	0.6	0.65	0.7	0.8	0.9
I_f	0	0	12	30	56	100	230	360
V_r	0	2.5	5	10	15	20	22.5	25
I_r	0	0.8	1	1.1	1.2	1.4	1.6	2.4

where V_f = forward voltage, I_f = forward current in milliamps (mA), V_r = reverse voltage and I_r = reverse current in microamps (μA).

1 Construct a combination graph showing the following features.

- **a** Place the zero position in the middle of the page so that each axis bisects the other.
- **b** Divide the upper *y*-axis and mark it for the forward current.
- **c** Divide the right hand *x*-axis and mark it for the forward voltage.
- **d** Using the information in the table, draw a line of best fit for the coordinates of the forward voltage and current in the upper right quadrant of the graph.
- **e** Divide and mark the left hand *x*-axis for the reverse voltage.
- **f** Divide and mark the lower *y*-axis for the reverse current.
- **g** Using the information in the table, draw a line of best fit for the coordinates of the reverse voltage and current in the lower left quadrant of the graph.

2 At what forward voltage do you think the diode is fully turned on, that is, when does the curve become a straight line?

3 Would this diode provide protection against reverse polarity in a circuit powered with a 9V battery? Give reasons for your answer.

4 As temperature rises above 25°C, the voltage needed to turn on the diode rises by 2.5 mV per degree centigrade. What voltage above 0.6 V will be needed if the temperature is 156°C?