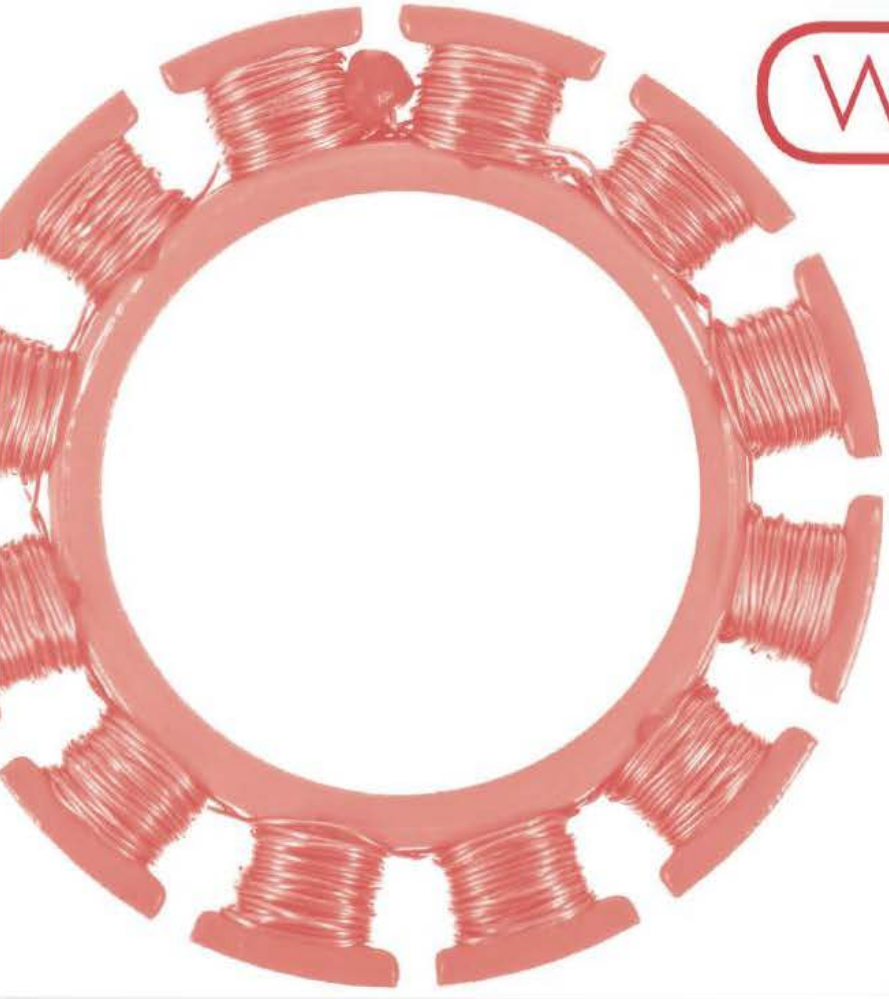
Cambridge IGCSE®

Physics

Workbook



Heather Kennett

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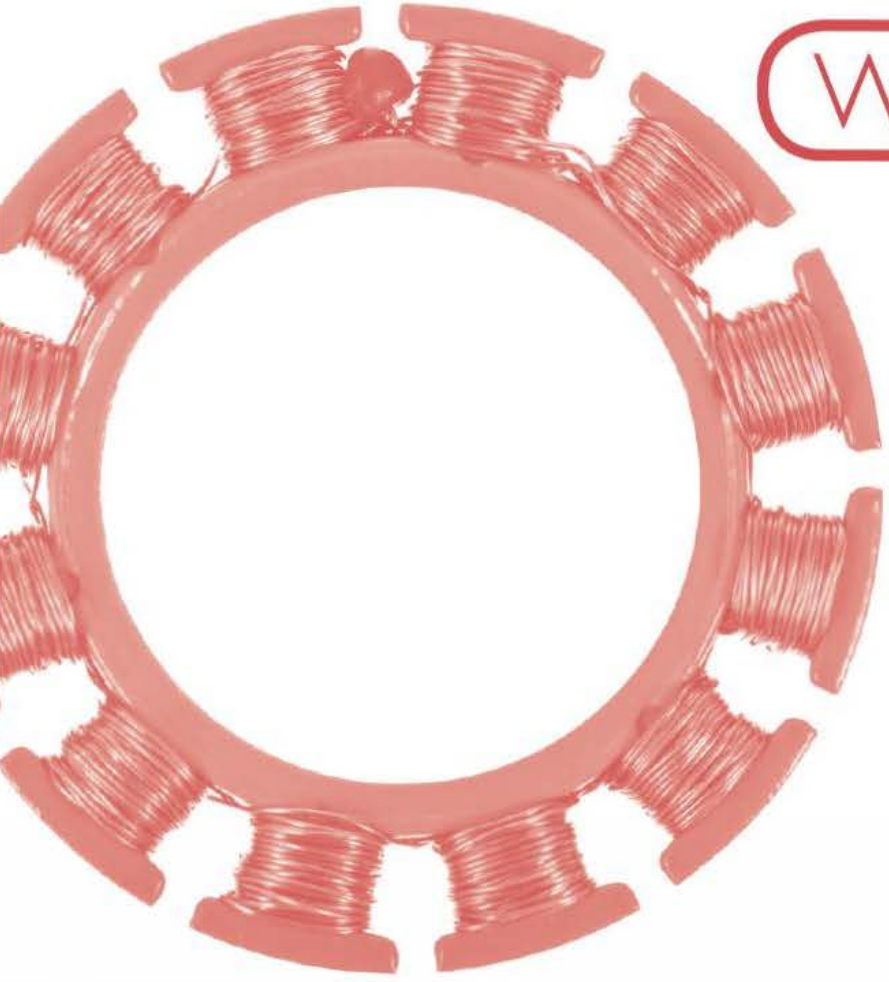

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Contents

Preface

Cambridge *IGCSE® Physics Workbook* is the new edition of the *IGCSE Physics Practice Book*. It is designed as a 'write-in' book for students to practise and test their knowledge and understanding of the content of the IGCSE Physics course.

The sections are presented in the same order as in the Student Book, *IGCSE Physics* 3rd edition, and as in the 2016 Cambridge International Examinations IGCSE Physics syllabus. All questions have been marked as either Core or Extended. At the end of every section, there are longer questions (Exam focus) which aim to introduce students to an examination format.

The Workbook should be used as an additional resource throughout the course alongside the Student Book. The 'write-in' design is ideal for use in class by students or for homework.

1 Measurement and motion

Core

1 For each quantity, select the correct standard SI unit from the box below.

gram	kilogram	millimetre	centimetre	metre	kilometre	second	minute	hour

a mass ..... [1] b length ..... [1] c time ..... [1]

2 State the number of millimetres in the following measurements:

a 2 cm = ... mm [1] b 0.4 cm = ... mm [1]

c 12 cm = ... mm [1] d 0.5 m = ... mm [1]

e 1.4 m = ... mm [1]

3 Convert the following lengths to metres:

a 1500 cm = ... m [1] b 150 cm = ... m [1]

c 15 cm = ... m [1] d 1.5 cm = ... m [1]

4 Write down the following numbers as powers of ten with one figure before the decimal point:

a 1000 = ... [1] b 225 000 = ... [1]

c 650 = ... [1] d 15 000 = ... [1]

5 Write down the following numbers in full:

a 10^4 = ... [1] b 2.5×10^2 = ... [1]

c 1.5×10^6 = ... [1] d 3.5×10^8 = ... [1]

6 Express the following decimals as powers of ten with one figure before the decimal point:

a 0.001 = ... [1] b 0.02 = ... [1]

c 0.0012 = ... [1] d 0.0102 = ... [1]

7 Write down the following fractions as **i** powers of ten, **ii** decimals:

a $\frac{1}{100}$ i ..... [1] ii ..... [1]

b $\frac{2}{1000}$ i ..... [1] ii ..... [1]

c $\frac{3}{10000}$ i ..... [1] ii ..... [1]

d $\frac{4}{5000}$ i ..... [1] ii ..... [1]

8 State the following lengths in metres as powers of ten:

a 5 mm = ... m [1] b 50 cm = ... m [1]

c 5 km = ... m [1] d 50 dm = ... m [1]

e 5 μm = ... m [1] f 5×10^{-3} μm = ... m [1]

9 What is the number of significant figures in each of the following measurements?

a 1.53 m number of significant figures = ... [1]

b 1.60 m number of significant figures = ... [1]

c 2.5×10^{4} m number of significant figures = ... [1]

d 3×10^{-2} m number of significant figures = ... [1]

e 0.016 m number of significant figures = ... [1]

f 250 m number of significant figures = ... [1]

10 Round 1.263 m to:

a one significant figure ..... [1]

b two significant figures ..... [1]

c three significant figures. ..... [1]

11 A student measures a length of 0.615 m using a metre ruler. The smallest division on the ruler is 1 mm.

Is he justified in giving three significant figures? ..... [1]

12 Calculate the area of a rectangle of length 6.0 cm and width 4.5 cm, giving your answer to an appropriate number of significant figures.

area = ... [1]

13 What is the area of a right-angled triangle of sides 30 cm, 40 cm, 50 cm?

area = ... [2]

14 How many bricks of size 5 cm × 2 cm × 3 cm would a child need to build a rectangular block of dimensions 15 cm × 15 cm × 10 cm?

number of bricks = ... [2]

15 A student records the time taken for 20 complete swings of a pendulum to be 32 seconds. What is the period of the pendulum?

period = ... [1]

16 A magazine has a thickness of 8 mm, a mass of 100 g and contains 50 pages. Calculate:

a the thickness of a single page

thickness of a page = ... [1]

b the mass of a single page

mass of a page = ... [1]

17 Find the average speed of a jogger who runs 900 m in 5 minutes.

average speed = ... [2]

18 Three runners competing in a 1 km race finish the race with these times:

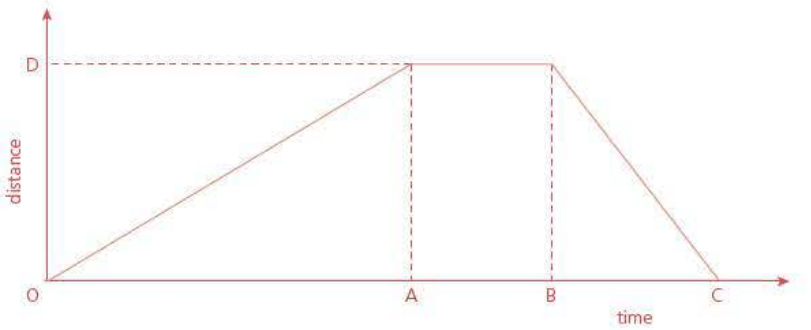
A 200 s B 180 s C 230 s

a Which runner came in first? ..... [1] b Which runner came in last? ..... [1]

c Find the average speed of runner A.

average speed of runner A = ... [2]

19 A farmer takes a drive in his tractor. The graph below shows how his distance from the farm varies with time. Distance OD = 270 m.



a State how far the tractor travels in time interval:

i OA ..... [1]

ii AB ..... [1]

iii BC ..... [1]

b If BC = 3 minutes, what is the speed of the tractor over time interval BC?

speed over time interval BC = ... [2]

20 A woman cycles along a level road a distance of 2.4 km in 10 minutes.

a What is the woman's average speed?

average speed = ... [2]

b The woman does work during her cycle ride.

Against what force is this work done? ..... [1]

21 Circle the correct SI unit of density. [1]

A g/cm^2 **B** g/m^3 **C** kg/m^3 **D** kg/cm^3

22 A block of ice has dimensions 2 cm × 2 cm × 2 cm and a mass of 7.36 g. Calculate the density of the ice.

density = ... [2]

23 The density of aluminium is 2.7 g/cm^3. Calculate:

a the volume of a sheet of aluminium of mass 108 g

volume = ... cm^3 [2]

b the mass of a sheet of aluminium of volume 100 cm^3.

mass = ... g [2]

24 A metal spanner has a mass of 200 g. It is lowered into a measuring cylinder of water until it is completely submerged. The original level of the water was 50 cm^3 and the final level is 75 cm^3. Calculate:

a the volume of the metal

volume = ... cm^3 [1]

b the density of the metal.

density = ... kg/m³ [2]

25 The density of air is 1.3 kg/m³. What is the mass of air in a room of dimensions 3 m × 4 m × 2.5 m?

mass of air = ... kg [2]

Extended

26 a A bus starts from rest and accelerates smoothly. After 10 s the bus reaches a speed of 8 m/s. Calculate the acceleration of the bus.

acceleration = ... [2]

b The bus continues to travel at 8 m/s and then decelerates smoothly as it approaches a bus stop. If the deceleration is 2 m/s², find the time over which the bus decelerates before it comes to rest.

time = ... [2]

27 A lorry is moving with a uniform acceleration of 1.5 m/s². At a certain time it is travelling at a speed of 6 m/s. Find the speed of the lorry 4 s later.

speed = ... [2]

28 The speed of a skier increases steadily from 8 m/s to 20 m/s in 60 seconds. Calculate:

a the average speed of the skier

average speed = ... [1]

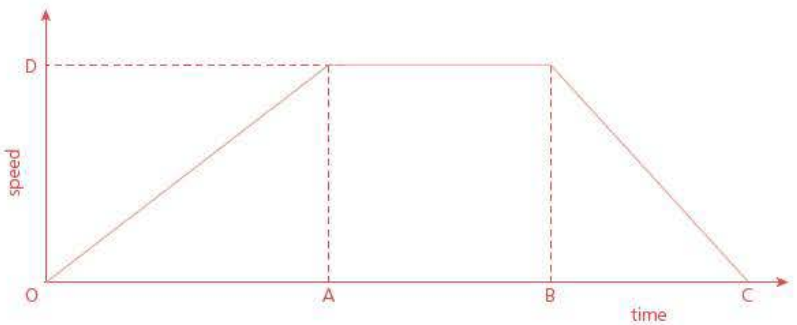
b the distance travelled by the skier in 60 s

distance = ... [2]

c the acceleration of the skier.

acceleration = ... [2]

29 A girl rides her skateboard in a park. The graph below shows how her speed varies over a period of time.



OD = 3 m/s, OA = 20 s, AB = 16 s, BC = 14 s. Find:

a the speed of girl at time A

speed = ... [1]

b her acceleration in time interval OA

acceleration = ... [1]

c the distance she travels in time interval AB

distance in time interval AB = ... [2]

d the distance she travels in time interval BC.

distance in time interval BC = ... [3]

30 An object falls from rest from the top of a high building. Ignore air resistance and take $g = 10\,m/s^2$.

a Find:

i the velocity of the object after 2 s

velocity = ... [1]

ii the distance the object falls in 2 s.

distance = ... [2]

b Describe the shape of a graph of velocity against time for the object.

..... [2]

Exam focus

Core

1 The volume of a liquid in a measuring cylinder is 0.5 dm^3. The liquid is poured into a square tank of internal dimensions 10 cm × 10 cm × 10 cm.

a How full will the container be?

Circle the correct answer.

A completely full **B** ½ full **C** ¼ full **D** ⅓ full *[3]*

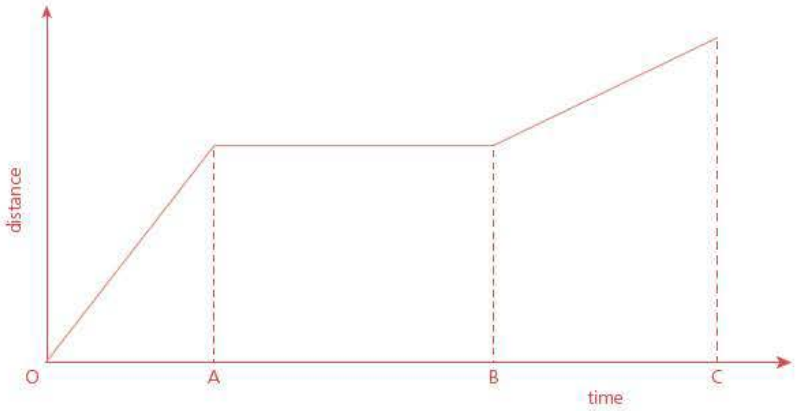
b A brick of dimensions 4 cm × 3 cm × 5 cm is then lowered into the tank so that it is completely submerged. How far will the water level rise?

Circle the correct answer.

A 0.6 cm **B** 1.0 cm **C** 1.5 cm **D** 2 cm *[3]*

[Total: 6]

2 A woman takes a walk to the local park. The graph below shows how her distance from home varies with time.



Choose the correct answer from the box to the questions **a**, **b** and **c**.

zero	constant	increasing	decreasing

a During the time interval OA,

i the distance of the woman from O is ..... [1]

ii her speed is ..... [1]

b During the time interval AB,

i the distance of the woman from O is ..... [1]

ii her speed is ..... [1]

c During the time interval BC,

i the distance of the woman from O is ..... [1]

ii her speed is ..... [1]

d Over which time interval is her speed greatest? ..... [1]

[Total: 7]

Extended

3 a The pitch of a micrometer screw gauge is 0.50 mm. When the micrometer is used to measure the width of a thin sheet of metal, the screw is turned back through four and a half turns from the closed position. What is the thickness of the sheet?

Circle the correct answer.

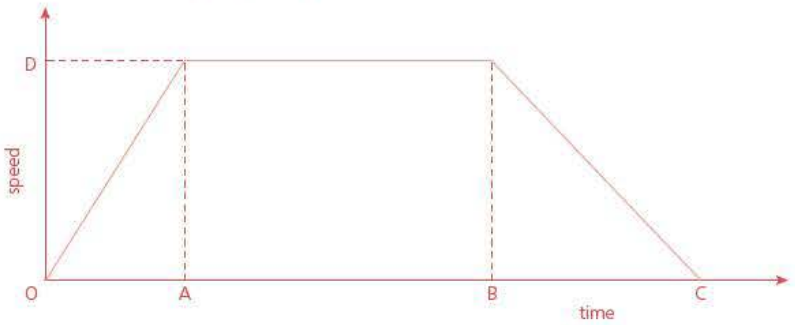
A 4.5 mm **B** 4.25 mm **C** 2.25 mm **D** 2.5 mm [3]

b A book has 120 pages and a thickness of 8.2 mm. The front and back cover of the book are each 0.5 mm thick. How thick is each page?

thickness = ... [3]

[Total: 6]

4 A man travels to work by car. He travels on local roads and on the motorway. The graph shows how his speed varies with time during the journey.



Choose the correct answer from the box to the questions **a**, **b** and **c**.

zero	constant	increasing	decreasing

a During OA,

i the speed of the car is ..... [1]

ii the acceleration of the car is ..... [1]

b During AB,

i the speed of the car is ..... [1]

ii the acceleration of the car is ..... [1]

c During BC,

i the speed of the car is ..... [1]

ii the acceleration of the car is ..... [1]

d If BC = 5 minutes and OD = 30 m/s, how far does the car travel in time interval BC?

distance travelled = ... [2]

e Over which time interval is the average speed of the car highest? ..... [1]

[Total: 9]

2 Forces and momentum

Core

1 Find the resultant of two forces, 5 N and 8 N, acting:

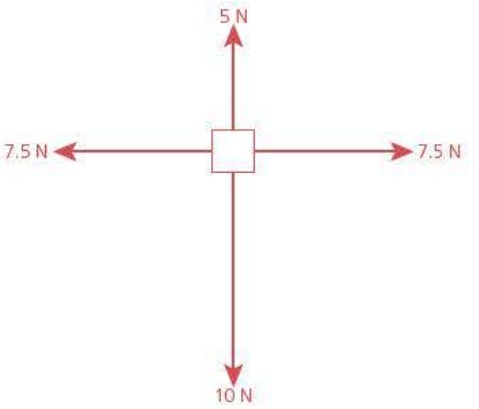
a in the same direction as each other

resultant = ... N [1]

b in opposite directions to each other.

resultant = ... N [1]

2 A box is subject to the forces shown in the sketch below.



a Work out the size and direction of the resultant force on the box.

resultant force = ... [2]

b State the size and direction of the extra force needed to reduce the resultant to zero.

extra force = ... [2]

3 Fill in the gaps in the following paragraph:

If there is no resultant ..... on a body, it remains at ..... or continues to move at a ..... speed in a ..... line. [2]

4 A skydiver of mass 80 kg jumps from a plane. Taking $g = 10\,m/s^2$, write down:

a the weight of skydiver .....

..... [1]

b the force due to gravity acting on the skydiver.....

..... [1]

c the resultant force on the skydiver when the air resistance is 300 N

resultant force = ... [1]

d the value of the air resistance after the skydiver's parachute has opened and the skydiver has reached terminal velocity. ..... [1]

5 The Mars Rover Curiosity has a mass of 900 kg. Taking the gravitational field strength to be 10 N/kg on Earth and 4 N/kg on Mars, give the value of the weight of the Rover on:

a Earth ..... [1]

b Mars ..... [1]

6 Give the weight of the following masses. Take the acceleration of free fall to be $10\,m/s^2$.

a A mass of 15 g has a weight of ..... N. [1]

b A mass of 50 g has a weight of ..... N. [1]

c A mass of 0.3 kg has a weight of ..... N. [1]

d A mass of 3 kg has a weight of ..... N. [1]

7 On the Earth the acceleration of free fall is about $10\,m/s^2$. On the Moon the acceleration of free fall is about $1.6\,m/s^2$. A man weighs 800 N on the Earth. Give his:

a mass measured on the Moon

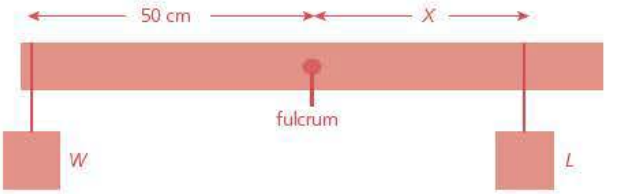
mass = ... kg [1]

b weight measured on the Moon

weight = ... N [1]

8 A uniform metre ruler is balanced at its midpoint.

a A weight, *W*, is hung from one end of the ruler and a load, *L*, is suspended at a distance *X* from the fulcrum, as shown.



Find the distance X for the beam to be balanced when:

i $L = 2W$

$X =$ ..... [1]

ii $L = 5W$

$X =$ ..... [1]

iii $L = 10W$

$X =$ ..... [1]

b An additional weight, also *W*, is now suspended at a distance 30 cm to the left of the fulcrum. Find *X* for the beam to be balanced when:

i $L = 2W$

$X =$ ..... [1]

ii $L = 5W$

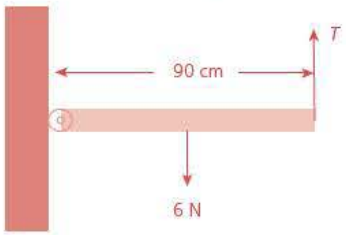
$X =$ ..... [1]

9 Use the following words to fill in the gaps in the paragraph below.

clockwise	direction	equals	equilibrium	forces
moments	no	point	resultant	sum

When a number of parallel ..... act on a body it will be in ..... when (i) the ..... of the forces in one direction ..... the sum of the forces in the opposite ..... and (ii) the sum of the ..... moments about any ..... equals the sum of the anticlockwise ..... about the same point. This means that there is ..... resultant force and no ..... turning effect when a system is in equilibrium. [5]

10 A uniform board of length 90 cm is pivoted at a hinge at one end. It is kept level by an upward vertical force *T* applied at the opposite end. The weight of the board is 6 N.



a Take moments about the hinge to find *T* when the board is level.

T = ... N [3]

b The hinge exerts an upward force, *F*, on the board. Equate parallel forces to determine *F* when the board is level.

F = ... N [2]

11 Explain how you would find the centre of mass of a triangular-shaped piece of card.

.....

.....

.....

..... [3]

12 This question is about the stability of objects.

a How far can an object be tipped before it topples over?

.....

..... [2]

b State **two** ways in which the stability of a vehicle could be increased.

1 .....

2 ..... [2]

Extended

13 A mass of 0.5 kg extends a spring by 10 cm. When an unknown mass, *M*, is hung on the spring, the extension is 15 cm. What is the value of *M*?

M = ... kg [1]

14 A force of 10 N extends a spring by 3 cm. What will be the extension if a mass of 0.3 kg is attached to the lower end of the spring?

Circle the correct answer.

A 0.9 mm **B** 1.0 mm **C** 3.0 mm **D** 9.0 mm **E** 10.0 mm [1]

15 Explain the difference between a scalar and a vector, and give an example of each.

.....

.....

.....

..... [4]

16 Forces of 4N and 3N act at 90° to each other. Use the parallelogram law to find the magnitude of their resultant.

resultant = ... N [3]

17 A mass of 50kg experiences a force F_1 to the right and a force F_2 to the left.

a If F_1 = 100N and F_2 = 80N, give:

i the resultant force on the mass

force = ... [2]

ii the acceleration of the mass.

acceleration = ... [2]

b If $F_1 = F_2$ = 80N, give:

i the resultant force on the mass

force = ... [1]

ii the acceleration of the mass

acceleration = ... [1]

18 Find the resultant force that produces an acceleration of 4m/s² in a mass of 15kg.

resultant force = ... [1]

19 A girl whirls a ball on the end of a string in a vertical circle at a constant speed.

The velocity of the ball is changing.

a Explain the difference between speed and velocity.

.....

..... *[1]*

b What causes the velocity of the ball to change?

.....

..... *[1]*

c When the girl whirls the ball faster and faster, the string breaks when the ball is at its lowest point. In which direction does the ball fly off?

..... *[1]*

20 The momentum of a body of mass m and velocity v is equal to $m \times v$. Calculate the momentum of a 5 kg trolley travelling at velocity:

a 3 m/s

momentum = ... kg m/s *[1]*

b 40 m/s

momentum = ... kg m/s *[1]*

21 An ice hockey puck moves in a straight line with a velocity of 5 m/s. It strikes a second identical puck, which is initially at rest, head-on. The second puck moves off in the same straight line as the first puck with a velocity of 4 m/s. Calculate the velocity of the first puck after the collision.

velocity of first puck after collision = ... *[2]*

22 A trolley of mass 200 kg is travelling north at 2 m/s. It collides head-on with a second trolley of mass 500 kg which is travelling south with a velocity of 5 m/s and they remain coupled together.

a Calculate the velocity of the two trolleys after the collision.

velocity of trolleys after collision = ... [2]

b What is the direction of motion of the trolleys after the collision? ..... [1]

23 A ball of mass 50 g is at rest before being struck by a bat. The collision between bat and ball lasts for 0.002 s and the speed of the ball immediately after it leaves the bat is 20 m/s.

a Calculate the momentum of the ball just after it leaves the bat.

momentum of ball = ... [2]

b What is the impulse acting on the ball during the collision?

impulse on the ball = ... [1]

c Find the steady force which the bat exerts on the ball during the collision.

force = ... [1]

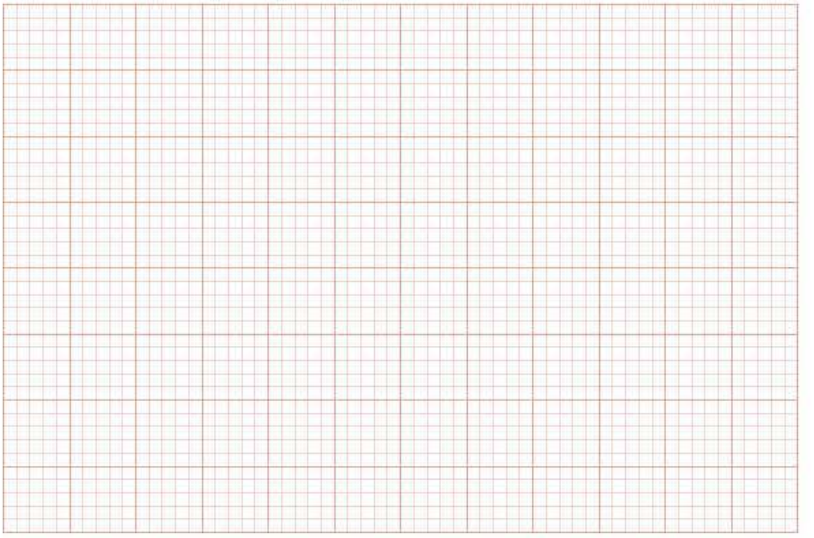
Exam focus

Core

1 The following measurements are obtained when a spring is stretched:

stretching force/N	2	4	6	8	10
extension/mm	1	2	3	4.2	6

a Draw a force/extension graph for the spring. Plot extension on the *y*-axis and force along the *x*-axis.



[4]

b Mark on your graph:

i the region over which Hooke's law holds *[1]*

ii the limit of proportionality. *[1]*

c From the graph, calculate the force constant for the spring.

force constant = ... N/m *[2]*

[Total: 8]

Extended

2 a Calculate the force constant of a spring which is stretched 10 cm by a mass of 2 kg.

force constant = ... N/m [2]

b The length of an unstretched spring is 20 cm. When a force of 0.5 N is applied to the spring it stretches to a total length of 30 cm. Assume Hooke's law holds.
Calculate the force constant of the spring.

force constant = ... N/m [2]

c The spring in part **b** is now stretched to 40 cm. Assuming that Hooke's law is still obeyed, calculate the extension and the force applied.

i extension of spring = ... [1]

ii force applied = ... [1]

[Total: 6]

3 A car rounding a bend on a flat road travels in an arc of a circle at a constant speed.

a Which of the following is constant? Circle the correct answer.

A velocity of the car **B** acceleration of the car [1]

b A force is required to keep the car moving in a circle.

i In which direction does the force act? ..... [1]

ii What effect does the force have on the car?

..... [2]

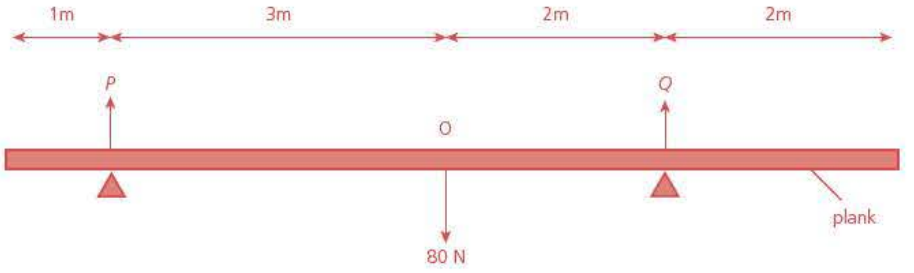
iii What provides the force?

..... [1]

iv If the driver slows down, will the force required to keep the car moving in a circular path be larger or smaller? ..... [1]

[Total: 6]

4 A trestle consists of a plank resting on two supports which exert upward forces of P and Q, as shown. The weight of the plank is 80 N (shown acting through its centre).



a Take moments about the left support to find the value of Q.

Q = ... N [2]

b Equate parallel forces to find the value of P.

P = ... N [2]

[Total: 4]

5 A golfer strikes a stationary golf ball of mass 45 g with a golf club. The golf club is in contact with the ball for a time of 0.001 s and exerts a force of 1350 N on it.

a Calculate the acceleration of the ball during the time it is in contact with the club.

acceleration = ... [2]

b Work out the velocity of the ball just after it is struck.

velocity = ... [2]

c Give **two** ways by which the velocity of the golf ball could be increased.

1 .....

2 ..... [2]

[Total: 6]

3 Energy, work, power and pressure

Core

1 Name the energy transfers which occur in:

a a steam turbine

..... [1]

b a generator

..... [1]

2 Explain what is meant by 'renewable' and 'non-renewable' sources of energy. Give **two** examples of each type.

a Renewable sources of energy

.....

Example: .....

Example: ..... [3]

b Non-renewable sources of energy

.....

Example: .....

Example: ..... [3]

3 Calculate the pressure on a surface when a force of 40 N acts on an area of:

a $4.0\,m^2$

pressure = ... [1]

b $0.5\,m^2$

pressure = ... [1]

c $0.1\,m^2$

pressure = ... [1]

d $4.0\,cm^2$

pressure = ... [2]

4 Calculate the force on each area if a pressure of 20 Pa acts on it.

a area = 2 m^2

force = ... [1]

b area = 1 m^2

force = ... [1]

c area = 1 cm^2

force = ... [2]

d area = 0.1 cm^2

force = ... [2]

5 A boy decides to take a walk in some soft snow. Which of the following footwear should he choose so that he sinks into the snow the least distance?

Circle the correct answer.

A boots of contact area 0.7 m^2

B snow shoes of contact area 1.5 m^2

C skis of contact area 1.0 m^2

D ice skates of contact area 5×10^{-4} m^2 [2]

6 In a hydraulic jack a force of 100 N is applied to a piston of surface area 4.0 cm^2.

a Calculate the pressure applied to the fluid by the piston.

pressure = ... [2]

b The fluid transmits the pressure to a larger piston of surface area 20 cm^2.

i Find the force exerted by the larger piston.

force = ... [2]

ii What weight can be lifted by the jack?

weight = ... [1]

Extended

7 A dog pulls a sledge across a flat snowfield for a distance of 500 m. The dog exerts a steady force of 120 N on the sledge. Calculate the work done.

work done = ... [2]

8 A lift raises a load of 9000 N to a height of 20 m in 15 seconds.

a Calculate the work done.

work done = ... [2]

b Calculate the power of the lift.

power = ... [2]

9 When a force of 150 N is applied to a piston X, it moves through a distance of 10 cm in the direction of the force.

a Find the work done by piston X.

work done = ... [2]

b Another piston, Y, does the same amount of work as piston X in part **a**. The force on piston Y is 750 N. How far does piston Y move in the direction of the force?

distance = ... [3]

10 An electrical appliance has an power input of 500 W.

a The appliance transfers energy at a rate of 350 W. Calculate its efficiency.

efficiency = ... [3]

b What happens to the 'lost' energy'?

..... [1]

11 Describe the transfers of energy which occur when:

a a stone falls from a cliff

..... [2]

b dinner is cooked in a microwave oven

..... [2]

c a DVD player is operated

..... [2]

d a hydroelectric power station operates.

..... [2]

12 Fill in the gaps in the following sentences.

Kinetic ..... is the energy a body has because of its ..... . A body of mass *m* and velocity *v* has kinetic energy equal to .... energy is the energy a body has because of its position or condition. A body of mass *m* raised through a height *h* in a gravitational field of strength *g* gains potential energy equal to ..... .

Energy cannot be created or destroyed: it is always ..... . It is constantly being transferred from one form to another. [3]

13 Calculate the kinetic energy of a mass of 5 kg travelling at a velocity of:

a 6 m/s

k.e. = ... J [3]

b 12 m/s

k.e. = ... J [3]

14 Taking g = 10 N/kg, work out the potential energy of a mass of 5 kg at a height of:

a 10 m above the ground

p.e. = ... J [2]

b 25 m above the ground.

p.e. = ... J [2]

15 What is the velocity of a truck with kinetic energy 2.7 kJ and mass 600 kg?

velocity = ... [3]

16 A box of mass 3 kg is dropped from a height of 5 m.

a Neglecting air resistance, calculate:

i the potential energy of the box before it is dropped

p.e. = ... [2]

ii the kinetic energy of the box just before it reaches the ground

k.e. = ... [1]

iii the velocity of the box just before it strikes the ground.

velocity = ... [3]

b What happens to the kinetic energy of the box when it strikes the ground?

..... [2]

17 Water flows over a dam wall at a rate of 2000 kg/s. The dam wall is 10 m high. How much power can be generated by the falling water, if 90% of its potential energy can be harnessed to produce electricity?

power generated = ... [3]

18 A swimming pool contains water to a depth of 3 m. What is the difference in water pressure between the top and bottom of the pool? Take the density of the water to be 1.0×10^3 kg/m^3.

pressure difference = ... [3]

Exam focus

Core

1 Write down two advantages and two disadvantages of using the following as sources of energy for electricity generation.

a solar energy

i advantages: ..... [2]

ii disadvantages: .....

..... [2]

b nuclear energy

i advantages: ..... [2]

ii disadvantages: .....

..... [2]

c wind energy

i advantages: ..... [2]

ii disadvantages: .....

..... [2]

d gas-fired power stations

i advantages: ..... [2]

ii disadvantages: .....

..... [2]

[Total: 16]

Extended

2 Two identical ropes are attached to either end of a beam of mass 60 kg.

a What is the tension, T, in each rope when they support the beam horizontally above the ground?

T = ... [2]

b How much work is done if the beam is raised vertically by 1.5 m?

work done = ... [2]

c How much power is needed to raise the beam 1.5 m in 3 seconds?

power = ... [2]

[Total: 6]

3 a A cyclist freewheels (without pedalling) from rest down a hill. Explain the energy changes which occur during her descent.

.....

.....

.....

..... [3]

b On reaching level ground the cyclist pedals along a straight road with a constant speed of 12 m/s. If she experiences a resistive force, F, of 5 N, which acts in the opposite direction to that in which she is travelling, work out the amount of energy she uses against F in 1 second.

energy used = ... [2]

c F then increases to 7.5 N. Calculate the cyclist's new speed, if she maintains the same rate of working as in part **b**.

i rate of working = ... [1]

ii speed = ... [2]

[Total: 8]

4 A ball of mass 60 g is projected vertically upwards from ground level with an initial velocity of 30 m/s. Neglect the effect of air resistance on the motion of the ball. Determine:

a the initial kinetic energy of the ball

initial k.e. = ... [3]

b the initial potential energy of the ball

..... [1]

c the potential energy of ball when it reaches its greatest height

..... [1]

d the greatest height reached by the ball.

greatest height = ... [2]

[Total: 7]

4 Thermal physics

Core

1 Write down the state of matter – gas, liquid or solid – in which the molecules are:

a least densely packed ..... [1]

b ordered in a regular pattern ..... [1]

c moving at high speed over large distances ..... [1]

d moving about over small distances ..... [1]

e vibrating to and fro about a fixed point. ..... [1]

2 Write down the state of matter – solid, liquid or gas – which:

a is highly compressible ..... [1]

b has a definite shape ..... [1]

c flows easily. ..... [1]

3 Some smoke particles are allowed to drift into a glass box which contains air. The box is then sealed and illuminated. The random motion of the smoke particles in the box is viewed through a microscope.

a Explain the random motion of the smoke particles.

.....

.....

.....

.....

.....

..... [3]

b The box is heated so that the temperature of the air it contains rises. How does the rise in temperature affect the motion of the smoke particles?

..... [1]

4 Use the kinetic theory to explain how a gas exerts a pressure on the walls of its container.

.....

..... [2]

5 The air in a closed container is heated.

a How does the air pressure inside the container change when the temperature rises?

..... [1]

b Explain your answer to **a** in terms of the kinetic theory.

.....

.....

..... [3]

6 The volume of a gas remains constant when it is heated in a closed container.

Circle **two** of the following statements that are false.

A The pressure of the gas will increase.

B The average kinetic energy of the molecules will decrease.

C The molecules will hit the walls of the container more often.

D The number of molecules will increase.

E The molecules will move in all directions. [2]

7 A fixed mass of gas is heated in a container which maintains it at constant pressure.

Circle **two** of the following statements that are true.

A The volume of the gas will decrease.

B The volume of the gas will increase.

C The average kinetic energy of the molecules will increase.

D The number of molecules will decrease.

E The molecules will hit the walls of the container more often. [2]

8 Explain how a bimetallic strip can be used in a thermostat.

.....

.....

.....

..... [4]

9 On the Celsius scale of temperature, what is the value of:

a the lower fixed point ..... [1] b the upper fixed point? ..... [1]

10 Different physical properties may be used to construct a thermometer.

a Give **two** examples of such physical properties.

1 .....

2 ..... [2]

b Name **two** ways in which the physical property should vary with temperature.

1 .....

2 ..... [2]

c What type of thermometer would you use to measure a high, rapidly changing temperature?

..... [1]

11 The following amounts of energy in joules are needed to raise the temperature of 1 kg of different materials, **A**, **B**, **C** and **D**, by 1 °C:

A 4000	B 960	C 450	D 390

a Which material has the highest specific heat capacity? ..... [1]

b What is the thermal capacity of 2 kg of substance **C**?

thermal capacity = ... [1]

12 Passive solar houses are energy efficient buildings designed to trap and store sunlight in the winter. They often include an internal feature of a brick or concrete wall close to a window. Explain why.

.....

..... [2]

13 A hot stone is dropped into a bucket of cold water. Circle the statement that is untrue.

A Heat flows from the stone to the water.

B Heat flows from the water to the stone.

C The average kinetic energy of the molecules in the water increases.

D The stone and the water reach a common temperature.

E The internal energy of the stone decreases. [1]

14 State the meaning of:

a melting point

.....

..... [2]

b boiling point

.....

..... [2]

15 Which of these materials would you choose to use for the following applications?

A wood	B glass	C steel	D fibreglass	E cardboard

a a cooking pot ..... [1]

b the handle of a saucepan ..... [1]

c a container for a take-away pizza ..... [1]

d roof insulation for your home ..... [1]

16 Describe an experiment to show the difference between a good and a bad conductor of thermal energy.

.....

.....

.....

.....

.....

..... [4]

17 Explain why a metal object at room temperature feels cold compared to a plastic object at the same temperature.

.....

..... [2]

18 Circle one of the following statements that is incorrect.

A hot air rises **B** cold air sinks

C cold air is less dense **D** hot air is less dense [1]

19 In a household with four family members who like to take frequent hot showers, would you place an immersion heater at the top or bottom of their hot water tank? Explain your choice.

.....

..... [3]

20 Circle the **one** correct answer below.

Convection takes place in:

A only solids **B** only liquids **C** only gases

D gases and liquids **E** liquids and solids [1]

21 Circle the **one** correct answer below.

We feel the heat from a coal fire by:

A convection **B** conduction **C** expansion **D** radiation [1]

22 These are features of a vacuum flask:

A double-walled glass container	**C** silvered glass surfaces
B vacuum	**D** metal container

Which of the above features reduces heat transfer by:

a both conduction and convection ..... [1] b radiation ..... [1]

23 To what part of the electromagnetic spectrum does the thermal radiation trapped in a greenhouse belong? ..... [1]

24 Use the following words to fill in the spaces in the paragraph below.

electromagnetic energy fluid higher lower radiation temperature thermal

Conduction is the transfer of ..... energy through matter from places of ..... temperature to places of ..... temperature without movement of the matter as a whole. Convection is the transfer of thermal ..... through a fluid from places of higher ..... to places of lower temperature by movement of the ..... . In ..... , thermal energy is transferred from one place to another by means of ..... waves; no medium is required. [4]

Extended

25 A fixed mass of gas occupies a volume of 200 cm^3 at a temperature of 27 °C and a pressure of 1 atmosphere. If the temperature is kept constant, find:

a the volume occupied when the pressure is halved

volume = ... [1]

b the volume occupied when the pressure is doubled.

volume = ... [1]

26 A fixed mass of gas occupies a volume of 100 cm^3 at a pressure of 2×10^5 Pa. The temperature of the gas is kept constant. Find:

a the pressure when the volume is doubled

pressure = ... [1]

b the pressure when the volume is halved.

pressure = ... [1]

27 Temperature is a measure of the average kinetic energy of molecules in a body.

a State what happens to the molecules in a solid when the temperature rises.

..... [2]

b For a given rise in temperature would a gas, a liquid or a solid expand the most?

..... [1]

28 A cup of coffee is heated in a microwave oven. The mass of the liquid is 70 g and its specific heat capacity is 4000 J/kg °C. Calculate the energy needed to raise the temperature of the coffee by 60 °C.

energy required = ... J [3]

29 A 150 W immersion heater is used to heat 500 g of water in an insulated container. It takes 9 minutes and 20 seconds to raise the temperature of the water from 20 °C to 60 °C. Calculate the specific heat capacity of the water.

specific heat capacity of water = ... [4]

30 In each of **a** and **b**, circle **one** statement that is incorrect.

a During melting:

A the temperature remains constant

B the average kinetic energy of the molecules increases

C the potential energy of the molecules increases

D latent heat of fusion is absorbed. [1]

b During solidification:

A the temperature of the material increases

B the average kinetic energy of the molecules remains constant

C the potential energy of the molecules decreases

D latent heat of fusion is given out. [1]

31 How much thermal energy is needed to change 50 g of ice at 0 °C to water at 0 °C? Take the specific latent heat of fusion of ice to be 340 J/g.

thermal energy needed = ... [2]

32 How much thermal energy is needed to raise the temperature of 50 g of water at 0 °C to 100 °C? Take the specific heat capacity of water to be 4.2 J/g °C.

thermal energy needed = ... *[2]*

33 Calculate the thermal energy needed to change 50 g of water at 100 °C to 50 g of steam at 100 °C. Take the specific latent heat of vaporisation of steam to be 2300 J/g.

thermal energy needed = ... *[2]*

34 Using your answers to questions **31**, **32** and **33**, find the total amount of thermal energy needed to change 50 g of ice at 0 °C to 50 g of steam at 100 °C.

total thermal energy needed = ... *[2]*

35 In an experiment to measure the specific latent heat of fusion of ice, 40 g of melted ice was collected when an immersion heater supplied 13 600 J of energy to ice at 0 °C. If no thermal energy was exchanged with the surroundings, calculate the specific latent heat of fusion of ice.

specific latent heat of fusion of ice = ... *[2]*

36 A freezer changes 150 g of water at 0 °C to ice at 0 °C.

a How much thermal energy is given out? Take the specific latent heat of fusion of ice to be 340 J/g.

thermal energy given out = ... *[2]*

b If it takes 5 minutes to freeze the ice in **a**, at what rate is the freezer working?

rate of working = ... *[2]*

37 It takes 92 kJ of energy to change 40 g of water at 100 °C to steam. Calculate the specific latent heat of vaporisation of steam.

specific latent heat of vaporisation = ... [2]

38 This question is about evaporation.

a Use kinetic theory to explain why a liquid cools when evaporation from its surface occurs.

.....

.....

.....

..... [4]

b Name **two** factors that increase the rate of evaporation of a liquid.

1 .....

2 ..... [2]

c Explain the difference between evaporation and boiling.

.....

.....

..... [4]

39 Circle the statement that is incorrect. During condensation:

A latent heat of vaporisation is given out

B latent heat of fusion is absorbed

C the potential energy of the molecules decreases

D the temperature remains constant [1]

40 This question is about radiation.

a Two copper blocks are immersed in hot water until they reach the same temperature. The blocks are identical except that block A is painted black and block B has a shiny surface. When the two blocks are removed from the hot water and placed well separated on a wooden board, which block cools faster? Explain your answer.

.....

..... [2]

b Explain why:

i shiny aluminium foil is sometimes placed behind central heating radiators

..... [1]

ii it is cooler to wear a white T-shirt than a black one on a hot day.

..... [1]

Exam focus

Core

1 Air is a poor conductor of thermal energy but a good insulator.

a Give **three** everyday examples of the use of trapped air to provide insulation.

1 .....

2 .....

3 ..... [3]

b Why is using trapped air for insulation more effective than using air alone?

..... [1]

[Total: 4]

Extended

2 An alcohol-in-glass thermometer is to be calibrated in °C.

a Explain how to determine:

i the lower fixed point

..... [2]

ii the upper fixed point.

.....

..... [2]

b The positions of the liquid surface in the capillary tube of the thermometer are marked for temperatures of 0 °C and 100 °C. The distance between the two marks is 10 cm.

At room temperature the liquid surface lies between the 0 °C and 100 °C marks and is 2.5 cm away from the 0 °C mark. What is the room temperature?

room temperature ..... [1]

c If a wider capillary tube was used, would:

i the distance between fixed points be larger or smaller? ..... *[1]*

ii the sensitivity of the thermometer be greater or less? ..... *[1]*

[Total: 7]

3 Describe an experiment to measure the specific heat capacity of an aluminium block.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total: 8]

4 An ice cube of mass *m* is dropped into 400 g of water at 25 °C. When the ice has completely melted, the water temperature has fallen to 15 °C. The specific heat capacity of water is 4.2 J/g °C and the specific latent heat of ice is 340 J/g.

Assuming that no thermal energy is exchanged with the surroundings, complete the following equations and use them to calculate the mass, *m*, of the ice cube.

a Thermal energy lost by water falling from 25 °C to 15 °C = ... *[2]*

b Thermal energy needed to melt ice cube of mass m at 0 °C = ... *[2]*

c Thermal energy needed to raise temperature of melted ice from 0 °C to 15 °C =

..... [2]

d Total thermal energy gained by ice cube = ... [1]

e Since energy is conserved,
total energy gained by ice cube = energy lost by ..... [1]

f Hence calculate the mass of the ice cube.

mass of ice cube, m = ... [3]

[Total: 11]

5 This question is about conduction.

a Use kinetic theory to explain how thermal energy is transferred through a solid object.

.....

.....

.....

..... [4]

b Why are poor electrical conductors also poor thermal conductors?

.....

..... [1]

[Total: 5]

5 Properties of waves

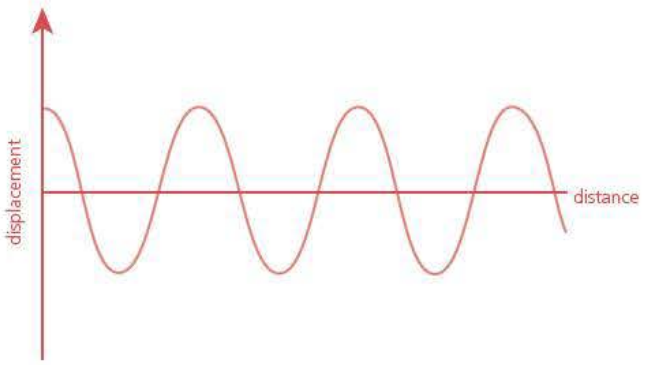
Core

1 Explain the difference between a transverse and a longitudinal wave.

.....

..... [4]

2 The sketch shows a displacement–distance graph of a wave at a particular instant.



Label a crest, a trough, the amplitude and the wavelength. [4]

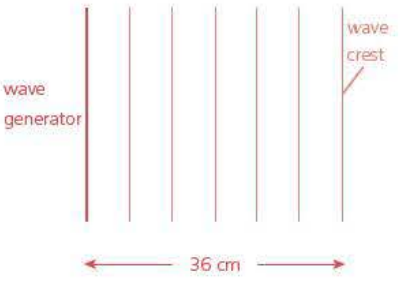
3 A wave crest passes a particular point every 1/10th of a second. What is the frequency of the wave?

frequency = ... Hz [1]

4 A heart rate is timed at 72 beats a minute. What is the frequency of the heart rate?

frequency = ... Hz [2]

5 The lines drawn represent the crests of water waves in a ripple tank.



The distance occupied by 6 waves is 36 cm. The frequency of the wave generator is 5 Hz.

Find:

a the wavelength of the waves

wavelength = ... [1]

b the frequency of the waves

frequency = ... [1]

c the speed of the waves

wave speed = ... [2]

d the time taken to travel 9.6 m.

time taken = ... [2]

6 When a water wave enters shallower water its speed changes from 10 m/s to 5 m/s. What changes occur to:

a the frequency ..... [1]

b the wavelength ..... [1]

c the direction of travel?

..... [1]

7 Use some of the following words to fill in the gaps in the paragraph below.

after	beam	before	direction	diverging	faster
lines	narrower	slower	ray	wider	

Light travels in straight ..... . In diagrams a ray is used to represent the ..... in which the light is travelling. A ..... is drawn as a straight line with an arrow on it. A ..... of light consists of many rays which may be parallel, ... or converging. A diverging beam spreads out, while a converging beam becomes ..... . Light travels much ..... than sound – we see a lightning flash ..... we hear the corresponding sound of the thunder. [4]

8 Sketch light rays in the following types of beam:

a parallel [1]

b converging [1]

c diverging [1]

9 Circle the correct statement. The image in a pinhole camera becomes larger if:

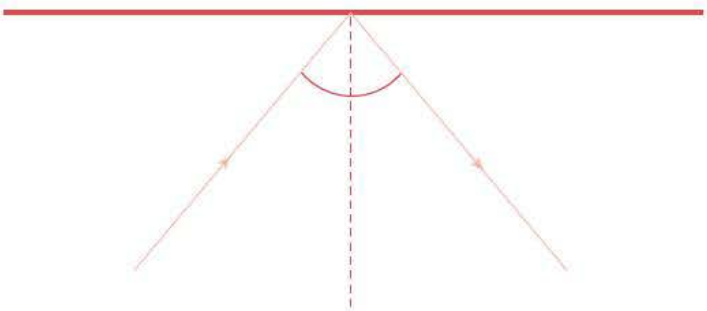
A the camera is shorter

B the camera is longer

C the pinhole is smaller

D the pinhole is larger [1]

10 A ray of light is reflected from a plane mirror as shown.



a Label the plane mirror, the incident ray, the normal to the mirror, the reflected ray, the angle of incidence, *i*, and the angle of reflection, *r*. [3]

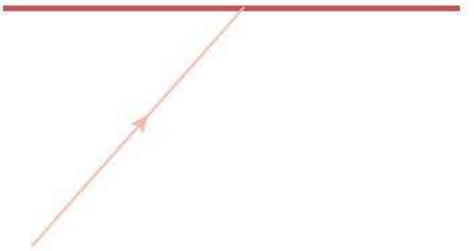
b Use a protractor to measure:

i the angle of incidence, *i* = ... [1]

ii the angle of reflection, *r* = ... [1]

11 In each of the following diagrams:

i



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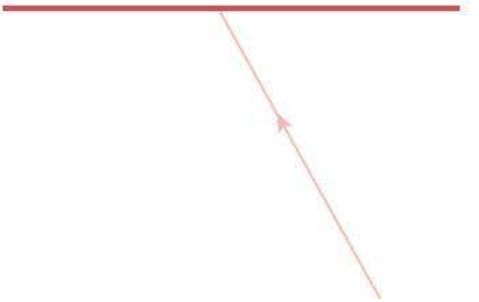

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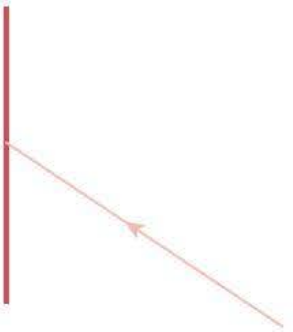

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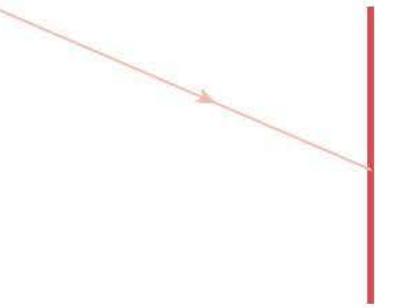

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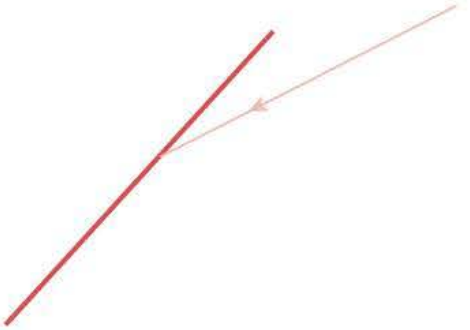

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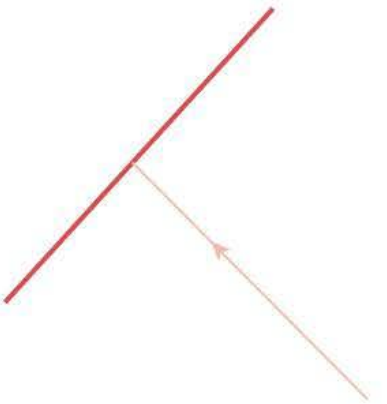
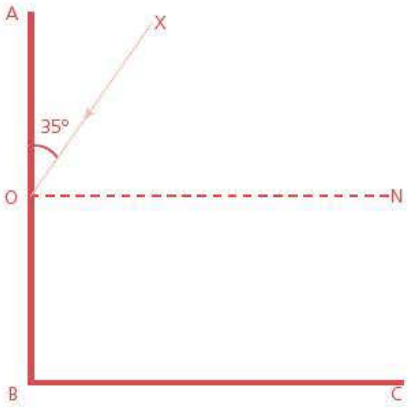


a draw in the normal to the plane mirror at the point the light ray strikes it *[3]*

b mark on the angle of incidence, *i* *[3]*

c draw in the reflected ray. *[3]*

12 Two plane mirrors, AB and BC, are set up at right angles. ON is normal to the mirror AB. A ray of light XO is incident on AB as shown. It is reflected at mirror AB and then travels on to mirror BC, where it is again reflected.



a On the diagram, continue the ray XO to show the path it takes after reflection at each mirror. *[2]*

b Write down the following values:

i angle of incidence at mirror AB = ... *[1]*

ii angle of reflection at mirror AB = ... *[1]*

iii angle of incidence at mirror BC = ... *[1]*

iv angle of reflection at mirror BC = ... *[1]*

c What do you notice about the path of the reflected ray?

..... *[1]*

13 Two plane mirrors are set at 45° to each other. A ray of light is incident at 45° on one of the mirrors.

a Make a sketch of the path of the ray showing how it is reflected from each mirror.

[2]

b Write down the following values:

i angle of reflection at first mirror = ... *[1]*

ii angle of incidence at second mirror = ... *[1]*

14 Circle **two** statements that are false.

The image in a plane mirror is:

A as far behind the mirror as the object is in front

B larger than the object

C real

D virtual

E laterally inverted

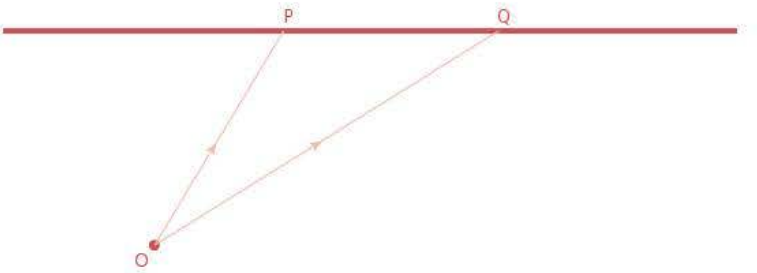
F upright *[2]*

15 Explain what is meant by a 'real' image.

.....

..... [2]

16 Two light rays, OP and OQ, from a point object, O, are incident on a plane mirror.



a Draw the normals to the mirror at the points of contact of the rays, and draw the reflected rays. Use dotted lines to extend the reflected rays behind the mirror to locate and mark the position of the image, I. [4]

b Is the image real or virtual? ..... [1]

c What can you say about the distance of the image from the mirror?

..... [1]

17 A girl is standing 0.5 m away from a plane mirror.

a How far away is the girl from her image in the mirror?

distance from image = ... [1]

b How far must the girl walk away from the mirror to be 3 m from her image?

distance walked = ... [1]

18 Explain what is meant by the term 'lateral inversion'.

.....

..... [2]

19 A boy looks at the reflection of his digital watch in a plane mirror and thinks the time is 10:11.

What is the correct time? ..... [2]

20 The letter **N** is reflected in a plane mirror. Sketch the image.

[2]

21 What happens to a ray of light when it passes from air into a different material, such as glass or water?

.....

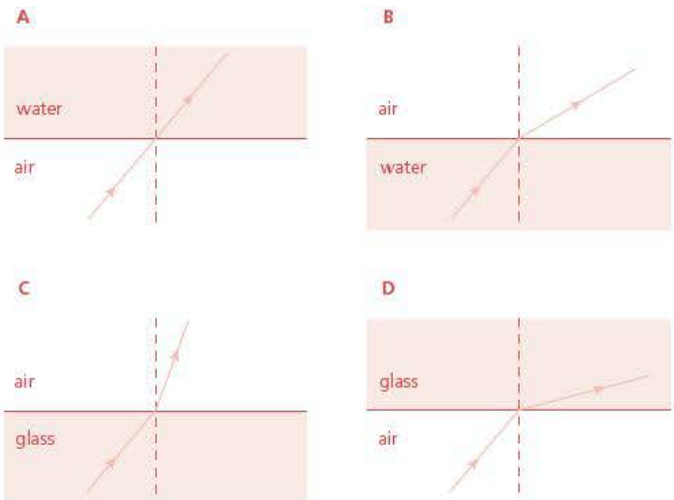
..... [2]

22 Use the following words to fill in the spaces in the paragraph below.

away from	denser	normal	normally	optically	towards

A ray of light is bent ..... the normal when it enters an optically ..... medium and ..... the ..... when it enters an ..... less dense medium. When a ray strikes a surface ..... it is not refracted. [3]

23 Which diagram shows the ray of light refracted correctly?



[1]

24 When sunlight falls on a triangular glass prism a band of colours (called a spectrum) is obtained.

a Explain why.

.....

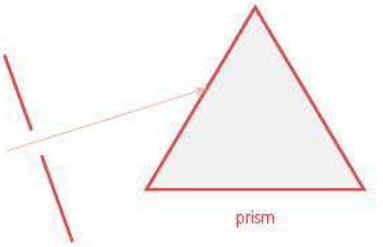
..... [2]

b Write down the colours of the spectrum, in order of diminishing wavelength.

.....

..... [3]

c Sketch the path of red and blue rays of light through the prism.



[3]

d Is the red or the blue ray refracted most? ..... [1]

e What does the term 'monochromatic' mean?

..... [1]

25 Explain what is meant by 'total internal reflection'.

.....

.....

..... [3]

26 Use the following words to fill in the spaces in the paragraph below.

centre	F	focus	parallel	principal	refracted	thin	top	two	undeviated

The image of an object formed by a ..... converging lens can be found by drawing ..... of the following three rays:

- a ray from the top of the object ..... to the principal axis of the lens which is refracted through the principal .....
- a ray from the top of the object which passes ..... through the optical ..... , C, of the lens
- a ray from the ..... of the object through the principal focus, ... , which is ..... parallel to the ..... axis of the lens. [5]

27 An object is placed 15 cm from a converging lens of focal length 12 cm. What form will the image take?

Circle one of the following:

A virtual, erect and larger

B real, inverted and smaller

C real, inverted and the same size

D real, inverted and larger [1]

28 How could you estimate the focal length of a converging lens?

.....

..... [2]

29 A small lamp is placed at the principal focus of a converging lens. What type of beam will be produced by the lens? ..... [1]

30 This question is about electromagnetic waves.

a Name **four** properties that are common to all types of electromagnetic wave.

1 .....

2 .....

3 .....

4 ..... [4]

b What type of electromagnetic wave is used in:

i intruder alarms ..... [1]

ii cooking ..... [1]

iii detecting broken bones ..... [1]

iv remote controllers for TVs ..... [1]

v luggage screening at airports ..... [1]

vi mobile phones? ..... [1]

31 Which of the waves in the box below:

a has the longest wavelength ..... [1]

b has the highest frequency ..... [1]

c is the most penetrating? ..... [1]

infrared light	blue light	X-rays	radio waves

32 What is the risk associated with and a precaution that can be taken when:

a using a mobile phone .....

..... [3]

b taking a medical X-ray photograph? .....

..... [2]

Extended

33 Light travels at a speed of 3×10^8 m/s in air. Calculate the speed of light in:

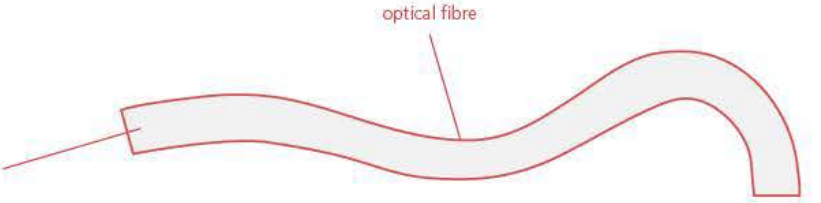
a glass of refractive index 3/2

b water of refractive index 4/3.

speed of light in glass = ... [3]

speed of light in water = ... [3]

34 An optical fibre is made of glass of refractive index 1.5. Sketch the path of a ray that undergoes total internal reflection in the optical fibre.



[2]

35 Water has a critical angle of 49°.

a Sketch what happens to a ray of light incident on a water/air boundary at the critical angle.

[2]

b Calculate the refractive index of water using the equation $n = 1/\sin c$.

refractive index = ... [2]

36 The critical angle for light travelling in a certain liquid is 52°. Calculate the refractive index of the liquid.

refractive index = ... [2]

37 Two converging lenses are available, with focal lengths of 5 cm and 50 cm. Which lens would you choose for use as a magnifying glass?

..... [1]

38 Identify the following waves as transverse or longitudinal:

a sound ..... [1]

b red light ..... [1]

c X-rays ..... [1]

d water ..... [1]

e radio ..... [1]

f ultrasonic ..... [1]

39 The speed of light in air is 3×10^8 m/s.

a Calculate the wavelength in air of violet light of frequency 7.5×10^{14} Hz.

wavelength of violet light = ... [2]

b Calculate the wavelength in air of red light of frequency 4.3×10^{14} Hz.

wavelength of red light = ... [2]

c Circle the one of the following that does not change when red light enters glass.

A speed

B frequency

C wavelength [1]

40 A sound wave has a wavelength of 20 cm and a speed of 330 m/s.

a Calculate the frequency of the sound wave.

frequency of wave = ... [2]

b State a typical value for a sound wave of:

i audible frequency ..... [1]

ii ultrasonic frequency ..... [1]

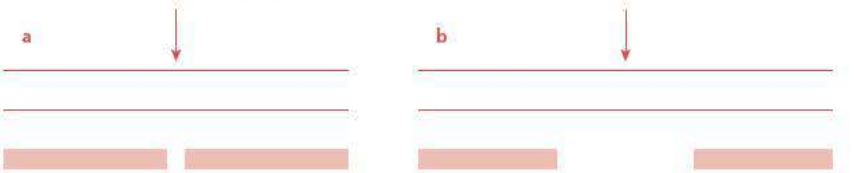
41 If 8 seconds elapse between a lightning flash and the clap of thunder, how far away is the storm? (Sound travels at 330 m/s.)

distance of storm = ... km [3]

Exam focus

Core

1 In a ripple tank experiment, straight waves are incident on a barrier with a gap.



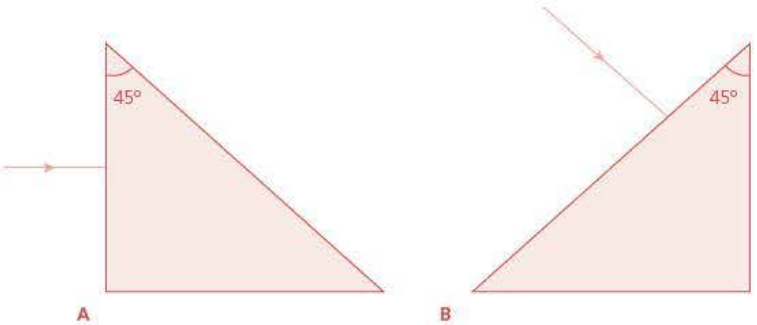
On the diagrams on page 57, draw the wave pattern after the waves pass through:

a a gap that is narrow compared with the wavelength [3]

b a gap that is wide compared with the wavelength. [3]

[Total: 6]

2 Right-angled glass prisms A and B are made of glass that has a critical angle of 42°.



a Complete the path of the rays through prisms A and B. [5]

b Name an instrument that would use prisms in orientation:

i A..... [1]

ii B..... [2]

[Total: 8]

3 Draw a half-size ray diagram to locate the image of an object placed on the principal axis, 10 cm from the optical centre of a thin converging lens of focal length 5 cm.

a Mark the position of the principal foci, optical centre, object and image on your diagram. [4]

b How far from the lens is the image formed? ..... [1]

c What is the size of the image compared to that of the object? ..... [1]

[Total: 6]

4 Sailors on a ship hear the echo of their foghorn from a cliff, 3 s after it sounded.

a If the sound travels at 330 m/s, work out the distance of the ship from the cliff.

distance of ship from cliff = ... [3]

b If the ship moves 165 m towards the cliff, what will be the time interval between the sounding of the foghorn and its echo reaching the ship?

time interval = ... [3]

[Total: 6]

5 The speed of sound in air is 330 m/s.

a How far does a sound travel in air in a time interval of 3 ms?

distance = ... [2]

b Sound takes 0.15 ms to travel down an iron bar of length 0.9 m. Find the speed of sound in iron.

speed = ... [2]

c Describe an experiment to determine the speed of sound in air. [4]

.....

.....

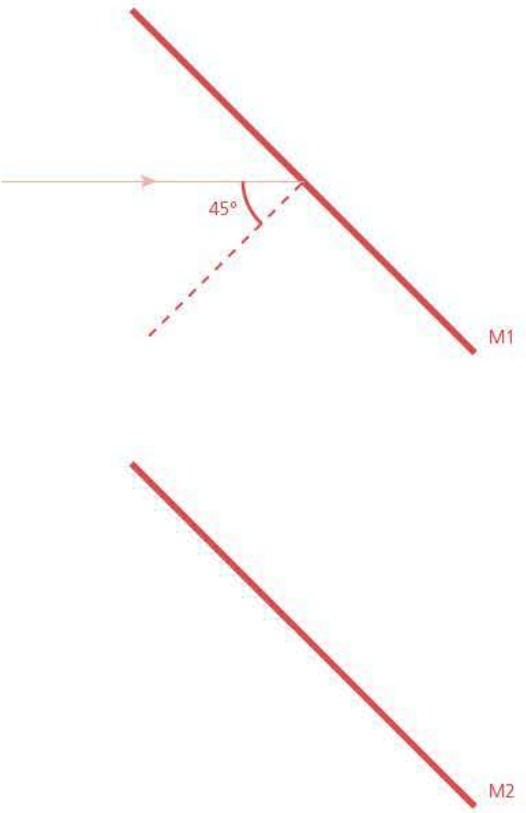
.....

.....

[Total: 8]

Extended

6 A ray of light is incident at 45° on mirror M1. It is reflected and strikes a second mirror M2. M2 lies parallel to M1.



a Continue the path of the ray on the diagram to show how it is reflected from M2. *[4]*

b For your diagram in part **a**, write down:

i the angle of reflection at M2 = ... *[1]*

ii the type of instrument in which this arrangement of mirrors could be used.

..... *[1]*

iii What advantage would the instrument have if the separation of M1 and M2 was increased?

..... *[1]*

c Circle **two** of the following statements that are true.

The image in a plane mirror is:

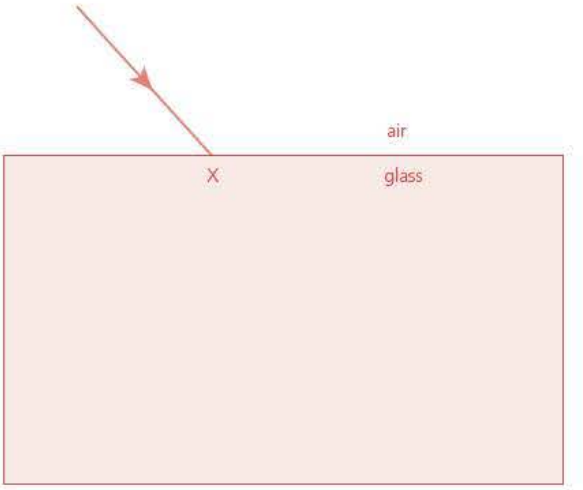
A as far behind the mirror as the object is in front **B** smaller than the object

C real **D** virtual **E** inverted *[2]*

[Total: 9]

7 A ray of light is incident as shown on a parallel-sided glass block.

a Draw the normal to the block at the point X. Sketch the path of the ray through the block and out the other side. Mark the angle of incidence, *i*, and the angle of refraction, *r*, on the diagram.



[4]

b What can you say about the direction of the ray when it leaves the block?

.....

..... *[2]*

c If the angle of incidence is 30° and the refractive index of the glass block is 1.5, calculate the angle of refraction at X.

angle of refraction = ... *[4]*

[Total: 10]

8 A small insect is viewed with a magnifying glass of focal length 4 cm. The insect is 2 cm from the lens.

a Draw a ray diagram to locate the image of the insect.

[5]

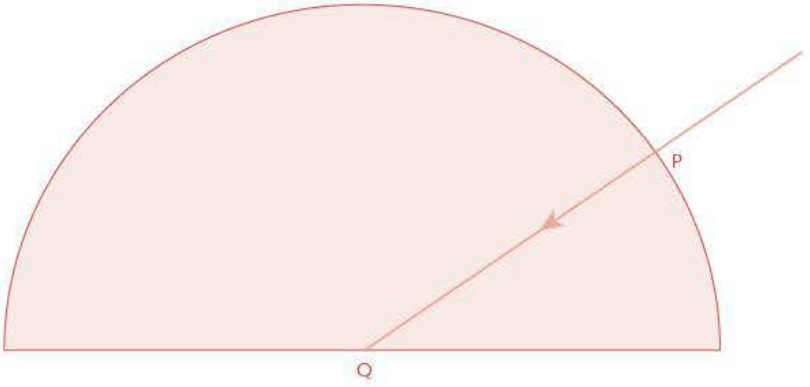
b What is the distance, v, of the image from the lens?

v = ... *[1]*

c Is the image real or virtual? ..... *[1]*

[Total: 7]

9 A laser directs a narrow beam of light along a radius of a semicircular glass block of refractive index 1.5, as shown.



a The light is not refracted when it enters the glass at P because:

..... *[1]*

b Draw in the normal at Q and measure the angle of incidence, i, at Q.

i = ... *[2]*

c Calculate the critical angle for the glass, using the equation:

$$\sin c = \frac{(\sin 90°)}{n}$$

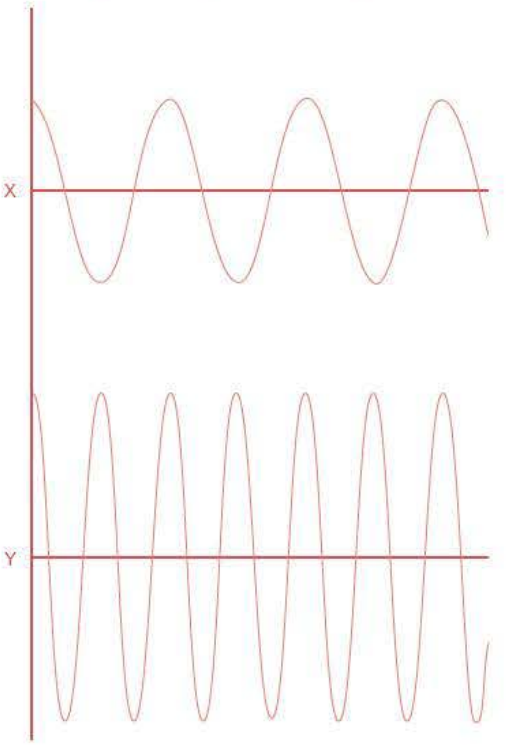
where n is the refractive index of the glass.

critical angle = ... [3]

d Draw in the path of the ray after it reaches Q. [2]

[Total: 8]

10 Two musical notes X and Y are represented by the following waveforms.



a Which of X and Y has:

i the higher frequency ..... [1]

ii the longer wavelength ..... [1]

iii the louder sound? ..... [1]

b Explain what is meant by 'compression' and 'rarefaction' in a sound wave.

.....

.....

.....

.....

..... [3]

c If the distance between two consecutive compressions of a sound a wave is 0.85 m and the speed of sound in the medium is 340 m/s, calculate the following:

i wavelength = ... [1]

ii frequency = ... [2]

[Total: 9]

11 In a medical ultrasound imaging system, ultrasonic pulses from a transducer placed on the patient's skin are reflected from an internal organ. The pulses travel at 1400 m/s through the body. There is a 40 μs time delay between the transmitted and reflected pulse arriving back at the transducer.

a How deep inside the body is the reflecting organ?

depth = ... [4]

b State the relationship between the speed, frequency and wavelength of a wave.

..... [1]

c Work out the wavelength of ultrasonic waves of frequency 10^6 Hz travelling at 1400 m/s.

wavelength = ... [2]

[Total: 7]

6 Electricity and magnetism

Core

1 Fill in the gaps in the sentences below using the following words:

attract demagnetised permanent pole repel soft south steel

A bar magnet has a north ..... and a ..... pole. Like poles ..... and unlike poles ..... . Magnetic materials, such as iron, which are easily magnetised and easily ..... , are termed ..... . Hard magnetic materials, such as ..... , are used in ..... magnets. [4]

2 The magnetic field around a bar magnet can be visualised as magnetic field lines.

a Describe an experiment which can be used to find the pattern of field lines around a bar magnet.

..... [3]

b Sketch the pattern of magnetic field lines around a bar magnet, marking on N and S poles.

[3]

3 Circle **two** of the following materials that a magnet would not attract.

A iron

B aluminium

C steel

D copper [2]

4 Give **two** ways by which a magnet could be made from a steel bar.

.....

..... [2]

5 When the following charges are brought close together, do they attract or repel each other?

a + + ... [1]

b − − ..... [1]

c + − ..... [1]

6 Explain in terms of electron movement what happens when a Perspex rod is charged positively by being rubbed with a cloth.

.....

..... [2]

7 Draw a circuit diagram containing a battery, an ammeter and two lamps which are connected in **a** series, **b** parallel.

On each diagram mark with an arrow the direction of conventional current, and place the ammeter so that it measures the total current from the battery.

a Series circuit

b Parallel circuit

[4]

[4]

8 Explain the difference between alternating current (a.c.) and direct current (d.c.).

.....

..... [4]

9 A certain type of lamp reaches its full brightness when a 12 V battery is connected across it. What can you say about the brightness of such lamps when:

a a 12 V battery is connected across two of the lamps connected in series

..... [1]

b a 12 V battery is connected across two of the lamps connected in parallel

..... [1]

c a 6 V battery is connected across two of the lamps connected in parallel?

..... [1]

10 This question is about electrical resistance.

a Write down the relationship between potential difference, current and resistance.

..... [2]

b Describe an experiment to determine the resistance of a wire using a voltmeter and an ammeter.

.....

.....

.....

..... [4]

11 What is the p.d. across a 4Ω resistor when there is a current of 0.3 A in it?

p.d. across resistor = ... [1]

12 There is a current of 2 A in a lamp when a p.d of 12 V is applied across it. Calculate the resistance of the lamp.

resistance of the lamp = ... [2]

13 A p.d. of 1.5 V is applied across a resistor of 5Ω. Calculate the current in the resistor.

current in the resistor = ... [2]

14 A p.d. of 1.5 V is applied across two resistors of value 6Ω and 9Ω connected in series.

Calculate:

a the total resistance

total resistance = ... [2]

b the current

current = ... [2]

c the p.d. across the 6Ω resistor

p.d. across 6Ω resistor = ... [2]

d the p.d. across the 9Ω resistor.

p.d. across 9Ω resistor = [2]

15 Circle the statement that is false for a series circuit.

A The current at every point is the same.

B The sum of the p.d.s across each component equals the total p.d. across the supply.

C The combined resistance of the resistors is less than the sum of the individual resistors.

D A complete circuit is needed for there to be a current. [1]

16 Circle the statement that is incorrect for an electrical appliance.

A A fuse protects the appliance.

B A fuse should be placed in the live wire.

C A fuse should be placed in the neutral wire.

D The metal case should be earthed. *[1]*

17 Give **two** examples of:

a input transducers

1 .....

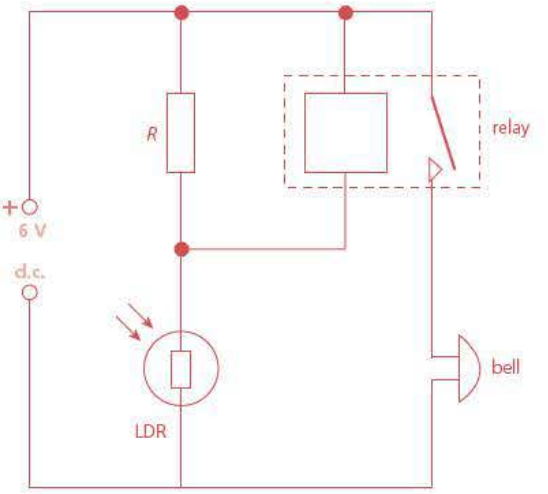
2 ..... *[2]*

b output transducers.

1 .....

2 ..... *[2]*

18 A light-dependent resistor (LDR) in series with a resistor is used in a potential divider across a d.c. supply to operate a relay and a bell as shown.



When light falls on the LDR, its resistance and the p.d. across it fall.

a State what happens to the following:

i the p.d. across *R*, when light falls on the LDR

..... *[1]*

ii the relay, when the p.d. across it reaches its operating p.d.

..... *[1]*

iii the bell, when the relay reaches its operating p.d. when light falls on the LDR.

..... *[1]*

b Suggest a use for the circuit.

..... *[1]*

Extended

19 Explain why:

a metals are good electrical conductors

.....

..... [2]

b plastics are good electrical insulators.

.....

..... [2]

20 A positively charged rod is brought near to a negatively charged electroscope and is then removed without touching it. What happens to the leaf of the electroscope?

Circle the correct answer.

The leaf of the electroscope:

A rises more and stays at that deflection

B rises more and then returns to its previous deflection

C falls and stays at that deflection

D falls and returns to its previous deflection [1]

21 Make a sketch showing the electric field lines:

a between two oppositely charged parallel metal plates

[3]

b around a small isolated positive point charge.

[3]

22 The current in a circuit is 5 A. Work out how much charge passes any point in the circuit in:

a 4 seconds

charge = ... *[2]*

b 2 minutes

charge = ... *[2]*

23 Find the current in a circuit when:

a 30 C of charge flows past a point in a circuit in 15 s

current = ... *[2]*

b 60 C of charge flows in 1 minute.

current = *[2]*

24 Circle the statement that is false for an electric circuit.

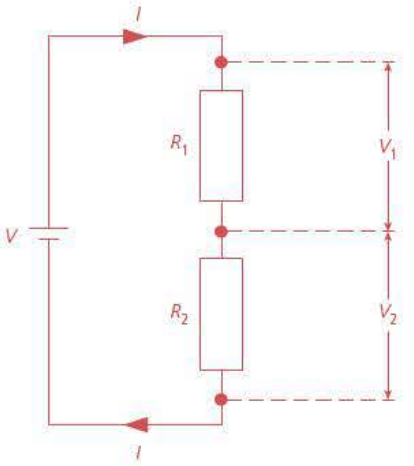
A Conventional current flows in a circuit from the positive terminal of a supply to the negative terminal.

B A complete circuit is needed for current to flow.

C Electrons flow in the same direction as the conventional current.

D Electrons flow in the opposite direction to the conventional current. *[1]*

25 A potential divider circuit is shown below.



a Circle the correct answer.

The ratio $\frac{V_1}{V_2}$ of the p.d.s across the two resistors R_1 and R_2 is given by:

A $R_1 + R_2$ **B** $\frac{R_1}{R_2}$ **C** $\frac{R_2}{R_1}$ **D** $\frac{1}{R_1}$ *[1]*

b If $R_1 = 5\,\Omega$, $R_2 = 15\,\Omega$ and $V_1 + V_2 = 10\,V$, calculate **i** V_1 and **ii** V_2.

i V_1 = ... *[2]* ii V_2 = ... *[2]*

26 The p.d. across a device is 6V. How much electrical energy does it convert to other forms when:

a a charge of 0.5C passes through it b the current is 3A for 20s?

energy = ... *[2]* energy = ... *[3]*

27 A battery supplies 48J of energy to a device in 10 seconds. If the p.d. across the device is 12V, calculate:

a the charge flowing through the device in the 10 seconds

charge = ... *[2]*

b the current in the device.

current = ... *[2]*

28 A number of 1.5 V cells are available.

a How could you produce a 6 V battery from them?

..... [2]

b How much electrical energy will the 6 V battery supply when it drives 2 C around a complete circuit?

electrical energy = ... [2]

29 Write down the name and symbol of the unit used to measure the following.

a charge ..... [1]

b current ..... [1]

c e.m.f. ..... [1]

d potential difference ..... [1]

e resistance ..... [1]

30 A p.d. of 6 V is applied across two resistors of value 4 Ω and 12 Ω connected in parallel.

Calculate:

a the total resistance

total resistance = ... [4]

b the current from the battery

current from battery = ... [2]

c the current in the 4 Ω resistor

current in 4 Ω resistor = ... [2]

d the current in the 12 Ω resistor

current in 12 Ω resistor = ... [2]

31 Sketch how the current varies with the p.d. across:

a an ohmic conductor

[3]

b a filament lamp.

[3]

32 State how the resistance varies with current in:

a an ohmic conductor ..... [1]

b a filament lamp. ..... [1]

33 State how the resistance of a wire changes if:

a its length is doubled ..... [1]

b its length is halved ..... [1]

c its cross-sectional area is halved ..... [1]

d its cross-sectional area is doubled. ..... [1]

34 Circle the statement that is false for a parallel circuit.

A The current from the source equals the sum of the currents in each branch.

B The p.d. across each component is less than the total p.d. across the supply.

C The combined resistance of resistors is less than that of the resistors individually.

D A complete circuit is needed for there to be a current. [1]

35 Sketch the *I–V* curve for a semiconductor diode.

[3]

36 A washing machine is rated at 10 A, 240 V. Work out:

a the power of the washing machine

power = ... [2]

b the energy supplied to the washing machine in 40 minutes.

energy supplied = ... [2]

37 A 2 kW heater is connected to a 250 V supply. Work out:

a the energy supplied to the heater when it is switched on for 2 hours

energy supplied = ... [2]

b the current in the heater.

current = ... [2]

38 The current in a resistor of 800 Ω is 0.5 A. If all the electrical energy is transferred to thermal energy in the resistor, work out:

a the rate of production of thermal energy

rate of production of thermal energy = ... [2]

b the thermal energy produced in the resistor in 5 minutes

thermal energy produced = ... [2]

39 Should a 3 A or a 13 A fuse be used for a 600 W electric motor connected to a 240 V supply?

size of fuse = ... [2]

40 Four appliances are plugged into a power board which is protected by a 13 A fuse and connected to a 240 V supply. The appliances are rated at 1.5 kW, 1.0 kW, 500 W and 300 W.

How many of the appliances can be turned on together without the fuse blowing?

Circle the correct answer.

A 1 **B** 2 **C** 3 **D** 4 *[3]*

41 Explain why a semiconductor diode can be used as a rectifier.

.....

..... *[3]*

42 Explain the difference between analogue and digital voltages.

.....

..... *[2]*

43 State whether the following devices are analogue or digital.

a a variable resistor ..... *[1]*

b a switch ..... *[1]*

c a logic gate ..... *[1]*

d a variable potential divider ..... *[1]*

44 Logic gates are used in digital electronics.

a Give the symbol for a NOT gate.

[1]

b Describe the function of a NOT gate in digital electronics.

..... *[2]*

45 Give the symbols for the following logic gates.

a OR *[1]*

b NOR *[1]*

c AND *[1]*

d NAND *[1]*

46 The truth table for an AND gate is given below.

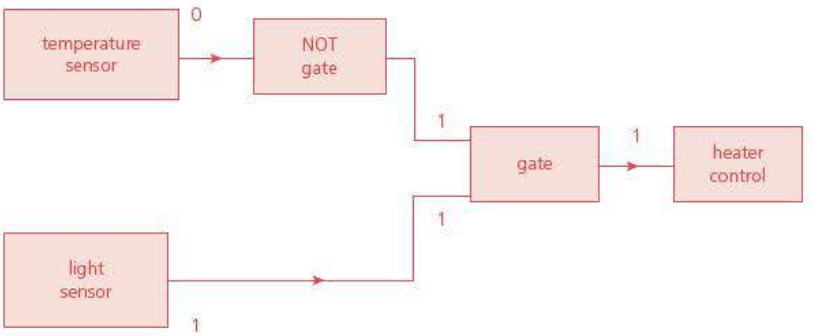
A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

What will be the output when:

a one of the inputs is high ..... [1]

b both inputs are high? ..... [1]

47 The control system shown in the block diagram is to be used to switch on a heater when it is light and the temperature drops too low. Complete the diagram with the name of a suitable logic gate.



[2]

Exam focus

Core

1 This question is about the hazards of electricity.

a Suggest **two** checks you could make to reduce the risk of receiving an electric shock from an old electrical appliance.

1 .....

2 ..... [2]

b Why is the severity of an electric shock increased by damp conditions?

.....

..... [2]

c What causes a wire to overheat?

..... [2]

d What purpose does a fuse serve in a circuit?

.....

..... [2]

[Total: 8]

Extended

2 20 party lights are connected in parallel and operated by a 24 V power supply.

a Explain why it is preferable to connect party lights in parallel rather than in series.

.....

..... [2]

b If each light has a resistance of 80 Ω, work out:

i the current in each lamp

current = ... [2]

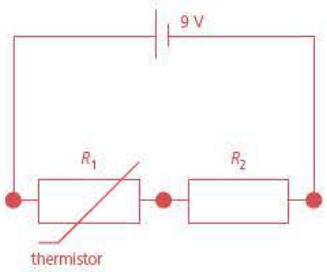
ii the total current drawn from the power supply

total current from supply = ... [2]

iii the total current drawn from the power supply if one lamp fails

total current if one lamp fails = ... [2]

3 A p.d. of 9 V is applied across a potential divider circuit containing a thermistor, R_1, and a fixed resistor, R_2.



a Find the current in the circuit and the values of the p.d.s across R_1 and R_2 when $R_1 = 18\,\Omega$ and $R_2 = 12\,\Omega$.

i current = ... [2]

ii p.d. across R_1 = ... [2]

iii p.d across R_2 = ... [2]

b Find the current in the circuit and the values of the p.d.s across R_1 and R_2 when $R_1 = 33\,\Omega$ and $R_2 = 12\,\Omega$.

i current = ... [2]

ii p.d. across R_1 = ... [2]

iii p.d across R_2 = ... [2]

c How does the p.d. across the thermistor change as its resistance increases? ..... [1]

[Total: 13]

4 A p.d. of 6 V is connected across a potential divider consisting of a light-dependent resistor (LDR) and a resistor R.

a If the resistance of the LDR decreases, what happens to:

i the current in the circuit ..... [1]

ii the p.d. across R ..... [1]

iii the p.d. across the LDR? ..... [1]

b If $R = 10\,\Omega$, what will be the resistance of the LDR when the p.d. across it is 3.5 V?

resistance of LDR = ... [4]

[Total: 7]

7 Electromagnetic effects

Core

1 Circle the correct answer.

An e.m.f. is induced in a conductor when it:

A moves parallel to magnetic field lines

B moves across magnetic field lines

C is at rest in a magnetic field. *[1]*

2 Explain why electrical energy is distributed around the country using a.c. rather than d.c.

.....

..... *[2]*

3 Circle the correct answer.

The main function of a step-up transformer is to:

A increase power

B increase current

C increase voltage

D decrease resistance of a circuit. *[1]*

4 240 V a.c. is applied to the primary coil of a transformer which has 600 turns. The secondary coil has 30 turns.

a Work out the p.d. across the secondary coil.

p.d. across secondary = ... *[3]*

b State the type of transformer. ..... *[1]*

5 An electromagnet is constructed by winding a solenoid on a soft iron core. Give **two** ways by which the strength of the electromagnet could be increased.

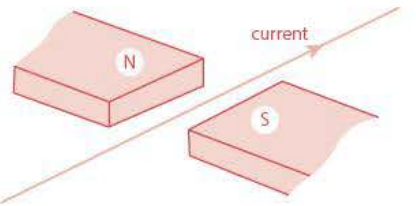
1 .....

2 ..... [2]

6 Sketch the field around a current-carrying straight wire, showing the direction of the current and of the field lines.

[3]

7 A straight, current-carrying wire is placed between the poles of a magnet as shown.



a In which direction does the wire move? ..... [1]

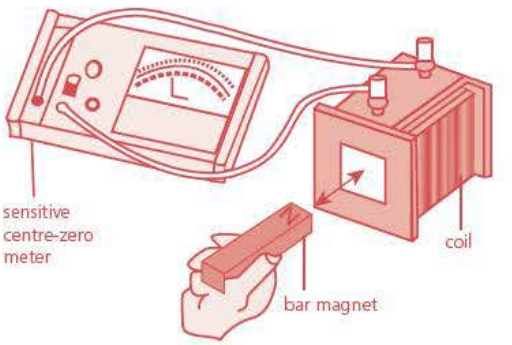
b In which direction does the wire move when:

i the current direction is reversed ..... [1]

ii the magnetic field direction is reversed? ..... [1]

Extended

8 A bar magnet is moved in and out of a coil that is connected to a sensitive centre-zero meter, as shown.



The meter needle swings to the left when the magnet is moving towards the coil. State how the needle behaves when the bar magnet:

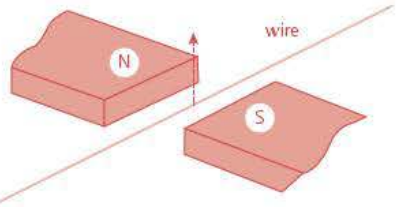
a is at rest inside the coil ..... [1]

b is moving back out of the coil ..... [1]

c moves more quickly towards the coil ..... [2]

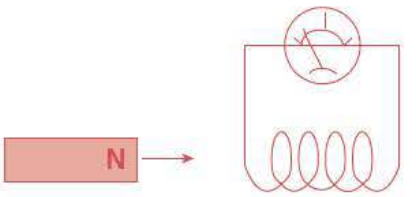
d is at rest and the coil is moved away from the magnet. ..... [2]

9 A straight wire is moved upwards through a horizontal magnetic field. Mark on the sketch the direction in which current will flow in the wire if it is connected to a complete circuit.



[2]

10 A bar magnet is moved towards a coil of wire connected to a meter, as shown.



An e.m.f. is induced in the coil and current flows in the circuit making the coil act like a magnet. What will be the polarity of the end of the coil nearest the magnet when the N pole of the magnet:

a approaches the coil ..... [1]

b is pulled back from the coil ..... [1]

c is at rest and the coil is moved towards the magnet? ..... [1]

11 When a coil is rotated in a magnetic field an e.m.f. is generated.

Circle the incorrect answer.

The size of the induced e.m.f. increases as:

A the speed of the coil increases

B the number of turns on the coil decreases

C the strength of the magnetic field increases. [1]

12 Electricity transmission lines deliver 80 kW of power to the consumer at a voltage of 400 000 V. The resistance of the transmission lines is 15 Ω.

a What is the current in the transmission lines?

current = ... [2]

b What is the rate of loss of energy from the transmission lines?

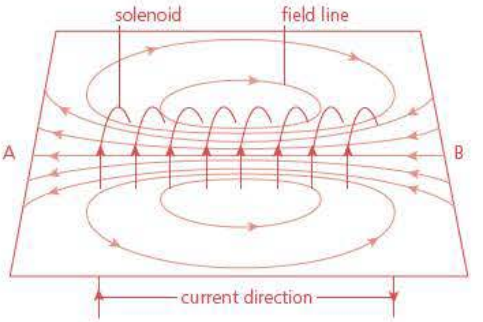
rate of energy loss = ... [2]

13 Give **two** ways by which a bar magnet can be demagnetised.

1 .....

2 ..... [2]

14 The pattern of magnetic field lines in and around a solenoid is shown below.



a A solenoid, like a bar magnet, has a N and a S pole.

i Is position **A** or **B** nearest to the S pole of the solenoid? ..... [1]

ii How could the polarity of the solenoid be reversed? ..... [1]

iii In which direction would the N pole of a plotting compass point if placed at A? ..... [1]

b State where the magnetic field is:

i strong ..... [1]

ii weak. ..... [1]

15 The current in the primary of a step-down transformer is 0.15 A. The input to the primary is 240 V and the output from the secondary is 12 V.

What size current can be drawn from the secondary if the transformer is:

a 100% efficient in transferring power

secondary current = ... [3]

b 90% efficient in transferring power?

secondary current = ... [2]

16 Circle the correct answer.

Cathode rays consist of:

A light rays emitted by a fluorescent screen **B** beams of fast moving electrons

C beams of ions **D** X-rays [1]

17 List **four** properties of cathode rays.

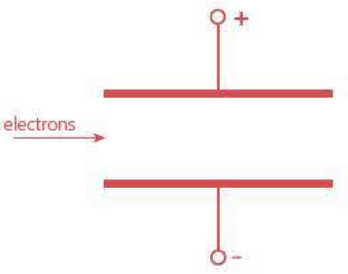
1 .....

2 .....

3 .....

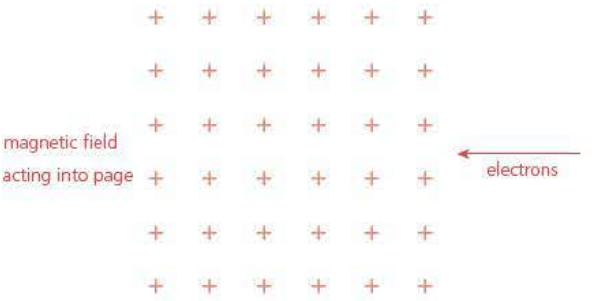
4 ..... [4]

18 A high-speed electron beam enters a region of uniform electric field, produced by a p.d. applied to two parallel metal plates, as shown.



In which direction are the electrons deflected? ..... [1]

19 A high-speed electron beam enters a region of uniform magnetic field, as shown.

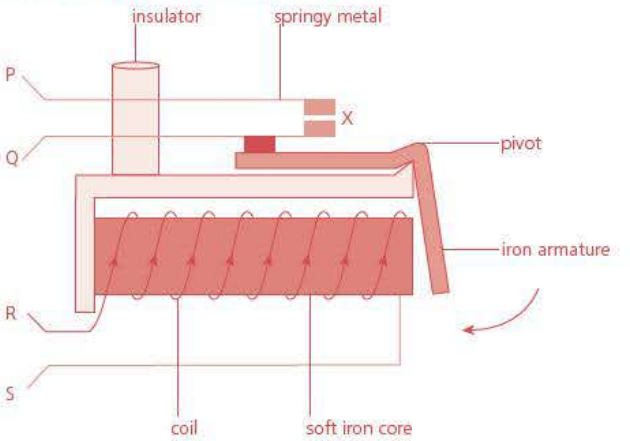


In which direction are the electrons deflected? ..... [1]

Exam focus

Core

1 The diagram represents a relay when it is switched off.



a What will cause the relay to switch on? .....

..... [1]

b What role does the soft iron core play in the relay? .....

..... [2]

c What happens at X when the relay is switched on? .....

..... [2]

d Give a reason for using a relay. .....

..... [2]

[Total: 7]

2 An electromagnet, P, is used to lift some scrap iron. The table shows the maximum load that can be lifted when there are different currents in the electromagnet.

current/A	0.5	1.0	1.5	2.0	2.5
load/N	20	40	60	80	100

a Draw a load/current graph with current along the *x*-axis and load along the *y*-axis.

[4]

b Is your graph linear? ..... [1]

c What current is needed to lift a load of 30 N? ..... [1]

d What maximum load could be lifted by a current of 1.25 A? ..... [1]

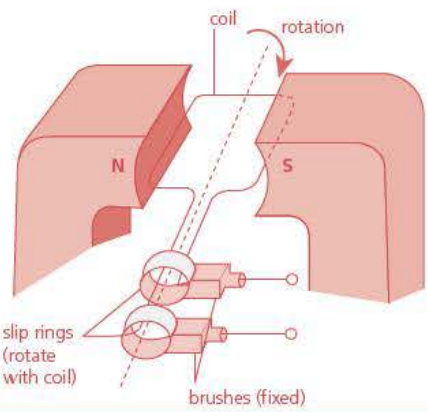
e A second electromagnet, Q, has the same design as electromagnet P but has twice the number of turns on the coil. What advantages would electromagnet Q have over electromagnet P?

..... [1]

[Total: 8]

Extended

3 The diagram shows a simple generator.



a Explain the function of the slip rings.

..... [1]

b Sketch the voltage output of the generator against time for one revolution of the coil.

[3]

c Will the coil be horizontal or vertical when the induced voltage is a maximum?

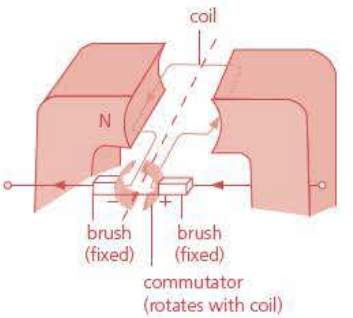
..... [1]

d What type of current would there be in a circuit connected to the brushes?

..... [1]

[Total: 6]

4 In a d.c. electric motor a current-carrying coil attached to a commutator is mounted between the poles of a magnet. The coil experiences a couple.



a Explain the effect of the couple on the coil.

..... [1]

b How could the size of the couple on the coil be increased?

..... [3]

c What effect would increasing the couple on the coil have?

..... [1]

d What is the function of the commutator?

.....

..... [2]

[Total: 7]

5 When 250 V a.c. is applied to the primary coil of a step-up transformer, the output from the secondary coil is 1000 V. The current in the primary is 0.8 A and there are 100 turns on the primary coil.

a Work out the number of turns on the secondary coil.

number of turns on secondary = ... [3]

b Evaluate the power input to the transformer.

power input = ... [2]

c If no energy were lost in the transformer, what would be the current in the secondary coil?

current in secondary coil = ... [3]

d What effect does the resistance of the coil windings have on the efficiency of a transformer?

..... [1]

[Total: 9]

8 Atomic physics

Core

1 State which of the following radiations:

α-particles β-particles γ-rays

a causes most ionisation ..... [1]

b causes least ionisation ..... [1]

c is most penetrating ..... [1]

d is least penetrating ..... [1]

e requires a few millimetres of aluminium to stop it ..... [1]

f travels only a few centimetres in air ..... [1]

2 State which of the following radiations:

α-particles β-particles γ-rays

a are electrons ..... [1]

b are helium nuclei ..... [1]

c are electromagnetic waves ..... [1]

d are easily deflected by an electric field ..... [1]

e are not deflected by a magnetic field ..... [1]

f have a positive charge ..... [1]

g have a negative charge ..... [1]

3 α, β and γ are ionising radiations.

a Explain what happens when ionisation of a gas occurs.

.....

..... [2]

b How may ionisation be detected?

..... [1]

4 Circle the incorrect statement.

Radioactive decays:

A occur randomly over space and time

B are affected by chemical interactions

C result from unstable nuclei

D produce α-particles, β-particles and γ-rays

E are spontaneous and cannot be controlled. *[1]*

5 Explain the meaning of the terms:

a half-life

.....

..... *[3]*

b background radiation.

.....

..... *[3]*

6 Radioactive carbon-14 has a half-life of 5700 years. A 10 g piece of wood found in an archaeological excavation gives a count-rate of 80 counts/minute. A 10 g sample of a piece of wood cut recently from a living tree has a count-rate of 160 counts/minute.

Estimate the age of the wood taken from the excavation.

estimated age of wood = ... *[2]*

7 A radioactive source gives a count-rate of 240 counts/s at the start of an experiment and a count-rate of 60 counts/s after 80 minutes. Work out the half-life of the source.

half-life = ... *[3]*

8 Circle the incorrect statement.

A All the positive charge of an atom is concentrated in the nucleus.

B Most of the mass of an atom is concentrated in the nucleus.

C Negatively charged electrons orbit the nucleus.

D The nucleus has a very small size compared with the whole atom.

E The nucleus consists of protons and neutrons which have a similar mass.

F Electrons and protons have equal and opposite charge.

G Electrons and neutrons have the same charge.

H The mass of an electron is very small compared with the mass of a proton or neutron. *[1]*

9 If the charge on an electron is denoted as being –1 unit, state the charge on:

a a proton ..... *[1]*

b a neutron ..... *[1]*

c an α-particle ..... *[1]*

d a β-particle ..... *[1]*

e a γ-ray ..... *[1]*

f a helium nucleus. ..... *[1]*

10 The nucleon number of an atom is written as *A*, the proton number as *Z* and the neutron number as *N*.

a Write down the relationship between *A*, *Z* and *N*.

..... *[1]*

b In terms of *A*, *Z* and *N*, how many electrons are there in a neutral atom?

..... *[1]*

c An atom X may be represented in nuclide notation as ${}^{A}_{Z}X$. In this format, how would you represent the following?

i a helium atom ..... *[1]*

ii an electron ..... *[1]*

iii a neutron ..... *[1]*

11 Explain the term 'isotopes of an element'.

.....

..... *[3]*

12 Carbon exists as different isotopes.

a A neutral atom of one isotope of carbon has 6 protons, 6 electrons and 8 neutrons. Find the nucleon number for this isotope.

nucleon number = ... [1]

b A second isotope of carbon has a nucleon number of 12. For a neutral atom of this isotope, state the number of:

i protons ..... [1]

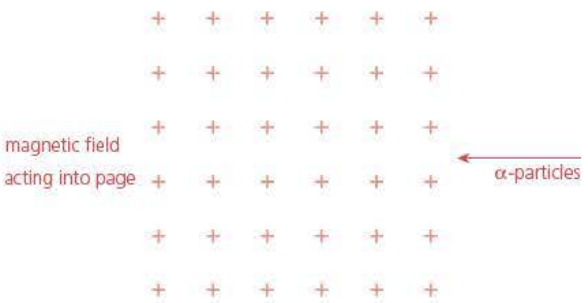
ii neutrons ..... [1]

iii electrons ..... [1]

c Will the two isotopes have the same chemical properties? ..... [1]

Extended

13 A beam of α-particles enters a region of uniform magnetic field, as shown.



In which direction would the α-particles initially experience a force? ..... [1]

14 In order to monitor paper quality in a factory, a radiation source is placed close to one side of a moving sheet of paper and a Geiger counter is placed on the opposite side.

a Explain what happens to the count-rate on the Geiger counter when the paper passing it:

i becomes thicker ..... [1]

ii becomes thinner. ..... [1]

b What type of radiation source should be used for this application? Explain your answer.

.....

..... [2]

15 In a famous experiment α-particles were fired at a thin metal foil. Outline how the behaviour of the α-particles provided evidence for the nuclear model of the atom.

.....

.....

..... [3]

16 The radioactive nuclide iodine-131 decays through β-particle emission as indicated in the equation below.

$^{131}_{53}I \rightarrow {}^{A}_{Z}Xe + {}^{0}_{-1}e$

a Find the values of *A* and *Z*.

i *A* = ... [1]

ii *Z* = ... [1]

b How many neutrons are there in the nucleus of an atom of iodine-131? ..... [1]

c What happens to the number of neutrons in the nucleus of an iodine-131 atom when it decays to xenon? ..... [2]

Exam focus

Core

1 Name **two** for each:

a dangers of ionising radiation

1 .....

2 ..... [2]

b uses of radioactive sources

1 .....

2 ..... [2]

c safety precautions that should be taken when handling radioactive materials.

1 .....

2 ..... [2]

[Total: 6]

Extended

2 Some large unstable nuclei undergo nuclear fission.

a Explain the term 'nuclear fission'.

.....

..... [2]

b The equation below represents what may happen when a nucleus of U-235 is struck by a neutron.

$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{A}_{56}Ba + {}^{90}_{Z}Kr + {}^{1}_{0}n + {}^{1}_{0}n$

Find the values of A and Z.

i A = ... [2]

ii Z = ... [2]

c Energy is released in nuclear fission.

i In what form does this energy appear?

..... [1]

ii How is the energy used in a nuclear power station?

..... [1]

3 In certain conditions some nuclei can undergo nuclear fusion.

a Explain the term 'nuclear fusion'.

.....

..... [2]

b One of the fusion reactions that occurs in the Sun is given by the following equation.

$^{3}_{2}\text{He} + {}^{3}_{2}\text{He} \rightarrow {}^{A}_{2}\text{X} + {}^{1}_{1}\text{H} + {}^{1}_{Z}\text{Y}$

Find the values of A and Z.

i A = ... [2]

ii Z = ... [2]

c Identify the nuclides:

i X ..... [1]

ii Y ..... [1]

d Energy is released in the fusion reactions that take place in the Sun. In what form is this energy apparent to us?

..... [1]

4 A very small amount of radioactive americium dioxide is used in a smoke detector.

The nuclide americium-241 decays to neptunium-237 as shown in the equation below:

$^{241}_{95}\text{Am} \rightarrow {}^{237}_{93}\text{Np} + {}^{A}_{Z}\text{X}$

a Find the values of A and Z.

i A = ... [2]

ii Z = ... [2]

b Name the particle $^{A}_{Z}\text{X}$ emitted in the decay process. ..... [1]

c State the function that X performs in the smoke detector.

..... [1]

[Total: 6]

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