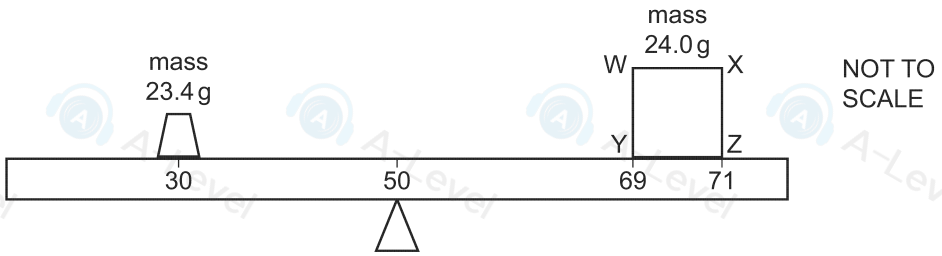
12 A cube WXZY has sides of length 2.0 cm and mass 24.0 g. The cube rests on a metre rule of negligible mass. The geometrical centre of the cube is vertically above the 70.0 cm mark on the scale of the rule.



The cube has a non-uniform density so that its centre of gravity is **not** at its geometrical centre. The centre of gravity of the cube is in the plane of the diagram.

The rule rests on a pivot at the 50.0 cm mark. A mass of 23.4 g is placed vertically above the 30.0 cm mark. The rule is horizontal and in equilibrium.

What can be determined about the position of the centre of gravity of the cube?

A It must be somewhere along a horizontal line that is 0.5 cm from line WX.

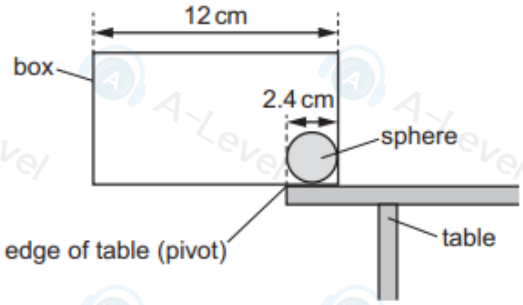
B It must be somewhere along a horizontal line that is 0.5 cm from line YZ.

C It must be somewhere along a vertical line that is 0.5 cm from line WY.

D It must be somewhere along a vertical line that is 0.5 cm from line XZ.

13 A box of length 12 cm and weight 0.43 N is placed on a horizontal table, with the greater part of its length overhanging the edge of the table. The edge of the table acts as a pivot. The centre of gravity of the box is at its geometric centre.

To balance the box, a uniform sphere of diameter 2.4 cm is placed inside the box, touching one end, as shown.



Assume that the forces acting on the box are in the plane of the diagram.

What is the minimum mass of the sphere that is needed to maintain the system in equilibrium?

A 0.066 kg **B** 0.13 kg **C** 0.22 kg **D** 1.3 kg

40 Which particle is a lepton?

A meson

B positron

C proton

D quark

1 Which estimate is reasonable?

A 1×10^{-3} kg for the mass of a grain of sand

B 1×10^{-2} m^3 for the volume of a tennis ball

C 1×10^{0} J for the work done lifting an apple from waist height to head height

D 1×10^{4} W for the power of a light bulb in a house

19 A metal wire obeys Hooke's law and has a Young modulus of 2.0×10^{11} Pa. The wire has an original length of 1.6 m and a diameter of 0.48×10^{-3} m.

What is the spring constant of the wire?

A 7.2×10^{3} N m^{-1}

B 2.3×10^{4} N m^{-1}

C 2.9×10^{4} N m^{-1}

D 9.0×10^{4} N m^{-1}

15 The total energy input E_{in} in a process is partly transferred to useful energy output U and partly transferred to energy that is wasted W.

What is the efficiency of the process?

A $\frac{U}{E_{in}} \times 100\%$

B $\frac{W}{E_{in}} \times 100\%$

C $\frac{U}{W} \times 100\%$

D $\frac{U+W}{E_{in}} \times 100\%$

30 The number of free electrons passing a point in a wire in 24 hours is 6.0×10^{23}.

What is the average current in the wire?

A 6.3 pA **B** 1.1 A **C** 67 A **D** 4.0 kA

18 A metal wire is stretched. The wire obeys Hooke's law.

Which quantity has a value that does **not** change?

A extension

B strain

C stress

D Young modulus

16 Which product of two quantities is equal to power?

A force × distance

B force × velocity

C work done × time

D work done × velocity

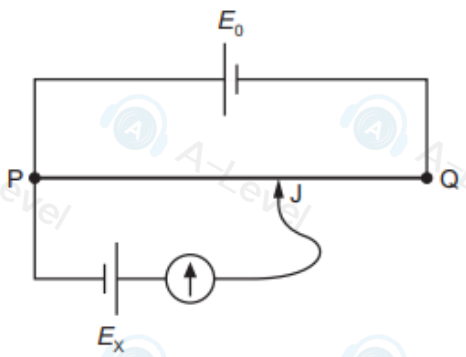
37 A potentiometer circuit is used to determine the electromotive force (e.m.f.) E_X of a cell. The circuit includes a second cell of known e.m.f. E_0 and negligible internal resistance, and a uniform resistance wire PQ of known length.

E_X is less than E_0.

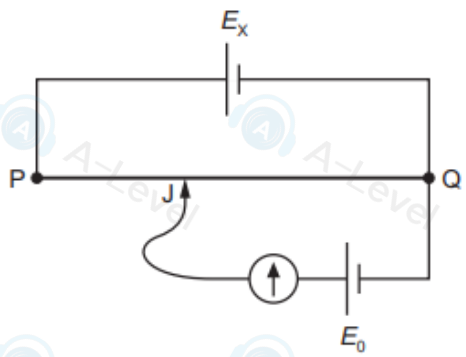
The movable connection J can be positioned anywhere along the length of the resistance wire.

Which circuit is suitable for determining E_X?

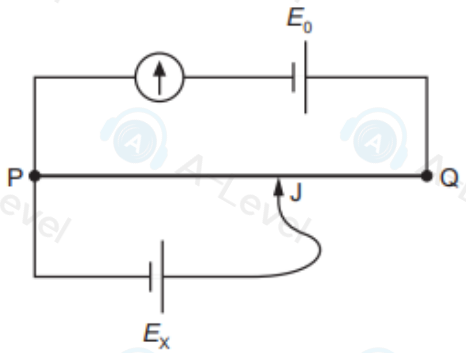
A



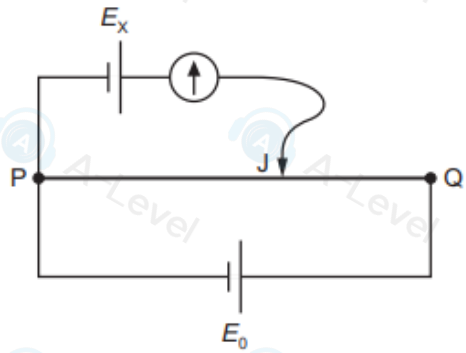
B



C



D



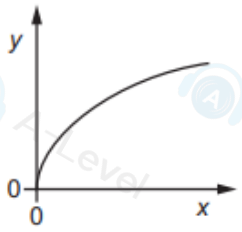
36 Kirchhoff's first and second laws are consequences of the conservation of different quantities.

What are those quantities?

	Kirchhoff's first law	Kirchhoff's second law
A	charge	energy
B	energy	current
C	current	charge
D	energy	charge

21 A wire is extended by different forces. The wire obeys Hooke's law.

A graph is plotted to show the variation of a quantity y with a quantity x.



What could x and y represent?

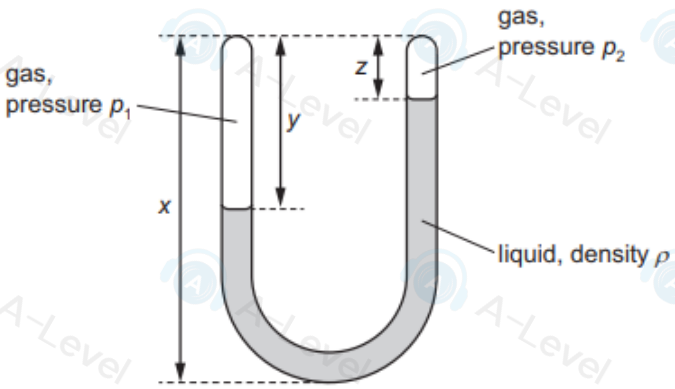
	x	y
A	elastic potential energy	extension
B	extension	force
C	force	extension
D	extension	elastic potential energy

18 A student attempts to derive the formula for kinetic energy E_K. She begins by considering an object of mass m which is initially at rest. A constant force F applied to the object causes it to accelerate to final velocity v in displacement s. The kinetic energy gained by the object is equal to the work done on the object by the force F.

Which equation would the student **not** need in order to derive the formula for E_K?

A $F = ma$ **B** $W = Fs$ **C** $E = \frac{1}{2}Fs$ **D** $v^2 = u^2 + 2as$

15 A closed U-shaped tube contains a stationary liquid of density ρ. One side of the tube contains a gas at pressure p_1 and the other side contains a gas at pressure p_2, as shown.



The acceleration of free fall is g.

Which equation is correct?

A $p_1 = \rho g y$

B $p_2 = \rho g(x - z)$

C $p_1 - p_2 = \rho g(y - z)$

D $p_1 + p_2 = \rho g x$

20 A known tensile force acts on a metal wire. The wire does not exceed its limit of proportionality.

Which two measurements enable the strain of the wire to be calculated?

A the unstretched length of the wire and the cross-sectional area of the wire

B the unstretched length of the wire and the extension of the wire

C the Young modulus of the metal and the extension of the wire

D the Young modulus of the metal and the unstretched length of the wire

12 What is **not** a necessary requirement of the forces in a couple?

A They act in opposite directions.

B They act along different lines.

C They have the same magnitude.

D They produce a resultant force.

2 What is a power of 3.7 MW when expressed in kilowatts?

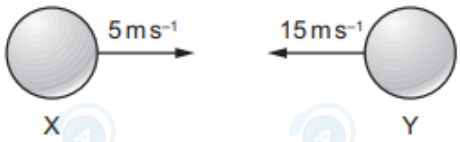
A 3.7×10^{-3} kW

B 3.7×10^{-3} KW

C 3.7×10^{3} kW

D 3.7×10^{3} KW

10 Two balls X and Y are moving towards each other with speeds of $5\,m\,s^{-1}$ and $15\,m\,s^{-1}$ respectively.



They make a perfectly elastic head-on collision and ball Y moves to the right with a speed of $7\,m\,s^{-1}$.

What is the speed and direction of ball X after the collision?

A $3\,m\,s^{-1}$ to the left

B $13\,m\,s^{-1}$ to the left

C $3\,m\,s^{-1}$ to the right

D $13\,m\,s^{-1}$ to the right

35 Each of Kirchhoff's two laws presumes that some quantity is conserved.

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

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

19 An object is stretched until it reaches the elastic limit.

Which statement must describe the stress on the object when it is at the elastic limit?

A It is the maximum stress for which the object obeys Hooke's law.

B It is the maximum stress that can be applied to the object before it has elastic deformation.

7 Which statement is **not** a requirement of a pair of forces that obey Newton's third law of motion?

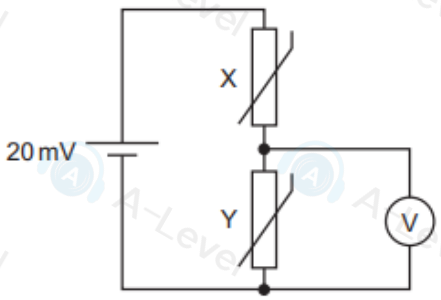
A The forces act in opposite directions.

B The forces act on different objects.

C The forces act on objects in contact.

D The forces are of equal magnitude.

37 A potential divider circuit is designed to detect the difference in temperature between two different places.



The cell has electromotive force (e.m.f.) 20 mV and negligible internal resistance.

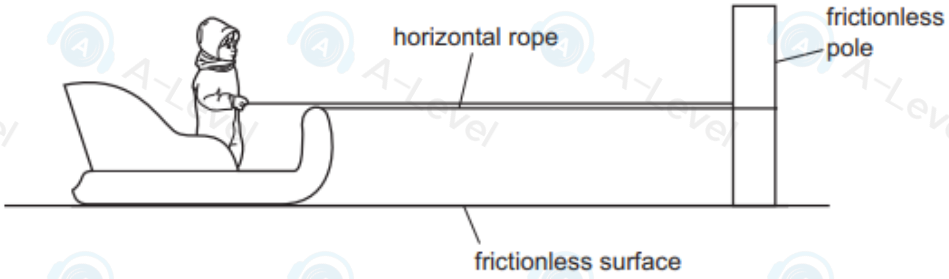
Initially, thermistors X and Y are at the same temperature and have the same resistance. The voltmeter reads 10 mV. X is then placed in a cold environment and its resistance doubles. Y is placed in a warm environment and its resistance halves.

What is the new reading on the voltmeter?

A 4 mV **B** 5 mV **C** 15 mV **D** 16 mV

8 A child of mass 20 kg stands on the rough surface of a sledge of mass 40 kg. The sledge can slide on a horizontal frictionless surface.

One end of a rope is attached to the sledge. The rope passes around a fixed frictionless pole, and the other end of the rope is held by the child, as shown.



The rope is horizontal. The child pulls on the rope with a horizontal force of 12 N. This causes the child and the sledge to move with equal acceleration towards the pole.

What is the frictional force between the child and the sledge?

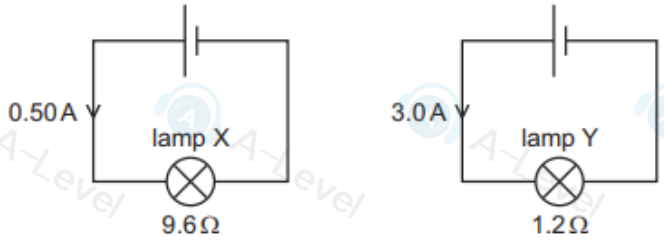
A 4.0 N **B** 6.0 N **C** 8.0 N **D** 12 N

8 A constant resultant force F acts on an object of mass m for time t.

What is the change in momentum of the object?

A $\frac{F}{t}$ **B** $\frac{Ft}{m}$ **C** Ft **D** $\frac{F}{mt}$

32 The circuit diagrams show two lamps X and Y each connected to a cell. The current in lamp X is 0.50 A and its resistance is 9.6 Ω. The current in lamp Y is 3.0 A and its resistance is 1.2 Ω.



What is the ratio $\frac{\text{power in lamp X}}{\text{power in lamp Y}}$?

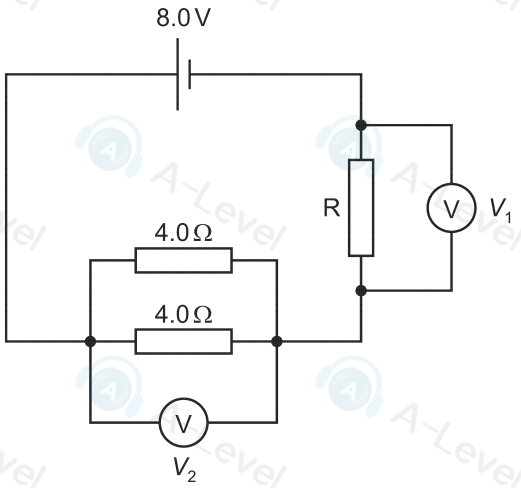
A 0.22 **B** 0.75 **C** 1.3 **D** 4.5

17 Researchers have developed a new type of filament lamp with an efficiency of 40%. Old-type filament lamps have an efficiency of 5.0%. The two types of lamp produce the same useful output power.

What is the ratio $\frac{\text{input power to new type of lamp}}{\text{input power to old type of lamp}}$?

A 0.13 **B** 0.63 **C** 1.6 **D** 8.0

36 A cell has an electromotive force (e.m.f.) of 8.0 V and negligible internal resistance. The cell forms part of a circuit, as shown.

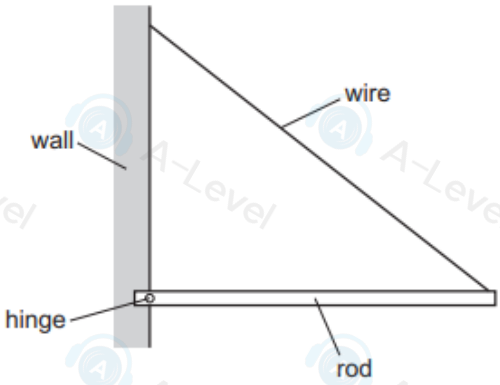


The reading V_1 is 4.0 V and the reading V_2 is also 4.0 V.

What is the resistance of resistor R?

A 0.50 Ω **B** 2.0 Ω **C** 4.0 Ω **D** 8.0 Ω

12 A uniform rod is attached by a hinge at one end to a wall. The other end of the rod is supported by a wire so that the rod is horizontal and in equilibrium.



Which arrow shows the direction of the force on the rod from the hinge?

A **B** **C** **D**



3 A spring is suspended from a fixed point and a force is applied. The position of a pointer attached to the bottom of the spring against a vertical ruler is recorded.

Before the force is applied, the position of the pointer is (225 ± 2) mm.

After the force is applied, the position of the pointer is (250 ± 2) mm.

The extension of the spring is determined.

What is the percentage uncertainty in the extension?

A 1.6% **B** 1.8% **C** 8.0% **D** 16%

11 Two forces form a couple.

Which statement describes the two forces?

A They are in the same direction.

B They are perpendicular to each other.

C They have the same magnitude.

D They pass through the same point.