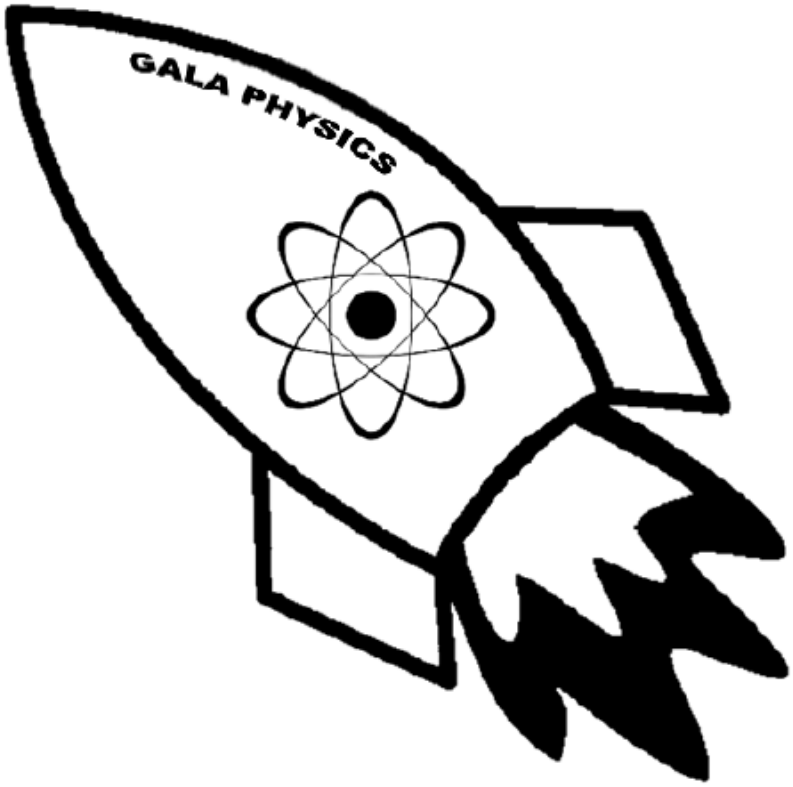
Galashiels Academy

# National 4 Physics




## Electricity & Energy
## Consolidation and Revision Questions

| | |
|---|---|
| **Name:** | **Class:** |

**Electricity and Energy Questions**

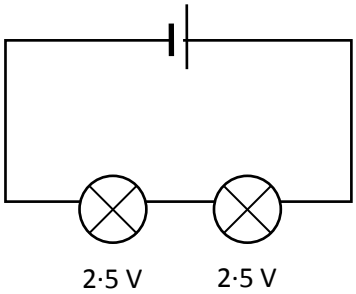
1. **Series Circuits**
2. **Parallel Circuits**
3. **Mixed Circuits**
4. **Energy Transformation and Power**
5. **Electromagnetism**
6. **Renewable and non-renewable energy**
7. **Transformers**
8. **Transmission of Electricity**
9. **Efficiency**
10. **Kinetic theory**
11. **Electronic Systems**
12. **Output Devices**
13. **Input Devices**
14. **Analogue and Digital Signals**
15. **Logic Gates**

**Exercise 1: Series Circuits**

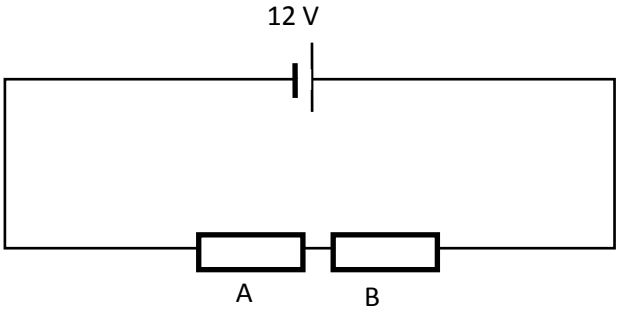
1. What is the rule about current in a series circuit?

2. What is the rule about voltage in a series circuit?

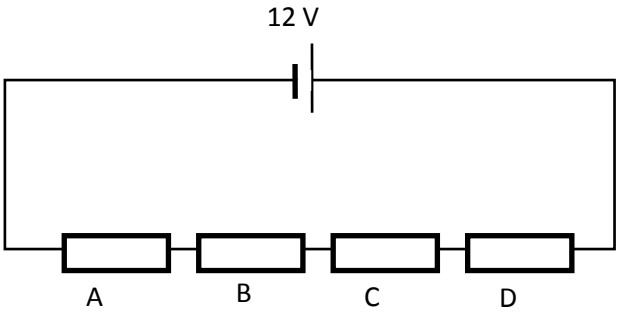
3. Two identical 2.5 V bulbs are connected to a supply as shown. What is the voltage of the supply?



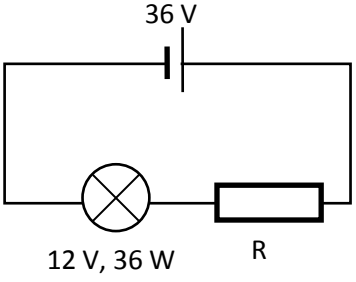

4. Two identical resistors are connected across a 12 V supply as shown in the diagram. What is the voltage across each of the resistors?




5. Four identical resistors are connected across a 12 V supply as shown in the diagram. What is the voltage across each of the resistors?

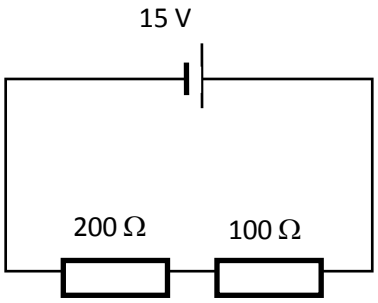



6. A simple circuit with a bulb and resistor in series is shown below.




   (a) If the bulb is operating at its correct voltage and power rating what is the voltage across the resistor R?
   (b) If the current in the bulb is 3 A. What current flows in the resistor?

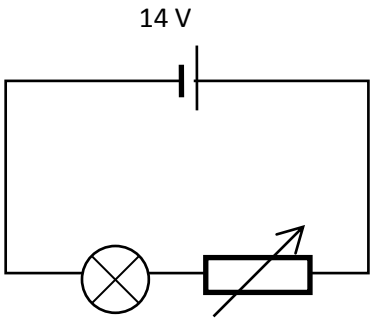
7. Two resistors are connected in series to a supply as shown in the diagram.




(a) The current in the 200 Ω resistor is 0·05 A. What is the current in the other resistor?

(b) The voltage across the 100 Ω resistor is 5 V. What is the voltage across the 200 Ω resistor?

8. A variable resistor (also known as a rheostat) is used as a dimmer switch in a simple series circuit as shown.

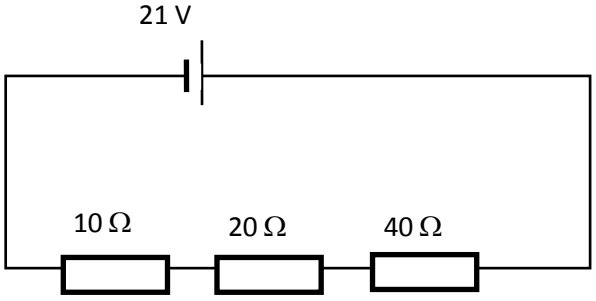



The variable resistor is adjusted until the bulb is shining brightly. The voltage across the bulb is 13·8 V and the current through the variable resistor at this setting is 1·7 A.

(a) Calculate the voltage across the variable resistor.

(b) What is the current flowing in the bulb?

9. Two resistors are connected in series to a supply as shown in the diagram.




(a) The current in the 10 Ω resistor is 0·3 A. What is the current in the 40 Ω resistor?

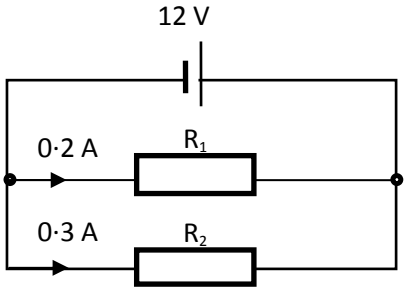
(b) The voltage across the 10 Ω resistor is 3 V and voltage across the 20 Ω resistor is 6V What is the voltage across the 40 Ω resistor?

**Exercise 2: Parallel Circuits**

1. What is the rule about current in a parallel circuit?

2. What is the rule about voltage in a parallel circuit?

3. Two resistors are connected in parallel to a 12 V battery.

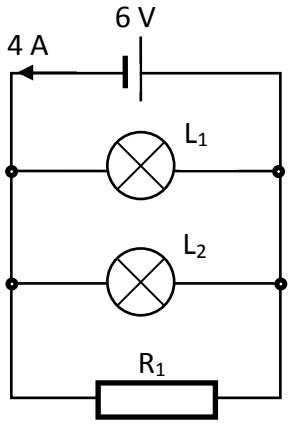



   (a) What is the voltage across $R_1$?

   (b) What is the voltage across $R_2$?

   (c) What size of current is drawn from the battery?

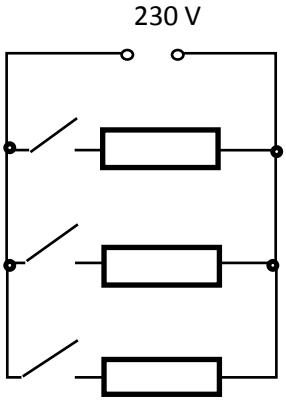
4. Two identical bulbs and a resistor are connected in parallel to a 6 V supply.




   (a) What is the voltage across $L_2$?

   (b) A current of 1·8 A flows through each of the bulbs. What is the current flowing through the resistor?

5. An electric fire has three elements which can be switched on and off independently. The elements are connected in parallel to the mains supply. Each element draws a current of 0·3A when switched on.

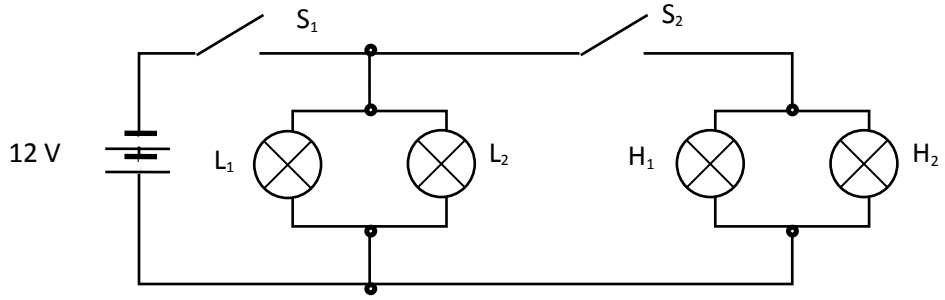



   (a) What is the voltage across the middle element?

   (b) What is the total current flowing from the supply when two of the elements are switched on?

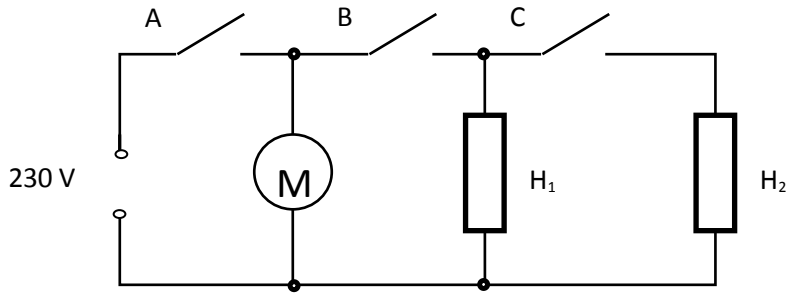
   (c) What is the maximum current drawn from the mains by the fire?

6. The headlamps and side lights in a car are connected in parallel. The diagram below shows how they are connected. The side lights ($L_1$ & $L_2$) may be switched on by themselves using switch $S_1$. The headlights ($H_1$ & $H_2$) are switched on by switch $S_2$ and only come on if the sidelights are already on.




(a) What is the voltage across the sidelight $L_1$?
(b) What is the voltage across the headlight $H_2$?
(c) Each sidelight draws a current of 3 A from the car battery. What is the total current drawn from the battery when $S_1$ only is closed?
(d) Each headlight draws a current of 5 A from the car battery. What is the total current drawn from the battery when $S_1$ and $S_2$ are closed?

7. A hairdryer contains a motor and two heating elements (resistors). The hairdryer shown below has three heat settings- cold, warm and hot. The circuit diagram shows how these settings are achieved using switches A, B and C.

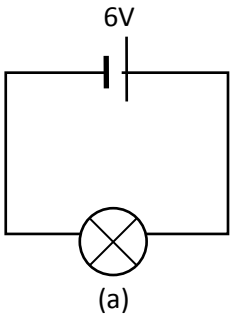


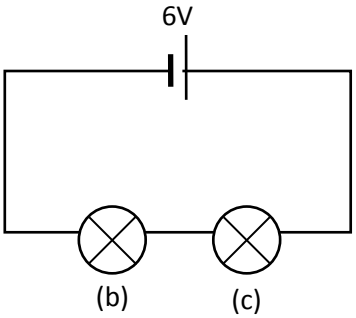

The motor draws a current of 3 A from the mains and the heating elements draw a current of 2 A each from the mains.

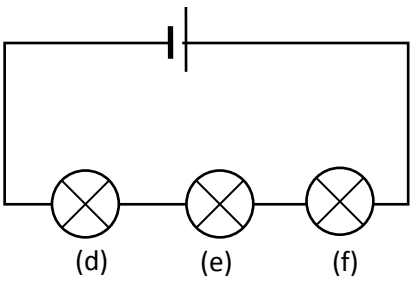
(a) Which switches must be closed to make the hairdryer blow warm air?
(b) What current is drawn from the mains when the hairdryer blows warm air?
(c) Which switches must be closed to make the hairdryer blow hot air?
(d) What current is drawn from the mains when the hairdryer blows hot air?
(e) What is the minimum current drawn from the mains when the hairdryer is on?
(f) What is the voltage across the motor?

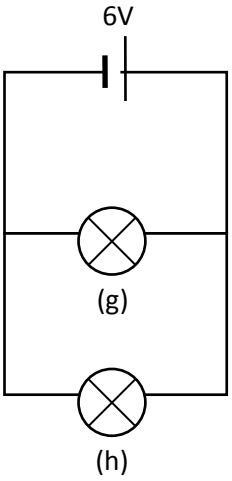
**Exercise 3: Mixed Series and Parallel Circuits**

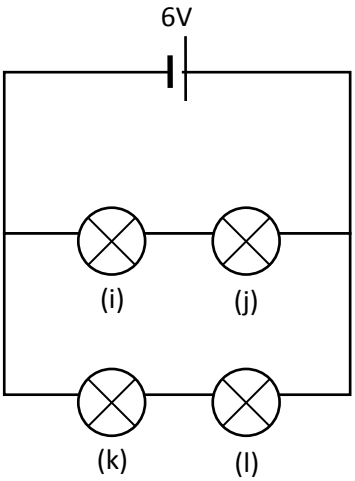
1. In the following circuits the bulbs are identical. Calculate the voltage across each lettered bulb.

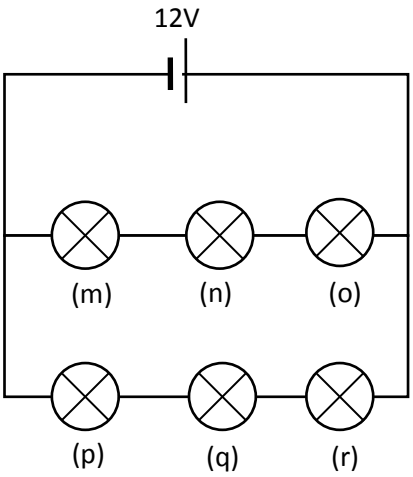


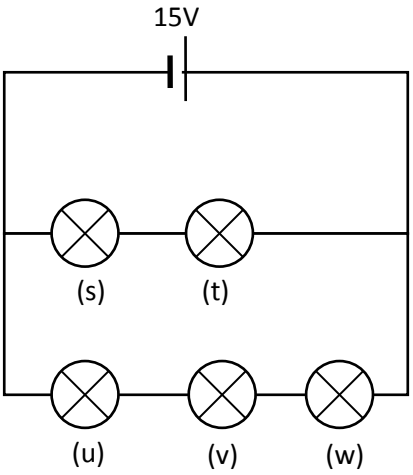



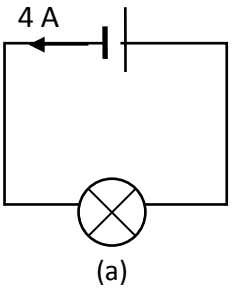



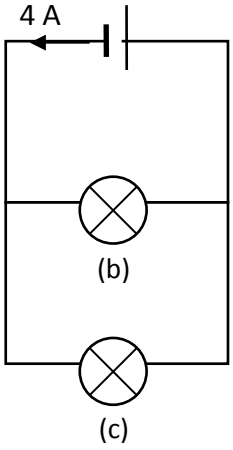



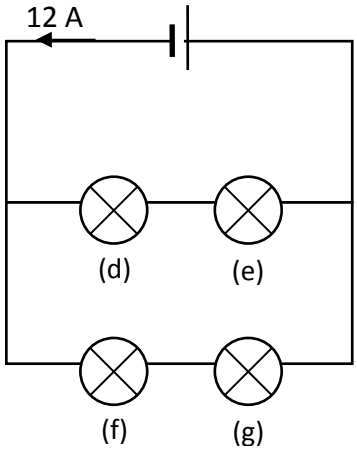



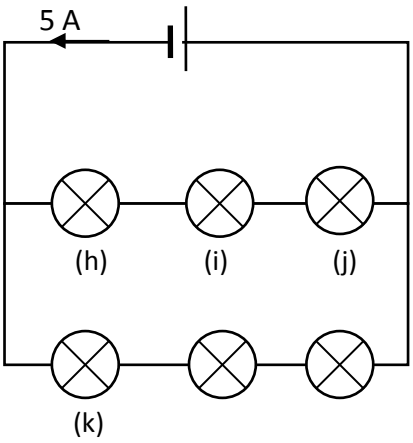



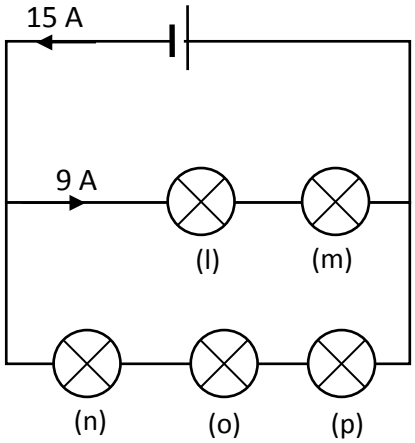
2. In the following circuits the bulbs are identical. Calculate the current through each lettered bulb.

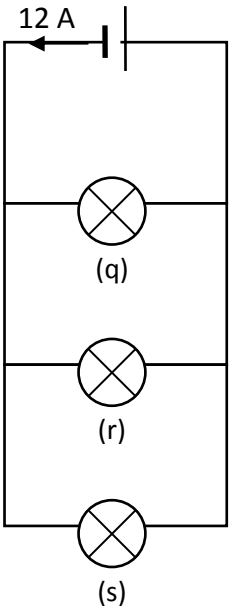


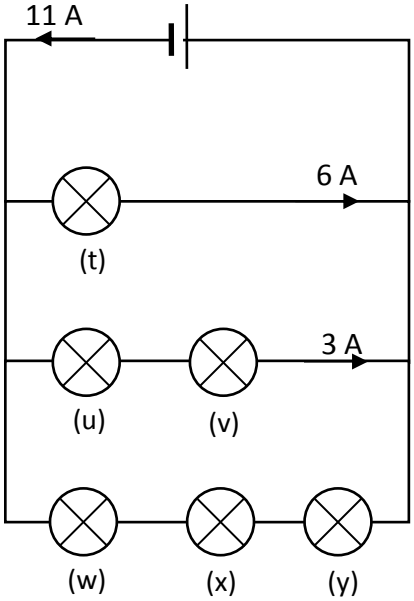



**Exercise 4: Energy Transformations and Power**

1. What is the useful energy transformation in the following electrical appliances?

(a) Light bulb
(b) Food mixer
(c) Fan
(d) Radio
(e) Television
(f) Door bell
(g) A lift going up
(h) Hair drier

2. Find the missing values in the following table.

| | *Power* (W) | *Energy* (J) | *Time* (s) |
|---|---|---|---|
| (*a*) | | 1 500 | 30 |
| (*b*) | | 180 000 | 36 000 |
| (*c*) | 100 | | 600 |
| (*d*) | 1 200 | | 2 |
| (*e*) | 3 000 | 120 000 | |
| (*f*) | 2·5 | 25 | |

3. How long will it take for a 60 W bulb to use 720 J of electrical energy?

4. A bulb uses 45 000 J of energy in 300 seconds.
What is its power rating

5. A 50 W immersion heater is switched on for 80 seconds. How much electrical energy passes through it in this time?

6. Calculate the power rating of an electric sewing machine which uses 4 560 J of energy in 8 minutes.

7. A 1 200 W hairdryer is switched on for 20 minutes. How much electrical energy does it use?

8. 7. For how many minutes must a 600 W shaver be switched on in order to use 540 000 J of electrical energy?

9. How long will it take a 1400 W paint stripper to use 1 680 000 J of electrical energy?

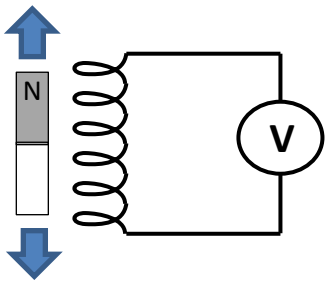
9. An electric fire uses 5·22 MJ of electrical energy in 30 minutes. Calculate the power rating of the fire. (1 MJ = 1 x $10^6$ J = 1 000 000 J)

10. A microwave oven is on for twenty minutes each day. If it uses 7·98 MJ of electrical energy in one week, what is its power rating?

**Exercise 5: Electromagnetism**

1. Describe how to make a simple electromagnet.

2. A coil of wide is connected to a voltmeter. A magnet is placed next to the coil. The magnet is continually moved back and forwards and a voltage is produced across the coil.




(a) What will happen to the voltage if the speed of movement is increased?
(b) What will happen to the voltage if the magnet stops moving?
(c) What will happen to the voltage is a stronger magnet is used?
(d) What will happen to the voltage if more turns are put in the coil?
(e) Is the current in the coil ac or dc and what does this stand for?
(f) Describe what happens to the direction of the current.

**Exercise 6: Renewable and Non-renewable Fuels**

1. Which of the following are fossil fuels:
   coal, wind, oil, nuclear, solar, gas

2. If an energy source is described as renewable, what does this mean?

3. Sources of energy can be classifies into renewable and non-renewable.

| Renewable | Non-renewable |
|---|---|
| | |

   Copy the table above and enter the following sources of energy in the correct column:
   coal, oil, solar, wind, nuclear, hydroelectric,
   gas, biomass, wave, tidal, geothermal

4. State a disadvantage of each of the following renewable energy sources:
   (a) Solar
   (b) Wind
   (c) Geothermal

5. State an advantage of each of the following renewable energy sources:
   (a) Solar
   (b) Wind
   (c) Waves

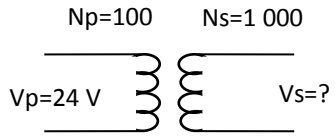
**Exercise 7: Transformers**

1. Find the missing values in the following table.

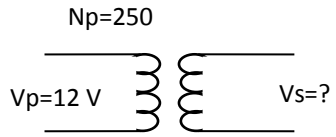
| | $N_p$ | $N_s$ | $V_p$ (V) | $V_s$ (V) |
|---|---|---|---|---|
| (*a*) | 10 | 1 | 20 | |
| (*b*) | 200 | 100 | 480 | |
| (*c*) | 50 | 150 | | 300 |
| (*d*) | 15 | 90 | | 480 |
| (*e*) | 10 | | 60 | 240 |
| (*f*) | | 1 000 | 30 | 3 000 |

2. Calculate the voltage induced in the secondary coil in each of the following transformers:

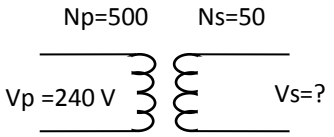
(*a*)




(*b*)

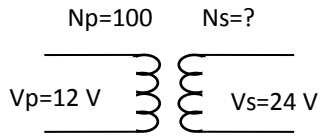



(*c*)

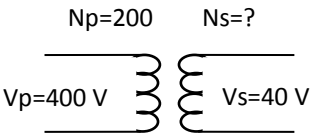



3. Calculate the number of turns in each of the secondary coils below:

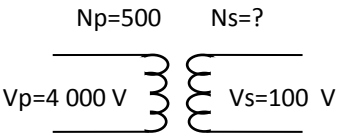
(*a*)




(*b*)

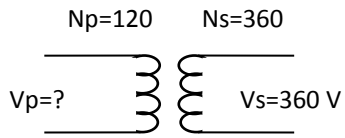



(*c*)

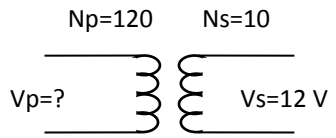



4. Calculate the primary voltage in each of the following transformers:

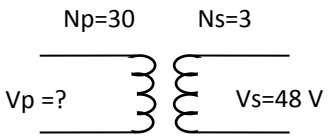
(*a*)




(*b*)

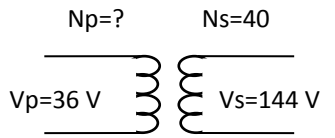



(*c*)

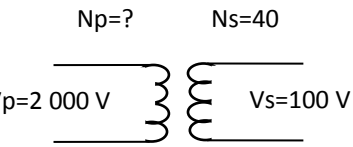



5. Calculate the number of turns in the primary coil of each of the following transformers:

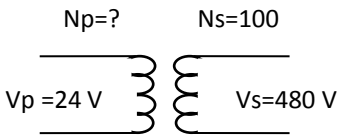
(*a*)




(*b*)




(*c*)



6. A transformer is designed with 20 turns of wire in the primary coil and 2 000 turns in the secondary coil. If the induced voltage in the secondary coil is 4 000 V calculate the primary voltage.

7. A step down transformer changes the voltage of a signal from 360 V down to 18 V. If the transformer had 200 turns in the primary coil calculate the number of turns in the secondary coil.

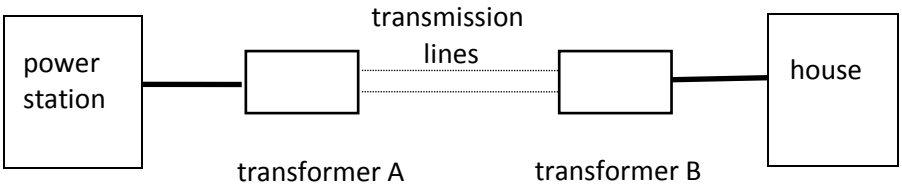
8. An industrial power plant uses step up transformers to step up the voltage of signals by a factor of 30. Suggest a possible turn ratio in the primary and secondary coils to achieve this.

9. A young boys train set is designed to operate safely at 20 V. A transformer has to be capable of stepping mains voltage down to this value. Calculate the number of turns in the secondary coil if there are 115 turns in the primary coil.

10. Louise's aunt in America sends her a 'mega' frying pan as a wedding gift. It is designed to operate at 115 V. Suggest a possible turns ratio for the transformer if the pan is to be operated safely at British mains voltage.

**Exercise 8: Transmission of Electricity**

1. A model transmission line is shown below.




(a) Transformer A has 15 turns in its primary coil and 225 in its secondary coil. The power station produces a voltage of 23 000 V. Calculate the voltage across the transmission lines.

(b) The voltage in the transmission lines becomes the primary voltage of transformer B. The house needs a voltage of 230V. If Transformer B has 30000 turns in its primary coil, calculate how many turns it needs in its secondary coil.

2. A student sets up a demonstration to show how electricity is transmitted from a power station to our homes. He has a number of different transformers to choose from.

| | *Primary turns* | *Secondary turns* |
|---|---|---|
| A | 100 | 10 |
| B | 10 | 100 |
| C | 100 | 100 |

(a) Which transformer is most suitable to use between the power station and transmission lines? Explain your answer.

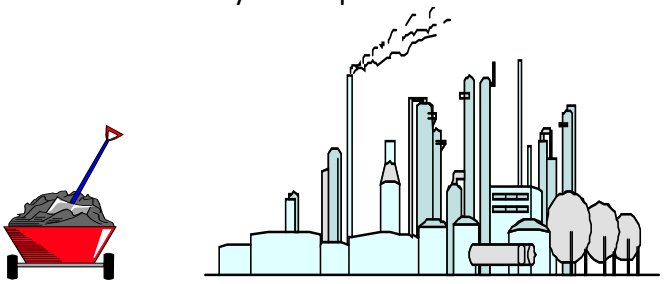
(b) Which transformer is most suitable to use between the transmission lines and our home? Explain your answer.

**Exercise 9: Efficiency**

1. Find the missing values in the following table.

| | Efficiency (%) | Useful energy in (J) | Useful energy out (J) |
|---|---|---|---|
| (*a*) | | 1 400 | 700 |
| (*b*) | | 675 | 135 |
| (*c*) | 80 | 1 200 | |
| (*d*) | 45 | | 1 500 |
| (*e*) | 60 | 300 | |
| (*f*) | 25 | | 6 000 |

2. A coal fired power station has a power output of 200 MW. The power produced by the boiler is 340 MW. Calculate the efficiency of the power station.



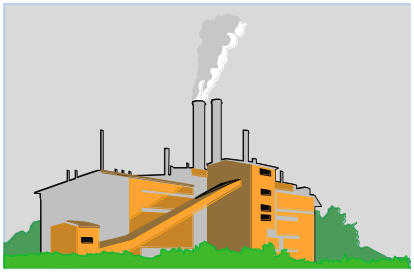
3. A turbine converts 65 000 J of heat energy into 13 000 J of kinetic energy. What is the efficiency of the turbine?

4. A generator converts 3 156 MJ of kinetic energy into 450 MJ of electrical energy. What is the efficiency of the generator?

5. A thermal power station converts 420 MJ of chemical energy into 124 MJ of electrical energy. What is the efficiency of this power station?

6. An electrical pump used in a pumped storage hydroelectric power station is 80 % efficient. How much work can the pump do if it is supplied with 25 kJ of energy each second?

7. An oil fired power station which is 40% efficient produces an output of 300 MW. How much power must be supplied to the station to produce this output?

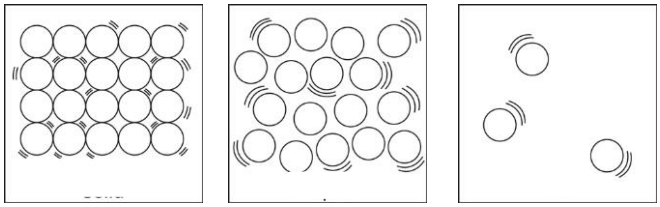
8. 

The output from an oil-fired power station is 250 MW and it is 32 % efficient. How much power must be provided by the oil to produce this output?

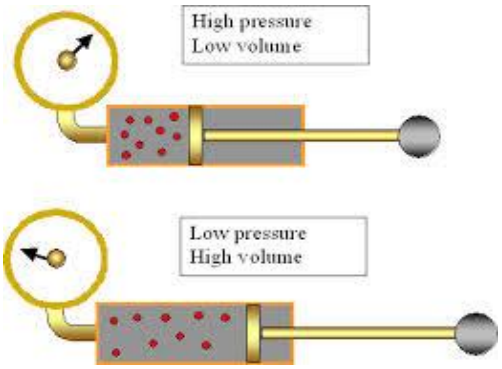
**Exercise 10: Kinetic Theory**

1. What state of matter is represented by the following diagrams:

(a) (b) (c)

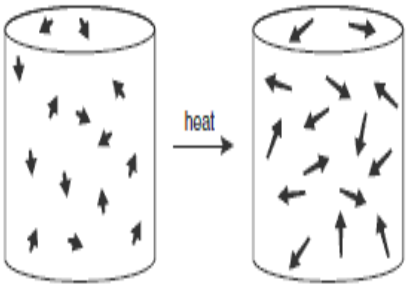


2. Copy and Complete: Explaining Boyle's Law.



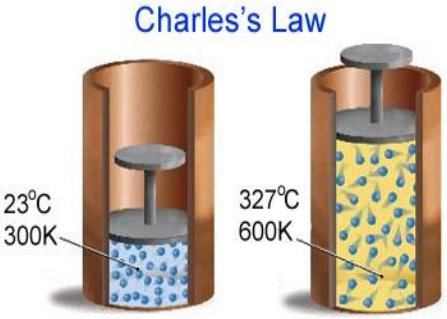

As the volume of gas increases the pressure decreases. This is because the particles are further apart and collide ____ frequently with the walls of the container.

3. Copy and Complete: Explaining Gay Lussac's Law




As the temperature of the gas increases the particles gain _____ energy (longer arrows in diagram below) and move _____. They hit the walls of the container _____ often and with _____ force thereby causing the pressure to increase.

4. Copy and Complete: Explaining Charles' Law

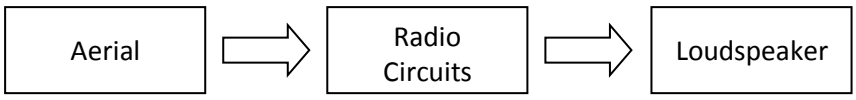



As the temperature of the gas increases, the particles gain _____ energy and move _____. The particles hit the walls of the container more often and with _____ force. The volume must _____ to give a greater surface area to keep the pressure constant.

**Exercise 11: Electronic Systems**

1. Any electronic system consists of three parts. Name the three parts.

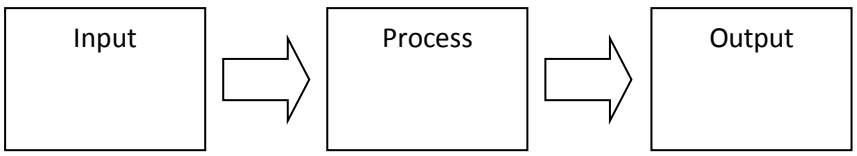
2. The block diagram for a radio is shown below:




   (a) Which of these three blocks represents the process device for the radio?
   (b) Which part is input?

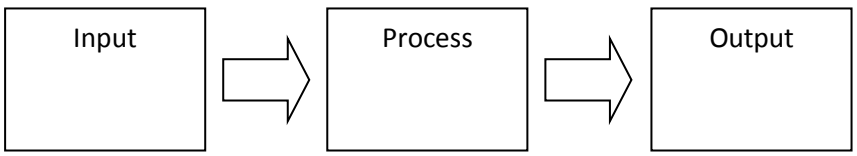
3. A calculator can be broken down into three sub-systems. These sub-systems are the display, the keypad and the circuits.

   Copy the following block diagram and complete it with the three sub-systems for the calculator.



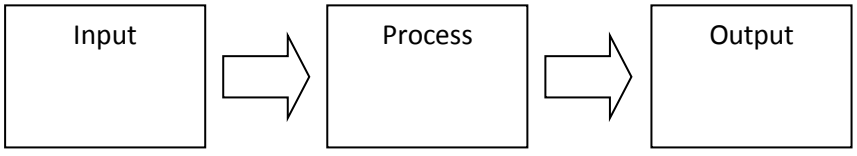

4. A digital thermometer can be broken down into three sub-systems. These sub-systems are the display screen, the temperature sensor, and the electronic circuits.

   Copy the following block diagram and complete it with the three sub-systems for the thermometer.




5. An electric guitar system can be broken down into three sub-systems. These sub-systems are the amplifier, the guitar, and the loudspeaker.

   Copy the following block diagram and complete it with the three sub-systems for the electric guitar system.



**Exercise 12: Output Devices**

1. Which of the components in the list below are output devices?

   bulb thermistor relay thermocouple solenoid loudspeaker
   dynamo LED LDR buzzer motor microphone

2. What would the energy transformation be for the following devices?
   (a) LED
   (b) Buzzer
   (c) Bulb
   (d) motor
   (e) loudspeaker
   (f) solenoid

3. What would be an appropriate output device for a public address system?

4. What would be an appropriate output device for a door-bell?

5. What would be an appropriate output device to make a conveyor belt move at a supermarket checkout?

6. What would be an appropriate output device for giving a car driver a visual indication that a door is open?

7. What would be an appropriate output device to raise and lower blinds automatically in a luxury flat.

8. What would be an appropriate output device to be used in a central locking system of a car?

9. What would be an appropriate output device to be used in a torch?

**Exercise 13: Input Devices**

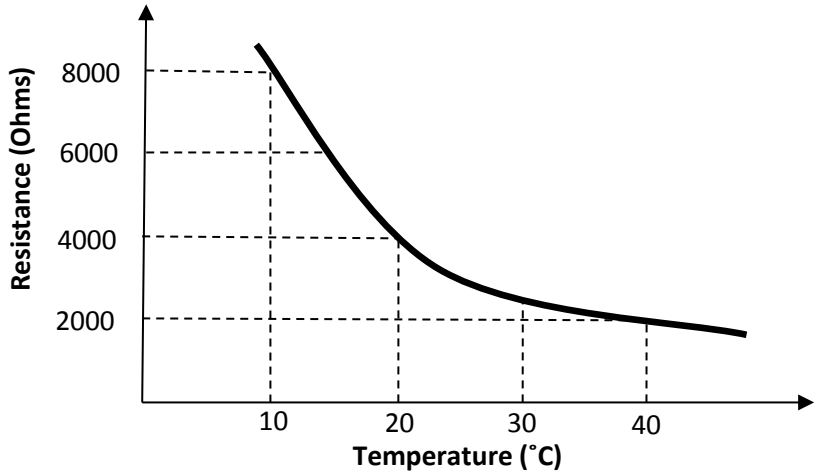
1. The following is a list of input devices:
   Capacitor microphone thermistor solar cell
   Light dependent resistor (LDR) Switch thermocouple

   Select from the list above a suitable input device for each of the following:
   (a) Public address system in a railway station
   (b) Digital thermometer
   (c) Contestant to press in a quiz game
   (d) Light detector on a camera
   (e) Pilot light flame detector in a gas central heating system
   (f) Sunlight hours recorder at a weather station.
   (g) Time delay circuit for courtesy lights in a car

2. A thermistor is placed in a beaker of water. The water is heated by a Bunsen burner. As the temperature increases what happens to the resistance of the thermistor?

3. A LDR is placed in a brightly lit room. The lights in the room are then turned off. What happens to the resistance of the LDR?

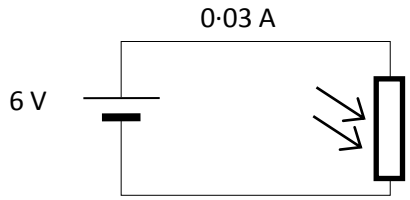
4. A thermistor is used as a temperature sensor and the following graph shows how its resistance changes with temperature.



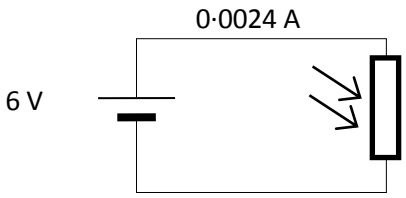

   (a) What happens to the resistance of the thermistor as the temperature increases?
   (b) What is the resistance of the thermistor at 20˚C?
   (c) If the resistance of the thermistor is 3000 ohms, what is the approximate temperature?
   (d) The current flowing through the thermistor at 20˚C is 0.006A? If the temperature rises to 25˚C what is the current most likely to be?
      - 0.005A
      - 0.006A
      - 0.007A

   (e) Explain your answer to part (d).

5. The circuits below show two identical LDR's each connected to a 6 V supply. One LDR is placed in a cupboard and the other is placed beside a window.




Circuit (i)

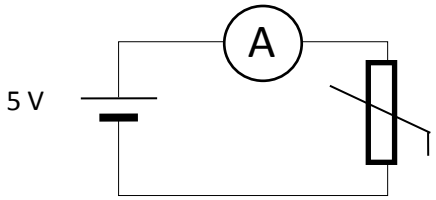



Circuit (ii)

(a) Use Ohms Law (V=IR) to calculate the resistance of each LDR.

(b) Which circuit shows the LDR in the cupboard?

6. The following circuit shows a thermistor connected to a 5 V supply and placed in a school laboratory.




In the morning the ammeter gave a reading of 0.00125 A. Later in the same day the reading had risen to 0.0025 A.

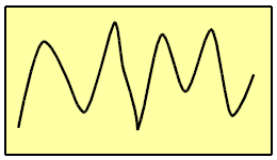
(a) Calculate the resistance of the thermistor in the morning.

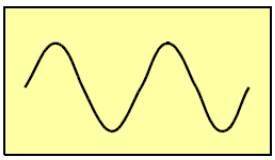
(b) Calculate the resistance of the thermistor later in the day.

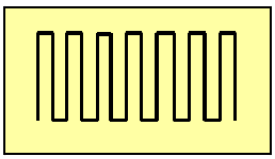
(c) What happened to the temperature in the room during the day? Explain your answer.

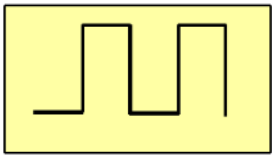
**Exercise 14: Analogue and Digital Signals**

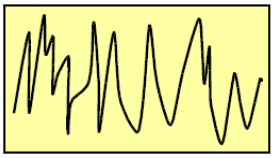
1. For each of the following signals state whether it is analogue or digital.

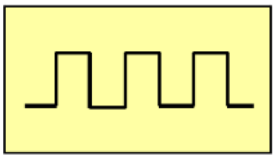
(a) 

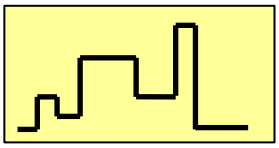
(b) 

(c) 

(d) 

(e) 

(f) 

(g) 

2. Copy and complete the following table to show the different ways of describing a digital signal.

| Logic Level | High Voltage / Low Voltage | On / Off |
|---|---|---|
| Logic 0 | | |
| Logic 1 | | |

3. How many different voltage levels (or logic levels) are there in a digital signal?

4. How many different voltage levels (or logic levels) are there is an analogue signal?

**Exercise 15: Logic Gates**

1. Identify the logic gate represented by each of the following truth tables. Write the name of the gate and draw the symbol for the gate.

(*a*)

| Input | Output |
|---|---|
| 0 | 1 |
| 1 | 0 |

(*b*)

| Input A | Input B | Output |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

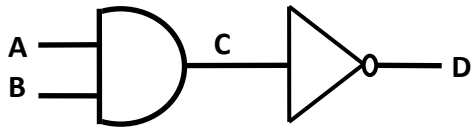
(*c*)

| Input A | Input B | Output |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

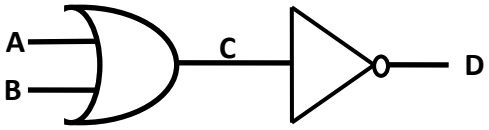
2. For each of the following combinations of logic gates complete a truth table of the form:

| A | B | C | D |
|---|---|---|---|
| 0 | 0 | | |
| 0 | 1 | | |
| 1 | 0 | | |
| 1 | 1 | | |

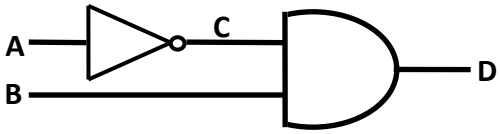
(*a*)



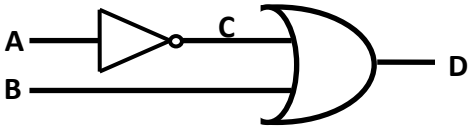

(*b*)




(*c*)



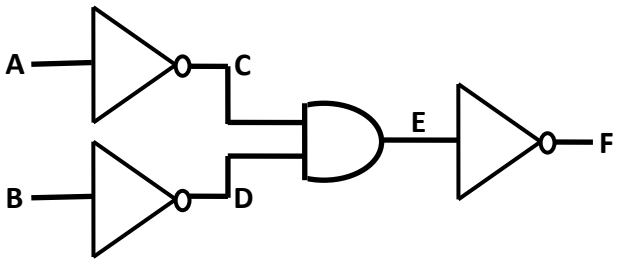

(*d*)



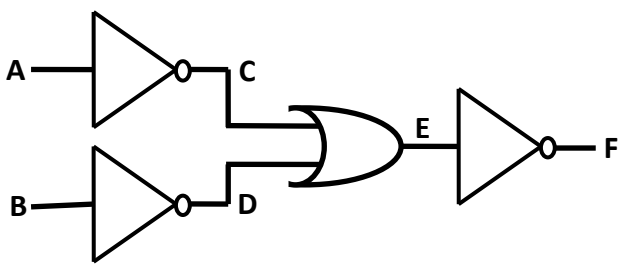

3. For each of the following combinations of logic gates complete a truth table of the form:

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| 0 | 0 | | | | |
| 0 | 1 | | | | |
| 1 | 0 | | | | |
| 1 | 1 | | | | |

(a)



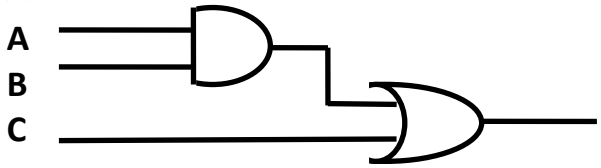

(b)



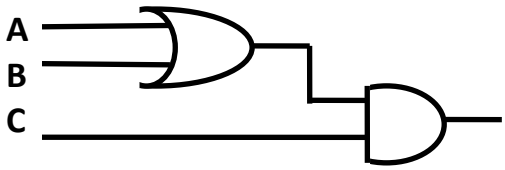
4. Each of the following combinations of logic gates has three inputs. For each combination complete a truth table of the form:

| Input A | Input B | Input C | Output |
|---|---|---|---|
| 0 | 0 | 0 | |
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 0 | 1 | 1 | |
| 1 | 0 | 0 | |
| 1 | 0 | 1 | |
| 1 | 1 | 0 | |
| 1 | 1 | 1 | |

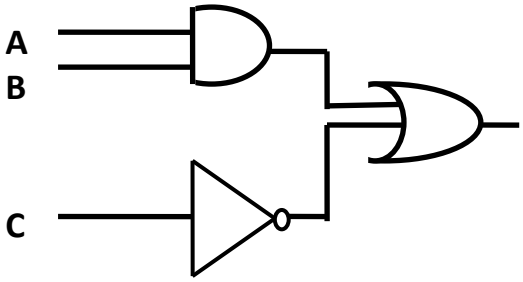
(a)



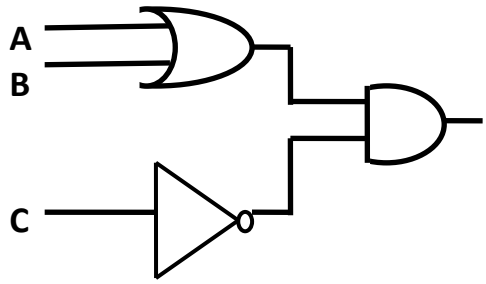

(*b*)



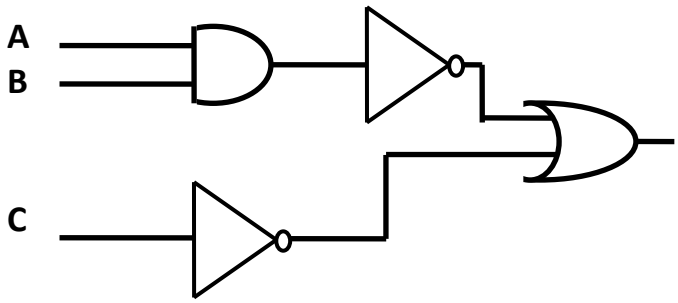

(*c*)



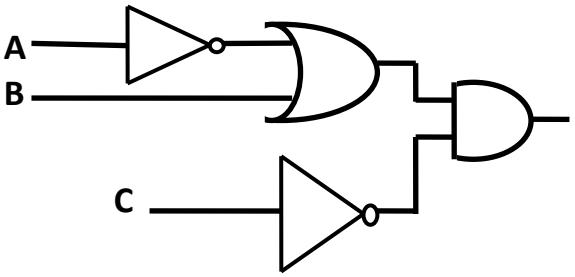

(*d*)



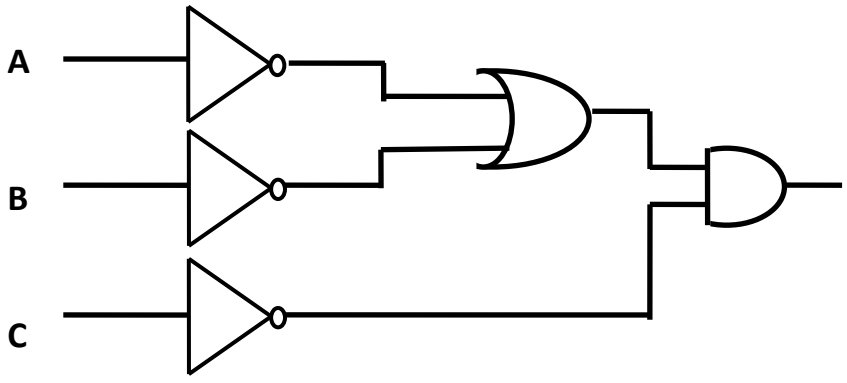

(*e*)




(*f*)



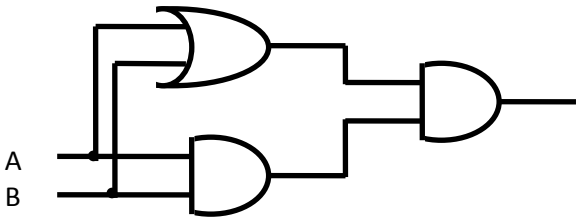

(*g*)



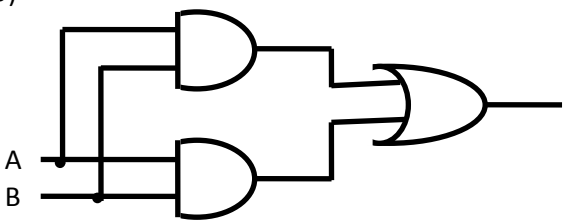
5. Each of the following combinations of logic gates involve linked inputs, that is two inputs being fed into different gates. For each combination complete a truth table of the form:

| Input A | Input B | Output |
|---|---|---|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |

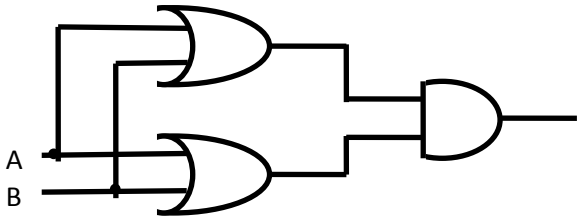
(*a*)



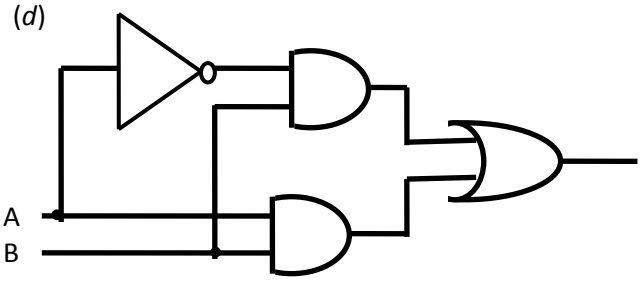

(*b*)




(*c*)

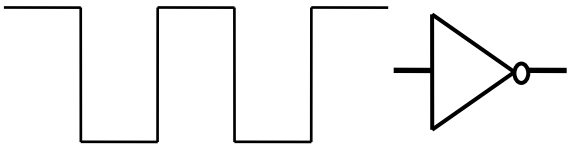



(*d*)

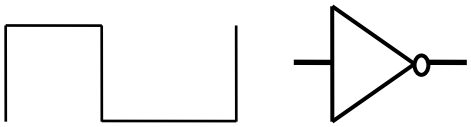



6. Show the pattern of pulses that would appear at the output of each of the following gates as a result of the input pulses shown.

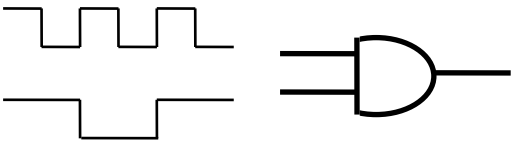
(*a*)



(*b*)



(*c*)



(*d*)