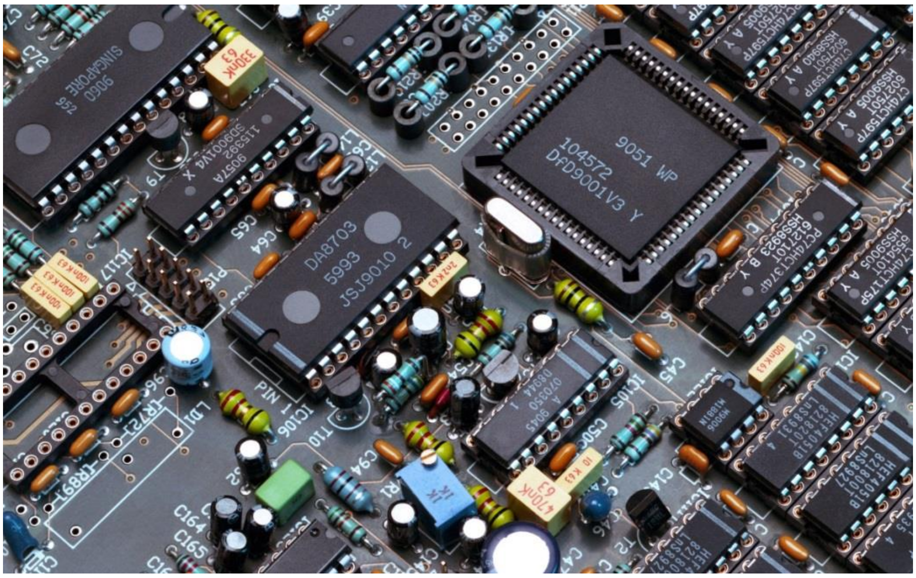
Farr High School

NATIONAL 5 PHYSICS

Unit 1
Electricity and Energy

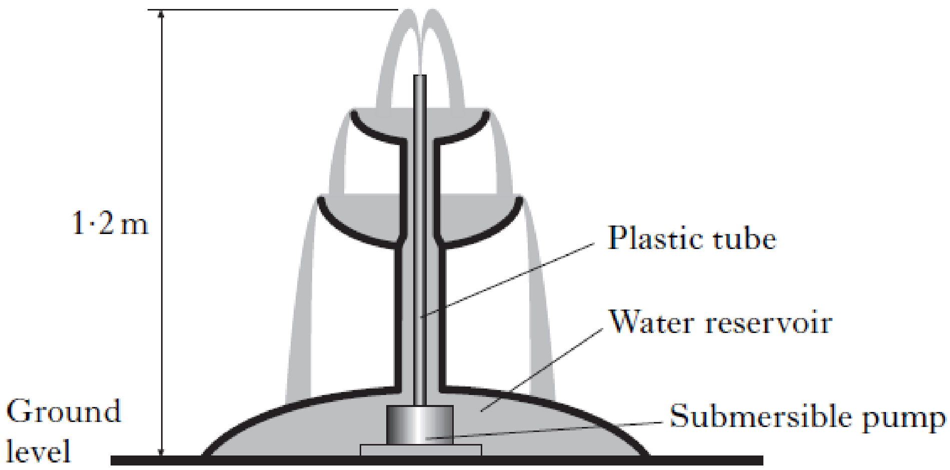


Exam Questions

Conservation of Energy

2011 C 12

1. A small submersible pump is used in a garden water fountain. The pump raises 25 kg of water each minute from a reservoir at ground level.
The water travels through a plastic tube and reaches a height of 1.2m above ground level.



Calculate how much gravitational potential energy the water gains each minute. 3

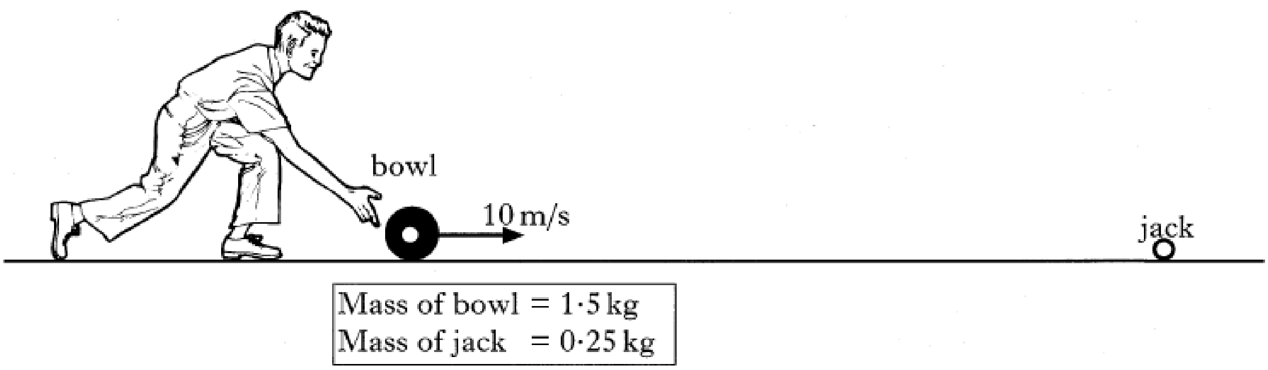
2012 Int2 7 MC

2. An electrical motor raises a crate of mass 500 kg through a height of 12 m in 4 s.
The minimum power rating of the motor is

A 1.25 kW
B 1.5 kW
C 15kW
D 60 kW
E 240 kW 1

2005 Int2 21a

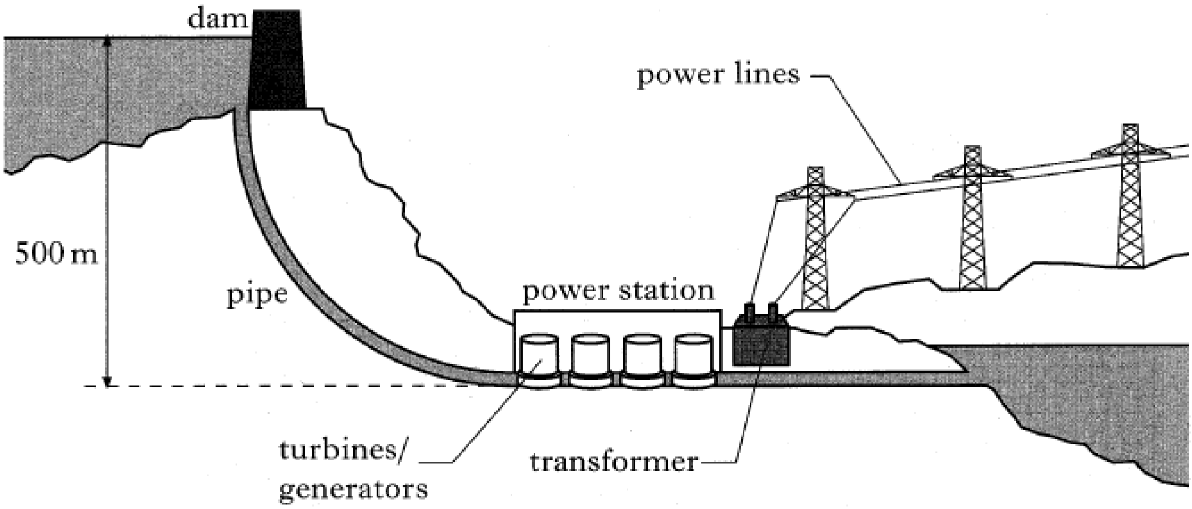
3. In a game of bowls, a bowler releases a bowl with a velocity of 10 ms^{-1}.



Show that the kinetic energy of the bowl when it is released is 75J. 3

2005 Int2 23a

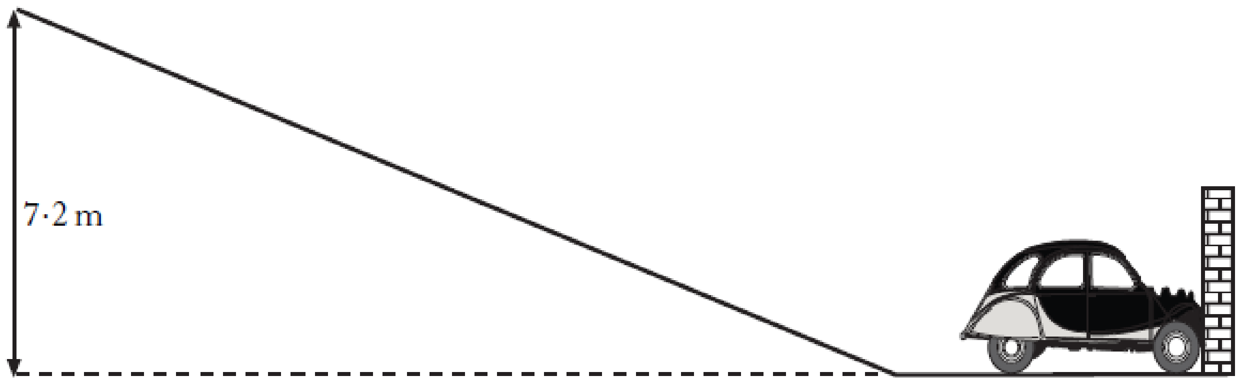
4. A new hydro-electric power station is being planned for the Highlands.



Water is stored in a reservoir at a vertical height of 500m above the power station.
Each second 8000kg of water flows through the power station.
Show that the water loses 40MJ of gravitational potential energy each second. 3

2008 Int2 24

5. An early method of crash testing involved a car rolling down a slope and colliding with a wall. In one test, a car of mass 750 kg starts at the top of a 7.2m high slope.

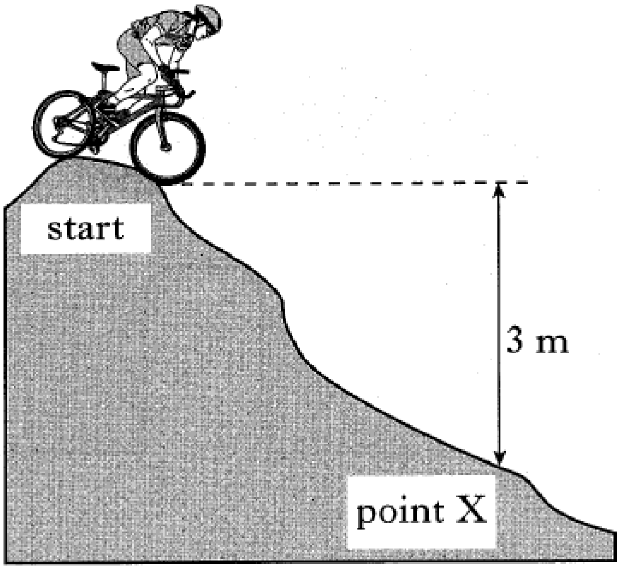


(a) Calculate the gravitional potential energy of the car at the top of the slope. 3

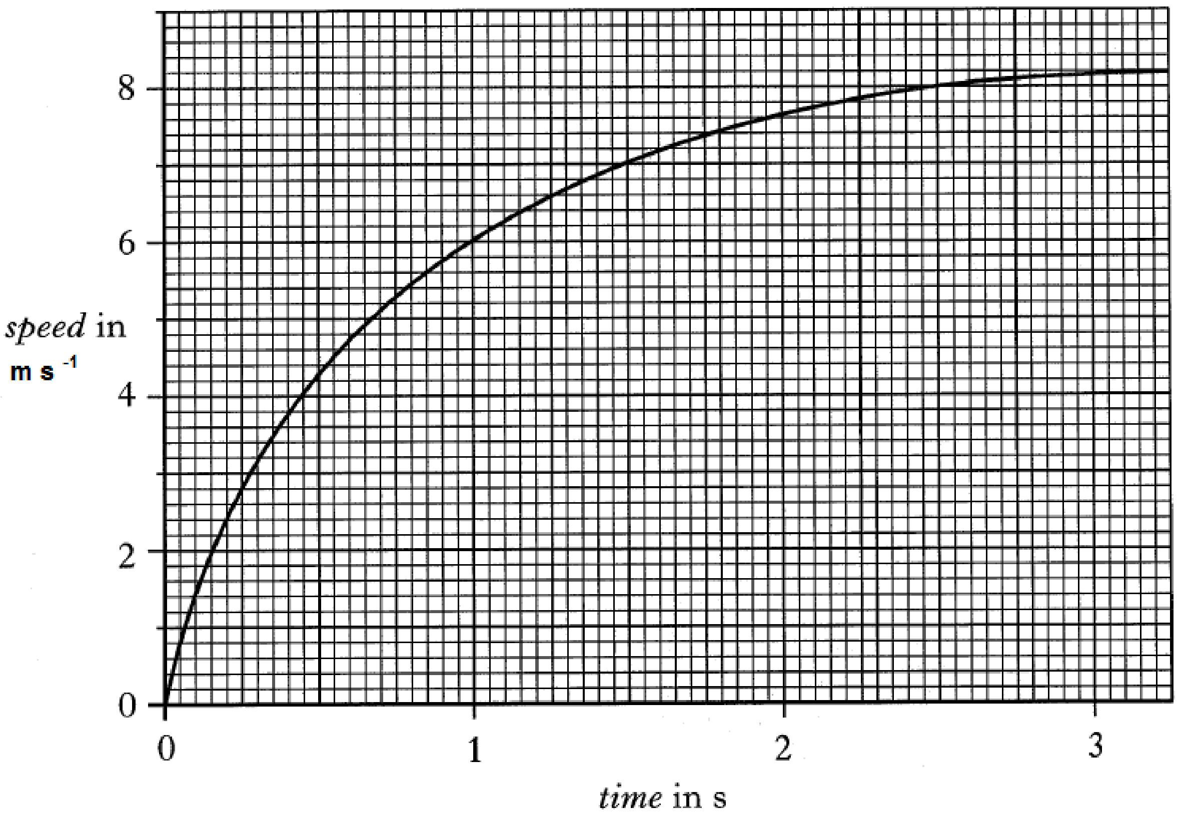
(b) (i) State the value of the kinetic energy of the car at the bottom of the slope, assuming no energy losses. 1

(ii) Calculate the speed of the car at the bottom of the slope, before hitting the wall. 3

6. In a mountain bike competition, a competitor starts from rest at the top of a hill. He pedals downhill and after 2.5 s he passes point X which is 3 m lower than the start. The total mass of the bike and the competitor is 90 kg.



`A speed-time graph for this part of the competitor's journey is shown below.



(a) Calculate the decrease in gravitational potential energy of the competitor and bike between the start and point X. 3

(b) Calculate the kinetic energy of the competitor and bike at point X. 3

(c) Explain the difference between your answers to (a) and (b). 2

Electric Charge Carriers and Electric Fields

2011 Int2 26a

1. A student has two electrical power supplies. One is an a.c. supply and the other is a d.c. supply.
Explain a.c and d.c. in terms of electron flow in a circuit. 2

2011 Int2 8 MC

2. A student makes the following statements about electrical supplies.

I The frequency of the mains supply is 50 Hz.
II The quoted value of an alternating voltage is less than its peak value.
III A d.c supply and an a.c. supply of the same quoted value will supply the same power to a given resistor.

Which of the following statements is/are correct?

A I only
B II only
C III only
D I and II only
E I, II and III 1

2012 Int2 14 MC

3. The current in an 8 Ω resistor is 2 A.
The charge passing through the resistor in 10 s is

A 4 C
B 5 C
C 16 C
D 20 C
E 80C 1

2012 Int2 15 MC

4. Which of the following statements is/ are correct?

I In an a.c. circuit the direction of the current changes regularly.
II In a d.c. circuit positive charges flow in one direction only.
III In an a.c. circuit the size of the current varies with time.

A I only
B II only
C I and II only
D I and III only
E I, II and III 1

2010 Int2 22(c)

5. Inside a storm cloud water droplets move around and collide with each other. The Motion of water droplets in the cloud causes flashes of lightning. One lightning flash transfers 1650C of charge in 0·15 s.
Calculate the electric current produced by this flash. 3

2005 Int2 7MC

6. An ampere is one
A volt per joule
B joule per second
C joule per coulomb
D coulomb per second
E ohm per volt 1

2005 Int2 9MC

7. The charge passing a point in a conductor when a current of 4mA flows for 1000s is
A 0.25C
B 0.4C
C 4C
D 250C
E 4000C 1

2006 Int2 26a

8. Explain the difference between direct current (dc) and alternating current (ac) in terms of the movement of charges in a conductor. 2

Potential Difference (Voltage)

2006 Int2 7MC

1. Which of the following statements is/are correct?

   I The voltage of a battery is the number of joules of energy it gives to each coulomb of charge

   II A battery only has a voltage when it is connected in a complete circuit

   III Electrons are free to move within an insulator

   A I only
   B II only
   C III only
   D II and III only
   E I, II and III 1

2007 Int2 7MC

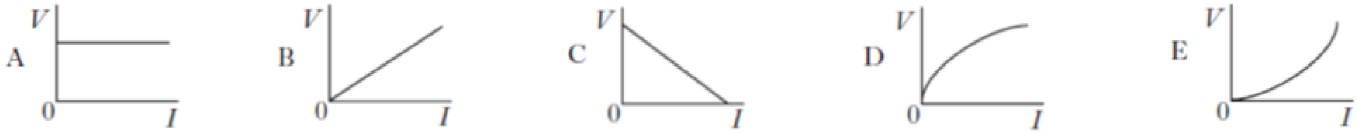
2. The voltage of an electrical supply is a measure of the

   A resistance of the circuit
   B speed of the charges in the circuit
   C energy given to the charges in the circuit
   D power developed in the circuit
   E current in the circuit. 1

Ohm's Law

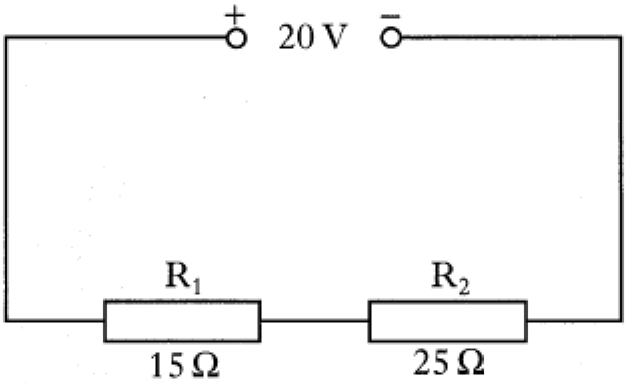
2011 Int2 6 MC

1. Which graph shows how the potential difference V across a resistor varies with the current I in the resistor? 1



2005 Int2 25a

2. A student connects two resistors in series with a power supply set at 20V.

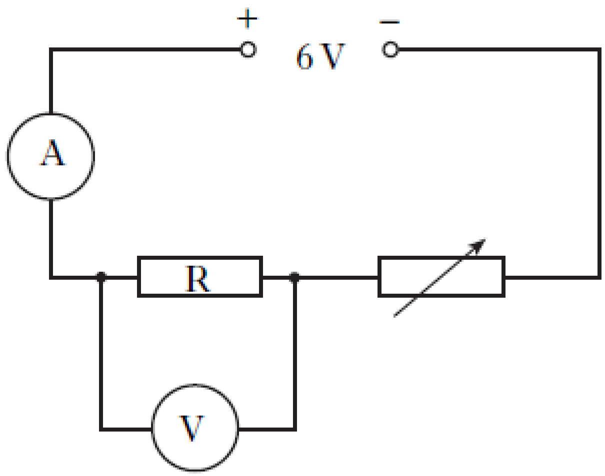


(a) Calculate the current in the circuit. 4

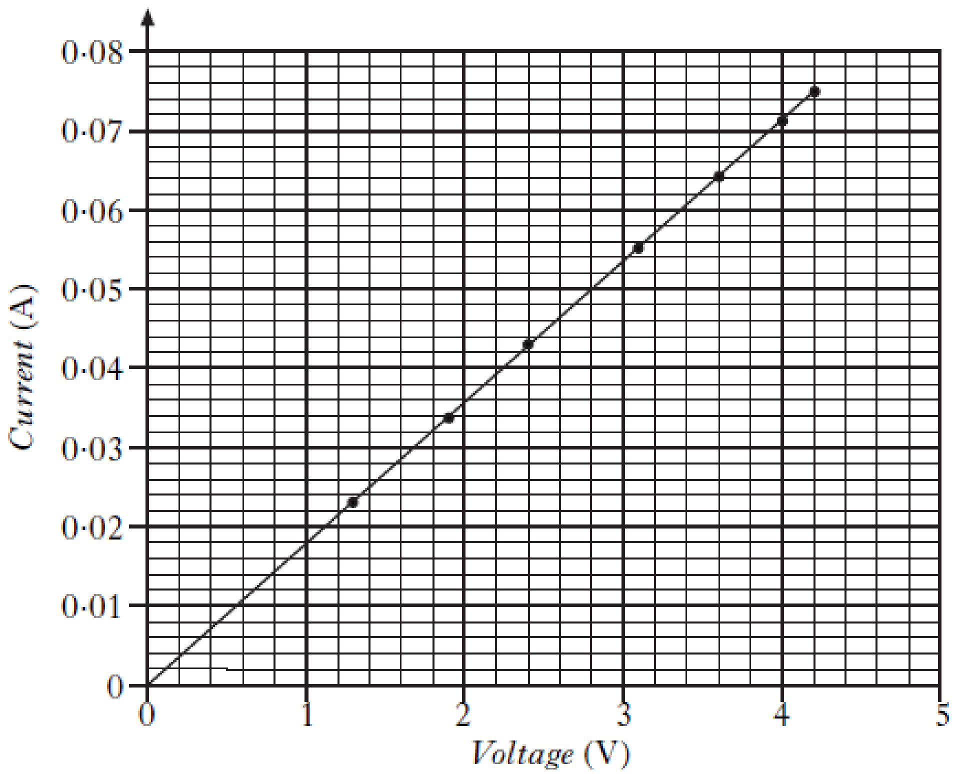
(b) Calculate the potential difference across resistor R_1. 3

(c) Redraw the above circuit diagram showing meters correctly connected to measure the quantities in (a) and (b) above. 2

3. A student sets up the following circuit to investigate the resistance of resistor R.



The variable resistor is adjusted and the voltmeter and ammeter readings are noted. The following graph is obtained from the experimental results.



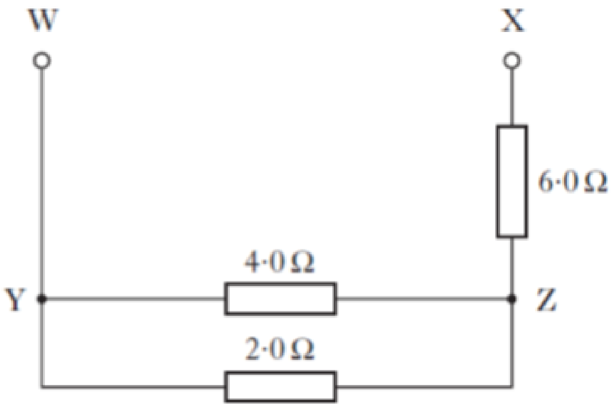
(a) Calculate the value of the resistor R when the reading on the voltmeter is 4.2V. 4

(b) Using information from the graph, state whether the resistance of the resistor R, increases, stays the same or decreases as the voltage increases. Justify your answer. 2

<u>Practical Electrical and Electronic Circuits</u>

2011 Int2 25

1. Part of a circuit is shown below.



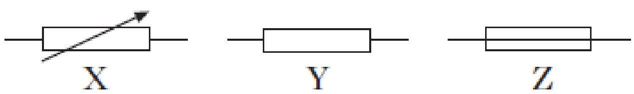
(a) Calculate the total resistance between points Y and Z. 3

(b) Calculate the total resistance between points W and X. 3

(c) Calculate the voltage across the 2.0 Ω resistor when the current in the 4.0 Ω resistor is 0.10 A. 3

2011 Int2 5 MC

2. Which row in the table identifies the following circuit symbols?

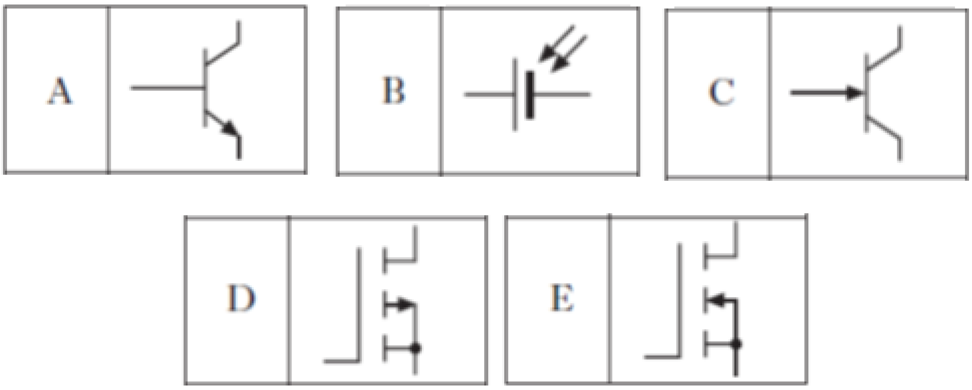


	Symbol X	*Symbol Y*	*Symbol Z*
A	fuse	resistor	variable resistor
B	fuse	variable resistor	resistor
C	resistor	variable resistor	fuse
D	variable resistor	fuse	resistor
E	variable resistor	resistor	fuse

1

2011 Int2 10 MC

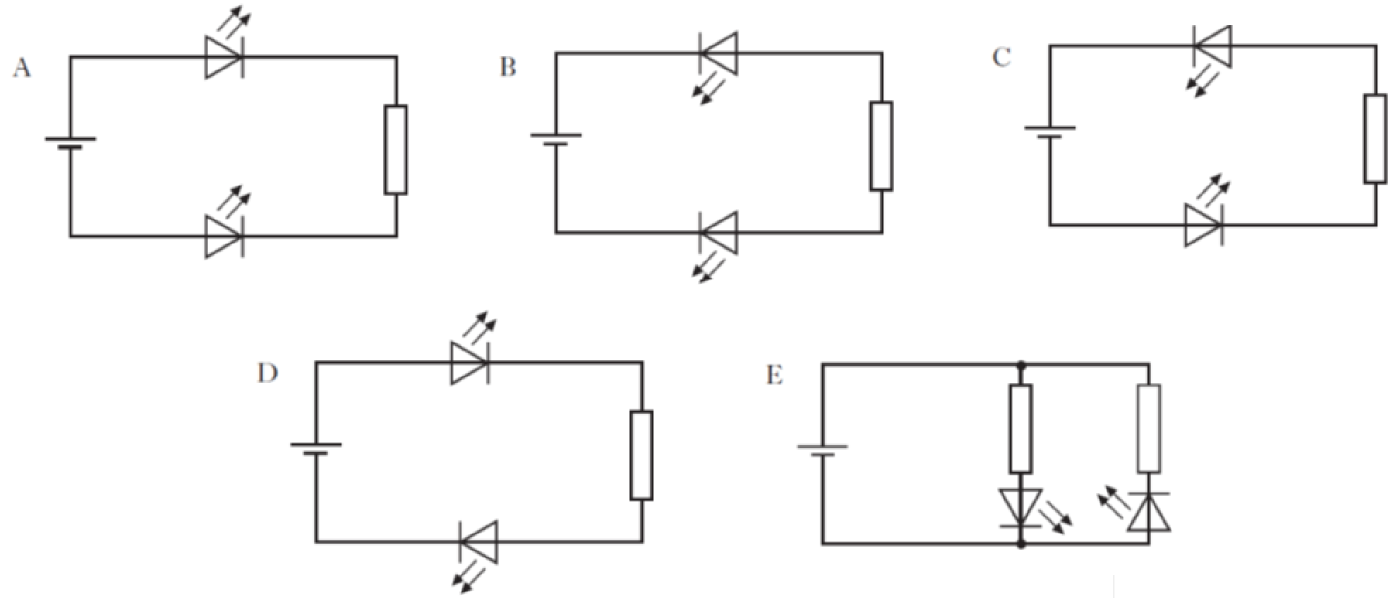
3. Which of the following is the circuit symbol for an NPN transistor?



1

2012 Int2 11 MC

4. A student sets up the circuits shown.
In which circuit will both LEDs be lit? 1

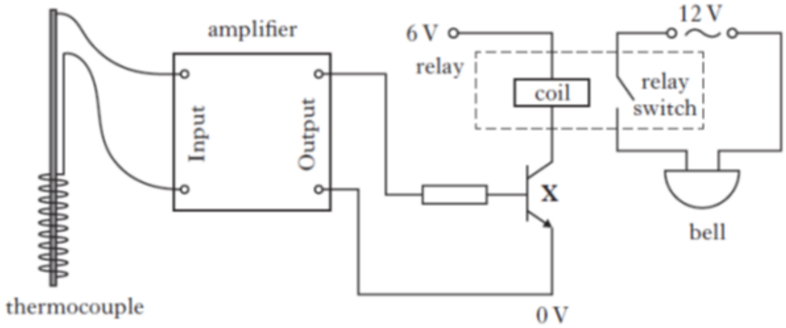


2005 Int2 11MC

5. Which of the following devices converts electrical energy to kinetic energy?
A Motor
B Lamp
C LED
D LDR
E Microphone 1

2013 Credit 8

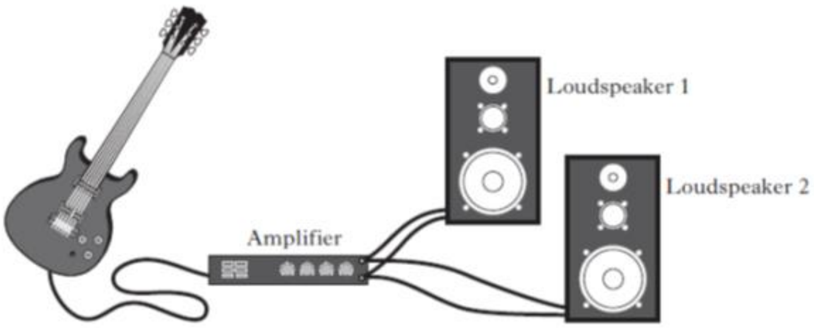
6. A student designs a circuit to act as a high temperature warning device.



(a) Name component X. 1

(b) Explain how the circuit operates to sound the bell when the temperature of the thermocouple reaches a certain value. 2

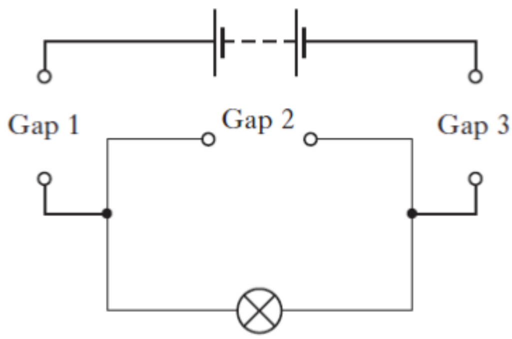
(c) The student also plays an electric guitar. The guitar is connected to a Different amplifier and two loudspeakers as shown.



Each loudspeaker has a resistance of 16 Ω.
Calculate the combined resistance of the two loudspeakers when connected as shown. 3

2013 Int2 8

7. A circuit with three gaps is shown below.

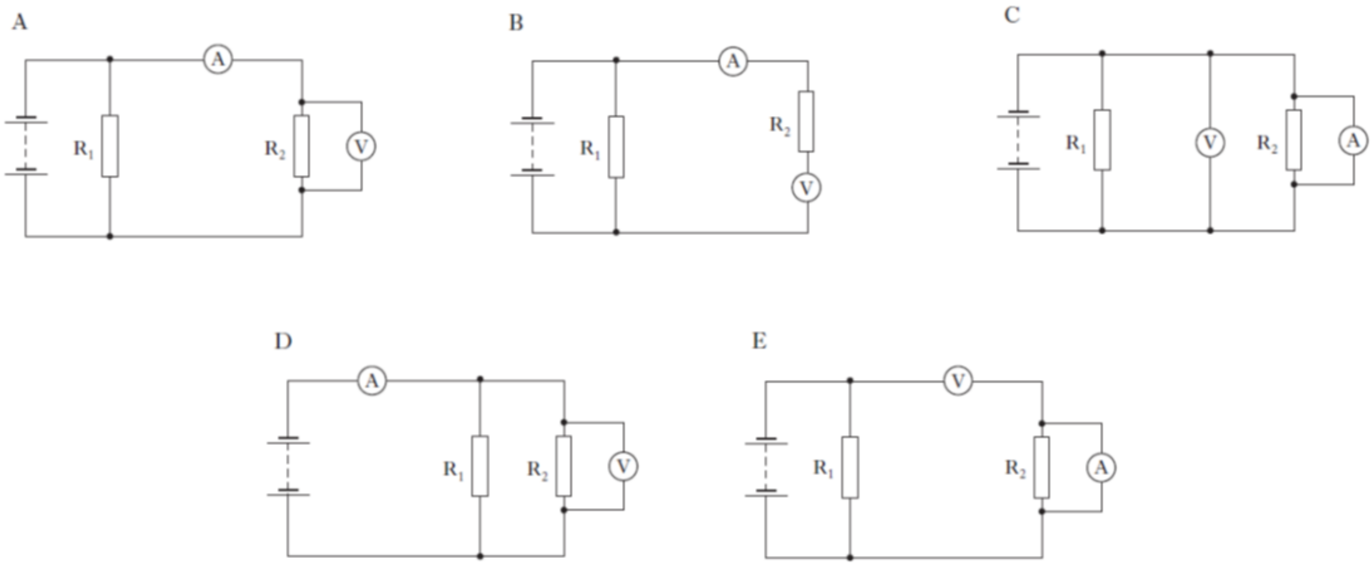


Which row in the table shows the combination of conductors and insulators that should be placed in the gaps to allow the lamp to light? 1

	Gap 1	Gap 2	Gap 3
A	Conductor	Insulator	Conductor
B	Conductor	Conductor	Insulator
C	Conductor	Conductor	Conductor
D	Insulator	Insulator	Conductor
E	Insulator	Insulator	Insulator

2013 Int2 MC 9

8. In which circuit below would the meter readings allow the resistance of R_2 to be calculated? 1



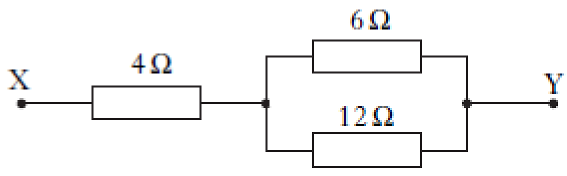
2013 Int2 MC12

9. Which of the following devices converts heat energy into electrical energy?

A Solar cell
B Resistor
C Thermocouple
D Thermistor
E Transistor 1

2010 Int2 8 MC

10. Three resistors are connected as shown.

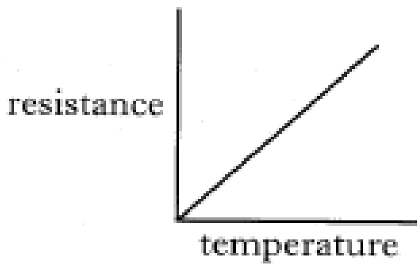


The total resistance between X and Y is
A 2Ω
B 4Ω
C 8Ω
D 13Ω
E 22Ω. 1

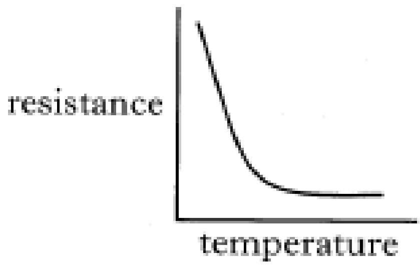
2005 Int2 13MC

11. Which graph shows how the resistance of most thermistors varies with temperature? 1

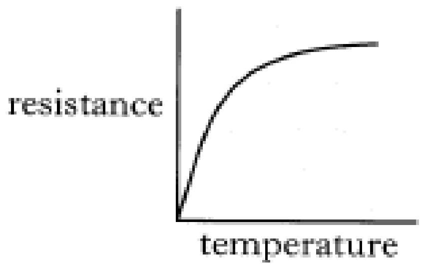
A



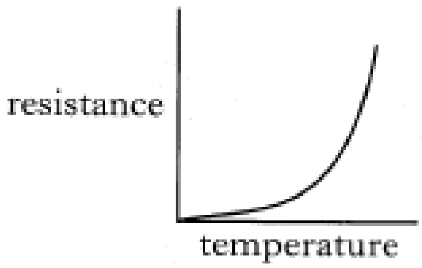
B



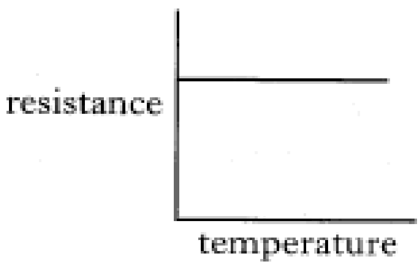
C



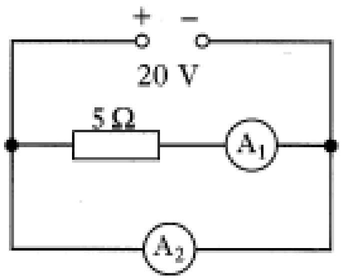
D

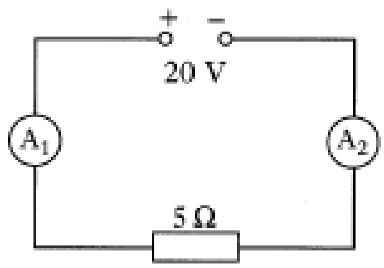


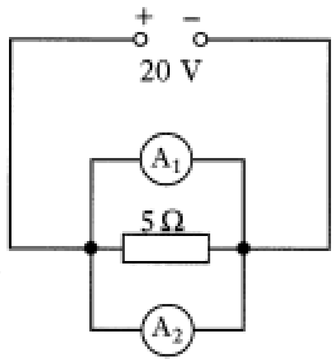
E

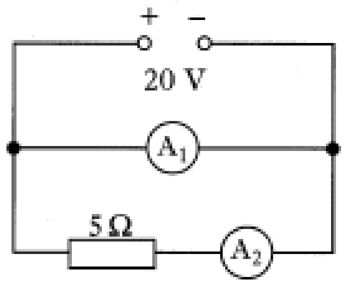


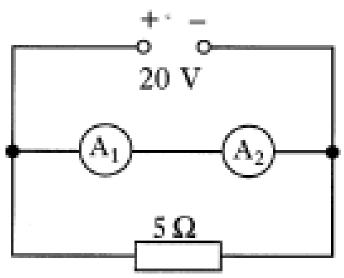
12. A student suspects that ammeter A_1 may be inaccurate. Ammeter A_2 is known to be accurate.
Which of the following circuits should be used to compare A_1 with A_2? 1

A


B


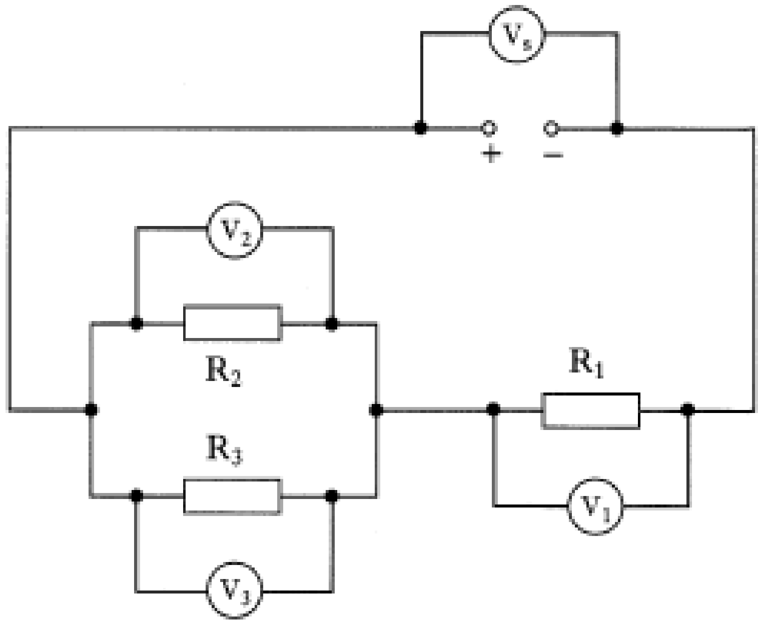
C


D


E


2006 Int2 9MC

13. A circuit is set up as shown.



Which of the following statements about the readings on the voltmeters must always be true?

I $V_1 = V_2$

II $V_2 = V_3$

III $V_s = V_1 + V_2$

A II only

B I and II only

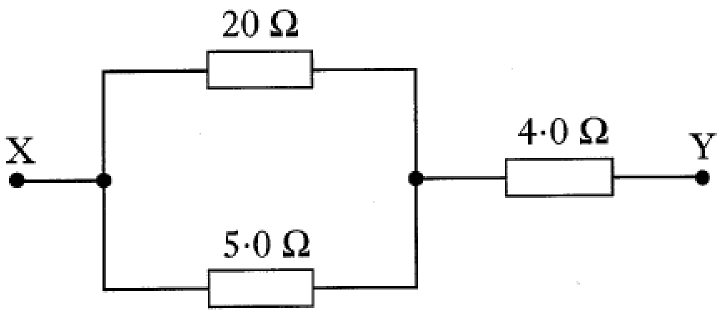
C I and III only

D II and III only

E I, II and III 1

2006 Int2 10MC

14. Three resistors are connected as shown.



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The resistance between X and Y is

A 0.5 Ω

B 2.0 Ω

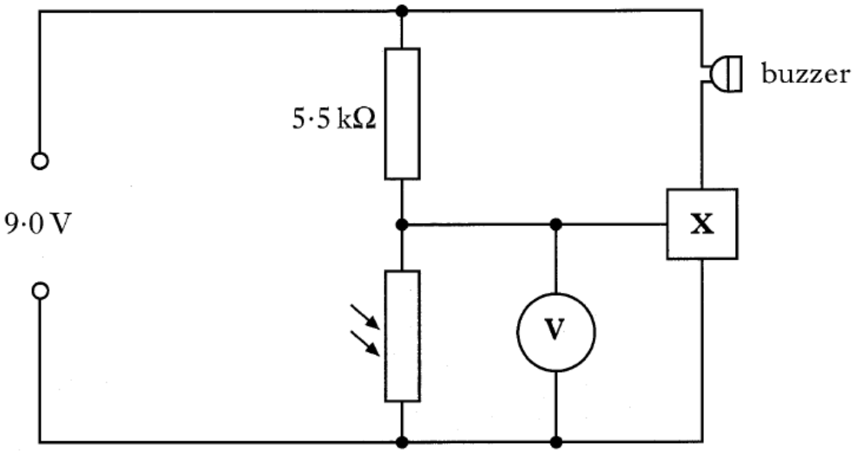
C 4.25 Ω

D 8.0 Ω

E 29 Ω 1

2005 Int2 27

15. A circuit diagram of an electronic system is shown below.
The system is designed to sound a warning when the light intensity falls below a certain level.



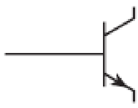
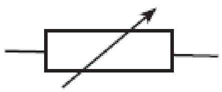
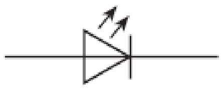
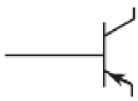
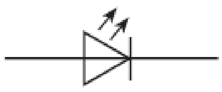
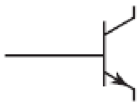
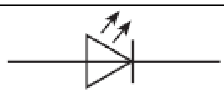
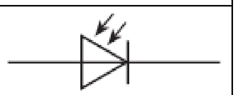
(a) Component X is a transistor.
Two types of transistor are suitable for this system, an NPN transistor and an n-channel enhancement MOSFET.
Draw and name the circuit symbol for each transistor. 2

(b) What is the purpose of the transistor in this system? 1

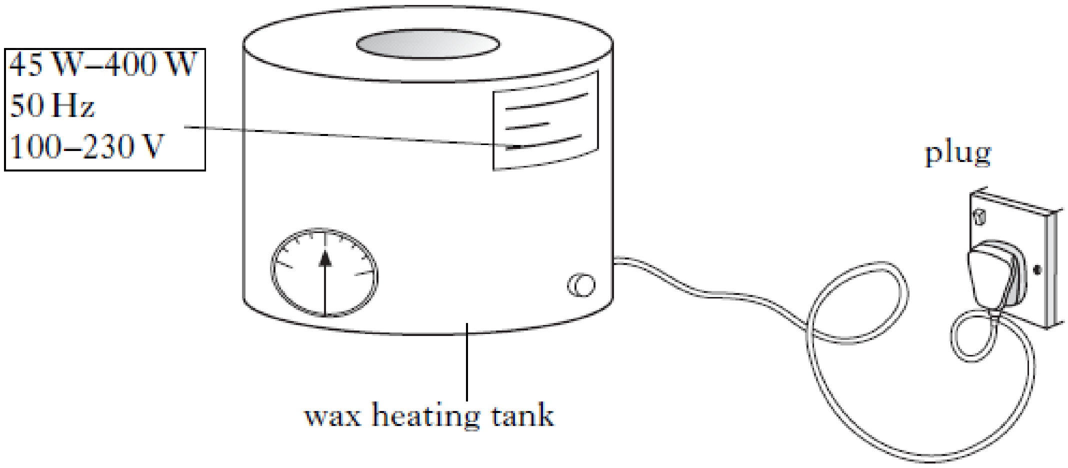
(c) A MOSFET is used at position X.
When the light intensity falls, the voltmeter reading rises to 2.4V and the buzzer sounds.
Calculate the resistance of the LDR when this happens. 4

2007 Int2 11MC

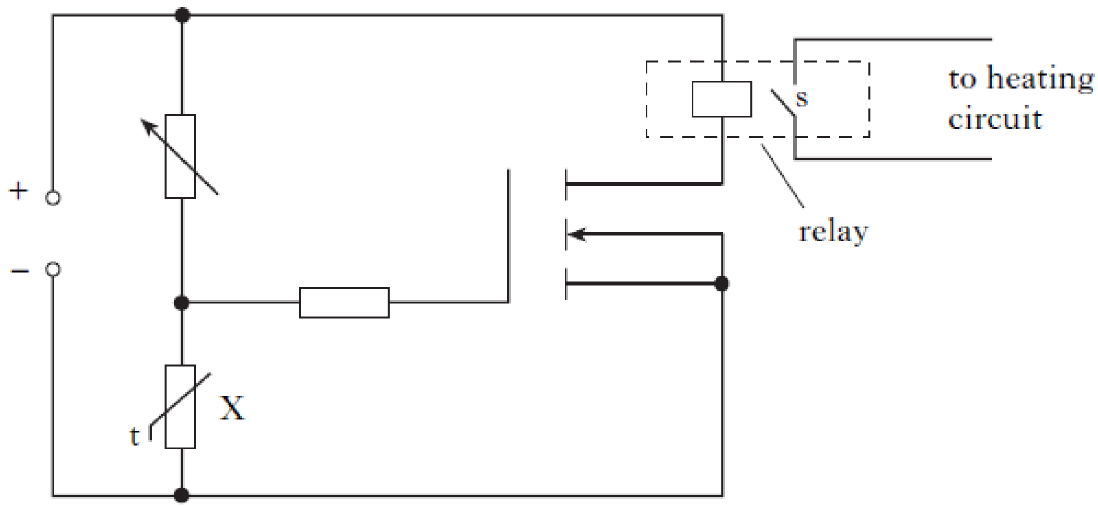
16. Which row in the table shows the symbols for an LED and an NPN transistor? 1

	LED	*NPN transistor*
A		
B		
C		
D		
E		

17. At a beauty salon, a beautician uses hot wax to help remove hair from a client's leg. It is very important that the wax remains at a constant temperature in the heating tank.



When the wax drops below a certain temperature, a heater is automatically switched on. A simplified circuit is shown.



(a) Name component X. 1

(b) Explain how the circuit works to switch the heater on. 3

(c) What is the purpose of the variable resistor? 1

Electrical Power

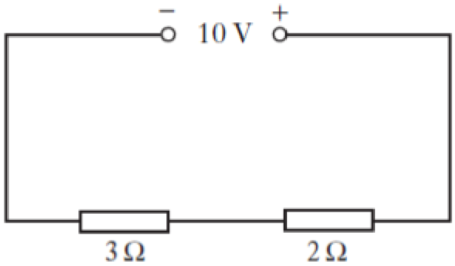
2011 Int2 4 MC

1. An engine applies a force of 2000 N to move a lorry at a constant speed. The lorry travels 100 m in 16 s. The power developed by the engine is

   A 0.8 W
   B 12.5 W
   C 320 W
   D 12500 W
   E 3200000 W — 1

2011 Int2 7 MC

2. A circuit is set up as shown.

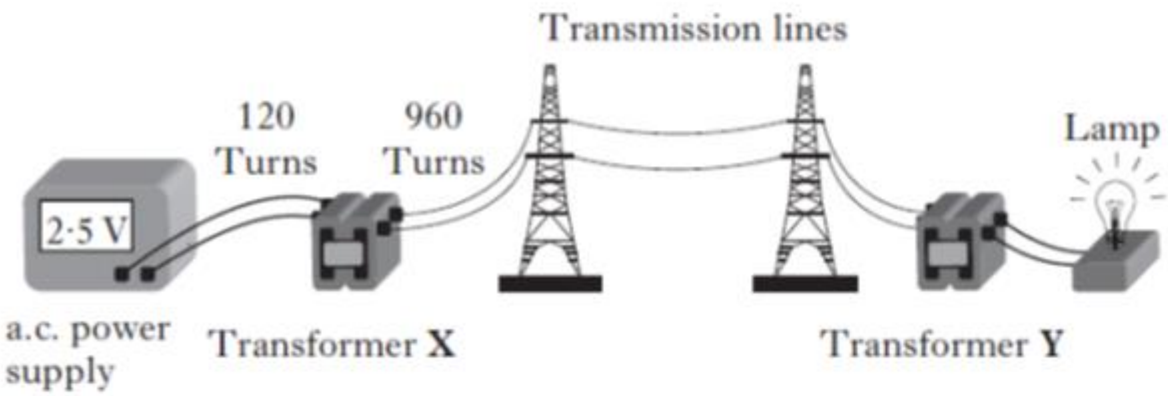


   The potential difference across the 2 W resistor is

   A 4 V
   B 5 V
   C 6 V
   D 10 V
   E 20 V — 1

2012 C 11c

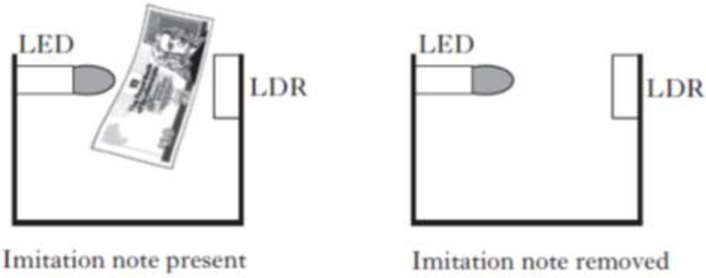
3. Model power transmission lines are set up to demonstrate how electricity is distributed from a power station to consumers.



   The current in the transmission lines is 200 mA. The transmission lines have a total resistance of 20 Ω.
   Calculate the total power loss in these transmission lines. — 3

4. A bank has an alarm system which can be triggered by the cashiers who work behind the counter.

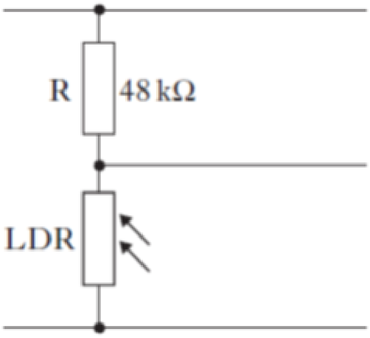
The alarm is triggered when the cashier removes an imitation £20 note from a cash drawer.
A circuit, inside the cash drawer, contains an LED which is directed at an LDR as shown.
When the cashier removes the imitation £20 note the alarm is triggered.



The table shows the resistance of the LDR in different light conditions.

Imitation £20 note	*Resistance* (kΩ)
present	24
removed	2

Part of the cash drawer circuit is shown below.



(a) When the imitation £20 note is removed from the drawer, the voltage across the LDR is 0.36 V.
Calculate the voltage across R. 3

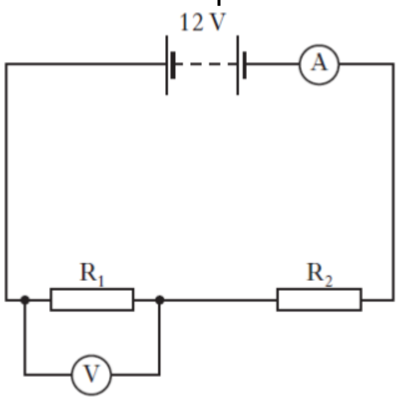
(b) The alarm has a loudspeaker as an output device, which emits a sound when The alarm is triggered. The loudspeaker has a resistance of 48 ▫ and a power of 3.0 W.
Calculate the voltage across the loudspeaker when it sounds. 3

2013 C 5c

5. A patient in a hospital has laser eye surgery. The laser used in the procedure produces 250 pulses of light per second. Each light pulse transfers 60 mJ of energy. Calculate the average power produced by each pulse of light. 4

2013 Int2 10 MC

6. A circuit is set up as shown.

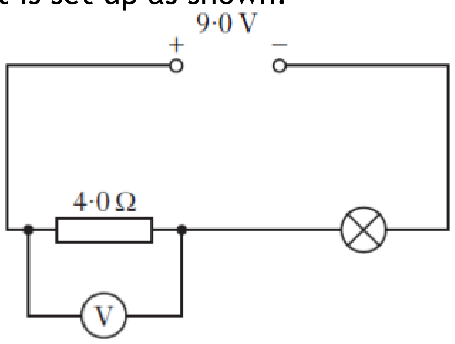


The reading on the ammeter is 3•0 A. The reading on the voltmeter is 4•0 V. Which row in the table shows the current in resistor R2 and the voltage across resistor R_2? 1

	Current in resistor R_2 (A)	Voltage across resistor R_2 (A)
A	1.5	8.0
B	3.0	4.0
C	3.0	8.0
D	1.5	12.0
E	6.0	4.0

2013 Int2 11MC

7. A circuit is set up as shown.



The current in the lamp is 1.5 A. The reading on the voltmeter is 6•0 V. The power developed in the lamp is

A 3.0 W
B 4.5 W
C 6.0 W
D 9.0 W
E 13.5 W 1

2010 Int2 9 MC

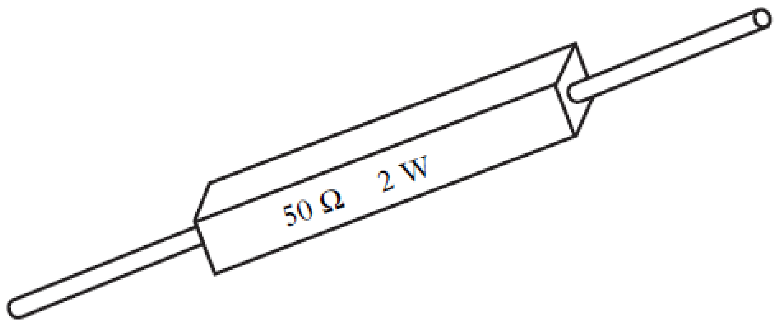
8. The resistance of a wire is 6 Ω.
The current in the wire is 2A.
The power developed in the wire is
A 3W
B 12W
C 18W
D 24W
E 72W. 1

2007 C 4bi

9. A 25 W lamp is designed to be used with mains voltage.
Calculate the resistance of the lamp. 4

2008 Int2 25a

10. Some resistors are labelled with a power rating as well as their resistance value.
This is the maximum power at which they can operate without overheating.

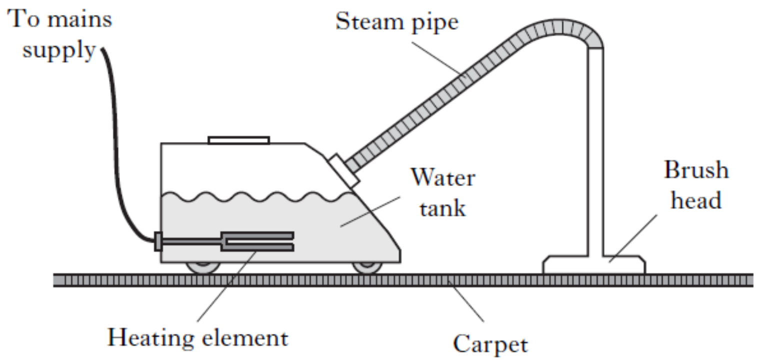


A resistor is labelled 50Ω, 2W.
Calculate the maximum operating current for this resistor. 3

Specific Heat Capacity

2011 C 11

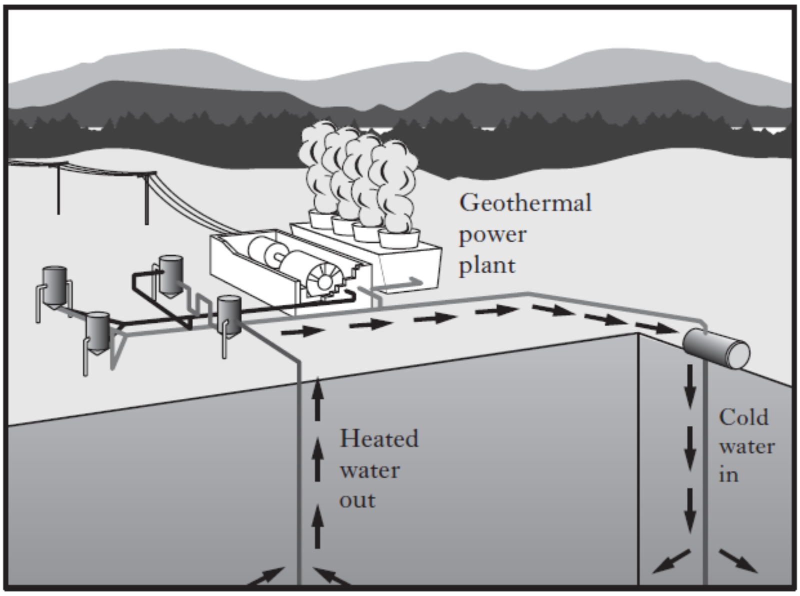
1. A steam cleaner is used to clean a carpet. The water tank is filled with 1.6 kg of water at 20 °C. This water is heated until it boils and produces steam. The brush head is pushed across the surface of the carpet and steam is released.



Calculate how much heat energy is needed to bring this water to its boiling point of 100 °C. 4

2013 C 12

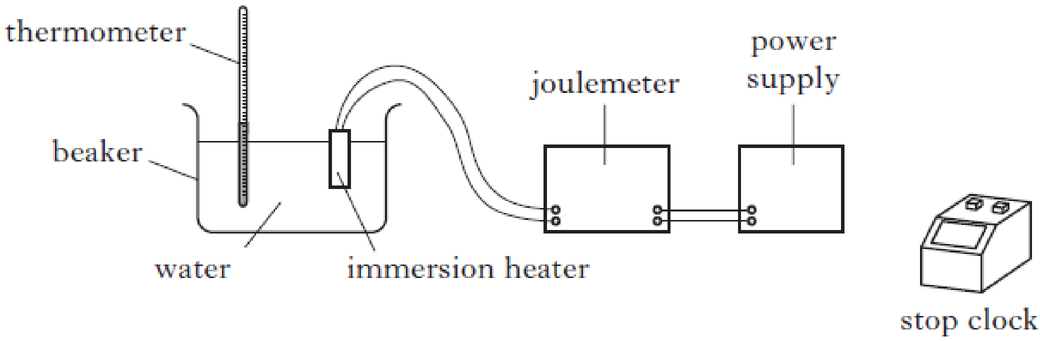
2. An experimental geothermal power plant uses heat energy from deep underground to produce electrical energy. A pump forces water at high pressure down a pipe. The water is heated and returns to the surface. At this high pressure the boiling point of water is 180 °C.



The plant is designed to pump 82 kg of heated water, to the surface, each second. The specific heat capacity of this water is 4320 J kg-1 °C-1.

The water enters the ground at 20 °C and emerges at 145 °C.
Calculate the heat energy absorbed by the water each second. 3

3. An experiment was carried out to determine the specific heat capacity of water. The energy supplied to the water was measured by a joulemeter.



The following data was recorded.
Initial temperature of the water = 21 °C.
Final temperature of the water = 33 °C.
Initial reading on the joulemeter = 12 kJ.
Final reading on the joulemeter = 120 kJ.
Mass of water = 2.0 kg.
Time = 5 minutes.

(a) (i) Calculate the change in temperature of the water. 1

(ii) Calculate the energy supplied by the immersion heater. 1

(iii) Calculate the value for the specific heat capacity of water obtained from this experiment. 3

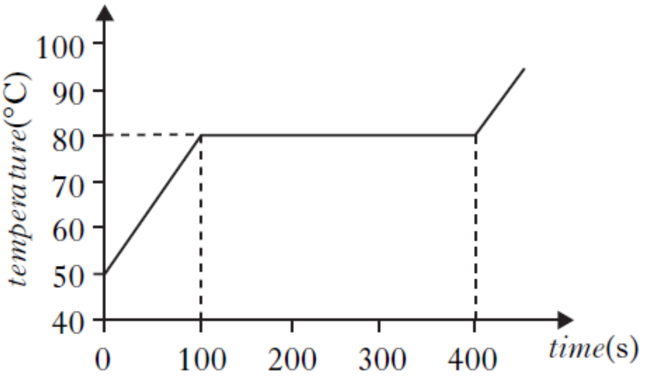
(b) (i) The accepted value for the specific heat capacity of water is quoted in the table in the Data Sheet.
Explain the difference between the accepted value and the value obtained in the experiment. 2

(ii) State how the experiment could be improved to reduce this difference. 1

(c) Calculate the power rating of the immersion heater. 3

2010 Int2 5 MC

4. 100 g of a solid is heated by a 50W heater. The graph of temperature of the substance against time is shown.



The specific latent heat of fusion of the substance is

A $1{\cdot}3 \times 10^3$ Jkg^{-1}
B $1{\cdot}5 \times 10^3$ Jkg^{-1}
C $3{\cdot}0 \times 10^3$ Jkg^{-1}
D $1{\cdot}5 \times 10^5$ Jkg^{-1}
E $1{\cdot}9 \times 10^5$ Jkg^{-1}. 1

2010 Int2 23

5. On the planet Mercury the surface temperature at night is –173 °C. The surface temperature during the day is 307 °C. A rock lying on the surface of the planet has a mass of 60 kg.

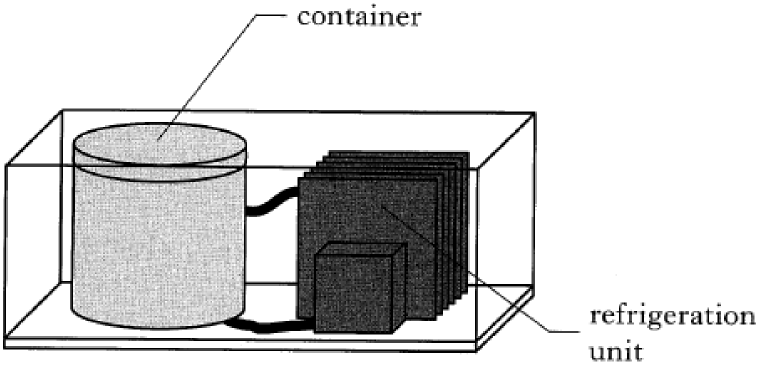
(a) The rock absorbs 2·59 × 107 J of heat energy from the Sun during the day.
Calculate the specific heat capacity of the rock. 3

(b) Heat is released at a steady rate of 1440 J/s at night.
Calculate the time taken for the rock to release 2·59 × 107J of heat. 3

(c) Energy from these rocks could be used to heat a base on the surface of Mercury.
How many 60 kg rocks would be needed to supply a 288 kW heating system? 3

2005 Int2 24

6. An ice cream maker has a refrigeration unit which can remove heat at 120 Js^{-1}. Liquid ice cream, of mass 0.6kg at a temperature of 20 °C, is added to the container.



(a) Calculate how much energy must be removed from the mixture to cool it to its freezing point of -16°C.
(Specific heat capacity of ice cream = 2100 J kg^{-1} °C^{-1}) 3

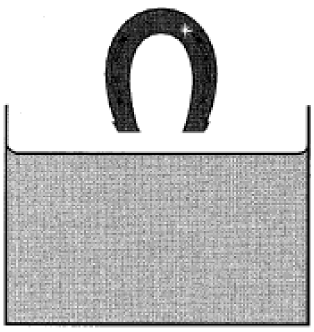
(b) Calculate how much heat energy must be removed to freeze the ice cream at this temperature.
(Specific latent heat of fusion of ice cream = 2.34 x 10^5 J kg^{-1}) 3

(c) (i) Calculate the time taken to cool and freeze the ice cream. 4

(ii) What assumption have you made in carrying out this calculation? 1

2006 Int2 24

7. A blacksmith cools a hot iron horse-shoe of mass 0.75 kg by dropping it into water. The mass of the water is 15 kg and its initial temperature is 17°C. Heat energy from The iron warms the water until both the iron and the water are at 23°C.



(a) Calculate the heat energy absorbed by the water. 3

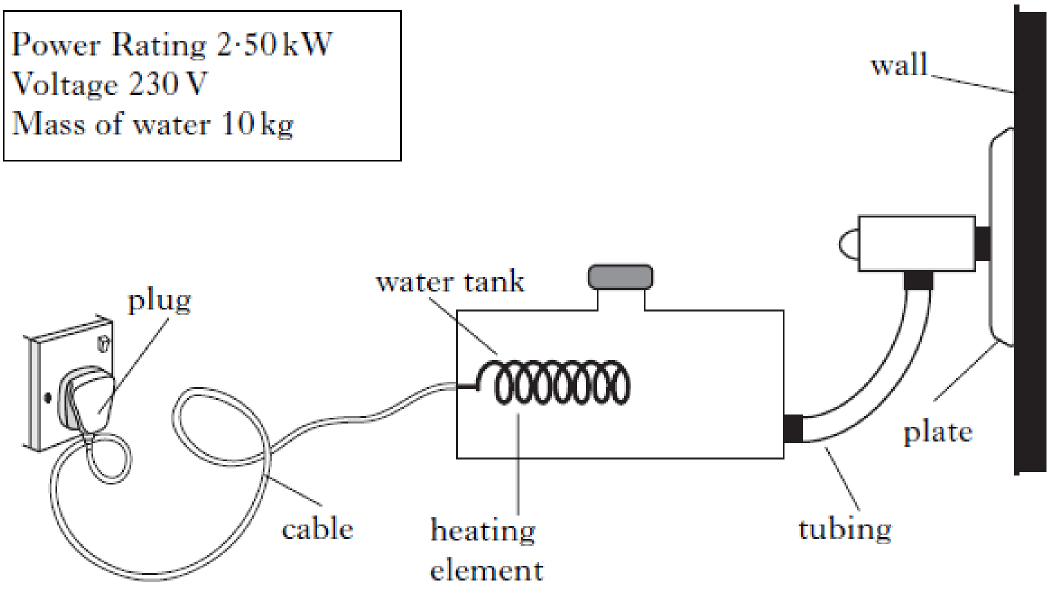
(b) Calculate the initial temperature of the horse shoe. 3

(c) State **one** assumption required for the calculation in part (b). 1

(d) What would happen to the temperature rise of the liquid if the blacksmith had replaced the water with the same mass of oil? You **must** explain your answer. 2

8. A steam wallpaper stripper is used on the walls of a room.
Water is heated until it boils and produces steam. The plate is held against the wall and steam is released from the plate.

Power Rating 2·50 kW
Voltage 230 V
Mass of water 10 kg



The tank is filled with water. The water has an initial temperature of 20 °C.

(a) Calculate the energy required to bring the water to its boiling point. 3

(b) Calculate the time taken for this to happen. 3

(c) The actual time taken for this to happen was found to be longer than that calculated in (b). Explain why. 1

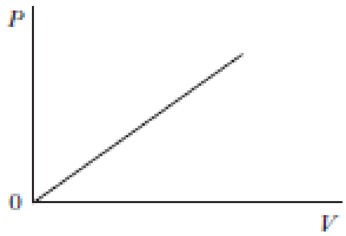
Gas Laws and the Kinetic Model

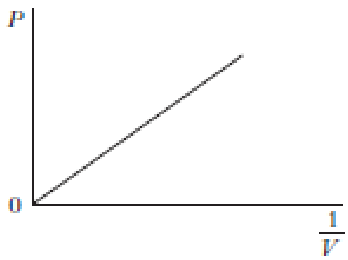
2013 H 7MC

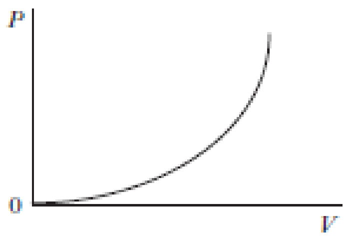
1. The pressure of a gas in a sealed syringe is $1{\cdot}5 \times 10^5$ Pa.
   The temperature of the gas is 27 °C.
   The temperature of the gas is now raised by 10 °C and the volume of the gas halved.
   The new pressure of the gas in the syringe is
   A $1{\cdot}1 \times 10^5$ Pa
   B $2{\cdot}8 \times 10^5$ Pa
   C $3{\cdot}1 \times 10^5$ Pa
   D $4{\cdot}1 \times 10^5$ Pa
   E 11×10^5 Pa. 1

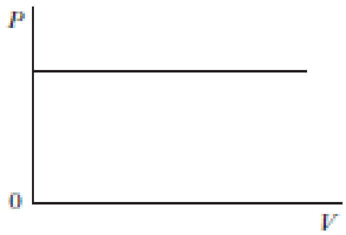
2012 H 7MC

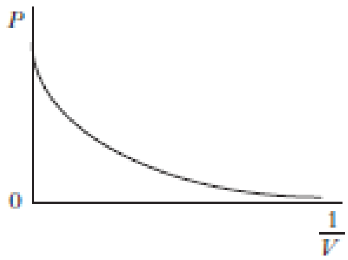
2. Which of the following graphs shows the relationship between the pressure P and the volume V of a fixed mass of gas at constant temperature?

A


B


C


D


E


2011 H 5MC

3. An aircraft cruises at an altitude at which the external air pressure is $0·40 \times 10^5$ Pa. The air pressure inside the aircraft cabin is maintained at $1·0 \times 10^5$ Pa.
The area of an external cabin door is $2·0$ m^2.
What is the outward force on the door due to the pressure difference?
A $0·30 \times 10^5$ N
B $0·70 \times 10^5$ N
C $1·2 \times 10^5$ N
D $2·0 \times 10^5$ N
E $2·8 \times 10^5$ N

2011 H 7MC

4. A fixed mass of gas is heated inside a rigid container. As its temperature changes from T_1 to T_2 the pressure increases from $1·0 \times 10^5$ Pa to $2·0 \times 10^5$ Pa.
Which row in the table shows possible values for T_1 and T_2?

	T_1	T_2
A	27 °C	327 °C
B	30 °C	60 °C
C	80 °C	40 °C
D	303 K	333 K
E	600 K	300 K

2009 H 6MC

5. The density of the gas in a container is initially 5.0kgm^{-3}.
Which of the following increases the density of the gas?

I Raising the temperature of the gas without changing its mass or volume.
II Increasing the mass of the gas without changing its volume or temperature.
III Increasing the volume of the gas without changing its mass or temperature.

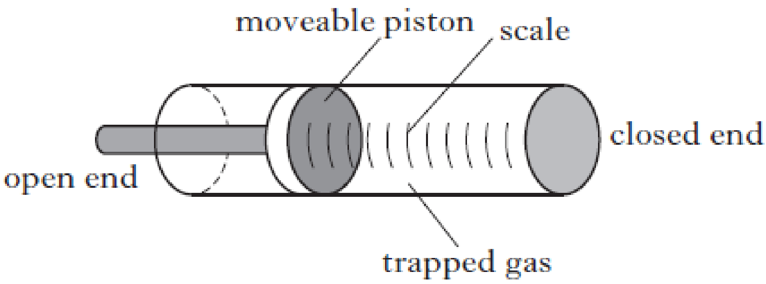
A II only
B III only
C I and II only
D II and III only
E I, II and III

2008 H 7MC

6. One pascal is equivalent to
A 1 Nm
B 1 Nm^2
C 1 Nm^3
D 1 Nm^{-2}
E 1 Nm^{-3}.

2013 H 24abii

7. A diver is measuring the pressure at different depths in the sea using a simple pressure gauge. Part of the pressure gauge consists of a cylinder containing gas trapped by a moveable piston.



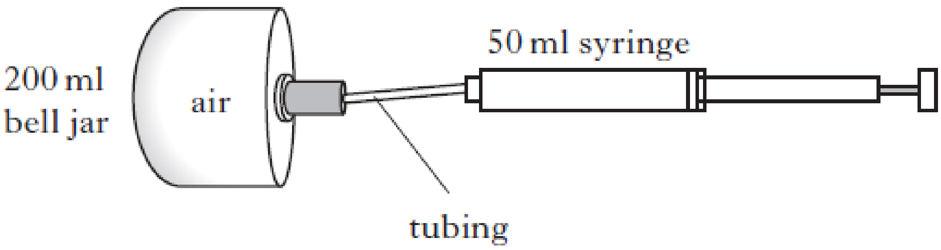
At sea level, the atmospheric pressure is $1{\cdot}01 \times 10^5$ Pa and the trapped gas exerts a force of 262 N on the piston.

(*a*) Calculate the area of the piston. 3

(*b*) The diver now descends to a depth, *h*, where the gauge registers a total pressure of $5{\cdot}13 \times 10^5$ Pa. The temperature of the trapped gas remains constant.
While at this depth, a bubble of gas is released from the diver's breathing apparatus.
State what happens to the volume of this bubble as it rises to the surface.
Justify your answer. 1

2011 H 23b

8. A technician uses the equipment shown to investigate the relationship between the volume and pressure of a gas at constant temperature.

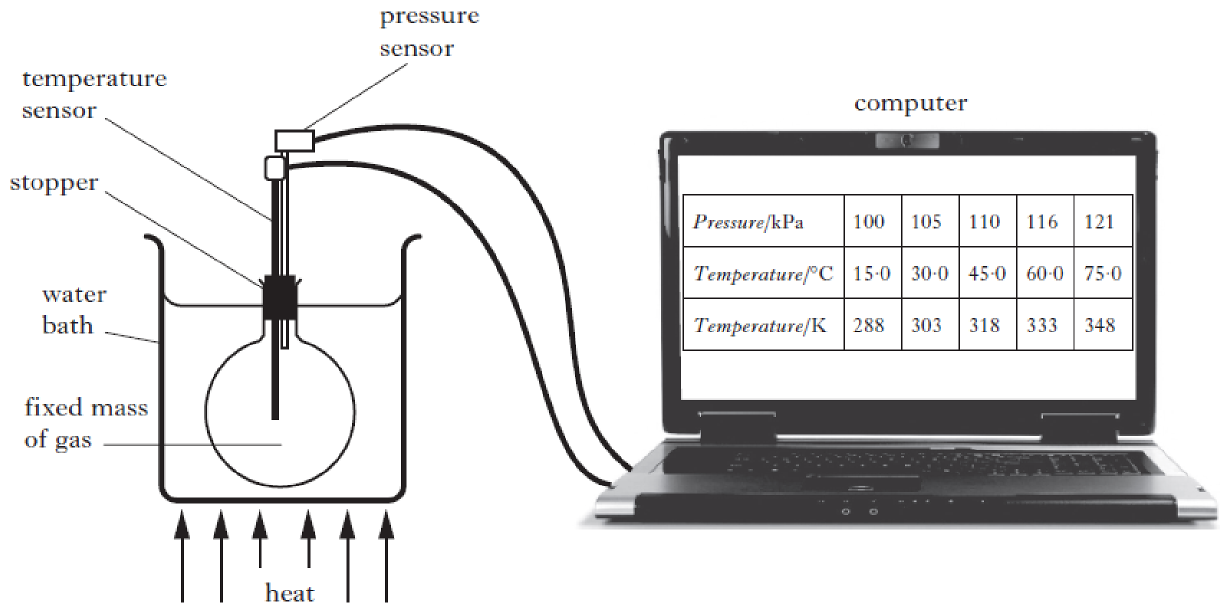


The pressure in the bell jar is $1{\cdot}01 \times 10^5$ Pa.

(a) The technician uses a syringe to remove 50 ml of the air from the bell jar.
Calculate the new pressure of the air inside the bell jar. 3

(b) Use the kinetic model to explain this change in pressure after removing air with the syringe. 4

9. A student carries out an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas. The apparatus used is shown.



The pressure and temperature of the gas are recorded using sensors connected to a computer. The gas is heated slowly in the water bath and a series of readings is taken. The volume of the gas remains constant during the experiment.
The results are shown.

Pressure/kPa	100	105	110	116	121
Temperature/°C	15·0	30·0	45·0	60·0	75·0
Temperature/K	288	303	318	333	348

(a) Using all the relevant data, establish the relationship between the pressure and the temperature of the gas. 2

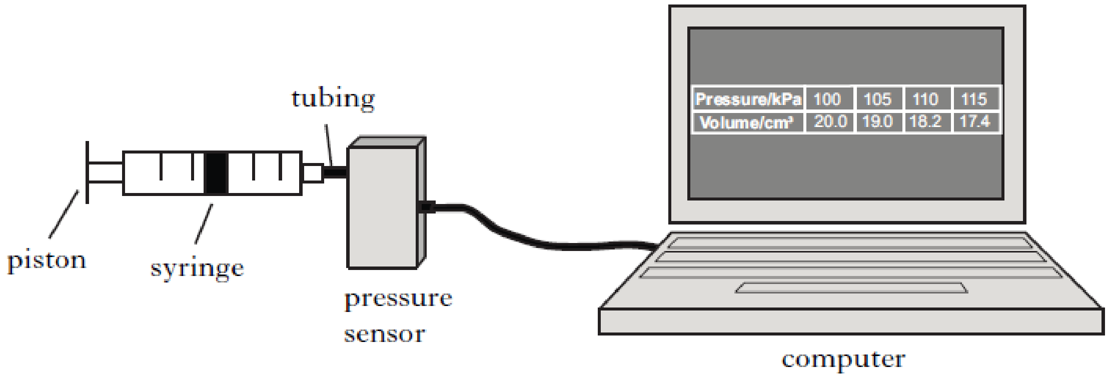
(b) Use the kinetic model to explain the change in pressure as the temperature of the gas increases. 3

(c) Explain why the level of water in the water bath should be above the bottom of the stopper. 1

2009 H 23ac

10. A student is training to become a diver.

(a) The student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.



The pressure of the gas is recorded using a pressure sensor connected to a computer. The volume of the gas is also recorded. The student pushes the piston to alter the volume and a series of readings is taken.
The temperature of the gas is constant during the experiment.
The results are shown.

Pressure/kPa	100	105	110	115
Volume/cm^3	20·0	19·0	18·2	17·4

(i) Using all the data, establish the relationship between the pressure and volume of the gas. 2

(ii) Use the kinetic model to explain the change in pressure as the volume of gas decreases. 3

(b) The diver goes to dive in a loch. At a depth of 12.0 m, the total pressure is 2.21 × 105Pa.the diver fills her lungs with air from her breathing apparatus. She then swims to the surface.
Explain why it would be dangerous for her to hold her breath while doing this. 3

2008 H 23ai

11. A cylinder of compressed oxygen gas is in a laboratory.

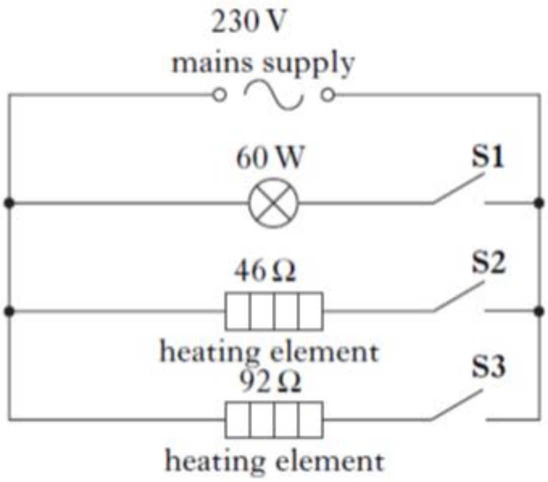
The oxygen inside the cylinder is at a pressure of 2.82×10^6 Pa and a temperature of 19.0 °C.
The cylinder is now moved to a storage room where the temperature is 5.0 °C.
Calculate the pressure of the oxygen inside the cylinder when its temperature is 5.0 °C. 3

Various

2011 C 3

1. A mains electric fire has two heating elements which can be switched on and off separately. The heating elements can be switched on to produce three different heat settings: LOW, MEDIUM and HIGH. The fire also has an interior lamp which can be switched on to give a log-burning effect.

The circuit diagram for the fire is shown.



(a) When switch S1 is closed, the lamp operates at its stated rating of 60W. Calculate the current in the lamp. 3

(b) Switch S1 is opened and switches S2 and S3 are closed.

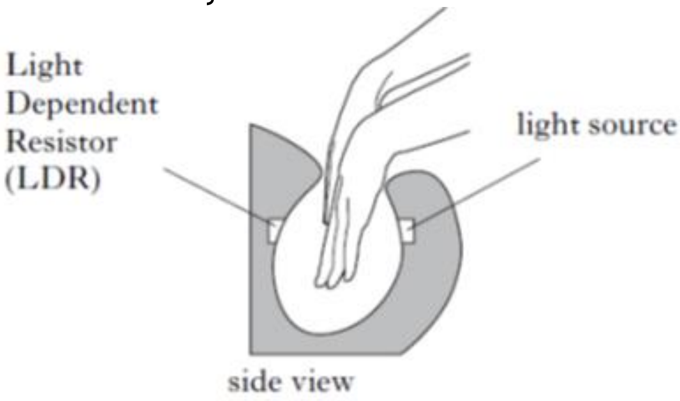
(i) Calculate the combined resistance of both heating elements. 3

(ii) Calculate the total power developed in the heating elements when S2 and S3 are closed. 3

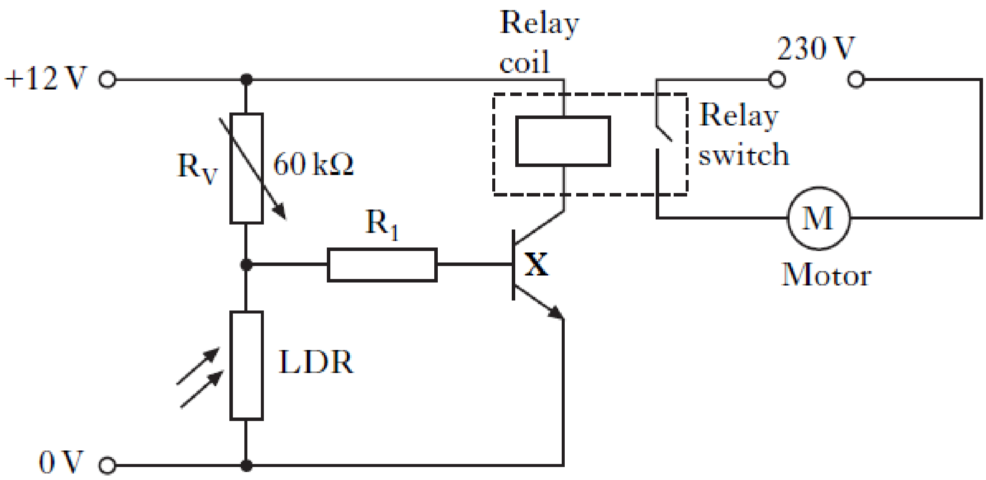
(iii) (A) State which switch or switches would have to be closed to produce the LOW heat setting. 1

(B) Explain your answer to (b) (iii) (A). 1

2. An automatic hand dryer used in a washroom is shown in the diagram below.



Inserting hands into the dryer breaks a light beam, this is detected using a light dependent resistor (LDR). The LDR is part of a switching circuit which activates the dryer when hands are inserted.
Part of the circuit for the hand dryer is shown.

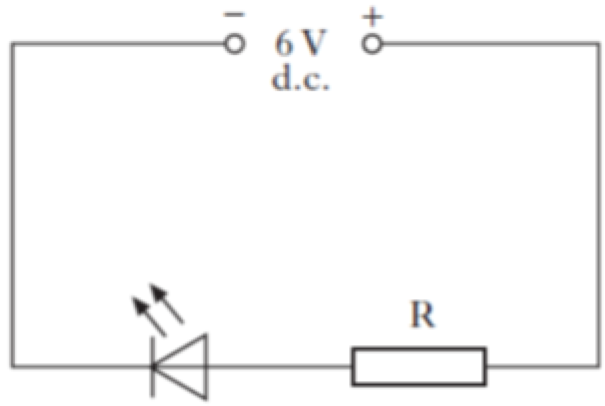


(a) The variable resistor RV is set to a resistance of 60 k.
Calculate the voltage across the LDR when its resistance is 4 kΩ. 3

(b) Name component X in the circuit diagram. 1

(c) Explain how this circuit operates to activate the motor in the dryer when the light level falls below a certain value. 2

3. Light emitting diodes (LEDs) are often used as on/off indicators on televisions and computers.
An LED is connected in a circuit with a resistor R.

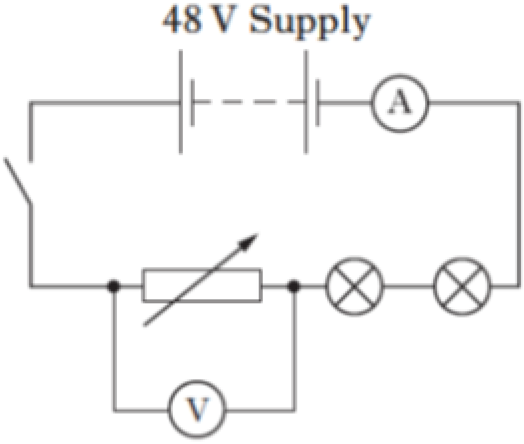


(a) State the purpose of resistor R. 1

(b) The LED is rated at 2 V, 100 mA.
Calculate the resistance of resistor R. 4

(c) Calculate the power developed by resistor R when the LED is working normally. 3

4. A student sets up a circuit to operate two identical 12 V, 36 W lamps from a 48 V supply.



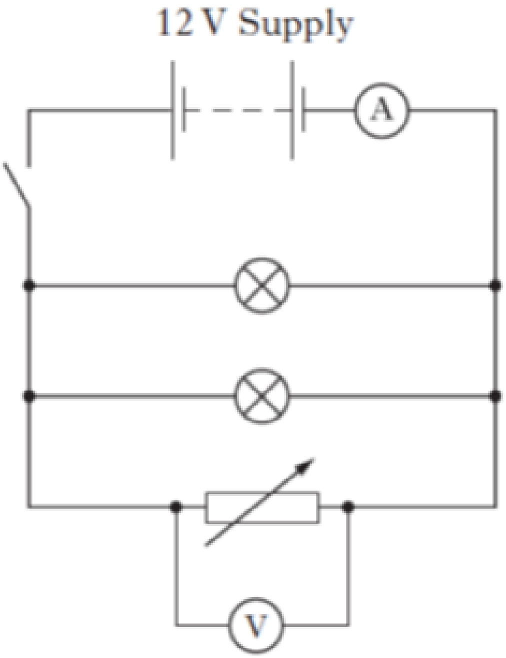
(a) When the switch is closed, the lamps operate at their correct power rating. Calculate:

(i) the reading on the ammeter; 3

(ii) the reading on the voltmeter; 1

(iii) the resistance of the variable resistor. 3

(b) The student sets up a second circuit using a 12 V supply and the same lamps. Each lamp has a resistance of 4 ¤. The resistance of the variable resistor is set to 6 Ω.



(i) Calculate the total resistance of this circuit. 3

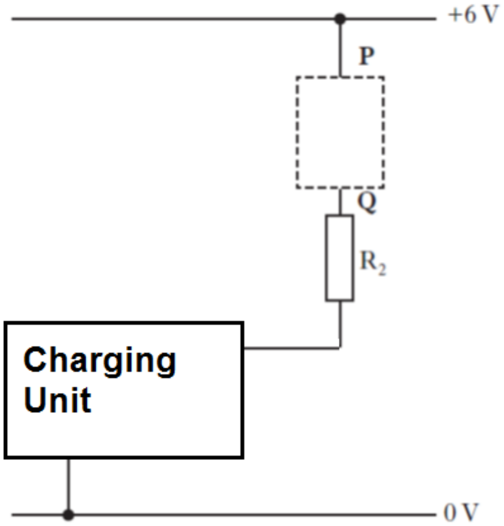
(ii) The variable resistor is now removed from the circuit.

(A) State what happens to the reading on the ammeter. 1

(B) Explain your answer. 1

5. A laptop is plugged into the mains to charge. An LED lights to indicate that the laptop is charging.

The LED is connected to a pulse generator.
The circuit diagram for this is shown

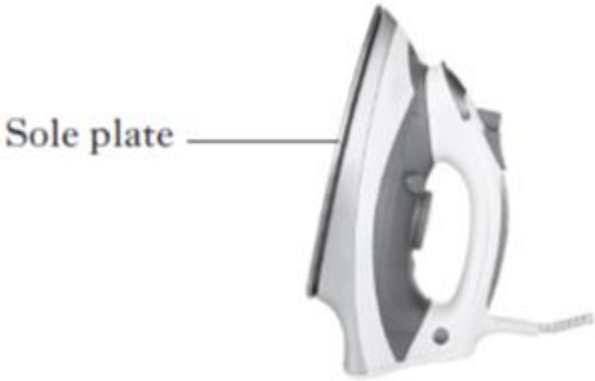


(a) Complete the diagram to show the LED correctly connected between P and Q. 1

(b) State the purpose of resistor R2 connected in series with the LED. 1

(c) When lit, the current in the LED is 15 mA and the voltage across it is 1•2 V.
Calculate the value of resistor R2 in series with the LED. 4

6. A manufacturer has developed an iron with an aluminium sole plate. A technician has been asked to test the iron.



The technician obtains the following data for one setting of the iron.

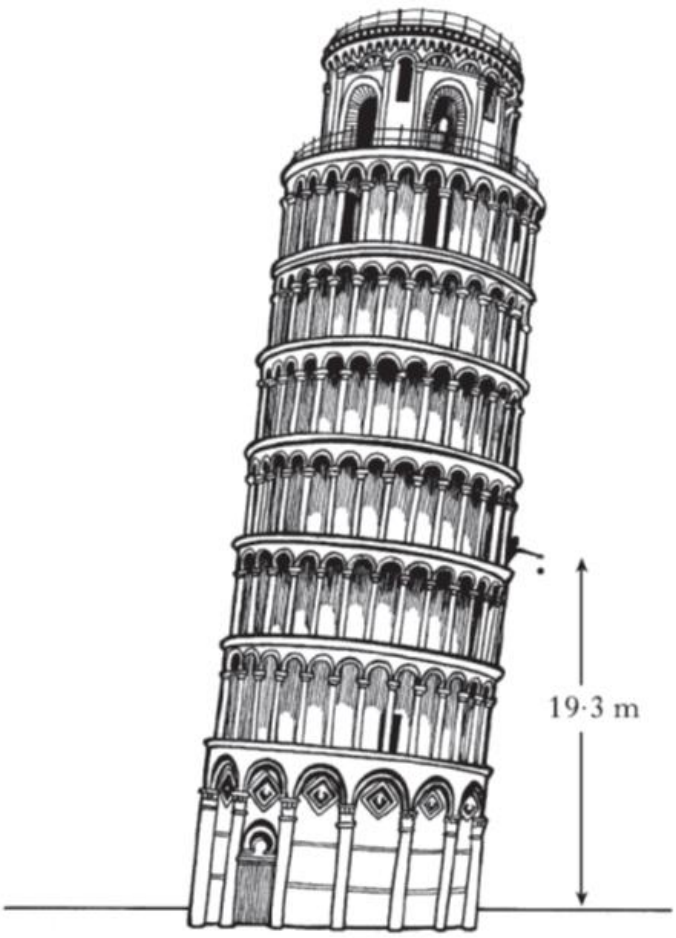
Starting temperature of sole plate: 24 °C
Operating temperature of the sole plate: 200 °C
Time for iron to reach the operating temperature: 35 s
Power rating of the iron: 1.5 kW
Operating voltage: 230 V
Specific Heat Capacity of Aluminium: 902 J kg^{-1} $°C^{-1}$

(a) Calculate how much electrical energy is supplied to the iron in this time. 3

(b) Calculate the mass of the aluminium sole plate. 3

(c) The actual mass of the aluminium sole plate is less than the value calculated in part (b) using the technician's data.
State one reason for this difference. 1

7. A student reproduces Galilleo's famous experiment by dropping a solid copper ball of mass 0•50 kg from a balcony on the Leaning Tower of Pisa.



(a) The ball is released from a height of 19•3 m.
Calculate the gravitational potential energy lost by the ball. 3

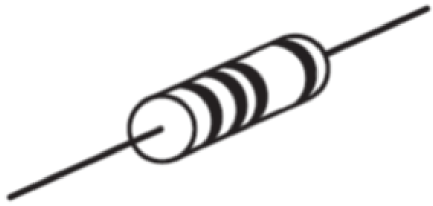
(b) Assuming that all of this gravitational potential energy is converted into heat energy in the ball, calculate the increase in the temperature of the ball on impact with the ground. 3

(c) (i) State if the actual temperature change of the ball is greater than, the same as or less than the value calculated in part (a)(ii). 1

(ii) You must explain your answer to part (c) (i). 1

2012 Int2 24

8. A resistor is labelled: "10 Ω ± 10%, 3 W".



This means that the resistance value could actually be between 9 Ω and 11 Ω.

(a) A student decides to check the value of the resistance.
Draw a circuit diagram, including a 6 V battery, a voltmeter and an ammeter, for a circuit that could be used to determine the resistance. 3

(b) Readings from the circuit give the voltage across the resistor as 5•7 V and the current in the resistor as 0•60 A.
Use these values to calculate the resistance. 3

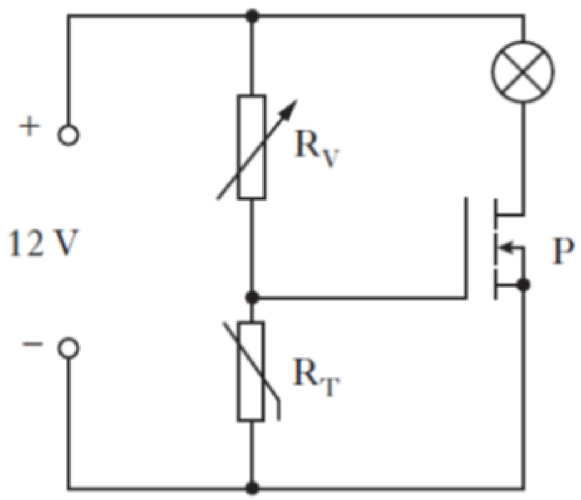
(c) During this experiment, the resistor becomes very hot and gives off smoke. The student states that two of these resistors would not have overheated if they were connected together in parallel with the battery.

(i) State if the student is correct. 1

(ii) Explain your answer to part (c) (i). 1

2012 Int2 25ab

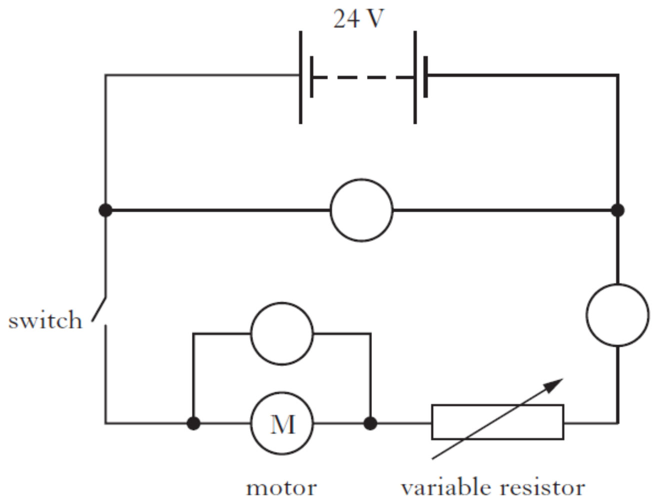
9. The circuit shown switches a warning lamp on or off depending on the temperature.



(a) Name component P. 1

(b) As the temperature increases the resistance of thermistor RT decreases.
State what happens to the voltage across RT as the temperature increases? 1

10. A student has designed a simple electric cart. The cart uses 2 large 12 V rechargeable batteries to drive an electric motor. The speed of the cart is controlled by adjusting a variable resistor.
The circuit diagram for the cart is shown.



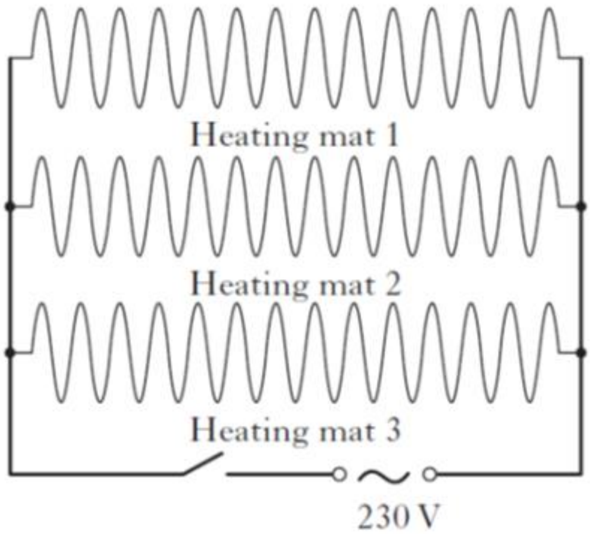
(a) The circuit contains two voltmeters and an ammeter.
Complete the diagram by labelling the meters. 1

(b) When the cart is moving at a certain speed the voltage across the motor is 18 V and the resistance of the variable resistor is 2•1 Ω.
Calculate the current in the motor. 4

(c) The batteries take 10 hours to fully recharge using a constant charging current of 3•2 A.
Calculate how much charge is transferred to the batteries in this time. 3

(d) For the cart to be able to reverse, the motor has to rotate in the opposite direction.
State one change which could be made to the circuit to make the motor rotate in the opposite direction. 1

11. A house owner installs a heating system under the floor of a new conservatory. Three heating mats are fitted. The mats contain resistance wires and are laid underneath the floor.
Each mat is designed to operate at 230 V and has a power of 300 W.



(a) State how the three heating mats are connected together to operate at their correct voltage. 1

(b) Calculate the current in each heating mat when switched on. 3

(c) Calculate the total resistance of the heating system when all three mats are switched on. 4

12. An overhead projector contains a lamp and a motor that operates a cooling fan.
A technician has a choice of two lamps to fit in the projector.

Lamp A: rated 24·0 V, 2·5 Ω

Lamp B: rated 24·0 V, 5·4 Ω

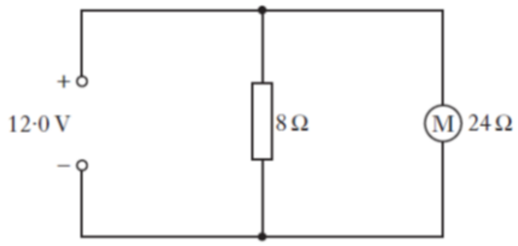
(a) (i) State which lamp gives a brighter light when operating at the correct voltage. 1

(ii) Explain your answer to (a) (i). 1

(b) Calculate the power developed by lamp A when it is operating normally. 3

(c) The overhead projector plug contains a fuse.
Draw the circuit symbol for a fuse. 1

(d) The technician builds a test circuit containing a resistor and a motor, as shown in Circuit 1.

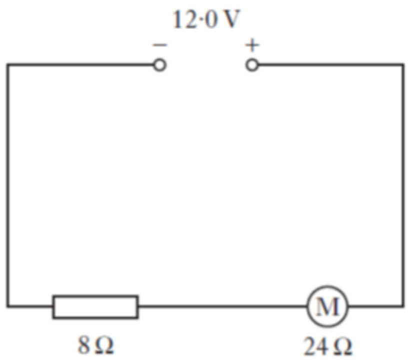


Circuit 1

(i) State the voltage across the motor. 1

(ii) Calculate the combined resistance of the resistor and the motor. 3

(e) The resistor and the motor are now connected in series, as shown in Circuit 2.

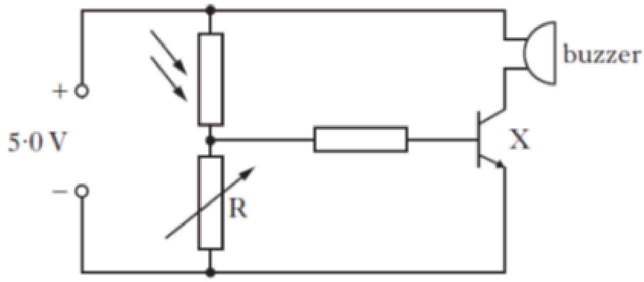


Circuit 2

(i) State how this affects the speed of the motor compared to Circuit 1. 1

(ii) Explain your answer to (e) (i). 1

13. A photographic darkroom has a buzzer that sounds when the light level in the room is too high. The circuit diagram for the buzzer system is shown below.



(a) (i) Name component X. 1

(ii) Explain the purpose of component X in the circuit 1

(b) The darkroom door is opened and the light level increases.
Explain how the circuit operates to sound the buzzer. 3

(c) The table shows how the resistance of the LDR varies with light level.

Light level (units)	*LDR Resistance* (Ω)
20	4500
50	3500
80	2500

The variable resistor has a resistance of 570 Ω.
The light level increases to 80 units.
Calculate the current in the LDR. 4

(d) State the purpose of the variable resistor R in this circuit. 1