Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2023

SECONDARY FOUR EXPRESS

PHYSICS 6091/01
(PAPER 1 Multiple Choice)

TIME: 1 HOUR

READ THESE INSTRUCTIONS FIRST

Write your name and Exam Index number on the Answer Sheet in the spaces provided.
Write in soft pencil.

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.

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.

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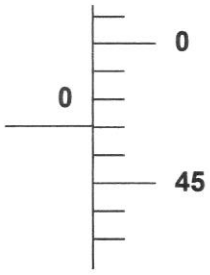
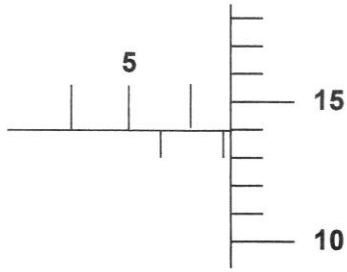
1 A micrometer is used to measure the diameter of a wire.

The diagrams show the micrometer when the jaws are closed and the micrometer when the wire is between the jaws.



Micrometer when jaws are closed

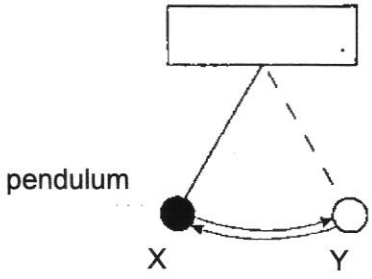


micrometer when wire is between the jaws

What is the diameter of the rod?

A 4.42 mm
B 6.61 mm
C 6.67 mm
D 7.11 mm

2 The diagram shows a simple pendulum. Using a stopwatch, which would be the most accurate way to measure the period of the pendulum?



A Time the motion from X to Y and back to X.
B Time the motion from X to Y and back to X again for 20 cycles and multiply by 20.
C Time the motion from X to Y and back to X for 20 cycles and divide by 20.
D Time the motion from X to Y and double it.

3 Green light has a wavelength of 550 nm.

What is the wavelength of blue light?

A 0.450 μm
B 0.650 μm
C 4.500 μm
D 6.500 μm

4 What is the order of magnitude of the diameter of a human hair?

A 10^{-8} m
B 10^{-6} m
C 10^{-4} m
D 10^{-2} m

5 Which pair contains a vector and a scalar quantity?

A area and displacement
B distance and volume
C temperature and pressure
D weight and velocity

6 Two forces, 3 N and 7 N respectively, are acting on a small ball-bearing.

Which is a possible resultant force acting on the ball-bearing?

A 1 N
B 3 N
C 8 N
D 11 N

7 Which quantity does not have a unit?

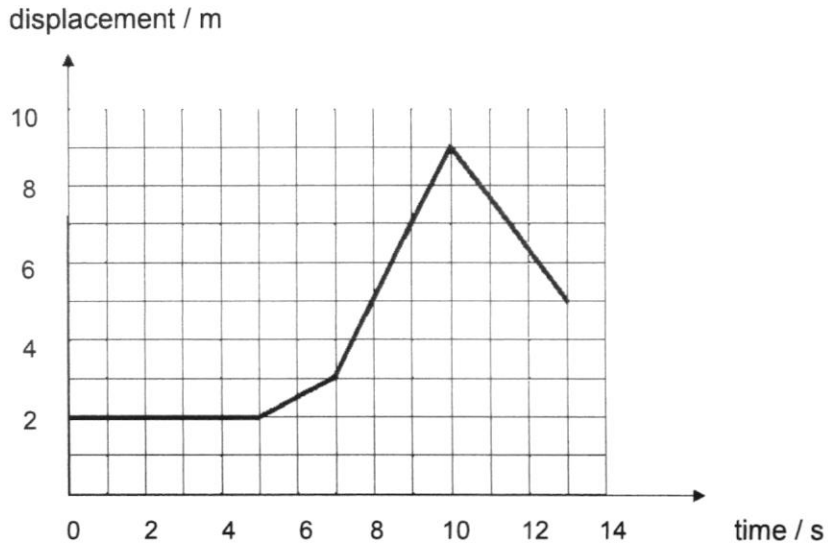
A electric current
B gravitational field strength
C potential difference
D refractive index

8 A 1000 kg mass was placed 2 m directly above a 1 kg mass and both were dropped from a tower at the same time. Assuming air resistance is negligible,

Which statement is correct about the time of landing?

A Not possible to predict.
B The 1000 kg mass would land on the ground at same time as the 1 kg mass.
C The 1000 kg mass would land on the ground faster than the 1 kg mass.
D The 1000 kg mass would land on the ground later than the 1 kg mass.

9 The diagram shows the displacement-time graph of a bicycle.



When is the velocity of the bicycle 2.0 m/s?

A 0 s to 5 s
B 5 s to 7 s
C 7 s to 10 s
D 10 s to 13 s

10 A motorcycle of mass 800 kg accelerates at 2.0 m/s^2. The engine of the motorcycle exerts a driving force of 2500 N on it.

What is the total resistive force acting on the motorcycle?

A 900 N
B 1600 N
C 2100 N
D 4100 N

11 When his parachute is fully opened, a parachutist falls towards the ground at constant speed. Under these conditions, which statement correctly identifies an action-reaction pair?

A Downward force on parachute by air and the downward force on air by parachute.
B Downward force on parachute by air and the weight of the parachutist.
C Upward force on parachute by air and the weight of the parachutist.
D Upward force on parachute by air and the downward force on air by parachute.

12 The mass of a body resists changes to its motion.

Which property of the body is responsible for this resistance?

A inertia
B gravitational potential energy
C kinetic energy
D temperature

13 A mountaineer of weight 700 N at the bottom of Mount Everest climbs to the top. The gravitational field strength changes from 9.81 N/kg at the bottom to 9.79 N/kg at the top.

What are his mass and weight at the top of Mount Everest?

	mass at top of Mount Everest / kg	weight at top of Mount Everest / N
A	71.4	699
B	71.4	700
C	71.5	699
D	71.5	700

14 5000 kg of iron is melted and mixed with 2.0 m^3 of molten copper.

If the density of molten iron and molten copper are 7500 kg/m^3 and 9000 kg/m^3 respectively, what is the approximate density of the mixture?

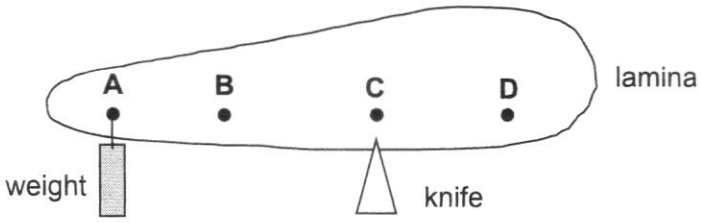
A 8.3 kg/m^3
B 8.6 kg/m^3
C 8300 kg/m^3
D 8600 kg/m^3

15 Which statement correctly defines gravitational field?

A It is a region in which a mass experiences a gravitational force of attraction.
B It is the amount of substance in a body.
C It is the gravitational force per unit mass.
D It is the gravitational potential energy stored in a body.

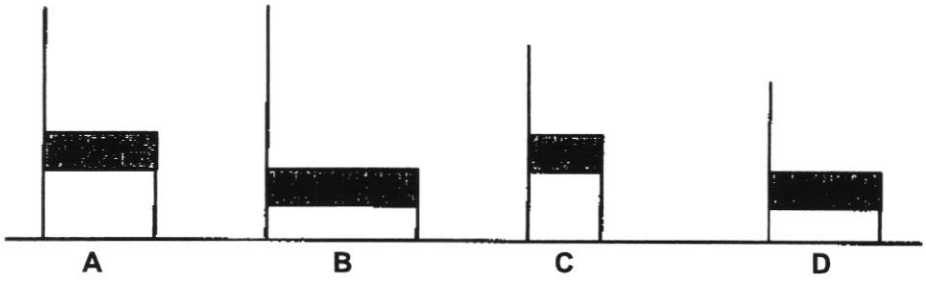
16 In order to balance a non-uniform lamina on a knife edge as shown, a weight is suspended at point A.

Where is the position of centre of gravity of this arrangement?

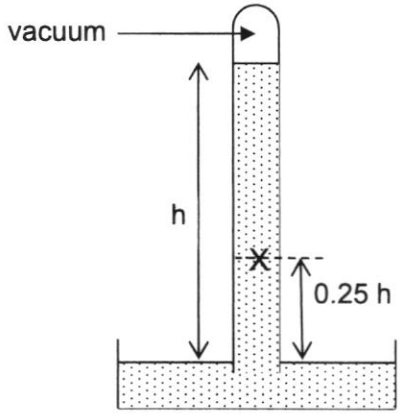


17 The following chairs, drawn to the same scale, are displayed in a furniture store.

Which of these chairs is the most stable?



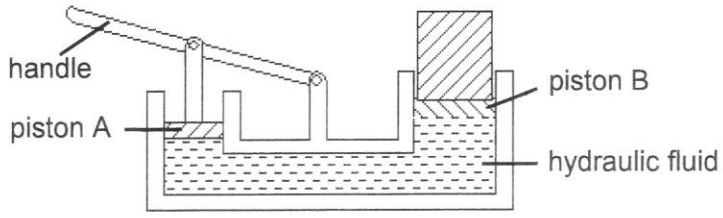
18 The diagram shows a barometer. The atmospheric pressure is 100 000 Pa.



What is the pressure at the point marked 'X'?

A 25 000 Pa
B 75 000 Pa
C 100 000 Pa
D 125 000 Pa

19 The diagram shows a simple hydraulic jack.



What change(s) should be made to the area of the pistons to lift a heavier load if the force applied at the handle remains unchanged?

	piston A	piston B
A	doubled	halved
B	doubled	remains unchanged
C	halved	doubled
D	remains unchanged	halved

20 A washing machine has a power input of 2.5 kW.

What is the work done in half an hour if the washing machine has an efficiency of 95%?

A 71 kJ
B 79 kJ
C 4300 kJ
D 4700 kJ

21 A bus moves from rest with uniform acceleration along a horizontal road.

After travelling a distance of 100 m, it has 300 000 J of kinetic energy.

What resultant force is acting on the car?

A 100 N
B 1000 N
C 3000 N
D 30 000 N

22 The temperature shown by a mercury-in-glass thermometer decrease.

Which of the following is constant?

A the density of the mercury
B the internal energy of the mercury
C the mass of the mercury
D the volume of the mercury

23 A sealed container of gas is heated.

What happens to the molecules of the gas?

A The average kinetic energy of the molecules increases and they hit the container more frequently.
B The average kinetic energy of the molecules increases and they hit the container less frequently.
C The molecules do not change size and the spaces between the molecules become smaller.
D The molecules expand and the spaces between the molecules become smaller.

24 Brownian motion can be observed by the behaviour of smoke particles in a smoke cell.

What does Brownian Motion show?

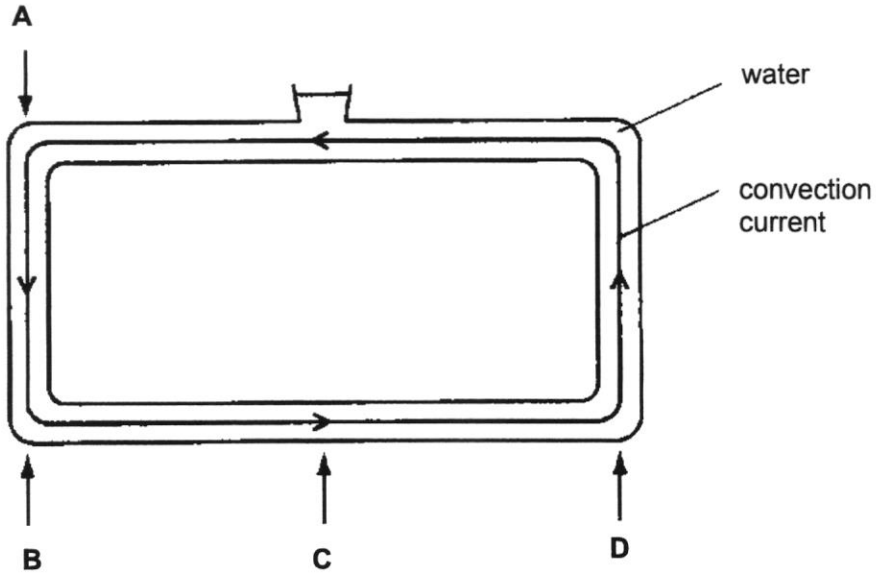
A Air is a poor conductor.
B Air molecules are moving.
C Air molecules have more mass than smoke particles.
D Convection occurs in air.

25 Which statement on gas/liquid is correct?

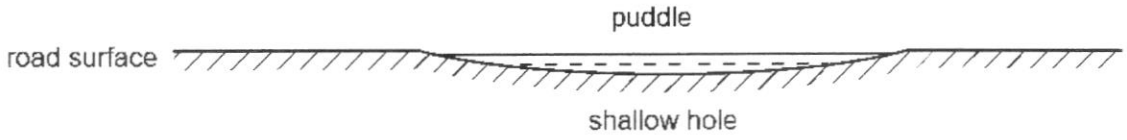
A The volume of a gas is fixed but its shape is not fixed.
B The volume of a gas is not fixed and its shape is not fixed.
C The volume of a liquid is fixed and its shape is fixed.
D The volume of a liquid is not fixed but its shape is fixed.

26 The diagram shows a convection current produced when water in a standing container is heated.

Where is the container heated to produce the convection current?



27 The diagram shows a cross-section through a rain-water puddle formed in a shallow hole in the road surface. Over time, air temperature, wind speed and wind direction remain constant.



What happens to the rate of evaporation of water from the puddle?

A It decreases because the surface area decreases.
B It increases because the puddle gets shallower.
C It increases because the temperature of water has decreased.
D It remains constant because air temperature and wind speed is unchanged.

28 A block of steel is at room temperature.

Which row describes a bigger block of steel at the same temperature.

	internal energy	heat capacity	specific heat capacity
A	higher	higher	same
B	higher	same	higher
C	same	higher	higher
D	same	same	same

29 Which change of state occurs when thermal energy is absorbed by a substance?

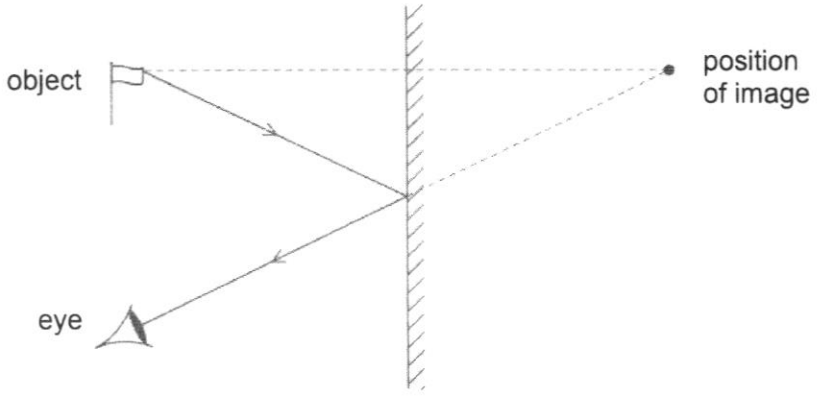
A boiling and melting
B boiling and solidification
C condensation and melting
D condensation and solidification

30 A rope is fixed to a wall at one end. The other end of the rope is moved up and down to produce a wave.

During this motion, what is transferred along the rope?

A atoms
B energy
C mass
D weight

31 The diagram shows the position of an image formed by a plane mirror.

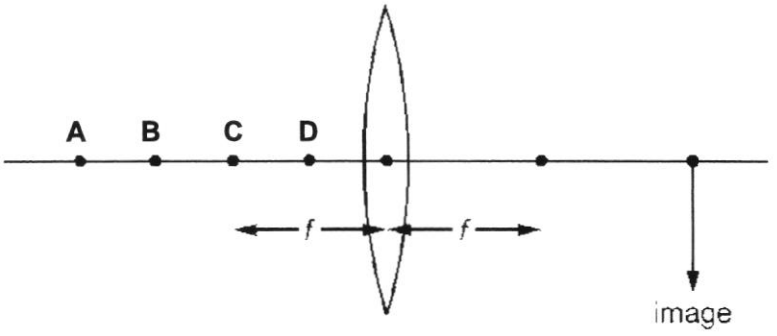


What are the characteristics of the image?

	orientation	size
A	inverted	same size
B	upright	diminished
C	laterally inverted	same size
D	upright	enlarged

32 The diagram shows a thin converging lens of focal length *f* and an image.

Where must the object be placed to produce the image that has the same size as the object?



33 Which waves travel at the same speed in air?

A gamma rays and radio waves

B infra-red and sound

C microwaves and ultrasound

D ultrasound and ultra-violet

34 A siren is emitting a sound. As time passes, the sound becomes louder and higher pitched.

What is happening to the amplitude and to the frequency of the emitted sound wave?

	amplitude	frequency
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

35 Which statement about electric current is correct?

A It is the rate of flow of charge and its unit is the ampere.
B It is the rate of flow of charge and its unit is the coulomb.
C It is the rate of flow of electrons and its unit is the ampere.
D It is the rate of flow of electrons and its unit is the coulomb.

36 Diagram X shows a drum inside a photocopier. After an intense beam of light is shone on the image on the paper, positive charges remain on the drum as shown. Diagram Y shows the drum rolling and toner powder is attracted to the drum. Diagram Z shows a piece of paper passing over the drum's surface.

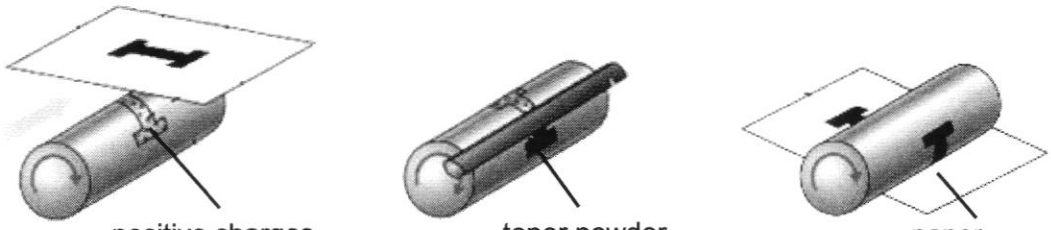
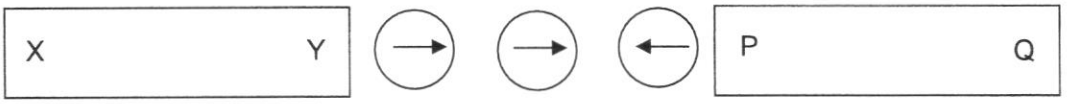


Diagram X Diagram Y Diagram Z

Which row of the table correctly states the charge of the toner and the paper?

	toner	paper
A	negative	negative
B	negative	positive
C	positive	negative
D	positive	positive

37 Three compasses are placed between two permanent magnets XY and PQ as shown in the diagram.

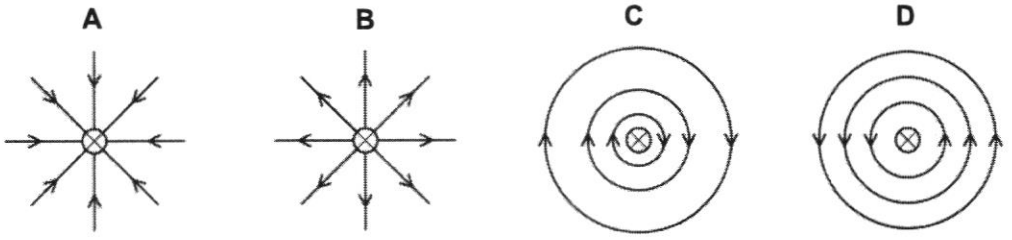


Which statement about the magnets is true?

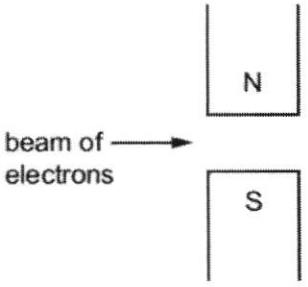
A PQ is a stronger magnet than XY; Y and P are both N-poles.
B PQ is a stronger magnet than XY; Y and Q are both N-poles.
C XY is a stronger magnet than PQ; Y and P are both N-poles.
D XY is a stronger magnet than PQ; Y and Q are both N-poles.

38 A straight wire is perpendicular to the paper. It carries a current into the paper.

Which diagram shows the magnetic field pattern of the current in the wire?



39 A horizontal beam of electrons passes between the two poles of a magnet.



In which direction is the beam deflected?

A into the page
B out of the page
C towards the N-pole of the magnet
D towards the S-pole of the magnet

40 Why is high voltage used to transmit electrical energy along cables from a power plant?

A It decreases the resistance of the cables.
B It increases the current in the cables.
C It prevents the loss of energy in the transformers at the ends of the cables.
D It reduces the energy loss in the cables.

Name:	Class:	Class Index No.:

Anglo-Chinese School
(Barker Road)

PRELIMINARY EXAMINATION 2023

SECONDARY FOUR EXPRESS

PHYSICS 6091

PAPER 2

TIME: 1 HOUR 45 MINUTES

READ THESE INSTRUCTIONS FIRST

Write your name, class & exam index number in the box provided at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 13 has a choice of parts to answer.

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 the sound use of Physics than 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	
Section B	
Total	/ 80

*This question paper consists of **24** printed pages.*

SECTION A (50 marks)

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

1 Fig. 1.1 shows a 58 g ball being thrown vertically upwards from the top of a building with an initial velocity of 20 m/s. It reaches the highest point and begins to fall. It lands on the ground when time is 6.0 s. The velocity-time graph is shown in Fig. 1.2. Air resistance is negligible.

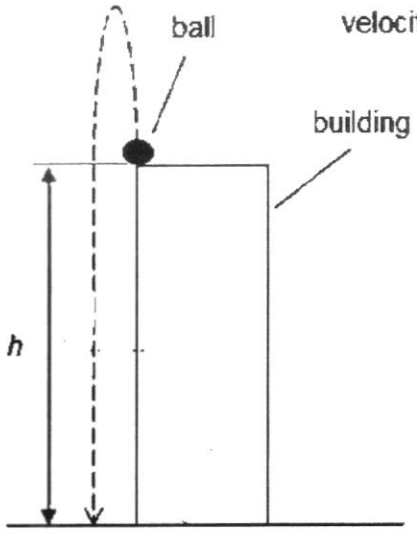


Fig. 1.1

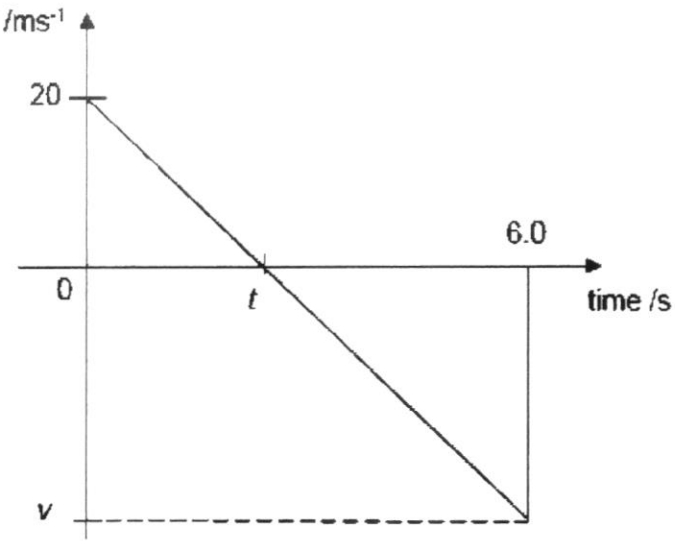


Fig. 1.2

(a) Explain how Fig. 1.2 shows that the ball is moving in the opposite direction after a period of time.

.....

..... [1]

(b) Determine the time t for the ball to reach its highest point.

t = ... [1]

(c) Calculate the velocity v of the ball just before it touches the ground.

v = ... [1]

(d) Calculate the height h of the building.

h = ... [2]

2 Fig. 2.1 shows a car being lifted by two ropes. The car remains horizontal and moves vertically upwards at a constant speed.

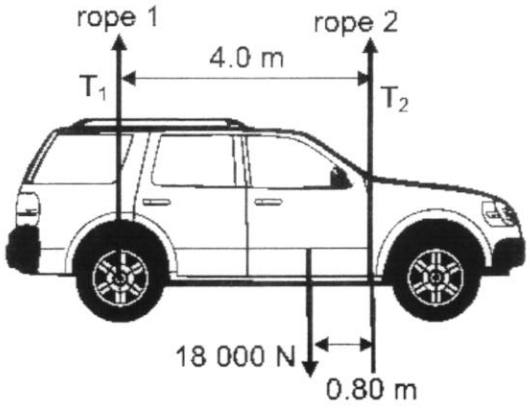


Fig. 2.1

The weight of the car is 18 000 N and the tensions in rope 1 and rope 2 are T_1 and T_2 respectively.

(a) State the two conditions for the car to be in a state of equilibrium while it is moving upwards at a constant speed.

.....

.....

.....

..... [2]

(b) Taking moments about the rear wheel, calculate T_1 and T_2.

T_1 = ...

T_2 = ... [3]

3 Fig. 3.1 shows a manometer joined to a cylinder containing a gas. The piston has a cross-sectional area of 0.012 m^2.

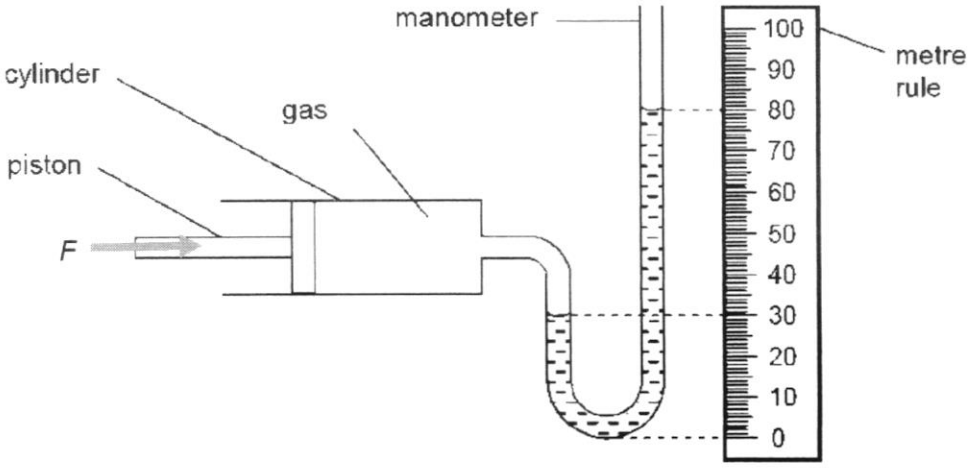


Fig. 3.1

Atmospheric pressure is 100 kPa.
The pressure exerted by the piston on the gas is 140 kPa.
Force *F* is the force of the piston acting on the gas.

Calculate

(a) the force *F*,

F = ... [2]

(b) the density of the liquid.

density = ... [2]

(c) With the same force *F* still exerting on the piston, the gas in the cylinder is now heated. It is observed that the piston moves to the left.

Explain, using ideas about molecules, why the piston moves to the left.

.....

.....

.....

.....

.....

..... [3]

4 Fig. 4.1 shows a 0.50 kg ball sliding down a rough incline from position A which is 7.5 m above the ground with an initial speed of v_o. Friction along the incline produces 10.7 J of heat energy. The ball leaves the incline at position B moving vertically upward and reaches a height of 13.0 m above the ground at position C.

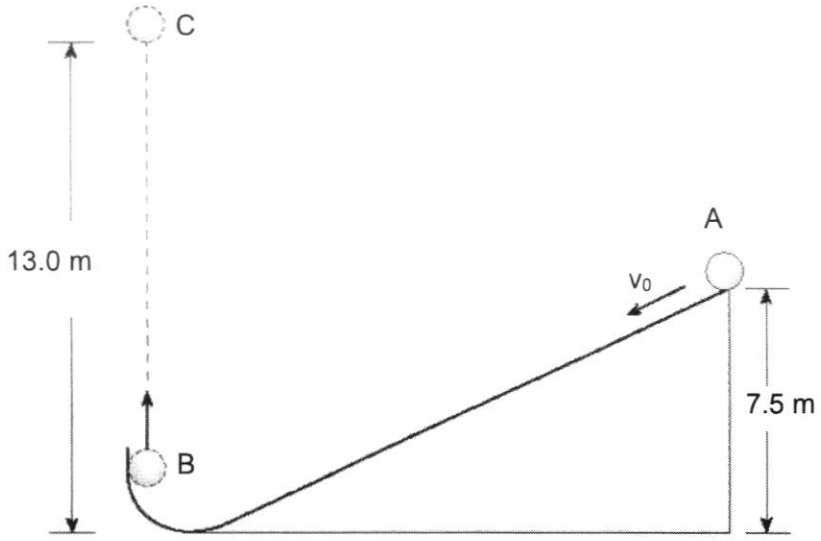


Fig. 4.1

(a) State the principle of conservation of energy.

.....

..... [1]

(b) **(i)** Calculate the gravitational potential energy of the ball at position C.

Take gravitational field strength g is 10 N/kg.

gravitational potential energy = ... [2]

(ii) Calculate the initial speed v_0, at position A.

v_0 = ... [2]

(c) State one assumption for your calculations in **(b)(ii)**.

.....

..... [1]

5 In a company that manufactures frying pans, a researcher wishes to select a new material that can be used for the base of the pan. Fig. 5.1 shows four possible materials and their properties.

material	melting point / °C	specific heat capacity / J/(kg °C)
A	2350	900
B	950	480
C	1600	480
D	7800	130

Fig. 5.1

(a) **(i)** The researcher carries out a series of experiments on the materials.

In one of the experiments, a 2 kg sample of material A is heated by an electrical heater of power 450 W. The initial temperature of the sample is 25 °C.

Calculate the time taken for the temperature of the sample to rise to 100 °C.

time taken = ... [2]

(ii) Using the data in Fig. 5.1, discuss which material is the most suitable to be used for the base of the frying pan. Give two reasons to support your choice.

.....

.....

.....

..... [2]

(b) 2.3 kg of hot water at boiling point is poured into the frying pan.
5 190 000 J was supplied to convert all the water into steam at boiling point.

Calculate the specific latent heat of vaporisation of water.

specific latent heat of vaporisation= ..... [1]

6 In Fig. 6.1 the vertical lines represent the crests of a wave in a ripple tank. The distance between the first crest and last crest is 35.0 cm.

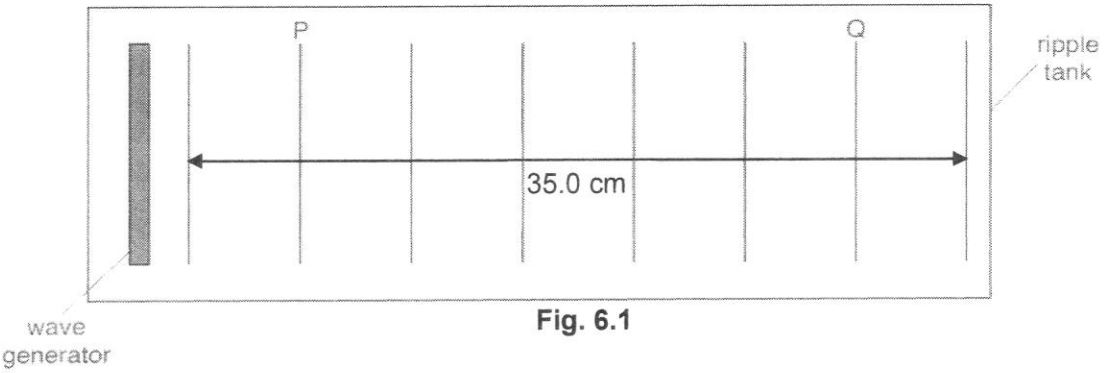


Fig. 6.1

It takes 2.5 s for the wave to travel from P to Q.

(a) Determine the wavelength of the wave in the ripple tank.

wavelength = ... [1]

(b) Determine the frequency of the wave.

frequency = ... [2]

7 A battery of electromotive force (e.m.f.) 4.5 V and negligible internal resistance is connected to two filament lamps P and Q and a resistor R, as shown in Fig. 7.1.

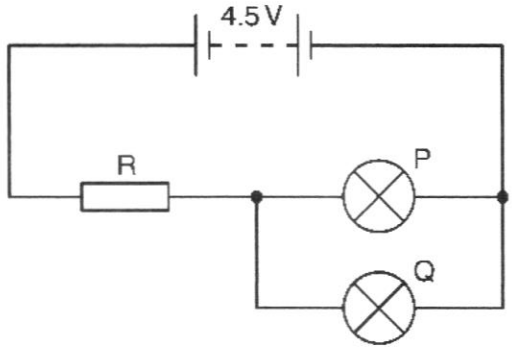


Fig. 7.1

The I–V characteristic graph of the filament lamps are shown in Fig. 7.2.

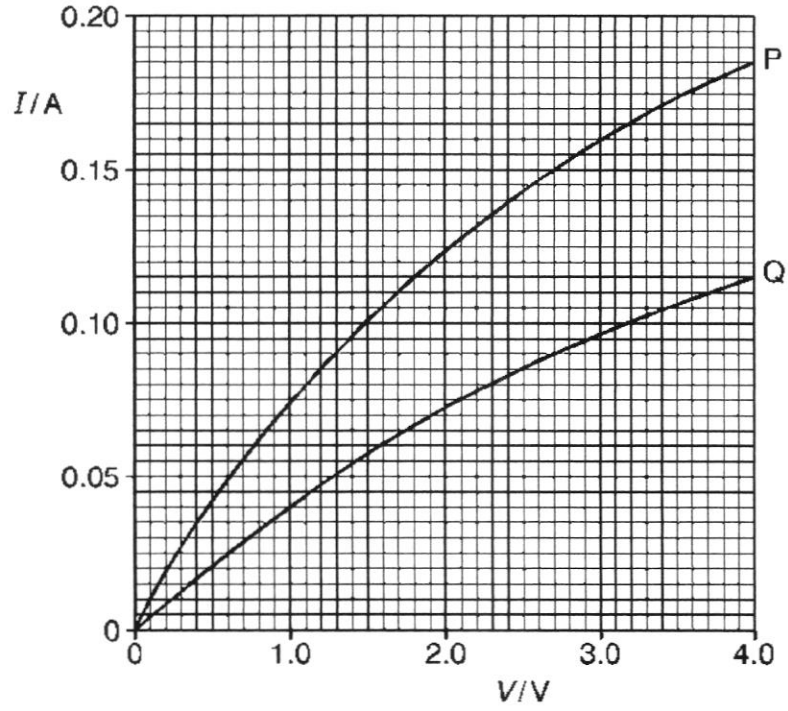


Fig. 7.2

The setup in Fig. 7.1 will give a current of 0.15 A flowing in lamp P.

(a) Use Fig. 7.2 to determine the current in the battery. Show your working clearly.

current = ... [2]

(b) Calculate the potential difference across resistor R.

potential difference = ... [1]

(c) The filament wires of the two lamps are made from a material with the same resistivity at their operating temperature in the circuit.

The diameter of the wire of lamp P is twice the diameter of the wire of lamp Q.
The resistances of the wires of lamp P and lamp Q are 18 Ω and 3 Ω respectively.

Show that the ratio of the length of wire of lamp P to the length of wire of lamp Q is 24:1.

[2]

8 Fig. 8.1 shows an electrical circuit.

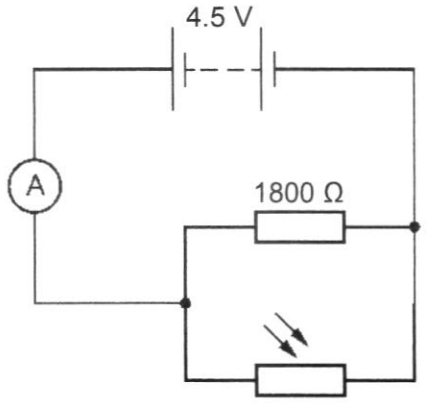


Fig. 8.1

(a) The light incident on the light dependent resistor causes its resistance to be 9000 Ω.

Calculate

(i) the total resistance of the circuit,

resistance = ... [1]

(ii) the reading on the ammeter.

reading = ... [1]

(b) A very bright lamp near the circuit is switched on and the intensity of the light incident on the LDR increases.

State and explain what happens to the ammeter reading.

.....

.....

.....

.....

..... [2]

9 Fig. 9.1 shows a simple d.c. motor. A rectangular coil PQRS is connected to a power supply and is placed between two solenoids.

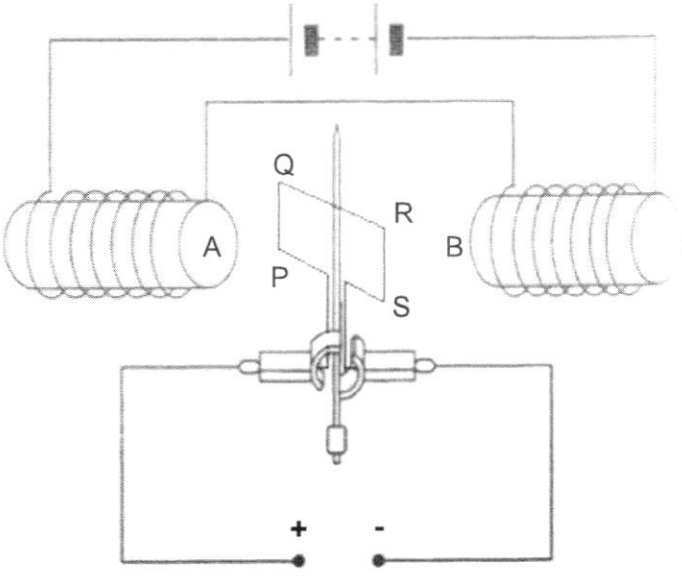


Fig. 9.1

(a) Identify the magnetic poles at A and B.

A: .....

B: ..... [1]

(b) Explain why the coil turns and state the direction of its rotation

.....

.....

.....

..... [2]

(c) Describe the action of the split-ring commutator in the d.c. motor.

.....

..... [1]

(d) When the coil is vertical, the split-ring commutator is not in contact with the carbon brushes and no current flows through the coil.

Explain why the coil continues to turn even though no current is flowing.

.....

..... [1]

10 Fig. 10.1 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

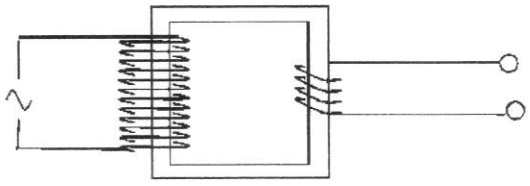


Fig. 10.1

coil	number of turns
J	50
K	100
L	1 000
M	1 500

Table 10.2

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 10.2 above.

(a) Based on Table 10.2, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer.

Show your workings.

primary coil: .....

secondary coil: ..... [2]

(b) Assume that the transformer is 75 % efficient and the power output is 15 kW, calculate the current flowing in the primary coil.

current = ... [2]

(c) Soft iron is used for the core of the transformer.

Explain why a soft iron core is used.

.....

..... [1]

SECTION B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 **(a)** Two light signals, green light and violet light, are sent from a transmitter to a receiver by two different methods in Fig. 11.1.

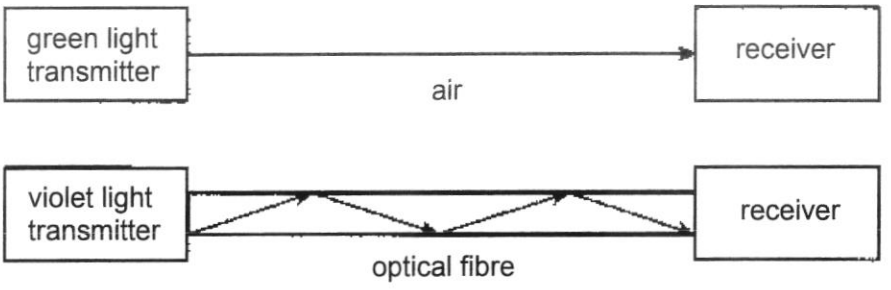


Fig. 11.1

The structural composition of the optical fibre through which the violet light travels is as shown in Fig. 11.2.

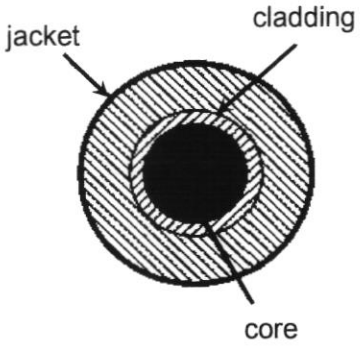


Fig. 11.2

(i) State what is meant by refractive index.

.....

..... [1]

(ii) Name the phenomenon which prevents the violet signal from escaping from the optical fibre.

..... [1]

(iii) State and explain whether the core or cladding has a lower refractive index.

.....

..... [1]

(iv) Compared to the green light, the violet light takes a longer time to arrive at the receiver.

Suggest two reasons for this.

.....

.....

.....

..... [2]

(b) Fig. 11.3 shows the graph of the angle of refraction *r* against the angle of incidence *i*, when a light ray travels from the material indicated in the graph into air.

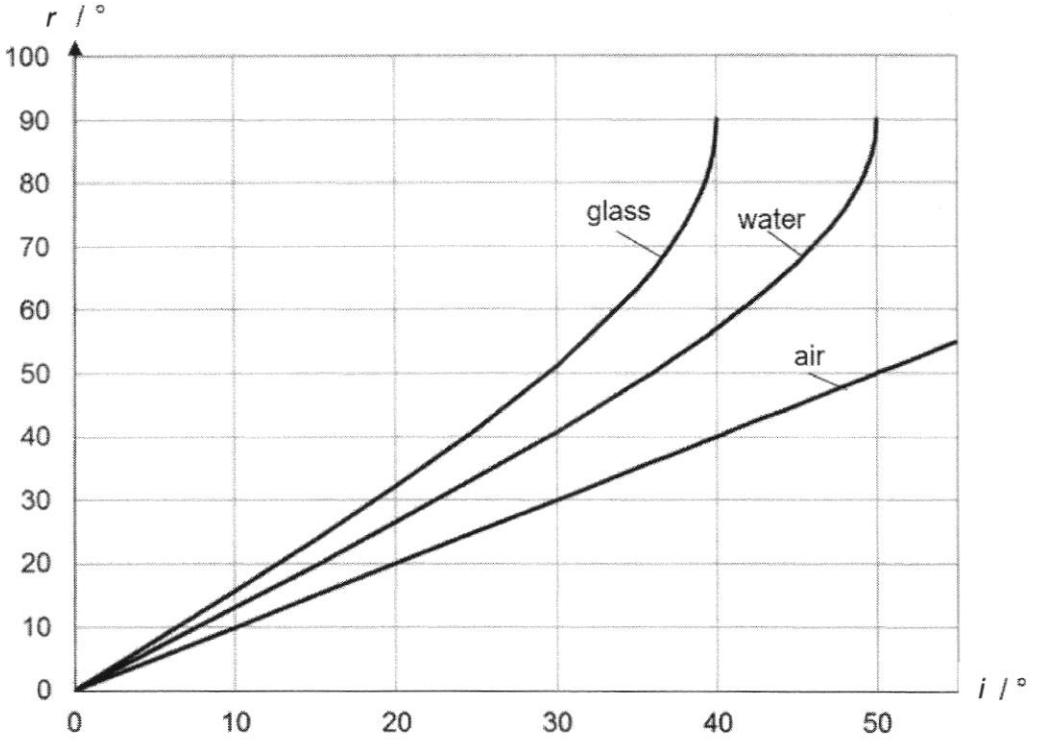


Fig. 11.3

(i) Using the data from Fig. 11.3, explain what happens to the light ray if the angle of incidence exceeds 40° in glass.

.....

.....

.....

..... [2]

(ii) Determine the refractive index of water.

refractive index = ... [2]

(iii) State and explain how the graph for glass in Fig. 11.3 would change if the light ray that travels through the glass now emerges into water instead of air.

.....

..... [1]

12 Ultrasound is used in quality control to detect cracks in a piece of metal.

Pulses of ultrasound are sent into the piece of metal from a transmitter. A detector is placed next to the transmitter on the front surface of the metal as shown in Fig. 12.1.

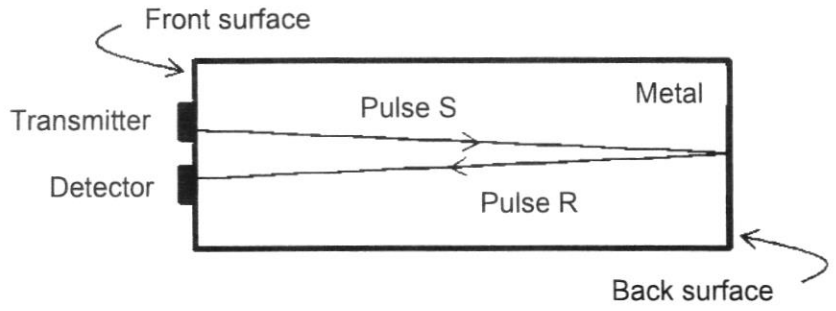


Fig. 12.1

Fig. 12.2. shows the cathode-ray oscilloscope (c.r.o.) trace of the ultrasound pulses produced if the metal contains no cracks.

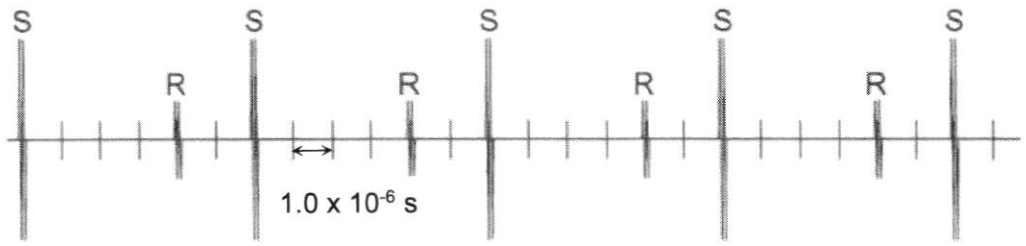


Fig. 12.2

The time-base of the c.r.o. is set at 1.0×10^{-6} s/division.

Pulses labelled S are pulses initially sent out by the transmitter. Each pulse labelled R is the reflection from the back surface of the metal of the previous pulse S.

(a) State what is meant by ultrasound.

.....

..... [1]

(b) Determine the period of pulses sent out by the transmitter using Fig. 12.2.

period = ... [1]

(c) Suggest two reasons why the amplitude of R is less than the amplitude of S.

.....

.....

.....

..... [2]

(d) Sometime later, the piece of metal is tested again. It now has a small crack halfway between the front surface and the back surface as shown in Fig. 12.3.

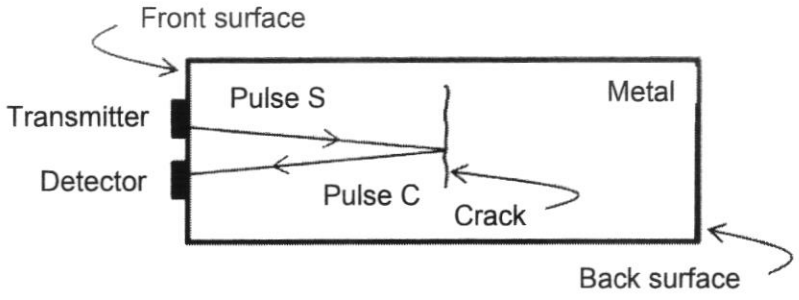


Fig. 12.3

On **Fig. 12.2**, draw the position and size of the pulses produced by this crack. Label each of these pulses **C**. [2]

(e) A second beam of ultrasound has a frequency of 8.0×10^6 Hz and a speed of 4000 m/s in the metal.

Calculate the wavelength of this ultrasound in the metal.

wavelength = ... [2]

(f) State one property that ultrasound and microwave have in common.

..... [1]

(g) Name one medical application of ultrasound.

..... [1]

13 EITHER

A positively charged metal sphere X is moved towards a neutral metal sphere Y as shown in Fig. 13.1. Metal sphere Y is attached to a solenoid P which is grounded through wire R. Solenoid Q is connected to a galvanometer and is positioned near solenoid P.

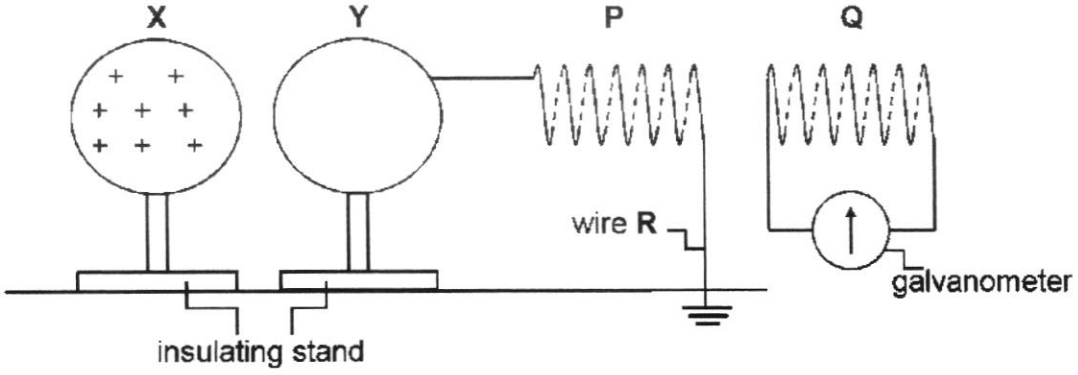


Fig. 13.1

(a) X is moved but not touching Y.

Describe and explain the subsequent movement of charges in solenoid P and sphere Y.

.....

.....

.....

..... [2]

(b) Indicate with an arrow on wire R, the direction of the current flow during the movement of charges. [1]

(c) It is observed that during the movement of charges, the galvanometer deflects to the right, then to the left before going back to zero.

Explain

(i) why the galvanometer deflects.

.....

.....

.....

..... [2]

(ii) why the galvanometer finally goes back to zero.

.....

..... [1]

(iii) why solenoid Q experiences a force when the galvanometer deflects.

.....

..... [1]

(d) Explain, in terms of magnetic properties, why solenoids are made of copper instead of steel.

.....

..... [1]

(e) State and explain how the experiment can be modified to create a larger deflection in the galvanometer.

.....

.....

..... [2]

13 OR

Fig. 13.1 shows a part of the main electrical circuit in a house.

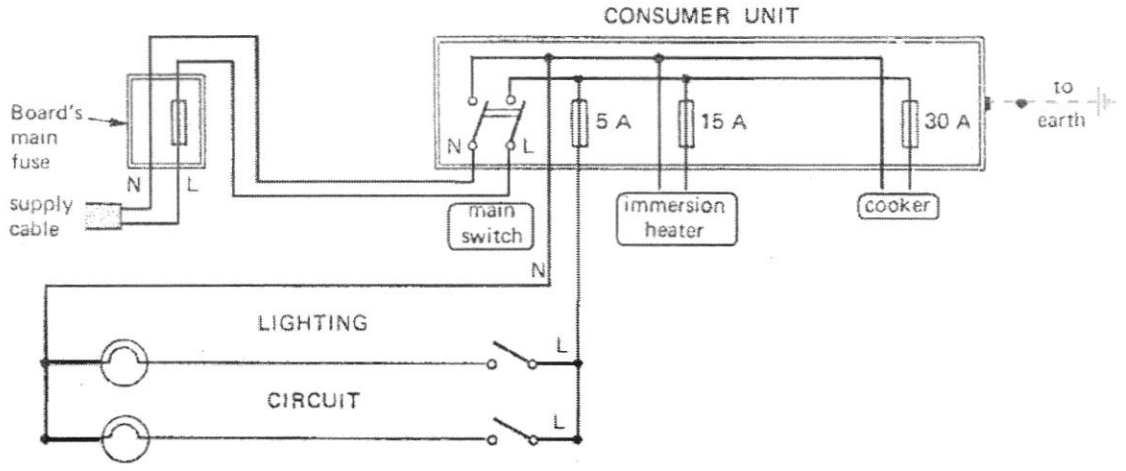


Fig. 13.1

(a) State the function of the neutral wire in a circuit.

.....

.....

..... [1]

(b) Explain why the lamps are connected in this arrangement.

.....

.....

..... [1]

(c) The consumer unit is earthed.

Describe and explain how this makes the consumer unit safe.

.....

.....

.....

.....

..... [2]

(d) Calculate the maximum current that can flow in the live wire of the board's main fuse.

Suggest a suitable fuse rating.

current = ...

suitable fuse rating = ... [2]

(e) With all the appliances being switched on, the live wire touches the neutral wire at the main switch.

(i) Describe and explain the effect on the lamps, immersion heater, cooker and fuses when this fault happens.

.....

.....

.....

..... [3]

(ii) Suggest another device that can replace the board's main fuse in the circuit. State the advantage of using the device instead of the fuse.

.....

..... [1]

END OF PAPER

Anglo-Chinese School (Barker Road)
2023 Sec 4 Exp Physics (6091) Preliminary Examination Marking Scheme

Paper 1

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

Paper 2

Overall remarks:

- Students who give answers in fractions will get 1 mark deducted off the whole paper.
- 1 mark is deducted for every different incorrect unit.

		Answers	Marks	Examiner's Comments
1	a	Velocity changes from positive to negative. Line goes below x-axis. after time t, velocity becomes negative.	B1	Do not accept: line is negative (line cannot be negative) velocity is below x-axis (velocity can be negative but cannot be below x-axis)

1	b	a = (v-u) / t -10 = (0 – 20) / t time = 20 / 10 = 2 s	A1	
1	c	a = (v-u) / t -10 = (v – 0) / (6-2) v = - 40 m/s	B1	must have -ve sign
1	d	Height = ½ x 4 x 40 – ½ x 2 x 20 = 60 m	M1 A1	
2	a	Resultant force is zero. Resultant moment is zero OR Sum of clockwise moments about a pivot is equal to sum of anticlockwise moments about the same pivot. (pivot must be mentioned)	B1 B1	Common misconception: resultant force is upwards "Word" pivot must be present
2	b	Taking moments about rear wheel, T_2 x 4 = 18 000 x (4 - 0.8) T_2 = 14 400 N T_1 = 18 000 – 14 400 = 3 600 N	M1 A1 A1	
3	a	F = pA = 140 000 x 0.012 = 1680 N	M1 A1	
3	b	Liquid pressure + atmospheric pressure = gas pressure hpg + 100 000 = 140 000 hpg = 40 000 (0.80 – 0.30) x p x 10 = 40 000 p = 8000 kg/m^3 OR 8 g/cm^3	 M1 A1	Need to convert 50 cm to 0.5 m to work in SI units
3	c	KE increase and speed of molecules increase Frequency of collison of molecules with piston walls increases Total force of collision increases Force per unit area increases	B1 B1 B1	

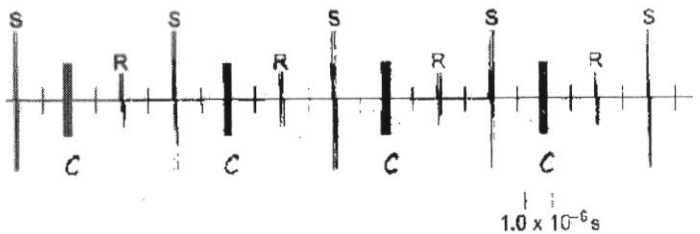
		Gas pressure increases Resultant pressure outwards (and pushes piston to the left) *1 mark for every 2 points		
4	a	**Energy cannot be created or destroyed but can only be converted from one form to another form** (total amount of energy in an isolated system remains constant)	B1	
4	bi	GPE = mgh = 0.5 x 10 x 13 = 65 J	 M1 A1	
4	bii	Total energy at end + energy converted to heat due to slope friction = Total energy at start GPE at C + 10.7 = GPE at A + KE at A $mgh + 10.7 = mgh + \frac{1}{2}mv^2$ $0.5 \times 10 \times 13 + 10.7 = (0.5 \times 10 \times 7.5) + (\frac{1}{2} \times 0.5 \times v^2)$ $\frac{1}{2} \times 0.5 \times v^2 = 38.2$ v = 12.4 m/s	 M1 A1	
4	c	No energy to overcome air resistance or converted to sound energy	B1	Do not accept if answer is not specific - no energy loss (must be specific to which form of energy is energy lost to)
5	ai	$Q = mc\Delta\theta$ $Pt = mc\Delta\theta$ $450 \times t = 2 \times 900 \times (100 - 25)$ t = 300 s OR 5 mins	 M1 A1	
5	aii	D. Highest melting point so it can withstand the heat/wont melt so easily		

		Smallest specific heat capacity so temperature will rise fastest for the same amount of thermal energy supplied Any 1 point – 1 mark	B1 B1	
5	b	$Q = ml_v$ 5 190 000 = 2.3 x l_v l_v = 5 190 000 / 2.3 =2 256 522 J / kg	 M1 A1	Units must be present. Common mistake was J/ kg / deg celsius which is for specific heat capacity
6	a	wavelength = 35 / 7 = 5 cm	A1	
6	b	period = 2.5 / 5 T = 0.5 Frequency = 1/ period = 1/ T = 1 / 0.5 = 2Hz OR *v* = 25 / 2.5 = 10 cm/s *v* = frequency x wavelength 10 = *f* x 5 *f* = 2 Hz OR 2.5 s → 5 complete waves 1 s → 5/2.5 = 2 complete waves (frequency → no. of complete waves in 1 s) f = 2 Hz	M1 A1	
7	a	Using graph For P, When current = 0.15 A in P, V across P = 2.7 V		

		Since P and Q are in parallel, V across Q = V across P = 2.7 V Using graph, When V across Q = 2.7 V, current in Q = 0.09 A Total current = 0.15 + 0.09 = 0.24 A	M1 A1	
7	b	V across resistor = 4.5 – 2.7 = 1.8	A1	
7	c	((pL/A) of P)/ ((pL/A) of Q) = 18/3 $A = \frac{1}{4}\pi D^2$ Since diameter of P is twice diameter of Q, $A_P = 4A_Q$ Since resistivity p is the **same**, $(L_P / 4A) / ((L_Q / A) = 6$ $(L_P / L_Q) = 6 \times 4 = 24$	M1 A1	
8	ai	1 / R = 1/ **1800** + 1 / **9000** R = **1500** Ω	B1	Must see working
8	aii	I = V / R = **4.5** / 1500 = 0.003 A	B1	Must see working
8	b	Light intensity increases, **resistance of LDR decreases** **Effective resistance** of circuit **decreases** [**Current increases** OR **ammeter reading increases**] Either one	B1 B1	The word "effective" is important because the LDR's resistance is one of two resistors present in the circuit. The ammeter reading measures the circuit's current.
9	a	A : North B: South	B1	

9	b	Magnetic field of current interacts with magnetic field of magnet Downward force acting on PQ Upward force acting on RS [Forces act at a distance from the axis of coil] optional Coil rotates anticlockwise (ECF based on magnetic poles in 9(a)	B2	3 Pts – 2 marks 2 Pts – 1 mark 1 Pt – 0 mark Need to state clearly direction of force on each side of coil (use Flemming's left hand rule to determine direction of force)
9	c	Ensure the **current** in the circuit **reverses for every half revolution**	B1	
9	d	Due to **inertia / momentum**, the coil continues to turn though current is not flowing in coil in vertical position.	B1	
10	a	Ratio of turns = Ratio of voltage 3300 / 220 = 15 *1500 / 100 = 15 Select M as Primary coil K as Secondary coil	 M1 A1	
10	b	Power in Secondary = 0.75 x Power in Primary 15 000 = 0.75 x I x V 15 000 = 0.75 x I x 3300 I = 6.06 A	 M1 A1	75% efficient means output power is 75% of input power
10	c	To ensure **maximum magnetic flux linkage** of primary coil with secondary coil **by concentrating magnetic field lines**. Accept if a student is able to mention one of the two bolded ideas.	B1	
11	ai	**The refractive index is the ratio of the speed of light in vacuum to the speed of light in the medium**	B1	
	aii	Total internal reflection	A1	

	aiii	For total internal reflection to occur in the core, light has to travel from **an optically denser to a less dense medium** (**optically** must be present) Hence, the **cladding has a lower refractive index.**	B1	
	aiv	1. The **speed of light is lower in the optical fibre** than in the air since the **optical density of the optical fibre is higher** than that of air. 2. The **path of green light is shorter (straight path)** than that of **violet light** (jagged path) for the same distance between the transmitter and receiver.	B1 B1	
	bi	When ***r* = 90°, *i* = 40°, this is the critical angle** **Total internal reflection will occur** and the light ray is reflected back into the glass or water.	B1 B1	
	bii	n = 1/sin c n = 1/sin 50° n = 1.31 Award 1 mark to **students who** use i = 40 and r = 30 as data and substituted correctly. (No other angles are allowed)	M1 A1	Remarks: Students should examine graphs carefully when selecting data points. i = 40 and r = 30 is not an exact point and hence only 1 mark is awarded.
	biii	The graph(gradient) for glass will be **less steep** since the amount of **bending** will be **lesser** hence **angle of refraction will be lower** for each angle of incidence. Marking point: **State how the graph for glass would change**: gradient less steep, gentler slope **Explain:** bending **less** (from normal), angle of refraction is smaller as compared to when light emerges to air.	B1	
12	a	**Sound wave** of **above 20 kHz.** (frequency is implied) OR **Sound wave** of high **frequency above human audibility range**	B1	

	b	6 divisions on time base. $T = 6 \times 1 \times 10^{-6} = 6 \times 10^{-6}$ s	A1	
	c	Not all ultrasound is reflected from back surface. Some pass through the back. Some sound energy is absorbed by the metal. Some sound energy is spread out/scattered/dissipated/reflected in other directions. Sound energy is converted to other forms of energy like thermal energy. Any 2 points – idea of energy loss or not all energy is reflected.	B2	
	d	 One pulse halfway between S and R (1 mark) Pulse height smaller than S but bigger than R (1 mark)	A2	
	e	$v = f\lambda$ $4000 = 8 \times 10^6 \times \lambda$ $\lambda = 5 \times 10^{-4}$ m	M1 A1	
	f	Obey laws of reflection, refraction Obey the wave equation speed = wavelength x frequency Transfer energy from one point to another point without transferring matter	B1 Either 1	Do not accept: Transfer energy from one point to another point (**need to state without transferring matter**)

	g	prenatal scan (not check for pregnancy → use pregnancy test kit) blast/locate kidney stone evaluate blood flow examine breast lump Any reasonable application. Reject: CT scan, medical imaging	B1	
13	EITHER			
	a	**Electrons in Y will move to the side facing X as unlike charges attract.** This results in a shortage of electrons on the right side of Y and **electrons will move from the ground to P and then Y to neutralize the positive charges on the right side of Y.** There will now be an excess of electrons on sphere Y resulting it being negatively charge.	B1 B1	Common mistake was to state the movement of positive charges which cannot move. Positive charges can only be attracted or repelled but cannot move.
	b	As there is electrons flowing up from the ground, there will thus be a **current flowing down to the ground.**	A1	conventional current flows in opposite direction to electron flow
	ci	During the movement of charges in P, **the current produces a magnetic field. Q experiences a change in magnetic flux.** By Faraday's Law, **an induced emf is produced in Q** and hence an induced current flow in the closed circuit causing a deflection in the galvanometer.	B1 B1	
	cii	Once the right side of Sphere Y is completely neutralized, there is no more charge movement in P. **Q will no longer experience a change in magnetic flux** and hence there will not be an induced emf or induced current.	B1	
	ciii	By Lenz's Law, **the induced current** (in Q) **produces a magnetic effect to oppose change in magnetic flux.** This results in a magnetic force (experienced by P and Q since like poles repel).	B1	
	d	Copper is a **non-magnetic material** whereas steel is a magnetic material. **Steel will magnetise and interfere with the function of solenoid.**	B1	
	e	The solenoid P and Q can be brought closer.	B1 state	

		There could have more turns in the solenoids Inserting a soft iron core in Q. All these could bring about a **higher rate of change of magnetic flux** linkage leading to a larger induced emf in Q.	any 1 B1 explain	
13	OR			
	a	The neutral wire allows **current to return** from the appliance **to the power supply / to complete the circuit**.	B1	
	b	When **one lamp is blown, the other lamp will continue to work** OR **lamps can work independently**.	B1	
	c	The appliances in the consumer unit have metallic external casings. When the **live wire is connected to the metal casing,** **the earth wire provides the path of low resistance and direct the current away from the user.**	B1 B1	Metal casing must be present Need to state clearly that **earth wire has low or zero resistance**
	d	Current = 5 + 15 +30 = 50 A Suitable fuse rating: 51 A to 55 A.	A1 A1	
	ei	**Short circuit will occur** and the lamps, immersion heater and cooker will not work. OR **effective resistance becomes zero** **A large current** above the fuse rating **flows through the board's main fuse and blow the fuse**. (It must be clear that it's the main fuse that's blown) The **5A, 15A and 30A fuses are not affected**.	B1 B1 B1	No marks awarded if the word main in main fuse is missing. Need to state clearly what happens to the 5A, 15A and 30A fuses
	eii	**Circuit breaker.** **It can be reset** conveniently after the fault is corrected.	B1	Do not accept switch. Switch is to cut off current / high potential but fuse context is to cut off excessive current which only circuit breaker can do it.