康 柏 中 学

COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SCIENCE (PHYSICS, CHEMISTRY) 5076/01

Paper 1 Multiple Choice

Secondary Four Express / Five Normal (Academic)

Name: _____ Duration: 1 h

Index No: _____ Date: 31 Aug 2022

Class: Sec _____ Marks: ____/40

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, 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.

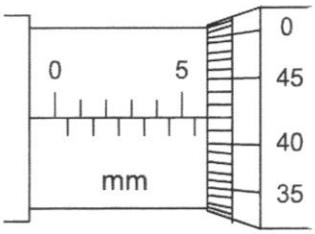
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

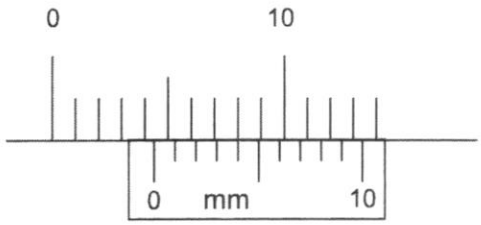
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Data Sheet is printed on page 16.
A copy of the Periodic Table is printed on page 17.
The use of an approved scientific calculator is expected, where appropriate.

This paper consists of **17** printed pages including this page. Setter: Mr Chan HL & Mdm C Lim

1 The diagrams show part of a micrometer screw gauge and a vernier scale.



micrometer screw gauge



vernier caliper

What are the readings shown?

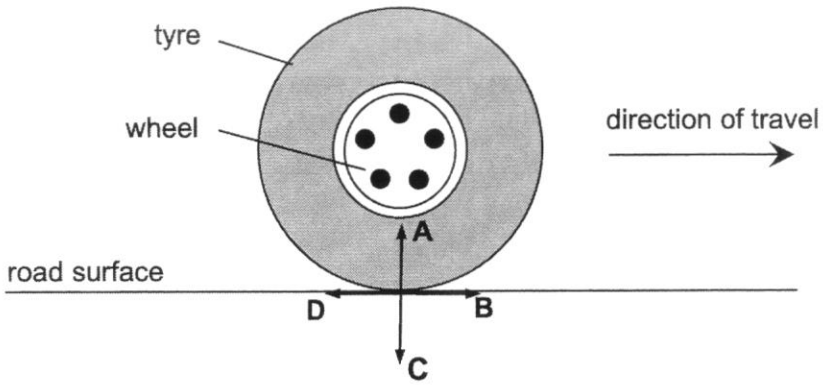
	micrometer scale reading / mm	vernier scale reading / mm
A	5.42	3.4
B	5.42	4.4
C	5.92	3.4
D	5.92	4.4

2 What is the order of magnitude for the diameter of an atom and for the diameter of the Earth?

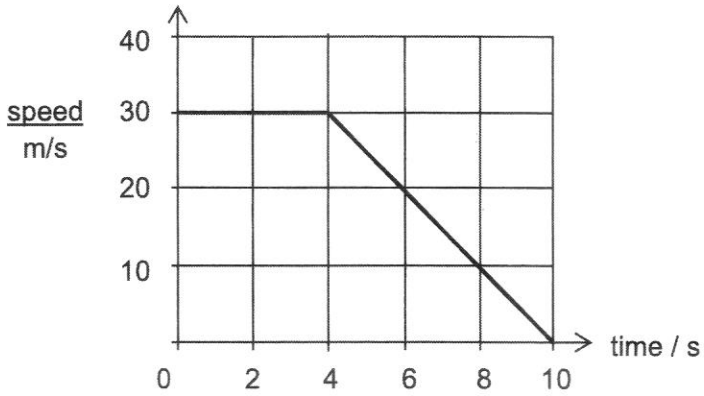
	diameter of atom	diameter of Earth
A	0.1 nanometres	10 megametres
B	0.1 nanometres	10 gigametres
C	0.1 micrometres	10 megametres
D	0.1 micrometres	10 gigametres

3 A car is accelerating along a road in the direction shown. The wheel shown is connected to the engine.

In which direction is the force of friction exerted by the road on the car tyre?



4 The speed-time graph shows a motorcycle travelling at a steady speed before decelerating uniformly to a stop.



What is the average speed of the motorcycle over the 10 s?

A 15 m/s

B 21 m/s

C 30 m/s

D 210 m/s

5 A brick is brought from Earth to the surface of the Moon.

Given that the gravitational field strength of the Moon is 1.6 N/kg, how will the properties of the brick change?

	inertia	weight	density
A	decreases	increases	remains unchanged
B	decreases	increases	increases
C	remains unchanged	decreases	decreases
D	remains unchanged	decreases	remains unchanged

6 Student A lifts a box weighing 40 N from the floor to a height of 0.80 m in 4.0 s.
Student B lifts another box weighing 60 N from the floor to a height of 0.50 m in 2.0 s.

Compared to student A, student B does

A less work but exerts more power.

B more work but exerts less power.

C the same work but exerts more power.

D the same work but exerts less power.

7 Which statement is correct?

A In a gas, the kinetic energy of the molecules increases with decreasing temperature.

B In a liquid, the molecules move around one another.

C The molecules in a liquid are further apart than in a gas.

D The molecules in a liquid are closer together than in a solid.

8 Boiling and evaporation are different processes.

Which statement is **not** correct?

A Boiling occurs throughout the entire liquid but evaporation only occurs at the surface.

B Evaporation can only occur when the temperature of the liquid is high enough.

C Evaporation causes the temperature of a liquid to fall.

D When a boiling liquid is heated its temperature remains constant.

9 What is meant by the amplitude of a wave?

A the average displacement from the equilibrium position

B the instantaneous displacement from the equilibrium position

C the maximum displacement from the equilibrium position

D the minimum displacement from the equilibrium position

10 Which row correctly lists the applications of parts of the electromagnetic spectrum?

	microwaves	infra-red radiation	gamma rays
A	cooking	cancer treatment	television controller
B	sunbed	television controller	sterilisation
C	satellite television	toaster	cancer treatment
D	telecommunications	sterilisation	security inspections

11 Which statement about microwaves and ultra-violet radiation is correct?

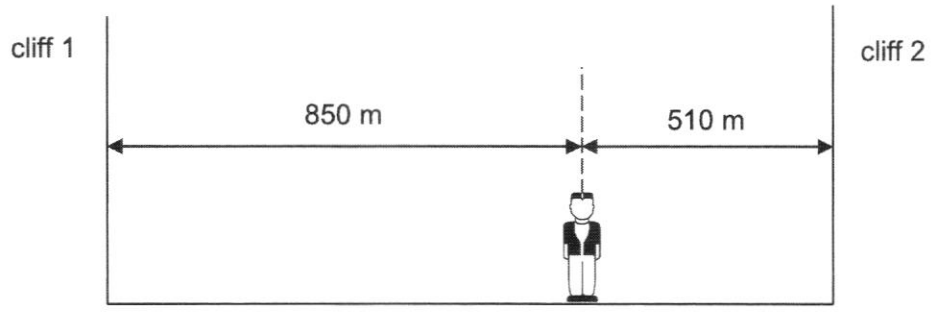
A They travel at about 330 m/s in air.

B They travel as longitudinal waves in air.

C Ultra-violet radiation does not obey the law of reflection but microwaves do.

D Ultra-violet radiation has a higher frequency than microwaves.

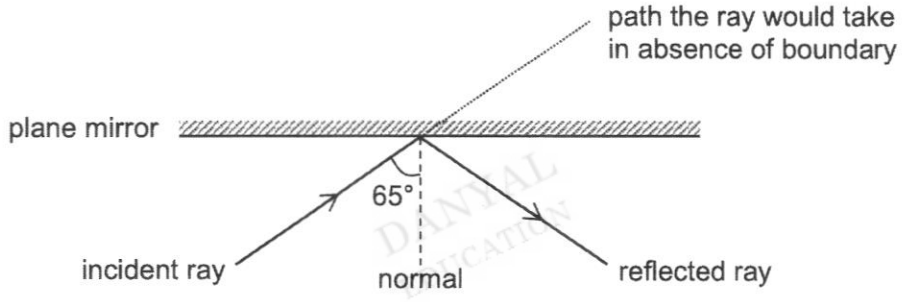
12 A man stands between 2 cliffs as shown in the diagram and claps his hands once.



Assuming that the velocity of sound in air is 340 m/s, what will be the time interval between the 2 loudest echoes?

A 0.17 s **B** 0.33 s **C** 1.0 s **D** 2.0 s

13 A ray of light incident on a plane mirror will change direction when it is reflected.



What is the change in direction of the ray?

A 50°

B 65°

C 130°

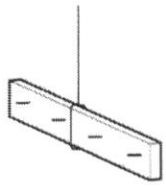
D 155°

14 When a plastic rod is rubbed with a duster, the plastic rod becomes negatively charged and the duster positively charged.

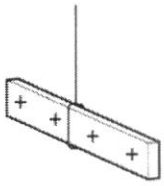
Which of the following correctly explains the charges on the plastic rod and the duster?

	plastic rod	duster
A	gained electrons	lost electrons
B	lost protons	gained protons
C	lost electrons	gained electrons
D	lost protons	lost electrons

15 The diagram shows a negatively charged polythene strip and a positively charged acetate strip that are freely suspended.



polythene strip



acetate strip

Two rods X and Y are brought in turn to these two strips.
Rod X attracts both the polythene strip and the acetate strip.
Rod Y attracts the polythene strip but repels the acetate strip.

Which type of charge is on each rod?

	rod X	rod Y
A	negative	positive
B	positive	negative
C	uncharged	negative
D	uncharged	positive

16 A charge of 150 C flows through an electric appliance in 2.0 minutes.

What is the average current in the appliance?

A 0.013 A

B 1.25 A

C 75 A

D 300 A

17 A wire of length 1.8 m and a cross-section of 3.0×10^{-6} m^2 has a resistance of 1.2 Ω. Another wire of the same material has a length of 0.90 m and a cross-sectional area of 1.0×10^{-6} m^2.

What is the resistance of the shorter wire?

A 0.20 Ω

B 0.80 Ω

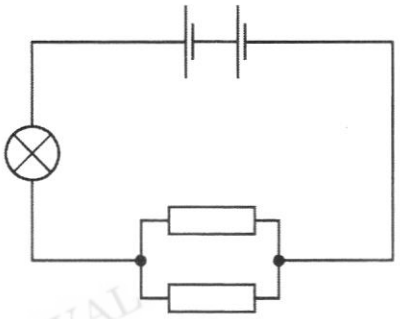
C 1.8 Ω

D 7.2 Ω

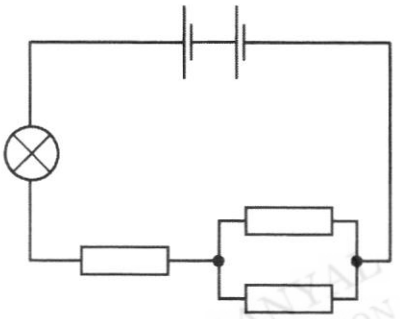
18 A lamp is connected in four circuits, each using identical batteries. The resistors are all identical.

In which circuit will the lamp be brightest?

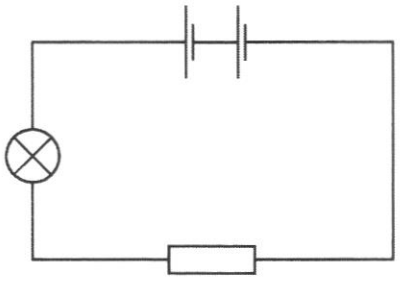
A



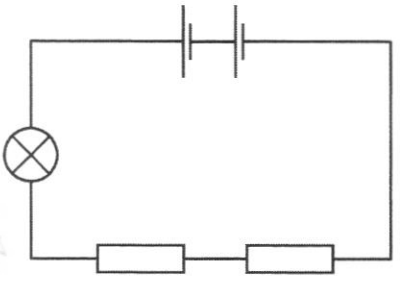
B



C



D



19 A kitchen hood is controlled by one switch. The unit contains a 0.80 kW fan and a 50 W lamp.

In one week, the lamp uses 0.60 kWh of electrical energy.

How much electricity is used by the fan alone?

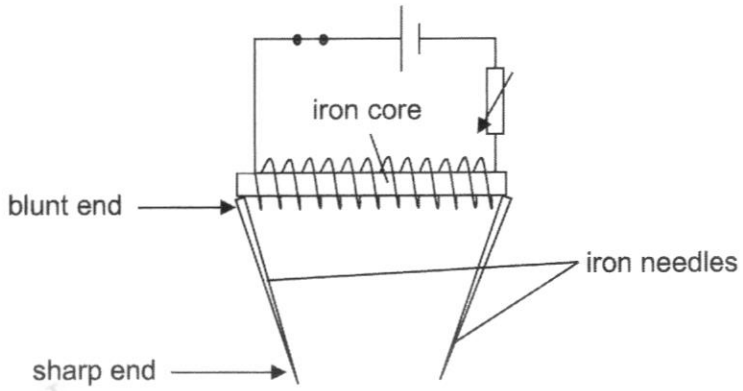
A 0.063 kWh

B 0.80 kWh

C 9.6 kWh

D 12 kWh

20 The figure shows a coil of insulated wire around an iron core.
Two iron needles hang from the ends of the iron core and are inclined towards each other as shown.



Which statement is correct?

A The blunt ends of both needles are north poles.

B The needles have become permanently magnetised

C The needles are induced magnets.

D The sharp ends of both needles are north poles.

21 Which apparatus is most suitable for collecting 25.0 cm^3 of fluorine at room temperature?

A burette

B gas syringe

C measuring cylinder

D pipette

22 The melting and boiling points of two substances X and Y are shown.
Substances X and Y are miscible liquids.

substance	melting point / °C	boiling point / °C
X	5.5	80
Y	–95	110

Which method is most suitable to separate substances X and Y?

A crystallisation

B filtration

C fractional distillation

D simple distillation

23 Which statements about the Kinetic Particle Theory are correct?

1 In gaseous state, particles are far apart and moving in random directions.

2 Particles in solid state have lower kinetic energy than particles in liquid state.

3 During boiling, particles gain energy and break free from their fixed positions.

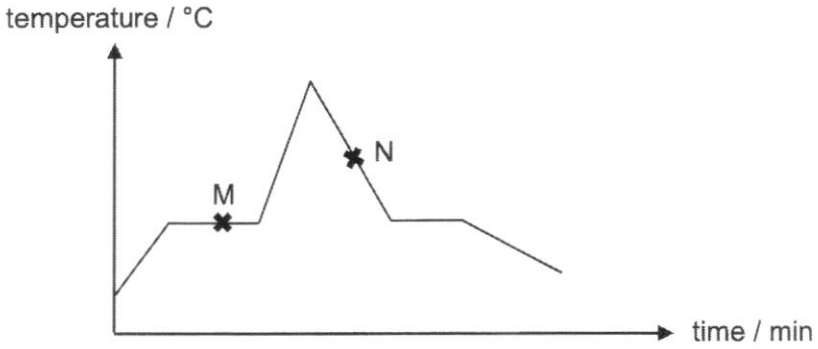
A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

24 A solid substance is heated to melt and cooled as shown in the diagram.



What are the physical states of the substance at M and N?

	M	N
A	liquid	liquid + solid
B	liquid + solid	liquid
C	liquid + solid	solid
D	solid	liquid + solid

25 A solution of lead(II) nitrate is tested with different reagents.

Which row gives the correct observation?

	test	observation
A	aqueous ammonia added	white precipitate formed, soluble in excess
B	aqueous sodium hydroxide added	white precipitate formed, soluble in excess
C	aqueous sodium hydroxide added	effervescence observed
D	dilute nitric acid added	effervescence observed

26 An element X forms an ion X^{2-}.

Which group of the Periodic Table is this element found in?

A Group I

B Group II

C Group VI

D Group VII

27 The chemical formula of the compound formed by P and Q is PQ_2.

Both P and Q are non-metals.

What is the correct electronic configuration of P and Q?

	P	Q
A	2.2	2.7
B	2.4	2.6
C	2.8.1	2.6
D	2.8.6	2.1

28 Potassium chlorate has the formula $KClO_3$.

What is the chemical formula of copper(II) chlorate?

A $CuClO_3$

B Cu_2ClO_3

C $Cu_3(ClO_3)_2$

D $Cu(ClO_3)_2$

29 A solution of nitric acid is made by dissolving 31.5 g of HNO_3 in 200 cm^3 of water.

What is the concentration, in mol/dm^3, of this solution?

A 0.0025 mol/dm^3

B 0.1575 mol/dm^3

C 2.5 mol/dm^3

D 157.5 mol/dm^3

30 A student adds an aqueous solution of sodium hydroxide to a solution of dilute hydrochloric acid. The reaction is exothermic.

Which row shows the direction of heat flow and the change in temperature for this reaction?

	temperature change	direction of heat flow
A	fall	from surroundings
B	fall	to surroundings
C	rise	from surroundings
D	rise	to surroundings

31 Copper(II) oxide is added to excess dilute nitric acid.

The equation for the reaction is shown.

$$CuO(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + H_2O(l)$$

Which change in the conditions will increase the speed of reaction?

A decrease the concentration of nitric acid

B decrease the volume of nitric acid

C increase the particle size of copper(II) oxide

D increase the temperature

32 Part of some chemical reactions are shown.

Which reaction represents reduction?

A $2Cl^- \rightarrow Cl_2 + 2e^-$

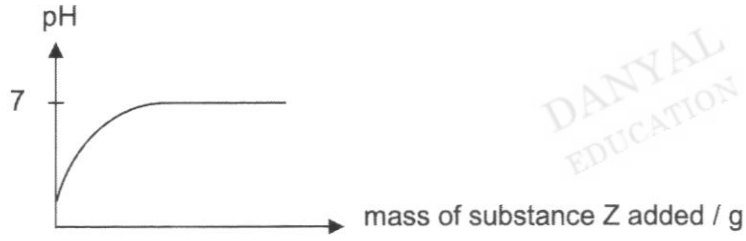
B $H^+ + OH^- \rightarrow H_2O$

C $Na^+ + Cl^- \rightarrow NaCl$

D $Fe^{3+} + e^- \rightarrow Fe^{2+}$

33 Substance Z is an insoluble solid. Excess substance Z is added into a beaker of dilute hydrochloric acid.

The pH of the reaction mixture is measured and shown.



What is substance Z?

A calcium hydroxide

B magnesium carbonate

C potassium oxide

D silver chloride

34 Some information about oxides of T and U are given.

	reacts with acid to form salt and water	reacts with base to form salt and water
oxide of T	✓	×
oxide of U	×	×

What type of oxides are oxides of T and U?

	T	U
A	acidic	amphoteric
B	amphoteric	acidic
C	basic	neutral
D	neutral	basic

35 Which salt requires pipette and burette in its preparation?

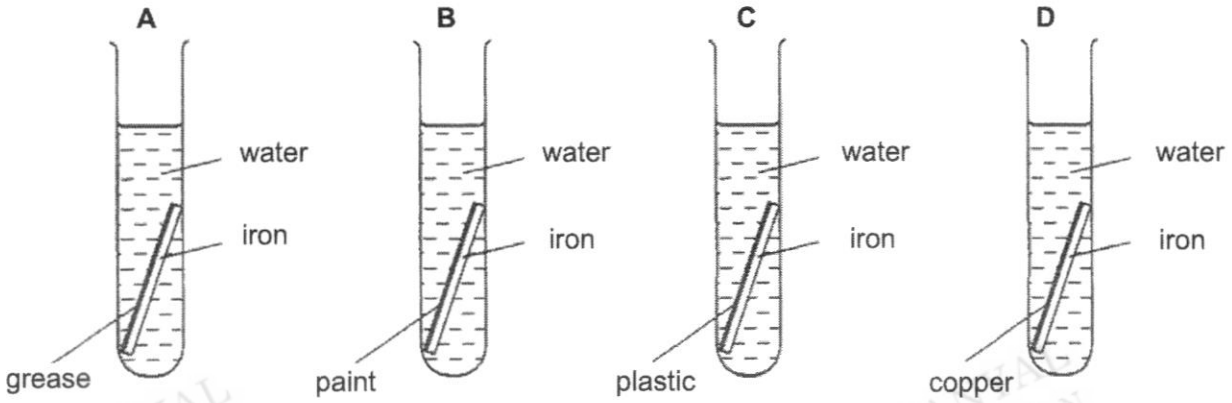
A ammonium chloride
B barium sulfate
C lead(II) chloride
D zinc nitrate

36 Which row about bromine is correct?

	state at room temperature	colour	displacement reactions
A	liquid	red-brown	displaces chlorine from chlorides
B	liquid	red-brown	displaces iodine from iodides
C	solid	brown	displaces chlorine from chlorides
D	solid	brown	displaces iodine from iodides

37 Identical pieces of iron are placed in four different test-tubes.

In which test-tube will the iron rust?



38 Two statements were made about acid rain.

Statement 1: The burning of fossil fuels containing sulfur is a cause of 'acid rain'.

Statement 2: Acid rain is formed from sulfur dioxide which is produced when sulfur compounds burn.

Which of the following is true?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

39 Which petroleum fraction is used as a material for road surfaces?

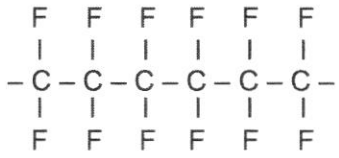
A bitumen

B diesel

C lubricating oil

D naphtha

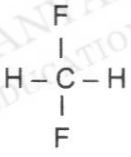
40 The diagram shows part of the structure of an addition polymer.



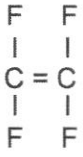
Which monomer is used to make this polymer?

A

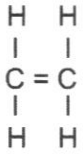
B



C



D



康 柏 中 学

COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SCIENCE (PHYSICS, CHEMISTRY) 5076/02

Paper 2 Physics

Secondary Four Express / Five Normal (Academic)

Name: _____ Duration: 1 h 15 min

Index No: _____ Date: 29 Aug 2022

Class: Sec _____ Marks: ____/65

READ THESE INSTRUCTIONS FIRST

Write your full name, class and index number on all the work you hand in.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A (45 marks)
Answer **ALL** questions in Section A.
Write your answers in the spaces provided on the question paper.

Section B (20 marks)
Answer any **two** questions
Write your answers in the spaces provided on the question paper.

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

For Examiner's Use	
Section A	
Section B	
Total	

This paper consists of **18** printed pages including this page. Setter: Mr Chan HL

Section A (45 marks)

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

1 A ship is being pulled by two tugs, as shown in Fig. 1.1.
The tugs pull with forces of 8500 N and 5000 N respectively, as shown in the diagram.

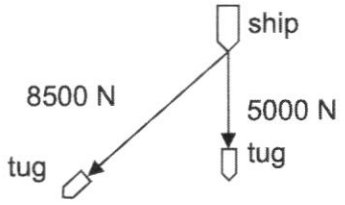


Fig. 1.1

An incomplete vector diagram for these forces is shown in Fig. 1.2.

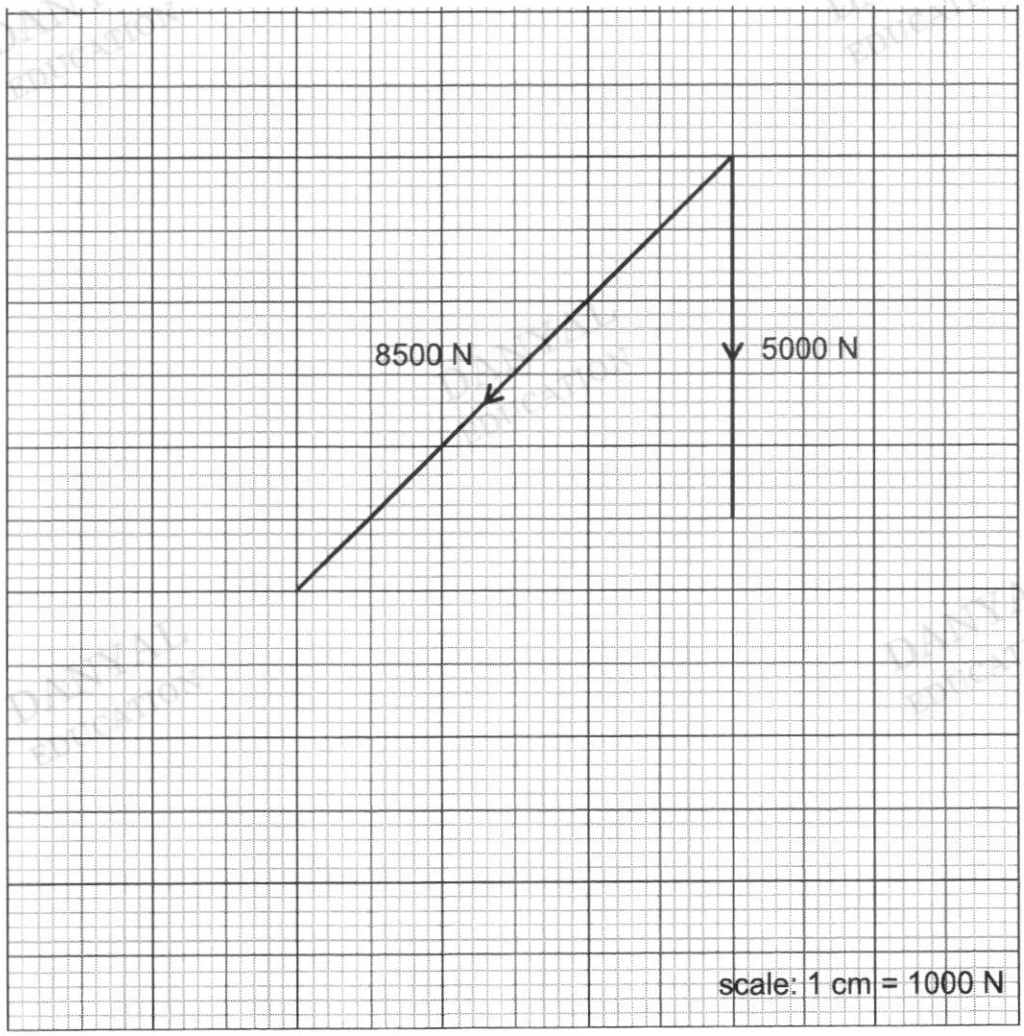


Fig. 1.2

Complete Fig. 1.2, using a scale of 1 cm to represent 1000 N to determine the resultant force that the tugs exert on the ship.

resultant force = ... N [3]

2 Fig. 2.1 shows the motion of a car along a straight road. As the car approaches a small town, it slows down. The car travels at a constant speed from the start of the town to the end of the town. After passing through the town, the car speeds up.

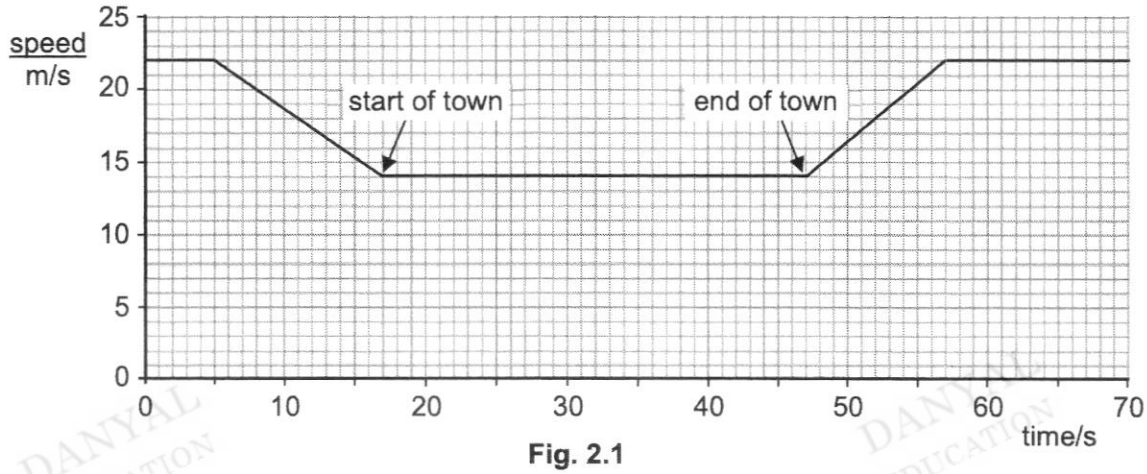


Fig. 2.1

(a) The car motor is providing a constant force to maintain a constant speed as the car travels through the town.

Explain why the speed remains constant even though the motor is applying a force.

.....

.....

..... [2]

(b) Calculate the deceleration of the car.

deceleration = ... m/s^2 [2]

(c) Calculate the distance travelled by the car **for the duration of its acceleration** after passing the town.

distance = ... m [2]

3 A reverse bungee ride involves a passenger cradle hurled vertically up into the air by the release of stretched elastic ropes as shown in Fig. 3.1.

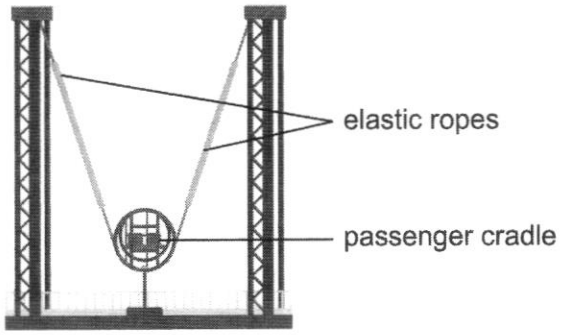


Fig. 3.1

The elastic ropes are pulled down a distance of 8.0 m using an average force of 50 kN.
The passenger cradle has a mass of 600 kg.
Energy is transmitted to the passenger cradle when the elastic ropes are released.
(gravitational field strength, g = 10 N/kg)

Ignoring any effects of friction, calculate

(a) the work done in pulling back the elastic ropes,

work done = ... J [2]

(b) the speed at which the passenger cradle launches from the ground,

speed = ... m/s [2]

(c) the maximum height reached by the passenger cradle.

height = ... m [2]

4 **(a)** Light travelling from water to air is incident on the surface at an angle of 49°, as shown in Fig. 4.1.

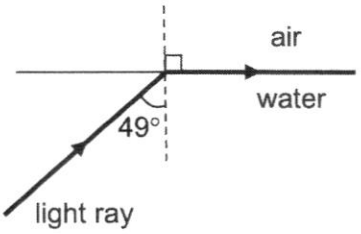


Fig. 4.1

Calculate the refractive index of water for this light.

refractive index = ... [2]

(b) Fig. 4.2 shows the side view of a water-filled aquarium **PQRS**. An electric lamp, placed in a box with a narrow slit, is immersed in one corner of the aquarium at **S**. The path of a light ray from the lamp passing through the water is drawn.

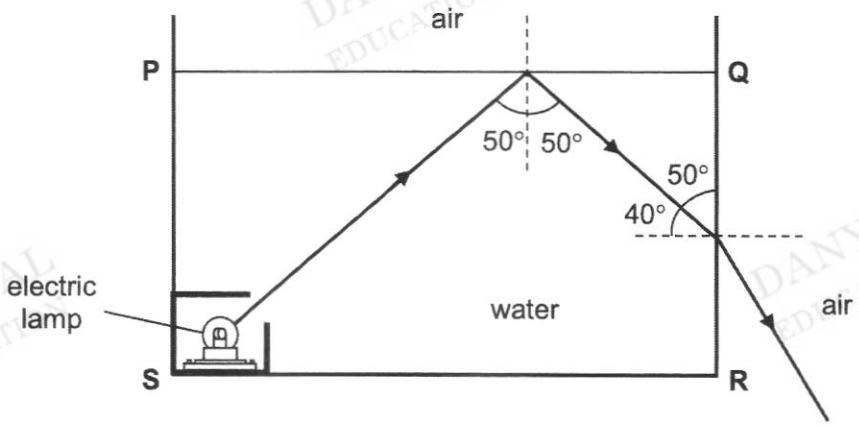


Fig. 4.2

The ray emerges out of the aquarium at surface **QR**.

Explain why the ray will emerge from surface **QR** but not surface **PQ**.

.....

.....

.....

..... [2]

5 A man is holding a load of weight *F* in his hand as shown in Fig. 5.1.

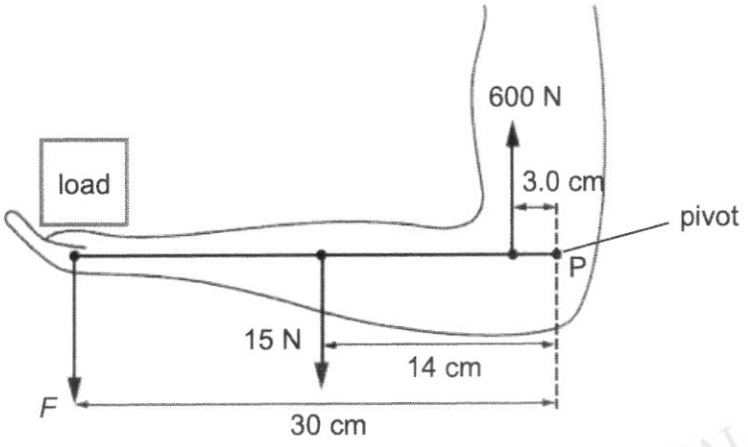


Fig. 5.1

The arm is pivoted at the elbow. The weight of the forearm is 15 N and it passes through its centre of mass. The muscle of the upper arm exerts a force of 600 N. P is the point in the elbow at which the arm pivots. The perpendicular distances of the line of action of forces from point P are shown in Fig. 5.1.

(a) Calculate the clockwise moment of the force exerted by the muscle of the upper arm.

clockwise moment = ... Ncm [2]

(b) Hence, calculate *F*, the maximum weight that can be supported by the hand.

weight = ... N [2]

(c) Explain why a load such as a bag will be easier to carry when the handle is placed near to the elbow.

.....

.....

..... [1]

6 Fig. 6.1 shows a bottle filled with two liquids A and B. The two liquids do not mix.

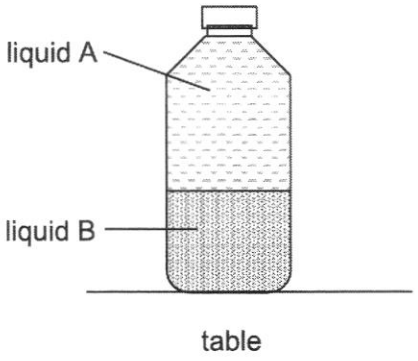


Fig. 6.1

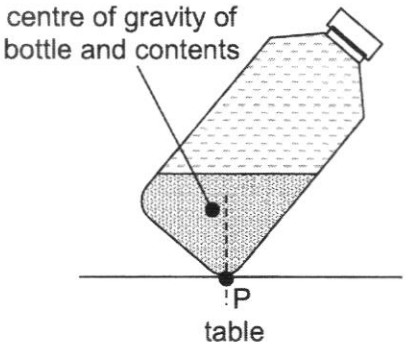


Fig. 6.2

(a) The volume of the bottle is 330 cm^3 and the volume of liquid A is 220 cm^3. The density of liquid A is 0.85 g/cm^3 and density of liquid B is 1.7 g/cm^3.

Determine the average density of contents of the bottle (liquids A and B)

average density = ... g/cm^3 [2]

(b) The bottle is tilted about P and held in position as shown in Fig. 6.2.

Explain what happens to the bottle when it is released.

.....

.....

.....

..... [2]

7 Fig. 7.1 shows the structure of a water cooler that is used to supply cold water in an office.

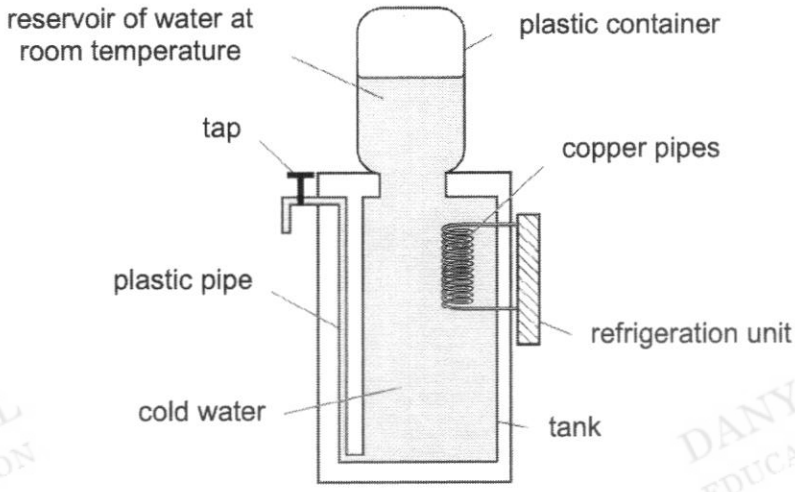


Fig. 7.1

When the tap is opened, water at room temperature from the reservoir in the plastic container flows down into the tank. Cold water from the tank flows through the plastic pipe and out of the tap.
Cold liquid from the refrigeration unit is pumped through the copper pipes and thermal energy passes through the copper to this liquid.

(a) Suggest why this pipe is made from copper.

.....

.....

..... [1]

(b) Describe the process by which all the water in the tank is cooled by the copper pipe.

.....

.....

.....

..... [2]

8 Fig. 8.1 shows a thin converging lens that is used to form a real image **I** from an object **O** (not shown). The horizontal line represents the principal axis.

The focal length of the lens is 2.0 cm.

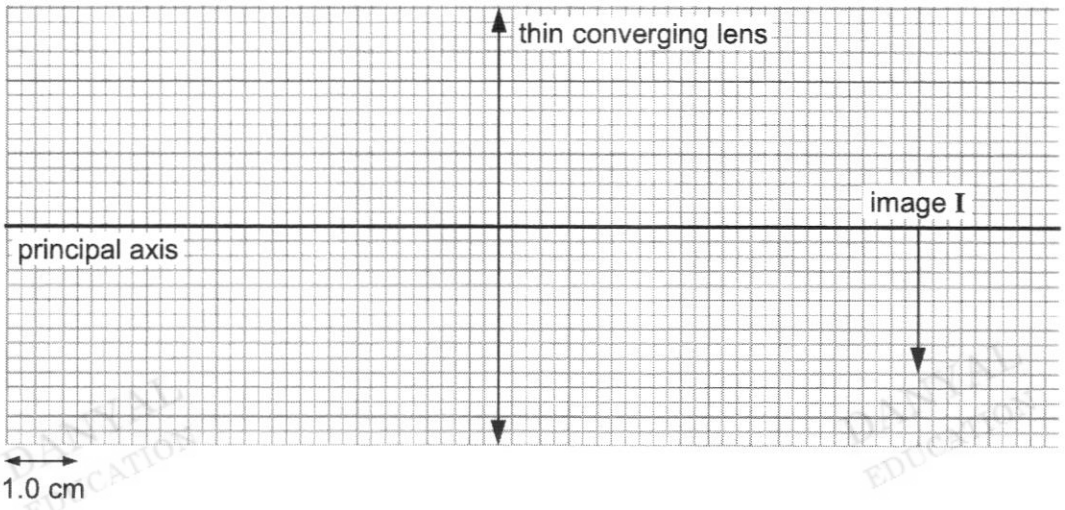


Fig. 8.1

Complete the ray diagram with 2 rays to locate and draw the object on Fig. 8.1.

Label the object **O** clearly on the diagram. [2]

9 A circuit containing four resistors and a battery of e.m.f. 12 V is connected, as shown in Fig. 9.1.

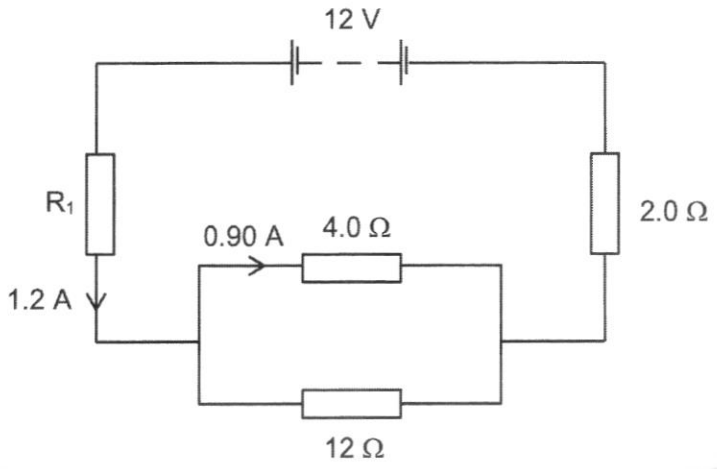


Fig. 9.1

(a) Calculate the potential difference across the 4.0 Ω resistor.

potential difference = ... V [1]

(b) Calculate the potential difference across resistor R_1.

potential difference = ... V [2]

10 Fig.10.1 shows a heating and lighting circuit in a typical house. They are connected to a 240 V mains supply.
The storage water heater has a metal case. The light bulbs are rated at 40 W, 240 V each.

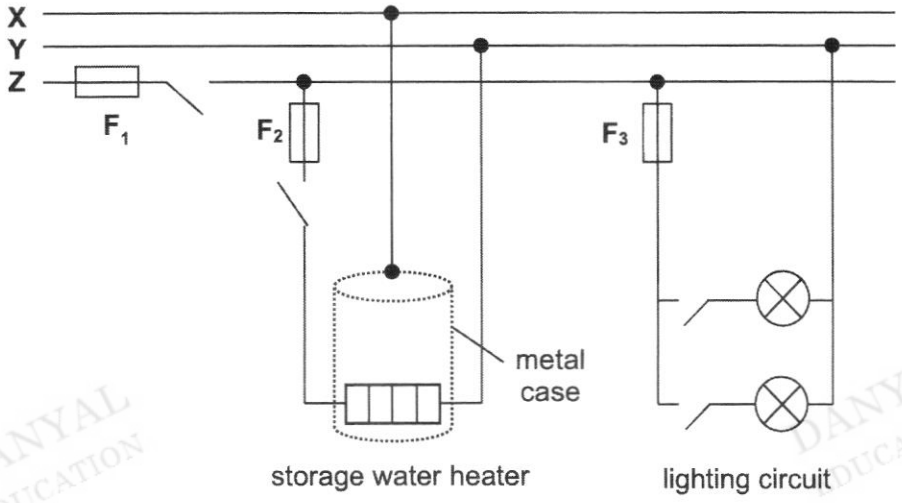


Fig. 10.1

(a) Wire **X** is connected to a part of the storage water heater but not to the lighting circuit. Describe the function of wire **X**.

.....

.....

.....

..... [2]

(b) All the switches are closed.
The user wishes to use a fuse of 10 A for F_3. Discuss, using suitable calculations, whether this would be a good idea.

.....

.....

.....

.....

..... [3]

11 Fig. 11.1 shows a coil of wire **ABCD** connected to a battery and held between the poles of a magnet.

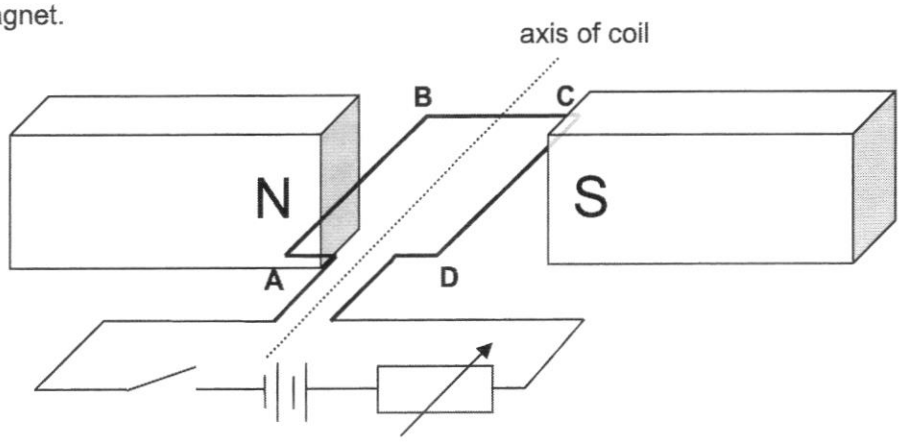


Fig. 11.1

(a) On Fig. 11.1, draw an arrow on the side **BC** of the coil to show the direction of the conventional current. [1]

(b) By considering the direction of current and the forces on coil **ABCD**, explain why there is a turning effect on the coil.

.....

.....

.....

.....

..... [3]

Section B (20 marks)

Answer any **two** questions from this section.

12 Fig. 12.1 shows a hydraulic device that is used to compress paper in a waste disposal site. When a jack is used, a force F_1 is exerted at the handle. This causes piston **A** to exert a force F_2 on the liquid, producing pressure in the liquid. The liquid transmits this pressure to piston **B** which then causes a force to be exerted on the paper.

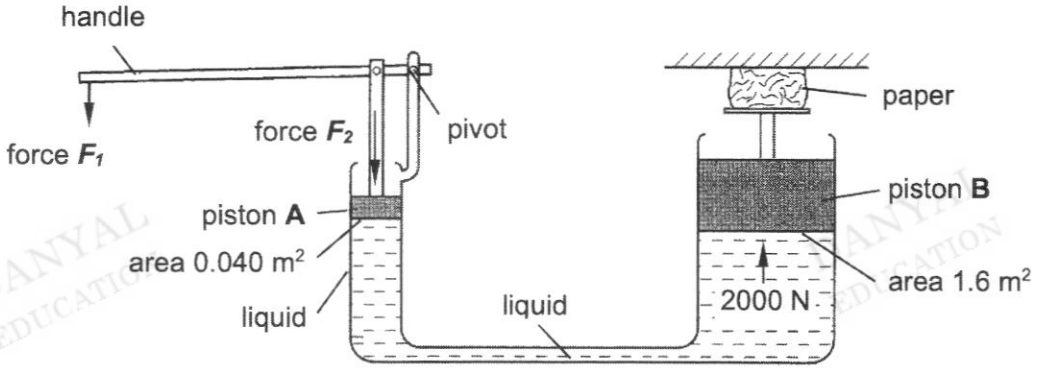


Fig. 12.1

(a) State and explain **two** reasons why the force exerted on the paper is greater than force F_1.

.....

.....

.....

.....

.....

..... [4]

(b) A force of 2000 N is exerted on piston **B**. The area of piston **A** is 0.040 m^2. The area of piston **B** is 1.6 m^2. Calculate

(i) the pressure exerted at piston **B**,

pressure = ... [2]

(ii) the force F_2 exerted on piston **A**.

force = ... [2]

(c) Suggest, with explanation, how the distance moved by piston **B** compares with the distance moved by piston **A.**

.....

.....

.....

..... [2]

13 A small glass measuring cylinder containing oil is placed inside a freezer where the temperature is -18 °C. Fig. 13.1 shows how the temperature of the oil varies with time *t*.

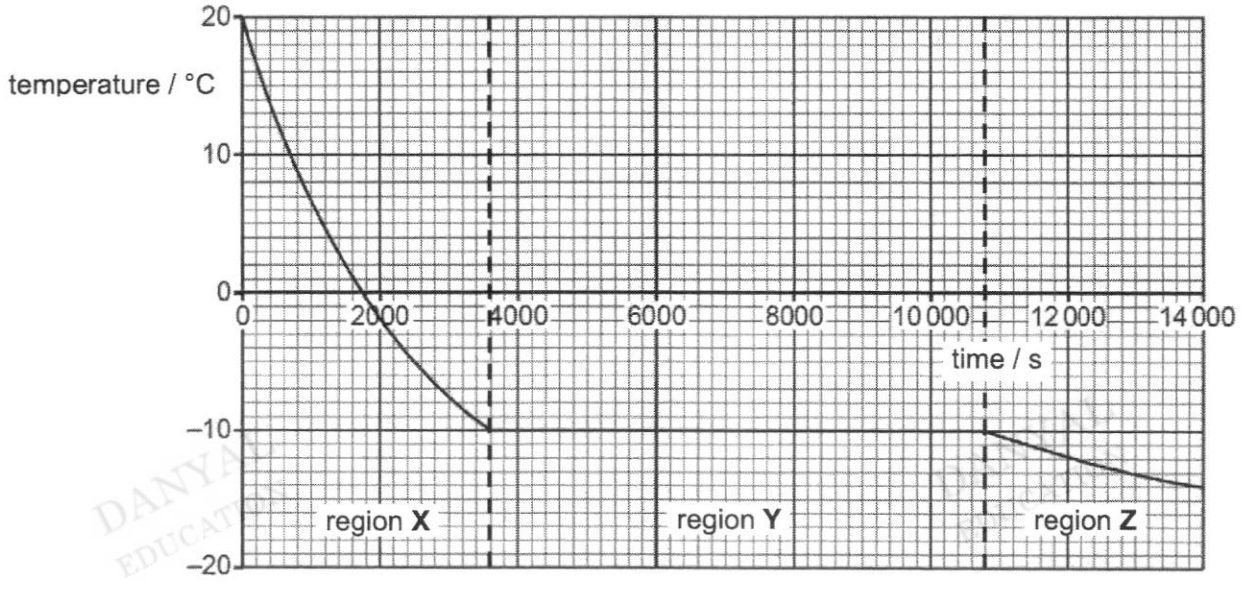


Fig. 13.1

(a) Explain why the oil temperature remains constant in region **Y**.

.....

.....

..... [2]

(b) Describe the changes, if any, that occur to the arrangement and to the motion of the molecules of oil as it cools from -11 °C to -14 °C in region **Z**.

arrangement of molecules .....

.....

.....

motion of molecules .....

.....

..... [2]

(c) The freezer has a power of 80 W. Use this information and Fig. 13.1 to calculate the energy used by the freezer in region **Y**.

energy = ... [2]

(d) In the cooling system of the refrigerator, a liquid that is very easy to evaporate is pumped through metal pipes inside and outside the food compartment.

The vapour from the freezing compartment is pumped to the outside of the refrigerator where it is compressed back into a liquid, causing the liquid to be heated. The hot liquid passes along a metal tube which are attached with blackened metal plates. The metal plates are in the air, as shown in Fig. 13.2.

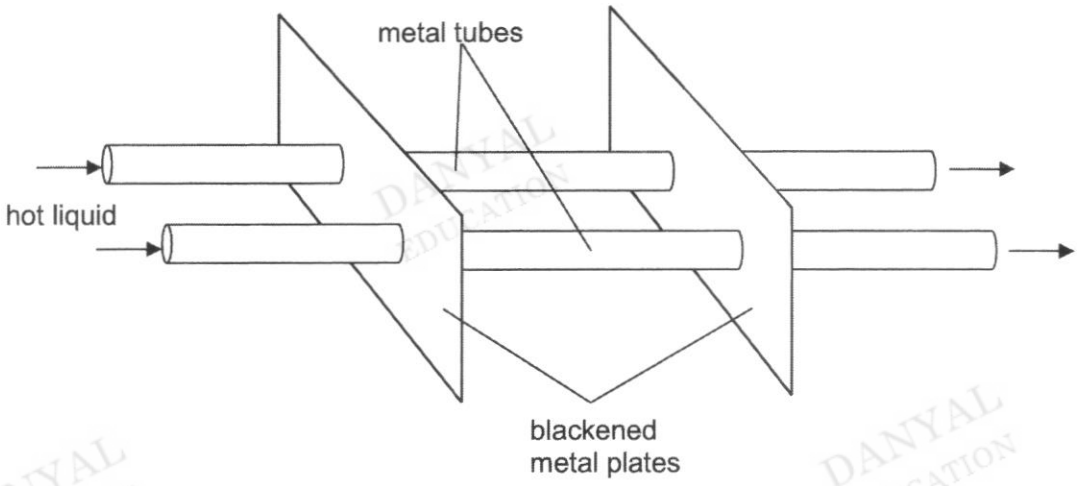


Fig. 13.2

Using ideas of thermal energy transfer, explain how energy is transferred as rapidly as possible from the hot liquid in the tube to the outside air.

.....

.....

.....

.....

.....

..... [4]

14 **(a)** Fig. 14.1 shows a coil of wire wound around a rectangular tube.
Two iron rods are placed next to each other at the bottom of the tube.

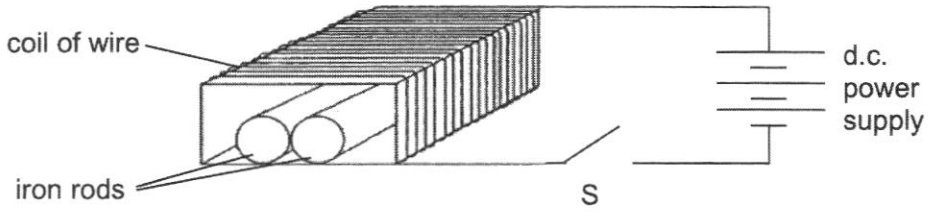


Fig. 14.1

Describe and explain what happens to the iron rods when switch S is closed.

.....

.....

..... [2]

(b) The voltage of a power supply **P** varies with time as shown in Fig. 14.2.
The direction of the voltage changes with 0.01 s.

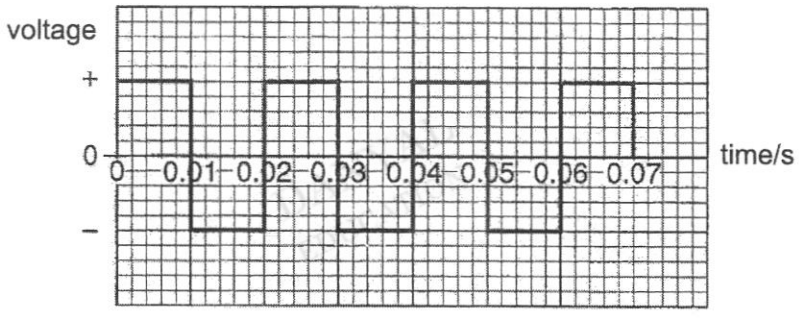


Fig. 14.2

Fig. 14.3 shows the d.c. supply of the coil of wire replaced by power supply **P**.

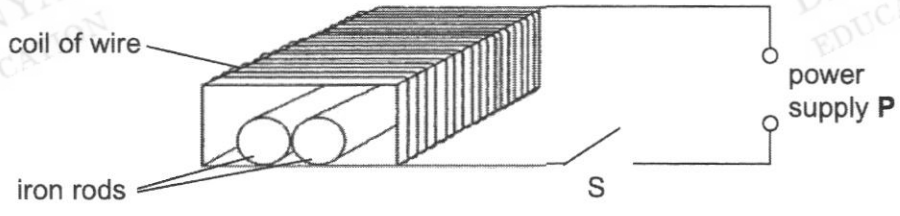


Fig. 14.3

Power supply P is switched on.
Describe and explain what happens to the iron rods when switch S is closed.

.....

.....

..... [2]

(c) The iron rods are replaced by an iron core and it is brought near to a bar magnet attached to a cone of paper to make a simple loudspeaker, as shown in Fig. 14.4.

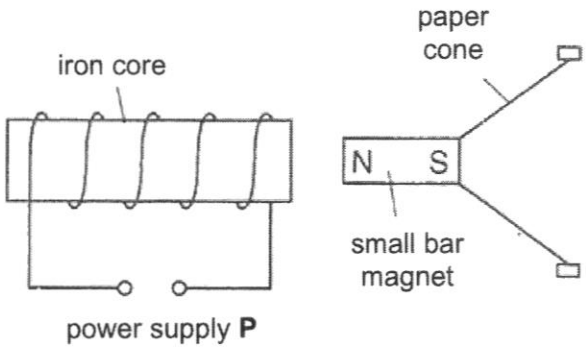


Fig. 14.4

The magnet causes the paper cone to vibrate forwards and backwards, producing a sound wave in the air.

(i) Use Fig. 14.2 to calculate the frequency of the sound wave.

frequency = ... [1]

(ii) Power supply P is adjusted to produce a sound wave of frequency of 210 Hz.
Assuming the speed of sound is 340 m/s, calculate the wavelength of this new sound wave and explain the effect on the sound produced.

wavelength = ...

explanation .....

.....

..... [3]

(iii) Describe **two** ways to increase the loudness of the sound produced by the paper cone.

.....

.....

.....

..... [2]

- End of Paper -

COMPASSVALE SECONDARY SCHOOL
Prelim Examination 2022
Secondary 4 Express / 5 N(A)
Science (Physics) ANSWERS

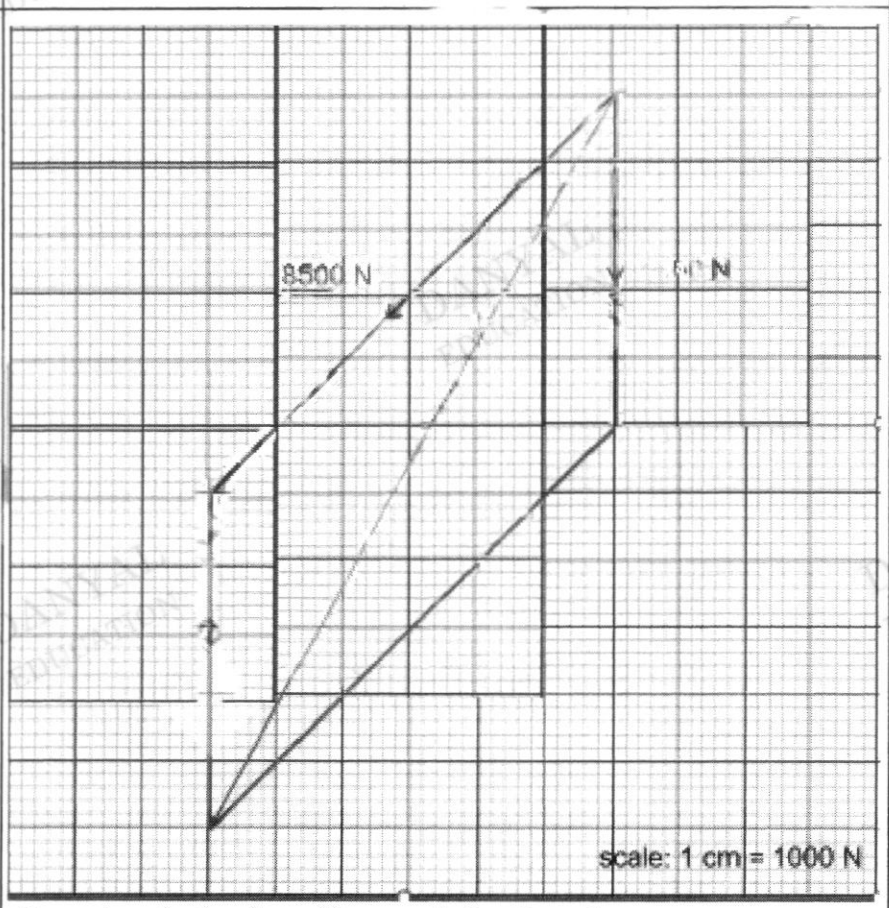
Paper 1

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
D	A	B	B	D	A	B	B	C	C
11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
D	D	A	A	D	B	C	A	C	C

A: 5 B: 5 C: 5 D: 5

Paper 2

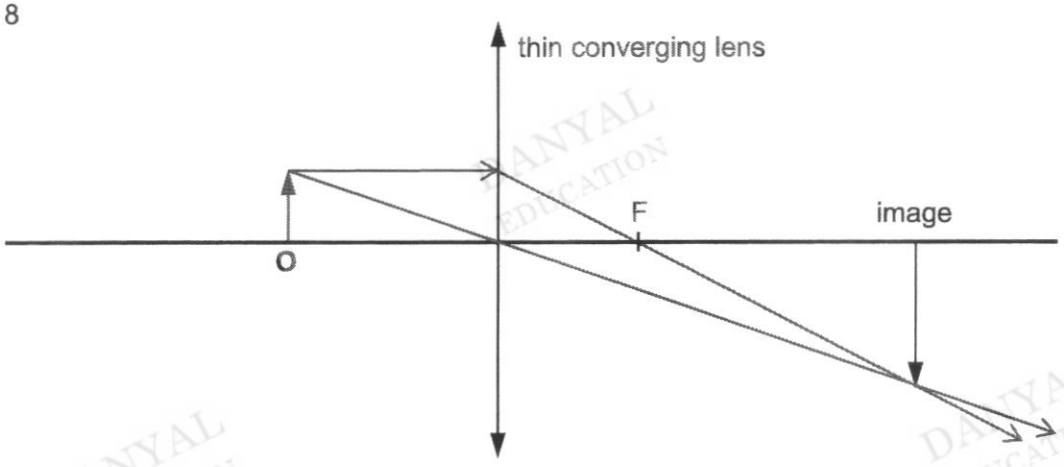
[1] penalty for missing/wrong unit in Section B to a maximum of [1] per question (Q12-14).

Qn	Answer	Marks
1		penalise if resultant is dotted line annotate but no penalty if single or no arrow for Fnet
	Correct scale drawing with correct direction of arrows	[1]
	Resultant force = 12500 N (12200 N - 12800 N)	[1]
	Resultant force at 29° (28° – 30°) to 5000 N force	[1]

2a	There are resistive forces (accept friction, air resistance) acting in the opposite direction to motion which are equal to the forward force/pushing force by the car motor. The resultant force is zero and since F = ma, acceleration is zero and the speed remains constant. Or resultant force is zero so by Newton's first law, the car continues in its state of constant speed.	[1] [1]
2b	a = (v – u) / t = (14 – 22) / (17-5) (*or other points from graph to find gradient*) = -0.67 m/s^2 (2 sf) (accept -0.667 m/s^2) Therefore deceleration = 0.67 m/s^2	 [1] [1]
2c	Distance travelled = area under v-t graph = ½ (14+22) x 10 = 180 m	 [1] [1]
3a	Work done = F x s = 50 000 x 8.0 = 400 000 J or 4.0 x 10^5 J	 [1] [1]
3b	KE of cradle = Work done ½ x 600 x v^2 = 400 000 (allow for e.c.f.) v^2 = 1333.33 v = 37 m/s (2 sf) (accept 36.5 m/s	 [1] [1]
3c	GPE gained = KE lost mgh = 400 000 (allow for e.c.f.) 600 x 10 x h = 400 000 h = 67 m (2 sf) (accept 66.7 m)	 [1] [1]
4a	n = 1 / sin c = 1 / sin 49 = 1.3 (2 sf) (accept 1.33)	 [1] [1]
4b	(As the light ray is travelling from an optically denser medium to less dense medium,) the angle of incidence of 50° is greater than the critical angle of 49°, therefore total internal reflection occurs at PQ. At QR the angle of incidence of 40° is smaller than the critical angle of 49°, therefore total internal reflection does not occur and the light ray refracts out of the aquarium.	 [1] [1]
5a	Moment = F x d = 600 x 3.0 = 1800 Ncm	 [1] [1]
5b	By the principle of moments, Total anticlockwise moments = Total clockwise moments 1800 = (15x14) + (Fx30) 30F = 1800 – 210 F = 53 N	 [1] [1]
5c	When the load is placed nearer to the elbow (pivot), the perpendicular distance is decreased and hence less force is required to obtain the same turning effect/moment is decreased.	 [1]

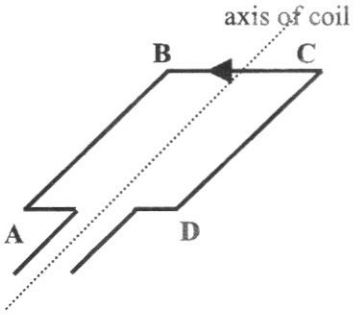
6a	Volume of liquid B = 330 – 220 = 110 cm^3 <ρ> = m_{total} / v_{total} = (220 x 0.85 + 110 x 1.7) / 330 = 1.1 g/cm^3 or 1.13 g/cm^3	[1] for correct working for M_A or M_B [1]
6b	The centre of gravity/line of action of the weight of the bottle remains within the base, anticlockwise moment due to the weight causes bottle to return to original position.	[1] [1]
7a	Copper is a good thermal conductor/conductor of thermal energy. This allows the thermal energy from the water to be conducted through the copper to the liquid inside.	[1]
7b	As the water near the copper pipe cools, it contracts, becomes denser and sinks. The cooler, denser water displaces the water from the bottom of the tank upwards to be cooled and sets up a convection current, causing the water near the copper pipe to mix with the rest of the water in the tank.	[1] [1]

8



[1] – either light ray passing optical centre or light ray passing focal point
[1] – both light rays and object drawn correctly

9a	V = I R = 0.90 x 4.0 = 3.6 V	[1]
9b	p.d. across 2.0 Ω resistor = I R = 1.2 x 2.0 = 2.4 V p.d. across R_1 = 12 – 3.6 – 2.4 = 6.0 V (allow ecf for 3.6 V from part (a), no ecf for 2.4 V)	[1] [1]
10a	Wire X is the Earth and it is connected to the metal case of the storage water heater.	

	When an electrical fault occurs and the casing becomes live (high voltage), the earth wire directs the current away/into the earth. The resulting large current blows the fuse (F_2), disconnecting the appliance from high voltage.	[1] [1]
10b	I = P / V = (40 / 240) x 2 = 0.33 A OR 0.333 A A 10 A would not be suitable as this rating is too high. The fuse would not blow even if the current exceeds the normal operating current / The current would need to exceed the normal operating current by a large amount for the fuse to blow.	 [1] [1] [1]
11a		[1]
11b	As current flows from D to C, the interaction between the magnetic field of the current-carrying wire and the magnetic field of the permanent magnets produces a force. By Fleming's left hand rule, the force on AB points downwards. Current then flows from B to A and an upward force is produced on the side CD, by Fleming's left hand rule. The forces in opposite directions produce a turning effect about the axis of the coil.	Interaction of mag field [1] Fleming's LHR correct for AB, CD [1] Forces in opp dir^n → turning effect [1]
12a	The moment due to force F_1 about pivot = moment due to force F_2. Since the perpendicular distance from F_1 to the pivot is much larger than the perpendicular distance from F_2 to the pivot, the force F_2 is much greater than F_1. The pressure on piston A is equal to the pressure on piston B. Since P = F/A and the area of piston B is much larger than the area of piston A, the force at piston B is greater than force at piston A. (Since the force at piston B is larger than F_2 and F_2 is greater than force F_1, the force exerted on the paper will be greater than force F_1.)	[1] [1] [1] [1]

12bi	P = F/A = 2000 / 1.6 = 1250 or 1300 Pa or N/m^2	 [1] [1]
12bii	Pressure exerted at piston A = Pressure exerted at piston B F_2 / 0.040 = 1250 F_2 = 50 N	 [1] [1]
12c	The distance moved by piston B is smaller than the distance moved by piston A since by conservation of energy, the work done by the smaller force, F_A at piston A over a distance, d_A must be equal to the work done by the larger force F_B at piston B over a smaller distance. $F_A \times d_A = F_B \times d_B$ OR The distance moved by piston B is smaller than the distance moved by piston A since liquids are incompressible and the volume of liquid moving in cylinder A with a smaller area must be equal to the volume of liquid moving in cylinder B with a larger area. $A_A \times d_A = A_B \times d_B$	[1] distance B < distance A [1] explanation - either qualitative or mathematical
13a	The thermal energy is released by the oil as the molecules form intermolecular bonds to change state from liquid to solid or undergo freezing/solidification.	 [1] [1]
13b	**arrangement of molecules** There is no change in the arrangement of the molecules as they remain closely packed together in an orderly/regular pattern/arrangement. **motion of molecules** The molecules continue to vibrate about their fixed positions but at a slower speed.	 [1] [1]
13c	E = P t = 80 x (10800 – 3600) = 576 000 J or 580 000 J (2 sf) or equivalent	 [1] [1]
13d	Thermal energy from the hot liquid is transferred through the metal tubes to the surrounding air by conduction since metals are good conductors of heat. This thermal energy from the hot liquid to the metal tubes is also transferred rapidly to the blackened metal plates by conduction since both are good conductors of heat. The thermal energy is then transferred to the surrounding air by radiation since black surfaces are good emitters of radiation and the increased surface area of the metal plates also increase the amount of heat transferred to the surrounding air by radiation.	[1] [1] [1] [1]

14a	The irons rods move away from each other when the switch S is closed. They are magnetised with the same poles at the same ends and they repel each other since like poles repel.	[1] [1]
14b	The irons rods still move away from each other when the switch S is closed. (accept similar statements e.g. they remain apart or no change from (a)) Although the polarities change many times each second, the rods are still magnetised with the same poles at the same ends and they repel each other since like poles repel.	[1] [1]
14ci	f = 1 / T = 1 / 0.02 = 50 Hz	[1]
14cii	v = f / λ 340 = 210 / λ λ = 0.62 or 0.618 m The sound produced will have a higher pitch since the frequency is higher.	[1] [1] [1]
14ciii	To increase the loudness of the sound, the e.m.f. (or current) of the power source can be increased, the number of turns (per unit length) of the coil can be increased or a stronger bar magnet can be used.	Any two

Paper 5

Qn	Answer	Marks
(i)	5 correct readings of U_A1, U_A2, U_B1 and U_B2.	[1] (see attached)
	Values of U_A and U_B correctly expressed to 1 d.p.	[1]
	Values of $U_{A(avg)}$ and $\frac{1}{U_{A(avg)}}$ correctly calculated. (Allow one error in calculation)	[1]
	Value of $U_{B(avg)}$ and $\frac{1}{U_{B(avg)}}$ correctly calculated. (Allow one error in calculation)	[1]
	Values of $\frac{1}{U_{A(avg)}}$ and $\frac{1}{U_{B(avg)}}$ correctly expressed to 2/3 s.f.	[1]

(j)	Axes labelled correctly Appropriate scale covering at least half the graph paper (with correct starting values) All points plotted correctly (allow for 1 error in plotting) Line of best fit drawn	[1] [1] [1] [1]
(k)	*y*-intercept correctly read from the graph (as reference, teacher's value is 0.0531)	[1]
(l)	Gradient calculation shown Gradient calculated correctly using values from students' graphs	[1] [1]
(m)	Working shown Value of f calculated within ±10% of teacher's values. Focal length = 15.3 cm (accept 13.8 cm to 16.8 cm)	M1 A1 (no A1 awarded if students' previous parts wrong)
(n)	Source of error correctly stated. e.g. difficult to determine a consistently sharp image, hence affecting readings of $\mathbf{U_A}$ and/or $\mathbf{U_B}$.	[1]