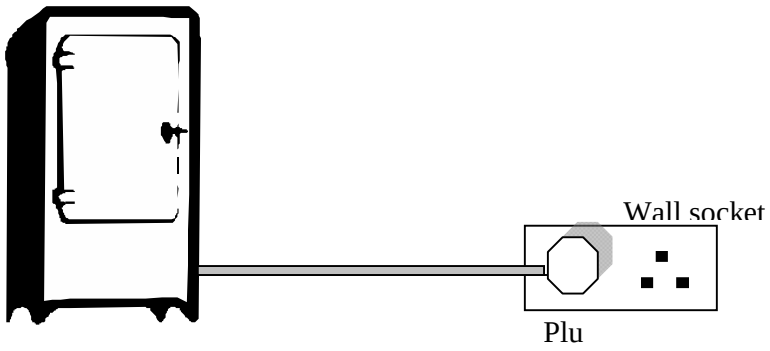
Prelim Revision

Electricity and Energy

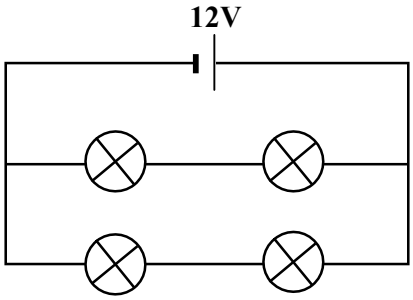
1. An electric refrigerator is rated at 650W.



(a) (i) Calculate the current flowing in the circuit when it is operating on the mains supply.

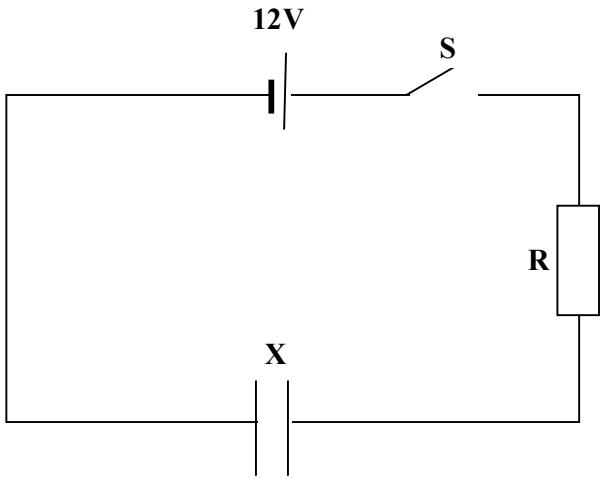
(ii) What charge is flowing in the electrical circuit when the refrigerator has been on for 24 hours?

(b) An electric circuit is wired as shown below.
Each bulb in the circuit has a resistance of 600Ý.



Calculate the total current in the circuit.

2. (a) The following circuit consists of a resistor and a component X. When S is closed device X begins to charge up.



(i) Name component X in the above circuit?

(ii) What changes could be made to slow down the rate at which X charges?

3. A tennis ball is bounced on the ground before serving. The ball has a mass of 0·05kg and hits the ground with a velocity of 6m/s.

Assuming there are no energy losses …..

(a) Calculate the kinetic energy of the ball as it leaves the ground.

(b) Calculate the height that the ball reaches after it has been bounced.

(c) In reality, there are some energy losses. Name one energy loss and describe how it affects the bounce of the ball.

4. The relationship between volume and temperature of a gas with a fixed pressure and mass is given by which of the formulae below?

A $V \propto T$ (in Celsius)
B $V \propto T^2$ (in Celsius)
C $V \propto T$ (in kelvin)
D $V \propto T^2$ (in kelvin)
E $V \propto T^{-1}$ (in kelvin)

5. At which of the following temperatures do the particles of a gas have zero kinetic energy?

A -273 K
B 0°C
C 0 K
D 273 K
E 273°C

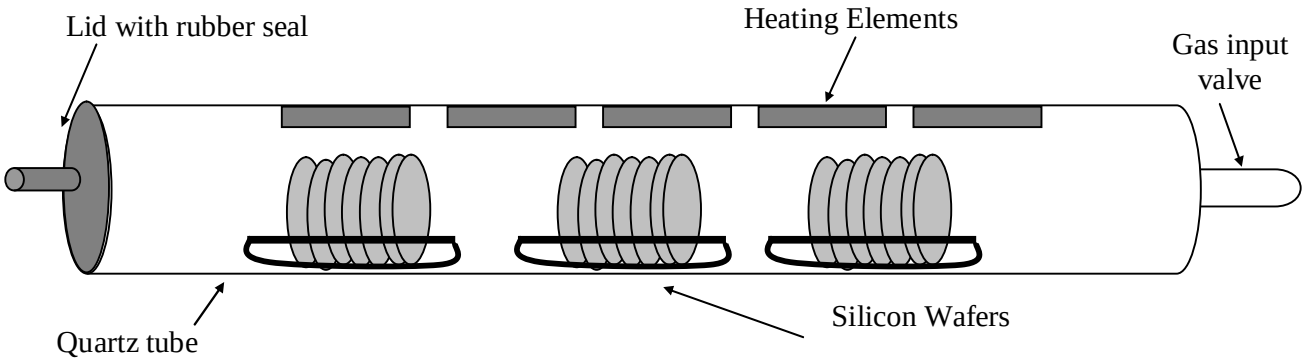
6. In an electronics factory a layer of oxide is deposited on a silicon wafer.

In this process gas is injected into a sealed tube as shown below and heating elements are used to control the temperature of the gas.

The temperature inside the tube has to be 900°C for a particular thickness of oxide.

The volume of the tube is $0{\cdot}12\,m^3$.

The gas pressure inside the tube is $0{\cdot}995 \times 10^5$ Pa.



(a) If one of the heating elements in the tube is faulty and the overall temperature drops to 850°C:

(i) Calculate the new pressure in the tube.

(ii) Explain, in terms of the kinetic theory of gases, why the pressure changes.

(b) The same process with the same mass of gas is carried out in another narrower tube at the original temperature of 900°C. The pressure in the narrower tube has to be $0{\cdot}900 \times 10^5$ Pa.

.

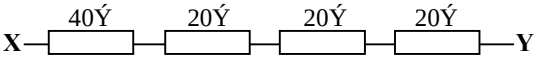
Calculate the volume of the narrower tube.

7. The unit of work done is:

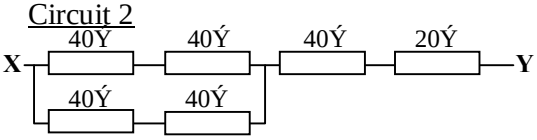
A N/s
B J/s^2
C Ns
D W/s^2
E J

8. Four different combinations of resistors are shown below between the points **X** and **Y**.
Only 20Ý and 40Ý resistors have been used.

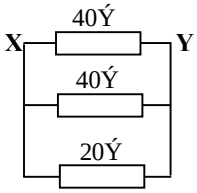
Circuit 1



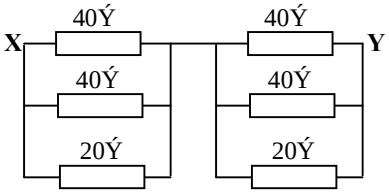
Circuit 2



Circuit 3



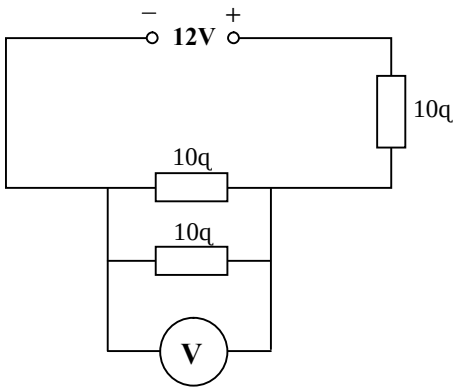
Circuit 4



Which two circuits have the same total resistance between **X** and **Y**?

A circuits 1 and 2
B circuits 1 and 3
C circuits 2 and 4
D circuits 1 and 4
E circuits 2 and 3

9. Each resistor in the circuit below is 10Ý.



The voltmeter reads:

A 12V
B 6V
C 4V
D 2V
E 1V

10. A motor in a washing machine is connected to the mains supply for 50 minutes.

If a current of 0·5A is drawn during this time, the energy supplied to the motor is:

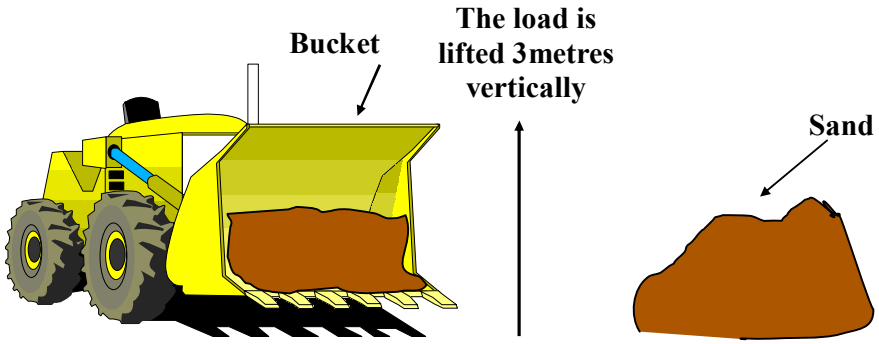
A 25J
B 1500J
C 5750J
D 11500J
E 345000J

11. The resistance of a LDR changes with:

A temperature
B light
C heat
D sound
E movement

12. An industrial digger lifts 750kg of wet sand from the ground position to a height of 3 metres at a **steady speed** of 0·5 m/s.

The mass of the bucket lifting the soil is 500kg.



(a) What is the weight of the sand and the bucket of the digger combined?

(b) Calculate the potential energy of the sand and the bucket at the height of 3 metres.

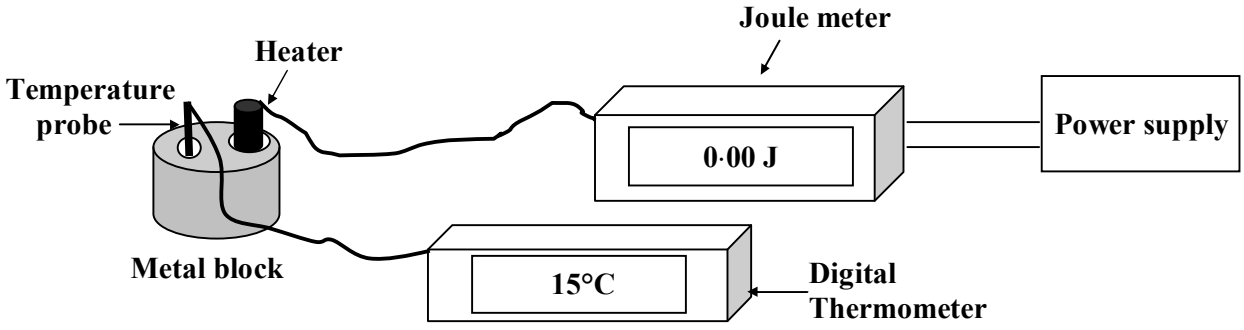
(c) In reality, more work would have to be done to lift the load. Explain why this would be the case.

13. A student investigated the amount of energy required to raise the temperature of three 1kg blocks of metal, namely **steel, soft iron and aluminium,** by the same amount.

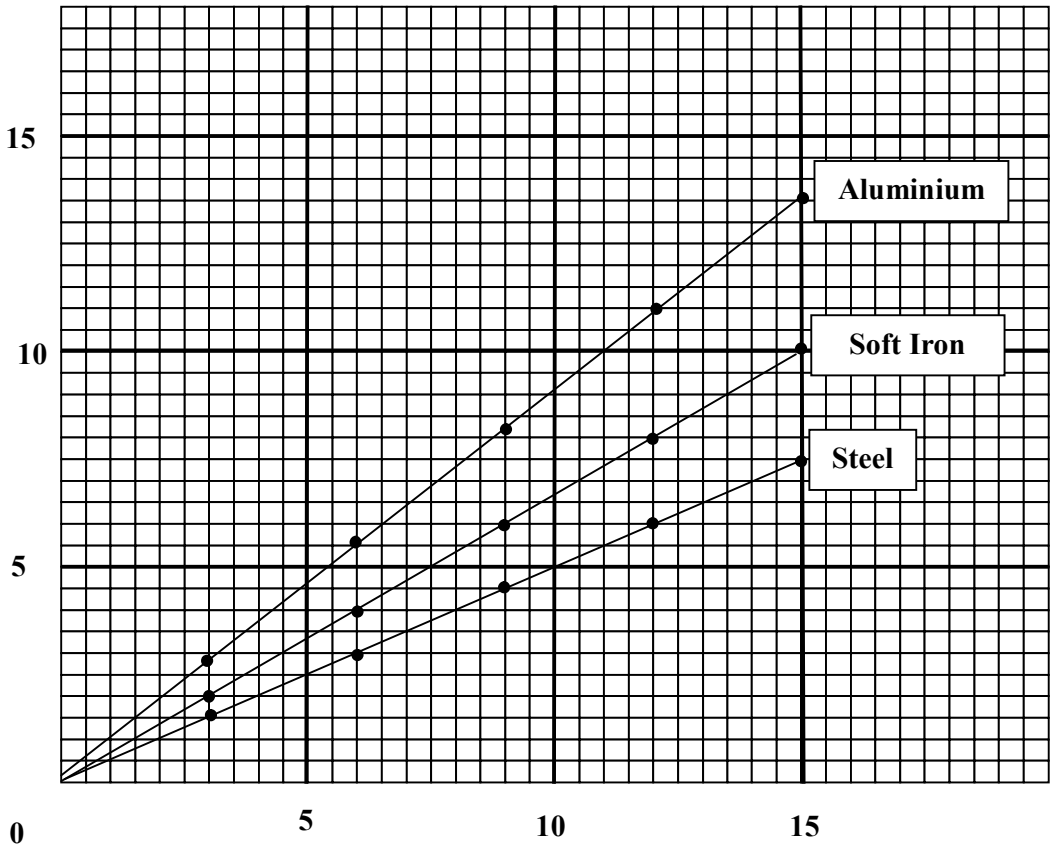
He raised the temperature of the three metals separately by 15°C and noted the heat energy required, at 3°C intervals, for each one.

The temperature of each metal at the start of the experiment was 15°C.

The apparatus he used is shown below:



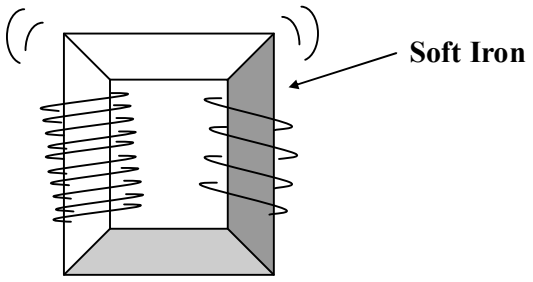
A graph of the results is shown on the opposite page:



(a) (i) Which of the metals has the highest specific heat capacity?

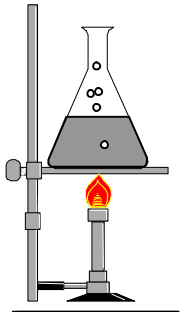
Explain your answer.

(ii) The temperature of the **soft iron** core of a transformer increases by 25°C.
Its mass is 2kg.



Calculate the energy dissipated in the **soft iron**.

(b) A student sets up an experiment to boil 0·2kg of water until all of it has turned into water vapour. The temperature of the water at the start of the experiment is 23°C.
(He assumes that there is no energy lost to the surroundings)

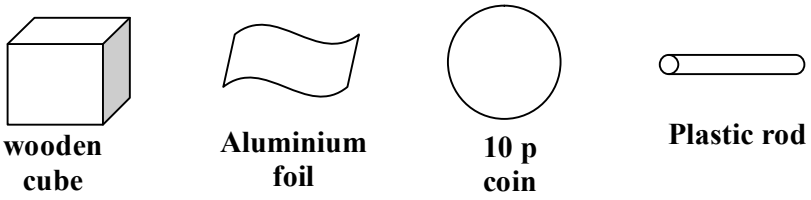


Specific Heat Capacity of water
4200J/kg°C

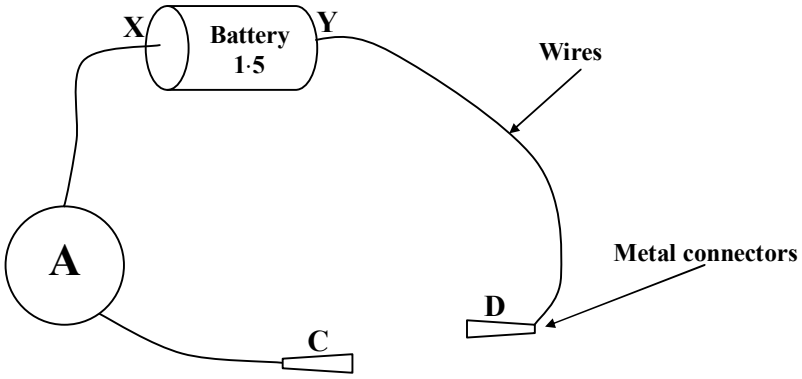
Using the information in the table above:

Calculate the energy required to raise the temperature of 0·2kg of water to boiling point.

14. A student was given the four items shown below and was asked to devise a method to test which of them will conduct electricity.



The student built the following circuit:



(a) She inserted each item in turn between C and D.

Copy and complete this table to show which of the four items are insulators and which are conductors? (two of the boxes in the table <u>will</u> be left blank)

Insulators	Conductors

(b) She then put in a piece of copper for two minutes and found the reading on The ammeter stayed steady at 0·05A during this time.

(i) What charge flowed in the circuit during the two minutes?

(ii) The charge on one electron is $1{\cdot}6 \times 10^{-19}$ coulombs. Calculate the number of electrons flowing in the circuit .

(iii) Calculate the energy dissipated in the circuit.

(c) Explain what would happen if:

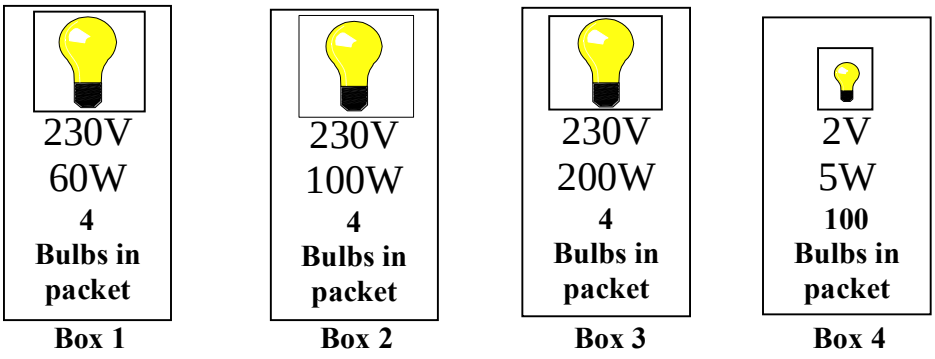
(i) Two negative charges were brought close together.

(ii) A positive and negative charge were brought close together.

15. A man goes into an electrical shop to buy some light bulbs for his new house.
He finds that there are four types of bulbs with different information on each box.

The labels are shown below:

(Note: when the bulbs are put into electrical circuits they will be referred to as lamps)



He decides to buy some of Box 2 bulbs and one packet of Box 4.

(a) Draw the electrical symbol for a lamp used in electrical circuits.

(b) The house has several lighting circuits, each is a parallel circuit.

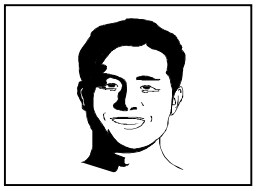
In one of these circuits 2 bulbs from box 2 are wired in parallel.
When the lamps are operating normally:

(i) What is the resistance of one of the lamps from box 2?

(ii) What is the total resistance if two of these lamps are wired in parallel?

(iii) Calculate the total current which flows in this circuit when it is connected to the mains voltage.

(c) He uses some of the bulbs from Box 4 in a **series** circuit to illuminate a picture of his daughterôs favourite pop star.



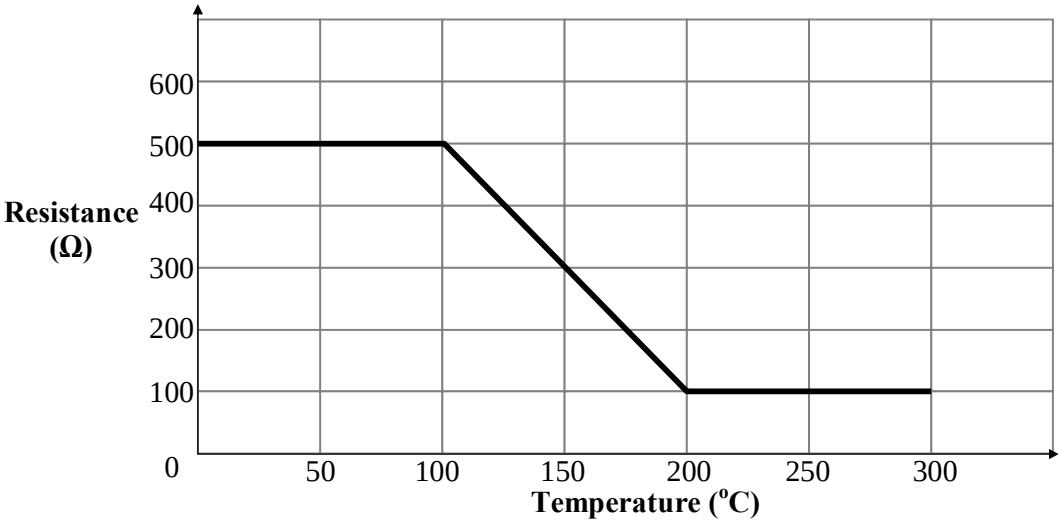
If he had a 12V supply for the circuit, how many lamps from Box 4 should be in it to provide their designed output?

Justify your answer.

16. (a) Draw the symbol for a thermistor.
1

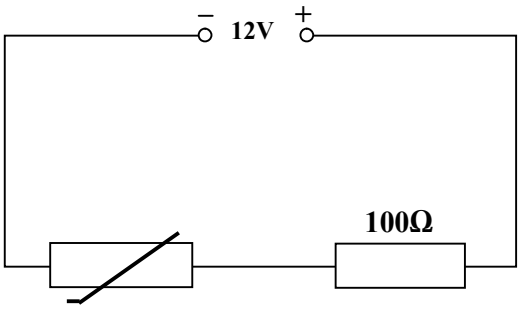
(b) The resistance of a thermistor depends on its temperature.

A graph of temperature against resistance is shown below for one type of thermistor.



(i) What is the resistance of this thermistor at 150°C?

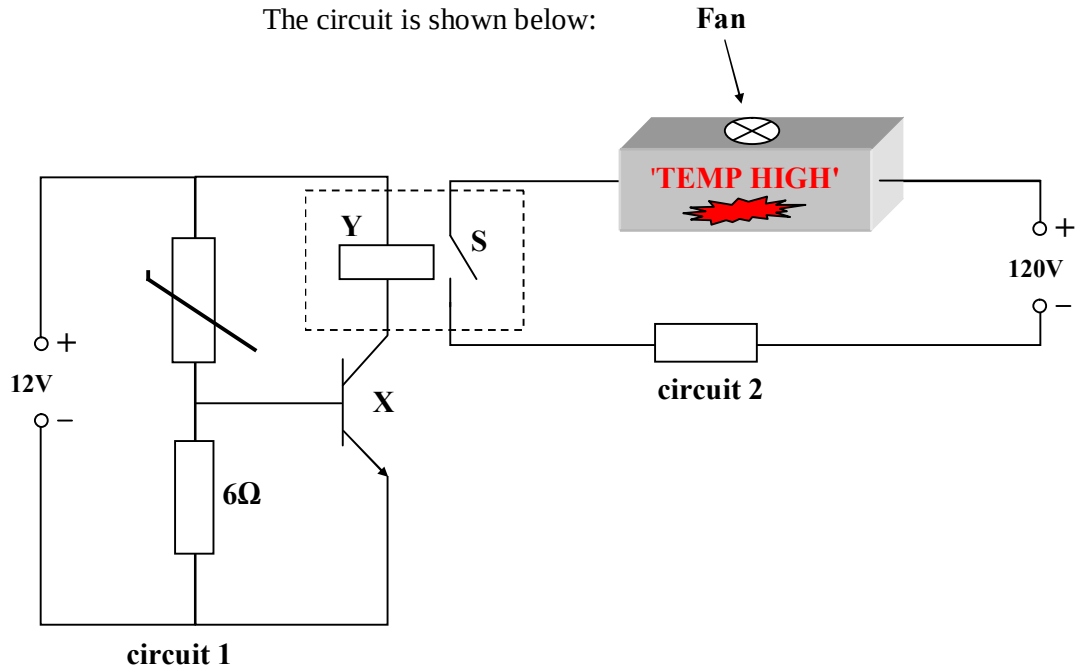
(ii) The thermistor is put into a potential divider circuit with a supply voltage of 12V as shown:



Calculate the potential difference across the thermistor at 150°C.

(c) The thermistor is put into the monitoring circuit shown below.
When the temperature is 200°C, or above, a fan automatically switches on and the words '**TEMP HIGH**' are displayed on a VDU .

The circuit is shown below:



(i) Name the electronic component **X** in **circuit 1**.

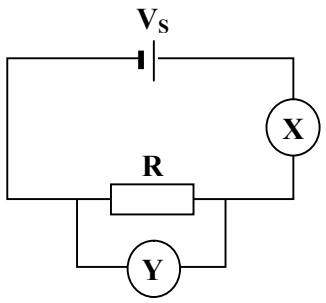
(ii) Calculate the voltage which will switch **X 'ON'** when the temperature reaches 200°C.

(iii) Explain why the fan turns on, referring to components X, Y and S.

17. The specific heat capacity of water is 4180J/kg °C.
The energy required to raise 5kg of water by 100°C is:

A 8·36J
B 209J
C 20900J
D 418000J
E 2090000J

18. This electrical circuit was set up to measure the value of R.



The meters at **X** and **Y** are measuring:

	X	**Y**
A	voltage	charge
B	current	charge
C	charge	voltage
D	voltage	current
E	current	voltage

19. Two objects, A and B, are dropped from the same height.

A has twice the mass of B.

Which of the following statements is/are correct?

I At the top, A has twice the potential energy of B.

II At the bottom, A has twice the kinetic energy of B.

III At the bottom, A has twice the speed of B.

A I only

B II only

C III only

D I and II only

E I, II and III

20. The temperature of a constant mass of gas is increased while its pressure is kept constant.

What happens to the velocity and the spacing of the molecules?

A The molecules move faster and are closer together.

B The molecules move faster and are further apart.

C The molecules move faster and the spacing is the same.

D The molecules move more slowly and are closer together.

E The molecules move more slowly and are further apart.

21. A resistor is rated at 2·0 W when the potential difference across it is 60 V.

The resistance of the resistor is

A 15 Ω

B 30 Ω

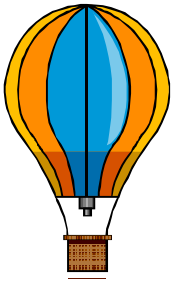
C 240 Ω

D 1800 Ω

E 7200 Ω.

Marks

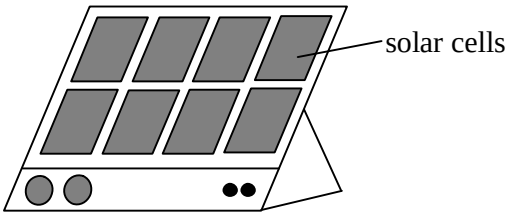
22. A hot air balloon of volume 500 m^3 is hovering stationary above the ground. The mass of the balloon and its occupants is 650 kg.



After a while, the air inside it cools from 77 °C to 72 °C and the balloon starts to descend.

Assuming the pressure of the air inside remains the same, calculate the new volume of the balloon.

23. A solar charger contains solar cells that can recharge batteries and power small electrical appliances.



(*a*) The charger provides 200 C of charge to a rechargeable battery.

State the symbol for charge and the full name for its unit.

(*b*) It takes 4 hours to deliver the charge to the battery.

Calculate the current.

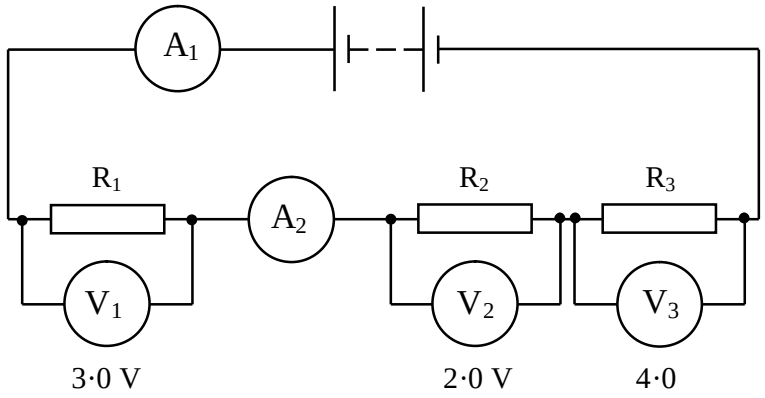
(i) The charger is used to operate a radio which is designed to use a supply voltage of 9·0V and a current of 1·0 mA.

State what is meant by the term *voltage*.

(ii) The charger actually provides a voltage of 12 V.

Calculate the size of the resistor which needs to be connected in series with the radio to ensure it operates at its correct voltage.

24. A student sets up the following circuit.



(*a*) Calculate the voltage of the battery.

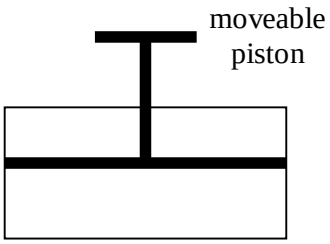
(*b*) The reading of ammeter A_1 is 10 mA. Determine the reading on ammeter A_2.

(*c*) Calculate the resistance of resistor R_1.

(*d*) The battery is removed from the circuit and replaced with a 1·5 V cell.

State the effect this has on the resistance of resistor R_1.

25. The volume of a chamber, full of a fixed mass of gas, can be changed using a moveable piston.



The pressure is $1{\cdot}10 \times 10^5$ Pa when the volume is $0{\cdot}5\text{cm}^3$.

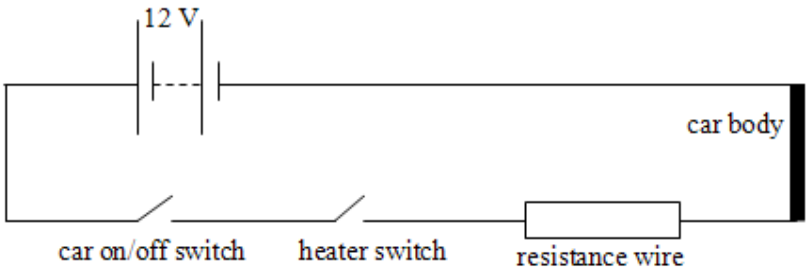
If the piston is compressed, such that the new volume is $0{\cdot}4\text{cm}^3$ and the temperature of the gas remains constant, the new pressure in the chamber will be:

A $0{\cdot}88 \times 10^5$ Pa
B $1{\cdot}00 \times 10^5$ Pa
C $1{\cdot}10 \times 10^5$ Pa
D $1{\cdot}38 \times 10^5$ Pa
E $1{\cdot}50 \times 10^5$ Pa

26. The rear window of a car has a length of resistance wire built in to the glass.

This resistance wire acts as a heater that can be used to melt any ice that forms on the window during frosty weather.

Part of the wiring diagram for the car is shown below.



(*a*) One side of the battery and one terminal of the resistance wire is attached to the car body

(i) Explain why there are two switches in series in this circuit.

(ii) Describe the function of the car body in this circuit.

(*b*) State what happens to the ratio of the voltage to the current in the resistance wire if the current is increased.

(*c*) When the heater is working normally the current in the resistance wire is 5·0 A.

Calculate the power developed in the resistance wire.

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27. A box contains the following electronic components:

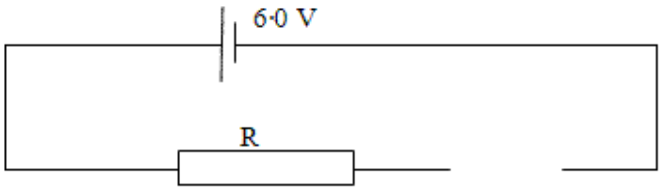
LED solenoid motor loudspeaker

(*a*) Match each of the components in the box to the output devices listed in the table.

device	*component*
electronic lock	
automatic fan	
public address system	
stand by indicator	

(*b*) An LED is to be connected to the cell and resistor shown below so it will light.

Complete the diagram.



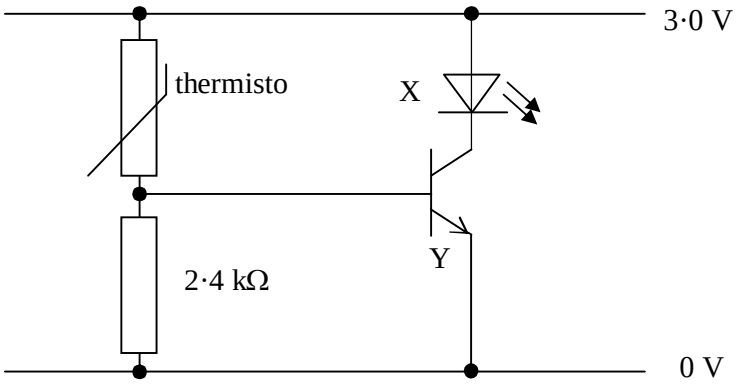
(*c*) The LED is rated at 1·5 V and 5·0 mA.

Calculate the value of R that allows the LED to operate at its rated value.

(*d*) The LED is left on for 10 minutes.

Show that the charge that flows from the cell during this time is 3·0 C.

28. The circuit shown below is part of warning system for a freezer. If the temperature rises above a certain temperature an LED on the door switches on.



Component Y is a NPN transistor.

(*a*) State the name of component X.

(*b*) At a particular temperature the resistance of the thermistor is 21·6 kΩ.

Calculate the voltage across the 2·4 kΩ resistor.

(*c*) As the temperature of this thermistor rises its resistance falls.

Explain how this circuit causes the LED to light when the temperature rises.

29. A coal fired power station is 40% efficient.

The chemical energy available from one tonne of coal is $2{\cdot}8 \times 10^{10}$ J.

(*a*) Show that the total electrical energy that can be produced in this power station from one tonne of coal is $1{\cdot}12 \times 10^{10}$ J.

(*b*) The maximum electrical power output of this power station is $1{\cdot}2 \times 10^{9}$ W.

Calculate how long it takes this power station to burn one tonne of coal at maximum output.

30. Which of the following statements about the absolute zero of temperature is/are true?

I The absolute zero of temperature is 273 K.

II At absolute zero, movement of molecules in an ideal gas stops.

III At absolute zero, the density of an ideal gas is zero.

A I only

B II only

C I and III only

D II and III only

E I, II and III

31. A volt is the same as a

A $J\ C^{-1}$

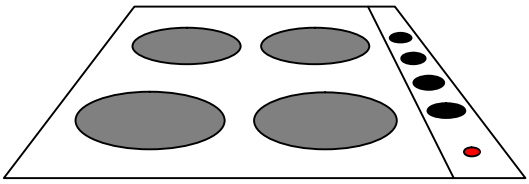
B $J\ s^{-1}$

C $A\ C^{-1}$

D $A\ s^{-1}$

E $W\ C^{-1}$.

32. A ceramic hob on an electric cooker has four identical heating zones.



(*a*) One of the heating zones has a maximum power rating of 1·15 kW.

Calculate the current that this heating zone draws from the mains supply when at its maximum power.

(*b*) Calculate the resistance of the heating zone when it is at its maximum power.

(*c*) The elements that heat the four heating zones on the hob are connected in parallel.

(i) Explain why the elements are connected in parallel.

(ii) Calculate the total resistance of the four elements.

(iii) Calculate the total current drawn from the mains supply when all four elements are at full power.

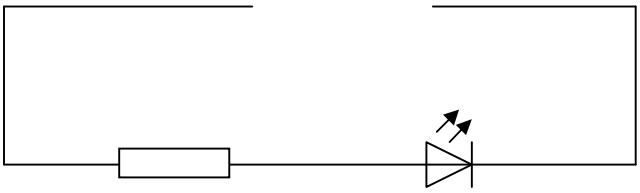
(iv) The following flexes are available for use with the hob.

5 A 10 A 20 A 30 A

Which flex should be used? Justify your choice.

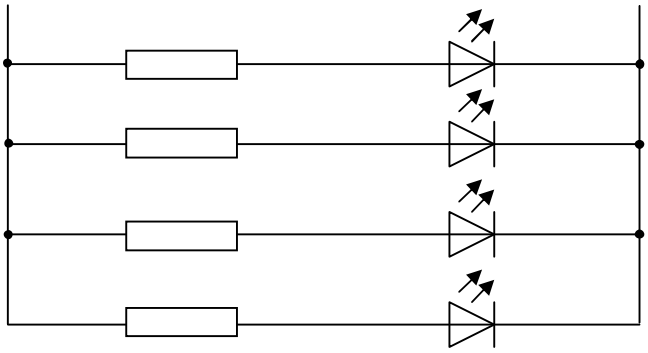
33. A technician wishes to connect an LED into a circuit so that it lights.

(*a*) Complete the diagram below by inserting a battery symbol in the gap so that the LED lights.



(*b*) The LED is rated at 1·5 V, 10 mA. Calculate the resistance of the resistor that should be used in this circuit with a 5·0 V battery.

(*c*) The technician now uses four resistors with this resistance and four LEDs identical to the first to produce a network for a display as shown below.

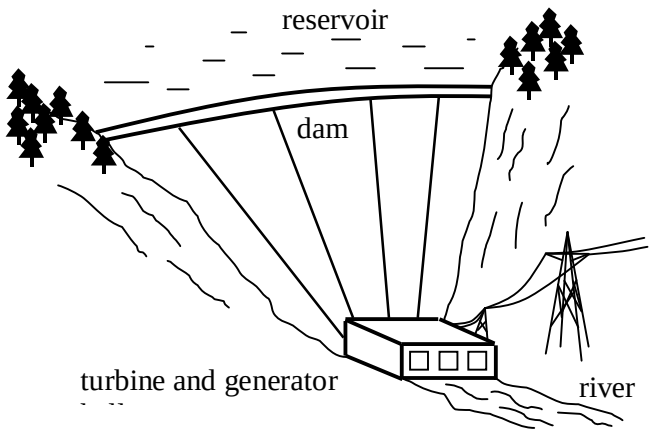


State:

(i) the current drawn from the battery by this network when working normally;

(ii) the voltage of the battery required to operate this network normally.

34. A hydroelectric power station consists of a reservoir behind a dam and turbines and generators at a height of 50·0 m below.



(*a*) State **one** advantage of using a hydroelectric power station rather than one that burns fossil fuels.

(*b*) A mass of $1{\cdot}20 \times 10^5$ kg of water falls through the 50·0 m from the reservoir to the turbines in a time of one minute.

Calculate the power input to the turbines.

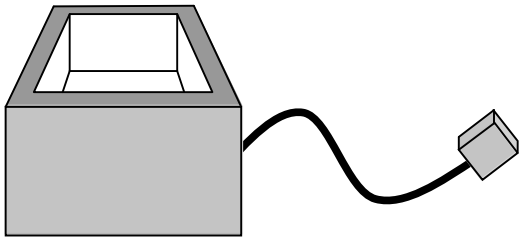
(*c*) The power output from the generators is 400 kW.

Calculate the percentage efficiency of the turbines and generators.

(*d*) The generators produce an alternating voltage of 8·00 kV.

Calculate the current produced by the generators.

35. Some people use a foot spa to ease pain in their feet.



(*a*) A mass of 5·0 kg of water with a temperature of 15°C is placed in the foot spa. An electric heater raises the temperature of the water to 25°C.

Calculate the minimum amount of energy supplied to the water by the electric heater.

(*b*) The water takes 5 minutes to reach 25°C.

Calculate the minimum power of the electric heater.

(*c*) The electric heater is connected to the mains electricity supply.

Calculate the minimum current in the electric heater.

(*d*) Calculate the number of coulombs of charge passing through the heater in 5 minutes.

36. A chairlift at a ski resort carries skiers through a vertical distance of 400 m.

(a) One of the skiers has a mass of 90.0 kg. What is the weight of this skier?

(b) (i) The chairlift carries 3000 skiers of average mass 90.0 kg in one hour.

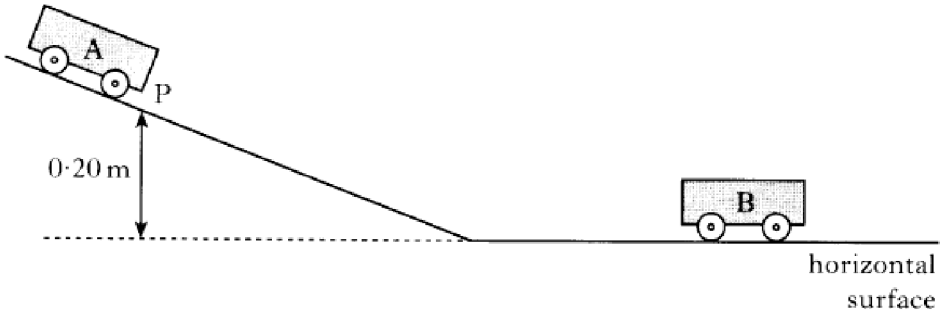
What is the total gravitational potential energy gained by the skiers?

(ii) The chairlift is powered by an electric motor which is 67.5 % efficient.

Calculate the input power to the motor.

37. A cart A of mass 1.2 kg is held at point P on a slope. P is 0.20 m above a horizontal surface.

A second cart B of mass 2.8 kg is placed close to the bottom of the slope as shown.



Cart A is released, runs down the slope and collides with cart B.
The carts stick together and move off along the horizontal surface.

(a) Calculate the change in gravitational potential energy of cart A from point P to the bottom of the slope.

(b) Assuming no energy losses, show that the speed of cart A at the bottom of the slope is 2.0 m/s.