Candidate Name: ______________________ Class ____ Index No. ____

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examination 2022

4E

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PHYSICS **6091/01**

Paper 1

30 Aug 2022
0800 – 0900
1 hour

Additional Material: Optical Mark Recognition (OMR)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class, index number on the OMR and this question booklet.

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 OMR.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on this paper.

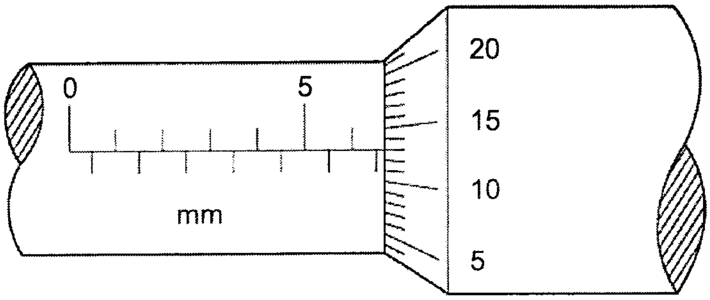
The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE	FOR EXAMINER'S USE	
		40

Setter: Mr Raymond Loh **Vetter:** Mrs Wong Kexin

This question paper consists of 15 printed pages including this page.

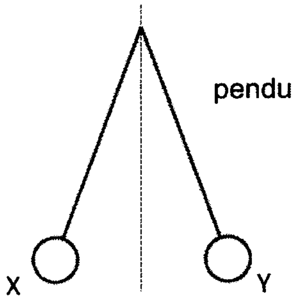
1 The diagram shows a micrometer screw gauge.



What is the reading shown?

A 5.63 mm **B** 6.50 mm **C** 6.63 mm **D** 7.13 mm

2 The diagram shows a frictionless pendulum swinging between points X and Y at a frequency of 2.0 Hz.



How long does it take for the bob to swing from X to Y?

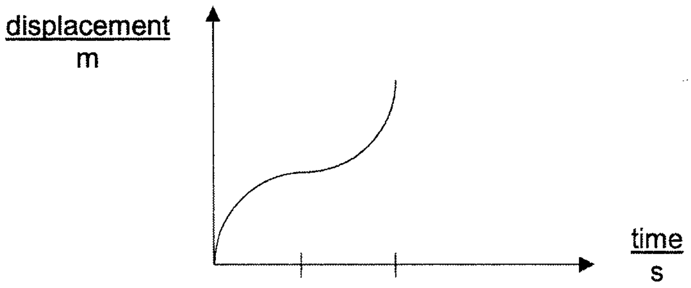
A 0.25 s **B** 0.50 s **C** 1.0 s **D** 2.0 s

3 A parachutist falling at a steady speed opens his parachute.

Which row gives the direction of the resultant force and the direction of the acceleration of the parachutist just after his parachute opens?

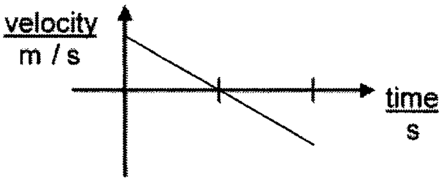
	direction of the resultant force	direction of the acceleration
A	downwards	upwards
B	downwards	downwards
C	upwards	upwards
D	upwards	downwards

4 The graph shows how the displacement of an object changes with time.

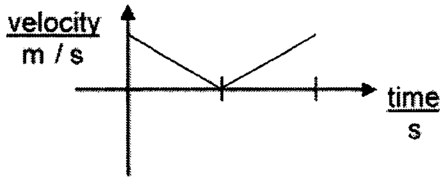


Which graph represents the velocity-time graph of the object?

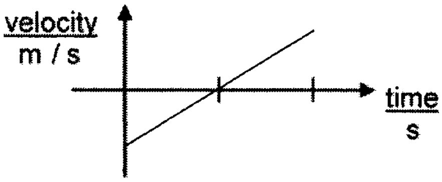
A



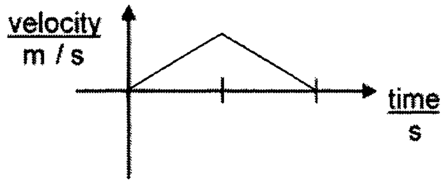
B



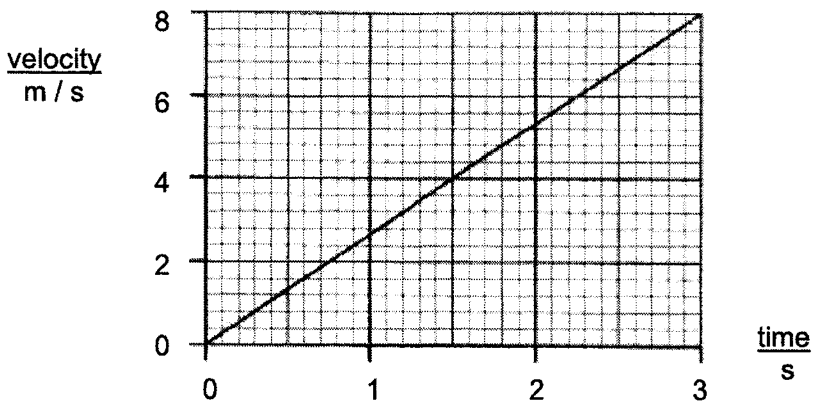
C



D



5 The graph shows how the velocity of a model car travelling on a flat surface varies with time.

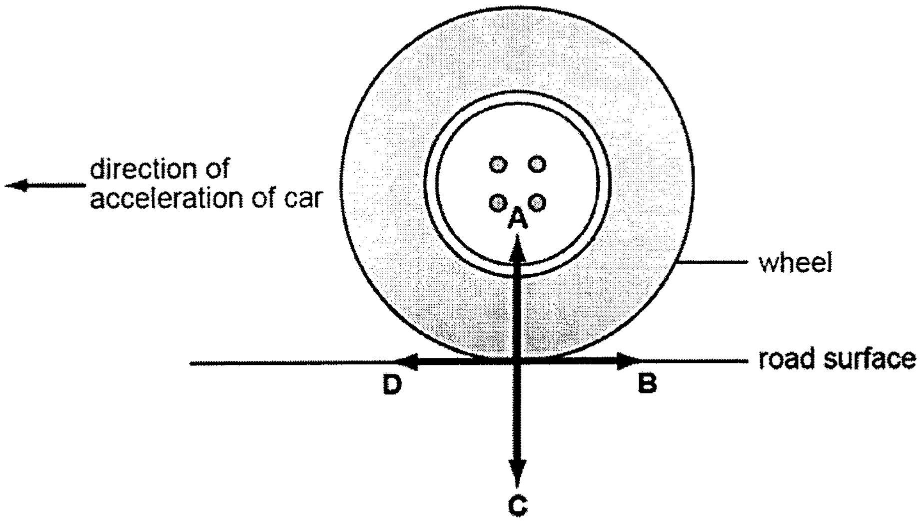


Which statement about the model car is **not** correct?

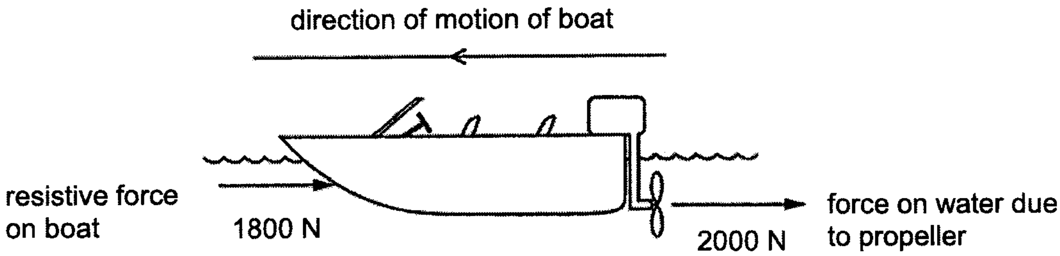
A Its acceleration is 2.7 m / s^2.
B Its distance travelled is 12 m.
C It is moving at a uniform velocity.
D It is moving in the same direction throughout the 3 s.

6 The diagram shows the wheel of a moving car. The wheel is connected to the engine. The car is accelerating along a road in the direction shown.

What is the direction of the frictional force exerted by the road surface on the wheel?



7 The propeller of a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.



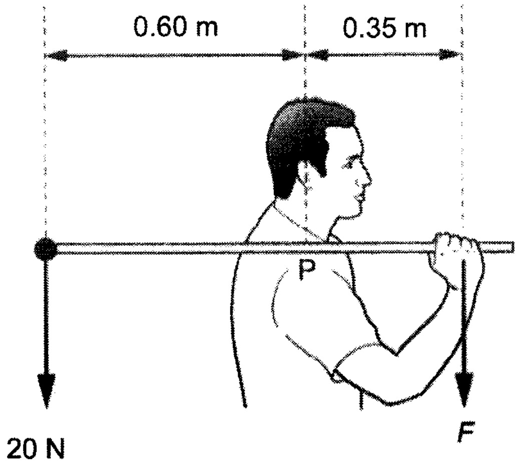
What is the magnitude of the resultant force on the boat?

A 200 N **B** 1800 N **C** 2000 N **D** 3800 N

8 Which property of an object causes the object to resist a change in the state of rest or motion of the object?

A density **B** mass **C** velocity **D** volume

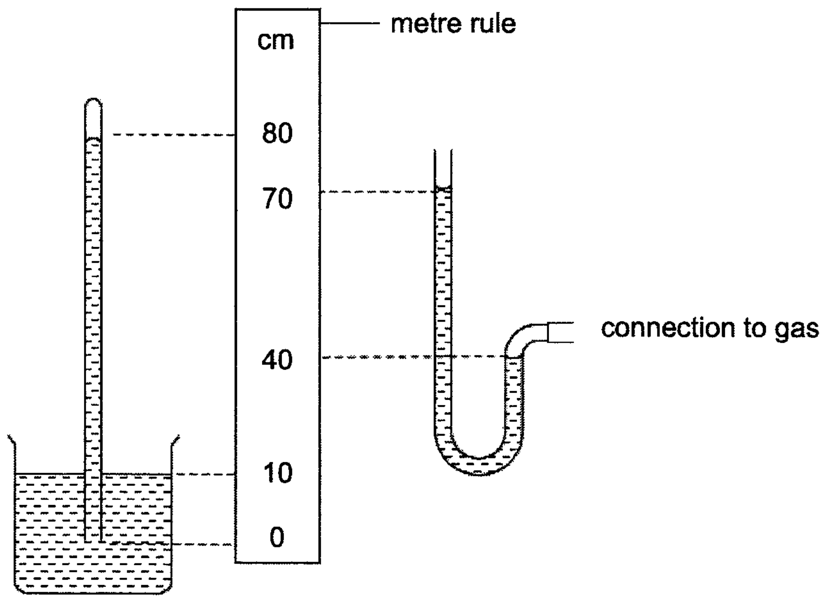
9 A man is carrying a load on the end of a uniform pole of length 1.0 m and weight 5 N. He rests the pole on his shoulder at point P which acts as a pivot. He keeps the pole in balance with a downward force *F* with his hand, as shown.



What is the force *F* applied by the man to balance the pole?

A 12.0 N **B** 17.0 N **C** 34.3 N **D** 35.7 N

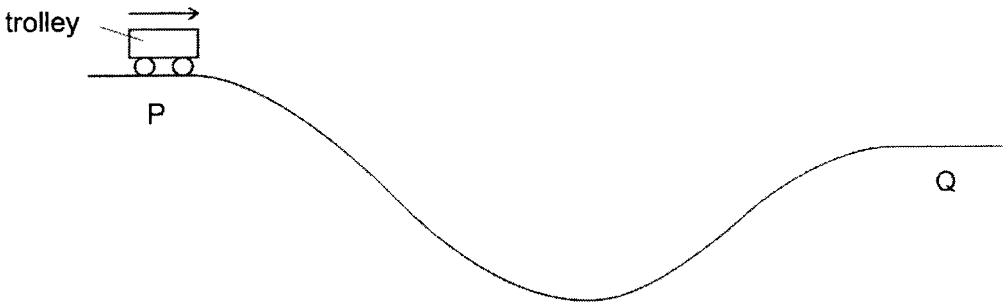
10 The diagram shows a mercury barometer and a mercury manometer placed beside each other. One end of the manometer is connected to a container filled with an unknown gas.



What is the pressure of the gas?

A 30 cm Hg **B** 60 cm Hg **C** 70 cm Hg **D** 100 cm Hg

11 A trolley of mass 20 kg moves from position P to Q along a rough track. At point Q, its gravitational potential energy is 100 J less than that at point P. Its speed at point P is 2.0 m / s. The work done against friction from point P to Q is 60 J.



What is the speed of the trolley at point Q?

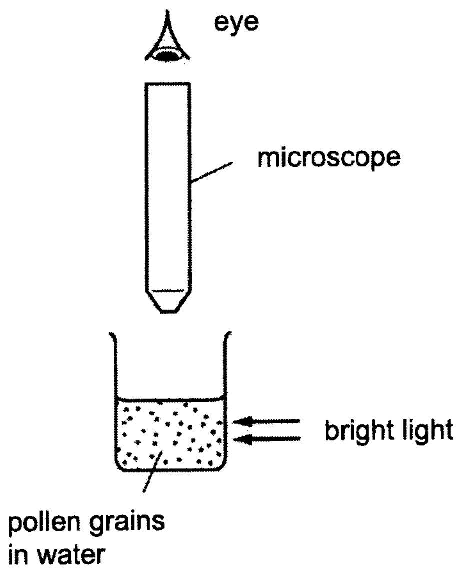
A 2.8 m / s **B** 3.2 m / s **C** 4.4 m / s **D** 5.8 m / s

12 A 1500 kg car accelerates from 10 m / s to 30 m / s in 10 s.

What is the average power output developed by the engine of the truck?

A 15 kW **B** 30 kW **C** 60 kW **D** 600 kW

13 Very small pollen grains are suspended in water. A bright light shines from the side. Through a microscope, small specks of light are seen to be moving in a random, jerky manner.



What are the moving specks of light?

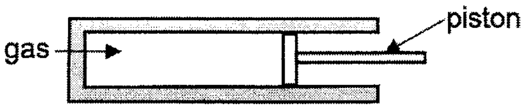
A Pollen grains being hit by other pollen grains.
B Pollen grains being hit by water molecules.
C Water molecules being hit by other water molecules.
D Water molecules being hit by pollen grains.

14 A sealed container contains nitrogen gas.

What will happen to the gas molecules when the container is heated?

A They will become denser.
B They will expand.
C They will move further apart.
D They will move more quickly.

15 The diagram shows a cylinder made of insulating material with a movable piston at one end. The piston can be pushed or pulled without the gas leaking out.



Which statement about the gas when the piston is moving is **not** correct?

A The density of the gas decreases as the piston is pulled outwards.
B The mass of the gas in the piston remains unchanged.
C The pressure of the gas decreases as the piston is pulled outwards.
D The temperature increases as the piston is pushed gently inwards.

16 When a hand is placed on a metal surface and a wooden surface at room temperature, it feels colder on the metal surface than on the wooden surface.

Which statement is the correct explanation?

A The metal surface is a better absorber of infra-red than wooden surface.
B The metal surface is a better thermal conductor than wooden surface.
C The metal surface is a better emitter of infra-red than wooden surface.
D The metal surface is at a much lower temperature than the wooden surface.

17 Which statement is true about the particles that remain in a liquid during evaporation?

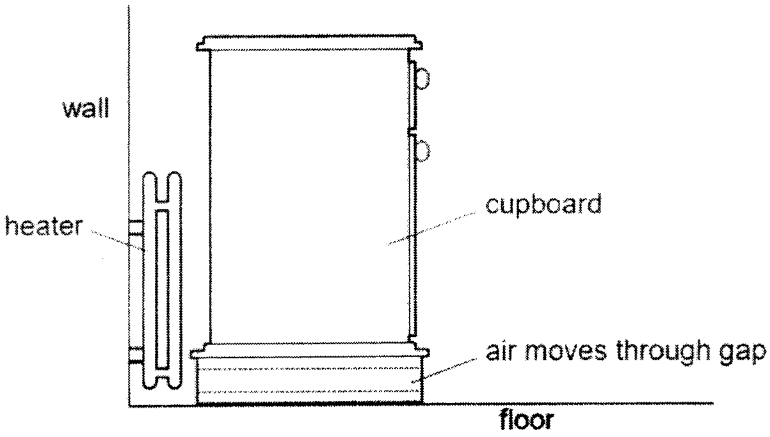
A The average size of the particles is decreasing.
B The average size of the particles is increasing.
C The average speed of the particles is decreasing.
D The average speed of the particles is increasing.

18 Two different liquids, X and Y, with the same mass and initial temperature, are heated by the same heat source. Liquid X reaches a temperature of 60°C slower than liquid Y.

Which statement is the correct explanation?

A Liquid X has a higher specific heat capacity than liquid Y.
B Liquid X has a higher specific latent heat of fusion than liquid Y.
C Liquid X has a lower specific heat capacity than liquid Y.
D Liquid X has a lower specific latent heat of fusion than liquid Y.

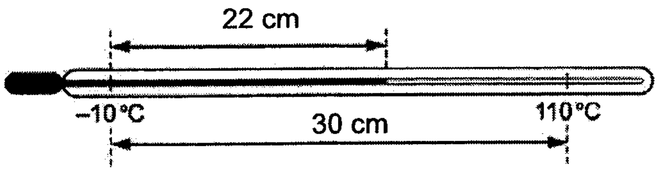
19 A cupboard is placed in front of a heater. Air can move through a gap under the cupboard.



Which of the following describes the temperature and the direction of motion of the air in the gap?

	temperature of air	direction of air
A	cool	towards the heater
B	cool	away from the heater
C	warm	towards the heater
D	warm	away from the heater

20 The diagram shows a mercury-in-glass thermometer. The distance between the –10 °C and the 110 °C markings is 30 cm.



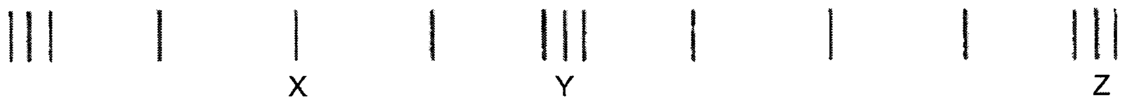
What is the temperature when the end of the mercury thread is at a distance of 22 cm from the –10 °C mark?

A 60.0 °C **B** 65.0 °C **C** 78.0 °C **D** 88.0 °C

21 Which row shows an example of a transverse wave and a longitudinal wave?

	transverse wave	longitudinal wave
A	infra-red radiation	X-ray
B	visible light	radio wave
C	ultrasound wave	ultra-violet radiation
D	gamma ray	ultrasound wave

22 A longitudinal wave travels along a spring.
The diagram represents the position of the coils of the spring at one particular instant.

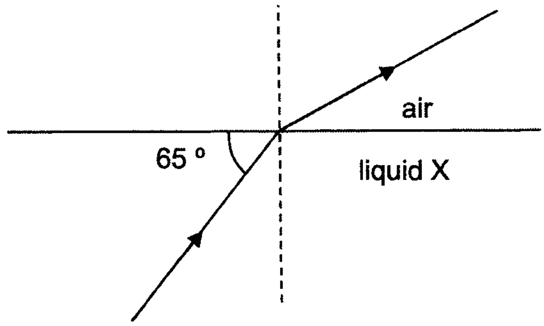


The coils vibrate from side to side. Each coil completes 4.0 oscillations in 2.0 s.

Which row shows the correct frequency and wavelength of the wave?

	frequency / Hz	wavelength / m
A	0.5	XY
B	2.0	XY
C	0.5	YZ
D	2.0	YZ

23 A ray of light is incident from below the surface of liquid X as shown in the diagram. The refractive index of liquid X is 1.2.

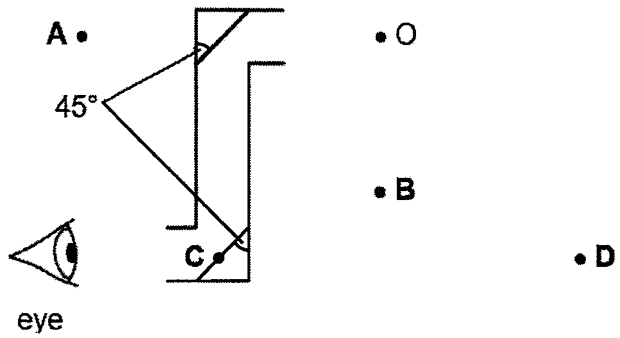


What is the angle of refraction in air?

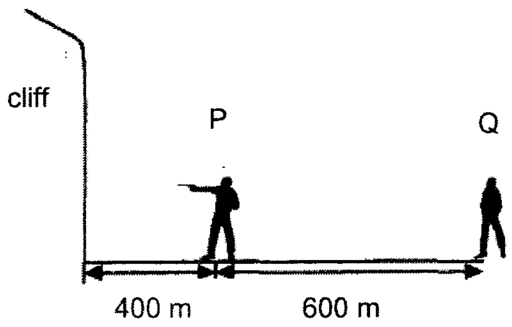
A 30 ° **B** 35 ° **C** 42 ° **D** 49 °

24 The diagram shows a child using a periscope to look at an object O on the other side of the wall. The periscope has two plane mirrors.

At which position is the image of O seen?



25 Two people, P and Q, stand in front of a vertical cliff as shown.

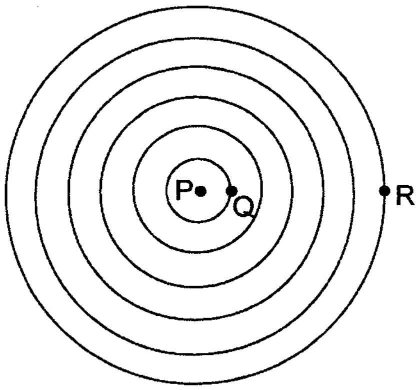


P fires one shot using a pistol and Q hears two shots.
The speed of sound in air is 340 m / s.

What is the time interval between the two shots that Q hears?

A 2.4 s **B** 2.9 s **C** 4.1 s **D** 5.0 s

26 The diagram shows the top view of some water waves produced from point P.



The waves have a speed of 0.40 m / s and take 2.0 s to travel from point Q to R.

What is the wavelength of the wave?

A 0.16 m **B** 0.20 m **C** 0.40 m **D** 0.80 m

27 Below are four statements about the uses of electromagnetic radiation.

Gamma rays are used in cancer treatment.
Infra-red waves are used in thermal imaging cameras.
Microwaves are used in satellite TV.
X-rays are used to check bone fractures.

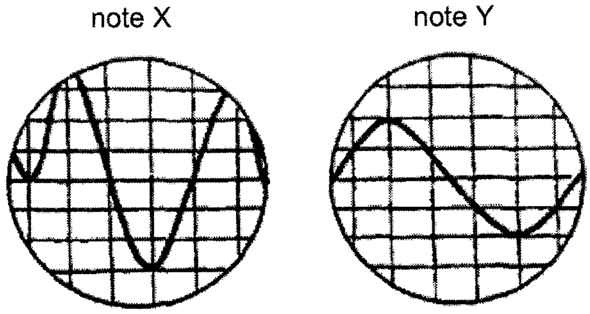
How many of these statements is/are correct?

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

28 Which electromagnetic wave will **not** cause damage to living cells?

A gamma rays
B microwaves
C ultra-violet radiation
D X-rays

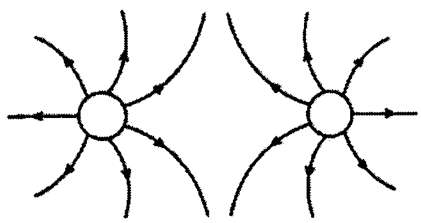
29 The waveforms of two notes X and Y are shown in the datalogger screens with the same scale.



Which row is true about note X as compared with note Y?

	loudness	pitch
A	louder than Y	higher than Y
B	louder than Y	lower than Y
C	not as loud as Y	lower than Y
D	not as loud as Y	higher than Y

30 The diagram shows the electric field pattern between two isolated point charges.



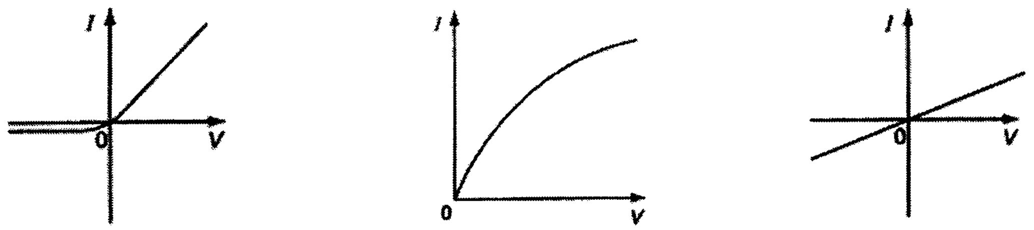
Which two point charges produce this pattern?

31 An electron is placed at a point where an electric field is acting vertically downwards. There is a force exerted on the electron due to the field.

In which direction does this force act on the electron?

A horizontally to the left
B horizontally to the right
C vertically downwards
D vertically upwards

32 Graphs X, Y and Z show how the current varies with potential difference for three electrical components.



graph X graph Y graph Z

Which electrical component does each graph represent?

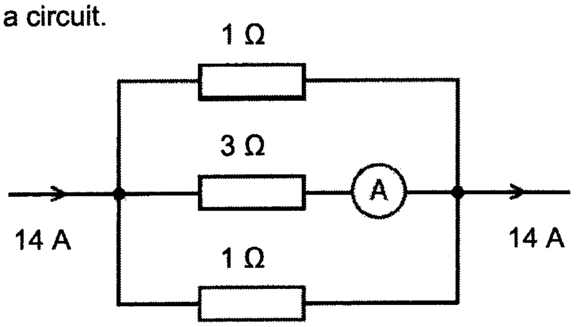
	graph X	graph Y	graph Z
A	filament lamp	semiconductor diode	metallic conductor
B	semiconductor diode	filament lamp	metallic conductor
C	metallic conductor	semiconductor diode	filament lamp
D	semiconductor diode	metallic conductor	filament lamp

33 A current of 10 A flows through an electrical component.

What is the amount of charge flowing through the electrical component in an hour?

A 0.0028 C **B** 10 C **C** 360 C **D** 36000 C

34 The diagram shows a circuit.



What is the reading of the ammeter?

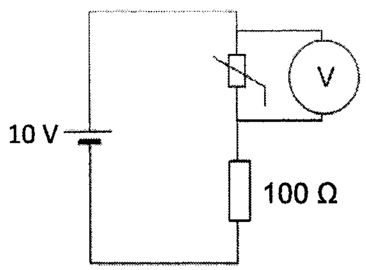
A 1 A **B** 2 A **C** 3 A **D** 4 A

35 The table shows the resistance of a light dependent resistor (LDR) and a thermistor under different conditions.

LDR	thermistor
dark: 10 kΩ bright: 100 Ω	cold: 1 kΩ hot: 100 Ω

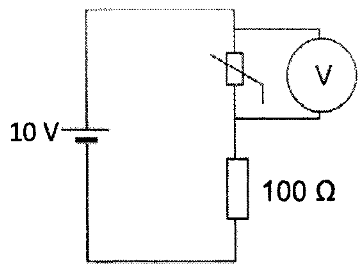
Which circuit will show the smallest voltmeter reading?

A



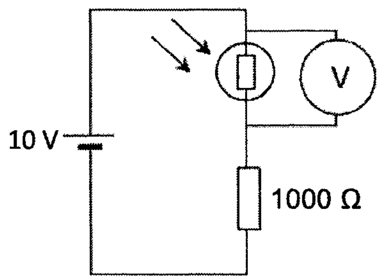
cold

B



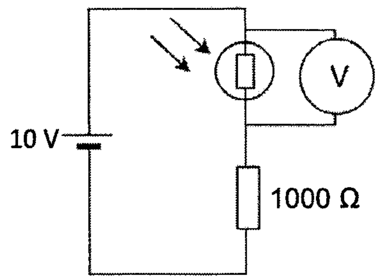
hot

C



bright

D



dark

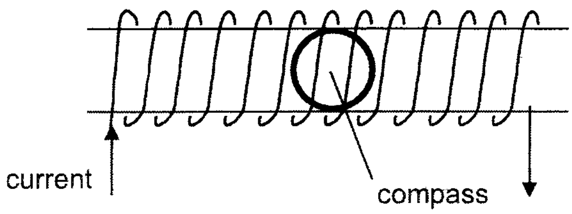
36 The diagram below shows the label on an electric iron. The iron is used for 12 hours every month. The cost of 1 kWh of electrical energy is 25 cents.

ELECTRIC IRON	
Operating Voltage	240 V
Power	2800 W
Fuse Rating	13 A

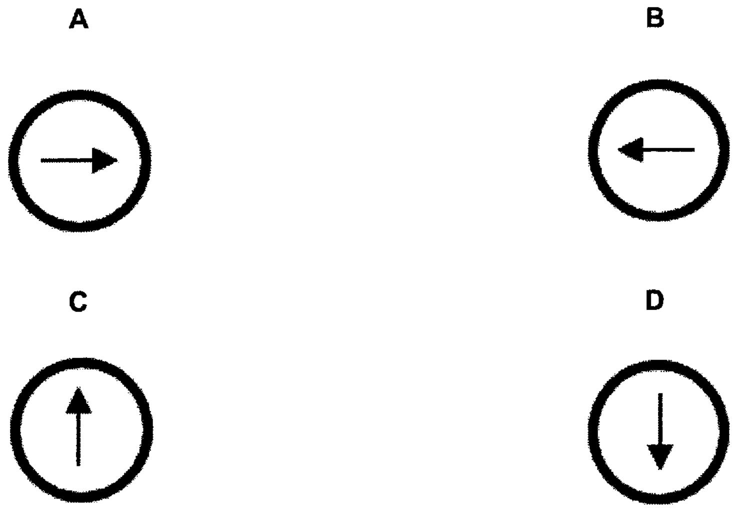
Which statement is **not** true about the electric iron?

A The energy dissipated in the iron every month is 121 MJ.
B The fuse will blow when the current flowing through the iron is above 13 A.
C The iron should use a fuse with a fuse rating of 10 A instead of 13 A.
D The user pays $8.40 every month to use the iron.

37 A compass is placed in the centre of a solenoid as shown in the diagram below.



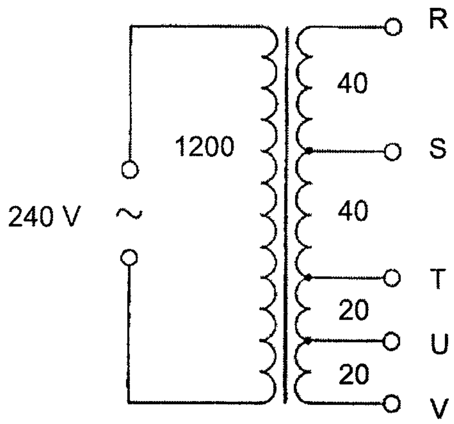
In which direction will the compass needle point?



38 What is the main function of the split ring commutator in a d.c. motor?

A It allows electrical contact between the coil of wire and the battery.
B It increases the turning effect of the coil of wire.
C It reverses the direction of the current in the coil every half a revolution.
D It reverses the direction of the force on the coil every full revolution.

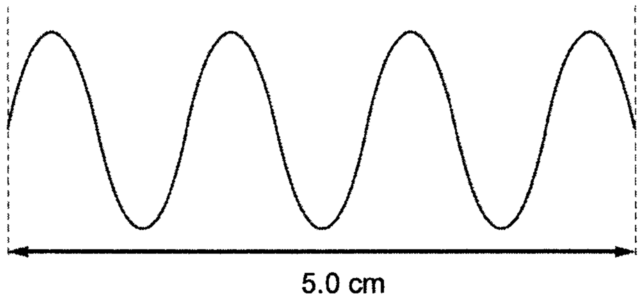
39 A transformer consists of one coil with 1200 turns and a second coil with a total of 120 turns, which can be tapped at various places.



Which pair of terminals should be connected to a 12 V, 24 W lamp for it to light up normally?

A RS **B** RT **C** ST **D** SU

40 A student uses a cathode-ray oscilloscope (c.r.o.) to measure the period of a signal. She sets the time-base of the c.r.o. to 20 ms / cm and observes the trace illustrated below. The trace has a length of 5.0 cm.



What is the period of the signal?

A 0.004 s **B** 0.029 s **C** 1.14 s **D** 28.6 s

End of Paper

	Class	Index No.
Candidate Name:		

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examination 2022

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PHYSICS **6091/02**

Paper 2 Theory

25 Aug 2022
1130 – 1315
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A (50 marks)
Answer **all** questions in the spaces provided.
Section B (30 marks)
Answer all questions. Question 11 has a choice of parts to answer.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
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.

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	**Total**
/50	**/30**	**/80**

Setter: Mr Raymond Loh **Vetter:** Mrs Wong Kexin,

This question paper consists of 19 printed pages including this page.

Section A

Answer **all** questions in this section.

1 Fig. 1.1 shows a box of mass 900 g resting on a rough plane inclined at an angle of 30° to the horizontal. The box is about to slip down the plane.
The gravitational field strength is 10 N / kg.

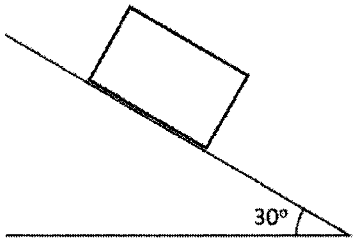


Fig. 1.1 (not to scale)

(a) On Fig. 1.1, draw the forces exerted on the box. Label them clearly. [1]

(b) Calculate the weight of the box.

weight of the box = ... [1]

(c) Draw a suitable scaled diagram to determine the magnitude of the frictional force acting on the box.

frictional force = ... [3]

(d) Suggest, in terms of forces, why the object does not slide down the rough plane.

....

.... [1]

2 Fig. 2.1 shows the hydraulic braking system of a car.

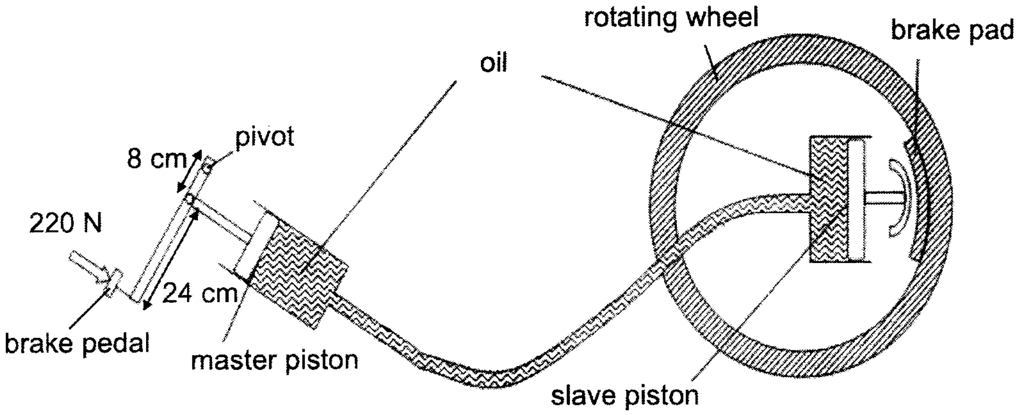


Fig. 2.1 (not to scale)

A force of 220 N is applied by the car driver on the brake pedal.
The cross-sectional area of the master piston is 1.5 cm^2.
The cross-sectional area of the slave piston is 5.0 cm^2.
The weight of both pistons is negligible.

(a) Calculate the force exerted on the master piston.

force = ... [2]

(b) Hence, calculate the force that the oil exerts on the slave piston.

force = ... [2]

3 Fig. 3.1 shows the path of a ball after being kicked by a boy.

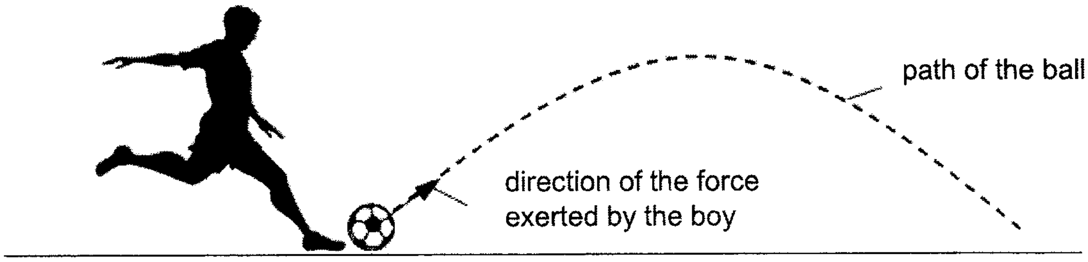


Fig. 3.1

As the boy kicks the ball, work is done.

(a) State what is meant by *work done.*

....

.... [1]

(b) The speed of the 200 g ball when it first leaves the ground is 20 m / s.
Calculate the initial kinetic energy of the ball.

initial kinetic energy = ... [2]

(c) The ball reaches a maximum height of 12 m from the ground. The gravitational field strength, g, is 10 N / kg.
Calculate the gravitational potential energy gained by the ball.

gravitational potential energy gained = ... [2]

(d) Hence or otherwise, determine the speed of the ball at the maximum height.

speed = ... [2]

4 Fig. 4.1 shows three rays emerging from the top of an object. The path of one ray through the lens has been completed in the diagram.

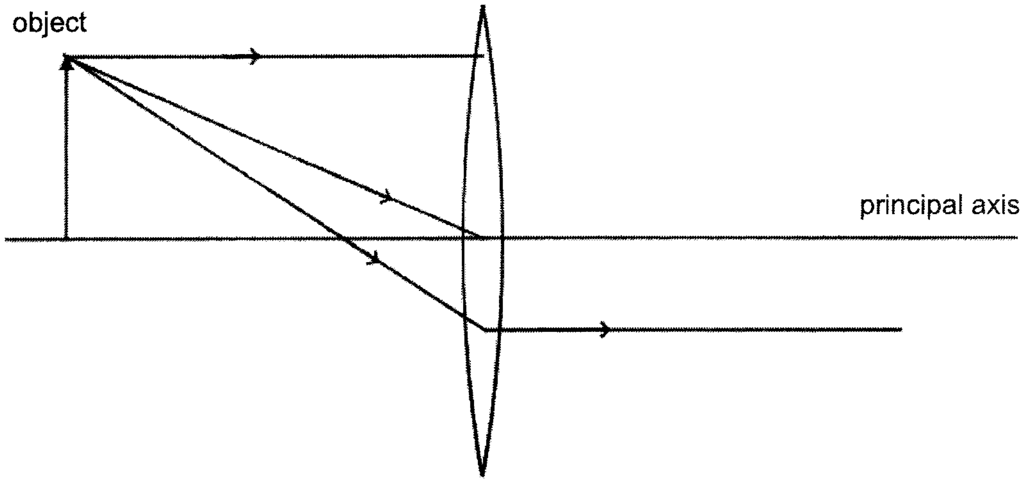


Fig. 4.1 (not to scale)

(a) Define the *focal length* of a converging lens.

....

....

.... [1]

(b) On Fig. 4.1,

(i) complete the paths of the other two rays,

(ii) identify the position of the image formed and label the image as "I",

(iii) mark the position of the principal focus and label it as "F". [3]

(c) Fig. 4.2 shows how the distance of the image to the lens varies with the distance of the object to the lens.

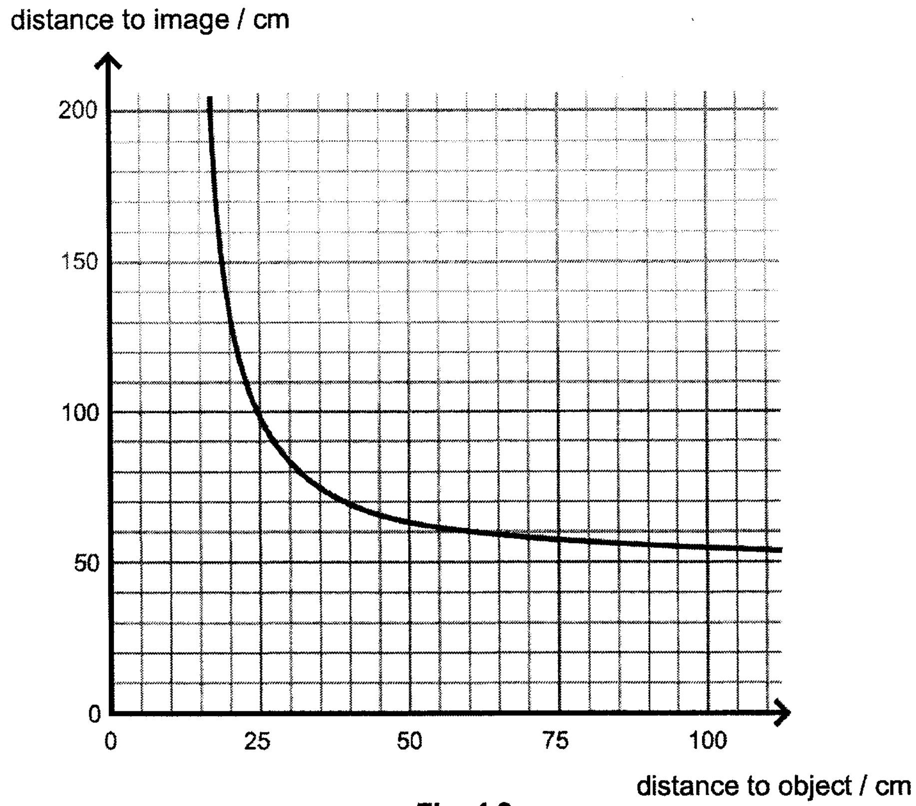


Fig. 4.2

(i) An object is placed such that its image is real and of the same size as the object.

Using the graph in Fig 4.2, determine the distance of the object to the lens.

distance of object = ... [1]

(ii) Hence, determine the focal length of the lens.

focal length = ... [1]

(iii) State **three** characteristics of the image formed when the object is placed at a distance less than the focal length of this lens.

....

.... [1]

5 Two small uncharged metal spheres A and B are suspended side by side by insulating strings, as shown in Fig. 5.1. The two small spheres are separated by a sheet of paper.

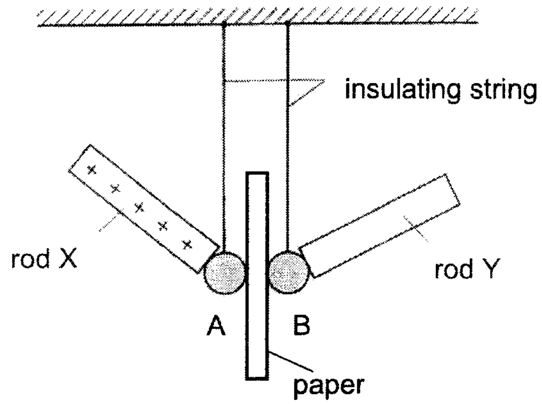


Fig. 5.1

Rod X and Y are both conductors that are held using insulators. Rod X is positively charged and touches sphere A. Rod Y is neutral and touches sphere B. After a while, rod Y is removed followed by rod X.

(a) State, if any, the charge of sphere B after the rods are removed.

.... [1]

(b) Explain your answer in **(a)**.

....

....

....

.... [3]

(c) Describe and explain what will happen to both spheres when the sheet of paper is subsequently removed.

....

....

....

....

....

.... [2]

6 Fig 6.1 shows a circuit with a battery of e.m.f. 6.0 V connected to a network of resistors and a voltmeter.

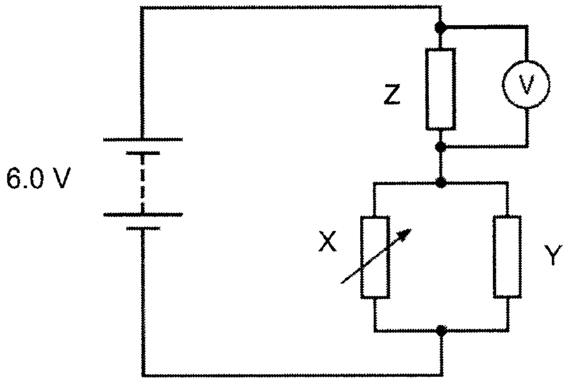


Fig. 6.1

Resistor Y has a resistance of 24 Ω and resistor Z has a resistance of 32 Ω.

(a) The resistance R_x of the variable resistor X is adjusted until the voltmeter reads 4.8 V. Calculate

(i) the current in resistor Z,

current = ... [2]

(ii) the amount of charge that flows through the battery in 25 s,

charge = ... [2]

(iii) the effective resistance of resistors X and Y connected in parallel,

total resistance = ... [2]

(iv) the resistance R_x of resistor X.

R_x = ... [2]

(b) The resistance R_x of resistor X is now decreased.
State and explain the change, if any, to the voltmeter reading.

....

....

....

.... [2]

7 Fig. 7.1 shows a simple d.c. motor.

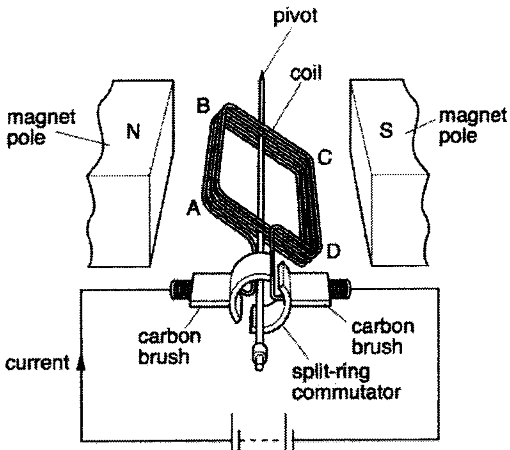


Fig. 7.1

As current flows from the external circuit into the coil, a set of forces cause the coil to rotate about the pivot.

(a) On Fig. 7.1, draw an arrow to show the direction of a force acting on the coil.
Label it as "F". [1]

(b) State the direction of rotation of the coil. Explain how you derive your answer.

....

....

....

.... [3]

(c) State the position of the coil when the moment on the coil is maximum. Explain your answer.

....

....

....

.... [2]

8 Fig. 8.1 shows a step-up transformer.

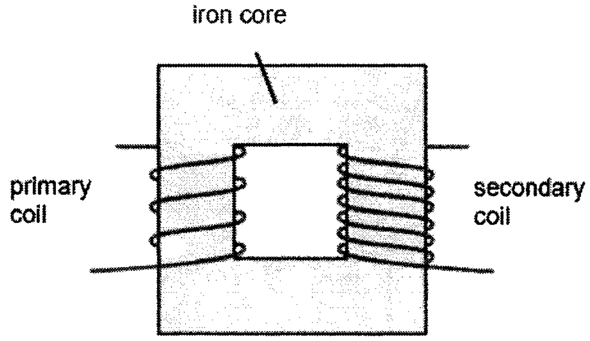


Fig. 8.1

(a) Describe the function of the iron core and why it cannot be replaced with steel.

....

....

....

.... [2]

(b) Explain why step-up transformers are used in power transmission.

....

....

....

.... [2]

Section B
Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows a cooling system used to cool a motor car engine by circulating water through it. The radiator is a heat exchanger where the hot water transfers its thermal energy to the air.

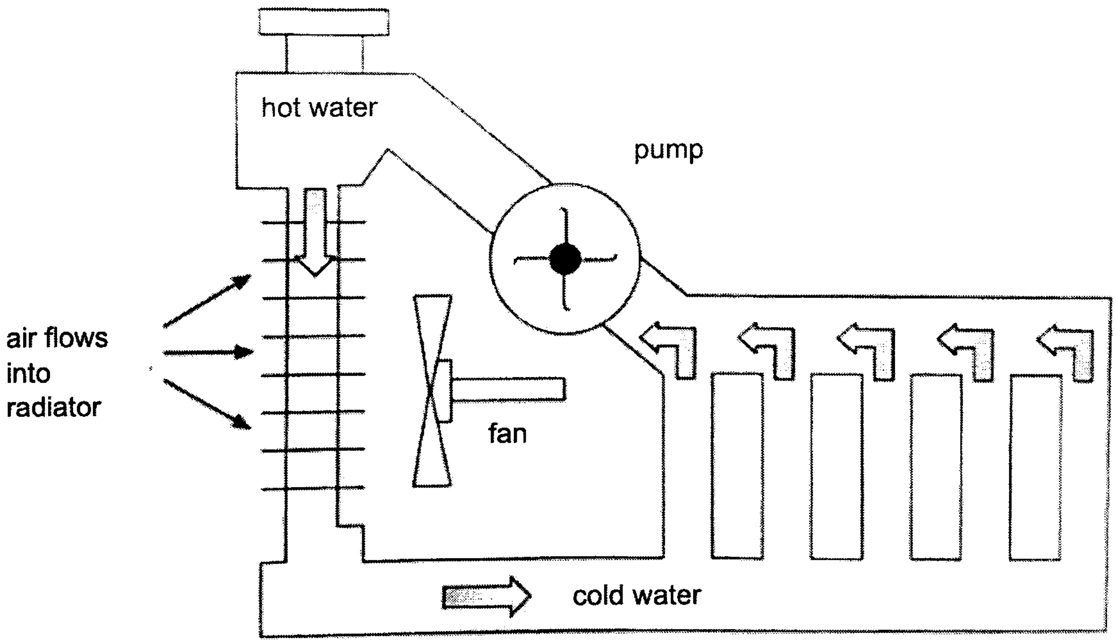


Fig. 9.1

A number of test runs are carried out to investigate the cooling system. Fig. 9.2 shows the data from one test run and the specific heat capacities of some substances.

duration of test / min	4.0
energy available from fuel used / J kg^{-1}	5.0×10^7
fuel consumed / kg	0.80
initial temperature of air / °C	20.0
initial temperature of cooling water / °C	30.0
final temperature of cooling water / °C	80.0
rate of flow of cooling water / kg s^{-1}	0.22
rate of flow of air over radiator fins / kg s^{-1}	1.25
specific heat capacity of castor oil / J kg^{-1} $°C^{-1}$	1800
specific heat capacity of glycerine / J kg^{-1} $°C^{-1}$	2430
specific heat capacity of water / J kg^{-1} $°C^{-1}$	4200
specific heat capacity of air / J kg^{-1} $°C^{-1}$	760

Fig. 9.2

Fig. 9.3 shows an expanded view of the cross-section of the radiator.

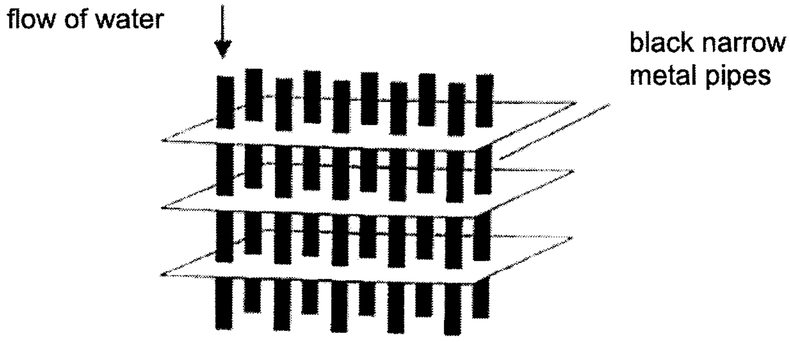


Fig. 9.3

(a) Explain why water is used as a coolant in the radiator of a motor car engine instead of the other fluids given in the table in Fig. 9.2.

....

....

....

.... [2]

(b) The manufacturer claims that 20% of the energy from the fuel is converted into useful mechanical energy.

(i) Calculate the amount of thermal energy removed from the hot water in the test run based on the manufacturer's claim.

energy = ... [1]

(ii) Calculate the actual amount of thermal energy removed from the hot water during the test run.

energy = ... [1]

(iii) Suggest a reason for the difference between the values in **(i)** and **(ii)**.

....

.... [1]

(c) Using Fig. 9.3, explain the features of the radiator that allow thermal energy to be transferred easily away from the hot water which flows through the tubes.

....

....

....

....

....

.... [3]

(d) Assuming that there is no heat loss by the cooling water as it flows from the engine to the radiator, calculate the average final temperature of air leaving the radiator in the test run.

final temperature = ... [2]

10 Fig. 10.1 shows a solenoid connected to a sensitive galvanometer.

The South pole of a permanent magnet is placed next to the left end X of the solenoid.

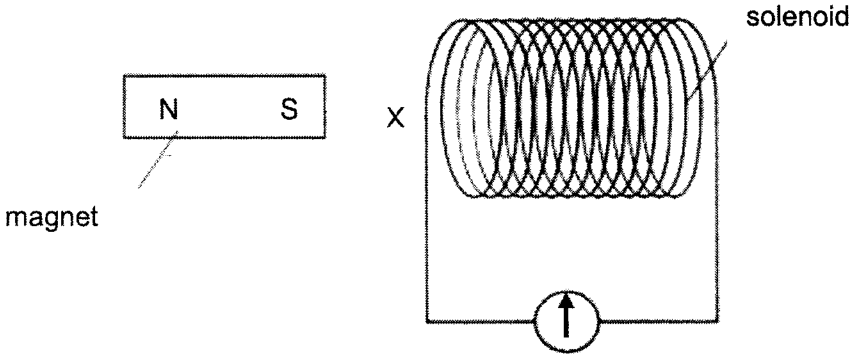


Fig. 10.1

(a) The solenoid is moved away from the magnet and the needle of the galvanometer deflects to the left.

(i) Explain why the needle of the galvanometer deflects.

....

....

.... [2]

(ii) State the magnetic pole induced at the left end X of the solenoid.

.... [1]

(iii) State the deflection, if any, of the needle of the galvanometer when the coil is held stationary and the magnet is moved towards the coil instead. Explain your answer.

....

....

....

.... [2]

(b) The galvanometer is replaced with a cathode ray oscilloscope (C.R.O.).
The magnet is then oscillated continually towards and away from the solenoid.
A trace is formed on the C.R.O. as shown in Fig. 10.2.

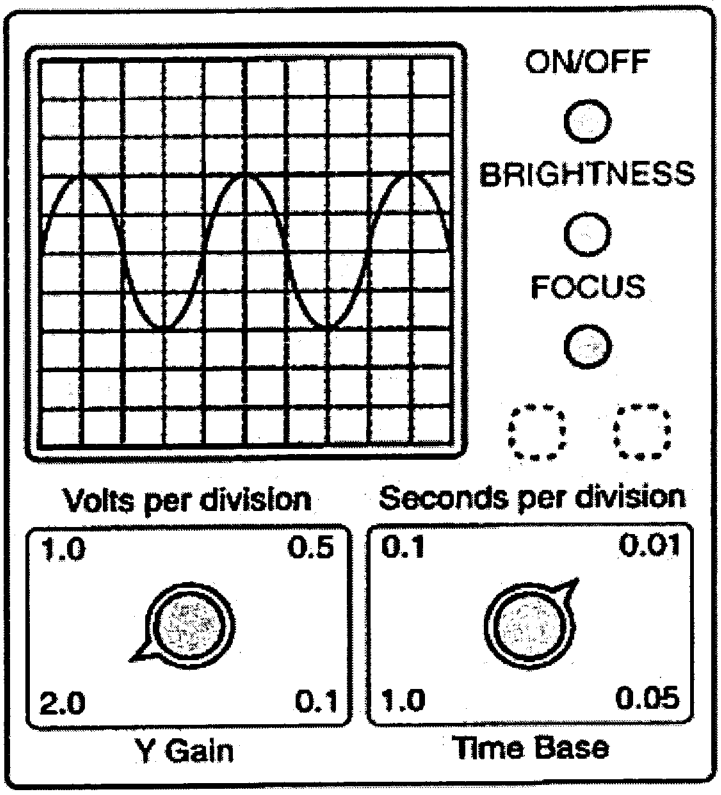


Fig. 10.2

(i) Determine the peak voltage and frequency of the trace in Fig. 10.2.

peak voltage = ... [1]

frequency = ... [2]

(ii) Describe the trace that will be formed if the time base is switched off.

....

.... [1]

(iii) The speed of oscillation is reduced to half of its original speed.

On the screen of the C.R.O. in Fig. 10.2, draw one cycle of the new trace. with the same settings shown. [1]

11 **Either**

Fig. 11.1 shows three different forms of long-distance communication.

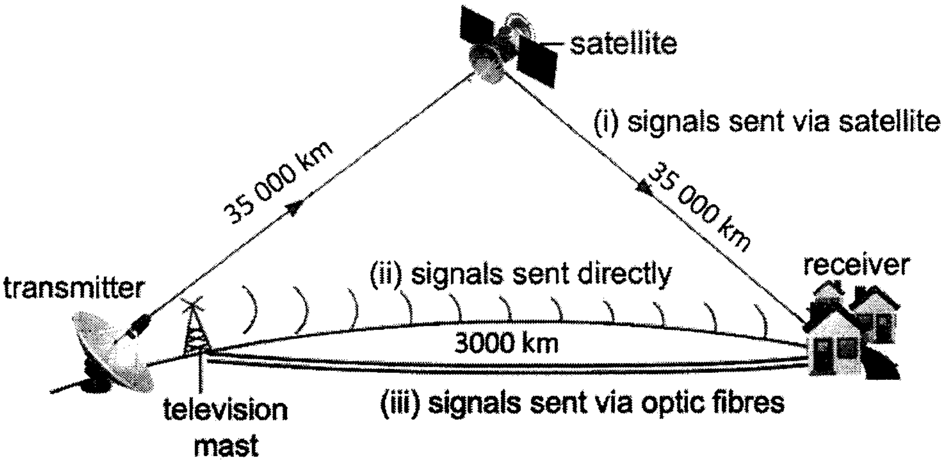


Fig. 11.1

(a) State which region of the electromagnetic spectrum is used for each form of communication.

(i)	signals sent via satellite communication	
(ii)	signals sent directly using television mast	
(iii)	signals sent via optic fibres	

[1]

(b) The speed of light in vacuum is 3.0×10^8 m / s.
The refractive index of the glass used in optic fibre is 1.5.

Calculate the speed of light in glass.

speed of light in glass = ... [2]

(c) State which form of communication took the least amount of time for each signal to be transmitted and received.

Justify your answer with appropriate calculations.

....

....

....

.... [2]

(d) The signal enters the optical fibre as shown in Fig. 11.2. The signal passes along the optical fibre.

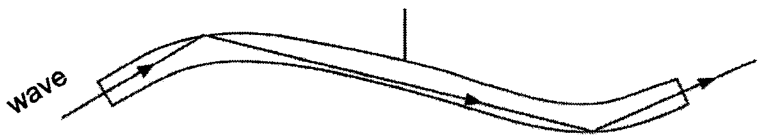


Fig. 11.2

Explain how the signal is able to pass along the optical fibre without escaping from the sides.

....

....

.... [3]

(e) Suggest why sound waves are not used as

(i) signals sent via satellite communication.

....

....

.... [1]

(ii) signals sent directly using television mast.

....

....

.... [1]

11 Or

(a) Fig. 11.3 shows circular wavefronts produced at the centre of a wave pool. Two plastic buoys, A and B, float on the water in the pool. Buoy A is on the crest of a wave at the instant shown.

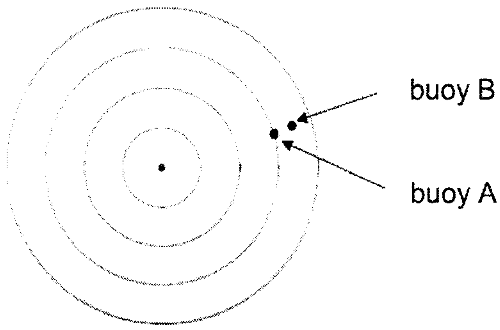


Fig. 11.3

Fig. 11.4 shows a snapshot of the displacement-distance graph of a wave at a particular instant. The wave takes 0.800 s to move from buoy A to buoy B.

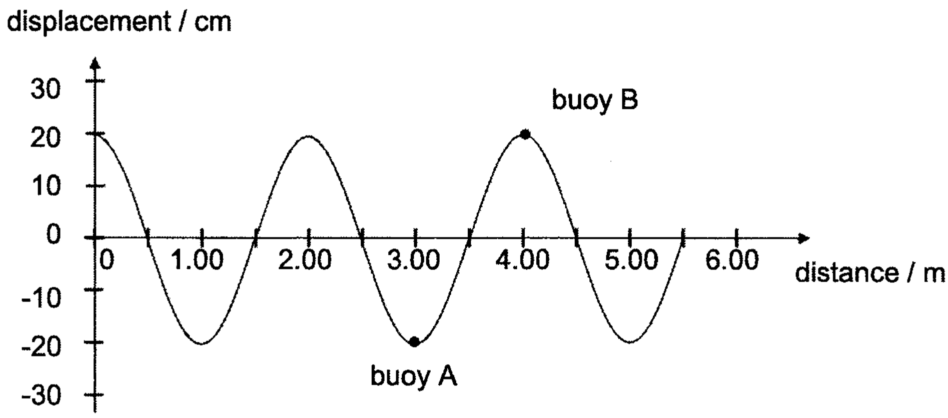


Fig. 11.4

(i) State what is meant by a *wavefront*.

....

.... [1]

(ii) Calculate the frequency of the wave.

frequency = ... [2]

(iii) Calculate the wavelength of the wave and the speed of the wave.

wavelength = ...

speed = ... [2]

(iv) On Fig. 11.4, draw using arrows, the direction buoys A and B will be moving in at the next instant. [1]

(b) Sonar is used to locate schools of fish and the depth of the seabed in the sea. The sonar sends pulses of ultrasound of frequency 45 kHz from the bottom of the ship to determine the depth of the seabed. The time intervals between the pulse and the subsequent echoes are then measured to determine the depth of the schools of fish or the seabed. The speed of the ultrasound in water is known to be 1450 m / s.

(i) State one difference between the pulses of the echo and the pulses sent. Explain your answer.

....

....

....

.... [2]

(ii) The time interval between the pulse and the echo is 150 ms.

Calculate the depth of the source of the echo.

depth = ... [2]

End of Paper

Paper 1

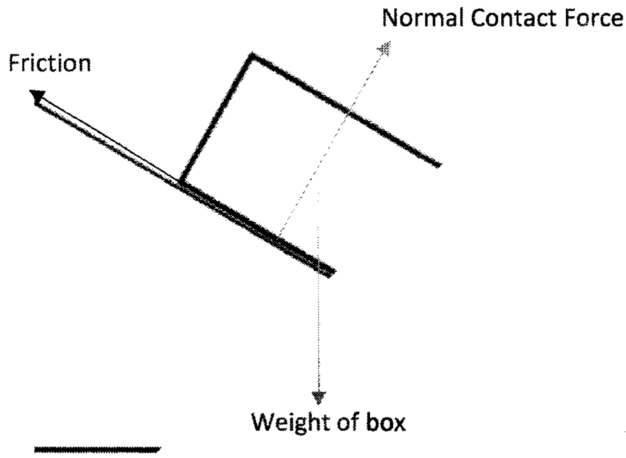
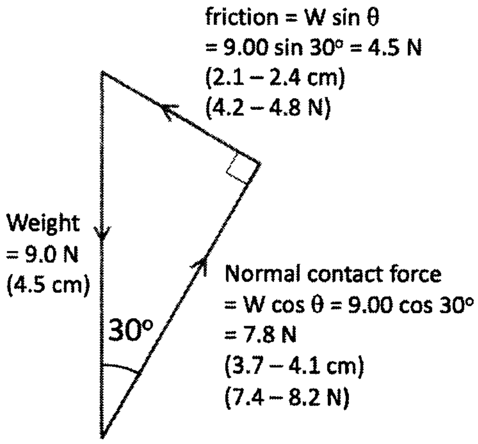
1	2	3	4	5	6	7	8	9	10
C	A	C	B	C	D	A	B	D	D

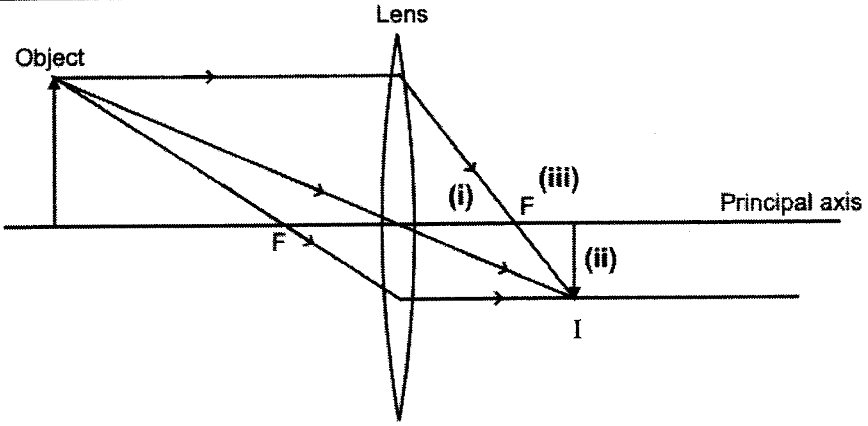
11	12	13	14	15	16	17	18	19	20
A	C	B	D	D	B	C	A	A	C

21	22	23	24	25	26	27	28	29	30
D	D	A	D	A	A	D	B	A	A

31	32	33	34	35	36	37	38	39	40
D	B	D	B	C	C	B	C	D	B

Section A

1	(a)		[1]
	(a)	W = mg = (0.900 kg)(10 N/kg) = 9.00 N (3sf) or 9.0 N (2sf)	[1]
	(b)	 1m – appropriate scale (1.0 cm to 2.0 N) 1m – correct vector diagram (right angle triangle, direction of arrows) 1m – correct magnitude of friction force Allow for e.c.f. from (a)	[1] [1] [1]
	(c)	Newton's first law. Forces are balanced. Resultant force of friction, weight and normal contact force = 0 N. (Any one)	[1]
2	(a)	moment by brake pad = moment by master piston (220)(32) = (F)(8) F = 880 N	[1] [1]

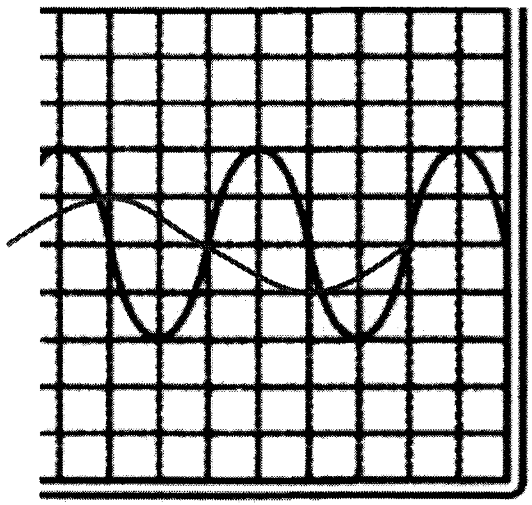
	(b)	$P_{master\ piston} = P_{slave\ piston}$ $F_1/A_1 = F_2/A_2$ $880 / 1.5 = F_2/5.0$ $F_2 = 2930$ N or 2900 N (allow for e.c.f.)	[1] [1]
3	(a)	The product of force applied and distance moved in the direction of the force	[1]
	(b)	KE = ½ x m x v^2 = 0.5 x 0.20 x 20^2 = 40 J	[1] [1]
	(c)	G.P.E at max height = m x g x h = 0.200 x 10 x 12 = 24 J (2sf)	[1] [1]
	(d)	At max height, KE remaining = 40 J – 24 J = 16 J (allow for e.c.f.) 0.5 x 0.200 x v^2 = 16 v = 12.6 m / s or 13 m / s	[1] [1]
4	(a)	The focal length is the **distance along the principal axis**, between the **principal focus and the optical centre** of the lens. OR Distance between the optical centre of the lens and the principal focus (focal point).	[1]
	(b)	 Accept either position of principal focus of **(iii)** Rays and arrowheads should be in solid lines	[1] [1] [1]
	(c)(i)	60.0 cm	[1]
	(ii)	2f = 60.0 cm f = 30.0 cm	[1]
	(iii)	1. Virtual 2. Upright 3. Magnified	[1]
5	(a)	Negatively charged	[1]
	(b)	The negative charges will be transferred from rod Y to sphere B.	[1]

		The negative charges are attracted by positively charged rod X as unlike charges attract.	[1]
		Hence, there is more negative charges than positive charges in sphere B upon removal of the rods. (Sphere B has a net negative charge)	[1]
	(c)	Sphere A will become positively charged (and B is negatively charged).	[1]
		They will attract each other.	[1]
		Since unlike charges attract.	[1]
6	(a)(i)	I = V/R = 4.8 / 32 = 0.15 A	[1] [1]
	(ii)	Q = I(t) = (0.15)(25) = 3.75 C or 3.8 C (allow for e.c.f.)	[1] [1]
	(iii)	Pd across parallel branch = 6.0 – 4.8 V = 1.2 V R = V/I = 1.2 / 0.15 = 8.0 Ω Alternative method: Potential Divider method [32 / (32 + R)] x 6.0 = 4.8 (32 + R) / 32 = 6.0 / 4.8 R = 8.0 Ω	[1] [1]
	(iv)	Method 1 ($1/R_1 + 1/R_2 = 1/R_{total}$) 1/R + 1/24 = 1/8 R = 12 Ω allow for e.c.f. Method 2 Current flowing through Y = 1.2 / 24 = 0.050 A Current flowing through X = 0.15 – 0.050 = 0.10 A R = V/I = 1.2 / 0.10 = 12 Ω	[1] [1] [1] [1]
	b	Overall resistance of circuit decreases, so overall current (I) increases. Voltmeter reading will increase since pd across Z increases (or V = RI). Alternative Answer Overall resistance of parallel branch decreases. Pd across Z will increase since Z will receive a larger proportion of the e.m.f and voltmeter reading increases. (Potential Divider)	[1] [1] [1] [1]
7	(a)	Either AB – Downward arrow Or CB – Upward arrow	[1]
	(b)	Current flows from A to B. By **Fleming's Left Hand rule**, the induced force which is perpendicular to the magnetic field and current will be **downwards**. For side, CD, current flows from C to D and the force will be **upwards**. The coil rotates in an **anticlockwise** direction.	[1] [1] [1]
	(c)	The **coil is horizontal**.	[1]

		That is when the **perpendicular distance from the centre of rotation to the line of action of the force** is **maximum**.	[1]
8	(a)	Iron is easily **magnetised and demagnetised** (or **soft magnetic material**) whereas steel **does not magnetise or demagnetise easily** (or **hard magnetic material**). This ensures **better magnetic flux linkage** between the 2 coils if iron is used instead of steel. Any other plausible answer.	[1] [1]
	(b)	**Reduce energy loss** during transmission Since **heat loss is P = I^2R**, the **lower the current, the lower the energy loss** during transmission.	[1] [1]

Section B

9	(a)	Water is used as a coolant because of its very **high specific heat capacity**. It can **take in a large amount of thermal energy** with only a **small rise in its temperature**.	[1] [1]
	(b)(i)	Thermal energy required to be removed as claimed = $(0.8 \times 5.0 \times 10^7) \times 80\%$ = 3.2×10^7 J	[1]
	(ii)	Actual amount of thermal energy removed $Q = mc\Delta\theta$ = $(0.22 \times 4 \times 60)(4200)(80-30)$ = 1.1088×10^7 J = 1.1×10^7 J	[1]
	(iii)	Some thermal energy is **lost to the surroundings**, apart from it being absorbed by the cooling water.	[1]
	(c)	**Metal** pipes are used as they are **good conductors** of heat and allows heat to be **conducted faster away** from the hot water to the external wall of the pipe. The metal pipes being coloured in **black** are **good emitters of radiation** and therefore **radiates heat to the surrounding air at a higher rate**. Using **narrow** pipes **increase the surface area** to facilitate a **higher rate of emission of heat** to the surrounding air.	[1] [1] [1]
	(d)	Energy absorbed by air = 1.1088×10^7 J (allow for e.c.f.) $(1.25 \times 4 \times 60)(760)(\theta - 20) = 1.1088 \times 10^7$ J $\theta = 68.6$ °C = 69 °C (68.6 °C also accepted)	[1] [1]
10	(a)(i)	As the coil moves away, there is a **changing magnetic field experienced by it**. Or	[1]

		There is a **changing magnetic flux linkage** between the magnet and the solenoid. According to **Faraday's Law**, there is an **induced emf** in a closed circuit, hence there is a flow of an induced current.	[1]
	(ii)	North-pole	[1]
	(iii)	Deflect right; According to Lenz's Law, **the direction of the induced e.m.f. opposes the change producing it.** Hence, the induced current flows in opposite direction as compared with the original motion.	[1] [1]
	(b)(i)	4.0 V ; T = 0.04 s f = 1 / 0.04 = 25 Hz	[1] [1] [1]
	(ii)	**Vertical line** across **4 divisions**	[1]
	(iii)	1 division above and 1 division below the x-axis 8 divisions along the x-axis 	[1]
11E	(a)	(i) microwaves (satellite communication) (ii) radio waves (television broadcast) (iii) visible light (optic fibre communication)	[1]
	(b)	$n = \frac{c}{v}$ $1.5 = \frac{3.0 \times 10^8\ m/s}{v}$ $v = 2.0 \times 10^8$ m/s	[1] [1]

	(c)	Signal with least time = (ii) radio communication time = $\frac{distance}{speed}$ Time taken for (i) satellite communication = $\frac{2 \times 35\ 000\ 000\ m}{3.0 \times 10^8\ m/s}$ = 0.23 s (2sf) Time taken for (ii) radio communication = $\frac{3\ 000\ 000\ m}{3.0 \times 10^8\ m/s}$ = 0.010 s (2sf) Time taken for (iii) optic fibre = $\frac{3\ 000\ 000\ m}{2.0 \times 10^8\ m/s}$ = 0.015 s (2sf)	[1] [1]
	(d)	Signal / wave / light experiences total internal reflection. Angle of incidence is greater than critical angle. Light is traveling from optically denser medium (glass) to optically less dense medium (air).	[1] [1] [1]
	(e)	(i) Sound waves cannot be transmitted in vacuum. Sound waves require a medium for propagation. (ii) speed of sound in air = 330 m/s. This much slower speed of sound would mean a very long time between transmitting the signal and receiving the signal (time = $\frac{3\ 000\ 000\ m}{330\ m/s}$ = 9090 s = 2.5 hours)	[1] [1]
11 O	(a)(i)	The imaginary line drawn by joining all adjacent points of a wave that are on the same phase.	[1]
	(a)(ii)	T = 2 x 0.80 s = 1.60 s f = 1/T = 1/1.60 = 0.625 Hz	[1] [1]
	(a)(iii)	wavelength = 2.0 m speed = 2.0 x 0.625 = 1.25 m / s or 1.3 m / s (allow for e.c.f.)	[1] [1]
	(a)(iv)	Arrows correctly drawn A – up, B – down	[1]
	(b)(i)	Echo smaller in amplitude – some energy absorbed by the surrounding Echo may be diffused – the seabed may be uneven.	[1] [1]
	(ii)	2 x d = 1450 x 0.150 d = 109 m (2 or 3 sf)	[1] [1]