162 The resistance of a metal cube is measured by placing it between two parallel plates, as shown.

The cube has volume V and is made of a material with resistivity $\rho$. The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

A $\rho V^{\frac{1}{3}}$      $\rho V^{\frac{2}{3}}$      $\dfrac{\rho}{V^{\frac{1}{3}}}$      $\dfrac{\rho}{V^{\frac{2}{3}}}$

163 A battery is marked 9.0 V.

What does this mean?

A   Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.

   The battery supplies 9.0 J to an external circuit for each coulomb of charge.

   The potential difference across any component connected to the battery will be 9.0 V.

   There will always be 9.0 V across the battery terminals.

164 Four resistors of equal value are connected as shown.
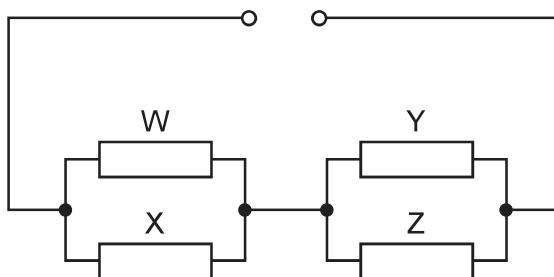
How will the powers to the resistors change when resistor W is removed?

A   The powers to X, Y and Z will all increase.

   The power to X will decrease and the powers to Y and Z will increase.

   The power to X will increase and the powers to Y and Z will decrease.

   The power to X will increase and the powers to Y and Z will remain unaltered.

**Current Electricity**

165  The diagram shows a fixed resistor and a light-dependent resistor (LDR) in series with a constant low-voltage supply.
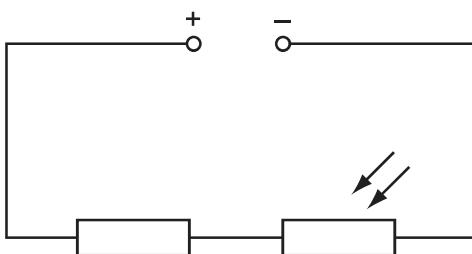
When the LDR is in the dark, the fixed resistor and the LDR have the same value of resistance.

Light is shone on the LDR.

What happens to the potential differences across the two components?

|   | p.d. across resistor | p.d. across LDR |
|---|---|---|
| A | decreased | increased |
|   | increased | decreased |
|   | no change | increased |
|   | no change | decreased |

166  The graphs show possible current-voltage (I-V) relationships for a filament lamp and for a semiconductor diode.
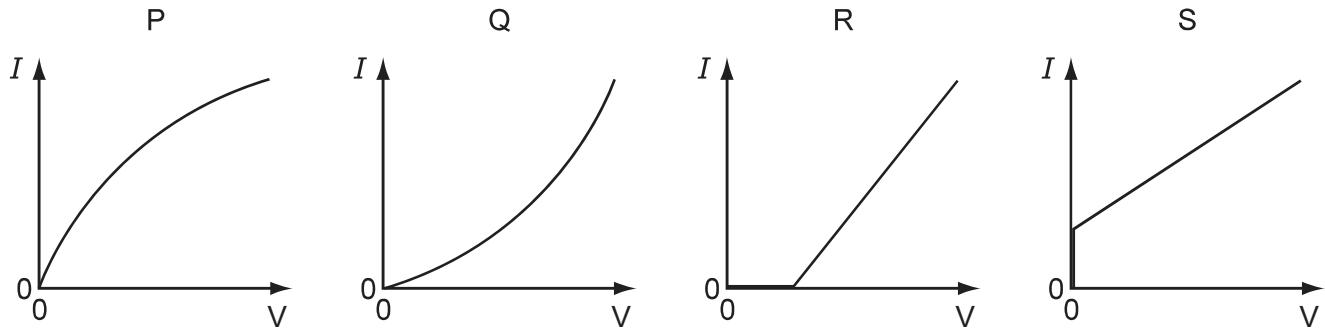
Which row best specifies the correct I-V graphs for the lamp and the diode?

|   | filament lamp | semiconductor diode |
|---|---|---|
| A | P | R |
|   | P | S |
|   | Q | R |
|   | Q | S |

**Current Electricity**

167  The diagram shows a d.c. circuit.
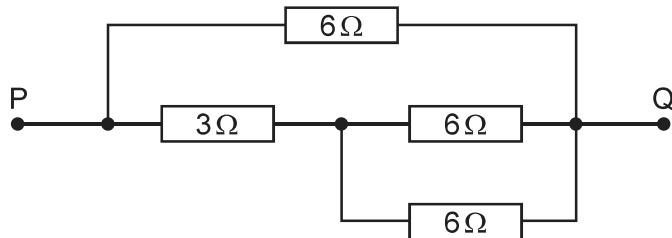


What is the resistance between the points P and Q due to the resistance network?

A   0.47 $\Omega$              2.1 $\Omega$                3.0 $\Omega$                21 $\Omega$


168  A copper wire of cross-sectional area 2.0 mm$^2$ carries a current of 10 A.

How many electrons pass through a given cross-section of the wire in one second?

A   1.0   10$^1$           5.0   10$^6$            6.3   10$^{19}$           3.1   10$^{25}$


169  The resistance of a metal cube is measured by placing it between two parallel plates, as shown.
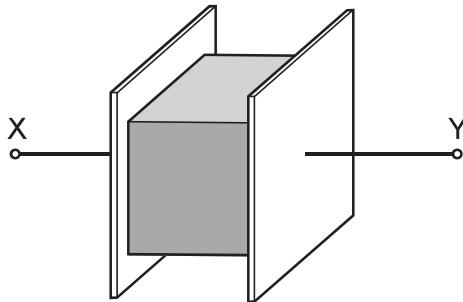
The cube has volume V and is made of a material with resistivity $\rho$. The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

A   $\rho V^{\frac{1}{3}}$              $\rho V^{\frac{2}{3}}$                $\dfrac{\rho}{V^{\frac{1}{3}}}$                $\dfrac{\rho}{V^{\frac{2}{3}}}$

170  Which statement is not valid?

A     urrent is the speed of the charged particles that carry it.

Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.

The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.

The resistance between two points is the p.d. between the two points, per unit current.


**Current Electricity**

171  In the circuit shown, XY is a length    of uniform resistance wire. $R_1$ and $R_2$ are unknown resistors. J is a sliding contact that joins the junction of $R_1$ and $R_2$ to points on XY through a small signal lamp S.
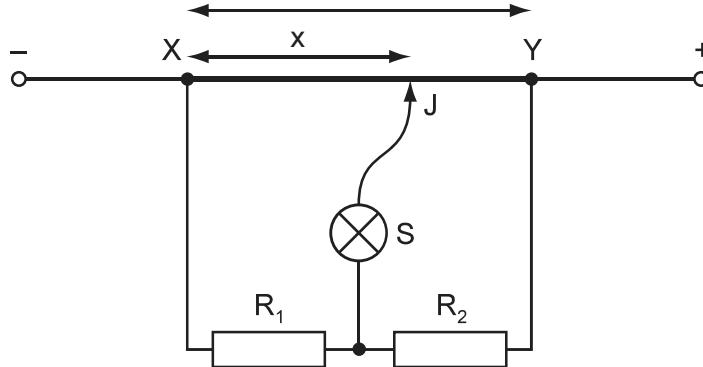
To determine the ratio $\dfrac{V_1}{V_2}$ of the potential differences across $R_1$ and $R_2$, a point is found on XY at which the lamp is off. This point is at a distance x from X.

What is the value of the ratio $\dfrac{V_1}{V_2}$ ?

A   $\dfrac{-}{x}$                   $\dfrac{x}{-}$                   $\dfrac{x}{x}$                   $\dfrac{x}{x}$

172  A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance.

In which circuit will the ammeter show the greatest reading?



Current Electricity
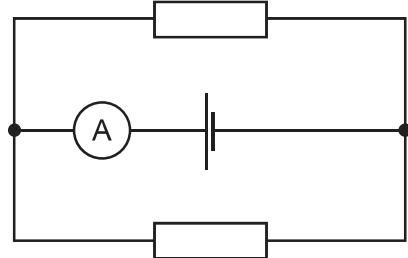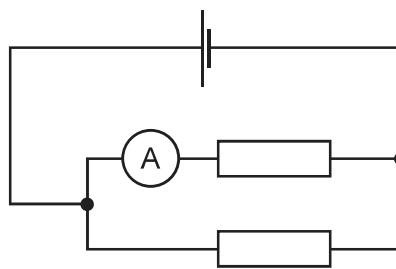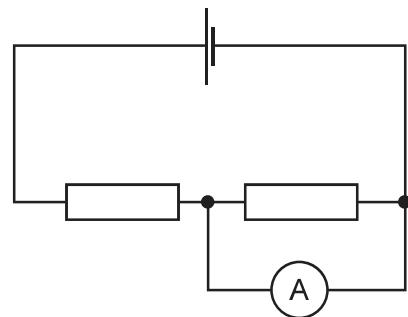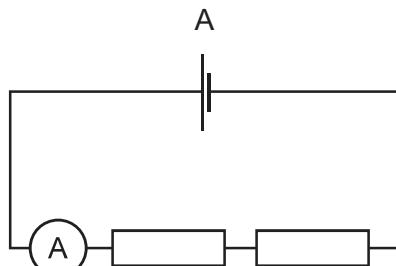
173 A cell of e.m.f. E and internal resistance r is connected in series with a switch S and an external resistor of resistance R.
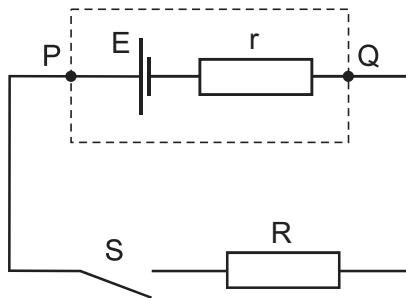


The p.d. between P and Q is V.

When S is closed,

A   V decreases because there is a p.d. across R.

V decreases because there is a p.d. across r.

V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R.

V remains the same because the sum of the p.d.s across r and R is still equal to E.

174 Which of the equations that link some of the following terms is correct?

| potential difference (p.d.) | V |
| current | I |
| resistance | R |
| charge | Q |
| energy | E |
| power | P |
| time | t |

A   $P = \dfrac{Q^2 R}{t}$

$ER^2 = V^2 t$

$\dfrac{VI}{P} = t$

$PQ = EI$

**Current Electricity**

175  The diagram shows a potential divider circuit designed to provide a variable output p.d.
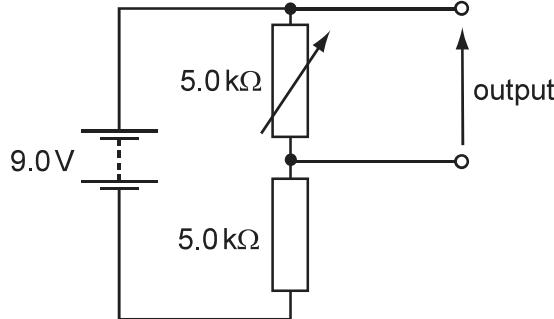
Which row gives the available range of output p.d.?

|   | maximum output | minimum output |
|---|---|---|
| A | 3.0 V | 0 |
|   | 4.5 V | 0 |
|   | 9.0 V | 0 |
|   | 9.0 V | 4.5 V |

176  The diagram shows part of a current-carrying circuit. The ammeter has negligible internal resistance.
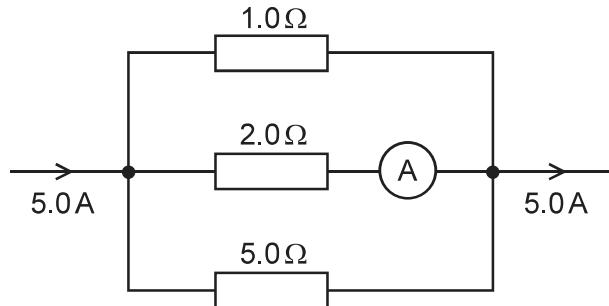
What is the reading on the ammeter?

A    0.7 A                    1.3 A                    1.5 A                    1.7 A

177  There is a current of 10 mA in a conductor for half an hour.

How much charge passes a point in the conductor in this time?

A    0.3                 5                      1                      300

178  A charge of  .0   passes through a resistor of resistance 30 Ω at a constant rate in a time of 20 s.

What is the potential difference across the resistor?

A    0.40 V                  5.3 V                   12 V                    75 V

Current Electricity

179 Three resistors of resistance R, 2R and 3R are connected in parallel.  9702/11/ /N/11/Q38
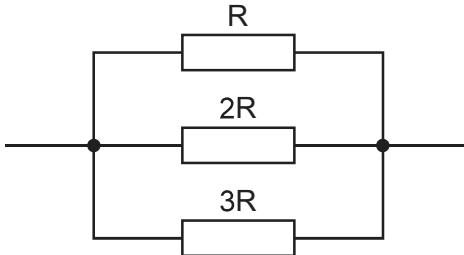


sing I  to represent the current through the resistor of resistance R, which row represents the relationships between the currents through the resistors?

|   | resistor resistance | | |
|---|---|---|---|
|   | R | 2R | 3R |
| A | I | $\frac{1}{3}$I | $\frac{1}{2}$I |
|   | I | $\frac{1}{2}$I | $\frac{1}{3}$I |
|   | I | $\frac{2}{3}$I | $\frac{1}{3}$I |
|   | I | 2I | 3I |

180 An iron wire has length  .0 m and diameter 0.50 mm. The wire has resistance R.  9702/11/ /J/12/Q34

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

A  $\dfrac{R}{16}$          $\dfrac{R}{}$          $\dfrac{R}{2}$          R

181 Two electrically-conducting cylinders X and Y are made from the same material.  9702/12/ /N/11/Q34

Their dimensions are as shown.
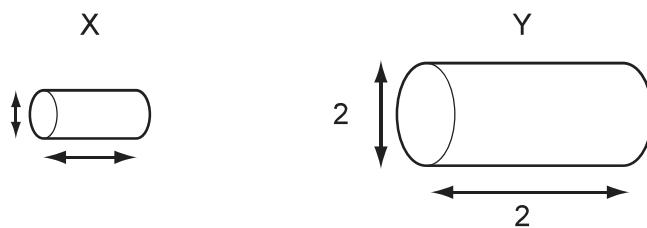


The resistance of each cylinder is measured between its ends.

What is the ratio $\dfrac{\text{resistance of X}}{\text{resistance of Y}}$ ?

A  $\dfrac{2}{1}$          $\dfrac{1}{1}$          $\dfrac{1}{2}$          $\dfrac{1}{4}$

**Current Electricity**

182 The graph shows the variation with potential difference (p.d.) of the current in a lamp filament.
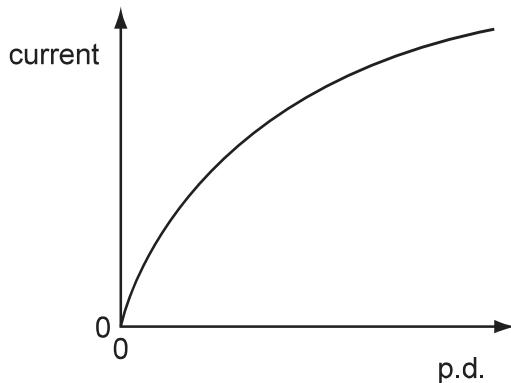
Which statement explains the shape of this graph?

A   As the filament temperature rises, electrons can pass more easily through the filament.

It takes time for the filament to reach its working temperature.

The power output of the filament is proportional to the square of the current in it.

The resistance of the filament increases with a rise in temperature.

183 A power supply of electromotive force (e.m.f.) 12 V and internal resistance $2\Omega$ is connected in series with a load resistor. The value of the load resistor is varied from $0.5\Omega$ to $4\Omega$.

Which graph shows how the power P dissipated in the load resistor varies with the resistance of the load resistor?

**Current Electricity**
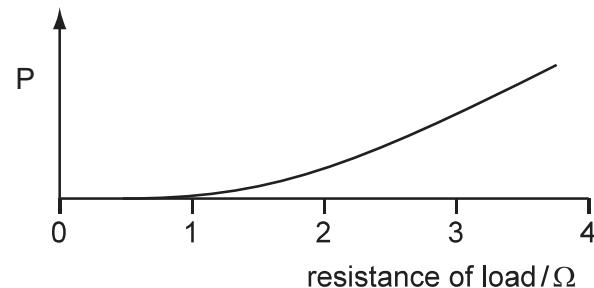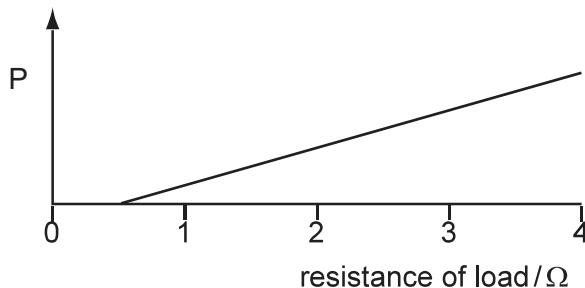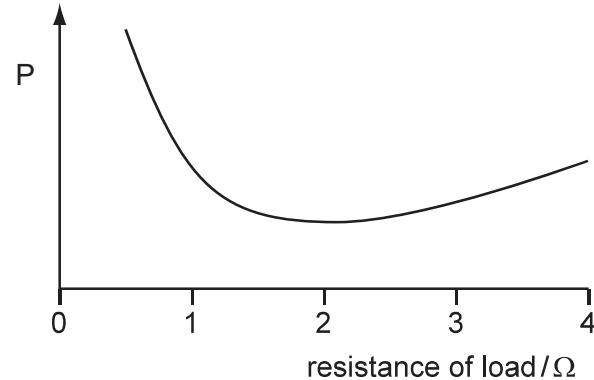
184 The diagram shows a potential divider circuit which, by adjustment of the contact X, can be used
to provide a variable potential difference between the terminals P and Q.   9702/12/ /N/11/Q37
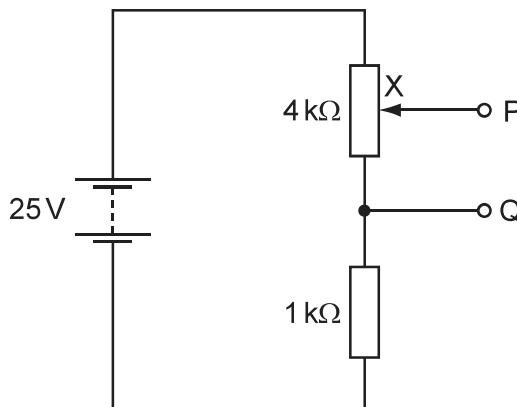


What are the limits of this potential difference?

A   0 and 5 V          0 and 20 V          0 and 25 V          5 V and 25 V

185 Each of  irchhoff s laws is linked to the conservation of a physical quantity.   9702/12/ /N/11/Q36

Which physical quantities are assumed to be conserved in the formulation of  irchhoff s first law
and of  irchhoff s second law?

|   | irchhoff s first law | irchhoff s second law |
|---|---|---|
| A | energy | charge |
|   | energy | momentum |
|   | charge | energy |
|   | momentum | energy |

186 Which statement about electrical resistivity is correct?   9702/11/ /N/11/Q33

A   The resistivity of a material is numerically equal to the resistance in ohms of a cube of that
material, the cube being of side length one metre and the resistance being measured
between opposite faces.

The resistivity of a material is numerically equal to the resistance in ohms of a one metre
length of wire of that material, the area of cross-section of the wire being one square
millimetre and the resistance being measured between the ends of the wire.

The resistivity of a material is proportional to the cross-sectional area of the sample of the
material used in the measurement.

The resistivity of a material is proportional to the length of the sample of the material used in
the measurement.

**Current Electricity**

187  A constant 60 V d.c. supply is connected across two resistors of resistance 400 kΩ and 200 kΩ.
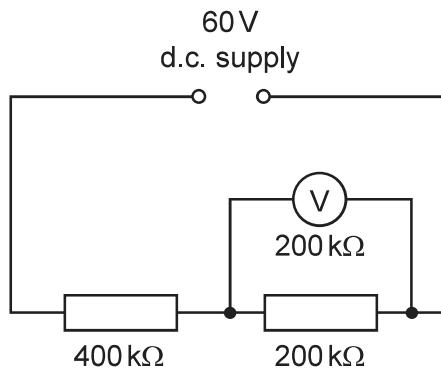
What is the reading on a voltmeter, also of resistance 200 kΩ, when connected across the 200 kΩ resistor as shown in the diagram?

A    12 V                    15 V                    20 V                    30 V


188  Which statement is not valid?

A      urrent is the speed of the charged particles that carry it.

Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.

The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.

The resistance between two points is the p.d. between the two points, per unit current.


189  The circuit below has a current I in the resistor R.
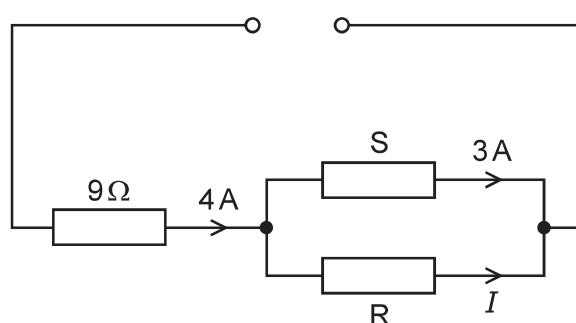
What must be known in order to determine the value of I ?

A    e.m.f. of the power supply

      resistance of resistor S

      irchhoff s first law

      irchhoff s second law

**Current Electricity**

190 A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance.  9702/13/ /N/11/Q36

In which circuit will the ammeter show the greatest reading?

A
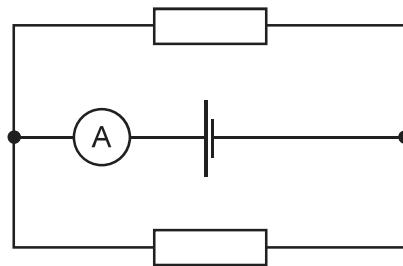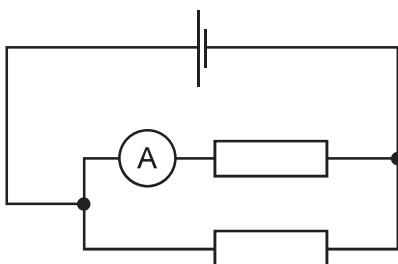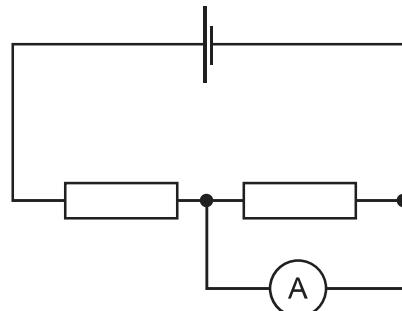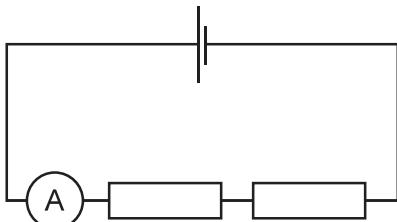
191 Three resistors of resistance R, 2R and 3R are connected in parallel.  9702/13/ /N/11/Q37

R

2R

3R

sing I to represent the current through the resistor of resistance R, which row represents the relationships between the currents through the resistors?

| | resistor resistance | | |
|---|---|---|---|
| | R | 2R | 3R |
| A | I | $\frac{1}{3}I$ | $\frac{1}{2}I$ |
| | I | $\frac{1}{2}I$ | $\frac{1}{3}I$ |
| | I | $\frac{2}{3}I$ | $\frac{1}{3}I$ |
| | I | 2I | 3I |

**Current Electricity**

192 A cell of e.m.f. E and internal resistance r is connected in series with a switch S and an external resistor of resistance R.

The p.d. between P and Q is V.

When S is closed,

A    V decreases because there is a p.d. across R.

V decreases because there is a p.d. across r.

V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R.

V remains the same because the sum of the p.d.s across r and R is still equal to E.

193 A potential divider consists of a light-dependent resistor ( R) in series with a variable resistor of resistance R. The resistance of the     R decreases when the light level increases. The variable resistor can be set at either high resistance or low resistance.

Which situation gives the largest output voltage?

| | light level at   R | R |
|---|---|---|
| A | high | high |
| | high | low |
| | low | high |
| | low | low |

**Current Electricity**
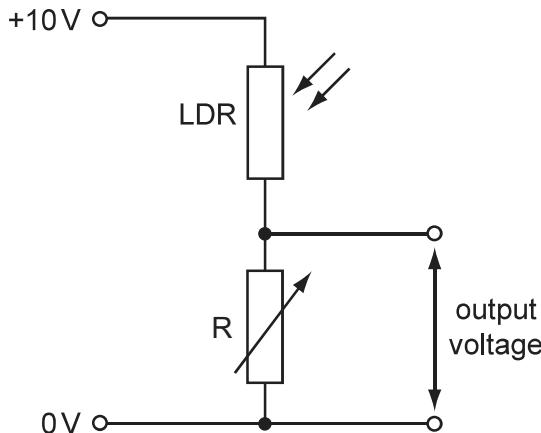
194 The diagram shows a potential divider circuit designed to provide a variable output p.d.
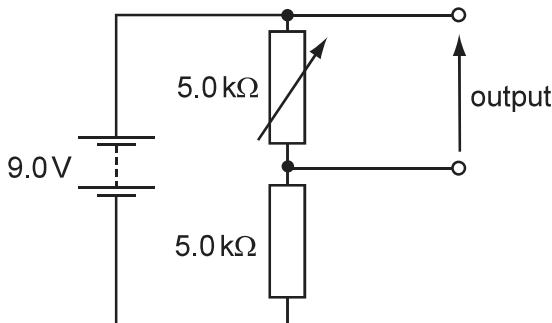
Which row gives the available range of output p.d.?

|   | maximum output | minimum output |
|---|---|---|
| A | 3.0 V | 0 |
|   | 4.5 V | 0 |
|   | 9.0 V | 0 |
|   | 9.0 V | 4.5 V |

195 Two copper wires of the same length but different diameters carry the same current.

Which statement about the flow of charged particles through the wires is correct?

A  harged particles are provided by the power supply. Therefore the speed at which they travel depends only on the voltage of the supply.

The charged particles in both wires move with the same average speed because the current in both wires is the same.

The charged particles move faster through the wire with the larger diameter because there is a greater volume through which to flow.

The charged particles move faster through the wire with the smaller diameter because it has a larger potential difference applied to it.

196 A power cable X has resistance R and carries current $I$.

A second cable Y has resistance 2R and carries current $\frac{1}{2}I$.

What is the ratio $\dfrac{\text{power dissipated in Y}}{\text{power dissipated in X}}$?

A  $\frac{1}{4}$　　　　$\frac{1}{2}$　　　　2　　　　4

**Current Electricity**

197 In the circuit below, the ammeter reading is I and the voltmeter reading is V.    9702/11/  /J/12/Q36
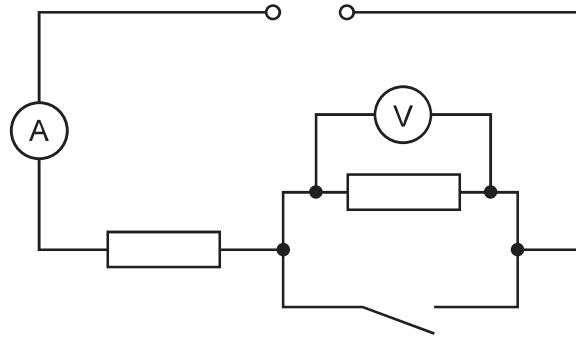


When the switch is closed, which row describes what happens to I and V?

| | I | V |
|---|---|---|
| A | decreases | decreases to zero |
| | increases | decreases to zero |
| | increases | stays the same |
| | stays the same | increases |

198 The diagram shows a circuit with four voltmeter readings V, $V_1$, $V_2$ and $V_3$.    9702/12/  /J/12/Q35
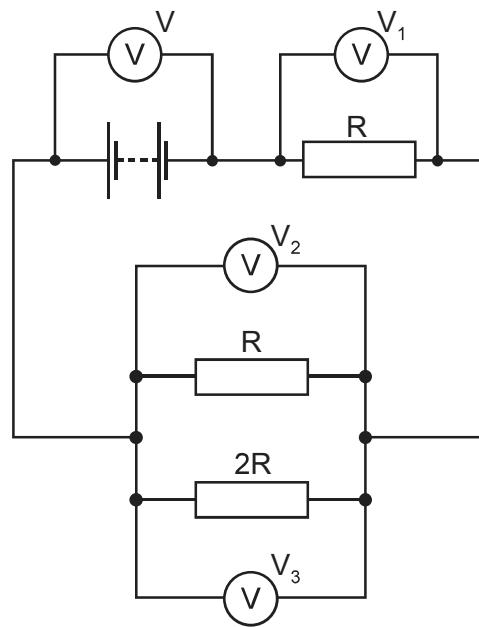


Which equation relating the voltmeter readings must be true?

A  $V = V_1 + V_2 + V_3$

  $V + V_1 = V_2 + V_3$

  $V_3 = 2(V_2)$

V  $V_1 = V_3$

**Current Electricity**

199 Which statement about electrical resistivity is correct?  9702/13/ /N/11/Q35

A  The resistivity of a material is numerically equal to the resistance in ohms of a cube of that material, the cube being of side length one metre and the resistance being measured between opposite faces.

The resistivity of a material is numerically equal to the resistance in ohms of a one metre length of wire of that material, the area of cross-section of the wire being one square millimetre and the resistance being measured between the ends of the wire.

The resistivity of a material is proportional to the cross-sectional area of the sample of the material used in the measurement.

The resistivity of a material is proportional to the length of the sample of the material used in the measurement.

200  The diagram shows a simple circuit.  9702/11/ /J/12/Q35
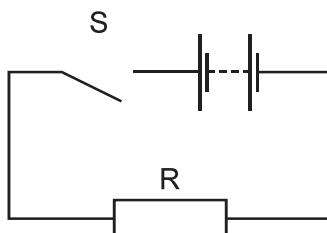


Which statement is correct?

A  When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.

When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

201  An iron wire has length  .0 m and diameter 0.50 mm. The wire has resistance R.  9702/13/ /J/12/Q32

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

A  $\dfrac{R}{16}$          $\dfrac{R}{}$          $\dfrac{R}{2}$          R

202  There is a current of 10 mA in a conductor for half an hour.  9702/13/ /J/12/Q34

How much charge passes a point in the conductor in this time?

A   0.3               5               1               300

**Current Electricity**

203  Which of the equations that link some of the following terms is correct?

| potential difference (p.d.) | V |
|---|---|
| current | I |
| resistance | R |
| charge | Q |
| energy | E |
| power | P |
| time | t |

A   $P = \dfrac{Q^2 R}{t}$

$ER^2 = V^2 t$

$\dfrac{VI}{P} = t$

$PQ = EI$

204  A potential divider consists of a light-dependent resistor (   R) in series with a variable resistor of resistance R. The resistance of the    R decreases when the light level increases. The variable resistor can be set at either high resistance or low resistance.



Which situation gives the largest output voltage?

| | light level at    R | R |
|---|---|---|
| A | high | high |
| | high | low |
| | low | high |
| | low | low |

**Current Electricity**
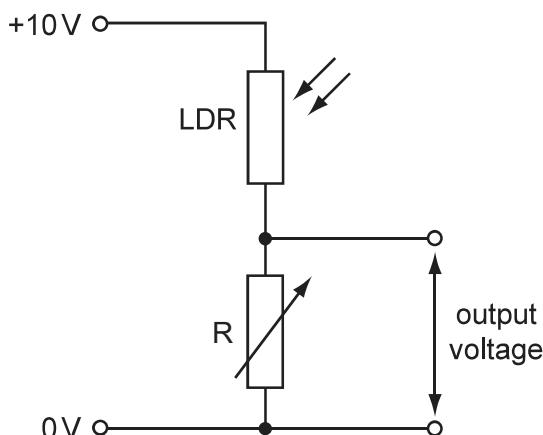
205 The diagram shows the circuit for a signal to display a green or a red light. It is controlled by the switch S.
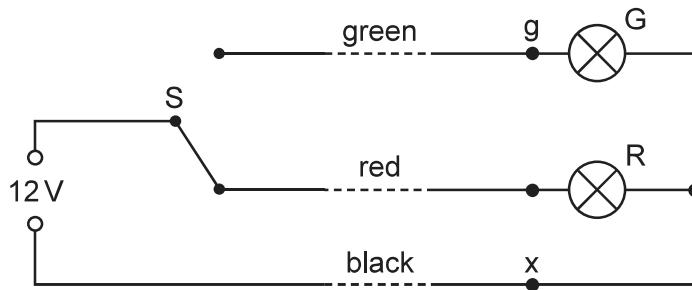
The signal is some way from S to which it is connected by a cable with green, red and black wires. At the signal, the green and red wires are connected to the corresponding lamp and the black wire is connected to a terminal x to provide a common return. The arrangement is shown correctly connected and with the switch set to illuminate the red lamp.

uring maintenance, the wires at the signal are disconnected and, when reconnected, the black wire is connected in error to the green lamp (terminal g) instead of terminal x. The red wire is connected correctly to its lamp and connections at S remain as in the diagram.
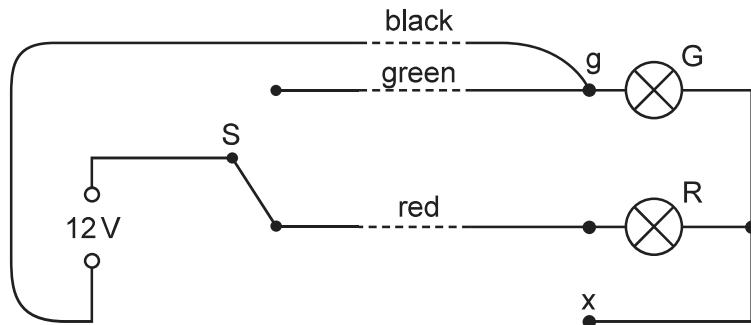


When the system is tested with the switch connection to the red wire, what does the signal show?

A    the green lamp illuminated normally

     the red lamp illuminated normally

     the red and green lamps both illuminated normally

     the red and green lamps both illuminated dimly

206 In a fire alarm system, a thermistor T has a resistance of $2000\,\Omega$ at room temperature. Its resistance decreases as the temperature increases. The alarm is triggered when the potential difference between X and Y reaches $4.5\,V$.
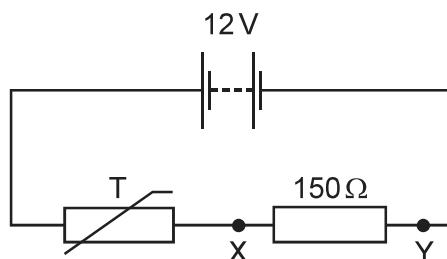
What is the resistance of the thermistor when the alarm is triggered?

A   $90\,\Omega$                    $150\,\Omega$                    $250\,\Omega$                    $1300\,\Omega$

207  In the circuit below, the ammeter reading is I and the voltmeter reading is V.
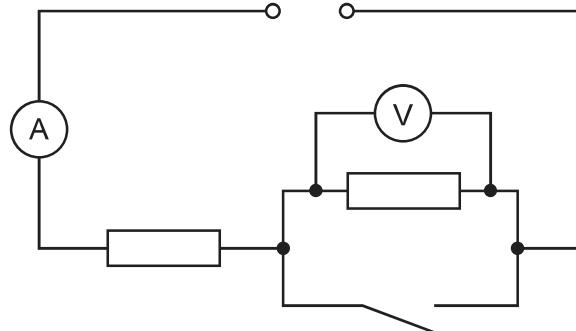


When the switch is closed, which row describes what happens to I and V?

|   | I | V |
|---|---|---|
| A | decreases | decreases to zero |
|   | increases | decreases to zero |
|   | increases | stays the same |
|   | stays the same | increases |

208  A light-dependent resistor (    R) is connected in series with a resistor R and a battery.
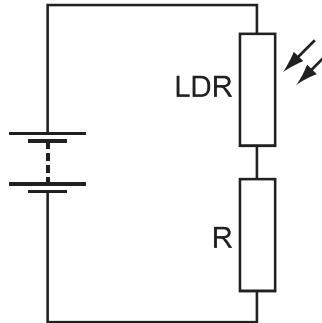
The resistance of the     R is equal to the resistance of R when no light falls on the     R.

When the light intensity falling on the     R increases, which statement is correct?

A    The current in R decreases.

     The current in the     R decreases.

     The p.d. across R decreases.

     The p.d. across the     R decreases.

209  The potential difference between point X and point Y in a circuit is 20V. The time taken for charge carriers to move from X to Y is 15 s. In this time, the energy of the charge carriers changes by 12 J.

What is the current between X and Y?

A    0.040 A                0.11 A                9.0 A                25 A

**Current Electricity**

210 Four identical resistors are connected in the three networks below. 9702/12/ /J/12/Q38

| 1 | 2 | 3 |
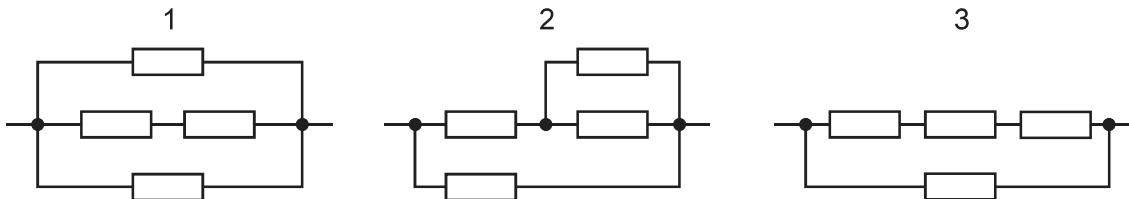


Which arrangement has the highest total resistance and which has the lowest?

|   | highest | lowest |
|---|---------|--------|
| A | 1 | 2 |
|   | 1 | 3 |
|   | 3 | 1 |
|   | 3 | 2 |

211 The diagram shows a simple circuit. 9702/13/ /J/12/Q36
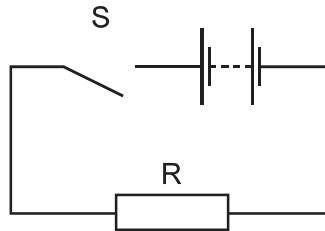


Which statement is correct?

A   When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.

When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

212 A cylindrical wire of length 10 m and diameter 2.0 mm has a resistance of 0.050 Ω. 9702/11/ /N/12/Q33

From which material is the wire made?

|   | material | resistivity / Ω m |
|---|----------|-------------------|
| A | bronze | $1.6 \quad 10^7$ |
|   | nichrome | $1.6 \quad 10^6$ |
|   | silver | $1.6 \quad 10$ |
|   | zinc | $6.3 \quad 10$ |

**Current Electricity**

213 The circuit below has a current I in the resistor R.
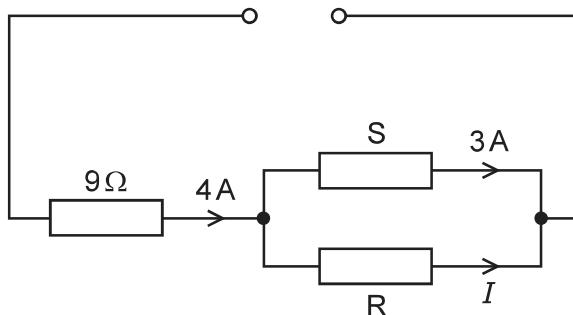


What must be known in order to determine the value of I ?

A    e.m.f. of the power supply

resistance of resistor S

irchhoff s first law

irchhoff s second law

214 The I-V characteristics of two electrical components P and Q are shown below.
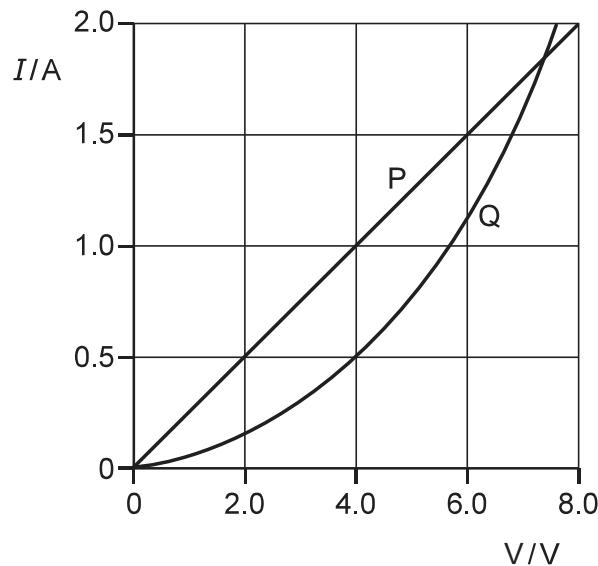


Which statement is correct?

A    P is a resistor and Q is a filament lamp.

The resistance of Q increases as the current in it increases.

For a current of 1.9 A, the resistance of Q is approximately half that of P.

For a current of 0.5 A, the power dissipated in Q is double that in P.

215 The graph shows the variation with length l of resistance R for two wires X and Y made from the same material.  9702/12/ /N/12/Q34
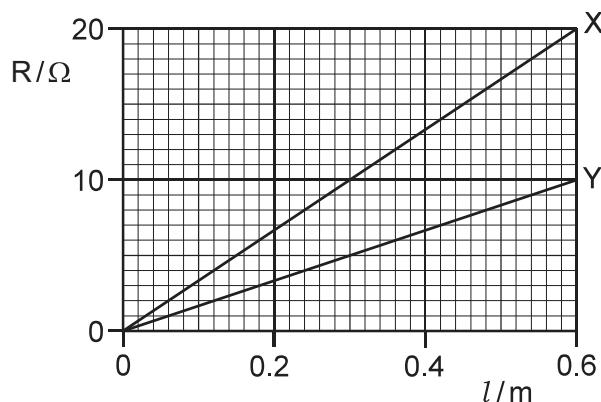


What does the graph show?

A   cross-sectional area of X = 2   cross-sectional area of Y

    resistivity of X = 2   resistivity of Y

    when equal lengths of X and Y are connected in series to a battery,
    power in X = 2   power in Y

    when equal lengths of X and Y are connected in parallel to a battery,
    current in X = 2   current in Y


216   A cell of internal resistance $2.0\,\Omega$ and electromotive force (e.m.f.) 1.5 V is connected to a resistor of resistance $3.0\,\Omega$.  9702/12/ /N/12/Q35

What is the potential difference across the $3.0\,\Omega$ resistor?

A   1.5 V                  1.2 V                  0.9 V                  0.6 V


217  A $100\,\Omega$ resistor conducts a current with changing direction and magnitude, as shown.  9702/12/ /N/12/Q36
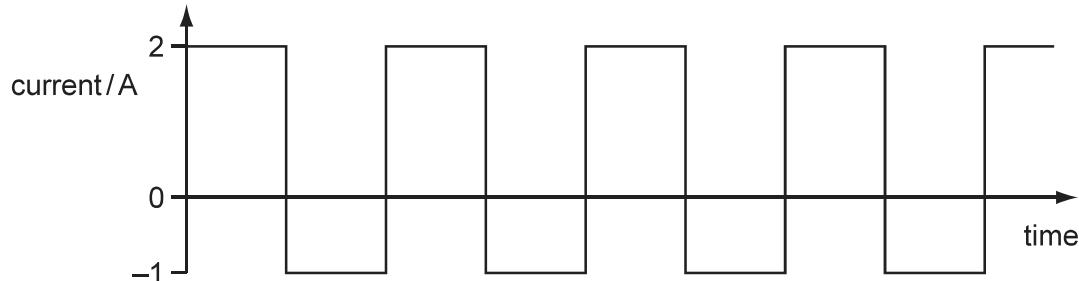


What is the mean power dissipated in the resistor?

A   100 W                 150 W                 250 W                 400 W


**Current Electricity**

218 A network of electrical components is connected across a battery of negligible internal resistance, as shown.
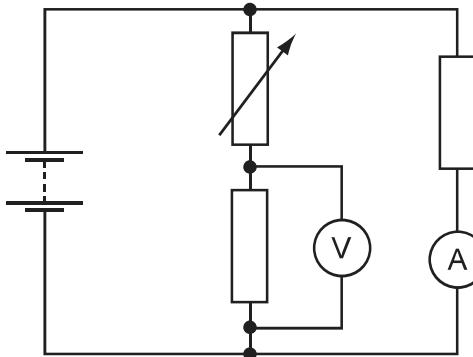
The resistance of the variable resistor is increased.

What is the effect on the readings of the ammeter and voltmeter?

|   | ammeter | voltmeter |
|---|---------|-----------|
| A | decreases | increases |
|   | increases | decreases |
|   | unchanged | decreases |
|   | unchanged | increases |

219 The diagram shows a potentiometer circuit.
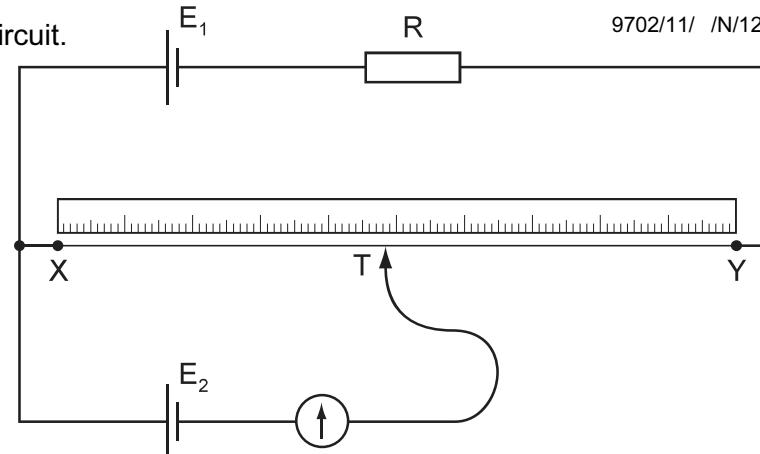
The contact T is placed on the wire and moved along the wire until the galvanometer reading is zero. The length XT is then noted.

In order to calculate the potential difference per unit length of the wire XY, which value must also be known?

A    the e.m.f. of the cell $E_1$

the e.m.f. of the cell $E_2$

the resistance of resistor R

the resistance of the wire XY

**Current Electricity**

220 The ammeter reading in the circuit below is I.
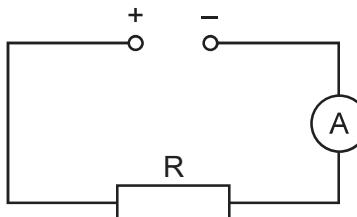
Another circuit containing the same voltage supply, two switches, an ammeter and two resistors each of resistance R, is shown.
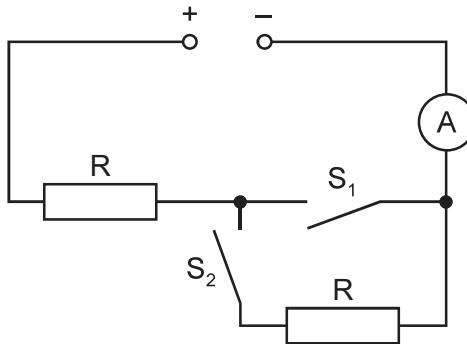


Which row is not correct?

| | $S_1$ | $S_2$ | ammeter reading |
|---|---|---|---|
| A | closed | closed | I |
| | closed | open | I |
| | open | closed | I |
| | open | open | 0 |

221 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2.0 Ω is connected in series with a 13 Ω resistor.
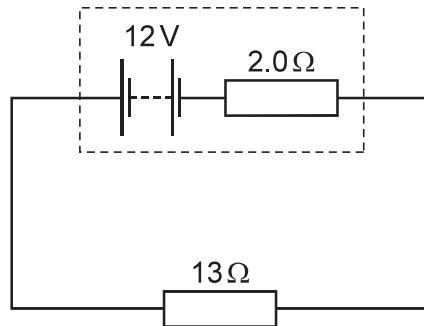
What is the power dissipated in the 13 Ω resistor?

A    .3 W              9.6 W              10 W              11 W

**Current Electricity**

222  A light-dependent resistor R has resistance of about 1 Ω in the dark and about 1 kΩ when illuminated. It is connected in series with a 5 kΩ resistor to a 1.5 V cell of negligible internal resistance.

1.5 V

R

5 kΩ
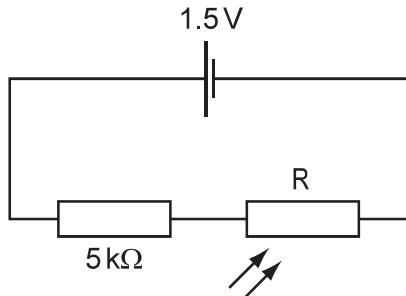
The light-dependent resistor is illuminated (in an otherwise dark room) by a flashing light.

Which graph best shows the variation with time t of potential difference V across R?

A

V / V

1.5

0

t

V / V

1.5

0

t

V / V

1.5

0

t

V / V

1.5

0

t
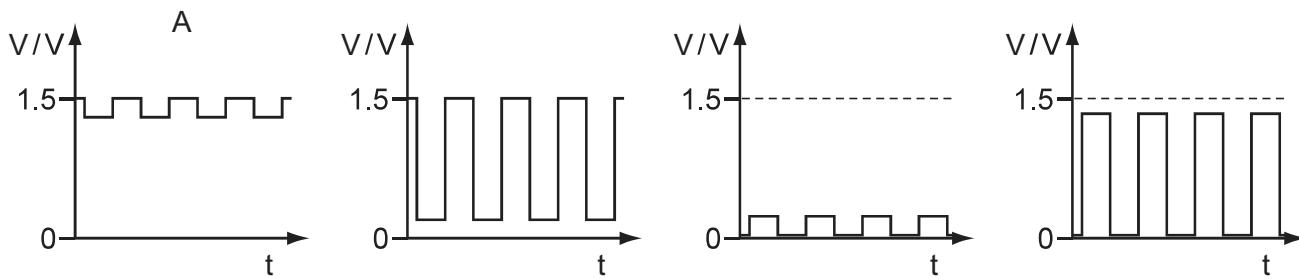
223  A copper wire is stretched so that its diameter is reduced from 1.0 mm to a uniform 0.5 mm.

The resistance of the unstretched copper wire is 0.2 Ω.

What will be the resistance of the stretched wire?

A    0.4 Ω               0. Ω               1.6 Ω               3.2 Ω

224  Four statements about potential difference or electromotive force are listed.

1    It involves changing electrical energy into other forms.

2    It involves changing other energy forms into electrical energy.

3    It is the energy per unit charge to move charge right round a circuit.

4    It is the work done per unit charge by the charge moving from one point to another.

Which statements apply to potential difference and which apply to electromotive force?

|   | potential difference | electromotive force |
|---|---|---|
| A | 1 and 3 | 2 and 4 |
|   | 1 and 4 | 2 and 3 |
|   | 2 and 3 | 1 and 4 |
|   | 2 and 4 | 1 and 3 |

Current Electricity

225  The diagram shows a four-terminal box connected to a battery and two ammeters.
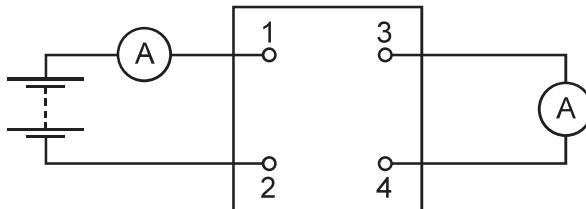


The currents in the two meters are identical.

Which circuit, within the box, will give this result?

A
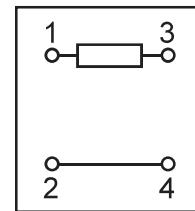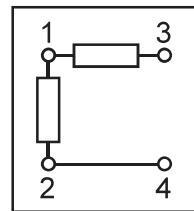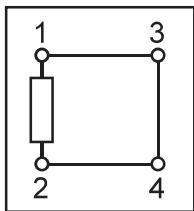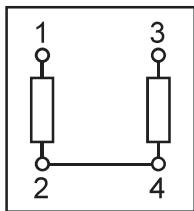


226  The diagram shows a resistor network. The potential difference across the network is V.
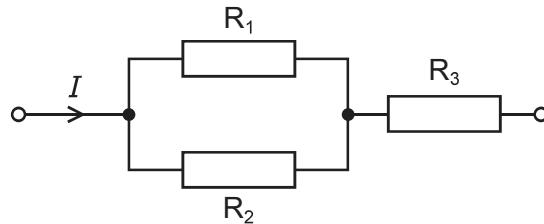
Is the equation shown below correct for the network?

$$V = I \, (1/R_1 + 1/R_2 + R_3)$$

A    Yes, it correctly combines two series resistors with one parallel resistor, and correctly uses
        hm s   aw.

     Yes, it correctly combines two parallel resistors with one series resistor, and correctly uses
        hm s   aw.

     No, because it should read $V = I$    $(1/R_1 + 1/R_2 + R_3)$.

     No, because the terms $1/R_2$ and $R_3$ have different units and cannot be added.

227  A low-voltage supply with an e.m.f. of 20 V and an internal resistance of $1.5\,\Omega$ is used to supply
     power to a heater of resistance $6.5\,\Omega$ in a fish tank.

What is the power supplied to the water in the fish tank?

A    41 W                 50 W                 53 W                 62 W

**Current Electricity**

228 In the circuit below, P is a potentiometer of total resistance $10\,\Omega$ and Q is a fixed resistor of resistance $10\,\Omega$. The battery has an e.m.f. of 4.0 V and negligible internal resistance. The voltmeter has a very high resistance.
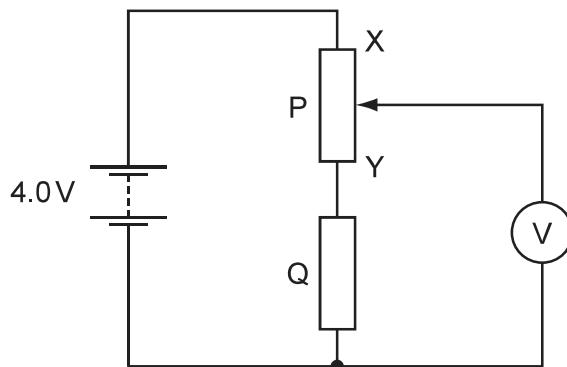
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph is obtained?
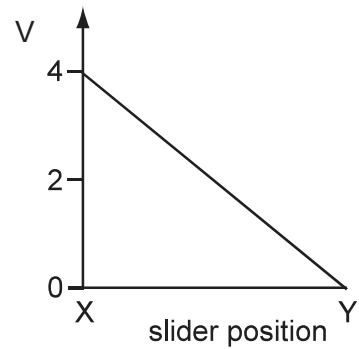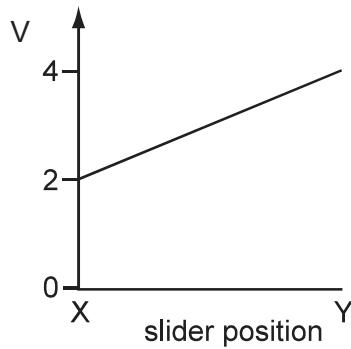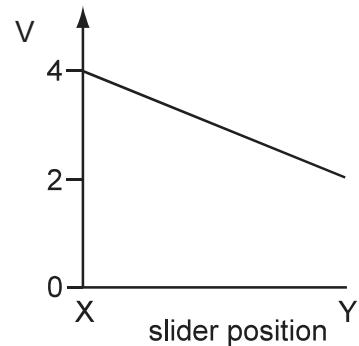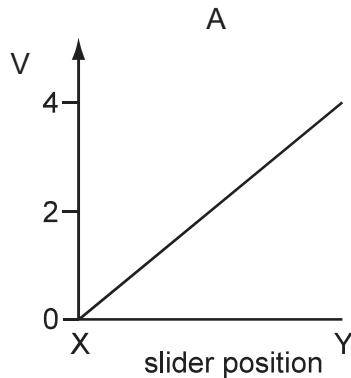


229 A power cable has length 2000 m. The cable is made of twelve parallel strands of copper wire, each with diameter 0.51 mm.

What is the resistance of the cable? (resistivity of copper = 1.7 × 10⁻⁸ Ω m)

A    0.014 Ω               3.5 Ω               14 Ω               166 Ω

**Current Electricity**

230 Five resistors are connected as shown.  9702/12/ /J/13/Q37
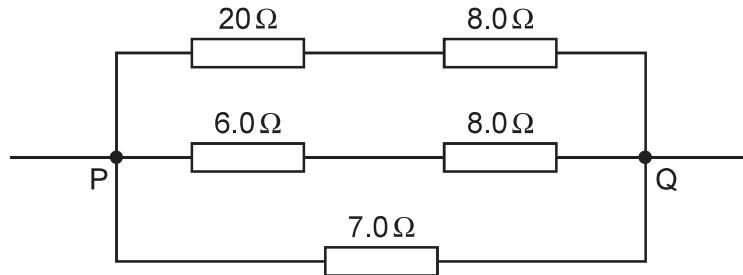


What is the total resistance between P and Q?

A   0.25Ω              0.61Ω              4.0Ω              16Ω

231 When a battery is connected to a resistor, the battery gradually becomes warm. This causes the internal resistance of the battery to increase whilst its e.m.f. stays unchanged.

As the internal resistance of the battery increases, how do the terminal potential difference and the output power change, if at all?  9702/11/ /J/13/Q33

|   | terminal potential difference | output power |
|---|---|---|
| A | decrease | decrease |
|   | decrease | unchanged |
|   | unchanged | decrease |
|   | unchanged | unchanged |

232 The principles of conservation of which two quantities are associated with  irchhoff s first and second laws?  9702/11/ /J/13/Q34

|   | first law | second law |
|---|---|---|
| A | charge | energy |
|   | charge | voltage |
|   | energy | charge |
|   | voltage | charge |

233 A filament lamp has a resistance of 1 0Ω when the current in it is 500 mA.  9702/12/ /J/13/Q34

What is the power transformed in the lamp?

A   45 W              50 W              90 W              1400 W

**Current Electricity**

234 A circuit is set up as shown, supplied by a 3 V battery. All resistances are 1 kΩ. 9702/11/ /J/13/Q35
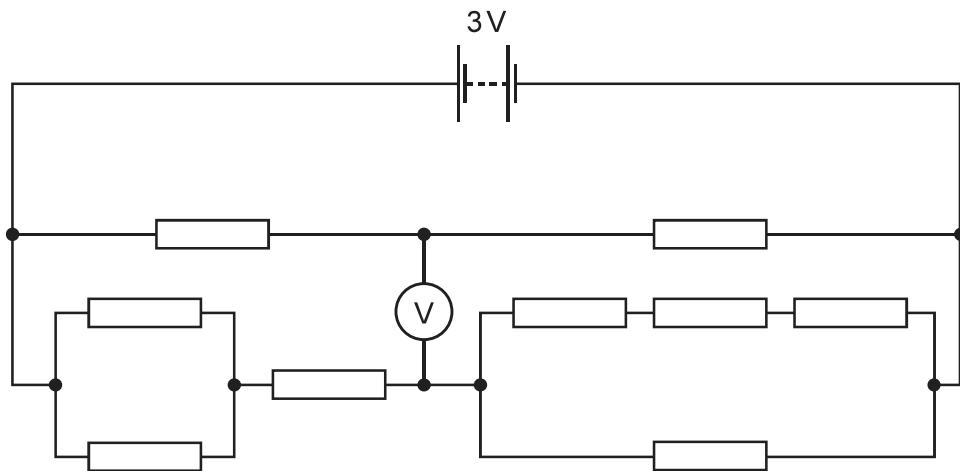


What will be the reading on the voltmeter?

A    0         0.5 V         1.0 V         1.5 V

235   A 12 V battery is in series with an ammeter, a 2 Ω fixed resistor and a 0 10 Ω variable resistor. A high-resistance voltmeter is connected across the variable resistor. 9702/11/ /J/13/Q37
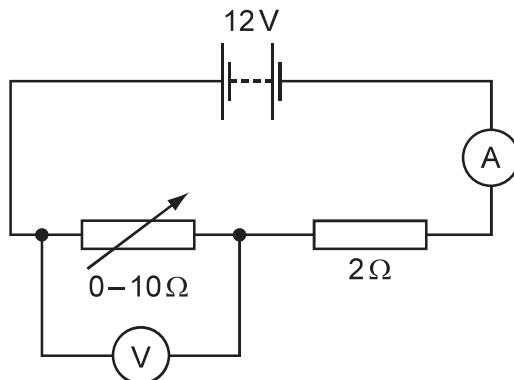


The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?

83
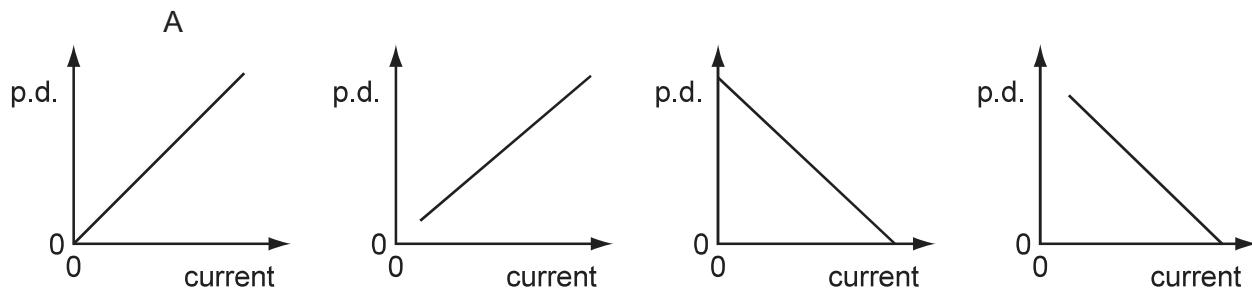
236  The diagram shows an incorrectly connected circuit. The ammeter has a resistance of $0.1\,\Omega$ and
     the voltmeter has a resistance of 1    $\Omega$.                                              9702/11/  /J/13/Q36
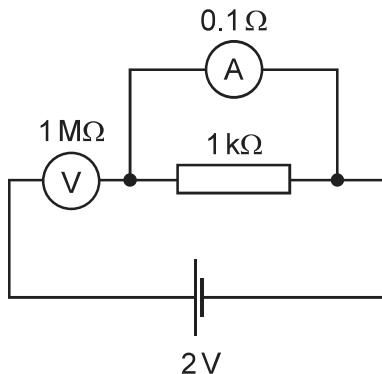


Which statement is correct?

A    The ammeter reads 2 mA.

     The ammeter reads 20 A.

     The voltmeter reads zero.

     The voltmeter reads 2 V.


237  In the circuit below, the reading $V_T$ on the voltmeter changes from high to low as the temperature
     of the thermistor changes. The reading V  on the voltmeter changes from high to low as the level
     of light on the light-dependent resistor (    R) changes.                          9702/12/  /J/13/Q38
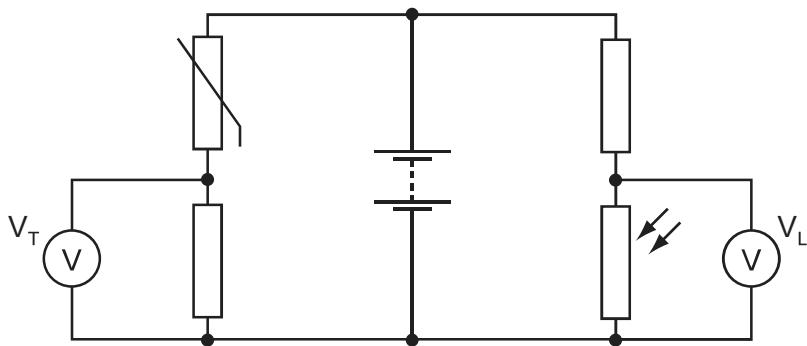


The readings $V_T$ and V  are both high.

What are the conditions of temperature and light level?

|   | temperature | light level |
|---|-------------|-------------|
| A | low         | low         |
|   | low         | high        |
|   | high        | low         |
|   | high        | high        |

**Current Electricity**

238 A 12 V battery is in series with an ammeter, a 2 Ω fixed resistor and a 0   10 Ω variable resistor. High-resistance voltmeters P and Q are connected across the variable resistor and the fixed resistor respectively, as shown.

12 V

0−10 Ω

2 Ω

A

V
P

V
Q
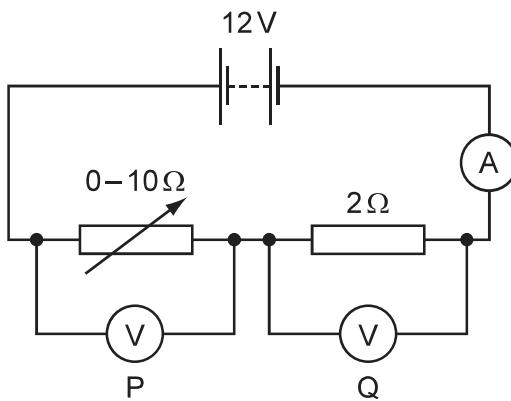
The resistance of the variable resistor is changed from its maximum value to zero.

Which graph shows the variation with current of the voltmeter readings?

A

voltmeter reading
P
Q
0
0
current

voltmeter reading
Q
P
0
0
current

voltmeter reading
P
Q
0
0
current

voltmeter reading
Q
P
0
0
current

**Current Electricity**
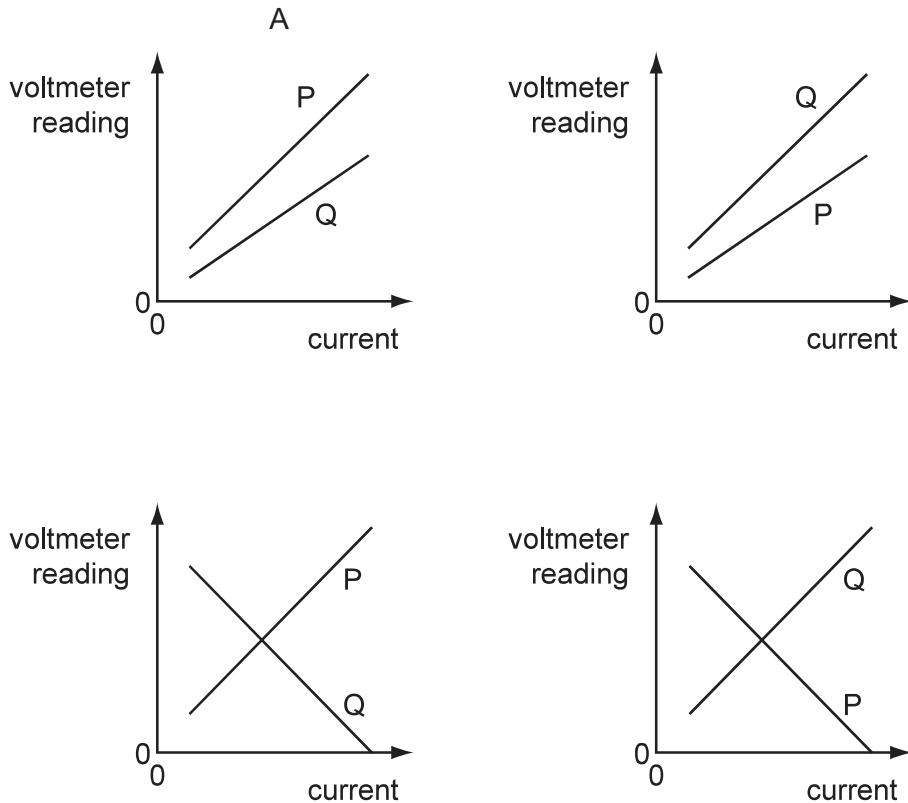
239  Two wires P and Q made of the same material are connected to the same electrical supply. P has twice the length of Q and one-third of the diameter of Q, as shown in the diagram.

9702/12/  /J/13/Q35
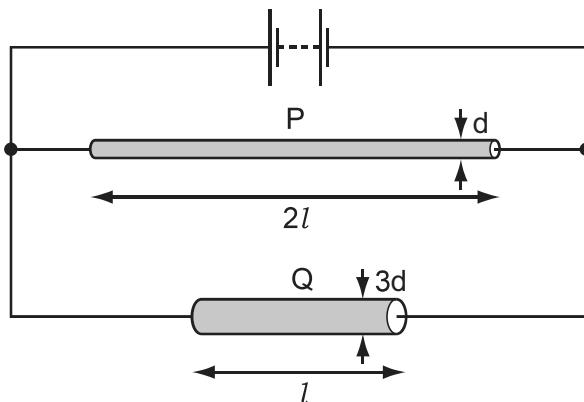


What is the ratio $\dfrac{\text{current in P}}{\text{current in Q}}$?

A  $\dfrac{2}{3}$          $\dfrac{2}{9}$          $\dfrac{1}{6}$          $\dfrac{1}{1}$

240  Two cells X and Y are connected in series with a resistor of resistance $9.0\,\Omega$, as shown.

9702/13/  /J/13/Q31
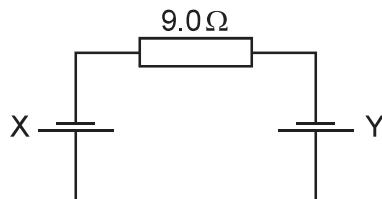


ell X has an electromotive force (e.m.f.) of $1.0\,$V and an internal resistance of $1.0\,\Omega$.   ell Y has an e.m.f. of $2.0\,$V and an internal resistance of $2.0\,\Omega$.

What is the current in the circuit?

A    0.25A                0.17A                0.10A                0.0 3A

241  An electric power cable consists of six copper wires c surrounding a steel core s.          9702/13/  /J/13/Q34
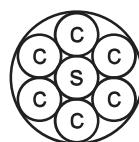


A length of $1.0\,$km of one of the copper wires has a resistance of $10\,\Omega$ and $1.0\,$km of the steel core has a resistance of $100\,\Omega$.

What is the approximate resistance of a $1.0\,$km length of the power cable?

A    $0.61\,\Omega$                $1.6\,\Omega$                $160\,\Omega$                $610\,\Omega$

**Current Electricity**

242 The graph shows how current I varies with voltage V for a filament lamp.
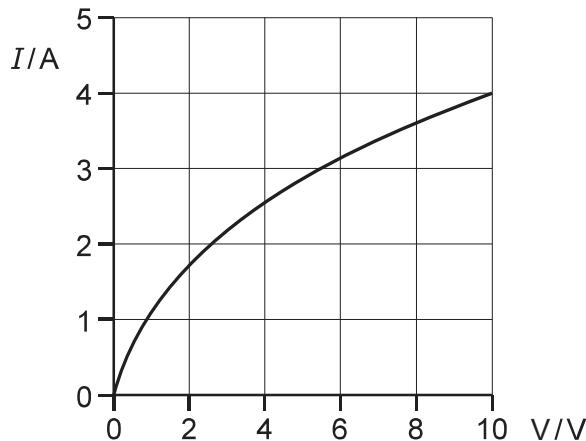


Since the graph is not a straight line, the resistance of the lamp varies with V

Which row gives the correct resistance at the stated value of V?

| | V/V | R/Ω |
|---|---|---|
| A | 2.0 | 1.5 |
| | 4.0 | 3.2 |
| | 6.0 | 1.9 |
| | .0 | 0.9 |

243 The circular cross-sectional area of a metal wire varies along its length. There is a current in the wire. The narrow end of the wire is at a reference potential of zero.
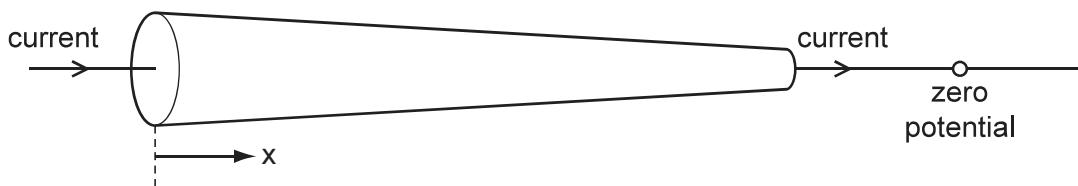


Which graph best represents the variation with distance x along the wire of the potential difference V relative to the reference zero?

A



**Current Electricity**
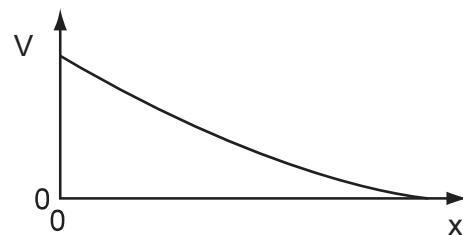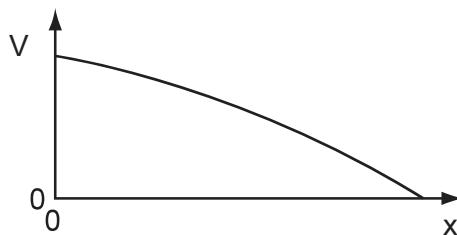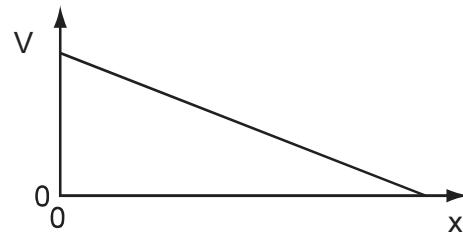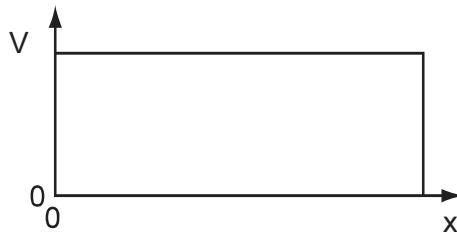
244  The diagram shows a length of track from a model railway connected to a battery, a resistor and a relay coil.

9702/13/ /J/13/Q35
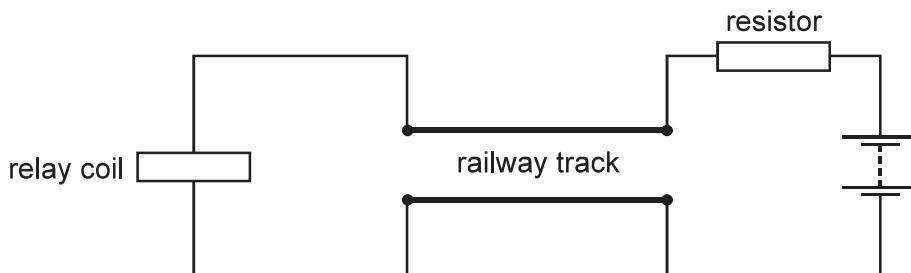


With no train present, there is a current in the relay coil which operates a switch to turn on a light.

When a train occupies the section of track, most of the current flows through the wheels and axles of the train in preference to the relay coil. The switch in the relay turns off the light.

Why is a resistor placed between the battery and the track?

A    to limit the heating of the wheels of the train

     to limit the energy lost in the relay coil when a train is present

     to prevent a short circuit of the battery when a train is present

     to protect the relay when a train is present

245  A 12V battery is in series with an ammeter, a 2Ω fixed resistor and a 0   10Ω variable resistor. A high-resistance voltmeter is connected across the fixed resistor.

9702/13/ /J/13/Q36
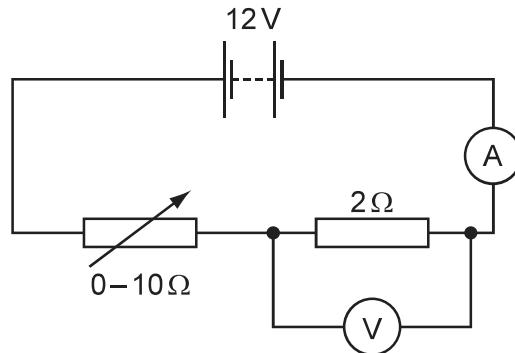


The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



**Current Electricity**
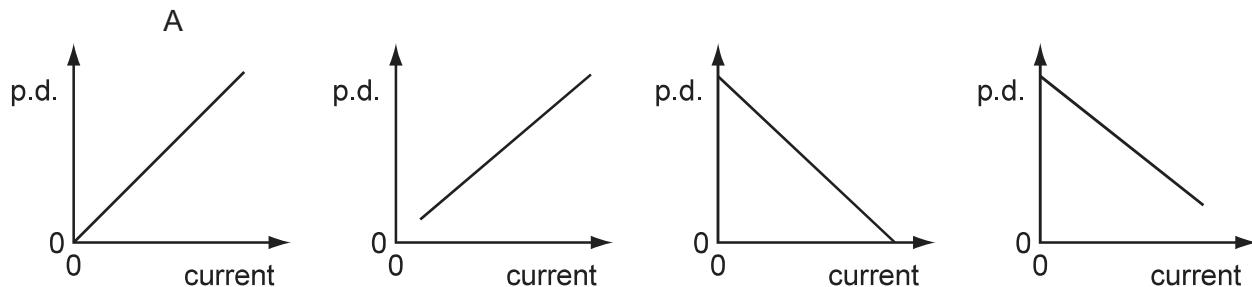
246 In the circuit shown, the battery and ammeter each have negligible resistance.   9702/13/ /J/13/Q37

12 V

X     Y     A
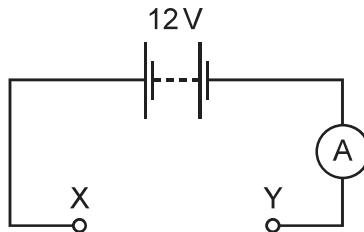
The following combinations of resistors are placed in turn between the terminals X and Y of the circuit.

Which combination would give an ammeter reading of   A?

A

1 Ω    2 Ω    3 Ω

2 Ω    1 Ω    3 Ω

1 Ω    2 Ω    3 Ω

2 Ω    1 Ω    3 Ω
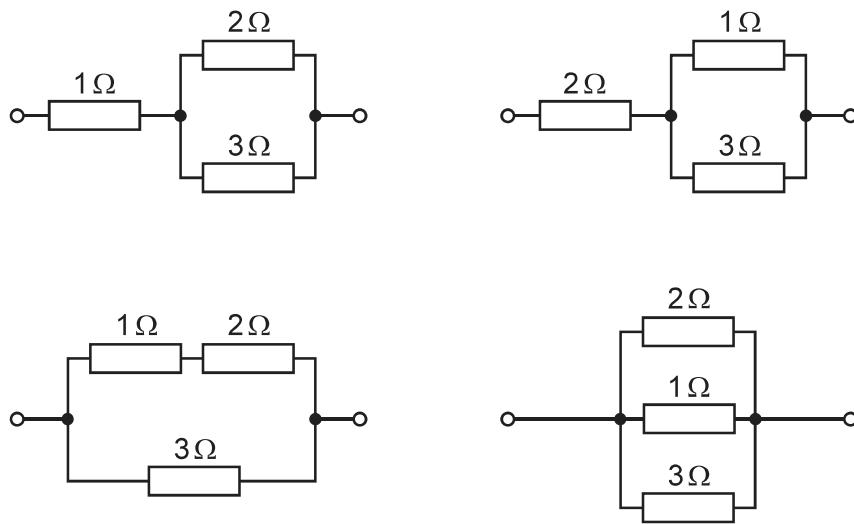
247 Four resistors of resistance R, 2R, 3R and 4R are connected to form a network.   9702/11/ /N/13/Q38

A battery of negligible internal resistance and a voltmeter are connected to the resistor network as shown.

3R

4R     V     2R

R
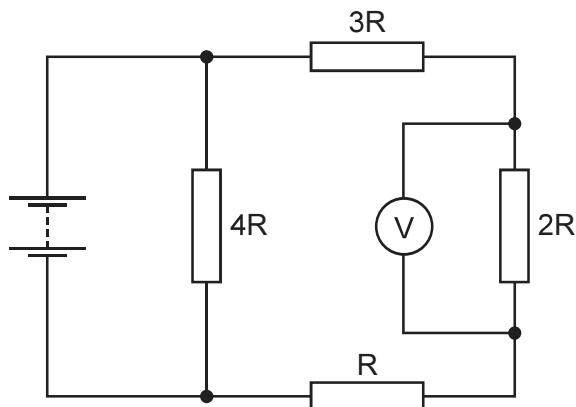
The voltmeter reading is 2 V.

What is the electromotive force (e.m.f.) of the battery?

A   2 V               4 V                    6 V                    10 V

Current Electricity

248 In the circuit below, P is a potentiometer of total resistance $10\,\Omega$ and Q is a fixed resistor of resistance $10\,\Omega$. The battery has an electromotive force (e.m.f.) of 4.0 V and negligible internal resistance. The voltmeter has a very high resistance.

9702/11/ /N/13/Q36
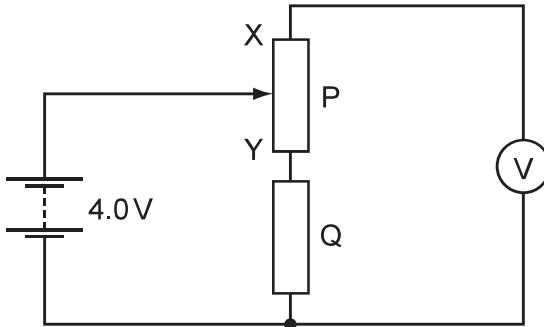


The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?
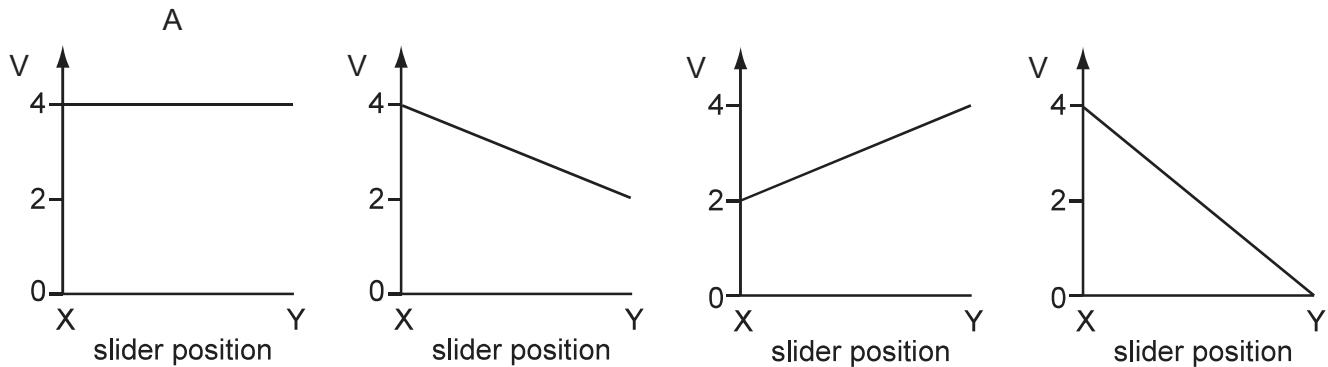


249 The diagram shows an electric circuit in which the resistance of the external resistor is 2R and the internal resistance of the source is R.

9702/11/ /N/13/Q33
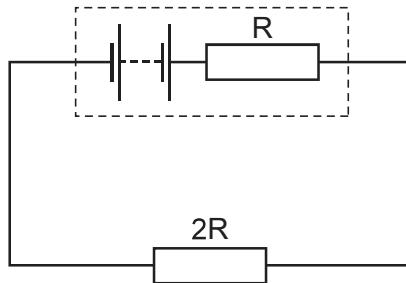


What is the ratio $\dfrac{\text{power in external resistor}}{\text{power in internal resistance}}$ ?

A  $\dfrac{1}{4}$              $\dfrac{1}{2}$              2              4

**Current Electricity**

250  A $2\,\Omega$ resistor and a $4\,\Omega$ resistor are connected to a cell.    9702/11/ /N/13/Q37
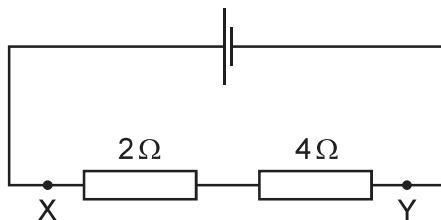


Which graph shows how the potential V varies with distance between X and Y?

A
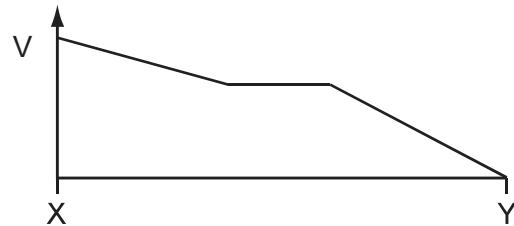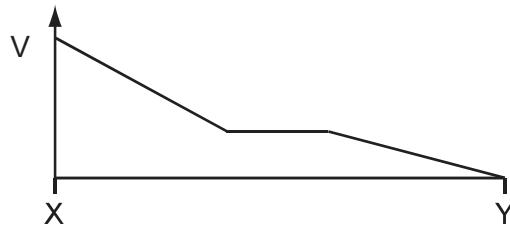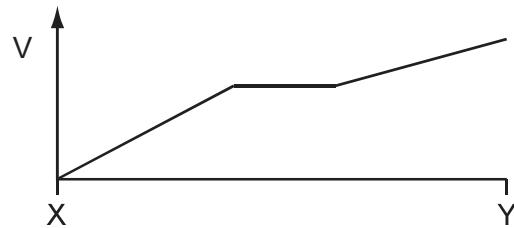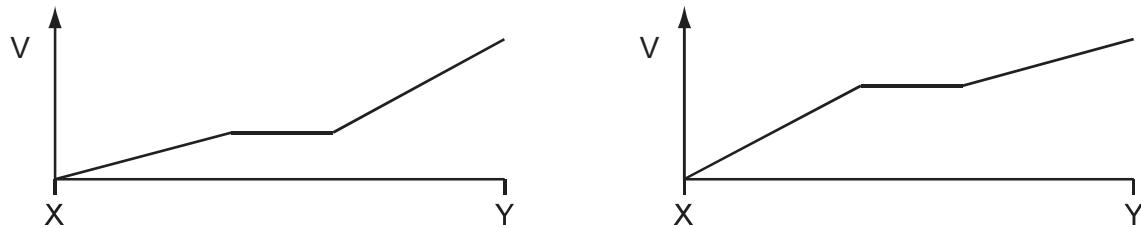


251  The wire of a heating element has resistance R. The wire breaks and is replaced by a different wire.    9702/11/ /N/13/Q35

ata for the original wire and the replacement wire are shown in the table.

|  | length | diameter | resistivity of metal |
|---|---|---|---|
| original wire | l | d | $\rho$ |
| replacement wire | l | 2d | $2\rho$ |

What is the resistance of the replacement wire?

A  $\dfrac{R}{4}$                  $\dfrac{R}{2}$                  R                  2R

252  The current in a component is reduced uniformly from 100 mA to 20 mA over a period of  .0 s.    9702/13/ /N/13/Q32

What is the charge that flows during this time?

A   160 m                  320 m                  4 0 m                  640 m

**Current Electricity**

253 Two lamps are connected in series to a 250 V power supply. ne lamp is rated 240 V, 60 W and the other is rated 10 V, 2.5 W.

Which statement most accurately describes what happens?

A oth lamps light at less than their normal brightness.

oth lamps light normally.

nly the 60 W lamp lights.

The 10 V lamp blows.

254 An electric current is passed from a thick copper wire through a section of thinner copper wire before entering a second thick copper wire as shown.
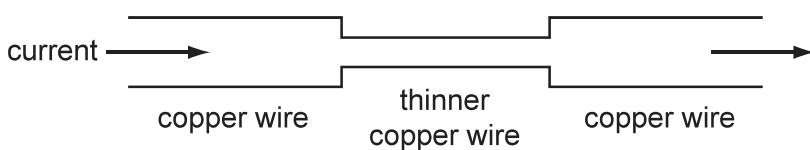
Which statement about the current and the speed of electrons in the wires is correct?

A The current and the speed of the electrons in the thinner wire are both less than in the thicker copper wires.

The current and the speed of the electrons is the same in all the wires.

The current is the same in all the wires but the speed of the electrons in the thinner wire is greater than in the thicker wires.

The current is the same in all the wires but the speed of the electrons in the thinner wire is less than in the thicker wire.

255 An electrical device of fixed resistance 20Ω is connected in series with a variable resistor and a battery of electromotive force (e.m.f.) 16 V and negligible internal resistance.
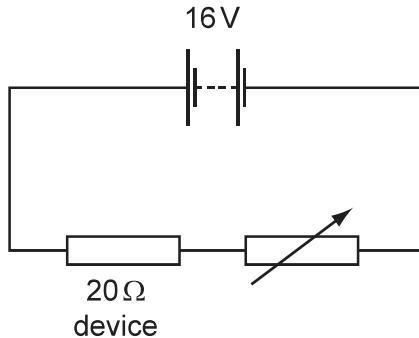
What is the resistance of the variable resistor when the power dissipated in the electrical device is 4.0 W?

A 16 Ω            36 Ω            44 Ω            60 Ω

**Current Electricity**

256 A copper wire is cylindrical and has resistance R.

What will be the resistance of a copper wire of twice the length and twice the radius?

A $\dfrac{R}{4}$ $\qquad\qquad$ $\dfrac{R}{2}$ $\qquad\qquad$ R $\qquad\qquad$ 2R

257 The diagram shows the electric motor for a garden pump connected to a 24V power supply by an insulated two-core cable.
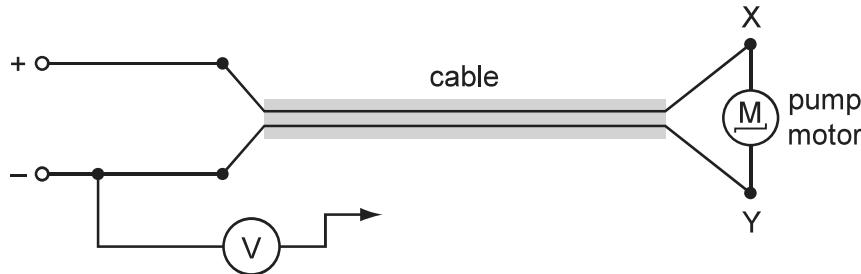
The motor does not work so, to find the fault, the negative terminal of a voltmeter is connected to the negative terminal of the power supply and its other end is connected in turn to terminals X and Y at the motor.

Which row represents two readings and a correct conclusion?

| | voltmeter reading when connected to X/V | voltmeter reading when connected to Y/V | conclusion |
|---|---|---|---|
| A | 24 | 0 | break in positive wire of cable |
| | 24 | 12 | break in negative wire of cable |
| | 24 | 24 | break in connection within the motor |
| | 24 | 24 | break in negative wire of cable |

258 Two wires P and Q made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has diameter 2mm and wire Q has diameter 1mm.

What is the ratio $\dfrac{\text{current in P}}{\text{current in Q}}$ ?

A $\dfrac{1}{4}$ $\qquad\qquad$ $\dfrac{1}{2}$ $\qquad\qquad$ $\dfrac{2}{1}$ $\qquad\qquad$ $\dfrac{4}{1}$

**Current Electricity**

259 In the circuit shown, the resistance of the thermistor decreases as temperature increases.
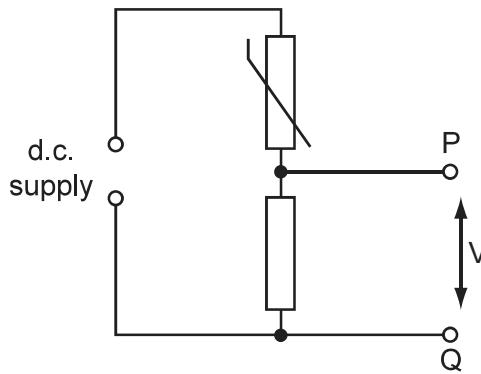
Which graph shows the variation with  elsius temperature $\theta$ of potential difference V between points P and Q?



A
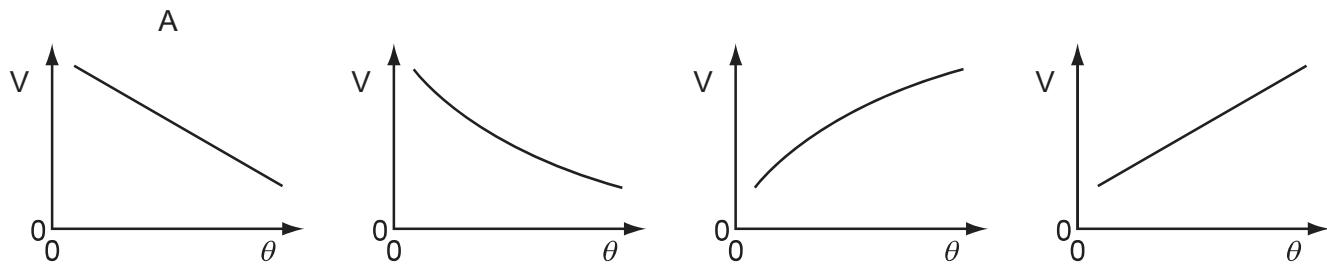
260 A 20 V d.c. supply is connected to a circuit consisting of five resistors  ,  , N, P and Q.
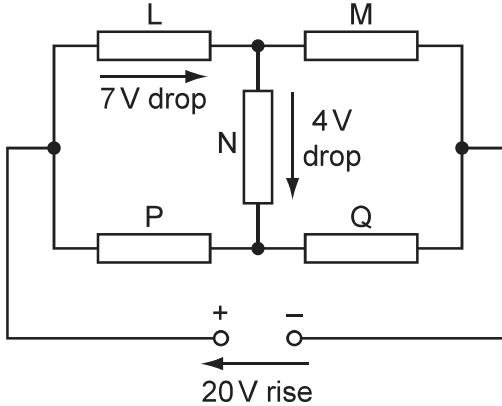
There is a potential drop of 7 V across  and a further 4 V potential drop across N.

What are the potential drops across  , P and Q?

| | potential drop across  /V | potential drop across P/V | potential drop across Q/V |
|---|---|---|---|
| A | 9 | 7 | 13 |
| | 13 | 7 | 13 |
| | 13 | 11 | 9 |
| | 17 | 3 | 17 |

Current Electricity

261 A battery of electromotive force (e.m.f.) V and negligible internal resistance is connected to a 1 kΩ resistor, as shown.
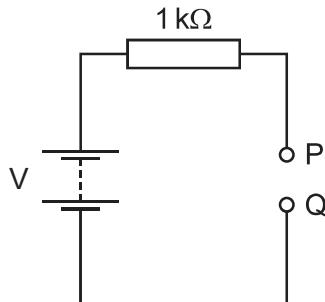
A student attempts to measure the potential difference (p.d.) between points P and Q using two voltmeters, one at a time. The first voltmeter has a resistance of 1 kΩ and the second voltmeter has a resistance of 1 Ω.

What are the readings of the voltmeters?

| | reading on voltmeter with 1 kΩ resistance | reading on voltmeter with 1 Ω resistance |
|---|---|---|
| A | $\dfrac{V}{2}$ | $\dfrac{V}{2}$ |
| | $\dfrac{V}{2}$ | $V$ |
| | $V$ | $\dfrac{V}{2}$ |
| | $V$ | $V$ |

262 The diagram shows an electric pump for a garden fountain connected by an 1 m cable to a 230 V mains electrical supply.
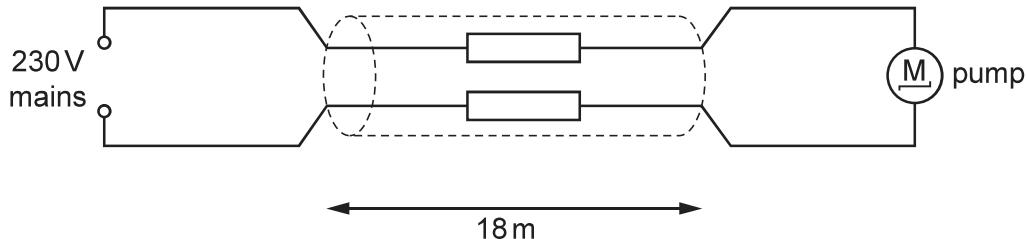
The performance of the pump is acceptable if the potential difference (p.d.) across it is at least 21 V. The current through it is then 0. 3A.

What is the maximum resistance per metre of each of the two wires in the cable if the pump is to perform acceptably?

A 0.40 Ωm[1]     0. 0 Ωm[1]     1.3 Ωm[1]     1.4 Ωm[1]

**Current Electricity**

263   ell X has an e.m.f. of 2.0 V and an internal resistance of 2.0 Ω.   ell Y has an e.m.f. of 1.6 V and an internal resistance of 1.2 Ω. These two cells are connected to a resistor of resistance 0.  Ω, as shown.
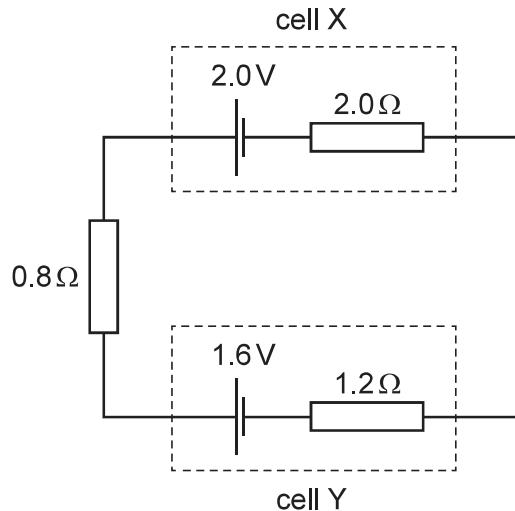
What is the current in cell X?

A    0.10 A                  0.50 A                  0.90 A                  1.0 A

264  In the circuit shown, all the resistors are identical.
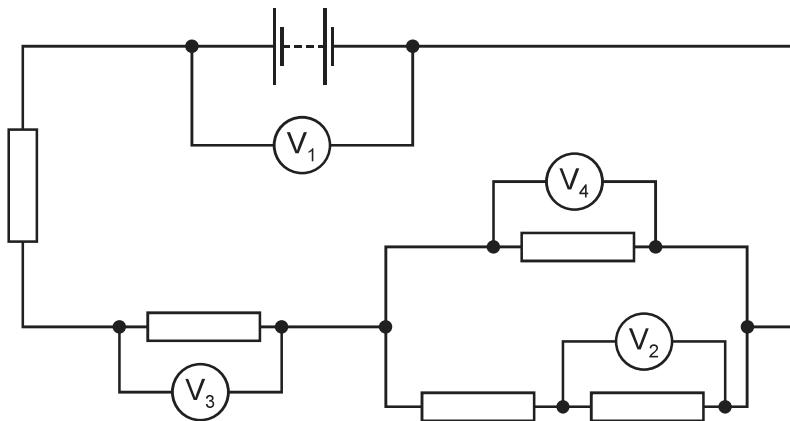
The reading on voltmeter $V_1$ is   .0 V and the reading on voltmeter $V_2$ is 1.0 V.

What are the readings on the other voltmeters?

| | reading on voltmeter $V_3$/V | reading on voltmeter $V_4$/V |
| --- | --- | --- |
| A | 1.5 | 1.0 |
| | 3.0 | 2.0 |
| | 4.5 | 3.0 |
| | 6.0 | 4.0 |

**Current Electricity**

265 In the circuit shown, a light-dependent resistor (    R) is connected to two resistors $R_1$ and $R_2$. The potential difference (p.d.) across $R_1$ is $V_1$ and the p.d. across $R_2$ is $V_2$. The current in the circuit is I.

9702/12/ /J/14/Q34
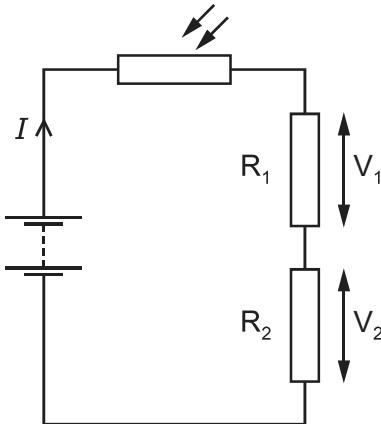


Which statement about this circuit is correct?

A    The current I increases when the light intensity decreases.

The     R is an ohmic conductor.

The p.d. $V_2$ increases when the light intensity decreases.

The ratio $\dfrac{V_1}{V_2}$ is independent of light intensity.

266 A power supply and a solar cell are compared using the potentiometer circuit shown.  9702/12/ /J/14/Q35
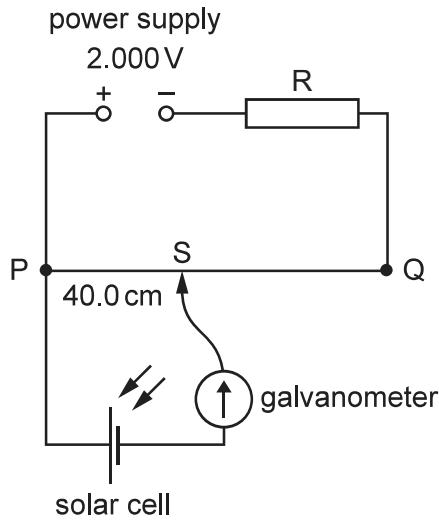


The e.m.f. produced by the solar cell is measured on the potentiometer.

The potentiometer wire PQ is 100.0 cm long and has a resistance of 5.00 Ω. The power supply has an e.m.f. of 2.000 V and the solar cell has an e.m.f. of 5.00 mV.

Which resistance R must be used so that the galvanometer reads zero when PS = 40.0 cm?

A    395 Ω              795 Ω              995 Ω              1055 Ω

**Current Electricity**

267 A cell has an electromotive force (e.m.f.) of 6V and internal resistance R. An external resistor, also of resistance R, is connected across this cell, as shown.
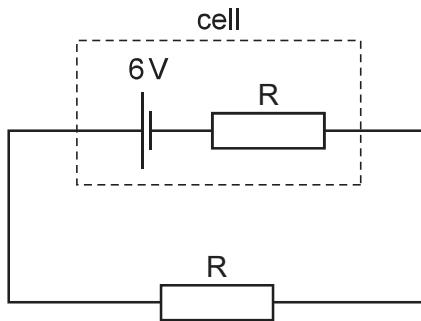
Power P is dissipated by the external resistor.

The cell is replaced by a different cell that has an e.m.f. of 6V and negligible internal resistance.

What is the new power that is dissipated in the external resistor?

A   0.5P              P                    2P                    4P

268 What is the current in the 40 Ω resistor of the circuit shown?
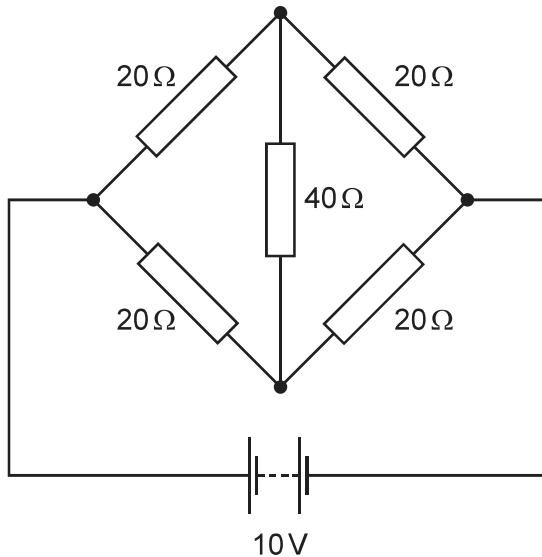
A   zero              0.13A                0.25A                0.50A

269  The diagram shows a light-dependent resistor ($L$R) and a thermistor forming a potential divider.
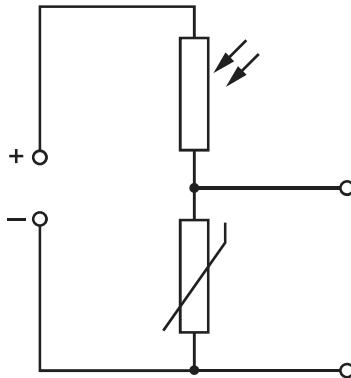
$U$nder which set of conditions will the potential difference across the thermistor have the greatest value?

| | illumination | temperature |
|---|---|---|
| A | low | low |
| | high | low |
| | low | high |
| | high | high |

270  The diagram shows a low-voltage circuit for heating the water in a fish tank.
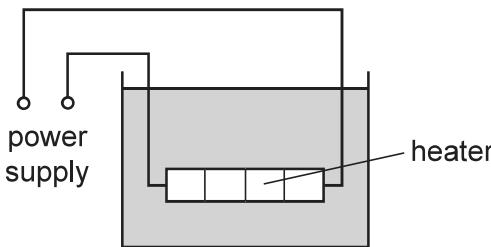
The heater has a resistance of $3.0\,\Omega$. The power supply has an e.m.f. of $12\,V$ and an internal resistance of $1.0\,\Omega$.

At which rate is energy supplied to the heater?

A  27W                 36W                 4 W                 64W

271  A copper wire is to be replaced by an aluminium alloy wire of the same length and resistance. $C$opper has half the resistivity of the alloy.

What is the ratio $\dfrac{\text{diameter of alloy wire}}{\text{diameter of copper wire}}$ ?

A  $\sqrt{2}$                 2                 $2\sqrt{2}$                 4

**Current Electricity**

272 The diagrams show the same cell, ammeter, potentiometer and fixed resistor connected in different ways.

W

X

Y

Z
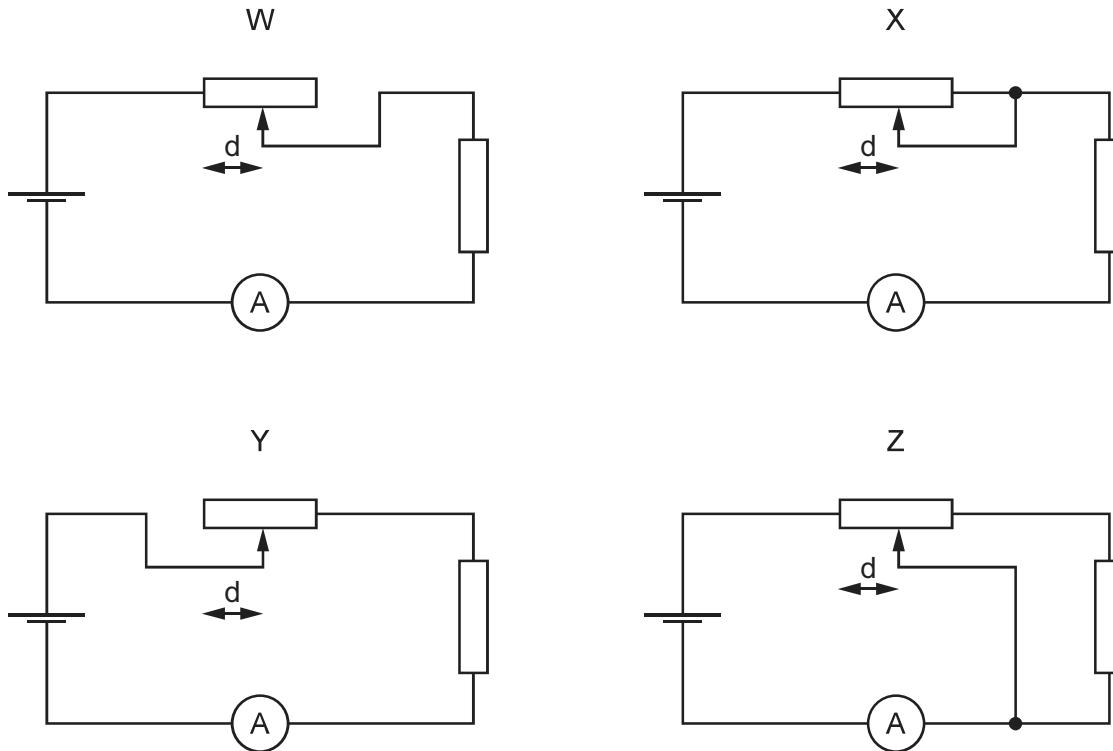
The distance d between the sliding contact and a particular end of the potentiometer is varied. The current measured is then plotted against the distance d.

For which two circuits will the graphs be identical?

A   W and X          W and Y          X and Y          Y and Z

273 A battery of negligible internal resistance is connected to a resistor network, an ammeter and a switch S, as shown.

4.8 Ω          7.2 Ω

S          2.8 Ω
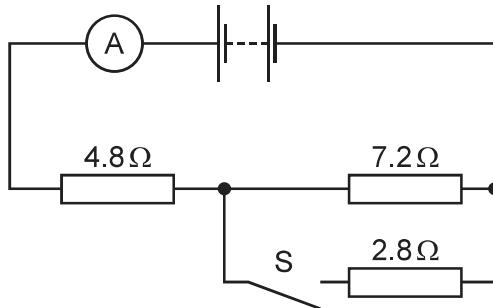
When S is open, the reading on the ammeter is 250 mA.

When S is closed, what is the change in the reading on the ammeter?

A   1.07 A          1.32 A          190 mA          440 mA

**Current Electricity**

274 Two electrically-conducting cylinders X and Y are made from the same material. 9702/11/ /J/14/Q30

Their dimensions are as shown.
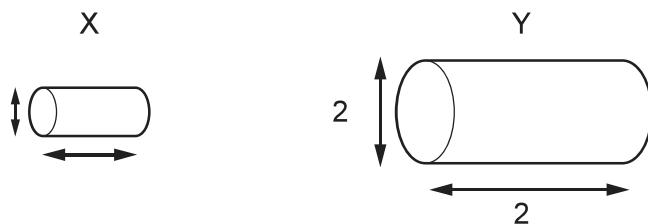


The resistance between the ends of each cylinder is measured.

What is the ratio $\dfrac{\text{resistance of X}}{\text{resistance of Y}}$ ?

A  $\dfrac{2}{1}$            $\dfrac{1}{1}$            $\dfrac{1}{2}$            $\dfrac{1}{4}$

275 A battery, with a constant internal resistance, is connected to a resistor of resistance $250\,\Omega$, as shown.

9702/11/ /J/14/Q31



$250\,\Omega$
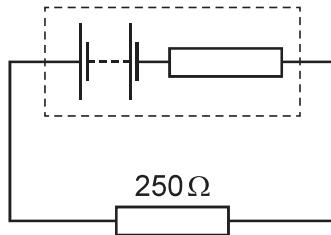
The current in the resistor is 40 mA for a time of 60 s.  During this time 6.0 J of energy is lost in the internal resistance.

What are the energy supplied to the external resistor during the 60 s and the e.m.f. of the battery?

|   | energy/J | e.m.f./V |
|---|---|---|
| A | 2.4 | 2.4 |
|   | 2.4 | 7.5 |
|   | 24 | 10.0 |
|   | 24 | 12.5 |

276 Which symbol represents a component whose resistance is designed to change with temperature?

9702/11/ /J/14/Q32

A



**Current Electricity**

277  In the circuit below, a voltmeter of resistance $R_V$ and an ammeter of resistance $R_A$ are used to measure the resistance R of the fixed resistor.
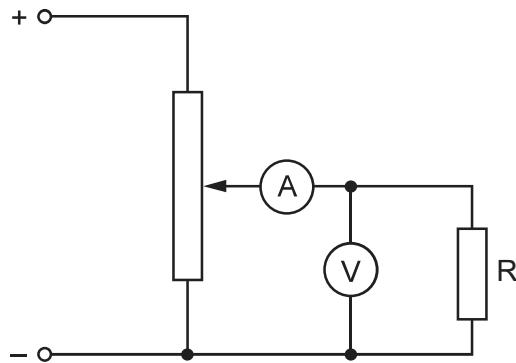
Which condition is necessary for an accurate value to be obtained for R?

A    R is much smaller than $R_V$.

     R is much smaller than $R_A$.

     R is much greater than $R_V$.

     R is much greater than $R_A$.


278  In the circuit shown, all the resistors are identical and all the ammeters have negligible resistance.
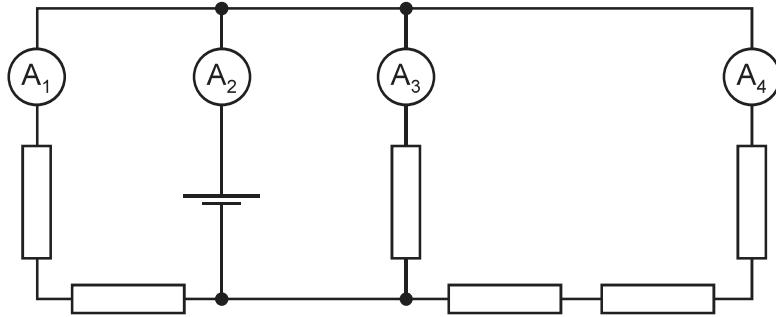
The reading on ammeter $A_1$ is 0.6 A.

What are the readings on the other ammeters?

|   | reading on ammeter $A_2$/A | reading on ammeter $A_3$/A | reading on ammeter $A_4$/A |
|---|---|---|---|
| A | 1.0 | 0.3 | 0.1 |
|   | 1.4 | 0.6 | 0.2 |
|   | 1. | 0.9 | 0.3 |
|   | 2.2 | 1.2 | 0.4 |

**Current Electricity**

279  The potential difference across a component in a circuit is 2.0 V.  9702/11/ /J/14/Q35

How many electrons must flow through this component in order for it to be supplied with 4.  J of energy?

A  2.6  $10^1$          1.5  $10^{19}$          3.0  $10^{19}$          6.0  $10^{19}$

280  What is the total resistance between points P and Q in this network of resistors?  9702/11/ /J/14/Q36
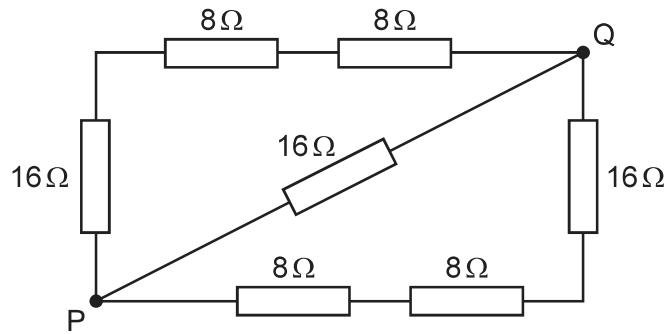


A    Ω          16 Ω          24 Ω          32 Ω

281  The combined resistance $R_T$ of two resistors of resistances $R_1$ and $R_2$ connected in parallel is given by the formula shown.  9702/11/ /N/14/Q35

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Which statement is used in the derivation of this formula?

A    The currents through the two resistors are equal.

The potential difference across each resistor is the same.

The supply current is split between the two resistors in the same ratio as the ratio of their resistances.

The total power dissipated is the sum of the powers dissipated in the two resistors separately.

Current Electricity

282  A pencil is used to draw a line of length 30 cm and width 1.2 mm. The resistivity of the material in the pencil is $2.0 \times 10^{-5}\,\Omega\,\mathrm{m}$ and the resistance of the line is $40\,\mathrm{k\Omega}$.  9702/11/ /N/14/Q32

What is the thickness of the line?

A    $1.25 \times 10^{-10}\,\mathrm{m}$

     $1.25 \times 10^{-}\,\mathrm{m}$

     $1.25 \times 10^{-7}\,\mathrm{m}$

     $1.25 \times 10^{-5}\,\mathrm{m}$

283  A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current I in the conductor.  9702/11/ /N/14/Q33
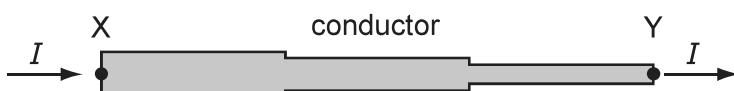


Point Y on the conductor is at zero potential.

Which graph best shows the variation of potential V with distance along the conductor?



**Current Electricity**
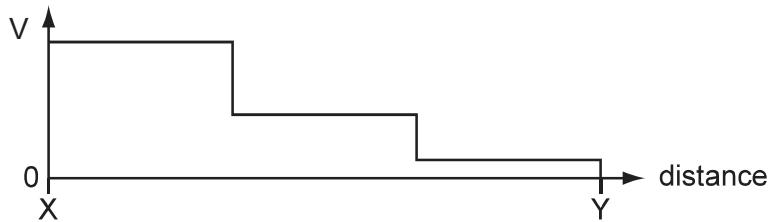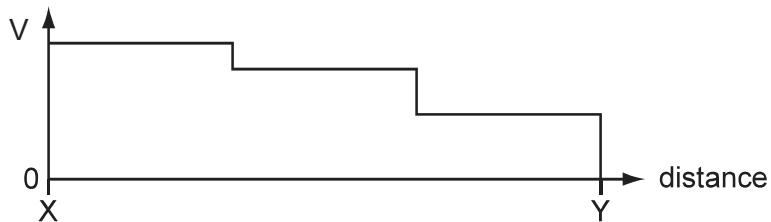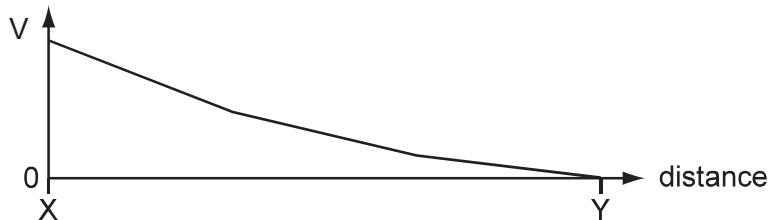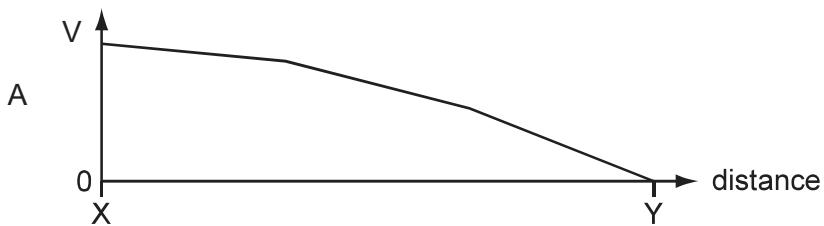
284  The graph shows how the electric current I through a conducting liquid varies with the potential difference V across it.

At which point on the graph does the liquid have the smallest resistance?
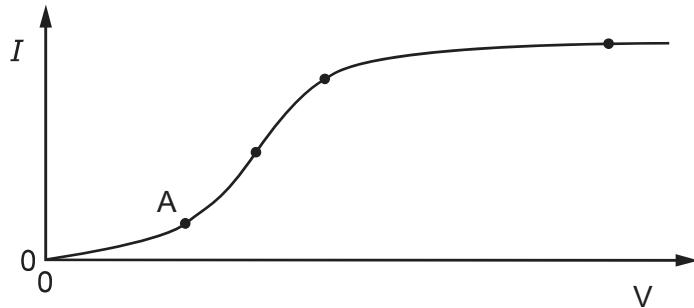


285  In the potentiometer circuit shown, the reading on the ammeter is zero.
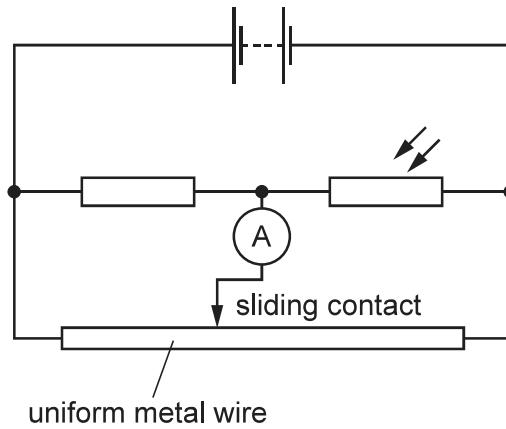
The light-dependent resistor ( R) is then covered up and the ammeter gives a non-zero reading.

Which change could return the ammeter reading to zero?

A    ecrease the supply voltage.

     Increase the supply voltage.

      ove the sliding contact to the left.

      ove the sliding contact to the right.

286  A metal wire of length 0.50 m has a resistance of 12 Ω.

What is the resistance of a wire of length 2.0 m and made of the same material, but with half the diameter?

A   12 Ω            4 Ω            96 Ω            192 Ω

**Current Electricity**

287  Six resistors, each of resistance R, are connected as shown.

9702/11/ /N/14/Q37
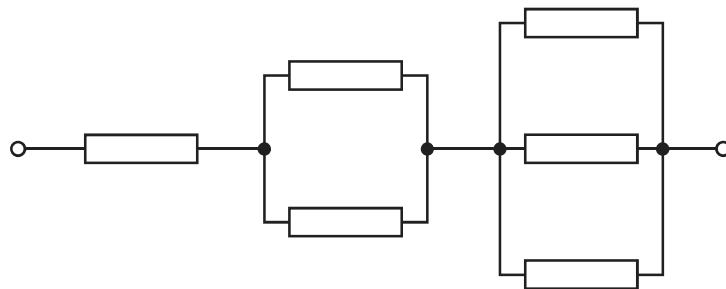


The combined resistance is 66 kΩ.

What is the value of R?

A    11 kΩ                  1  kΩ                  22 kΩ                  36 kΩ


288  A student found two unmarked resistors. To determine the resistance of the resistors, the circuit below was set up. The resistors were connected in turn between P and Q, noting the current readings. The voltage readings were noted without the resistors and with each resistor in turn.

9702/13/ /N/14/Q34
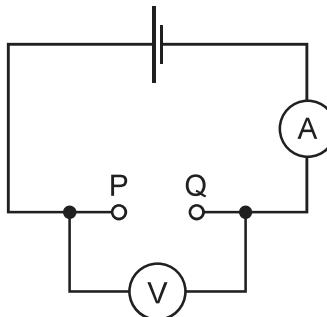


The results were entered into a spreadsheet as shown.

| 1.5 | 1.3 | 2 | 46 |
| 1.5 | 1.4 | 14 | 100 |

The student forgot to enter the column headings.

Which order of the headings would be correct?

| A | e.m.f. /V | V/V | R/Ω | I /mA |
|---|---|---|---|---|
|  | V/V | e.m.f. /V | R/Ω | I /mA |
|  | V/V | e.m.f. /V | I /mA | R/Ω |
|  | e.m.f. /V | V/V | I /mA | R/Ω |

**Current Electricity**

289 A potential divider consists of resistors of resistance $R_1$ and $R_2$ connected in series across a source of potential difference $V_0$. The potential difference across $R_1$ is $V_{out}$.
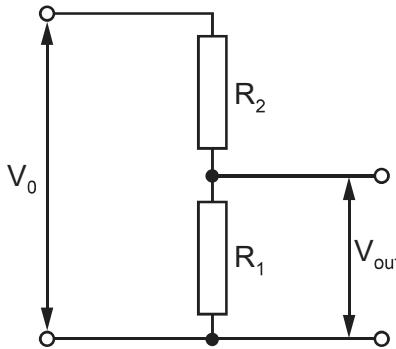
Which changes to $R_1$ and $R_2$ will increase the value of $V_{out}$?

|   | $R_1$ | $R_2$ |
|---|---|---|
| A | doubled | doubled |
|   | doubled | halved |
|   | halved | doubled |
|   | halved | halved |

290 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance.
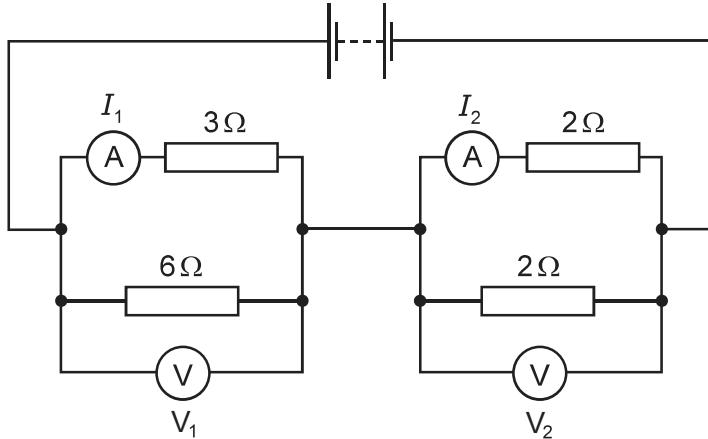
The readings on the meters are $I_1$, $I_2$, $V_1$ and $V_2$, as labelled on the diagram.

Which statement is correct?

A    $I_1$    $I_2$ and $V_1$    $V_2$

   $I_1$    $I_2$ and $V_1$    $V_2$

   $I_1$    $I_2$ and $V_1$    $V_2$

   $I_1$    $I_2$ and $V_1$    $V_2$

**Current Electricity**

291  An extension lead is used to connect a 240 V electrical supply to a heater as shown.  9702/13/ /N/14/Q36
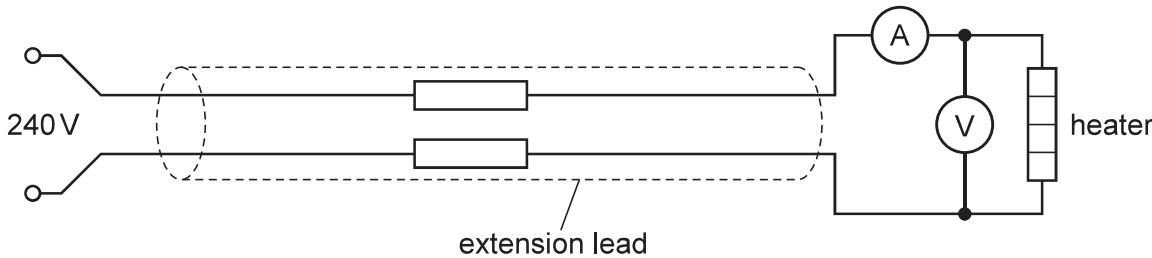


extension lead

A voltmeter measures the potential difference (p.d.) across the heater as 216 V and an ammeter measures the current through the heater as 7.7 A.

What is the total resistance of the extension lead?

A   3.1 Ω                6.2 Ω                2 Ω                31 Ω

292  A pedal bicycle is fitted with an electric motor. The rider switches on the motor for a time of 3.0 minutes. A constant current of 3.5 A in the electric motor is provided from a battery with a terminal voltage of 24 V.

9702/13/ /J/15/Q32

What is the energy supplied by the battery?

A    4 J                250 J                630 J                15 000 J

293  The diagram shows a simple circuit.                9702/13/ /J/15/Q33
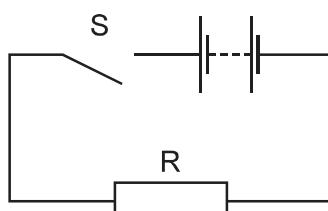


Which statement is correct?

A    When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance of R.

When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

When switch S is closed, the potential difference across the battery falls because work is done against the resistance of R.

294 A simple circuit is formed by connecting a resistor of resistance R between the terminals of a battery of electromotive force (e.m.f.) 9.0 V and constant internal resistance r.
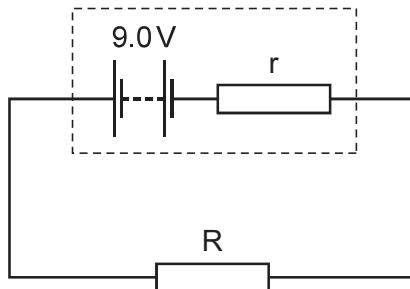
A charge of 6.0 flows through the resistor in a time of 2.0 minutes causing it to dissipate 4 J of thermal energy.

What is the internal resistance r of the battery?

A   0.17 Ω              0.33 Ω              20 Ω              160 Ω

295 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.
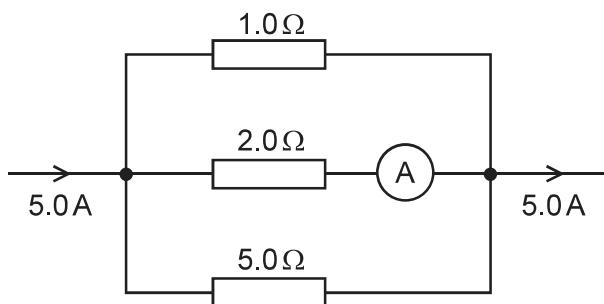
What is the reading on the ammeter?

A   0.7 A              1.3 A              1.5 A              1.7 A

296 Which statement is not valid?

A    urrent is the speed of the charged particles that carry it.

Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms per unit charge.

The potential difference (p.d.) between two points is the work done per unit charge when moving charge from one point to the other.

The resistance between two points is the p.d. between the two points per unit current.

**Current Electricity**

297 A box with four terminals P, Q, R and S contains two identical resistors.
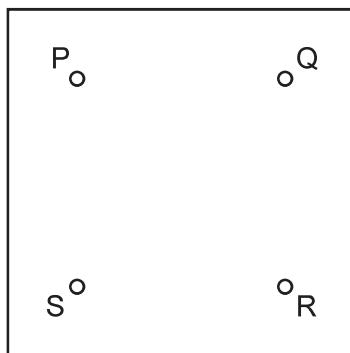


When a battery of electromotive force (e.m.f.) E and negligible internal resistance is connected across PS, a high-resistance voltmeter connected across QR reads $\dfrac{E}{2}$ .

Which diagram shows the correct arrangement of the two resistors inside the box?

A
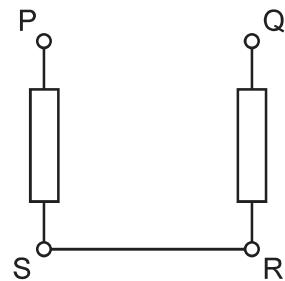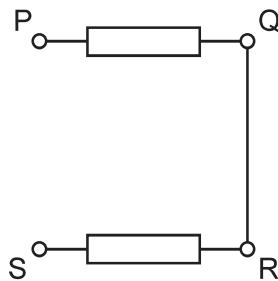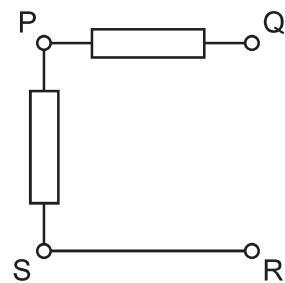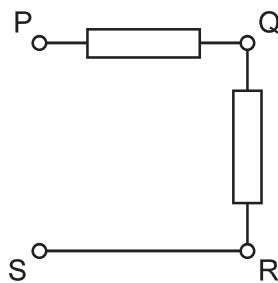


298 A source of e.m.f. 9.0 mV has an internal resistance of 6.0 Ω.

It is connected across a galvanometer of resistance 30 Ω.

What is the current in the galvanometer?

A    250  A                300  A                1.5 mA                2.5 mA

Current Electricity

299 Which unit is not used in either the definition of the coulomb or the definition of the volt?

A    ampere

joule

ohm

second

300 When a thin metal wire is stretched, it becomes longer and thinner. This causes a change in the resistance of the wire. The volume of the wire remains constant.

Which graph could represent the variation with extension x of the resistance R of the wire?
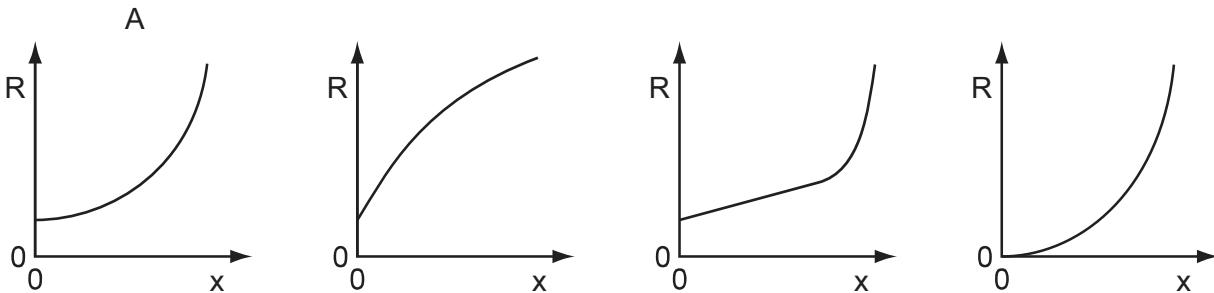


301 A cell of e.m.f. E delivers a charge Q to an external circuit.

Which statement is correct?

A    The energy dissipation in the external circuit is EQ.

The energy dissipation within the cell is EQ.

The external resistance is EQ.

The total energy dissipation in the cell and the external circuit is EQ.

302 The diagrams show two different circuits.
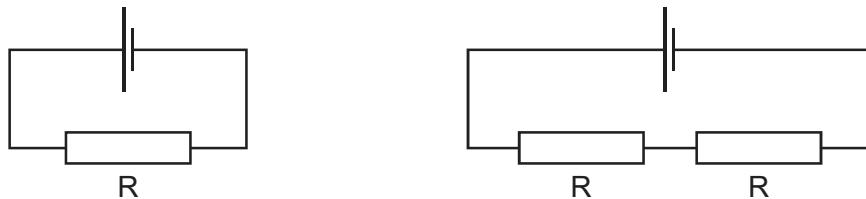
The cells in each circuit have the same electromotive force and zero internal resistance. The three resistors each have the same resistance R.

In the circuit on the left, the power dissipated in the resistor is P.

What is the total power dissipated in the circuit on the right?

A    $\dfrac{P}{4}$                $\dfrac{P}{2}$                P                2P

**Current Electricity**

303 Each of irchhoff s two laws presumes that some quantity is conserved. 9702/12/ /J/15/Q35

Which row states irchhoff s first law and names the quantity that is conserved?

| | statement | quantity |
|---|---|---|
| A | the algebraic sum of currents into a junction is zero | charge |
| | the algebraic sum of currents into a junction is zero | energy |
| | the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop | charge |
| | the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop | energy |

304 Which equation that links some of the following terms is correct? 9702/11/ /J/15/Q34

| | |
|---|---|
| potential difference (p.d.) | V |
| current | I |
| resistance | R |
| charge | Q |
| energy | E |
| power | P |
| time | t |

A  $P = \dfrac{Q^2R}{t}$

$ER^2 = V^2t$

$\dfrac{VI}{P} = t$

$PQ = EI$

**Current Electricity**

305 A potential divider circuit consists of fixed resistors of resistance 2.0 Ω and 4.0 Ω connected in series with a 3.0 Ω resistor fitted with a sliding contact. These are connected across a battery of e.m.f. 9.0 V and zero internal resistance, as shown.
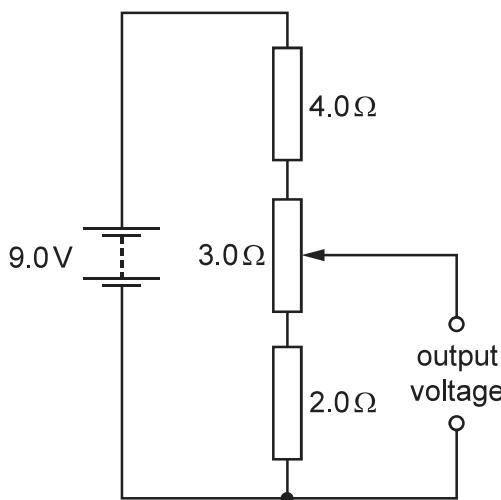
What are the maximum and the minimum output voltages of this potential divider circuit?

|   | maximum voltage / V | minimum voltage / V |
|---|---|---|
| A | 4.0 | 2.0 |
|   | 5.0 | 2.0 |
|   | 9.0 | 0 |
|   | 9.0 | 2.0 |

306 A cell of e.m.f. 2.0 V and negligible internal resistance is connected to a network of resistors as shown.
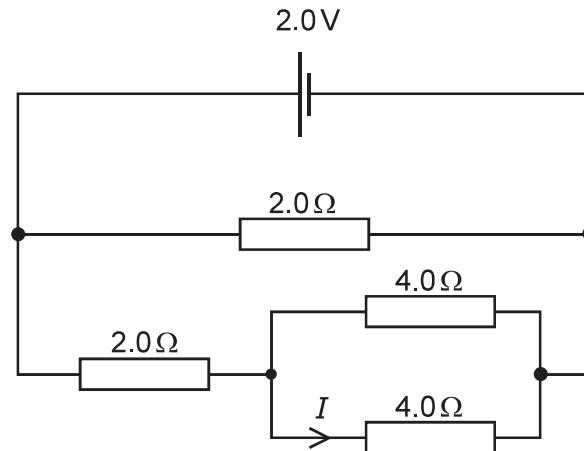
What is the current I ?

A    0.25 A                    0.33 A                    0.50 A                    1.5 A

**Current Electricity**

307 A battery with e.m.f. E and internal resistance r is connected in series with a variable external resistor.
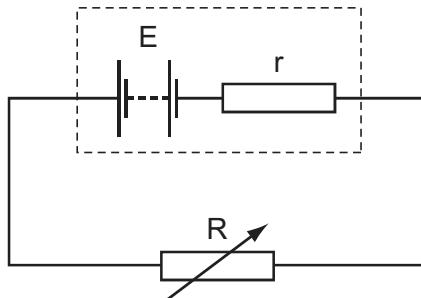
The value of the external resistance R is slowly increased from zero.

Which statement is correct? (Ignore any temperature effects.)

A   The potential difference across the external resistance decreases.

    The potential difference across the internal resistance increases.

    The power dissipated in r increases and then decreases.

    The power dissipated in R increases and then decreases.


308 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected in series with a resistor of resistance 6.0 Ω and a variable resistor of resistance from zero to 4.0 Ω. A voltmeter is connected across the variable resistor. The resistance of the variable resistor is changed.
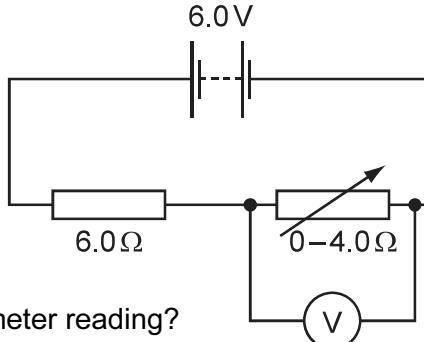
What is the range of the voltmeter reading?

A   0 V   2.4 V

    0 V   3.6 V

    2.4 V   6.0 V

    3.6 V   6.0 V


309 The charge that an electric battery can deliver is specified in ampere-hours.

For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2 A for 200 hours.

What is the maximum energy that a fully charged 12 V, 40 ampere-hour battery could supply?

A   1.7 kJ              29 kJ              1.7  J              29  J


**Current Electricity**

310  A wire RST is connected to another wire XY as shown.

50 cm
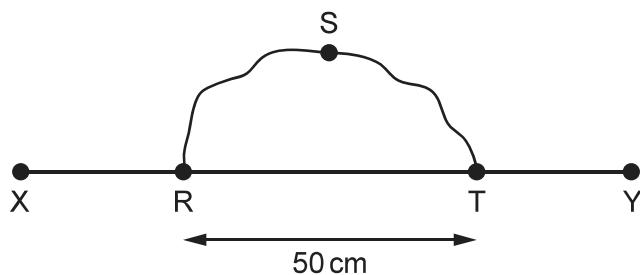
Each wire is 100 cm long with a resistance per unit length of $10\,\Omega\,m^{1}$.

What is the total resistance between X and Y?

A   3.3Ω                    5.0Ω                    .3Ω                    13.3Ω

**1** Which of the following summarises the change in wave characteristics on going from infra-red to ultraviolet in the electromagnetic spectrum?

| | frequency | speed (in a vacuum) |
|---|---|---|
| A | decreases | decreases |
| | decreases | remains constant |
| | increases | remains constant |
| | increases | increases |

**2** The diagram shows a cathode-ray oscilloscope trace of a sound wave. The time-base is calibrated at $2.0\,\text{ms}\,\text{cm}^{-1}$.
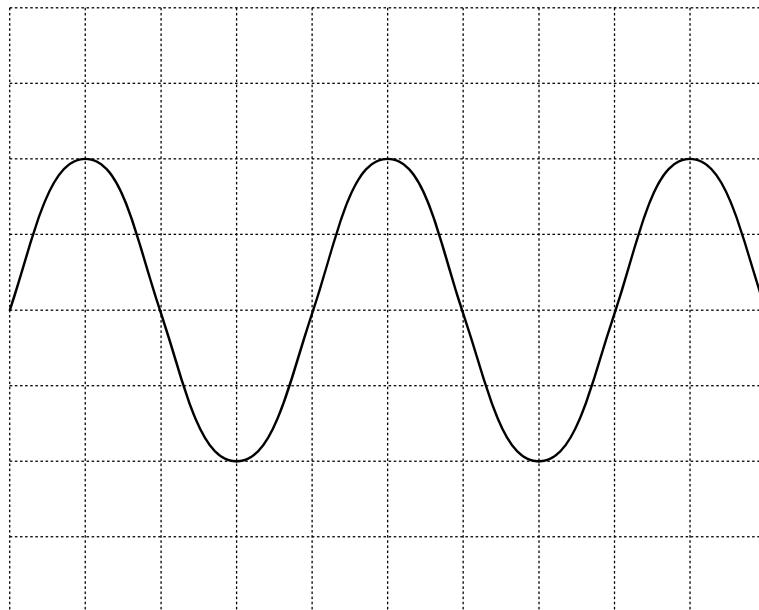
What is the frequency of the sound wave?

A     62.5 Hz                    125 Hz                    250 Hz                    500 Hz

**3** Which statement correctly relates the intensity of a sound wave to the vibrations of the molecules?

A     intensity $\alpha$ amplitude

intensity $\alpha$ (amplitude)$^2$

intensity $\alpha$ displacement

intensity $\alpha$ (displacement)$^2$

**Waves**

**4** Which value is a possible wavelength for radiation in the microwave region of the electromagnetic spectrum?

A  3  $10^{-2}$ m                 3  $10^{-5}$ m                 3  $10^{-8}$ m                 3  $10^{-10}$ m

**5** The four graphs represent a progressive wave on a stretched string. Graphs A and     show how the displacement $d$ varies with distance $x$ along the string at one instant. Graphs     and     show how the displacement $d$ varies with time $t$ at a particular value of $x$.

The labels on the graphs are intended to show the wavelength $\lambda$, the period $T$, and the amplitude $a$ of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?

A
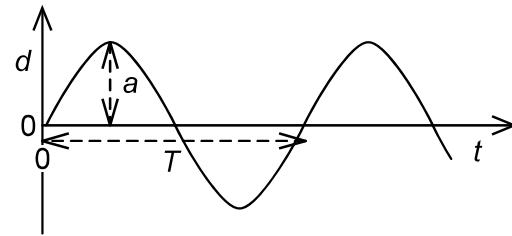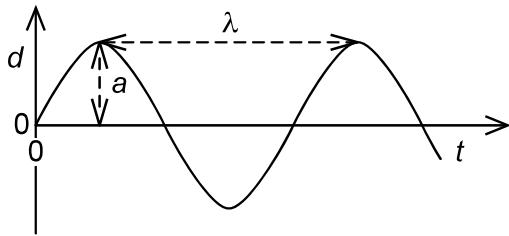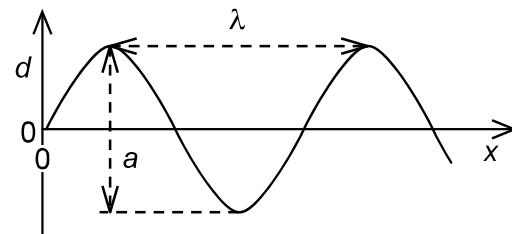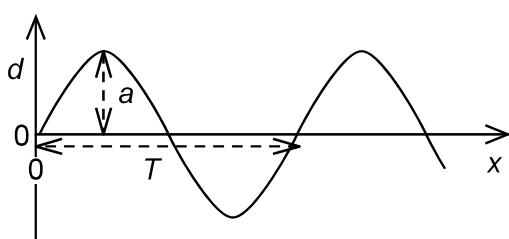


**6** A wave of amplitude $a$ has an intensity of 3.0 Wm$^{-2}$.

What is the intensity of a wave of the same frequency that has an amplitude $2a$?

A    4.2 Wm$^{-2}$                 6.0 Wm$^{-2}$                 9.0 Wm$^{-2}$                 12 Wm$^{-2}$

**7** Which of the following is true for all transverse waves?

A    They are all electromagnetic.

They can all be polarised.

They can all travel through a vacuum.

They all involve the oscillation of atoms.

**Waves**

**8** Electromagnetic waves of wavelength $\lambda$ and frequency $f$ travel at speed $c$ in a vacuum.

Which of the following describes the wavelength and speed of electromagnetic waves of frequency $f/2$?

|   | wavelength | speed in a vacuum |
|---|---|---|
| A | $\lambda/2$ | $c/2$ |
|   | $\lambda/2$ | $c$ |
|   | $2\lambda$ | $c$ |
|   | $2\lambda$ | $2c$ |

**9** A sound wave is displayed on the screen of a cathode-ray oscilloscope. The time base of the c.r.o. is set at $2.5\,ms/cm$.

1 cm
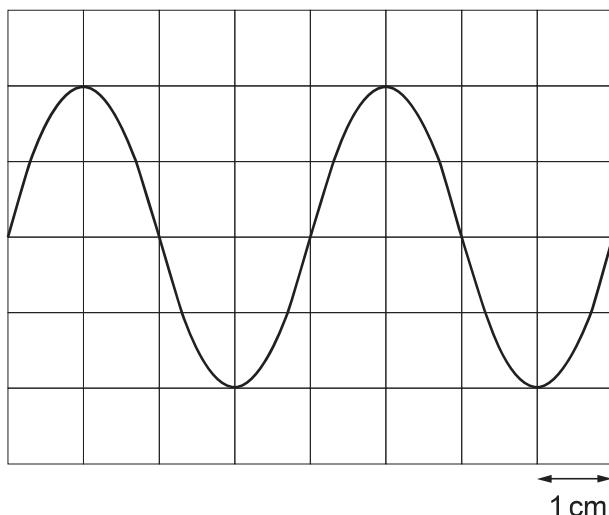
What is the frequency of the sound wave?

A    50 Hz                100 Hz                200 Hz                400 Hz

**10** When the light from two lamps falls on a screen, no interference pattern can be obtained.

Why is this?

A    The lamps are not point sources.

The lamps emit light of different amplitudes.

The light from the lamps is not coherent.

The light from the lamps is white.

**Waves**

**11** The graph shows how the displacement of a particle in a wave varies with time.
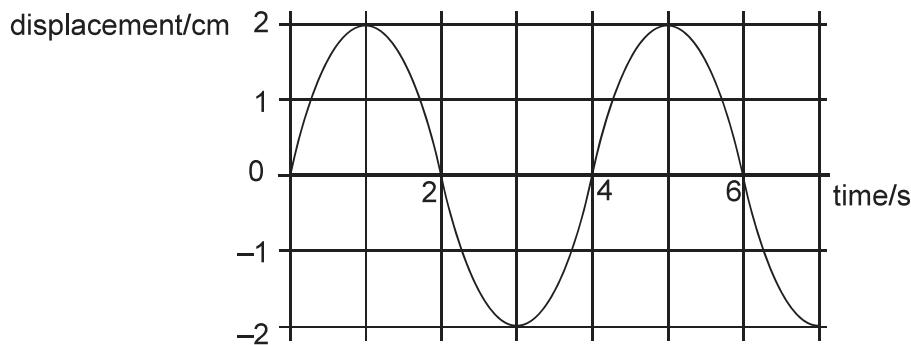


Which of the following is correct?

A   The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

The wave has an amplitude of 2 cm and must be transverse.

The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

The wave has an amplitude of 4 cm and must be transverse.

**12** Which of the following applies to a progressive transverse wave?

|   | transfers energy | can be polarised |
|---|---|---|
| A | no | no |
|   | no | yes |
|   | yes | no |
|   | yes | yes |

13  Which observation indicates that sound waves are longitudinal?

A   Sound can be reflected from a solid surface.

Sound cannot be polarised.

Sound is diffracted around corners.

Sound is refracted as it passes from hot air to cold air.

**Waves**

14  The diagram shows a transverse wave on a rope. The wave is travelling from left to right.

At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.
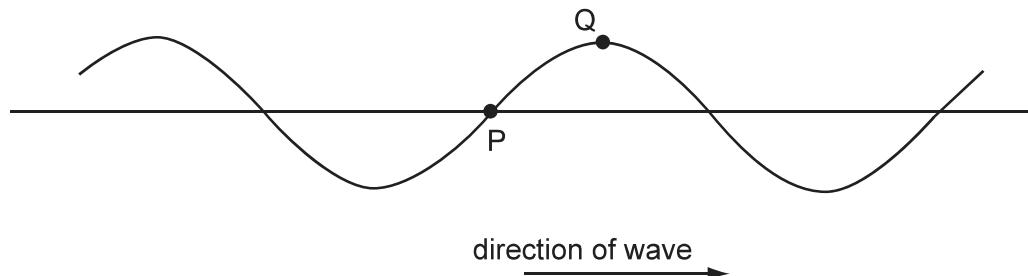
direction of wave

Which of the following describes the direction of motion, if any, of the points P and Q at this instant?

|   | point P | point Q |
|---|---------|---------|
| A | downwards | stationary |
|   | stationary | downwards |
|   | stationary | upwards |
|   | upwards | stationary |

15  A plane wave of amplitude A is incident on a surface of area S placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is E.

The amplitude of the wave is increased to 2A and the area of the surface is reduced to $\frac{1}{2}$ S.

How much energy per unit time reaches this smaller surface?

A   4E                      2E                     E                     $\frac{1}{2}$ E

16  What is the approximate range of frequencies of infra-red radiation?

A   $1 \times 10^3$ Hz    to   $1 \times 10^9$ Hz

    $1 \times 10^9$ Hz    to   $1 \times 10^{11}$ Hz

    $1 \times 10^{11}$ Hz    to   $1 \times 10^{14}$ Hz

    $1 \times 10^{14}$ Hz    to   $1 \times 10^{17}$ Hz

17  A wave of amplitude 20 mm has intensity $I_X$. Another wave of the same frequency but of amplitude 5 mm has intensity $I_Y$.

What is $\frac{I_X}{I_Y}$ ?

A   2                        4                      16                     256

**Waves**

18 Which of the following is a longitudinal wave? 9702/01/ /N/04/Q24

A    a light wave travelling through air

a radio wave from a broadcasting station

a ripple on the surface of water

a sound wave travelling through air

19 What do not travel at the speed of light in a vacuum? 9702/01/ /J/05/Q23

A    electrons

microwaves

radio waves

X-rays

20 The number of wavelengths of visible light in one metre is of the order of 9702/01/ /J/05/Q24

A   $10^4$.               $10^6$.               10 .               $10^{10}$.

21 A health inspector is measuring the intensity of a sound. Near a loudspeaker his meter records an intensity I. This corresponds to an amplitude A of the sound wave. At another position the meter gives an intensity reading of 2I. 9702/01/ /J/0/Q25

What is the corresponding sound wave amplitude?

A   $\frac{A}{\sqrt{2}}$              $\sqrt{2}\,A$              $2A$              $4A$

22   A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest. 9702/01/ /J/0/Q26

What is the nature of the sound wave in the tube?

A    longitudinal and progressive

longitudinal and stationary

transverse and progressive

transverse and stationary

23 The frequency of a certain wave is 500 Hz and its speed is 340 m s$^{-1}$. 9702/01/ /J/06/Q25

What is the phase difference between the motions of two points on the wave 0.17 m apart?

A   $\frac{\pi}{4}$ rad              $\frac{\pi}{2}$ rad              $\frac{3\pi}{4}$ rad              $\pi$ rad

**Waves**

24  Polarisation is a phenomenon associated with a certain type of wave.

Which condition must be fulfilled if a wave is to be polarised?

A   It must be a light wave.

It must be a longitudinal wave.

It must be a radio wave.

It must be a transverse wave.

25  A sound wave has displacement y at distance x from its source at time t.

Which graph correctly shows the amplitude a and the wavelength $\lambda$ of the wave?
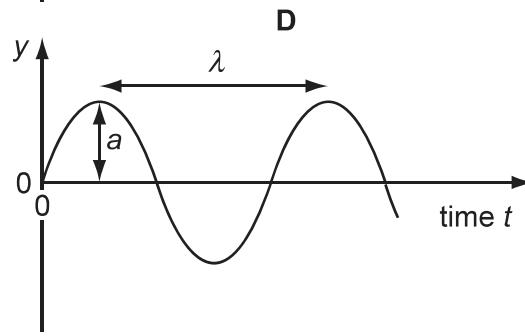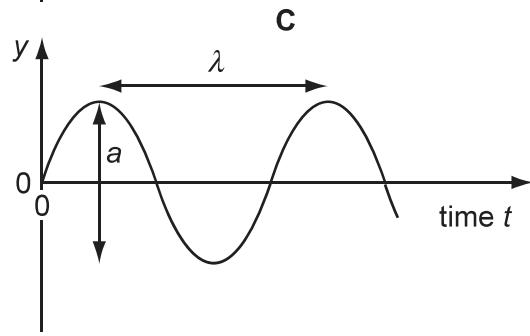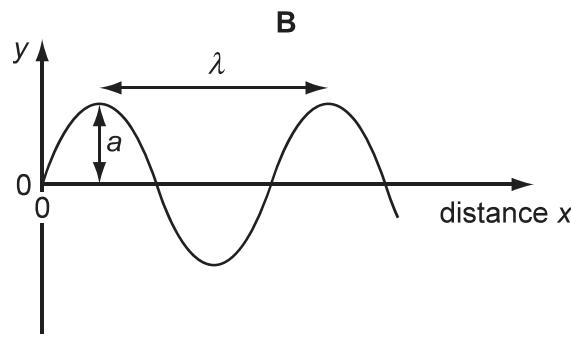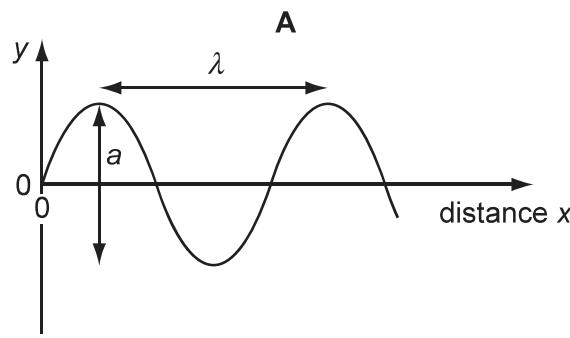


26  Which phenomenon is associated with transverse waves but not longitudinal waves?

A   polarisation

reflection

refraction

superposition

27  The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as $10^{x}$ Hz.

What is the value of x?

A   13                    15                    17                    19

**Waves**

28 The intensity of a progressive wave is proportional to the square of the amplitude of the wave. It is also proportional to the square of the frequency.                9702/01/ /N/05/Q24

The variation with time t of displacement x of particles in a medium, when two progressive waves P and Q pass separately through the medium, are shown on the graphs.
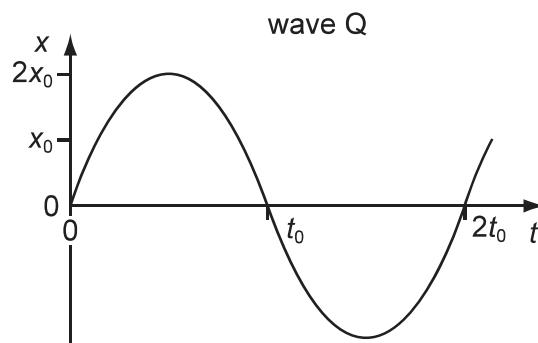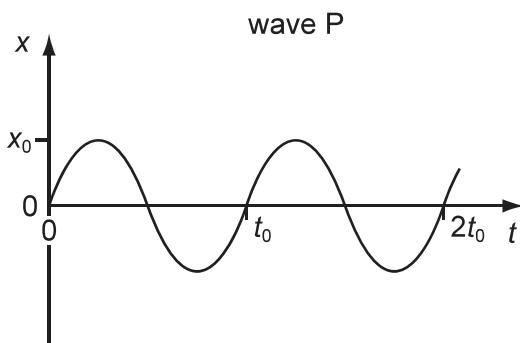


The intensity of wave P is $I_0$.

What is the intensity of wave Q?

A       $I_0$                              $I_0$                              $I_0$                              $16I_0$

29 A sound wave of frequency 150 Hz travels in water at a speed of 1500 m s $^{1}$. It then travels through the surface of the water and into air, where its speed is 300 m s $^{1}$.                9702/01/ /N/05/Q25

Which line in the table gives the correct values for the wavelengths of the sound in water and in air?

|   | wavelength in water/m | wavelength in air/m |
|---|---|---|
| A | 0.10 | 0.10 |
|   | 0.10 | 0.50 |
|   | 10 | 2.0 |
|   | 10 | 50 |

30 A wave motion is described by the oscillation of particles.                9702/01/ /N/06/Q24

What is the name given to the number of complete oscillations of a particle in one second?

A    amplitude

     frequency

     wavelength

     wave speed

**Waves**

31 A displacement-time graph is shown for a particular wave.
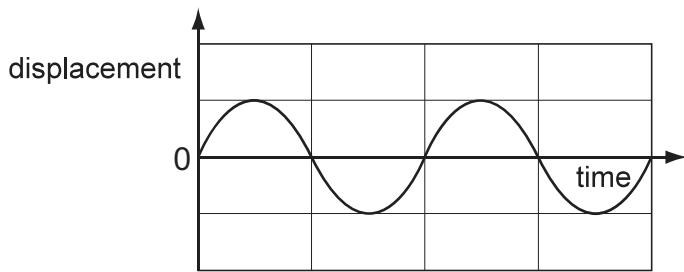


A second wave of similar type has twice the intensity and half the frequency.

When drawn on the same axes, what would the second wave look like?

A
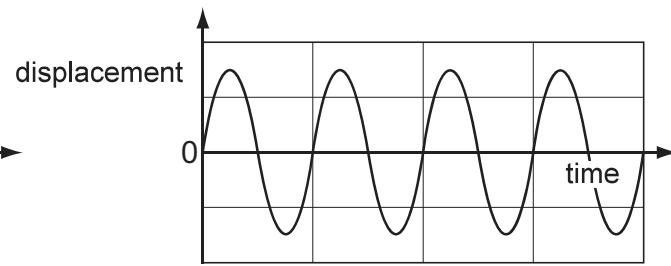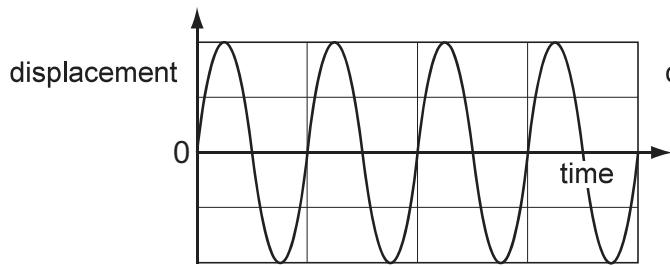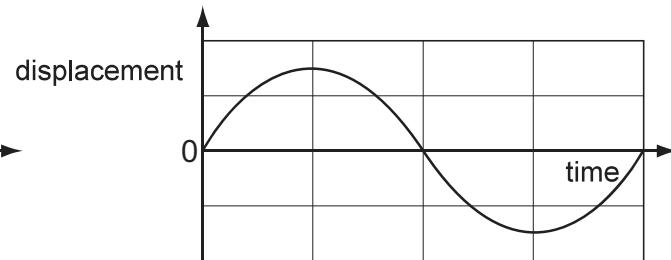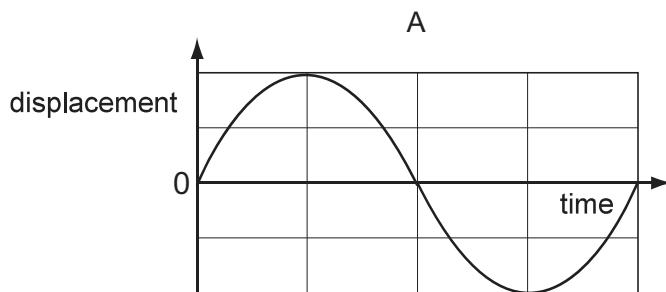








32 A displacement-time graph for a transverse wave is shown in the diagram.
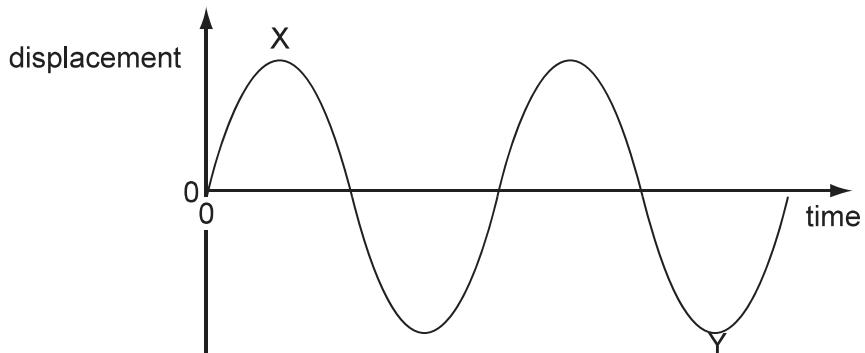


The phase difference between X and Y can be expressed as $n\pi$.

What is the value of n?

A    1.5                          2.5                          3.0                          6.0

**Waves**

33    ontinuous water waves are diffracted through a gap in a barrier in a ripple tank.    9702/01/ /N/06/Q26

Which change will cause the diffraction of the waves to increase?

A    increasing the frequency of the waves

increasing the width of the gap

reducing the wavelength of the waves

reducing the width of the gap

34    Which of the following types of wave can be polarised?    9702/01/ /J/07/Q21

A    a longitudinal progressive wave

a longitudinal stationary wave

a transverse stationary wave

a transverse sound wave

35    Sound wave X has intensity $10^{12}$ times greater than that of sound wave Y.    9702/01/ /J/07/Q22

 y how much is the amplitude of X greater than the amplitude of Y?

A    $10^6$ times

3.16   $10^6$ times

5   $10^{11}$ times

$10^{12}$ times

36    The graph shows the shape at a particular instant of part of a transverse wave travelling along a string.    9702/01/ /J/07Q23
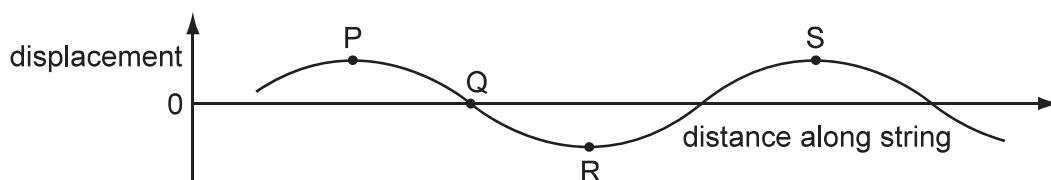


Which statement about the motion of points in the string is correct?

A    The speed at point P is a maximum.

The displacement at point Q is always zero.

The energy at point R is entirely kinetic.

The acceleration at point S is a maximum.

**Waves**

37  The diagram illustrates part of the electromagnetic spectrum.

| | | | visible | | |
|---|---|---|---|---|---|
| high frequencies | 1 | | | 2 | low frequencies |
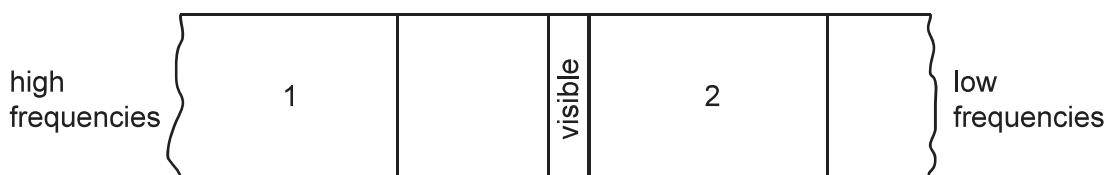
Which labels are correct for the regions marked 1 and 2?

| | 1 | 2 |
|---|---|---|
| A | infrared | X-rays |
| | microwaves | X-rays |
| | ultraviolet | microwaves |
| | X-rays | infrared |

38  What is the relationship between the intensity I and the amplitude a of a wave?

A   $\dfrac{I}{a}$ = constant

$\dfrac{I}{a^2}$ = constant

$I\,a$ = constant

$I\,a^2$ = constant

39  The graph represents a sinusoidal wave in the sea, travelling at a speed of  .0 m s $^{1}$, at one instant of time. The maximum speed of the oscillating particles in the wave is $2\pi af$, where a is the amplitude and f is the frequency.
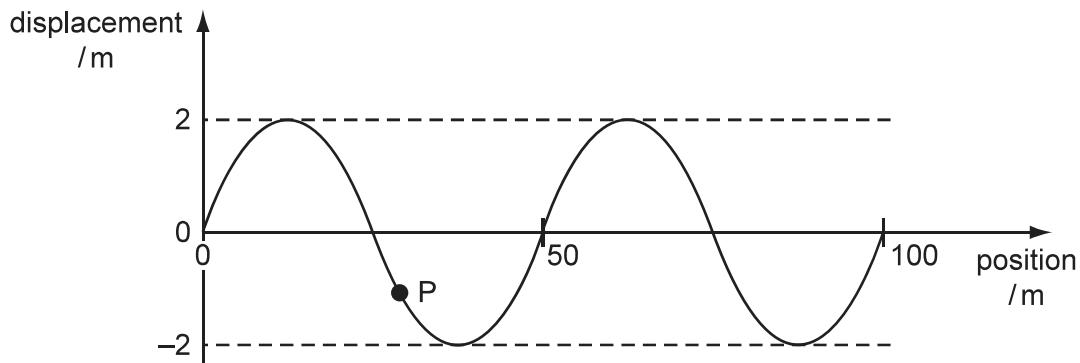


An object P of mass 2.0    10 $^3$ kg floats on the surface.

What is the maximum kinetic energy of P due to the wave? Assume that its motion is vertical.

A    0.026 mJ              4.0 mJ              39 mJ              64 mJ

**Waves**

40  An electromagnetic wave has a frequency of 10 Hz.

In which region of the electromagnetic spectrum does the wave occur?

A   infra-red

radio

ultraviolet

visible

41   The graph shows how the height of a water surface at a point in a harbour varies with time t as
waves pass the point.
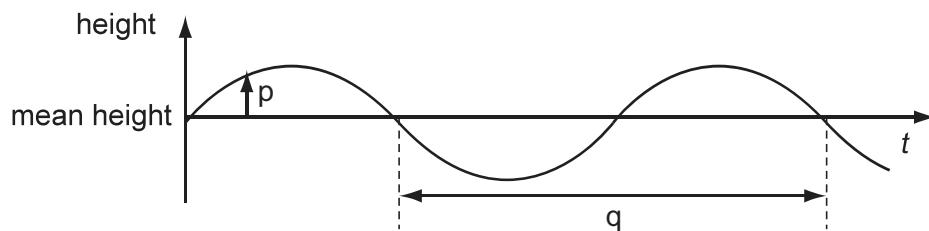


What are p and q?

|   | p | q |
|---|---|---|
| A | displacement | wavelength |
|   | displacement | period |
|   | amplitude | wavelength |
|   | amplitude | period |

42   The intensity I of a sound at a point P is inversely proportional to the square of the distance x of P
from the source of the sound. That is

$$I \propto \frac{1}{x^2}.$$
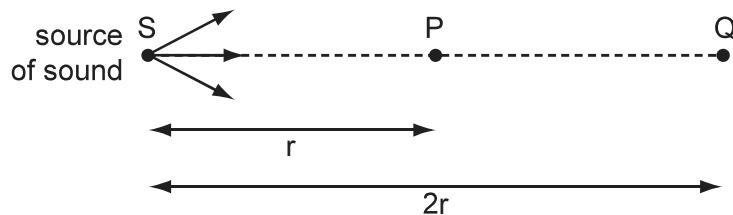


Air molecules at P, a distance r from S, oscillate with amplitude .0 m.

Point Q is situated a distance 2r from S.

What is the amplitude of oscillation of air molecules at Q?

A   1.4 m                2.0 m                2. m                4.0 m

**Waves**

43  Sound waves, emitted by a small loudspeaker, are reflected by a wall.

The frequency f of the waves is adjusted until a stationary wave is formed with the antinode nearest the wall at a distance x from the wall.

Which expression gives f in terms of x and the speed of sound c?

A  $f = \dfrac{4c}{x}$            $f = \dfrac{2c}{x}$            $f = \dfrac{c}{2x}$            $f = \dfrac{c}{4x}$

44  The diagram shows two waves X and Y.
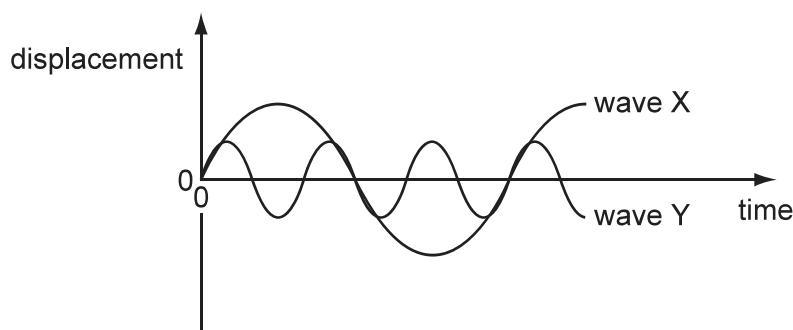


Wave X has amplitude   cm and frequency 100 Hz.

What are the amplitude and frequency of wave Y?

|   | amplitude / cm | frequency / Hz |
|---|---|---|
| A | 2 | 33 |
|   | 2 | 300 |
|   | 4 | 33 |
|   | 4 | 300 |

45  ight can exhibit all of the properties listed.

Which property can sound not exhibit?

A    interference

     polarisation

     refraction

     total internal reflection

46  The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as $10^x$ Hz.

What is the value of x?

A   13                15                17                19

**Waves**

47  The diagram represents the screen of a cathode-ray oscilloscope displaying two sound waves labelled X and Y.
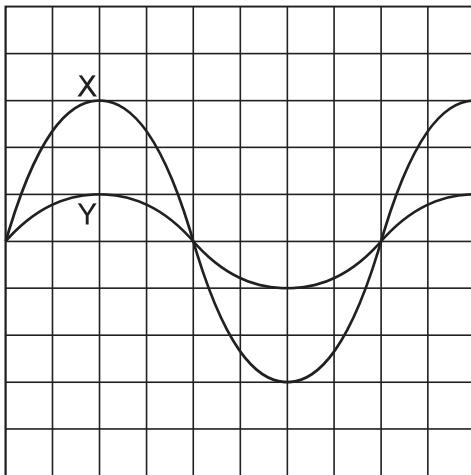
What is the ratio $\dfrac{\text{intensity of sound wave X}}{\text{intensity of sound wave Y}}$ ?

A  $\dfrac{9}{1}$          $\dfrac{3}{1}$          $\dfrac{\sqrt{3}}{1}$          $\dfrac{1}{1}$

48  Which wave properties change when light passes from air into glass?

A    colour and speed

      frequency and wavelength

      speed and wavelength

      wavelength and colour

49    The light from two lasers passes through a vacuum.    ne laser emits red light and the other emits green light.

Which property of the two laser beams must be different?

A    amplitude

      frequency

      plane of polarisation

      speed

50  The amplitude of a wave is A and its intensity is I.

Which amplitude is necessary for the intensity to be doubled to 2I ?

A  $A^2$              $\sqrt{A}$              $\sqrt{2}\,A$              $2A$

**Waves**

51    The light from two lasers passes through a vacuum.    ne laser emits red light and the other emits green light.                                                                    9702/12/  /N/09/Q23

Which property of the two laser beams must be different?

A    amplitude

frequency

plane of polarisation

speed

52    Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10$^5$ m.                    9702/11/  /J/10/Q22

Which type of wave are they most likely to be?

A    radio waves

microwaves

infra-red waves

ultraviolet waves

53    Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10$^5$ m.                    9702/13/  /J/10/Q23

Which type of wave are they most likely to be?

A    radio waves

microwaves

infra-red waves

ultraviolet waves

54    Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10$^5$ m.                    9702/12/  /J/10/Q24

Which type of wave are they most likely to be?

A    radio waves

microwaves

infra-red waves

ultraviolet waves

55    Which value is a possible wavelength for radiation in the ultra-violet region of the electromagnetic spectrum?                                                                    9702/12/  /N/10/Q24

A   3   10$^2$ m              3   10$^5$ m              3   10  m              3   10$^{10}$ m

**Waves**

56  The graph shows how the displacement of a particle in a wave varies with time.      9702/11/ /N/10/Q23
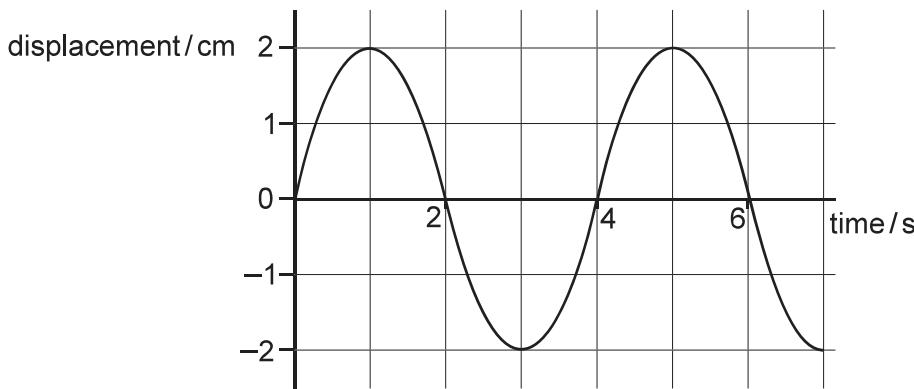


Which statement is correct?

A    The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

     The wave has an amplitude of 2 cm and must be transverse.

     The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

     The wave has an amplitude of 4 cm and must be transverse.


57  The diagram shows a vertical cross-section through a water wave moving from left to right.

9702/11/ /N/10/Q24

At which point is the water moving upwards with maximum speed?
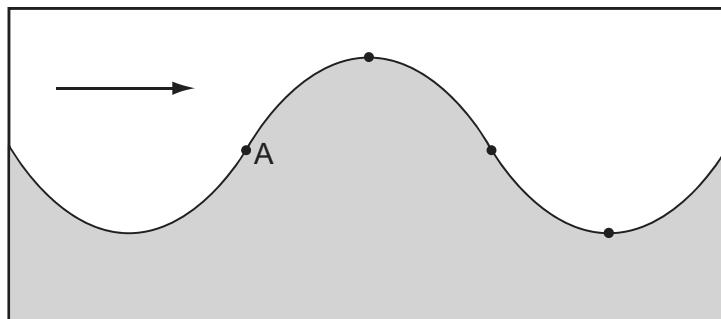



58  A stationary wave is produced by two loudspeakers emitting sound of the same frequency.

9702/11/ /N/10/Q26
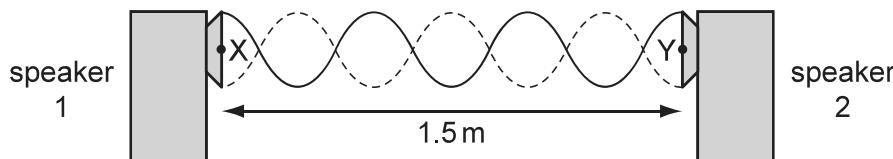


When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

A    0.50 m                    0.43 m                    0.25 m                    0.21 m


**Waves**

59   When plane-polarised light of amplitude a is passed through a polarising filter as shown, the amplitude of the light emerging is a cos θ.

amplitude = a
intensity = I

plane polarised light

amplitude = a cos θ

θ

polarising filter
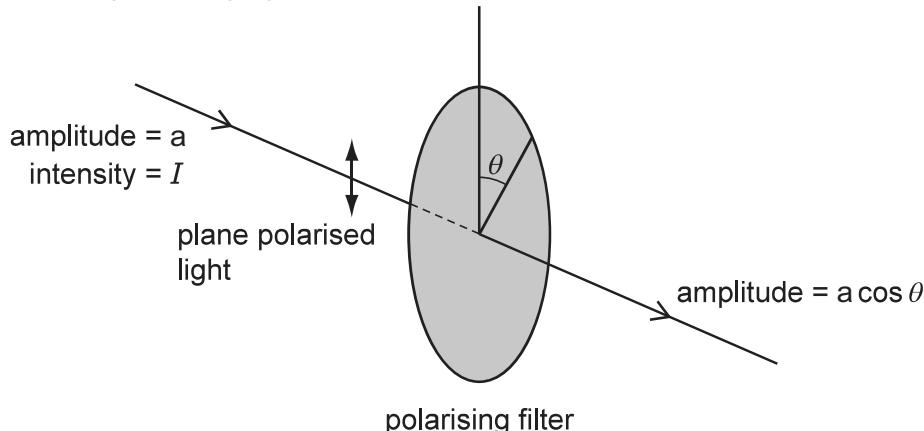
The intensity of the initial beam is I.

What is the intensity of the emerging light when θ is 60.0 ?

A   0.250 I              0.500 I              0.750 I              0. 66 I

60   When plane-polarised light of amplitude a is passed through a polarising filter as shown, the amplitude of the light emerging is a cos θ.

amplitude = a
intensity = I

plane polarised light

amplitude = a cos θ

θ

polarising filter
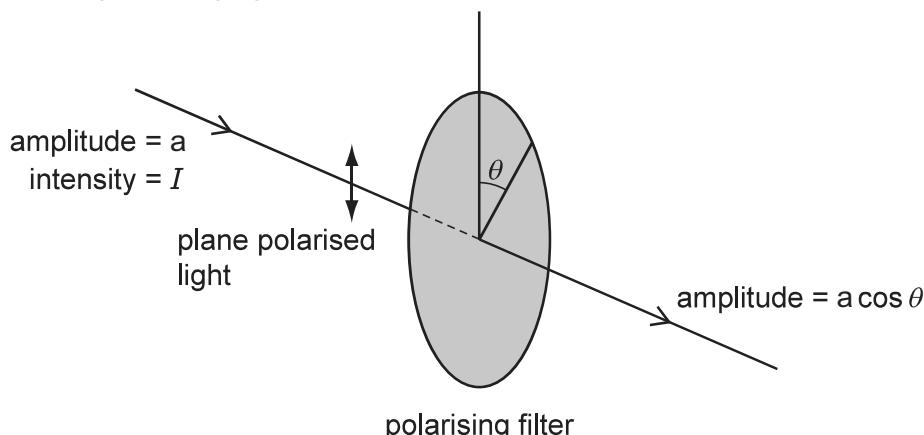
The intensity of the initial beam is I.

What is the intensity of the emerging light when θ is 60.0 ?

A   0.250 I              0.500 I              0.750 I              0. 66 I

61   Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around $10^{10}$ m?

A   infra-red

microwave

ultraviolet

X-ray

**Waves**

62 The diagram shows a vertical cross-section through a water wave moving from left to right.

At which point is the water moving upwards with maximum speed?
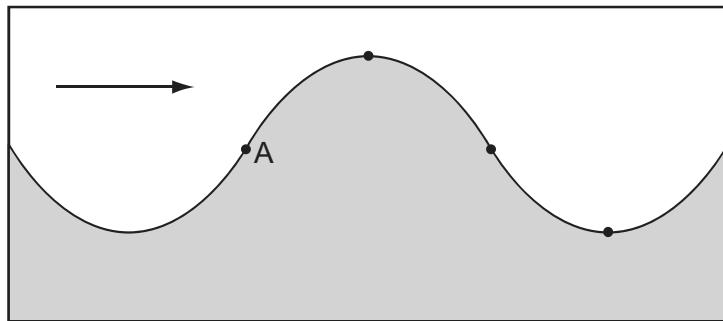


63 The graph shows how the displacement of a particle in a wave varies with time.     9702/13/ /N/10/Q27
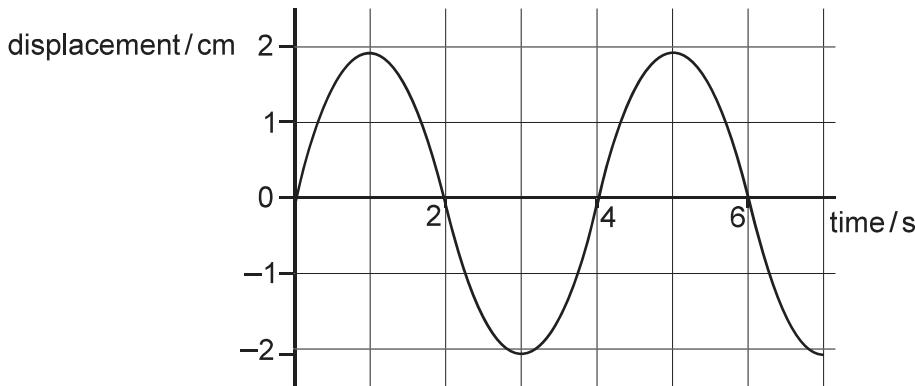


Which statement is correct?

A    The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

     The wave has an amplitude of 2 cm and must be transverse.

     The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

     The wave has an amplitude of 4 cm and must be transverse.

64 Which statement about sound waves in air at constant temperature is correct?     9702/11/ /J/11/Q23

A    Amplitude is inversely proportional to velocity.

     Frequency is inversely proportional to wavelength.

     Velocity is proportional to wavelength.

     Wavelength is proportional to amplitude.

65   In which order of magnitude are the frequencies of electromagnetic waves in the visible spectrum?     9702/12/ /J/11/Q25

A   $10^{12}$ Hz         $10^{13}$ Hz         $10^{14}$ Hz         $10^{15}$ Hz

**Waves**

66 The four graphs represent a progressive wave on a stretched string. raphs A and  show how the displacement d varies with distance x along the string at one instant.  raphs  and  show how the displacement d varies with time t at a particular value of x.

The labels on the graphs are intended to show the wavelength $\lambda$, the period T and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?
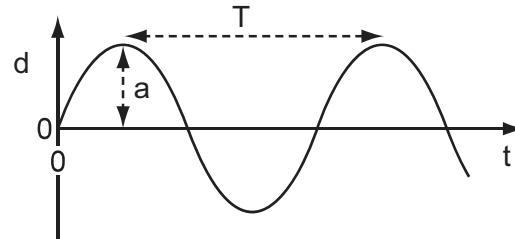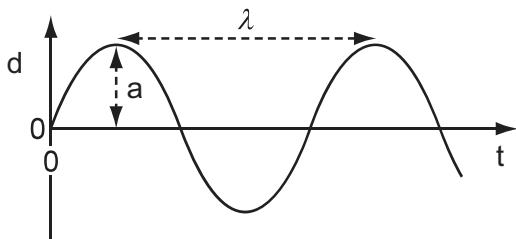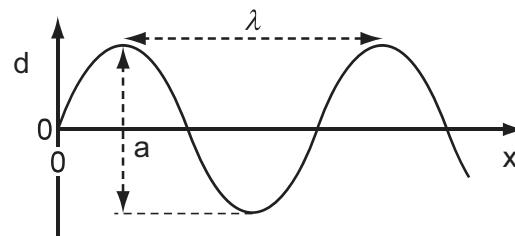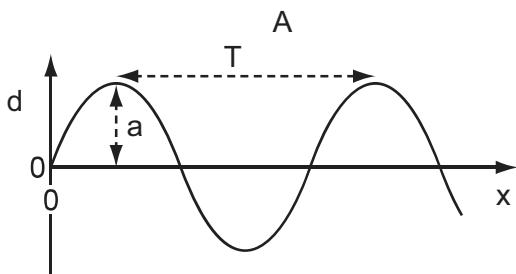


67 A source of sound of constant power P is situated in an open space. The intensity I of sound at distance r from this source is given by

$$I = \frac{P}{4\pi r^2}.$$

How does the amplitude a of the vibrating air molecules vary with the distance r from the source?

A  $a \propto \dfrac{1}{r}$ $\qquad$ $a \propto \dfrac{1}{r^2}$ $\qquad$ $a \propto r$ $\qquad$ $a \propto r^2$

68 P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q.

Which row is correct?

| | wavelength emitted by P/m | wavelength emitted by Q/m |
|---|---|---|
| A | $5 \times 10^5$ | $5 \times 10$ |
| | $5 \times 10^5$ | $5 \times 10^{10}$ |
| | $5 \times 10^7$ | $5 \times 10$ |
| | $5 \times 10^7$ | $5 \times 10^{10}$ |

**Waves**

69   A transverse progressive wave is set up on a string.

The graph shows the variation with time of displacement for a point on this string.
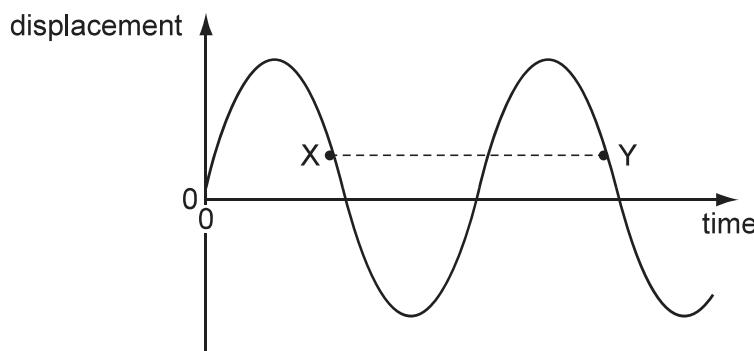


The separation XY on the graph represents the     1     of the wave.

X and Y have equal     2     .

Which words correctly complete gaps 1 and 2?

|   | 1 | 2 |
|---|---|---|
| A | time period | amplitudes |
|   | time period | displacements |
|   | wavelength | amplitudes |
|   | wavelength | displacements |

70   If a wave can be polarised, it must be

A    a longitudinal wave.

an electromagnetic wave.

a sound wave.

a transverse wave.

71    A source of sound of constant power P is situated in an open space. The intensity I of sound at
distance r from this source is given by

$$I = \frac{P}{4\pi r^2} \, .$$

How does the amplitude a of the vibrating air molecules vary with the distance r from the source?

A   $a \propto \dfrac{1}{r}$          $a \propto \dfrac{1}{r^2}$          $a \propto r$          $a \propto r^2$

**Waves**

72  The four graphs represent a progressive wave on a stretched string.   raphs A and     show how the displacement d varies with distance x along the string at one instant.    raphs     and     show how the displacement d varies with time t at a particular value of x.

The labels on the graphs are intended to show the wavelength $\lambda$, the period T and the amplitude a of the wave, but only one graph is correctly labelled.          9702/13/  /J/11/Q23

Which graph is correctly labelled?
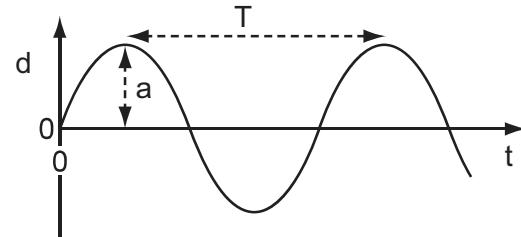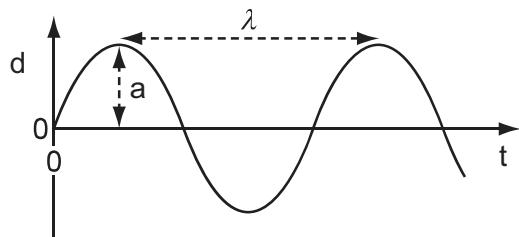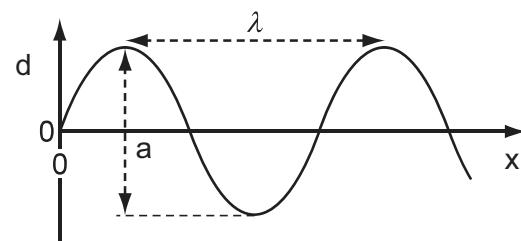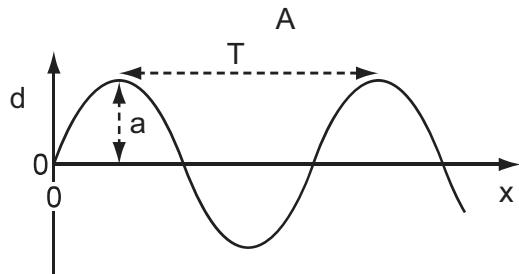


73  The diagram shows a view from above of a double slit interference demonstration.       9702/11/  /N/11/Q28

   is a monochromatic light source with a vertical filament.     is a barrier with two narrow vertical slits and S is a screen upon which interference fringes form.



The intensity is I at a point on the screen where the centre of the fringe pattern forms.

What is the intensity, at the same point, when one of the slits is covered up?

A  $\dfrac{I}{\sqrt{2}}$                    $\dfrac{I}{2}$                    $\dfrac{I}{2\sqrt{2}}$                    $\dfrac{I}{4}$

**Waves**
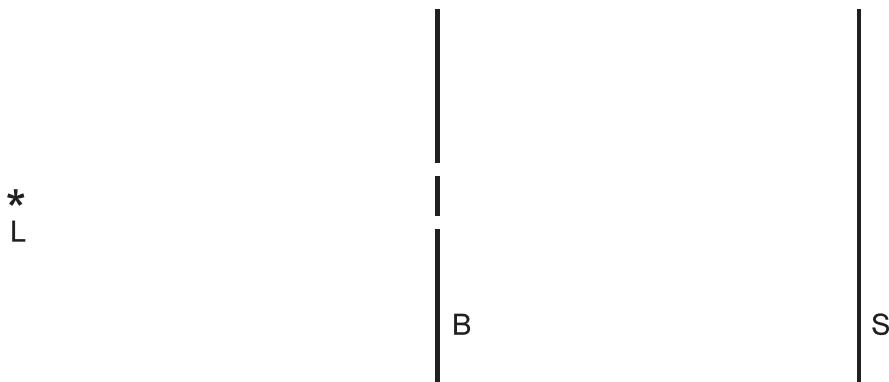
74  A wave that can be polarised must be

A   longitudinal.

progressive.

stationary.

transverse.

75  Which statement about electromagnetic radiation is correct?

A   Waves of wavelength 5   10 $^9$ m are high-energy gamma rays.

Waves of wavelength 3   10   m are ultra-violet waves.

Waves of wavelength 5   10 $^7$ m are infra-red waves.

Waves of wavelength 9   10 $^7$ m are light waves.

76  The diagram shows two sinusoidal waveforms.
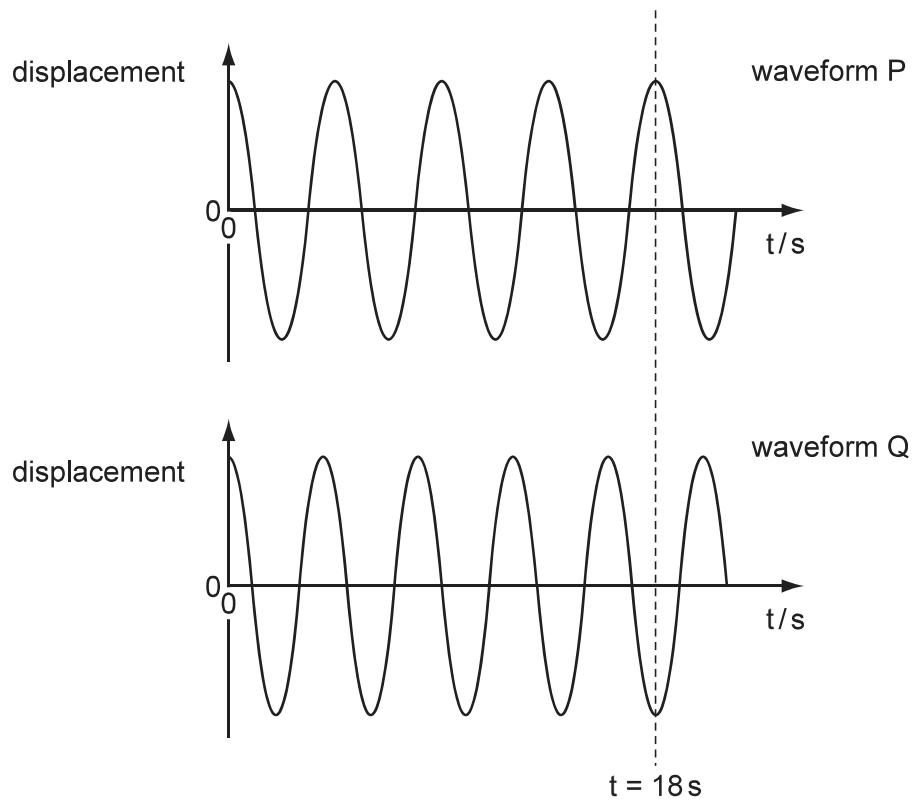


At time t = 0 the waves are in phase. At the dotted line, t = 1  s.

At which time is the phase difference between the two oscillations ⅛ of a cycle?

A   4.0 s                    4.5 s                    .0 s                    9.0 s

**Waves**

77 The diagram shows a view from above of a double slit interference demonstration.

is a monochromatic light source with a vertical filament. is a barrier with two narrow vertical slits and S is a screen upon which interference fringes form.



```
   *
   L
                              |        B                    |   S
```
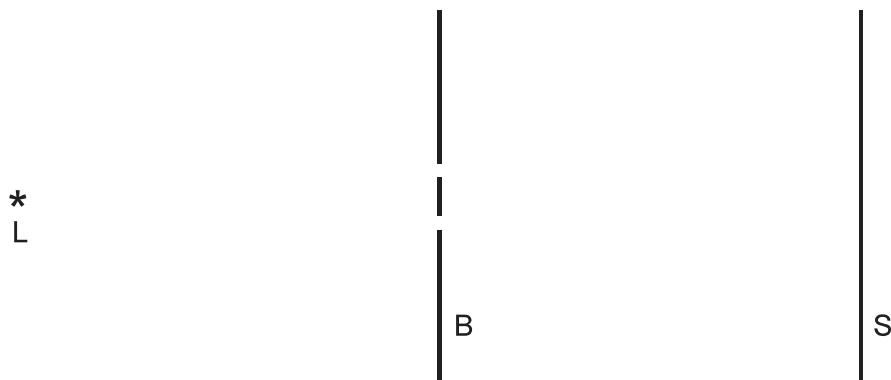
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78  P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q.

Which row is correct?

| | wavelength emitted by P/m | wavelength emitted by Q/m |
|---|---|---|
| A | $5 \times 10^{5}$ | $5 \times 10$ |
| | $5 \times 10^{5}$ | $5 \times 10^{10}$ |
| | $5 \times 10^{7}$ | $5 \times 10$ |
| | $5 \times 10^{7}$ | $5 \times 10^{10}$ |

79  Which observation indicates that sound waves are longitudinal?

A    Sound can be reflected from a solid surface.

Sound cannot be polarised.

Sound is diffracted around corners.

Sound is refracted as it passes from hot air to cold air.

**Waves**

80 Two waves E and    are shown. The waves have the same speed.                9702/11/  /J/12/Q26
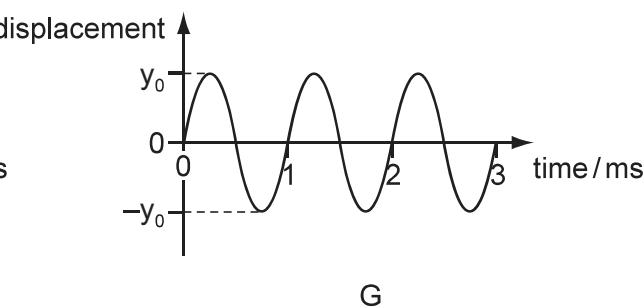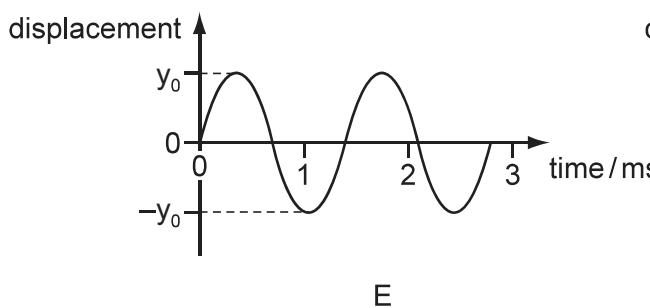
displacement



E

displacement



G

Which statement is correct?

A    Wave E has a greater amplitude than wave    .

Wave E has a greater intensity than wave    .

Wave E has a smaller frequency than wave    .

Wave E has a smaller wavelength than wave    .

81 The diagram shows a displacement-time graph for a progressive wave.                9702/11/  /J/12/Q27
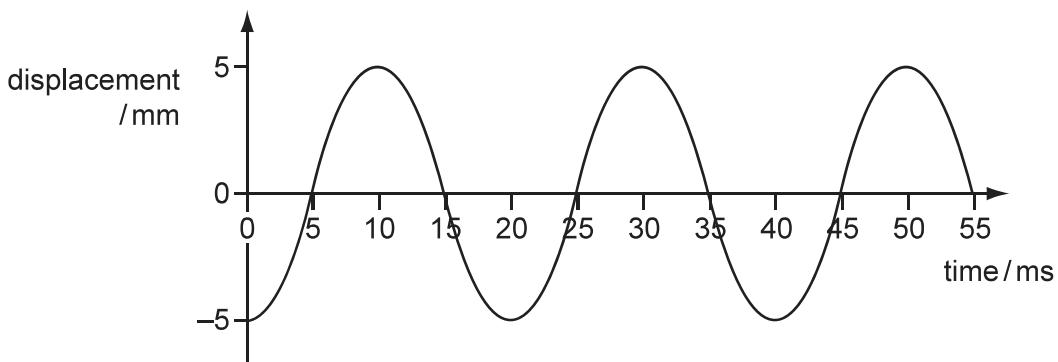


What are the amplitude and frequency of the wave?

|   | amplitude / mm | frequency / Hz |
|---|---|---|
| A | 5 | 40 |
|   | 5 | 50 |
|   | 10 | 40 |
|   | 10 | 50 |

82 A surveyor s device emits a laser pulse.                9702/12/  /J/12/Q26

What is the time taken for the pulse to travel from the device to a wall 150 m away, where it is reflected, and then return to the device?

A    0.05 ns              0.10 ns              0.50  s              1.0  s

**Waves**

83 The period of an electromagnetic wave is 1.0 ns.

What are the frequency and wavelength of the wave?

| | frequency/Hz | wavelength/m |
|---|---|---|
| A | 1.0 | $3.0 \times 10$ |
| | $1.0 \times 10^6$ | 300 |
| | $1.0 \times 10^9$ | 0.30 |
| | $1.0 \times 10^{12}$ | $3.0 \times 10^{-4}$ |

84 X and Y are two points on the surface of water in a ripple tank. A source of waves of constant frequency begins to generate waves which then travel past X and Y, causing them to oscillate.
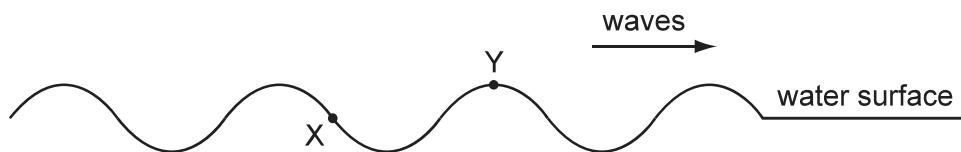
What is the phase difference between X and Y?

A   45                    135                    1 0                    270

85 The diagram shows a displacement-time graph for a progressive wave.
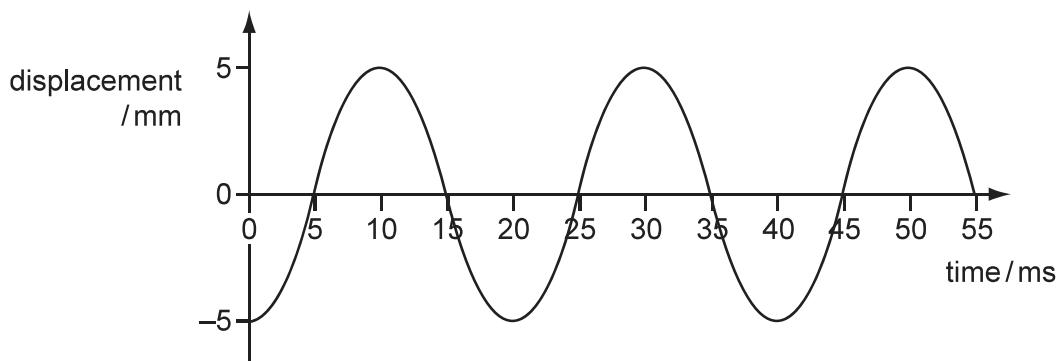


What are the amplitude and frequency of the wave?

| | amplitude/mm | frequency/Hz |
|---|---|---|
| A | 5 | 40 |
| | 5 | 50 |
| | 10 | 40 |
| | 10 | 50 |

**Waves**

86  Two waves E and    are shown. The waves have the same speed.                    9702/13/  /J/12/Q27
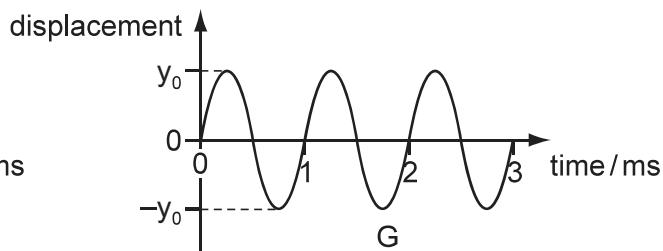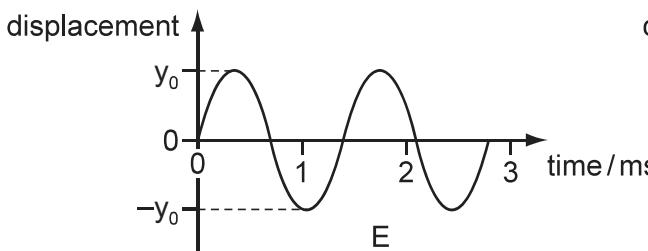


Which statement is correct?

A    Wave E has a greater amplitude than wave   .

      Wave E has a greater intensity than wave   .

      Wave E has a smaller frequency than wave   .

      Wave E has a smaller wavelength than wave   .

87  Which observation indicates that sound waves are longitudinal?                   9702/13/  /J/12/Q29

A    Sound can be reflected from a solid surface.

      Sound cannot be polarised.

      Sound is diffracted around corners.

      Sound is refracted as it passes from hot air to cold air.

88  The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.  9702/12/  /N/12/Q31



1.0 cm
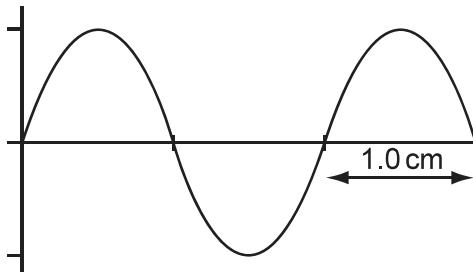
The time base setting is 0.20  s cm $^{1}$.

Which statement is correct?

A    The  frequency  of  the  wave  is  2.5    Hz  and  it  lies  in  the  radio  wave  region  of  the
      electromagnetic spectrum.

      The  frequency  of  the  wave  is  2.5    Hz  and  it  lies  in  the  microwave  region  of  the
      electromagnetic spectrum.

      The  frequency  of  the  wave  is  5.0    Hz  and  it  lies  in  the  radio  wave  region  of  the
      electromagnetic spectrum.

      The  frequency  of  the  wave  is  5.0    Hz  and  it  lies  in  the  microwave  region  of  the
      electromagnetic spectrum.

**Waves**

89  The diagram shows a graph of displacement against time for a sound wave.          9702/11/  /N/12/Q26
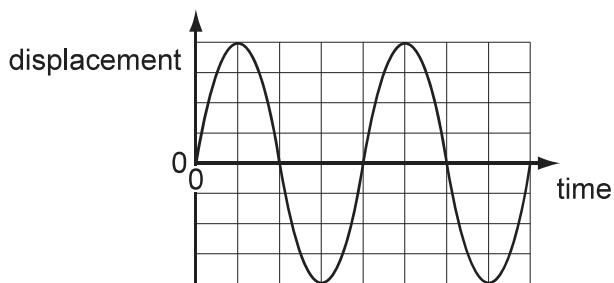


The intensity of the sound is halved.

Which graph shows the displacement of this sound wave?

A
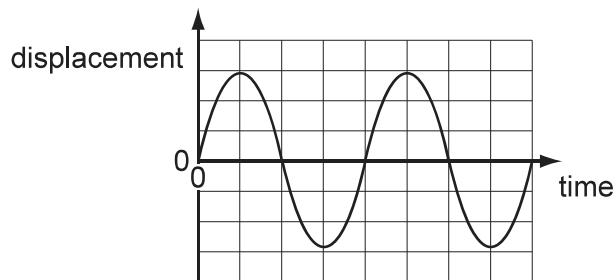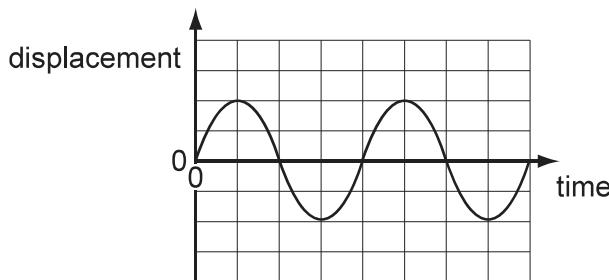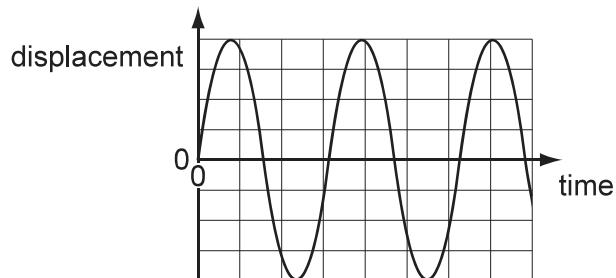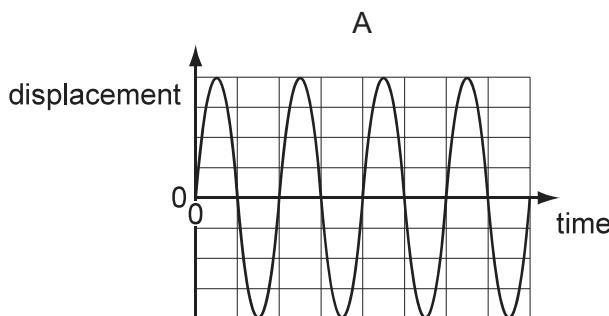





90  What do not travel at the speed of light in a vacuum?          9702/11/  /N/12/Q27

A    electrons

microwaves

radio waves

X-rays

91  A health inspector is measuring the intensity of a sound. Near a loudspeaker, his meter records an intensity I. This corresponds to an amplitude A of the sound wave. At another position, the meter gives an intensity reading of 2I.          9702/13/  /N/12/Q29

What is the corresponding amplitude of the sound wave?

A    $\dfrac{A}{\sqrt{2}}$                    $\sqrt{2}A$                    $2A$                    $4A$

**Waves**

92    iffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest
      when the wavelength and the obstruction are similar in size.

      For waves travelling through air, what is the combination of wave and obstruction that could best
      demonstrate diffraction?

      A    microwaves passing a steel post

           radio waves passing a copper wire

           sound waves passing a human hair

           visible light waves passing a gate post


93    A wave has a speed of $340 \, m \, s^{-1}$ and a period of 0.2 ms.

      What is its wavelength?

      A    0.095 m              95 m              $1.2 \times 10^3$ m              $1.2 \times 10^6$ m


94    Which line in the table summarises the change in wave characteristics on going from infra-red to
      ultraviolet in the electromagnetic spectrum?

|   | frequency | speed in a vacuum |
|---|-----------|-------------------|
| A | decreases | decreases |
|   | decreases | remains constant |
|   | increases | remains constant |
|   | increases | increases |


95    A light wave of amplitude A is incident normally on a surface of area S. The power per unit area
      reaching the surface is P.

      The amplitude of the light wave is increased to 2A. The light is then focussed on to a smaller
      area $\frac{1}{3}$S.

      What is the power per unit area on this smaller area?

      A    36P

           1 P

           12P

           6P


**Waves**

96  The order of magnitude of the frequency of the shortest wavelength of visible light waves can be
    expressed as $10^x$ Hz.

    What is the value of x?

    A   12                    13                    14                    15

97  The diagram shows two waves X and Y.
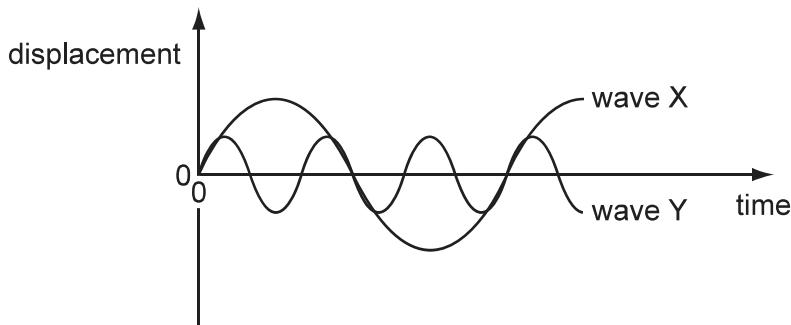


    Wave X has amplitude   cm and frequency 100 Hz.

    What are the amplitude and the frequency of wave Y?

|   | amplitude / cm | frequency / Hz |
|---|---|---|
| A | 2 | 33 |
|   | 2 | 300 |
|   | 4 | 33 |
|   | 4 | 300 |

98  What is correct for all transverse waves?

    A   They are all electromagnetic.

        They can all be polarised.

        They can all travel through a vacuum.

        They all involve the oscillation of atoms.

99  Which statement about different types of electromagnetic wave is correct?

    A   The frequency of infra-red waves is less than the frequency of blue light.

        The frequency of radio waves is greater than the frequency of gamma rays.

        The wavelength of red light is less than the wavelength of ultraviolet waves.

        The wavelength of X-rays is greater than the wavelength of microwaves.

**Waves**

100 Electromagnetic waves of wavelength $\lambda$ and frequency f travel at speed c in a vacuum.

What describes the wavelength and speed of electromagnetic waves of frequency f/2?

| | wavelength | speed in a vacuum |
|---|---|---|
| A | $\lambda/2$ | $c/2$ |
| | $\lambda/2$ | c |
| | $2\lambda$ | c |
| | $2\lambda$ | 2c |

101    range light has a wavelength of 600 nm.

What is the frequency of this light?

A   1 0   Hz              1 0 Hz              500 THz              500 kHz

102  A sound wave has displacement y at distance x from its source at time t.

Which graph correctly shows the amplitude a and the wavelength $\lambda$ of the wave?

A



**Waves**
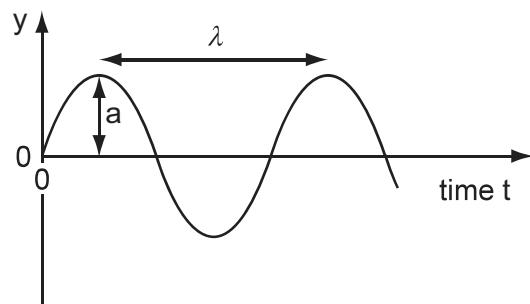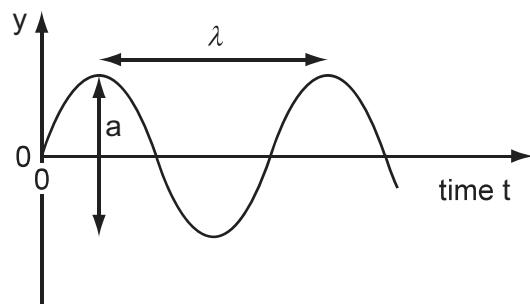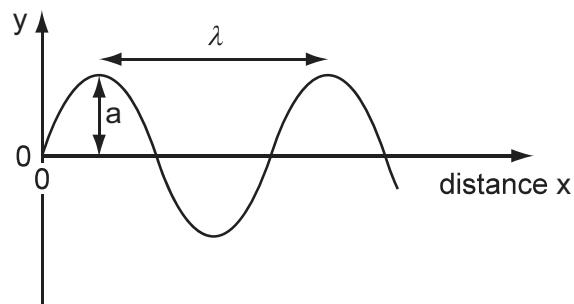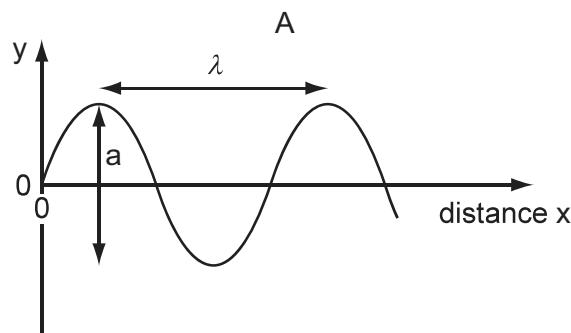
103  When the liquid crystal display of a calculator is observed through a polarising film, the display changes as the film is rotated.                         9702/13/  /J/13/Q25

Which property describes the radiation from the calculator display?

A    unpolarised

     a longitudinal wave

     a transverse wave

     a wave with a 3 cm wavelength

104  A wave has a frequency of 5   Hz.                         9702/11/  /J/13/Q4

What is the period of the wave?

A    20 000   s

     20 ns

     2 ns

     200 ps

105  The diagram shows a sketch of a wave pattern, over a short period of time.                         9702/11/  /N/13/Q25



1.0 m
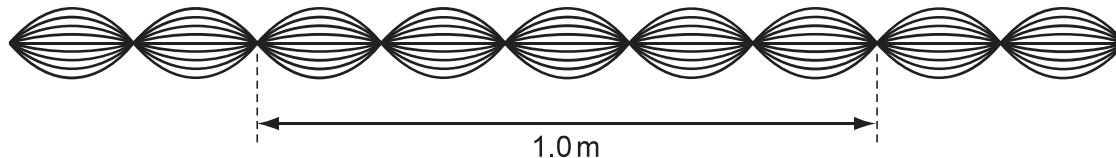
Which description of this wave is correct?

A    The wave is longitudinal, has a wavelength of 20 cm and is stationary.

     The wave is transverse, has a wavelength of 20 cm and is stationary.

     The wave is transverse, has a wavelength of 40 cm and is progressive.

     The wave is transverse, has a wavelength of 40 cm and is stationary.

106  Which statement about a light wave and a sound wave is correct?                         9702/11/  /N/13/Q26

A     oth can be polarised.

      oth can travel through free space.

      oth have a frequency inversely proportional to their wavelength.

      oth have an intensity proportional to their amplitude.

**Waves**

107 When plane-polarised light of amplitude A is passed through a polarising filter as shown, the amplitude of the light emerging is $A\cos\theta$.

polarising filter
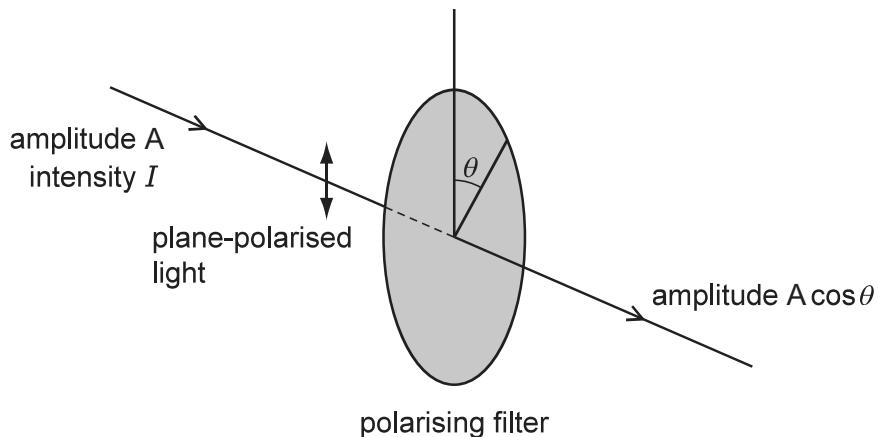
The intensity of the initial beam is I.

What is the intensity of the emerging light when $\theta$ is 60.0 ?

A 0.250 I 0.500 I 0.750 I 0. 66 I

108 The graph shows how the height of the water surface at a point in a harbour varies with time t as waves pass the point.
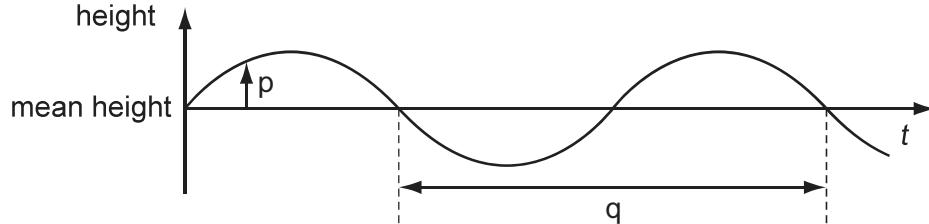
What are p and q?

|   | p | q |
|---|---|---|
| A | displacement | period |
|   | displacement | wavelength |
|   | amplitude | period |
|   | amplitude | wavelength |

**Waves**

109 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10 $^5$ m.

Which type of wave are they most likely to be?

A    radio waves

     microwaves

     infra-red waves

     ultraviolet waves

110 A cathode-ray oscilloscope (c.r.o.) displays a waveform corresponding to a sound wave.

In order to determine the frequency of the sound wave, which part of the displayed waveform must be measured and which c.r.o. setting must be known?

|   | on-screen measurement | c.r.o. setting |
|---|---|---|
| A | amplitude | time-base |
|   | amplitude | Y-gain |
|   | wavelength | time-base |
|   | wavelength | Y-gain |

111 Which statement about longitudinal waves is correct?

A    ongitudinal waves include radio waves travelling through air.

     Particles in a longitudinal wave vibrate at right-angles to the direction of transfer of wave energy.

     Some types of longitudinal wave can be polarised.

     Stationary waves can be produced by the superposition of longitudinal waves.

112 The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as 10$^x$ Hz.

What is the value of x?

A    13                    15                    17                    19

**Waves**

113  What is the approximate range of frequencies of infra-red radiation?

A   1   $10^3$ Hz    to   1   $10^9$ Hz

1   $10^9$ Hz    to   1   $10^{11}$ Hz

1   $10^{11}$ Hz   to   1   $10^{14}$ Hz

1   $10^{14}$ Hz   to   1   $10^{17}$ Hz


114  A small source emits spherical waves.
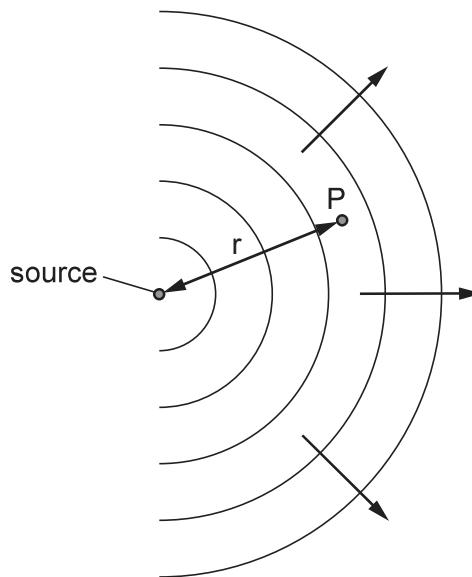


The wave intensity I at any point P, a distance r from the source, is inversely proportional to $r^2$.

What is the relationship between the wave amplitude a and the distance r?

A   $a^2 \propto \dfrac{1}{r}$            $a \propto \dfrac{1}{r}$            $a \propto \dfrac{1}{r^2}$            $a \propto \dfrac{1}{r^4}$


115  The speed v of waves in deep water is given by the equation       $v^2 = \dfrac{g\lambda}{2\pi}$

where $\lambda$ is the wavelength of the waves and g is the acceleration of free fall.

A student measures the wavelength $\lambda$ and the frequency f of a number of these waves.

Which graph should he plot to give a straight line through the origin?

A   $f^2$ against $\lambda$

f against $\lambda^2$

f against $\dfrac{1}{\lambda}$

$f^2$ against $\dfrac{1}{\lambda}$


**Waves**

116  A sound wave consists of a series of moving pressure variations from the normal, constant air pressure.

The graph shows these pressure variations for two waves at one instant in time.
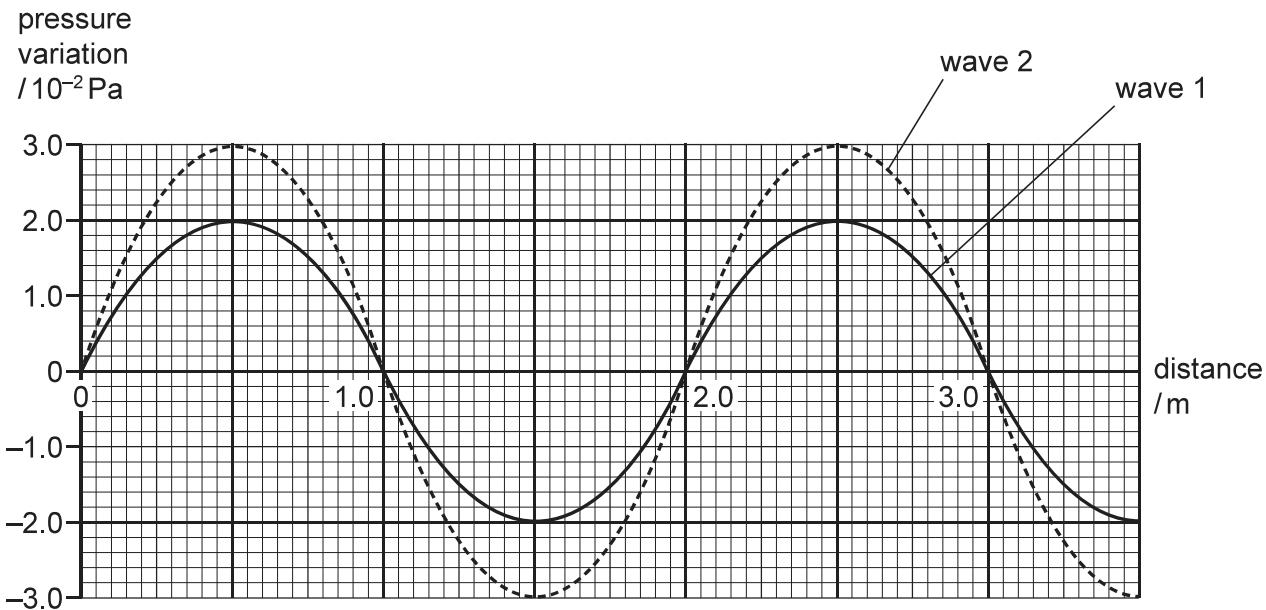


Wave 1 has an intensity of $1.6 \times 10^{6} \, W m^{-2}$.

What is the intensity of wave 2?

A  $2.4 \times 10^{6} \, W m^{-2}$

   $3.0 \times 10^{6} \, W m^{-2}$

   $3.6 \times 10^{6} \, W m^{-2}$

   $4.5 \times 10^{6} \, W m^{-2}$

117  The diagram shows a vertical cross-section through a water wave moving from left to right.

At which point is the water moving upwards with maximum speed?



**Waves**
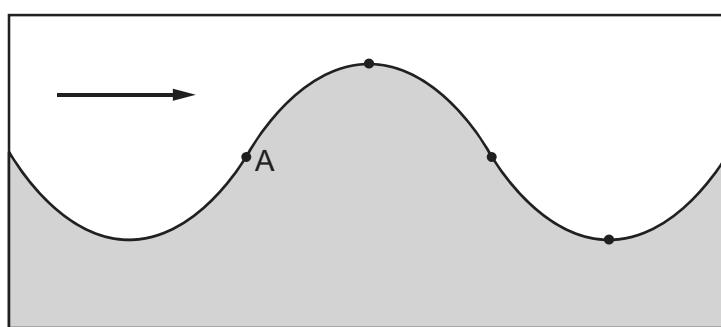
118  What, to two significant figures, are the period, the frequency and the amplitude of the wave represented by the graph?
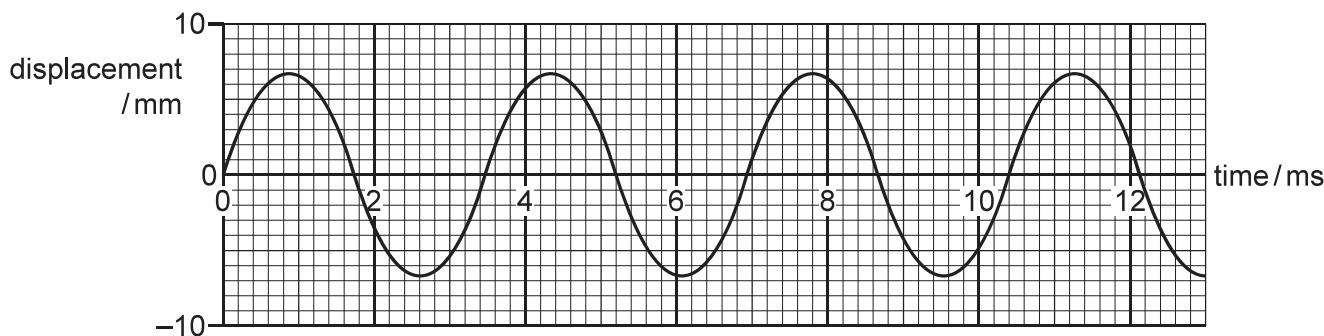
|   | period /s | frequency /Hz | amplitude /m |
|---|---|---|---|
| A | 0.0027 | 370 | 0.0067 |
|   | 0.0031 | 320 | 0.013 |
|   | 0.0035 | 290 | 0.0067 |
|   | 0.0042 | 240 | 0.013 |

119  Which statement about waves is correct?

A    All electromagnetic waves travel at the same speed in a vacuum.

ongitudinal waves can be polarised.

The amplitude of a wave is directly proportional to the energy transferred by the wave.

The frequency of infra-red light is greater than the frequency of ultra-violet light.

120  Which statement describes a situation when polarisation could not occur?

A    ight waves are reflected.

ight waves are scattered.

icrowaves pass through a metal grid.

Sound waves pass through a metal grid.

121  A stationary sound wave is produced in a tube.

Which statement describes the wave speed?

A    It is the distance between two adjacent nodes divided by the period of the wave.

It is the speed at which energy is transferred from one antinode to an adjacent antinode.

It is the speed of a particle at an antinode.

It is the speed of one of the progressive waves that are producing the stationary wave.

**Waves**

122 The variation with distance x of the intensity I along a stationary sound wave in air is shown by the following graph.
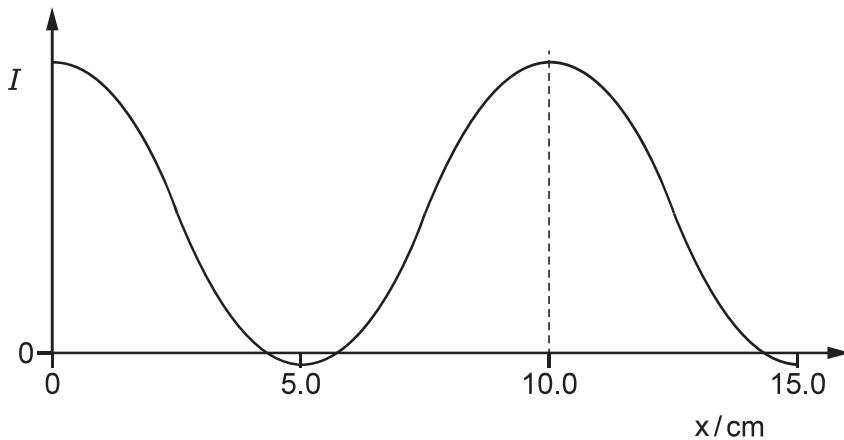
The speed of sound in air is 340 m s⁻¹.

What is the frequency of the sound wave?

A    1700 Hz              2270 Hz              3400 Hz              6 00 Hz

123 Plane wavefronts in a ripple tank pass through a gap as shown.
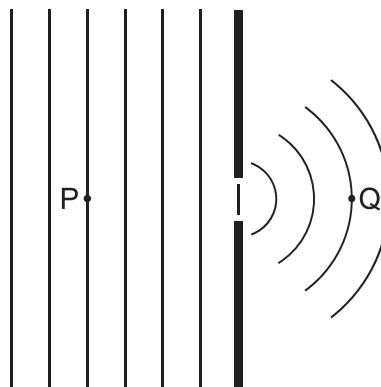
Which property of the wave will be different at Q compared with P?

A    velocity

frequency

amplitude

wavelength

124 Which statement about electromagnetic radiation is correct?

A    Waves of wavelength $5 \times 10^{-9}$ m are high-energy gamma rays.

Waves of wavelength $3 \times 10$ m are ultra-violet waves.

Waves of wavelength $5 \times 10^{-7}$ m are infra-red waves.

Waves of wavelength $9 \times 10^{-7}$ m are light waves.

**Waves**

125  When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown.   9702/11/ /N/14/Q23

displacement

0

0        T        2T    time
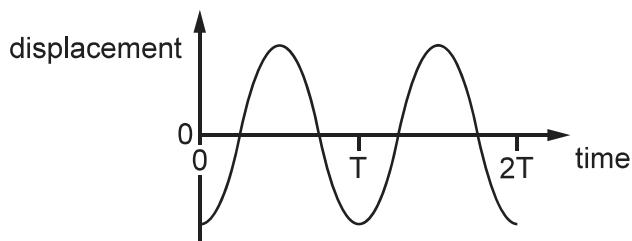
Which graph best shows how the kinetic energy of the air particle varies with time?

A

kinetic energy

0

0        T        2T    time

kinetic energy

0

0        T        2T    time

kinetic energy

0

0        T        2T    time

kinetic energy

0

0        T        2T    time
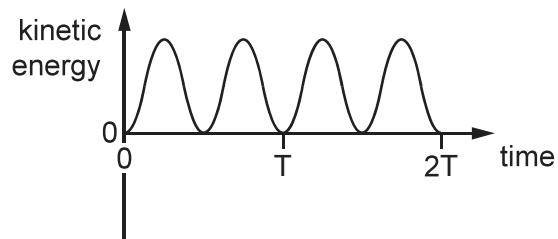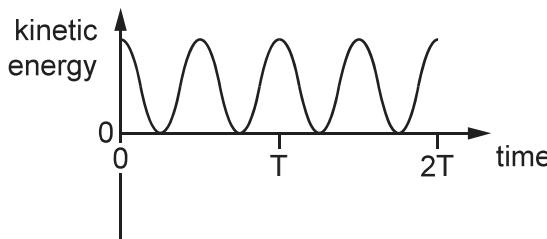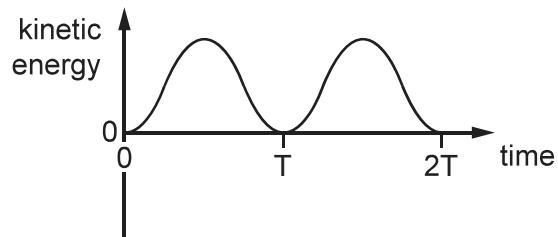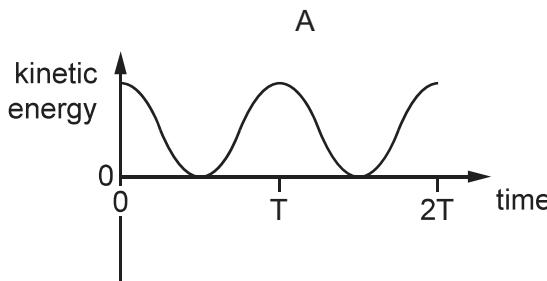
126  Two light waves of the same frequency are represented by the diagram.   9702/12/ /J/15/Q24

displacement

0

0    100    200    300    400    500    600    phase angle /
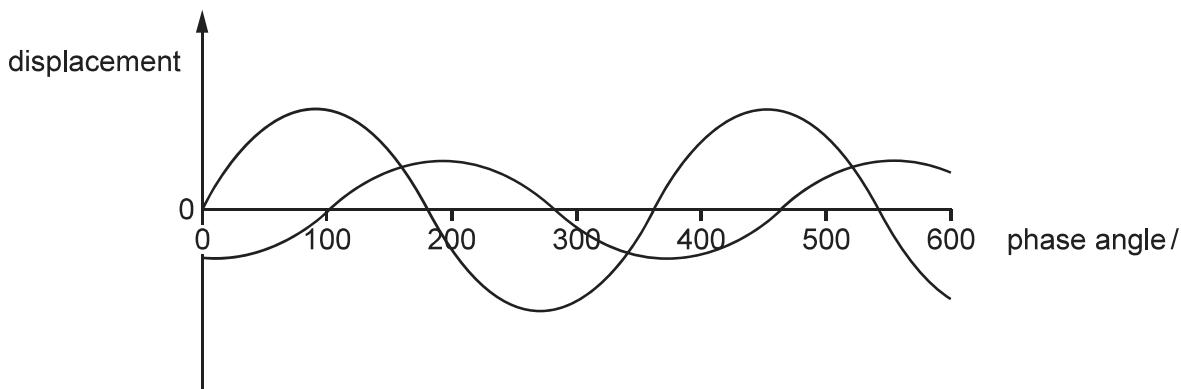
What could be the phase difference between the two waves?

A    150                    220                    260                    330

**Waves**

127  A cathode-ray oscilloscope (c.r.o.) is used to display the trace from a sound wave. The time-base
is set at 5  s mm $^1$.

1 cm

1 cm
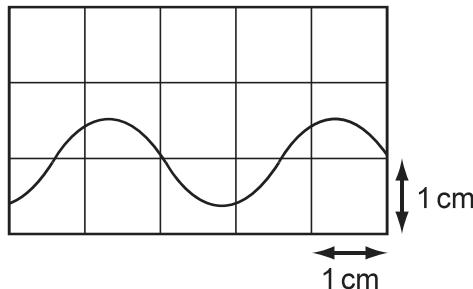
What is the frequency of the sound wave?

A    6.7 Hz              67 Hz              6.7 kHz              67 kHz

128  A wave pulse moves along a stretched rope in the direction shown.

P
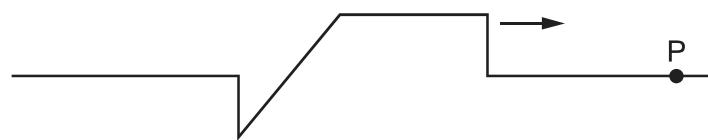
Which diagram correctly shows the variation with time t of the displacement s of the particle P in
the rope?



A

s

t

s

t

s

t

s

t
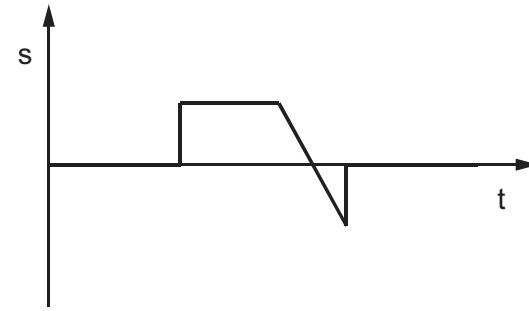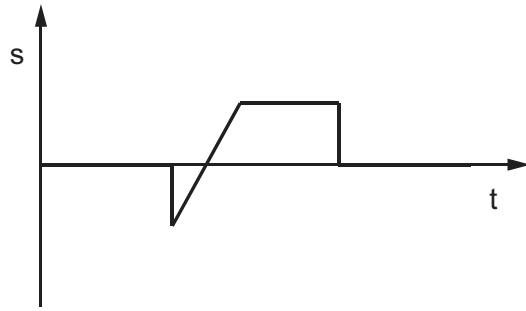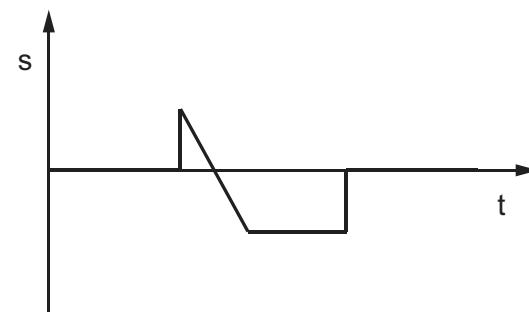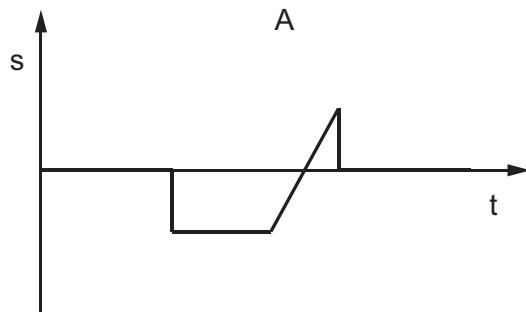
129  A sound wave has a speed of 330 m s $^1$ and a frequency of 50 Hz.

What is a possible distance between two points on the wave that have a phase difference of 60 ?

A    0.03 m              1.1 m              2.2 m              6.6 m

**Waves**

130 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10$^{10}$ m?

A infra-red

microwave

ultraviolet

X-ray

131 A sound wave moves with a speed of 320 m s$^{1}$ through air. The variation with time of the displacement of an air particle due to this wave is shown in the graph.
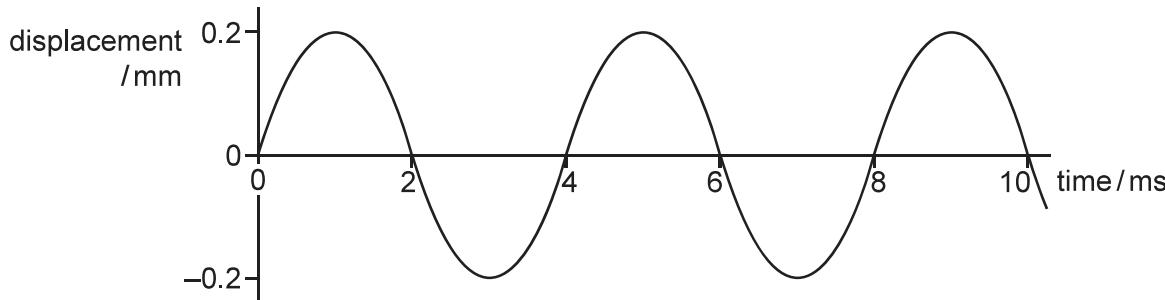
Which statement about the sound wave is correct?

A The frequency of the wave is 500 Hz.

The graph shows that sound is a transverse wave.

The intensity of the wave will be doubled if its amplitude is increased to 0.4 mm.

The wavelength of the sound wave is 1.2 m.

132 A wave of frequency 15 Hz travels at 24 m s$^{1}$ through a medium.

What is the phase difference between two points 2 m apart?

A There is no phase difference.

They are out of phase by a quarter of a cycle.

They are out of phase by half a cycle.

They are out of phase by 0. of a cycle.

133 A wave of amplitude a has an intensity of 3.0 W m$^{2}$.

What is the intensity of a wave of the same frequency that has an amplitude 2a?

A 4.2 W m$^{2}$       6.0 W m$^{2}$       9.0 W m$^{2}$       12 W m$^{2}$

**Waves**

134 An electromagnetic wave has a wavelength that is numerically of the same order of magnitude as the diameter of a nucleus.

9702/11/ /J/15/Q27

In which region of the electromagnetic spectrum does the wave occur?

A gamma ray

X-ray

visible light

infra-red

**Waves**