CEDAR GIRLS' SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS 6091/01

Paper 1 Multiple Choice

1 September 2025

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

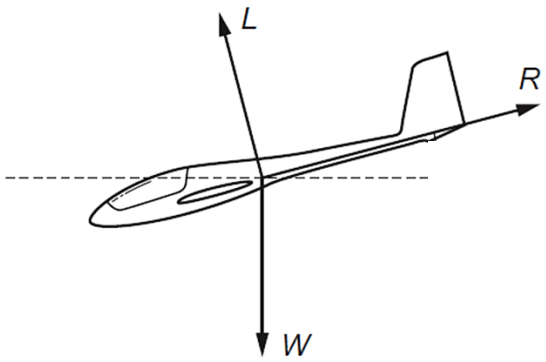
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

1 Which is the correct SI base unit expression for pressure?

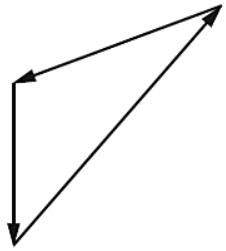
A (kg m)/s² **B** (kg m²)/s³ **C** kg/(m s²) **D** kg/(m² s)

2 A glider is descending at constant velocity. The diagram shows the directions of the lift *L*, air resistance *R* and weight *W* acting on the glider.



Which vector triangle could represent the forces acting on the glider?

A



B

C

D

3 In which row are quantities correctly categorised into scalar quantities and vector quantities?

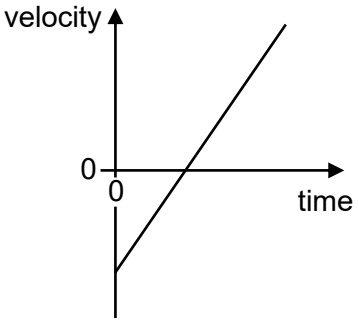
	scalar quantities	vector quantities
A	distance and energy	velocity and temperature
B	gravitational field strength and time	force and electric field strength
C	mass and energy	weight and acceleration
D	speed and moment	distance and force

4 A person stands on the edge of a sea cliff. The person throws a stone vertically upwards. Air resistance acting on the stone can be ignored.

The stone eventually hits the sea.

Which velocity–time graph best shows the motion of the stone from when it is released until it hits the sea?

A



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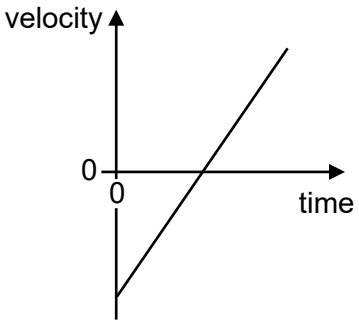

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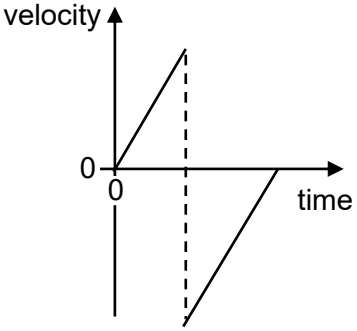
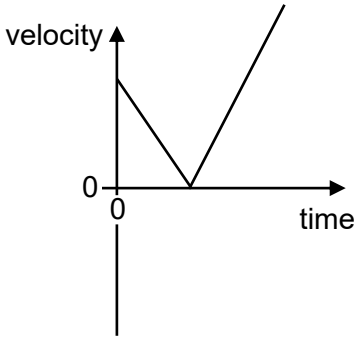
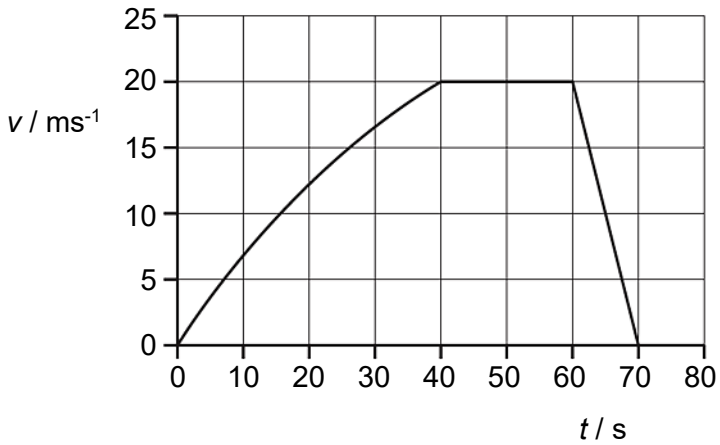


D



5 An object starts from rest at time $t = 0$ and moves in a horizontal line. The graph shows how the velocity v of the object varies with time.



What is the distance travelled by the object during the time that its acceleration is zero?

A 100 m **B** 400 m **C** 500 m **D** 800 m

6 On the asteroid Ceres, a stone dropped from rest from a height of 1.0 m would take 2.8 s to reach the surface of the asteroid.

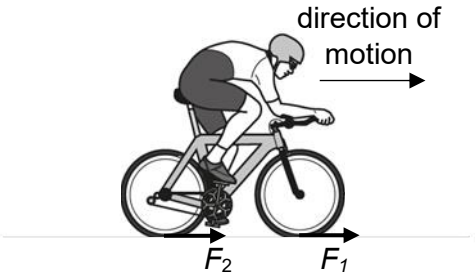
What would be the weight of a 70 kg astronaut on Ceres?

A 18 N **B** 70 N **C** 250 N **D** 700 N

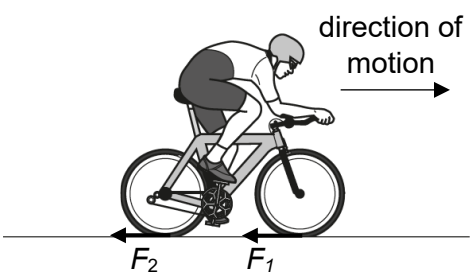
7 A race bicycle is accelerating along a level road.

Which diagram shows the direction of frictional force F_1 on the front wheel and the direction of frictional force F_2 on the rear wheel?

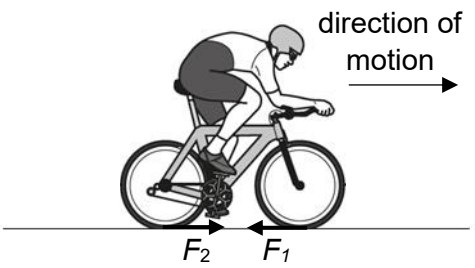
A



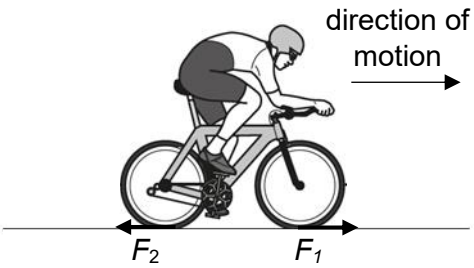
B



C



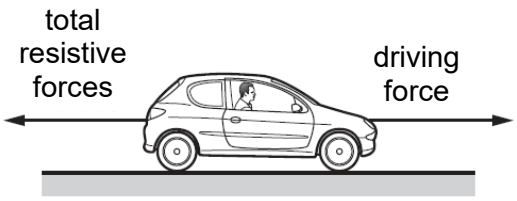
D



8 Each diagram illustrates a pair of forces of equal magnitude.

Which diagram gives an example of a pair of forces that is described by Newton's third law of motion?

A



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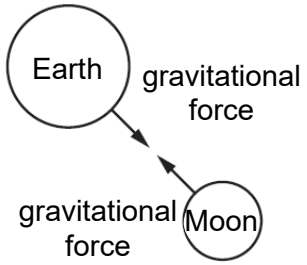

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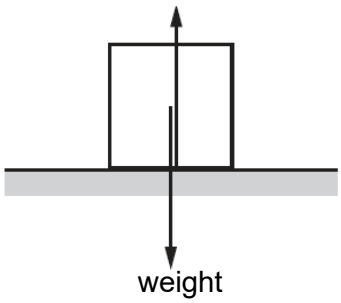
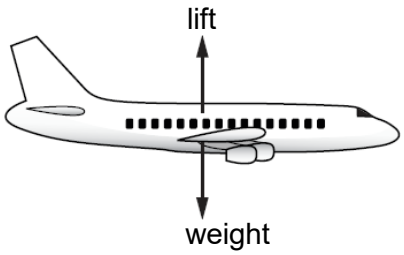
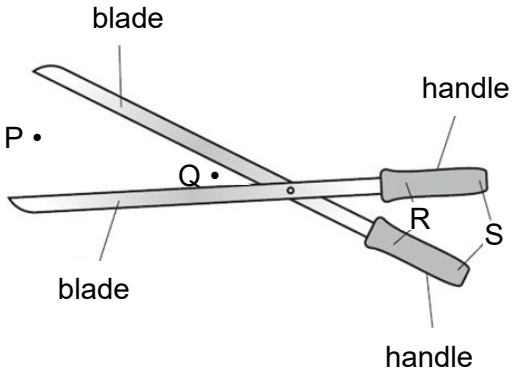


D



9 A pair of cutters is used to cut a rope.

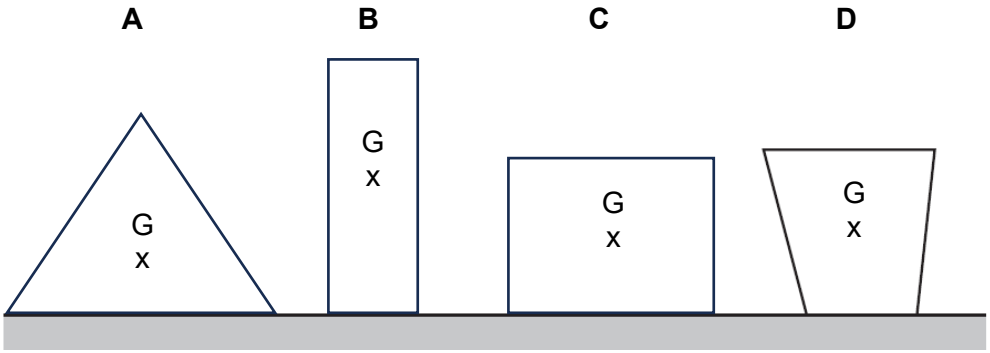


Where should the rope be positioned and at which labelled points should the hands be positioned to produce the greatest cutting force?

	rope position	hands position
A	P	R
B	P	S
C	Q	R
D	Q	S

10 Four objects of equal mass rest on a table. The centre of mass of each object is labelled G.

Which object is the most stable?



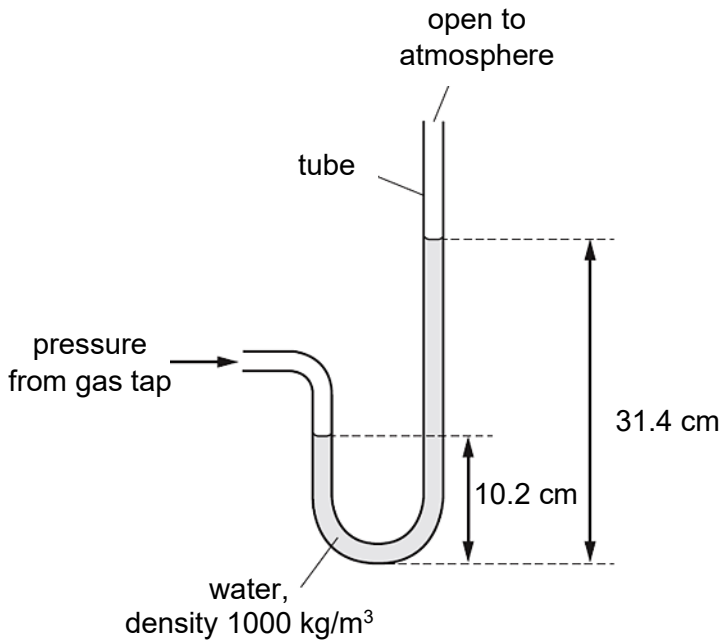
11 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 kg/m^3 and the density of alcohol is 800 kg/m^3.

What is the density of the mixture of volume 2.0 m^3?

A 850 kg/m^3 **B** 900 kg/m^3 **C** 940 kg/m^3 **D** 950 kg/m^3

12 One end of a U-shaped tube is attached to a gas tap, with its other end open to the atmosphere.

It contains water of density 1000 kg/m^3 and the heights of both sides of the water column are shown.

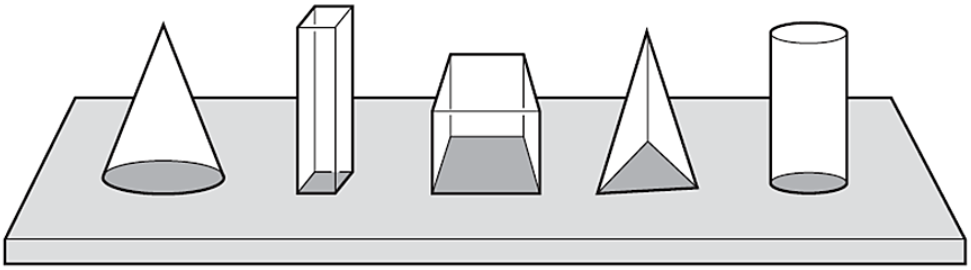


The atmospheric pressure is 101 kPa and the gravitational field strength is 10 N/kg.

What is the pressure of the gas from the gas tap?

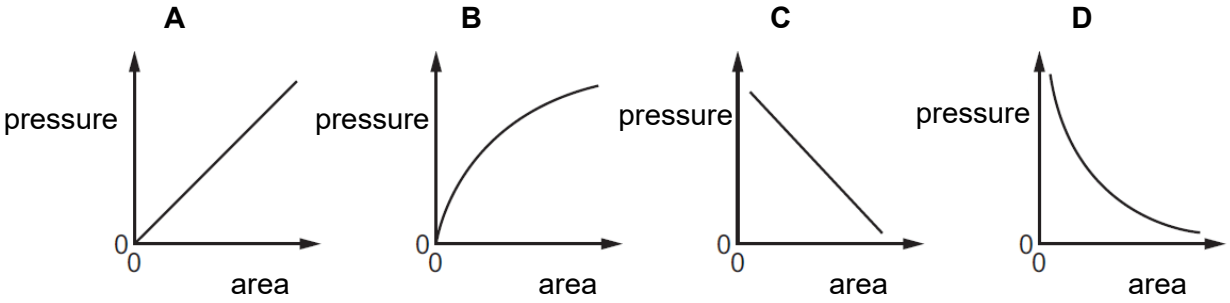
A 99 kPa **B** 100 kPa **C** 102 kPa **D** 103 kPa

13 Five blocks have the same mass but different base areas. They all rest on a horizontal table.



A graph is plotted to show the relationship between the pressure exerted on the table and the base area of the block.

Which graph shows this relationship?



14 A mass attached to the lower end of a spring oscillates up and down.

At which points in the path of the mass do the energy in gravitational potential store of the mass (E_g), the energy in elastic potential store in the spring (E_e) and the energy in kinetic store of the mass (E_k) have their highest values?

	E_g	E_e	E_k
A	bottom	middle	top
B	bottom	top	middle
C	top	bottom	middle
D	top	bottom	top

15 Which energy resource is non-renewable?

A geothermal

B natural gas

C solar

D tidal

16 Particles of dust, suspended in water, are viewed through a microscope. The particles can be seen to move irregularly.

This movement is due to

A convection currents in the water.

B evaporation of the water near the dust particles.

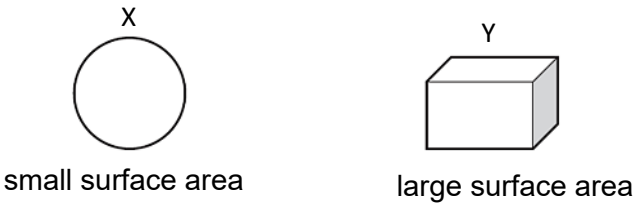
C gravitational forces acting on the particles of dust.

D water molecules hitting the dust particles in a random way.

17 Two samples of the same material have the same mass but different surface areas.

Each sample is heated to the same temperature and then left to cool to room temperature.

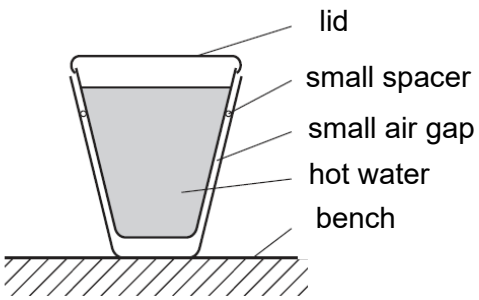
Each sample is allowed to cool to the same final temperature.



Which row correctly compares the decrease in energy in internal store and the initial rate of cooling for each sample?

	decrease in energy in internal store	initial rate of cooling
A	X loses more energy than Y	X cools down faster than Y
B	Y loses more energy than X	Y cools down faster than X
C	X and Y lose the same quantity of energy	X cools down faster than Y
D	X and Y lose the same quantity of energy	Y cools down faster than X

18 Two plastic cups are placed one inside the other. Hot water is poured into the inner cup and a lid is put on top as shown.



Which statement is correct?

A Heat loss by radiation is prevented by the small air gap.

B No heat passes through the sides of either cup.

C The bench is heated by convection from the bottom of the outer cup.

D The lid is used to reduce heat loss by convection.

19 A scientist wants to determine the specific latent heat of vaporisation of a liquid.

He pours the liquid into a vacuum flask and heats it with a 100 W heater. The mass of liquid in the vacuum flask when it starts to boil is 300 g. He continues to heat the liquid for a further 12 minutes, after which the mass of the remaining liquid is 100 g.

What is the specific latent heat of vaporisation of the liquid?
(Assume that all the energy supplied by the heater is used to vaporise the liquid.)

A 360 J/kg

B 6000 J/kg

C 240 000 J/kg

D 360 000 J/kg

20 A puddle of water is formed after a rain shower on a windy day.

Which statement explains the effect of the wind on the rate of evaporation of the water in the puddle?

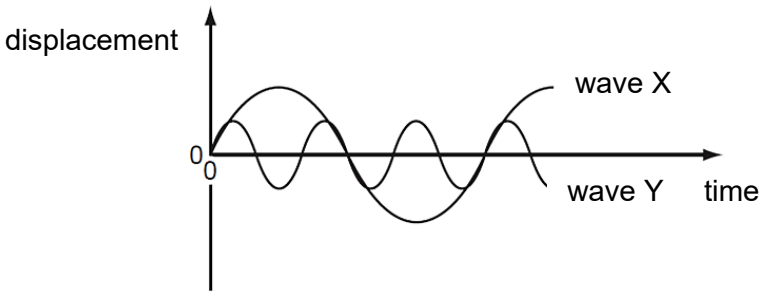
A The wind gives molecules in the water extra kinetic energy and so increases the rate of evaporation.

B The wind removes evaporated water from near the surface and so decreases the rate of evaporation.

C The wind removes evaporated water from near the surface and so increases the rate of evaporation.

D The wind takes energy from molecules near the surface and so decreases the rate of evaporation.

21 The diagram shows two waves X and Y.



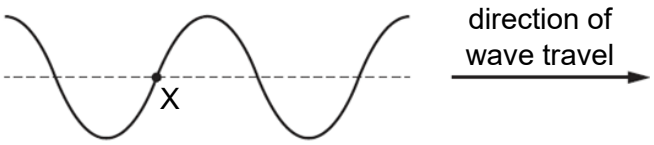
Wave X has amplitude 8 cm and frequency 100 Hz.

What are the amplitude and frequency of wave Y?

	amplitude / cm	frequency / Hz
A	2	33
B	2	300
C	4	33
D	4	300

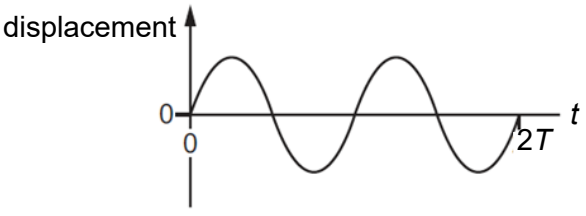
22 A transverse wave travels along a rope. The diagram shows the rope at time $t = 0$.

The wave is travelling from left to right. The period of the wave is T. One particle of the rope is labelled X.

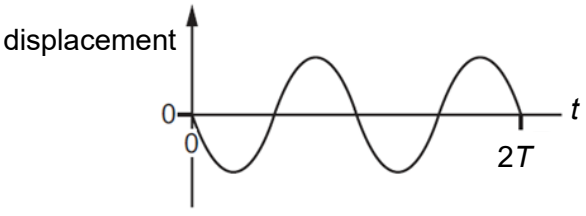


Which of the following shows the displacement-time graph of particle X between $t = 0$ and $t = 2T$?

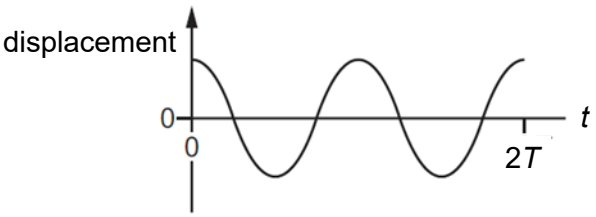
A



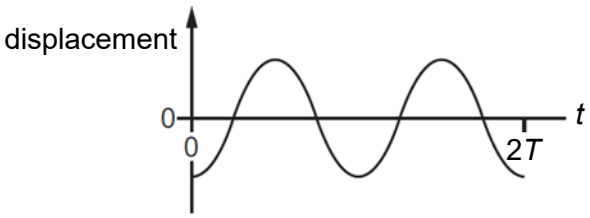
B



C



D



23 A man stands 110 m from a high wall. He makes a short, sharp sound and then hears an echo from the wall. The speed of sound in air is 330 m/s.

How long after making the sound does the man hear the echo?

A 0.33 s **B** 0.67 s **C** 1.5 s **D** 3.0 s

24 A fire alarm is not loud enough, and the pitch is too low. An engineer adjusts the alarm so that it produces a louder note of a higher pitch.

What effect does this have on the amplitude and on the frequency of the sound?

	amplitude	frequency
A	larger	greater
B	larger	smaller
C	smaller	greater
D	smaller	smaller

25 Visible light, X-rays and microwaves are all components of the electromagnetic spectrum.

Which statement about the waves is correct?

A In a vacuum, microwaves travel faster than visible light and have a shorter wavelength.

B In a vacuum, microwaves travel at the same speed as visible light and have a shorter wavelength.

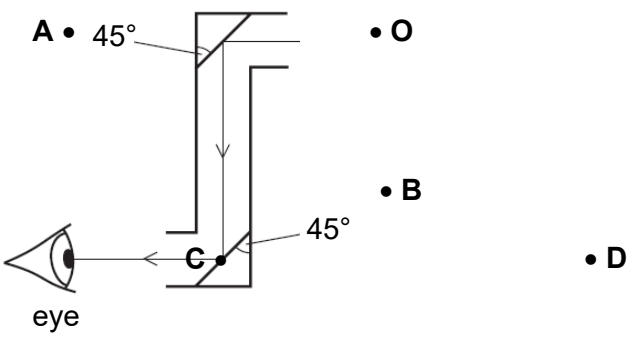
C In a vacuum, X-rays travel faster than visible light and have a shorter wavelength.

D In a vacuum, X-rays travel at the same speed as visible light and have a shorter wavelength.

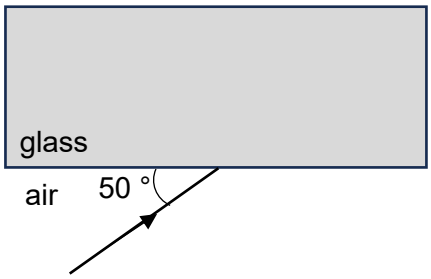
26 The diagram shows a child using a periscope to look at an object O on the other side of the wall.

The periscope has two plane mirrors.

At which position is the image of O seen?



27 A ray of light strikes the surface of a glass block as shown in the diagram.



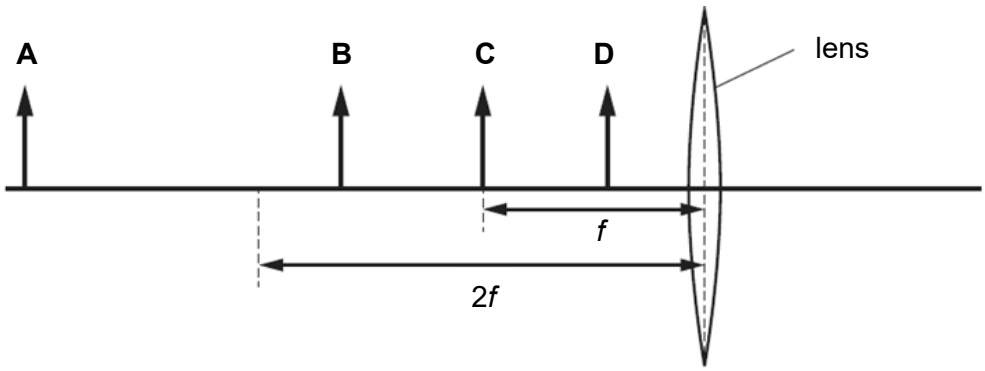
The speed of light in glass is 2.07×10^8 m/s.

How much the light ray will deviate when entering the glass?

A 13.7 ° **B** 23.7 ° **C** 26.3 ° **D** 31.9°

28 An object is placed in front of a converging lens. The lens has a focal length *f*.

In which labelled position should the object be placed in order to produce a real image of the object that is smaller than the object?



29 An electrostatically charged object will pick up small pieces of paper.

Which of the following will **not** pick up pieces of paper?

A an earthed metal rod rubbed with a duster

B a plastic comb pulled through dry hair

C a polythene rod rubbed with a woollen cloth

D a rubber balloon rubbed on a nylon shirt

30 Which statement describes the direction of an electric field at a point?

A the direction of the force on a negative charge

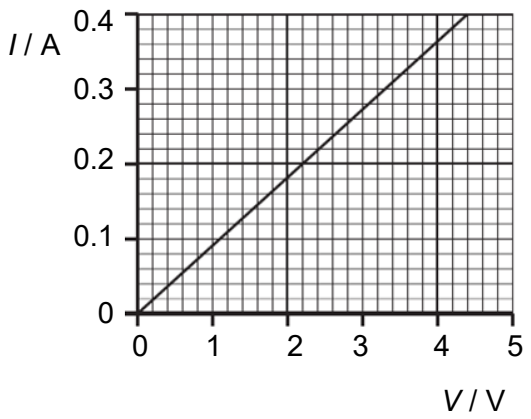
B the direction of the force on a north pole

C the direction of the force on a positive charge

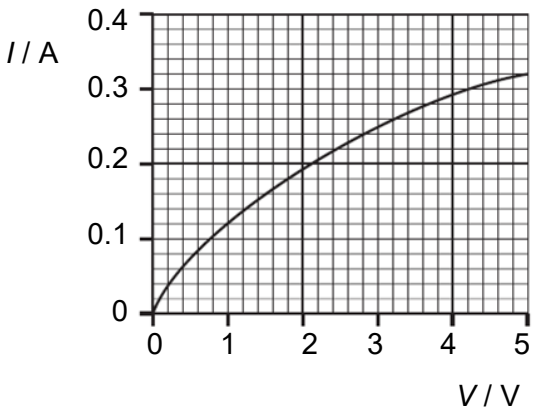
D the direction of the force on a south pole

31 A resistor and a filament lamp are connected in series with a power supply. The *I*–*V* characteristics of the resistor and of the lamp are shown below.

resistor



filament lamp



The potential difference (p.d.) across the resistor is 3.3 V.

What is the resistance of the lamp?

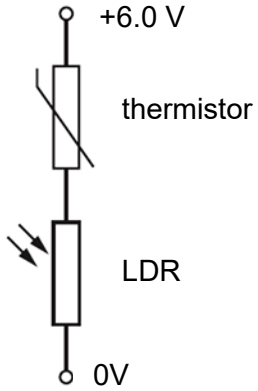
A 0.071 Ω **B** 4.2 Ω **C** 11 Ω **D** 14 Ω

32 Four lamps have filaments made from the same material. The lamps are connected in parallel across a battery.

Which filament lamp produces the most heat and light per second?

	length of filament	cross-sectional area of filament
A	l	A
B	$2l$	A
C	l	2A
D	$2l$	2A

33 A thermistor and a light-dependent resistor (LDR) are connected in series. A potential difference (p.d.) of 6.0 V is applied across them as shown.



The thermistor has a resistance of 6000 Ω in a cold room and 1000 Ω in a warm room. The LDR has a resistance of 2000 Ω in dim light and 500 Ω in bright light.

When is the p.d. across the LDR equal to 2.0 V?

A in a cold room with bright light

B in a cold room with dim light

C in a warm room with bright light

D in a warm room with dim light

34 With increasing hot weather due to climate change, an owner decided to install a 2.5 kW aircon unit to replace the two ceiling fans of 100 W each.

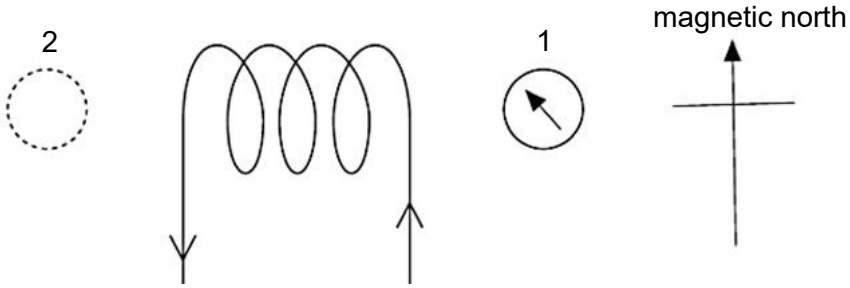
The aircon or the fans are switched on for 8 hours daily.

By just operating the aircon unit, what would be the additional cost that the owner needs to pay per week for the energy consumption if one kWh costs 30 cents?

A $38.64 **B** $40.32 **C** $42.00 **D** $45.36

35 A compass needle is placed near one end of a coil of wire at position 1.

When a current is passed through the coil, the compass needle points in the direction shown.



Which of the following will cause the needle of the compass to point closer to magnetic north?

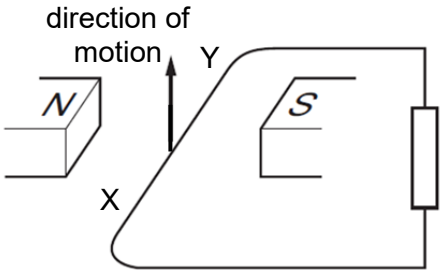
A Decreasing the current through the coil

B Increasing the current through the coil

C Moving the compass nearer to the coil

D Moving the compass to position 2

36 The diagram shows a wire XY moving upwards in a magnetic field.



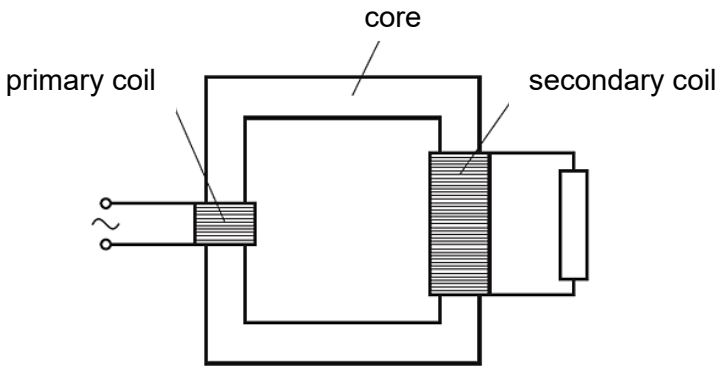
A current is induced in the wire.

The current-carrying wire XY experiences a force because of its interaction with the magnetic field.

Which row gives the direction of the induced current and the direction of the force experienced by the wire XY?

	direction of induced current	direction of force
A	from X to Y	downwards
B	from X to Y	upwards
C	from Y to X	downwards
D	from Y to X	upwards

37 The diagram shows the structure of a simple transformer.

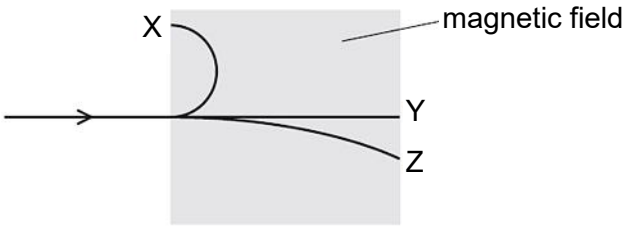


Which row shows the correct conditions for the efficiency of the transformer to be as high as possible?

	primary and secondary coils	material of core
A	thick copper wire	soft iron
B	thin copper wire	soft iron
C	thick iron wire	copper
D	thin iron wire	copper

38 The diagram represents the paths of three types of ionising radiation, X, Y and Z, through a magnetic field.

The three types of radiation are alpha, beta and gamma.



Which statement about the ionising radiation is correct?

A X is positively charged.

B Y is negatively charged.

C Z is the most ionising.

D X is the most penetrative.

39 When a nucleus of $^{238}_{92}$ U absorbs a slow neutron, it subsequently emits two β-particles.

What is the resulting nucleus?

A $^{239}_{90}$ Th **B** $^{239}_{94}$ Pu **C** $^{240}_{91}$ Pa **D** $^{240}_{93}$ Np

40 Which row correctly matches three radioactive sources to their uses?

	emits alpha-particles and has a long half-life	emits beta-particles and has a long half-life	emits gamma radiation and has a short half-life
A	monitoring the thickness of aluminium foil	smoke alarm	tracer to be injected to detect cancer
B	monitoring the thickness of aluminium foil	tracer to be injected to detect cancer	smoke alarm
C	smoke alarm	monitoring the thickness of aluminium foil	tracer to be injected to detect cancer
D	smoke alarm	tracer to be injected to detect cancer	monitoring the thickness of aluminium foil

END OF PAPER

2025 S4 Physics Prelim Mark Scheme

Paper 1

1	C	**11**	D	**21**	D	**31**	D
2	D	**12**	D	**22**	B	**32**	C
3	C	**13**	D	**23**	B	**33**	C
4	A	**14**	C	**24**	A	**34**	A
5	B	**15**	B	**25**	D	**35**	A
6	A	**16**	D	**26**	D	**36**	A
7	C	**17**	D	**27**	A	**37**	A
8	B	**18**	D	**28**	A	**38**	C
9	D	**19**	D	**29**	A	**39**	B
10	A	**20**	C	**30**	C	**40**	C

CEDAR GIRLS' SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR

CANDIDATE NAME	
CLASS	INDEX NUMBER

PHYSICS

6091/02

Paper 2 Structured and Free Response

28 August 2025

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer all questions. Write your answers in the spaces provided.

Section B
Answer **one** question. Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Section A		
1		**/ 7**
2		**/ 6**
3		**/ 7**
4		**/ 5**
5		**/ 7**
6		**/ 7**
7		**/ 7**
8		**/ 4**
9		**/ 10**
10		**/ 10**
Section B		
11		**/ 10**
12		**/ 10**
Deduction		
Total		**/ 80**

Section A

Answer **all** the questions in this section.

1 The resistive forces that act backwards on a car are air resistance and friction, as shown in Fig. 1.1.

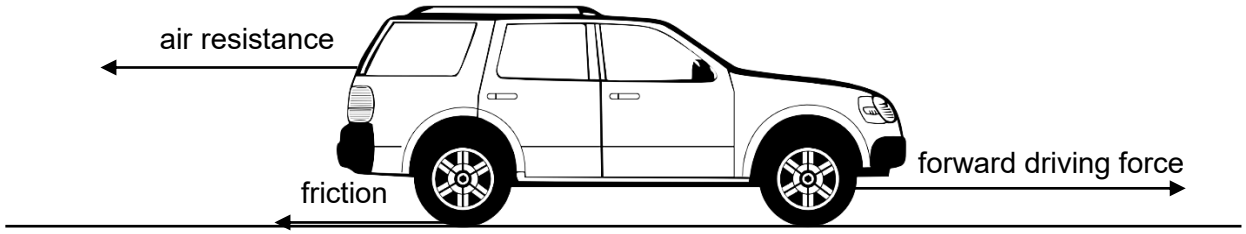


Fig. 1.1

Fig. 1.2 shows a graph of total resistive force that acts on the car against time *t*.

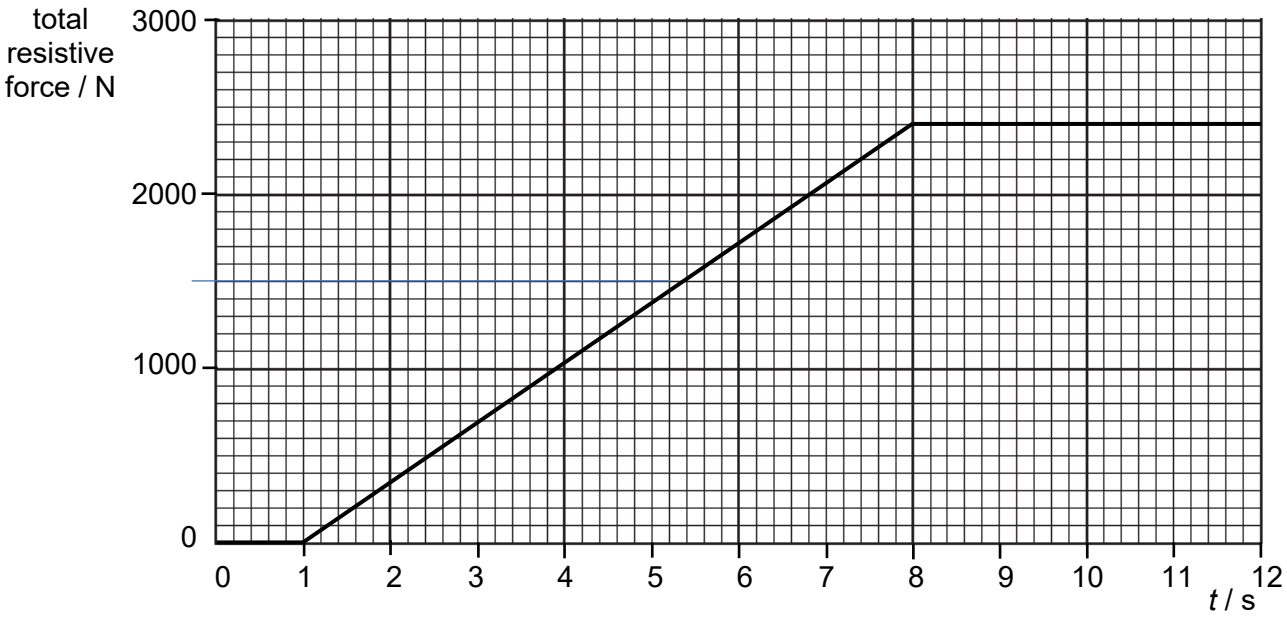


Fig. 1.2

The car is at rest at $t = 0$. The forward driving force acting on the car is zero until $t = 1.0$ s.

From $t = 1.0$ s until $t = 12$ s, the forward driving force has a constant value of 2400 N.

(a) (i) State the two time intervals when the resultant force acting on the car is zero.

..... [1]

(ii) Describe the motion of the car during these two intervals.

.....

……

……... [2]

(b) The car has a mass of 800 kg.

(i) Calculate the acceleration of the car at t = 3.0 s.

acceleration = …….. [2]

(ii) Calculate the value of t when the acceleration of the car is 0.50 m/s^2.

t = …….. [2]

[Total: 7]

2 Fig. 2.1 shows a barrier at the entrance to a car park. The wooden barrier arm has a weight of 60 N which acts through the centre of gravity at the position shown on Fig. 2.1.

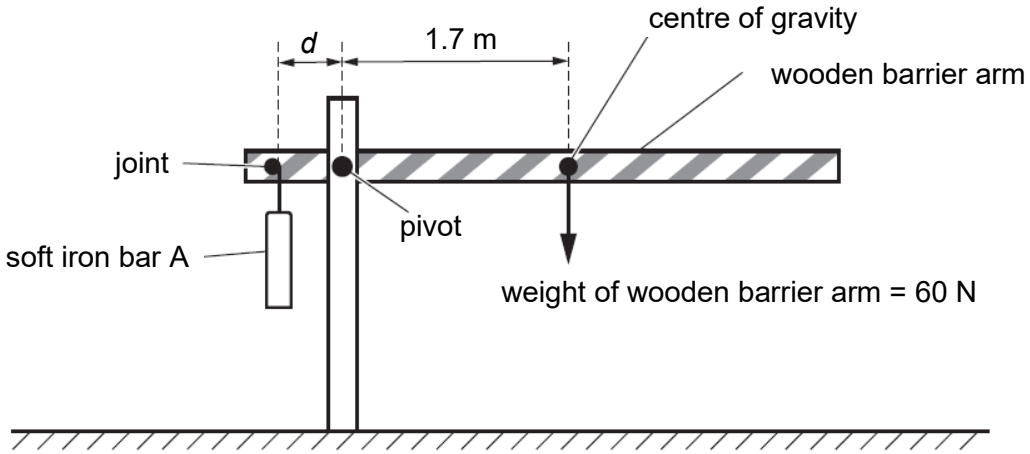


Fig. 2.1

(a) The wooden barrier arm is in equilibrium. The mass of the soft iron bar A is 23 kg.

The gravitational field strength is 10 N/kg.

Calculate *d*, the distance between the pivot and the joint holding the soft iron bar A.

d = ... [2]

(b) Fig. 2.2 shows a coil attached to a power supply placed below the soft iron bar A.

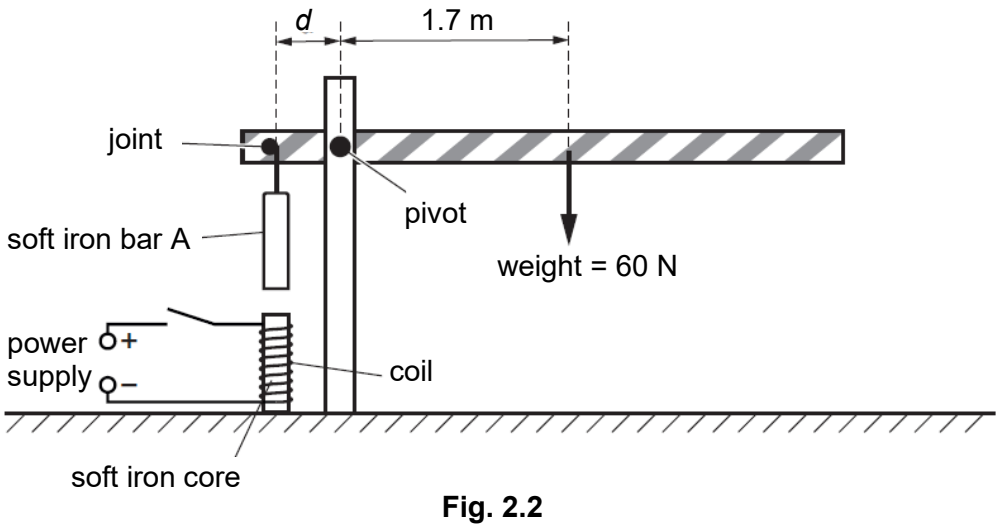


Fig. 2.2

(i) State and explain what happens to the wooden barrier arm when the switch in the coil circuit is closed.

…….....

…….....

.....

.....

..... [2]

(ii) A student suggests replacing the soft iron bar A with a steel bar of the same mass.

Explain why a steel bar is less effective than a soft iron bar in the barrier.

……

……..

……

……... [2]

[Total: 6]

3 At a sharp corner on a car racing circuit there is an escape lane as shown in Fig. 3.1.

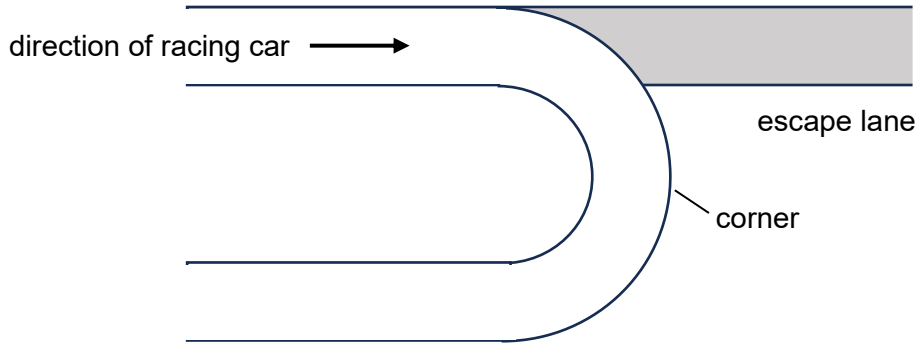


Fig. 3.1

The escape lane is a bed of small stones. The escape lane slopes upwards. A car of mass 700 kg approaches the escape lane at a speed of 40 m/s. The brakes fail and the car stops in the escape lane.

(a) Show that the energy in kinetic store of the car is 560 kJ when it approaches the escape lane.

[1]

(b) Describe what happens to the energy in kinetic store of the car as it stops.

……..

……..

……..

……..... [2]

(c) The car comes to rest 40 m along the escape lane, having risen through a vertical distance of 3.0 m. The gravitational field strength is 10 N/kg.

Calculate

(i) the change in energy in the gravitational potential store of the car when it stops in the escape lane,

change in energy = …….…….. [1]

(ii) the average frictional force exerted on the car in the escape lane.

force = …….…….. [2]

(d) The frictional force exerted on the car in the escape lane is not constant.

Suggest one factor, apart from the car's speed, that affects the value of the frictional force.

……..

…… [1]

[Total: 7]

4 A small aircraft takes off from the horizontal deck of a ship.

Before taking off, the aircraft is held in place by a holdback bar.

When the holdback bar is released, the aircraft is pulled along the deck by a steam-powered piston as shown in Fig. 4.1.

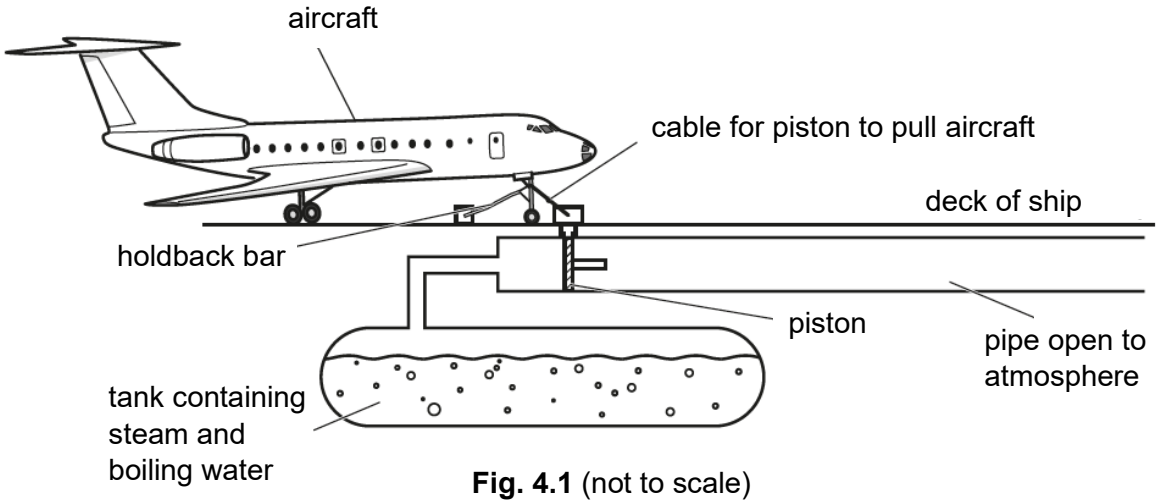


Fig. 4.1 (not to scale)

The steam exerts a high pressure on the piston.

(a) **(i)** Define *pressure*.

……

…….. [1]

(ii) Explain, using ideas about particles, how the steam creates a pressure on the piston.

……

……

…….. [2]

(b) When the pressure is high enough, the holdback bar is released. The steam pushes the piston along the pipe shown in Fig. 4.1.

The piston has a cross-sectional area of 0.30 m^2.

The pressure of the steam in the tank is 2.1×10^6 Pa and atmospheric pressure is 1.0×10^5 Pa.

Determine the resultant force on the piston caused by the pressure difference.

force = …….. [2]

[Total: 5]

5 Fig. 5.1 shows a connection to the internet made from a remote station A using a satellite above the Earth's surface.

Data is sent between stations A and B using an electromagnetic wave which travels to and from the satellite.

Station B is connected directly to the internet using optical fibre.

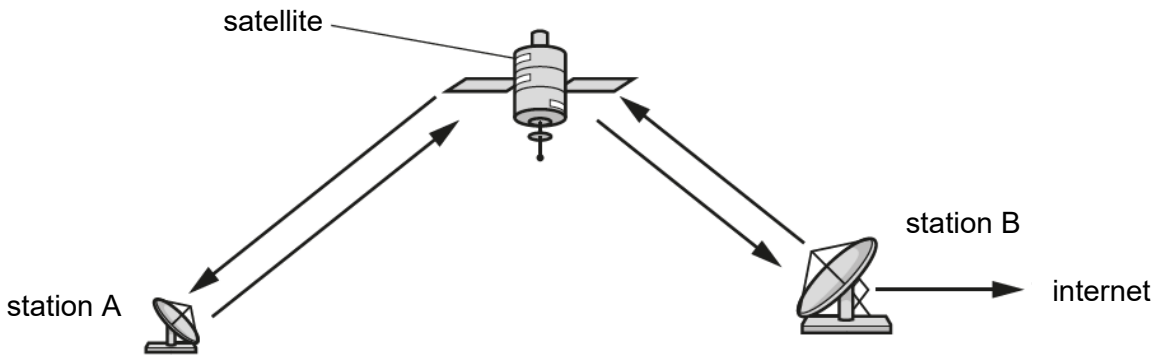


Fig. 5.1 (not to scale)

(a) State the type of electromagnetic (e.m.) wave used for this satellite data transmission.

……

…… [1]

(b) The frequency of this e.m. wave is 18 GHz.

Stations A and B are each 560 km from the satellite.

Calculate the number of wavelengths present in the e.m. wave as the data travels 560 km from A to the satellite.

number of wavelengths = …….. [2]

(c) The same data can be sent from A to B in a shorter time along the surface of the Earth using infrared waves and visible light to carry the information in optical fibres.

(i) Suggest one other advantage of using optical fibres to connect stations A and B directly.

……

…….. [1]

(ii) The critical angle of the glass in an optical fibre is 45°.

Calculate the refractive index of the glass.

refractive index = …….…….. [2]

(iii) Fig. 5.2 shows an optical fibre made of the glass described in **(ii).**

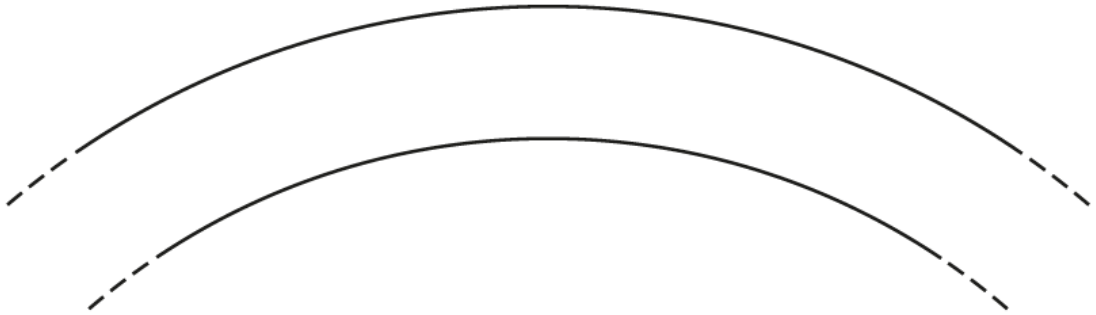


Fig. 5.2

On Fig. 5.2, draw accurately a ray of light in the fibre undergoing total internal reflection. [1]

[Total: 7]

6 A filament lamp is placed above a shiny metal surface, as shown in Fig. 6.1.

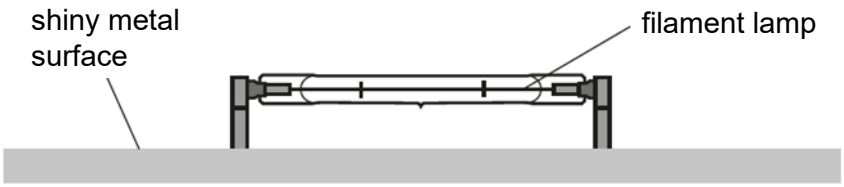


Fig. 6.1

A student reads in a textbook that a light-emitting diode (LED) is more efficient than a filament lamp.

(a) Suggest why the efficiency of a filament lamp is very low.

……..

…… [1]

(b) The student considers replacing the filament lamp shown in Fig. 6.1 with an LED of the same brightness.

Data about the filament lamp and a suitable LED are shown in Table 6.1.

Table 6.1

	Input power / W	Energy efficiency
Filament lamp	120	6.2%
LED	15	

The LED emits the same amount of visible light as the filament lamp.

Using this information and the data in Table 6.1, determine the efficiency of the LED.

efficiency = ……..…….. [2]

(c) The filament lamp is connected to the live and neutral wires in the mains supply.

The earth wire in the mains supply is connected to the shiny metal surface shown in Fig. 6.1.

There is a fuse in the live wire.

By accident, the live wire touches the shiny metal surface.

(i) Describe what then happens.

……

……

……

……[2]

(ii) In another similar lamp, the fuse is wrongly connected to the earth wire.

Explain why a person who touches the shiny metal surface is not protected when the live wire touches the shiny metal surface.

……

……

……

…….. [2]

[Total: 7]

7 Fig. 7.1 shows a wireless charging plate used to charge the battery in a mobile phone. The coil of wire is part of an electric circuit.

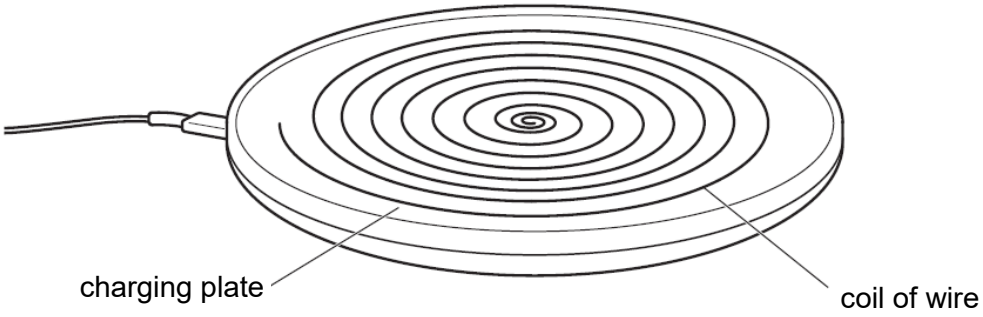


Fig. 7.1

The charging plate is connected to a 240 V a.c. power supply. The power supply is turned on.

(a) A mobile phone is placed on the charging plate as shown in Fig. 7.2. The coil in the mobile phone is part of a separate circuit that charges the battery.

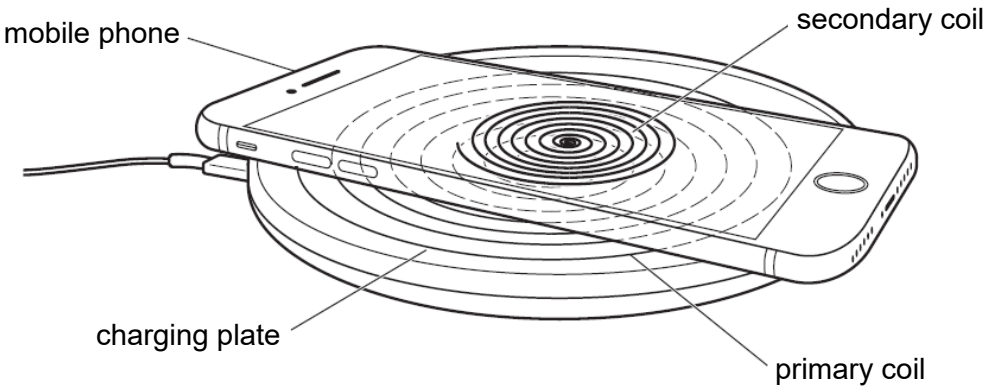


Fig. 7.2

The coil in the charging plate and the coil in the mobile phone act like a transformer.

(i) Explain why there is a current in the secondary coil shown in Fig. 7.2.

……

……

……

……[2]

(ii) Suggest why the transformer made from the charging plate and mobile phone is not 100% efficient.

……

……[1]

(b) The primary coil in the charging plate has 1000 turns while the secondary coil in the mobile phone has 50 turns.

Calculate the voltage across the coil in the mobile phone.

voltage = …….. [2]

(c) The mobile phone battery can be recharged using this charging plate and stores 22 kJ of energy when fully recharged. The current in the secondary coil is 0.65 A.

Calculate the time taken to fully recharge a completely uncharged battery.

time = …….. [2]

[Total: 7]

8 **(a)** Carbon-14 ($^{14}_{6}C$) is a radioactive isotope of carbon. Carbon-12 ($^{12}_{6}C$) is not radioactive.

All living organisms contain both carbon-12 atoms and carbon-14 atoms. The ratio of carbon-14 to carbon-12 is $1 : 1 \times 10^{12}$.

Carbon-14 has a half-life of 5700 years.

(i) When an organism dies, no new carbon is absorbed. The amount of carbon-12 in the dead organism remains fixed.

Describe how the amount of carbon-14 in the dead organism decreases with time.

……

……

…….…… [1]

(ii) A sample of wood contains carbon-14 and carbon-12 atoms in the ratio $1 : 4 \times 10^{12}$.

Calculate the number of years elapsed since the tree died.

number of years = …… [2]

(b) Other radioactive isotopes have different half-lives.

Suggest one reason why radioactive isotopes with a short half-life is more suitable to be administered into a patient's body during diagnostic imaging.

.....

..... [1]

[Total: 4]

9 A Cedarian carried out an experiment to investigate the terminal velocity of a falling object. Two metal balls X and Y are released from rest and allowed to fall through a tall cylinder of glycerin (a thick liquid).

The metal balls are both spherical. Table 9.1 shows the properties of the two balls.

Table 9.1

	radius / cm	density / kg m^{-3}
Ball X	7.5	7800
Ball Y	7.5	11 300

The distance fallen from a fixed point was recorded at equal time intervals for each ball as shown in Table 9.2.

Table 9.2

	Ball X	Ball Y
time / s	distance fallen / cm	distance fallen / cm
0.0	0	0
0.5	2.0	3.0
1.0	3.9	6.5
1.5	5.6	10.2
2.0	7.0	13.8
2.5	8.0	17.1
3.0	9.0	20.1

(a) Explain how the data in Table 9.2 can be used to determine whether the balls have reached terminal velocity.

…….

…….

…….

…… [2]

(b) Explain why the balls will eventually reach terminal velocity as they fall through glycerin.

……..

……..

……..

…… [2]

(c) **(i)** Explain why, despite both balls having the same size, one ball reaches terminal velocity first.

……

……

……

……

…… [2]

(ii) State which ball will reach terminal velocity first.

…… [1]

(iii) Estimate the terminal velocity of this ball.

terminal velocity = …….. [2]

(iv) On Fig. 9.1, sketch the velocity-time graph of this ball for 3.0 s.

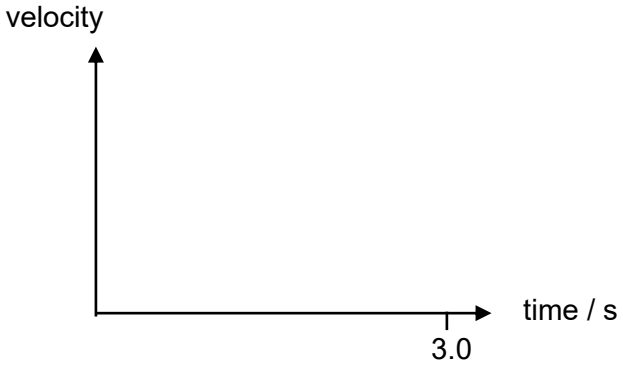


Fig. 9.1

[1]

[Total: 10]

10 **(a)** Fig. 10.1 shows a simple direct current (d.c.) motor.

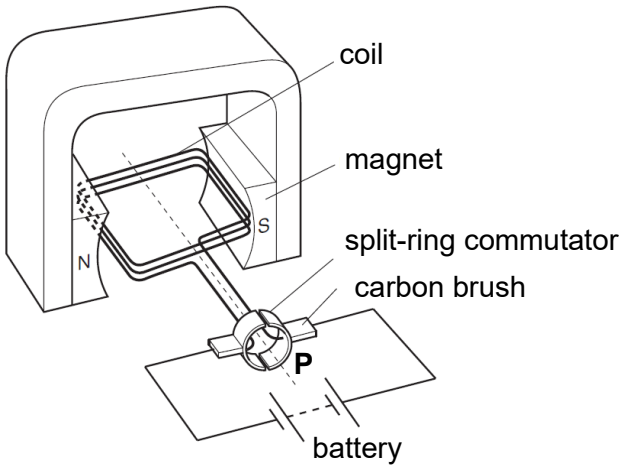


Fig. 10.1

(i) Explain the purpose of the split-ring commutator.

……

……

……

..... [2]

(ii) State the direction of rotation of the coil when viewed from the position **P**.

……..... [1]

(iii) Explain your answer to **(a)(ii)**.

……

……

..... [1]

(b) Fig. 10.2 shows a drone that uses lightweight brushless d.c. motors to rapidly spin propellers, generating lift and allowing precise control for hovering, ascending, and directional movement.

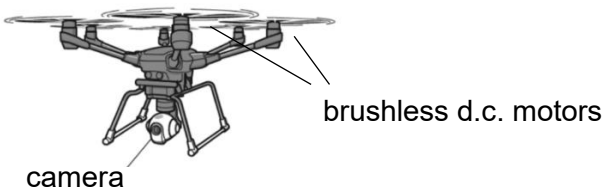


Fig. 10.2

A brushless d.c. motor uses fixed coils to create a rotating magnetic field, which causes surrounding permanent magnets to spin. It has no brushes and split-ring commutator.

(i) Suggest one advantage of using brushless d.c. motors in the drone.

…… [1]

(ii) For the drone to land safely, it needs to lose its lift. This can be achieved by reducing the speed of the brushless d.c. motors.

Suggest one way to reduce the speed of the motors.

……

…….. [1]

(c) The drone has two identical lamps that are connected to a 12 V battery as shown in Fig. 10.3.

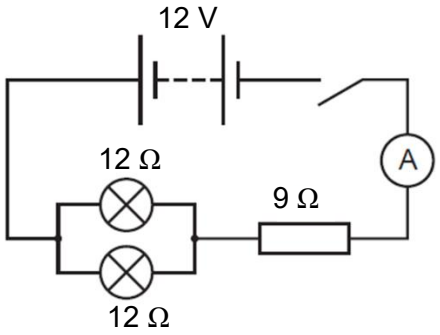


Fig. 10.3

(i) Assuming the ammeter is ideal, calculate its reading when the switch is closed.

ammeter reading =…….. [2]

(ii) Calculate the potential difference (p.d.) across each lamp.

p.d. =…….. [2]

[Total: 10]

Section B

Answer **one** question from this section.

11 A pan containing ice at –15 °C is placed on a gas heater as shown in Fig. 11.1.

Fig. 11.1

(a) Thermal conduction occurs in the metal from which the pan is made.

Using the kinetic particle model, describe the process of thermal conduction in a metal.

……..

……..

……..

……..

……..

…… [3]

(b) Fig. 11.2 shows how the temperature of the contents of the pan varies with time.

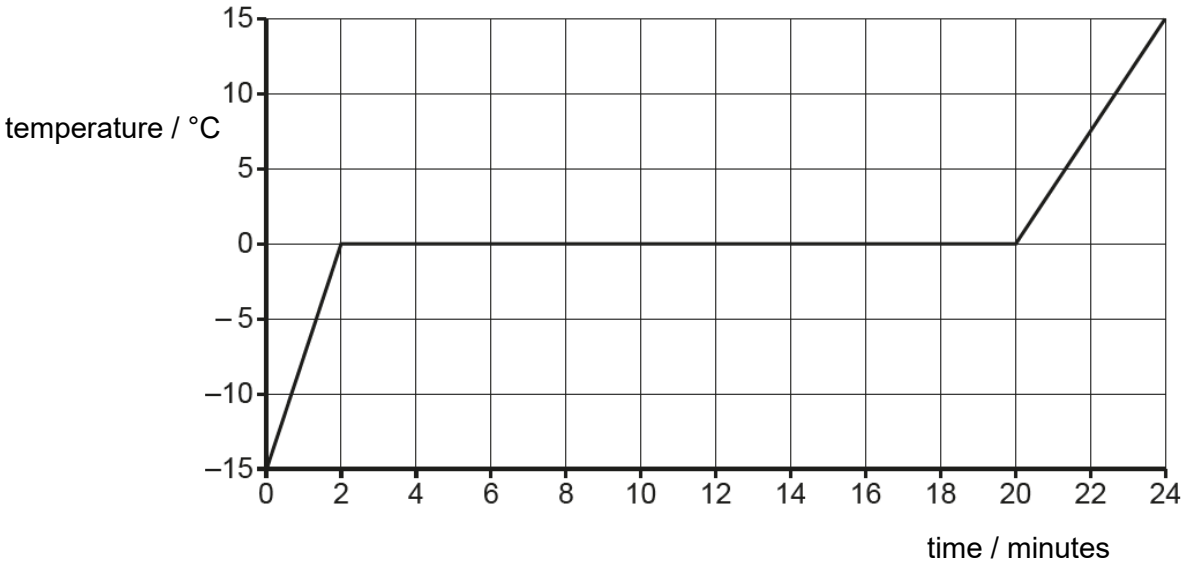


Fig. 11.2

(i) Explain why the temperature of the contents of the pan is constant between time = 2 min to 20 min.

……

……

……

…….. [2]

(ii) The initial mass of ice in the pan is 1.5 kg and the initial temperature is –15 °C.

The specific heat capacity of ice is 2100 J/(kg °C) and the specific latent heat of fusion of water is 334 000 J/kg.

Calculate the energy required to melt the ice completely.

energy = …….. [3]

(iii) All the energy transferred to the pan comes from the heater.

Using your answer to **(ii)** and Fig. 11.2, determine the power of the heater used to warm the ice.

power = …….. [1]

(iv) The graph in Fig. 11.2 has a smaller gradient after the ice has completely melted than when it is a solid.

Explain why.

……

……..… [1]

[Total: 10]

12 **(a)** In Fig. 12.1, A and B are two conductors mounted on insulating stands. A is positively charged and B is initially uncharged.

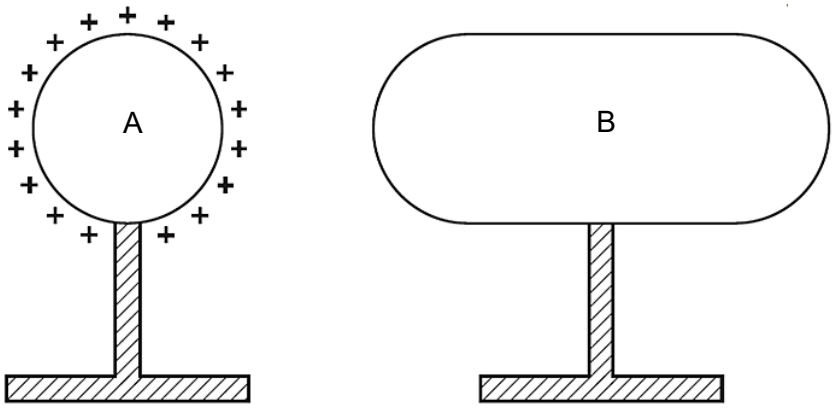


Fig. 12.1

(i) Conductor A is placed near conductor B.

On Fig 12.1, draw the charge distribution in conductor B. [1]

(ii) Explain the charge distribution in conductor B drawn in **(i)**.

……

……

……

…….. [2]

(iii) Conductor B is now connected to earth by a wire attached to the left side of conductor B.

Explain the change in the net charge of conductor B, if any.

……

…….. [1]

(b) Fig. 12.2 shows an electrostatic precipitator that stops dust and ash emerging from the chimney.

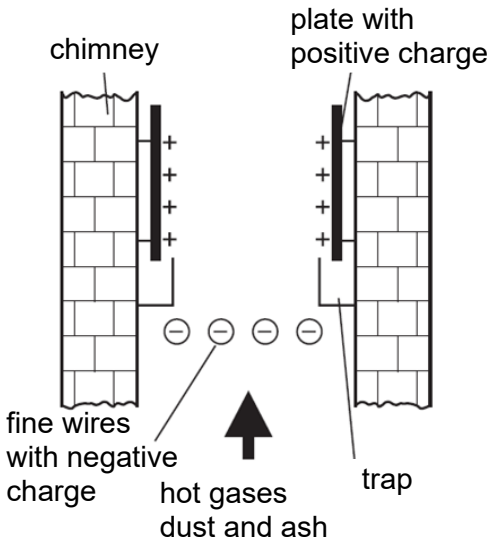


Fig. 12.2

(i) Explain how the precipitator works.

……

……

……

……[2]

(ii) Electrostatic precipitator is also used in portable electrostatic air purifiers designed for homes and offices. High voltage is often used in these devices.

Explain why, to clean the collector plates of the air purifier, the manual will advise the user to wear rubber gloves and to wait for a few minutes after switching it off.

……

……

……

…… [2]

(iii) Sometime a spark may jump when an earthed wire is brought near a charged plate. A charge of 1.8 μC flows between the wire and charged plate in a time of 1.2 ms.

Calculate the current.

current = …….. [2]

[Total: 10]

END OF PAPER

2025 S4 Physics Prelim Mark Scheme

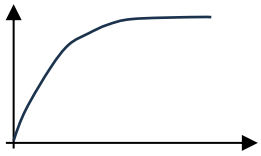
Paper 2

Section A

Qn	Solution	Mark
1(a)(i)	0 to 1 s and 8 to 12 s	[1]
(ii)	0 to 1 s, the car is at rest. 8 to 12 s, the car is moving at constant velocity or constant speed.	[1] [1]
(b)(i)	At t = 3.0 s, total resistive force is 700 N. F_{net} = forward force – total resistive force ma = 2400 – 700 800 x a = 1700 a = 2.13 m/s^2	 [1] [1]
(ii)	F_{net} = ma = 800 x 0.50 = 400 N 400 = forward force – total resistive force Total resistive force = 2400 – 400 = 2000 N t = 6.8 s	 [1] [1]
2(a)	anticlockwise moment = clockwise moment 23 x 10 x d = 60 x 1.7 230d = 102 d = 102/230 = 0.44 m	 [1] [1]
(b)(i)	Wooden barrier arm will turn anticlockwise about the pivot. The electromagnet will induce magnetism in soft iron bar A with an opposite pole, attracting and pulling it down.	[1] [1]
(ii)	Steel bar is a hard magnetic material and will retain some magnetism that is induced in it by the electromagnet. When the switch is opened, the steel bar will remain attracted to electromagnet and the wooden barrier arm cannot return to horizontal position.	 [1] [1]
3(a)	E_k = ½ m v^2 = ½ x 700 x 40^2 (this step must be shown to be awarded full credit) = 560 000 J (shown)	 [1]
(b)	As the car moves up slope, all the energy in kinetic store of the car will be transferred to the gravitational potential store of the car, as well as to the internal store of the car and escape lane.	[1] [1]
(c)(i)	Gain in E_p = mgh = 700 x 10 x 3.0 = 21 000 J	 [1]

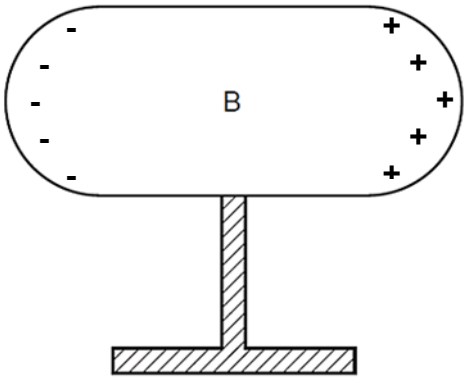
(ii)	Loss in E_k = Gain in E_p + work done to overcome friction 560 000 = 21000 + (f_r x s) = 21000 + (f_r x 40) f_r = 13 475 = 13 500 N	[1] [1]
(d)	Unevenness of the surface of the stones	[1]
4(a)(i)	Pressure is the force acting per unit area.	[1]
(ii)	Particles of steam are moving randomly at high speed. These particles will bombard the walls of the piston with a force. The total force acting per unit area results in a pressure on piston.	 [1] [1]
(b)	Pressure difference = $2.1 \times 10^6 - 1.0 \times 10^5$ Force/Area = $2.1 \times 10^6 - 1.0 \times 10^5$ Force = $(2.1 \times 10^6 - 1.0 \times 10^5) \times 0.30$ = 6.0×10^5 N	[1] [1]
5(a)	Microwave / Radiowave	[1]
(b)	Wave speed = freq x wavelength $3.0 \times 10^8 = 18 \times 10^9 \times \lambda$ λ = 0.017 m No of wavelengths = (560 000)/0.017 = 3.3×10^7 or 3.4×10^7	 [1] [1]
(c)(i)	Less disruption of signal / Less degradation of signal	[1]
(ii)	$\eta = 1/(\sin c)$ = 1/ (sin 45) = 1.41 or 1.4	 [1] [1]
(iii)	Angle of incidence = angle of reflection and angle between incident ray and reflected ray > 90° (use set square/protractor to ensure)	 [1]
6(a)	Larger percentage of energy is dissipated or wasted as heat in filament lamp	[1]
(b)	Both have the same output power 6.2 % = (output power/input power) x 100% 6.2 = output power/120 x 100 Output power = 7.44 W Efficiency of LED = (output power/input power) x 100% = 7.44/15 x 100 = 49.6 %	 [1] [1]
(c)(i)	A large current will flow from the live wire to ground via the low resistance earth wire. This will blow the fuse and disconnect the shiny metal surface and filament lamp (or circuit) from the high voltage supply.	[1] [1]
(ii)	A large current will flow from the live wire to the ground via the earth wire and will blow the fuse in the earth wire, disconnecting the circuit but the live wire is still connected to the shiny metal surface. Hence, the shiny metal surface remains at high voltage and user may get an electric shock when he touches the metal surface.	[1] [1]

7(a)(i)	The alternating current in the primary coil creates a changing magnetic field linking the secondary coil. This produces a change in magnetic flux linkage in the secondary coil, resulting in an induced emf in the secondary coil which produces a current in a closed circuit.	[1] [1]
(ii)	There is leakage or loss of magnetic flux linkage between the primary coil and secondary coil.	[1]
(b)	Vp/Vs = Np/Ns 240/Vs = 1000/50 Vs = 12 V	 [1] [1]
(c)	Energy = VIt 22 000 = 12 x 0.65 x t t = 2820 s	 [1] [1]
8(a)(i)	The amount of carbon-14 decreases by half every 5700 years.	[1]
(ii)	For living organisms ratio carbon-14 : carbon-12 1: 1 x 10^{12} 1/ (1x 10^{12}) : 1 For dead tree 1/(4 x 10^{12}) : 1 1/(4 x 10^{12}) = $(½)^n$ x (1/(1x10^{12}) , where n is no of half-lives n = 2 (or 2 half life) No of years = 5700 x 2 = 11400 yrs ago	 [1] [1]
(b)	Isotope will not remain radioactive for too long.	[1]
9(a)	The distance fallen by the ball every 0.5 s is indicative of the rate of change of displacement or the velocity of the ball. When the distance fallen every 0.5 s becomes constant, the ball has reached terminal velocity.	[1] [1]
(b)	When the ball falls, the drag force exerted by glycerin on it increases until it is equal to the weight of the ball. The resultant force acting on the ball becomes zero and acceleration of the ball become zero. Hence the ball reaches terminal velocity.	[1] [1]
(c)(i)	The 2 balls have different weights. (Do not accept different density) The ball with smaller weight will reach terminal velocity first as a smaller drag force exerted by the glycerin will be sufficient to cause the forces acting on it to be balanced.	[1] [1]
(ii)	Ball X	[1]
(iii)	velocity = (9.0-8.0)/0.5 = 2.0 cm/s	[1] [1]

(iv)		[1]
10 (a)(i)	It is to reverse the current through the coil each time it switches contact with the carbon brushes. This allows the coil to continue to rotate in one direction.	[1] [1]
(ii)	Clockwise	[1]
(iii)	Applying the Fleming's left hand rule, a downward force will be exerted on the right side of the coil and an upward force on the left side of the coil, causing it to turn clockwise.	[1]
(b)(i)	Lighter in weight. Less wear and tear. Less friction between the components within the drone.	[1] Any valid reason
(ii)	Reduce the current in the fixed coils	[1]
(c)(i)	Re = $(1/12 + 1/12)^{-1}$ + 9 = 6 + 9 = 15 Ω I = V/R = 12/15 = 0.80 A	[1] [1]
(ii)	p.d. across lamp = 6/15 x 12 = 4.8 V	[1] [1]

Section B

Qn	Solution	Mark
11(a)	Metal particles and free electrons near the heated end of metal will gain energy. The metal particles will vibrate faster and more vigorously about their fixed positions and collide with their neighbouring particles and transfer energy to them. The free electrons will move through the metal at a high speed, colliding with the metal particles at the cooler end of the metal and transferring energy to them.	[1] [1] [1]
(b)(i)	When ice melts from time = 2 min to 20 min, energy is absorbed to do work to overcome the atttractive forces between the ice particles. The energy absorbed by the ice is transferred to the potential energy of its particles but the kinetic energy of its particles remain unchanged. Hence the temperature is constant.	[1] [1]

(ii)	Total energy absorbed = $Q_{ice} + L_f$ = $mc\Delta\theta + ml$ = 1.5 x 2100 x 15 + 1.5 x 334 000 = 47 250 + 501 000 = 548 000 J (3 sf) or 550 000 J (2 sf)	[1] for Q_{ice} [1] for L_f [1]
(iii)	Power = Energy/ time = 548 000/(20 x 60) = 457 W or 458 W	Allow ecf [1]
(iv)	Water has a higher specific heat capacity than ice.	[1]
12(a)(i)	Equal no of protons and electrons  	[1]
(ii)	Electrons in conductor B will be attracted to the positively charged conductor A and move to the side facing conductor A (or left side of conductor B) as unlike charges attract. Protons in conductor B will be left on the opposite side (or right side of conductor B).	[1] [1]
(iii)	Conductor B becomes negatively charged as electrons flow from earth into the conductor to neutralise the positive charges.	[1]
(b)(i)	When dust and ash particles pass through the fine wires that are negatively charged, electrons will be transferred to them, making them negatively charged. As these negatively charged dust and ash particles rise, they will be attracted to the positively charged plates as unlike charges attract. Hence the gases that emerge from the chimney will be free of dust and ash.	[1] [1]
(ii)	Plate may contain some charge and will need time to be fully discharged. By wearing glove, user will be insulated and will not receive an electric shock when he touches the plates.	[1] [1]
(iii)	Q = It $1.8 \times 10^{-6} = I \times 1.2 \times 10^{-3}$ I = 0.0015 A	[1] [1]