JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

PHYSICS

6091/01

Paper 1 Multiple Choice

1 Sep 2021

1 hour

Candidates answer on the Multiple Choice answer sheet.

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 unless this has been done for you.

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.

For Examiner's Use
40

This document consists of **18** printed pages.

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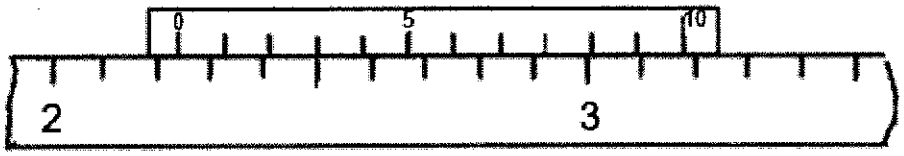
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1 A car's acceleration and maximum speed are improved by using an engine of smaller mass and greater driving force.

How many of the underlined quantities are vectors?

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

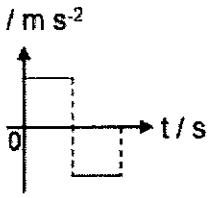
2 A pair of vernier calipers has a zero error of –0.01 cm. It was used to measure the length of an object and the reading is shown below.



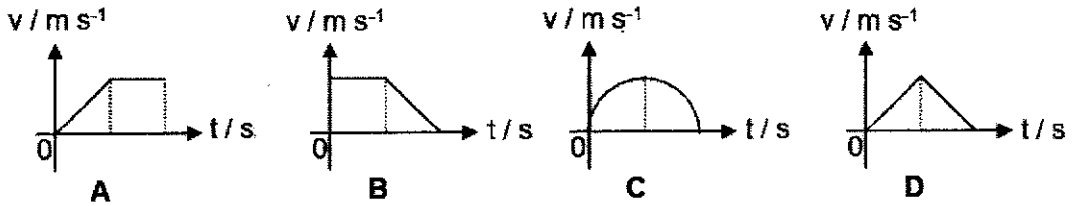
What is the actual length of the object?

A 2.12 cm **B** 2.14 cm **C** 2.22 cm **D** 2.24 cm

3 The acceleration-time graph of a body is shown below.



Which graph below correctly shows the velocity-time graph of the body?



4 A skydiver jumps from an aeroplane. After a few seconds, he reaches a terminal velocity without opening his parachute.

Why does he reach terminal velocity?

A Air resistance becomes greater than his weight and slows him down.

B Air resistance decreases and he speeds up.

C Air resistance increases and balances his weight so that his acceleration is zero.

D His weight decreases and balances the air resistance.

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5 The table below shows the variation with time t of the displacement s travelled by an aircraft as it starts moving along a runway.

t / s	0	2	4	6	8
s / m	0	12	30	52	75

How did the velocity and acceleration of the aircraft change during the 8 s of its motion?

	velocity	acceleration
A	increase	increase
B	increase	decrease
C	decrease	increase
D	decrease	decrease

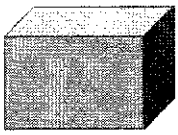
6 The diagram below shows a hot air balloon of mass 5000 kg flying in the sky.



What is the upward thrust required for the balloon to accelerate upwards at 5 m/s^2?

A 0 N **B** 25 kN **C** 50 kN **D** 75 kN

7 A block of iron of mass 2.0 kg and some water of mass 1.0 kg is shown below.



2.0 kg block of iron



water of mass 1.0 kg

Which of the following physical quantities of the block of iron is twice that of the water?

A Mass, weight and inertia only.

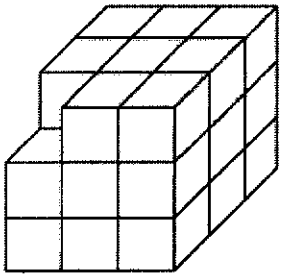
B Mass and inertia only.

C Weight, inertia and volume only.

D Mass, weight, inertia and volume only.

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8 Twenty seven identical small cubes are arranged such that it forms a big cube. The cubes are of the same material and the density of each cube is ρ.

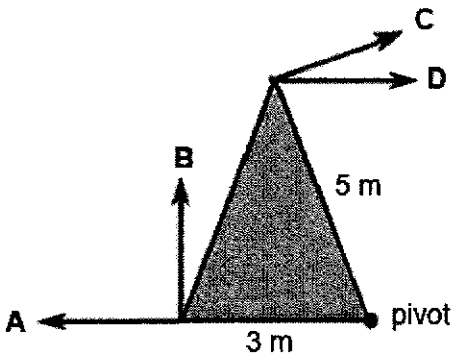


If one small cube is removed from the arrangement as shown in the diagram below, what is the density of the final big cube?

A ρ **B** $\frac{26}{27}\rho$ **C** $\frac{27}{26}\rho$ **D** $\frac{28}{27}\rho$

9 Four identical forces are exerted on an object as shown below.

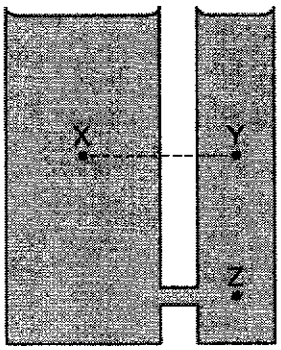
Which force will produce the greatest turning effect about the pivot?



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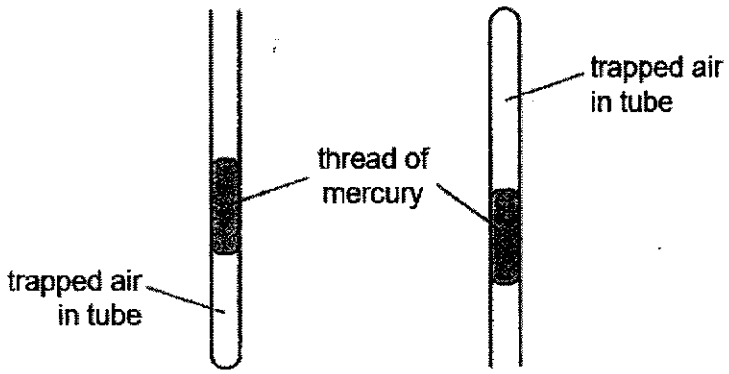
10 Two cylindrical vessels are joined together and filled with water.



How does the pressure at point X compare to the pressure at points Y and Z?

	compared to Y	compared to Z
A	pressure at X is higher	pressure at X is lower
B	pressure at X is higher	pressure at X is the same
C	pressure at X is the same	pressure at X is lower
D	pressure at X is the same	pressure at X is the same

11 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to the atmosphere.



When the tube is turned upside down, the volume of the trapped air increases.

Which statement explains this?

A The air gets hotter when the tube is turned upside down.

B The number of air molecules increases when the tube is turned upside down.

C The pressure in the trapped air is reduced.

D The trapped air molecules hit the mercury harder when travelling downwards.

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12 In a power station, fossil fuel is used to boil the water into steam. The steam is then used to rotate turbines which power generators.

Which of the following represents the main energy conversion taking place?

A chemical potential energy → heat energy → kinetic energy → electrical energy

B chemical potential energy → heat energy → electrical energy → kinetic energy

C kinetic energy → heat energy → electrical energy → chemical potential energy

D kinetic energy → heat energy → chemical potential energy → electrical energy

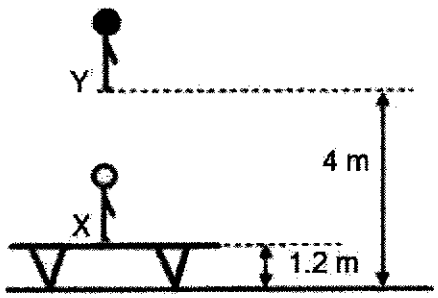
13 A small hydro-electrical power station diverts water from a river.

Every second, 20 kg of water flows through a pipe and falls through a vertical drop of 15 m. The efficiency of the power station is 60%. The gravitational field strength g is 10 N/kg.

What is the useful power output?

A 0.18 kW **B** 1.8 kW **C** 3.0 kW **D** 180 kW

14 A gymnast jumps vertically upward from a bench as shown.



The gymnast leaves the bench at a height of 1.2 m and reaches a maximum height of 4 m at Y.

What is the initial speed of the gymnast when she starts to rise at X?

A 5.28 m s^{-1} **B** 7.48 m s^{-1} **C** 8.94 m s^{-1} **D** 10.2 m s^{-1}

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15 When fine pollen grains suspended in water are viewed under a microscope, they are seen to be making small erratic movements.

What is the explanation for this observation?

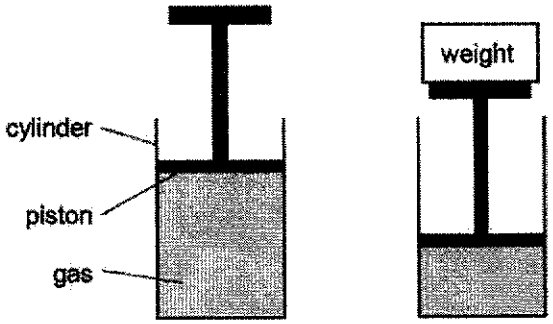
A The pollen grains are being bombarded by water molecules.

B The pollen grains are being bombarded by other suspended particles.

C The pollen grains are colliding with one another.

D There are convection currents in the water.

16 A piston is supported by gas trapped in a cylinder.



A weight is placed on the piston. The volume of gas supporting the piston decreases but the temperature of the gas is unchanged.

What happens to the molecules?

A They decrease in size.

B They have more kinetic energy.

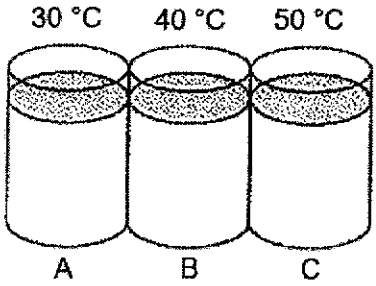
C They hit the piston more frequently.

D They move more slowly.

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17 Three glasses of water of the same mass are placed side by side touching each other as shown. Glass A is at 30 °C, glass B is at 40 °C and glass C is at 50 °C.



Which of the following shows the correct direction about the net transfer of thermal energy?

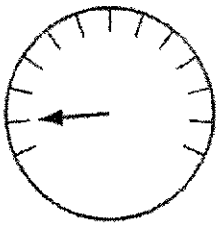
A from glass A to glass B

B from glass C to glass B, and from glass B to glass A

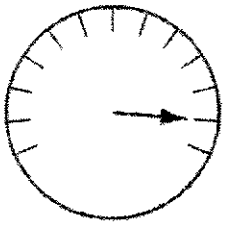
C from glass B to glass A and glass C

D no transfer of thermal energy

18 The diagrams show the scale on a voltmeter connected to a thermocouple thermometer.



thermocouple probe in melting ice



thermocouple probe in wet steam



thermocouple probe in liquid

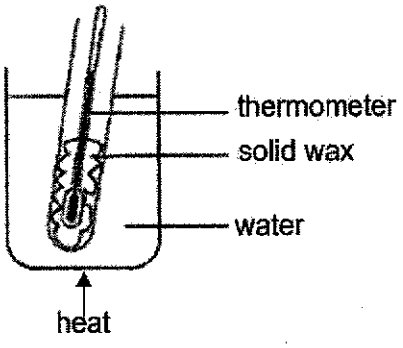
What is the temperature of the liquid?

A 30 °C **B** 40 °C **C** 70 °C **D** 80 °C

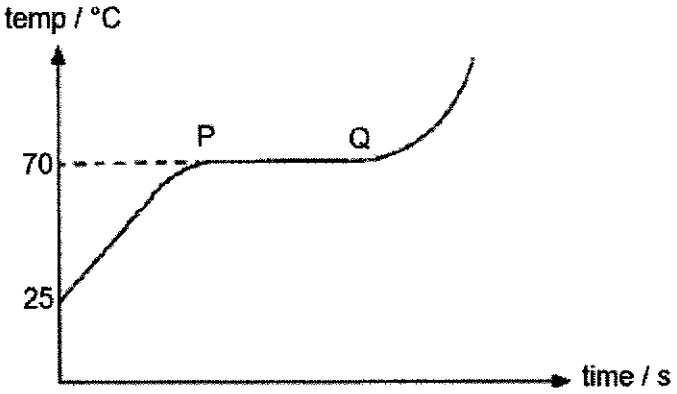
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19 A piece of solid wax in a test-tube is heated in a water bath.



The heating curve shows how the temperature of the wax varies with time.



Which statement is correct?

A Boiling point of wax is 70 °C.

B No thermal energy is absorbed by the wax between PQ.

C Only liquid wax is present between PQ.

D There is an increase in internal energy of the wax between PQ.

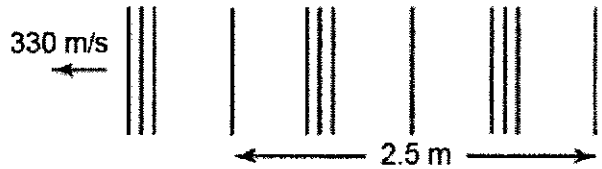
20 An immersion heater of power 800 W raises the temperature of 1.0 kg of water at 30 °C.

Given that the specific heat capacity of water is 4200 J kg^{-1} K^{-1}, how long does it take to raise the temperature of the water to 80 °C?

A 158 s **B** 263 s **C** 300 s **D** 420 s

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21 A longitudinal wave travelling at 330 m/s produces the waveform shown below.



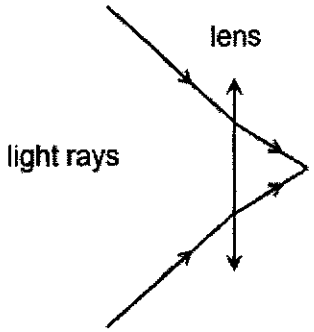
What is the frequency of the sound wave?

A 132 Hz **B** 198 Hz **C** 264 Hz **D** 330 Hz

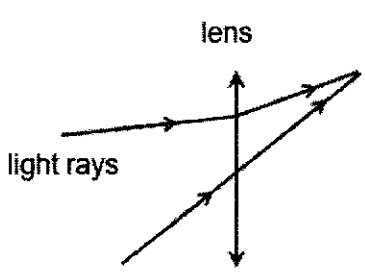
22 Some light rays are shone into a thin converging lens.

Which ray diagram shows the direction of the light rays correctly?

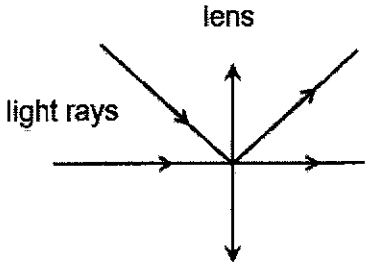
A



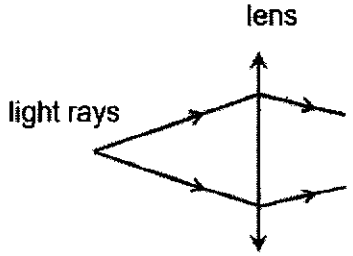
B



C



D



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23 Below are four statements about the use of electromagnetic radiation.

1. Gamma rays are used in medical treatment.
2. Infra-red waves are used in sunbeds.
3. Microwaves are used in mobile phones.
4. X-rays are used in intruder alarms.

How many of these statements are correct?

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

24 Which of the following correctly shows electromagnetic waves arranged in order of increasing wavelength?

A microwaves, visible light, gamma rays

B X-ray, infra-red radiation, visible light

C X-ray, visible light, microwaves

D radio waves, ultraviolet, visible light

25 Samuel blows a whistle that has a frequency of 10 000 Hz. His friend, Brooklyn, cannot hear the sound from the whistle. Brooklyn has normal hearing.

What could be a reason why Brooklyn cannot hear the sound?

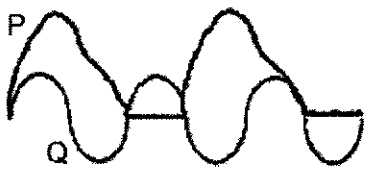
A The amplitude of the sound wave is too large.

B The amplitude of the sound wave is too small.

C The frequency of the sound wave is too high.

D The frequency of the sound wave is too low.

26 P and Q are the displays on a C.R.O as two musical instruments are sounded together.



Which of the following statements is not correct?

A The waves have different amplitudes.

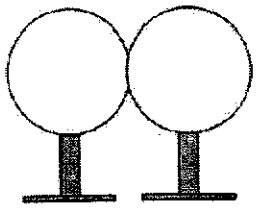
B The frequency of P is lower than that of Q.

C The wavelength of P is longer than that of Q.

D The speeds of the waves produced by P and Q are different.

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27 Two neutral conducting spheres are placed touching each other and supported by insulating stands as shown.



Which is the correct sequence to induce opposite charges on the two spheres?

1. Separate the two spheres by pulling the insulating stands away from each other.
2. Earth the spheres instantaneously.
3. Remove the charged rod.
4. Place a charged rod near the conducting spheres.

A 1 → 4 → 2 → 3

B 4 → 1 → 2 → 3

C 4 → 1 → 3

D 4 → 2 → 3

28 A student holds a rod in one hand and rubs the rod with a thin sheet of material held in his other hand.

Both the rod and the thin sheet become charged and remain charged.

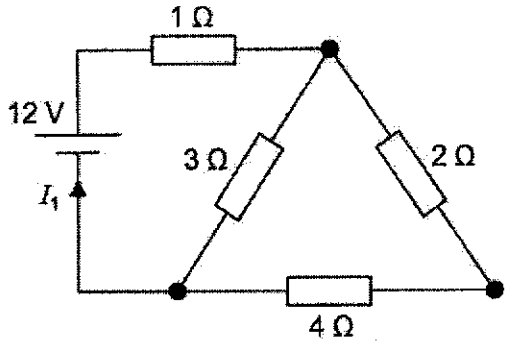
What materials could the rod and the thin sheet be made of?

	rod	thin sheet
A	copper	silk cloth
B	glass	aluminium foil
C	iron	paper handkerchief
D	nylon	woolen duster

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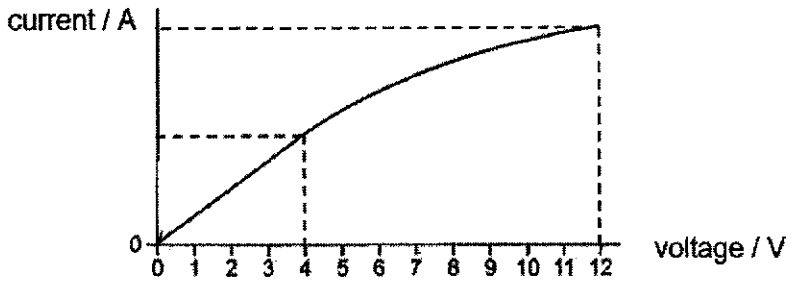
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29 What is the value of current I_1?



A 1 A **B** 3 A **C** 4 A **D** 12 A

30 The graph shows the variation of current with voltage in a 12 V lamp.

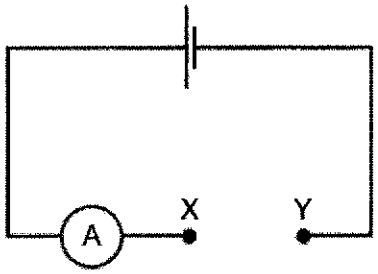


Which of the following about the resistance of the lamp is true?

	voltage from 0 V to 4 V	voltage from 4 V to 12 V
A	resistance is constant	resistance increases
B	resistance is constant	resistance decreases
C	resistance increases	resistance increases
D	resistance increases	resistance decreases

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31 The diagram shows an incomplete circuit.



Four wires of different length and thickness are connected in turn between point X and point Y. All four wires are made of the same metal.

Which wire will cause the greatest reading on the ammeter?

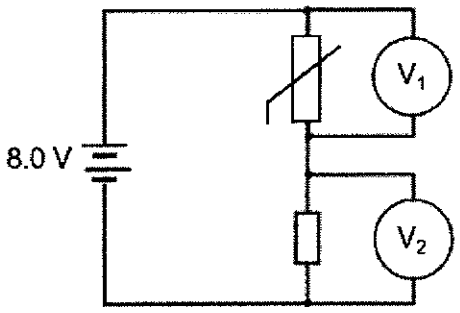
A long and thick wire

B long and thin wire

C short and thick wire

D short and thin wire

32 A circuit with a thermistor is used to detect changes in temperature.



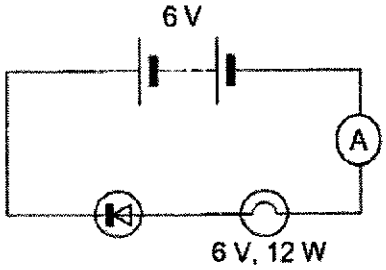
How do the readings on voltmeters V_1 and V_2 change as the surrounding temperature increases?

	V_1	V_2
A	increases	increases
B	increases	decreases
C	decreases	remains unchanged
D	decreases	increases

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33 In the circuit below, the bulb does not light up and the ammeter does not show any reading.



Which of the following will allow the bulb to light up?

A reversing the bulb connections

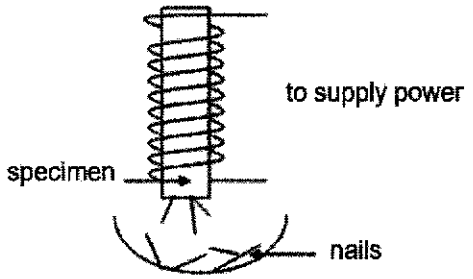
B reversing the battery connections

C using a bulb with lower power

D using a battery with higher e.m.f.

34 The diagram below shows a test for the magnetic properties of metals **X**, **Y**, and **Z**.

Metals **X**, **Y**, and **Z** are inserted into the solenoid. When the power to the solenoid is switched on, the specimen will pick up some iron nails. When the power is switched off, some of the iron nails will fall off.



The results are shown in the table below.

metal	no. of nails picked up	no. of nails left on
X	40	3
Y	0	0
Z	20	14

Which row shows the correct identities of metals **X**, **Y**, and **Z**?

	X	**Y**	**Z**
A	iron	aluminium	magnesium
B	iron	aluminium	steel
C	magnesium	copper	steel
D	steel	copper	iron

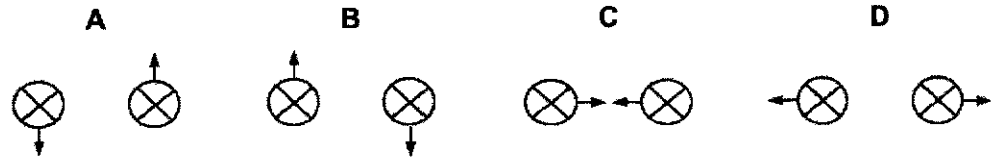
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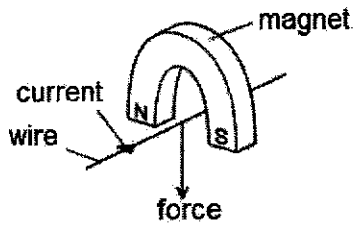
35 Each diagram is a cross-section through two parallel current-carrying conductors.

In both conductors, the current direction is into the plane of the paper. Both conductors carry equal amount of current.

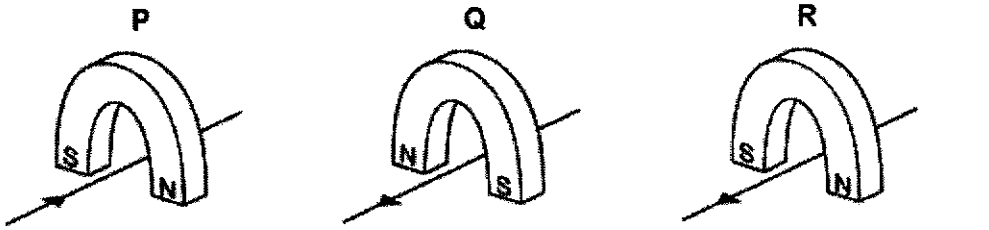
Which diagram shows the forces on the two conductors?



36 A wire passes between the poles of the horseshoe magnet. The current flowing in the wire causes a downward force on the wire.



Three other arrangements, **P**, **Q** and **R** of the wire and magnet are set up as shown.



magnet turned around | current direction reversed | current direction reversed and magnet turned around

Which arrangement(s) will cause a force in the same direction as the original arrangement?

A **P** only

B **R** only

C **P** and **Q** only

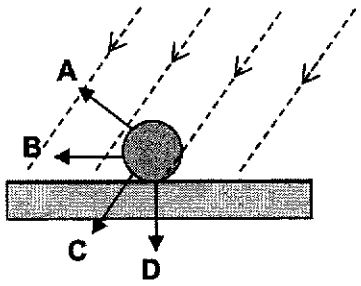
D **P**, **Q** and **R**

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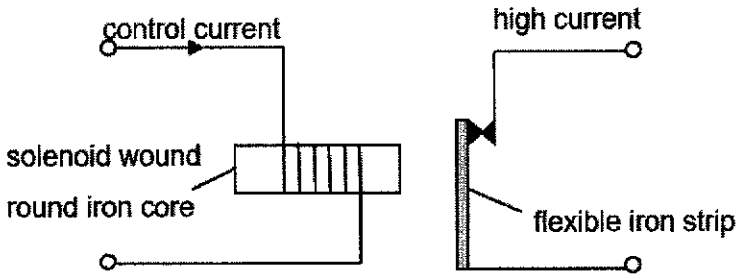
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37 The diagram shows the cross-section of a cable lying on the ground. There is a direct current in the cable. The Earth's magnetic field is in the direction shown.

Which arrow gives a possible direction for the magnetic force on the cable?



38 In the circuit shown, a control current is used to switch off a high current.



When the control current is switched on, the high current does not switch off.

Which change might switch off the high current?

A moving the strip further away from the iron core

B reducing the number of turns around the iron core

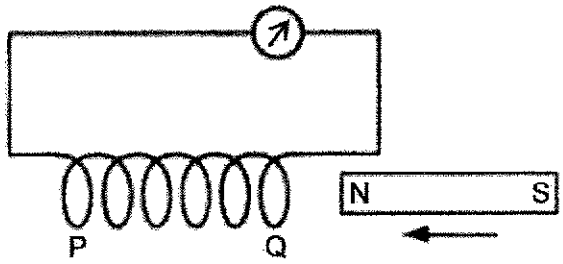
C replacing the iron core by a steel core

D using a larger control current

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39 A student pushes the N-pole of a bar magnet towards Q of a long solenoid and observes a deflection to the right on the sensitive galvanometer.



What will produce a deflection in the same direction?

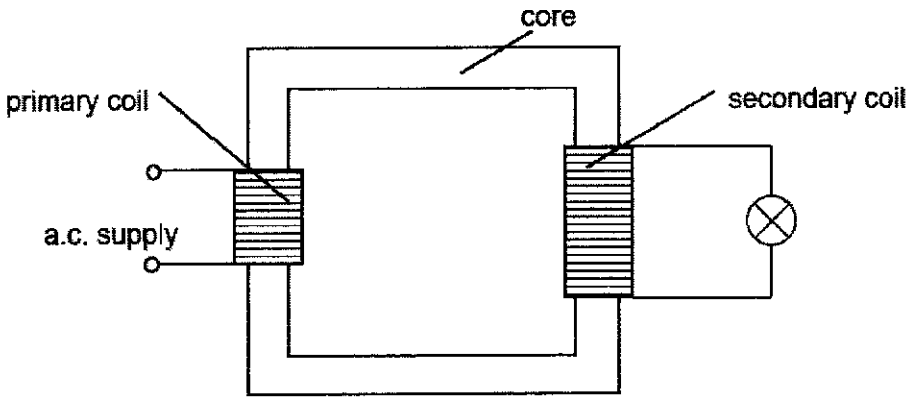
A pulling the N-pole away from Q

B pulling the S-pole away from P

C pushing the N-pole towards P

D pushing the S-pole towards P

40 The diagram shows a simple transformer with more turns on the secondary coil than the primary coil.



Which of the following statement is correct?

A An alternating current in the primary coil gives rise to a voltage in the secondary coil.

B The current in the secondary coil is larger than the current in the primary coil.

C There is a current from the primary coil to the secondary coil through the core.

D Transformers are more efficient when using d.c. current.

End of Paper

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JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

PHYSICS

6091/02

Paper 2 Theory

25 Aug 2021

1 h 45 min

Candidates answer on the Question Paper.

No Additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
Do not use paper clips, highlighters, glue or correction fluid.

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

Section B
Answer all questions. Question 12 has a choice of parts to answer.

Candidates are reminded that all quantitative answers should include appropriate units.
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.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	
Section B	
Total	

This document consists of **22** printed pages.

[Turn over

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Section A (50 marks)

Answer **all** questions in this section.

1 Fig. 1.1 shows a car moving along a horizontal road.
The car has a mass of 800 kg.

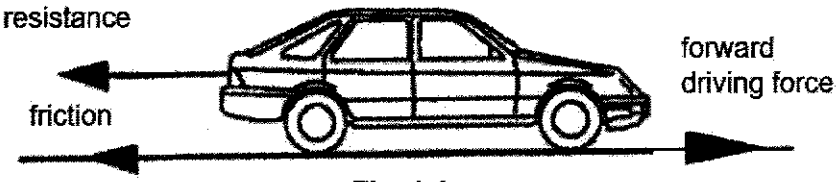


Fig. 1.1

(a) Fig. 1.2 shows the path of the car as it travels from A to B at 30 km/h due west for 1 hour and then from B to C at 40 km/h due south for 1 hour.

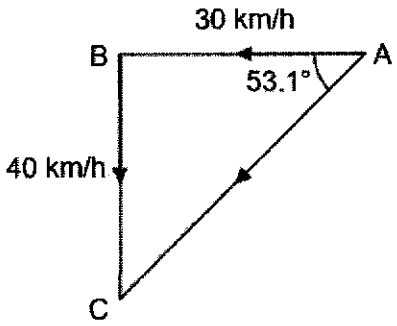


Fig. 1.2

(i) State the difference between speed and velocity.

.....

..... [1]

(ii) Hence, calculate the average speed and average velocity of the car for the 2 hour journey.

average speed = ...

average velocity = ... [1]

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(b) At one point in its motion, when the combined effect of air resistance and friction on the car is 400 N, the acceleration of the car is 1.4 m/s^2.

Calculate the forward driving force required to accelerate the car.

force = ... [2]

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2 Fig. 2.1 shows a student doing a push-up and is stationary at this position.

A force *F* acts upwards on his hands. There is also a force *R* acting upwards on his toes.

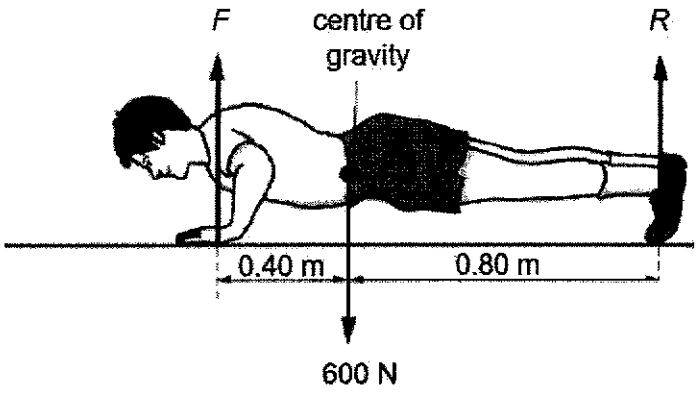


Fig. 2.1

(a) Describe how the student does work as his body rises from the ground.

.....

..... [1]

(b) State the form of energy that the student uses to do this work.

..... [1]

(c) The weight of the student produces a moment about his toes.

(i) Calculate the force *F* for the student to remain in equilibrium.

force *F* = ... [2]

(ii) Hence, calculate the value of the force *R*.

force *R* = ... [1]

(iii) The student wants to train harder.

Suggest and explain how he can modify his push-up position to achieve this.

.....

.....

..... [2]

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3 A student is given a square, metal plate of unknown density. Using various measuring instruments, he attempts to determine the density of the metal plate.

Fig. 3.1 shows the length, width and mass of the metal plate he has measured.

length of metal plate / cm	width of metal plate / cm	mass of metal plate / g
30.0	30.0	678.5

Fig. 3.1

(a) The student uses a micrometer screw gauge to measure the thickness of the metal plate once.

Fig. 3.2 shows the micrometer reading taken by the student.

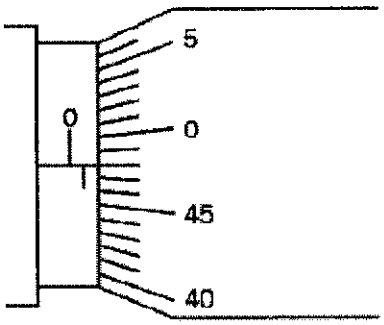


Fig. 3.2

(i) Determine the thickness of the metal plate.

thickness = ... [1]

(ii) Calculate the density of the metal plate.
Leave your answer in g/cm^3.

density = ... g/cm^3 [3]

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(b) **(i)** It is not advisable to take only one measurement of the thickness of the metal plate. Suggest a reason why.

.....

..... [1]

(ii) Describe how you would use the micrometer screw gauge to determine, as reliable as possible, the thickness of the metal plate.

.....

.....

.....

..... [2]

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4 Fig. 4.1 shows a round-bottomed flask connected to a mercury manometer. The air inside the flask is warm.

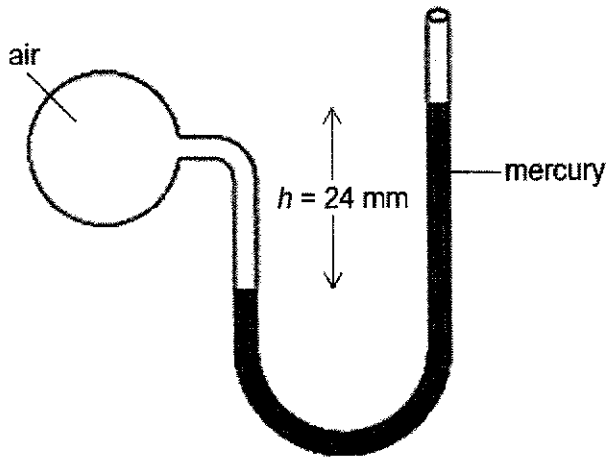


Fig. 4.1

(a) Taking atmospheric pressure to be 760 mmHg, and the density of mercury to be 1.36×10^4 kg/m^3, calculate the pressure of the air inside the flask, leaving your answer in SI units.

pressure = ... [2]

(b) The air inside the flask cools. State and explain what happens to the height *h* of the mercury.

.....

.....

.....

..... [2]

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5 Fig. 5.1 shows the path of a ray of light, ray P, through a right-angled prism.

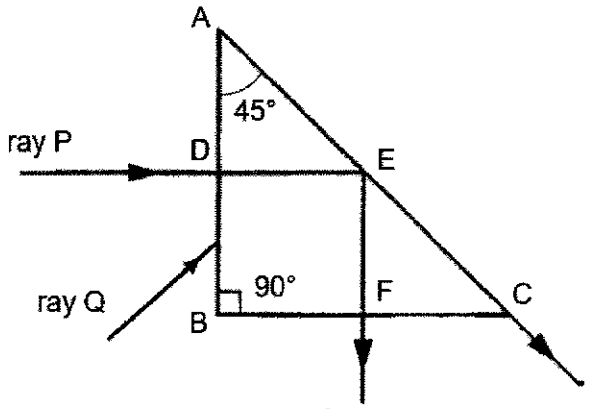


Fig. 5.1

(a) Explain what occurs at point E where the light ray splits into F and C.

.....

.....

..... [2]

(b) On Fig. 5.1,

(i) mark and label the critical angle *c* for the prism, [1]

(ii) complete the path for ray Q. [1]

(c) Determine the speed of the light ray at point F in the glass.

speed = ... [2]

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6 Fig. 6.1 shows a swimming pool which is equipped with a 'wave machine'. This machine makes straight waves in the water at the deep end of the pool, and these waves travel the length of the pool to the shallow end.

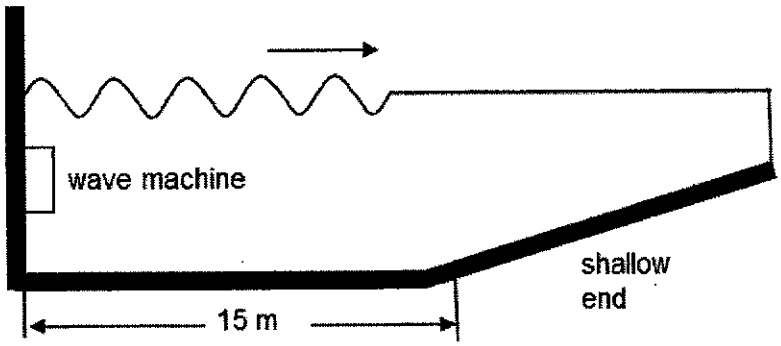


Fig. 6.1

The machine makes 30 waves per minute. In the deep end of the pool, the waves have a velocity of 1.25 m/s.

(a) Calculate the wavelength of the waves in the deep end of the pool.

wavelength = ... [2]

(b) Fig. 6.2 shows the top view of the wavefronts (not drawn to scale) in the deep end of the pool about to reach the shallow end.

On Fig. 6.2, sketch the next 4 wavefronts. [1]

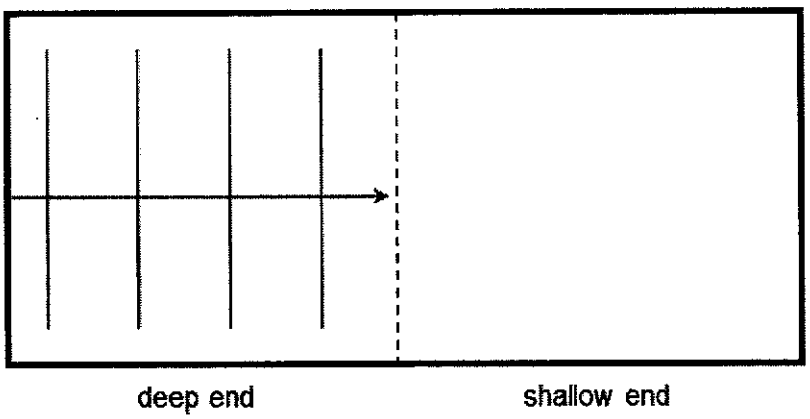


Fig. 6.2

(c) Explain the sketch in **(b)**.

.....

..... [1]

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7 A small drop of oil placed between two charged plates experiences a force F as shown in Fig. 7.1.

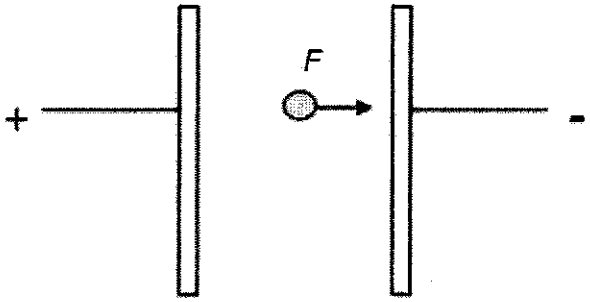


Fig. 7.1

(a) Suggest and explain the type of charge carried by the drop of oil.

.....

.....

..... [2]

(b) Fig. 7.2 shows the actual path taken by the drop of oil in between the plates.

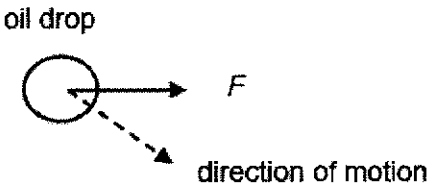


Fig. 7.2

Explain why the oil moved in the direction shown.

.....

.....

..... [2]

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8 A student is investigating the operation of a soap dispenser. A set volume of liquid soap is dispensed when a sensor in an electronic switch detects a hand underneath the nozzle as shown in Fig. 8.1.

The student suggests that a light dependent resistor (LDR) could be used as the sensor in the electronic switch. The circuit is set-up with a 5000 Ω fixed resistor, an LDR and a 12 V supply as shown in Fig. 8.2.

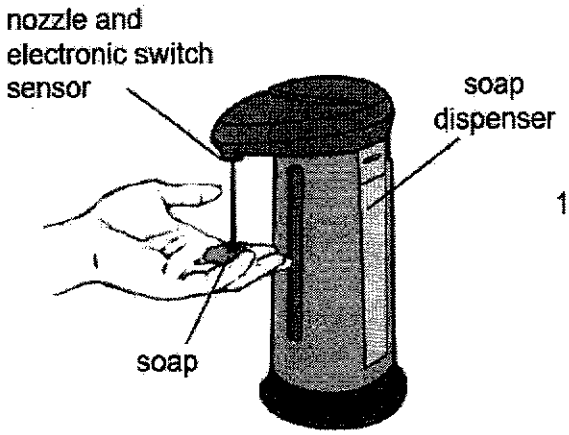


Fig. 8.1

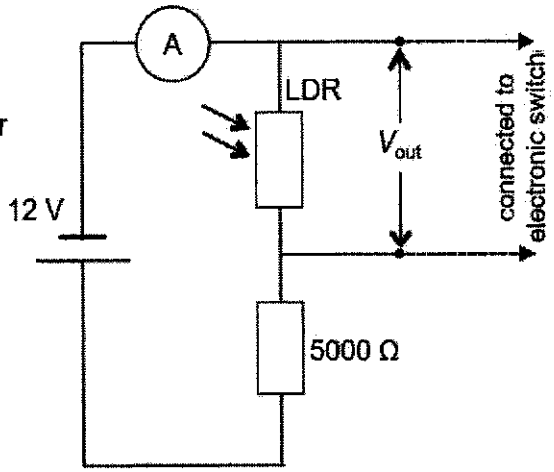


Fig. 8.2

(a) When the LDR is unblocked, the reading on the ammeter is 0.0015 A.

Calculate

(i) the resistance of the LDR,

resistance = ... [2]

(ii) the potential difference across the LDR.

p.d. = ... [2]

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(b) The electronic switch of the nozzle is activated to dispense soap when V_{out} is larger than the value calculated in **(a)(ii)**.

Explain how the soap dispenser works.

.....

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..... [3]

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9 Fig. 9.1 shows a magnet, two compasses and two nails.

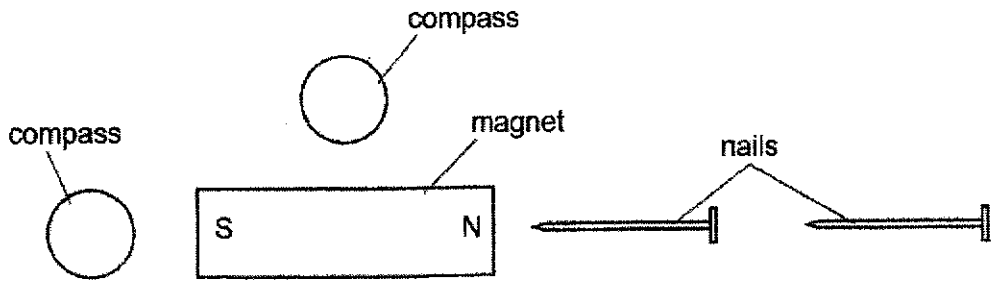


Fig. 9.1

(a) On Fig. 9.1, draw an arrow in each compass to show the direction of the magnetic field of the magnet at the two positions. [2]

(b) The magnet causes the nails to become magnetised by induction.

On Fig. 9.1, mark an N or an S at both ends of each nail to indicate their polarities. [2]

(c) When the magnet is removed, the nails are still magnetised.

(i) Describe how to test whether the nails are still magnetised when they are away from the magnet.

.....

..... [1]

(ii) Describe, with the aid of a diagram, how the nails can be demagnetised using the electrical method.

.....

.....

.....

..... [2]

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Section B (30 marks)

Answer **all** the questions from this section.
Answer only one of the two alternative questions in **Q12**.

10 The Senoko power station in Singapore contains a Combined Cycle Plant to generate electricity. Natural gas is burnt in a combustion chamber and the hot gases produced are used to drive four gas turbines connected to electrical generators. The exhaust gases from the four gas turbines are passed through a Heat Recovery Steam generator, where thermal energy is used to produce steam at high pressure. Each second, 76 kg of steam is output from the Heat Recovery Steam Generator.

This steam is passed into two steam turbines, which are also connected to electrical generators.

This multi-stage process ensures that 46% of the total energy in the natural gas is converted into electrical energy. When the Heat Recovery Steam Generator and steam turbines are used, the total electrical power output of the plant increases without burning more natural gas.

Details of the gas and steam turbines are given and a simplified diagram of the Heat Recovery Steam Generator is shown in Fig. 10.1.

Gas turbines

gas input temperature	1050 °C
gas output temperature	555 °C
electrical output from generator connected to each turbine	131 MW

Steam turbines

electrical output from generator connected to each turbine	163 MW

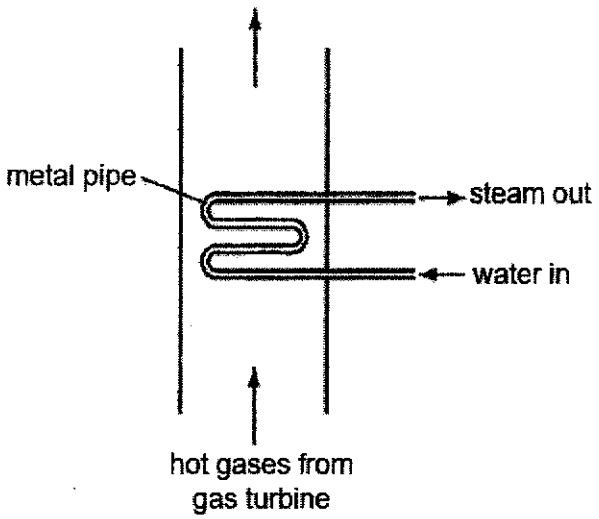


Fig. 10.1

(a) Explain why the addition of the Heat Recovery Steam Generator and the steam turbines allows more electrical power to be generated without burning more natural gas.

.....

.....

.....

..... [2]

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(b) Describe how energy is transferred from the hot gases to the water in the Heat Recovery Steam Generator.

.....

.....

.....

..... [2]

(c) Explain, in terms of molecular behaviour,

(i) how the internal energy of the gas decreases as it passes through the gas turbine,

.....

..... [1]

(ii) why energy is needed to produce steam in the Heat Recovery Steam Generator.

.....

.....

..... [2]

(d) Given that the specific latent heat of vaporisation of water is 2.3×10^6 J/kg, calculate the thermal energy required to produce the mass of steam output each second from the Heat Recovery Steam Generator,

energy per second = ... MW [1]

(e) **(i)** Calculate the total electrical power output from the Combined Cycle Plant comprising four gas turbines and two steam turbines.

power = ... MW [1]

(ii) Hence, determine the total energy input per second of natural gas into the plant.

energy per second = ... MW [1]

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11 A student builds a motor which consists of a coil **ABCD**, two metal rings and two magnets. The two ends of the coil are soldered to the two metal rings as shown in Fig. 11.1.

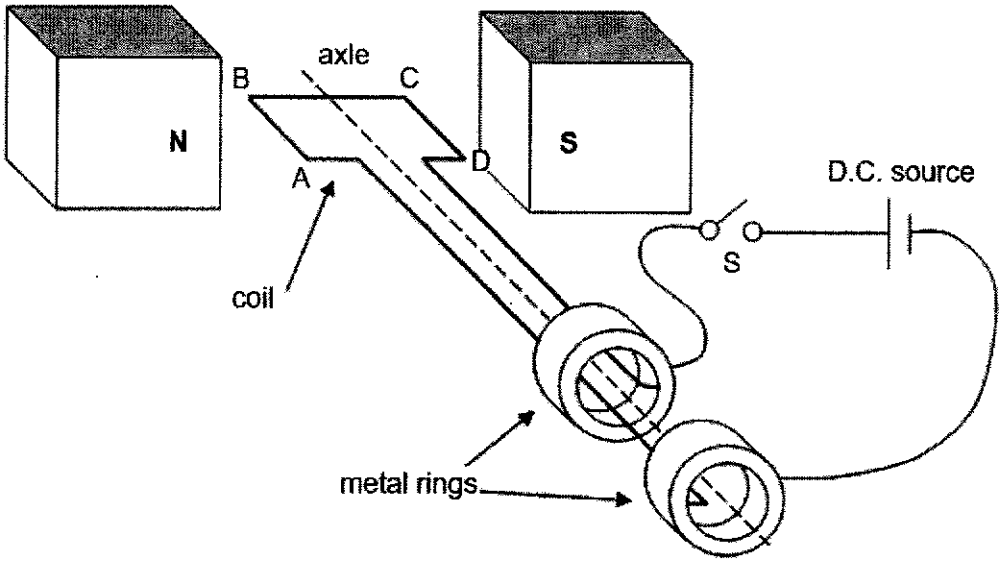


Fig. 11.1

(a) **(i)** Fig. 11.2 shows the front view of the design of the motor.

On Fig. 11.2, draw the direction of the force acting on the sides **AB** and **CD** of the coil when switch **S** is closed. [1]

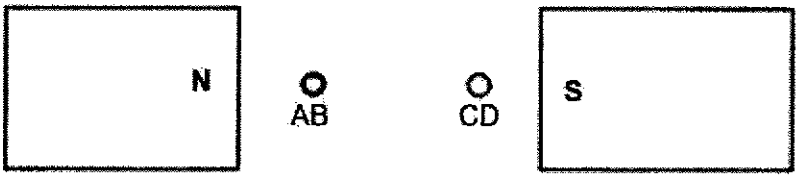


Fig. 11.2

(ii) Hence, state the direction in which the motor turns when switch **S** is closed.

..... [1]

(iii) It is observed that due to momentum, the coil moves to the position as shown in Fig. 11.3.

On Fig. 11.3, draw the direction of the force acting on wire parts **AB** and **CD**. [1]



Fig. 11.3

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(iv) There is a fault with the design of this motor set up by the student.

Explain what is wrong with the set up.

.....

..... [1]

(v) State a solution and explain briefly how it can help to rectify the motor's design.

.....

.....

.....

..... [2]

(b) Fig. 11.4 shows two towers that support a single cable of length 20.0 km, which links a factory to the electrical grid. The voltage at the tower A is at 6000 V while the voltage at the factory is at 5500 V.

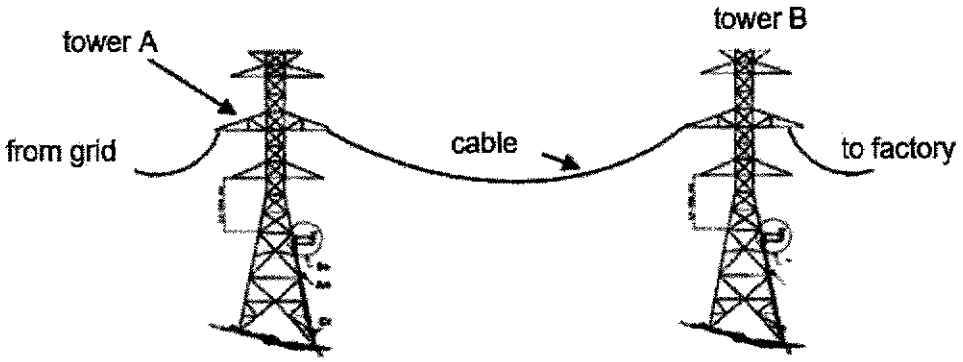


Fig. 11.4

The cable used is made from aluminium which has a resistance of 3.6 Ω/km.

Calculate the

(i) power loss in the cable,

power loss = ... [2]

(ii) cost of the power loss for a day given that 1 kWh costs $0.15.

cost = ... [2]

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EITHER

Fig. 12.1 shows the circuit diagram of a hairdryer. A motor-driven fan and a heating element are used to generate warm air. The hairdryer is connected to a 240 V a.c. supply. Switch S can be connected to either contact **X** or **Y**.

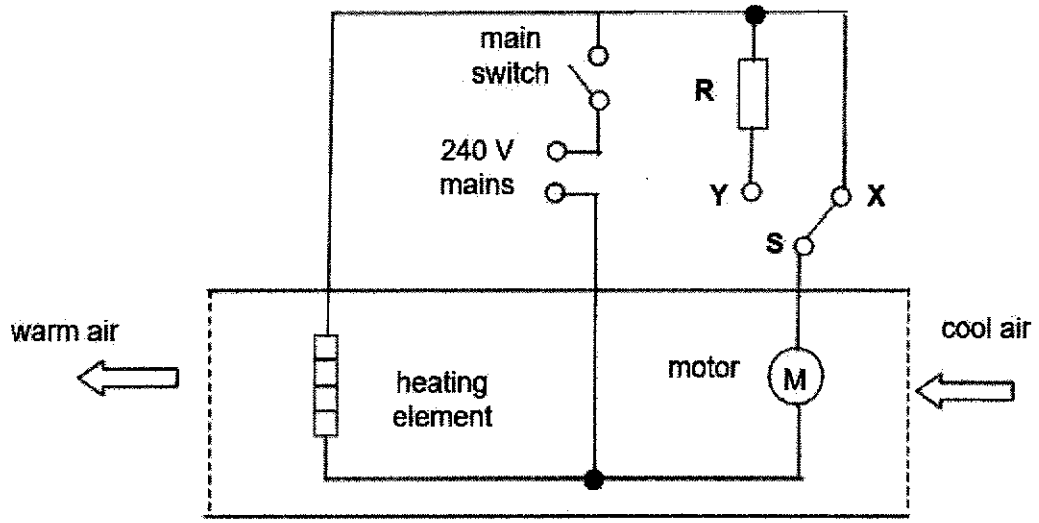


Fig. 12.1

(a) The hairdryer is used to dry wet hair.

Explain, using kinetic theory of particles, how the hairdryer can increase the rate of evaporation of water from the wet hair.

.....

.....

.....

.....

..... [3]

(b) During quality control tests of the hairdryer in the factory, the main switch is closed, with switch **S** being connected to contact **X**. Some measurements are made and the data is shown in Fig. 12.2.

resistance of the heating element	30 Ω
resistance of resistor **R**	20 Ω
temperature of air entering the hairdryer	25 °C
rate of air flow through the hairdryer	0.055 kg/s
specific heat capacity of air	1000 J/kg°C

Fig. 12.2

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(i) Calculate the amount of thermal energy supplied by the heating element per second.

energy per second = ... [1]

(ii) Estimate the temperature of the air flowing out of the hairdryer.

temperature = ... [2]

(iii) State one assumption in your calculation for **(b)(ii)**.

.....

..... [1]

(c) Switch **S** is then connected to contact **Y**. State and explain whether there is any change in the temperature of the air flowing out of the hairdryer, as compared to when switch **S** is connected to contact **X**.

.....

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.....

..... [3]

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OR

(a) Fig. 12.3 shows a trumpet producing a single note. The sound produced is picked up by a microphone and converted to an electrical waveform. The electrical waveform of the note is displayed on a cathode ray oscilloscope (C.R.O.).

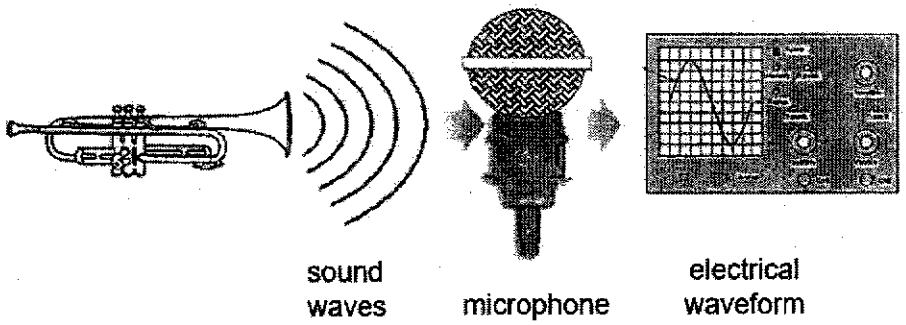


Fig. 12.3

Fig. 12.4 shows the internal parts of the microphone and the connection to the C.R.O.

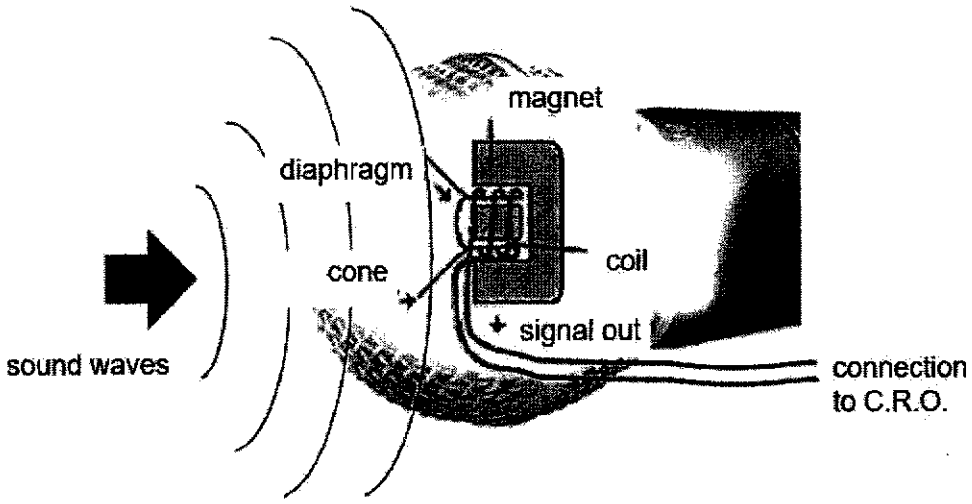


Fig. 12.4

A coil of wire is attached to the cone. A diaphragm that is connected covers the mouth of the cone. Describe how the sound waves from the trumpet is converted into the electrical waveform.

.....

.....

.....

.....

..... [3]

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(b) The trumpet then played another single note. Fig. 12.5 shows the waveform displayed on the oscilloscope screen.

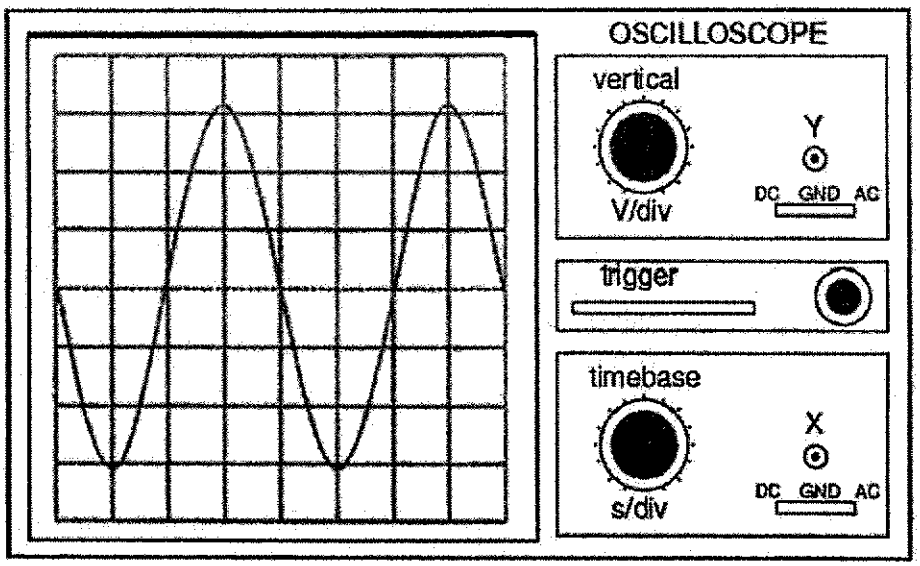


Fig. 12.5

(i) Given that the time base is set at 200 ms/div, determine the frequency of the note produced by the trumpet.

frequency = ... [2]

(ii) The time base is now adjusted to 50 ms/div. Draw on Fig. 12.5, the appearance of the waveform after the adjustment of the time base. [2]

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(c) The electrical waveform produced by the microphone is input into a mixer, an amplifier and finally to a speaker as shown in Fig. 12.6(a).

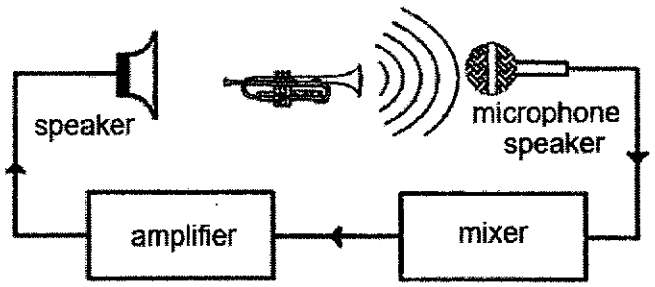


Fig. 12.6(a)

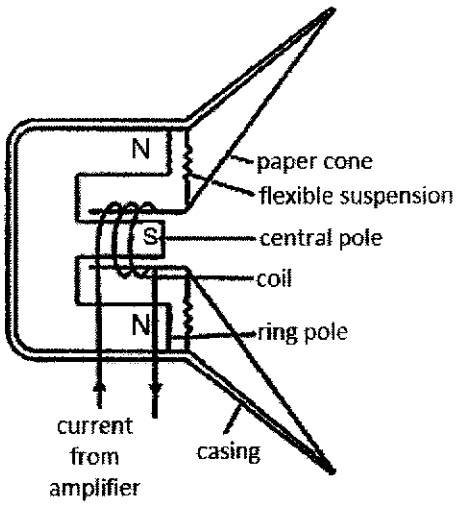


Fig. 12.6(b)

Fig. 12.6(b) shows the internal structure of the speaker.

Explain how the electrical waveform in Fig. 12.5 is eventually converted into sound after it is input into the speaker.

.....

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.....

..... [3]

End of Paper

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1-5	**BDDCB**	**6-10**	**DAACC**	**11-15**	**CABBA**	**16-20**	**CBCDB**
21-25	**CDBCB**	**26-30**	**DCDCA**	**31-35**	**CDBBC**	**36-40**	**BADDA**

Section A

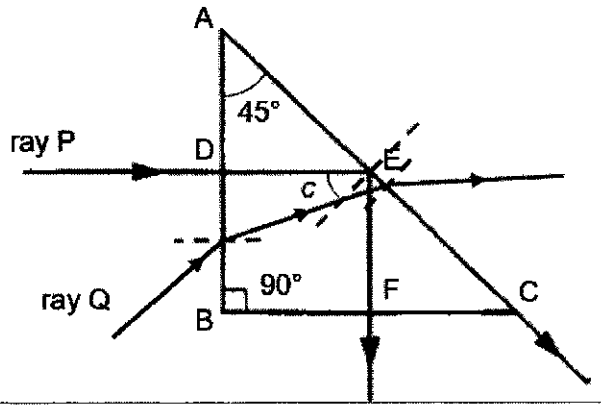
No	Marking Scheme	Marks	Remarks
A1a	distance = 30 + 40 = 70 km speed = 70/2 = 35 km/h displacement = 30 / cos 53.1 OR 40 / sin 53.1 OR by pythagoras' theorem = 50 km Velocity = 50 / 2 = 25 km/h Speed is the total distance travelled per unit time, whereas velocity is the total displacement per unit time.	 1 1	Most students stated **a** difference between speed and velocity, which is that speed is a scalar and velocity is a vector quantity. However, that is not the **key** difference between speed and velocity.
A1b	$F_R = F - f$ 800 x 1.4 = F – 400 F = 1520 N	 1 1	Some students merely calculated 800 x 1.4, without considering friction. Some students subtracted away the friction component instead of adding it. They should consider forming a clear equation before solving, to avoid such a mistake.
A2a	Force *F* on his body is in the same direction as the distance moved by his body.	1	Some students loosely used words like 'parallel to the force', where it should be 'in the same direction to the force'. Some answers were unclear about the direction of the force.
A2b	Chemical potential energy	1	Many students incorrectly wrote kinetic energy instead.
A2ci	Taking moments about his toes, 600 x 0.8 = F x 1.2 F = 400 N	 1 1	Mostly well done.
A2cii	W = F + R 600 = 400 + R R = 200 N	 1	Mostly well done.

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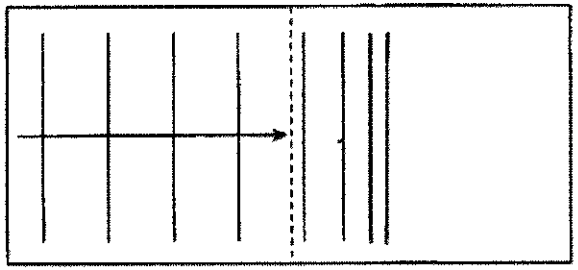
A2cIII	Put his hands nearer to his centre of gravity. This will lead to a shorter perpendicular distance from the pivot, hence a larger force will be required to balance the same moment due to his weight. Other accepted answers: pushup with one hand only/elevate toes to higher position to increase force required to keep horizontal position.	1 1	Generally well done, as students were able to describe how a greater moment could be produced. Weaker answers failed to mention 'perpendicular distance'.
A3ai	0.98 mm	1	Mostly well done.
A3aii	vol = 30.0 x 30.0 x 0.098 = 88.2 cm^3 density = $\frac{678.5}{88.2}$ = 7.69 g/cm^3	1 1 1	Mostly well done. Some students were confused with the conversion from mm to cm.
A3bi	The thickness of the metal plate may not be uniform	1	Mostly well done. Some students mentioned errors that could have been avoided, such as parallax errors and zero errors.
A3bii	Measure the thickness of the metal plate at three different points on the metal plate. Calculate the average of the readings taken to find the thickness of the metal plate. Awarded one mark for students who identified zero error in (b)(i), and described how to eliminate zero error in this part of the question.	1 1	Some students merely mentioned taking multiple readings, without mentioning that these readings should be taken at different positions along the metal.
A4a	$P_a = P_a + P_l$ $P_a = (0.76 + 0.024)(13600)(10)$ $P_a = 1.07 \times 10^5$ Pa	 1 1	Very poorly done. Students were unsure of the SI unit of pressure, and many students incorrectly combined pressure in mmHg with pressure in Pa.
A4b	**KE** of the air molecules **decreases when its temperature drops**. The air molecules exert **less pressure** on the liquid making *h* **shorter**.	1 1	Generally well done.
A5a	The angle of incidence at E is equal to the critical angle of the prism. Hence, part of the light is reflected back into the prism, while the rest is refracted along the prism-air boundary.	1 1	Very poorly done. Most students incorrectly mentioned that the angle of incidence is *greater than* the critical angle, and that TIR occurs with a *weak refracted ray*.

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A5bi **A5bii**		1, 1	Mostly well done
A5bc	$\frac{c}{v} = \frac{1}{\sin c}$ $v = c \times \sin c$ $v = 3 \times 10^8 \times \sin 45$ $v = 2.12 \times 10^8 m/s$	 1 1	Mostly well done
A6a	$f = \frac{30}{60} = 0.5\,\text{Hz}$ $v = f\lambda$ $1.25 = 0.5\lambda$ $\lambda = 2.5\,\text{m}$	1 1	Very well done

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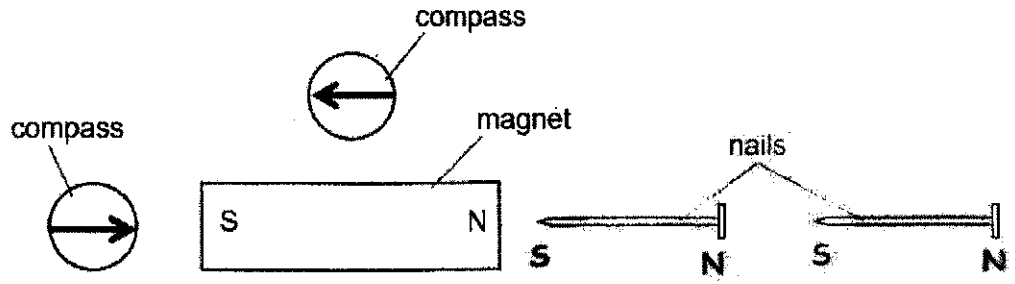
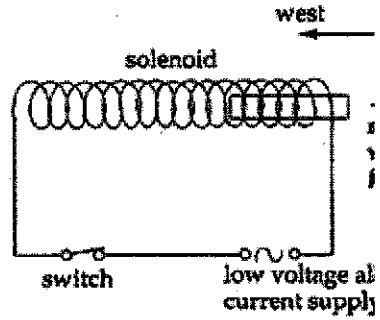
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A6b	 Must show wavelength decreasing Deep end Shallow end	1	Poorly drawn. Many students drew equally spaced wavefronts, and some were not drawn using a ruler.
A6c	As the depth decreases, the **velocity of the wave will also decrease**. Since the **frequency of the wave is constant**, as the velocity decreases, the wavelength will also decrease.	1	Many failed to describe that frequency is kept constant, or that velocity and wavelength are directly proportional.
A7a	The oil is positively charged. It experiences a resultant force in the direction of the negatively charged plate.	1 1	Very well done.
A7b	The weight of the oil acts vertically downwards on it. The force F and its weight produce a resultant force in the direction of the motion.	1 1	Poorly done. Most students tried to find a relation to the charges of the plates, rather than consider gravitational force.
A8ai	$R = \frac{V}{I} = \frac{12}{0.0015} = 8000\ \Omega$ $R_{LDR} = 8000 - 5000 = 3000\ \Omega$	1 1	Very well done.
A8aii	$V_{LDR} = I \times R_{LDR}$ $= 0.0015 \times 3000$ $= 4.5\ V$	1 1	Very well done.

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A8b	When the LDR is covered by the hand, the light intensity falling on the LDR decreases. This causes the resistance of the LDR to increase, and the voltage of the LDR increases beyond 4.5 V. Since V_{out} is connected parallel across the LDR, V_{out} will also exceed 4.5 V, and the electronic switch will be switched on.	1 1 1	Mostly well done. Some students also included the description of when the soap dispenser does not dispense soap.
A9a,b		2, 2	Very well done.
A9ci	Place both ends of each nail near the north pole of a magnet. If one end is repelled from the magnet, the nail is still magnetized.	1	Poorly done. May students described testing for attraction only, which can only confirm that the nail is a magnetic material.
A9cii	 Place each nail in a solenoid facing east-west direction as shown above. Switch on the alternative current. Slowly remove the nail from the solenoid while the alternating current is still on.	1 for clear diagram 1 for clear description	Mostly well done. Some students missed out mentioning placing the magnet in the east-west direction, or some drawings and descriptions did not show a closed circuit.

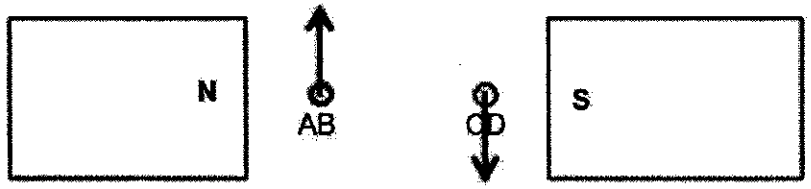
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Section B			
No	**Marking Scheme**	**Marks**	**Remarks**
B10a	The hot output gases at 555 °C from the gas turbines is used to boil 76 kg of water per second in the Heat Recovery Steam Generator. The high pressure steam produced is then used to produce more electrical energy with the steam turbines.	1 1	Not necessary to state exact values. Poorly done. Many students merely repeated the question in their answer, instead of using information provided.
B10b	Heat is transferred by convection as the less dense hot gases rises towards the metal pipes. As the hot gases pass over the metal pipes, heat is transferred by conduction through the walls of the metal pipes to the water in the pipes, which is then heated up to produce steam.	1 1	Most students failed to mention convection in the gas.
B10ci	The temperature of the gas decreases from 1050 °C to 555 °C. So the internal average kinetic energy of the gas molecules has decreases.	1	Some students did not mention that it is the *kinetic energy* that is decreasing, and gave vague answers.
B10cii	Energy is needed by the water molecules to do work to weaken the forces of attraction between the molecules in the liquid state so that they can exist as molecules in the gaseous state. Molecules in a gas are able to move about freely at high speeds because there is negligible forces of attraction between them.	1 1	Poorly done. Some students incorrectly used 'break forces of attraction', rather than *weaken*.
B10d	Q = ml = 76 x 2.3 x 10^6 = 175 MW (3sf)	1	Mostly well done. Some students did not convert units to MW.
B10ei	total electrical output = (4 x 131) + (2 x 163) = 850 MW	1	Mostly well done.
B10eii	total energy input = (100/46) x 850 = 1850 MW (3sf)	1	Mostly well done.

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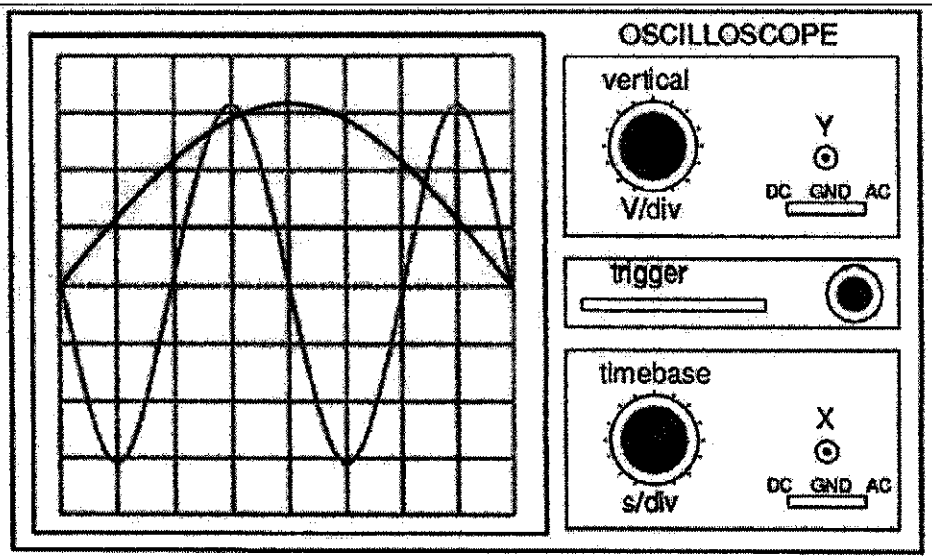
B11ai		1	Mostly well done.
B11aii	clockwise	1	Mostly well done.
B11aiii		1	Mostly well done.
B11aiv	The rectangular coil will only swing in a clockwise manner and turn anticlockwise after passing through the vertical position. It will oscillate about the vertical position.	1	Most students were able to describe the problem, some students provided a solution here, which was not required.
B11av	The ends of coil ABCD should be connected to a split ring commutator. Each half of the commutator presses against a carbon brush in good contact. The commutator reverses the direction of the current in the coil every half a revolution whenever the split ring changes contact from one carbon brush to the other.	1 1	Students need to be aware of the correct term *split ring commutator.* The mark was awarded even if students did not mention carbon brushes.
B11bi	Resistance of the wire = 20 x 3.6 = 72 Ω Power loss = V^2 / R = 500^2/ 72 = 3470 W	 1 1	CLT
B11bii	Cost = 3470/1000× 0.15 x 24 = $ 12.50	1 1	CLT
EITHER B12a	The hair dryer produces fast moving hot air molecules which collide with the water molecules on the wet hair and transfer thermal energy to it. The water molecules increase in KE and they move more vigorously/at higher speeds.	1 1 1	Students failed to describe how the water is heated through collisions with the fast moving air molecules. Also, in describing evaporation, students did not mention overcoming atmospheric force.

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	Thus, more water molecules at the surface of the water are able to overcome the forces of attraction between the other water molecules and the atmospheric force and escape into the surrounding.		
B12bi	Thermal energy per second = $P = V^2/R$ $= 240^2 / 30$ $= 1920$ W	1	Mostly well done
B12bii	Heat lost by heating in 1 s = heat gained by air in 1 s $1920 = 0.055 \times 1000 \times \Delta\theta$ $\Delta\theta = 34.9$ °C Temperature of air flowing out = 25 + 34.9 = 59.9 °C	1 1	Mostly well done.
B12biii	All the heat energy is transferred to the cold air, and no energy is lost to the surroundings OR Assume resistance of motor is negligible OR All the electrical energy is converted to thermal energy in the heating element	1	Mostly well done by students who attempted the question.
B12c	The addition of resistor R reduces the current across the motor. The speed of rotation of the motor produces moving cool air at a slower rate. Hence, the temperature of the air will be hotter, as the incoming air has a smaller mass of air per second and will be heated up more.	1 1 1	Most students who attempted the question were able to describe that the air moved at a slower rate, but only a few were able to relate it to greater heating of the air.
OR B12a	The sound waves from the trumpet sets the air molecules into oscillation. This produces a series of compressions and rarefactions in the air. This causes the diaphragm to oscillate at the same frequency as the source. Since the coil of wire is attached to the cone, the coil is set into oscillations. The coil's oscillation within the magnetic field will produce a changing magnetic flux linkage. This will in turn produce an induced e.m.f. which is displayed on the oscilloscope.	1 1 1	CLT
B12bi	from the graph, T = 200 x 4 = 800 ms $f = \frac{1}{T}$ $= \frac{1}{800 \times 10^{-3}}$ =1.25 Hz	 1 1	CLT

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B12bii	 1 mark for correct amplitude 1 mark for correct number of cycles shown.	2	CLT
B12c	The current from the amplifier passes through the coil which is placed between the radial magnetic field between the two poles of the magnet. The changing current produces a changing magnetic field in the coil of wire. This changing magnetic field interacts with the radial magnetic field of the permanent magnet producing a force. Since the coil is attached to the paper cone, the force will oscillate the cone, thereby setting the volume of air into oscillation. This oscillation of the air produces the same frequency of sound played on the trumpet.	1 1 1	CLT

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