NAME:	NO:	CLASS:

RIVERSIDE SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SUBJECT : Physics

SUBJECT CODE & PAPER : 6091/02

LEVEL/STREAM : 4 Express

DURATION : 1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Section A

Answer **all** questions.

Section B

Answer **all** questions. Question 11 has a choice of parts to answer.

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

At the end of the examination, submit Section A and B separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **24** printed pages.

Section A

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

1 **(a)** An athlete uses an exercise machine, as shown in Fig. 1.1.

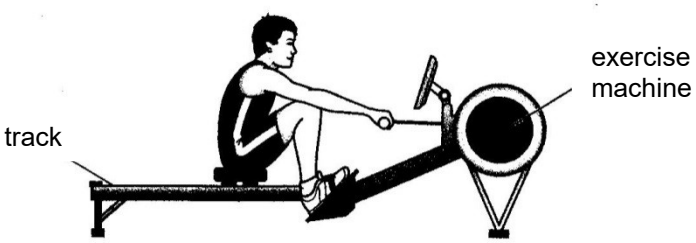


Fig. 1.1

The athlete moves backwards and forwards along the track. As he pulls the handle, he moves backwards and the machine displays the force exerted by the athlete. At the end of the track he stops pulling and then returns to the position shown. This is one complete movement.

(a) An accurate value for the average time for one complete movement is obtained.

Describe what measurements are taken and how they are used to find the average time for one complete movement.

……

……

……

……

……

……

……

…… [3]

(b) A student wants to calculate the average power input to the machine by the athlete.

Apart from the measurement in **(a)** and the average force exerted, state the other measurement that is needed.

……

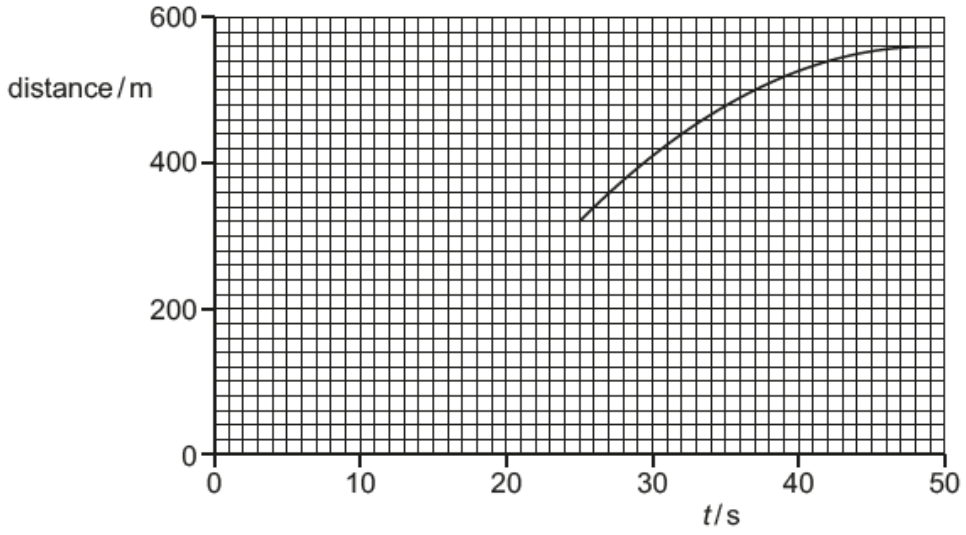
…… [1]

2 A train of mass 1.8×10^5 kg is at rest in a station. At time $t = 0$, the train begins to accelerate

non-uniformly along a straight, horizontal track and reaches a speed of 20 m/s at t = 15 s. The train continues at a speed of 20 m/s for 10 s.

At t = 25 s, the driver applies the brakes and the resistive force on the train causes it to decelerate uniformly to rest in further 24 s.

Fig. 2.1 is an incomplete distance-time graph for the journey.



(a) Complete Fig. 2.1 by drawing

(i) a curve to represent the motion of the train between t = 0 and t = 15 s

(ii) a line to represent the motion of the train between t = 15 s and t = 25 s.

[2]

(b) Calculate the kinetic energy of the train between t = 15 s and t = 25 s.

kinetic energy = …….…… [2]

(c) While the train decelerates to rest, it does work against the resistive force and its kinetic energy decreases.

(i) Define *work done*.

……..……..……

……..…… [1]

(ii) Using Fig. 2.1, determine the distance moved by the train while it decelerates.

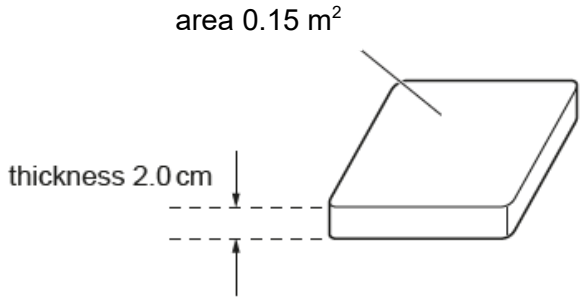
distance = ……..……[1]

(iii) Calculate the resultant force acting on the train while it decelerates.

resultant force = ……..……[2]

3 (a) Fig. 3.1 shows a piece of glass of thickness 2.0 cm and area 0.15 m^2
The density of the glass is 2.6 x 10^3 kg/m^3.

The gravitational field strength *g* is 10 N/kg.



(i) Explain what is meant by the *weight of an object*.

……..……

……..…….……. [1]

(ii) Calculate the weight of the glass.

weight of glass = ……..……[2]

(b) The piece of glass shown in Fig. 3.1 is used as the vertical viewing window of an aquarium. The atmospheric pressure outside the aquarium is 1.0 x 10^5 Pa. The average pressure on the inside of the aquarium window is 1.3 x 10^5 Pa.

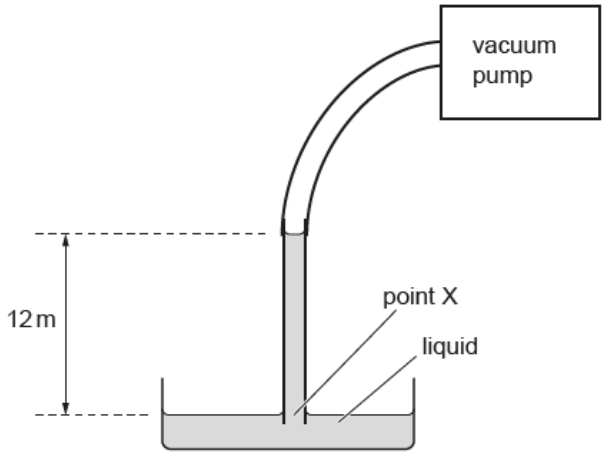
Calculate the resultant force acting on the window due to these pressures and state the direction in which it acts.

force = ……..……[2]

direction of force = ……..……[1]

(c) Fig. 3.2 shows a vacuum pump connected to the top of a vertical tube with its lower end immersed in a tank of liquid. The pump reduces the pressure above the column to zero and the pressure at point X is 9.6 x 10^4 Pa.

The gravitational field strength *g* is 10 N/kg.



Calculate the density of the liquid.

density of liquid = ……..……[2]

4 Fig. 4.1 shows a door and an automatic door-closer viewed from above

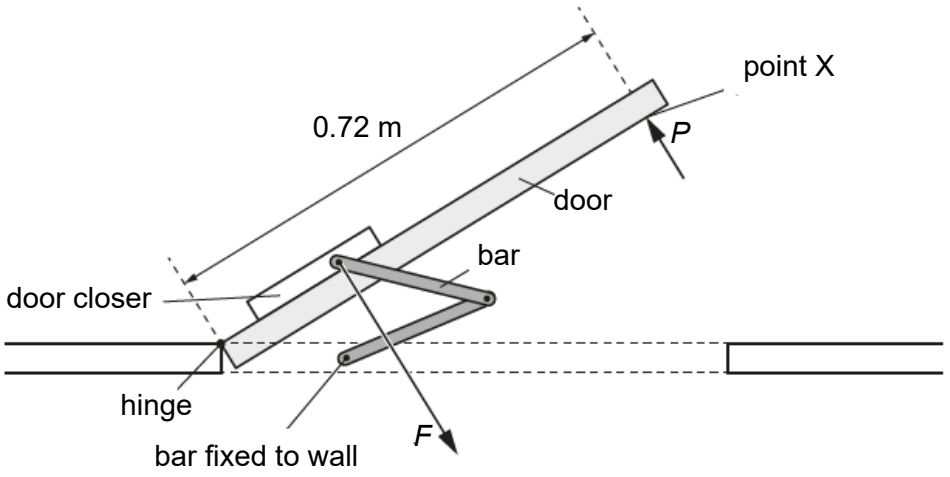


Fig. 4.1

When the door opens and closes, the hinge acts as a pivot.

A girl opens the door by exerting a force *P* at point X.

Force *P* is perpendicular to the surface of the door.

(a) Fig. 4.1 shows that point X is a distance of 0.72 m along the front of the door from the hinge. The force *P* is 25 N.

(i) Calculate the moment of force *P* about the hinge.

moment of force = ……..……[1]

(ii) The door rotates about the hinge by 90º. As it rotates, the force *P* remains perpendicular to the surface of the door. The circumference of a circle of radius 0.72 m is 4.5 m.

Calculate the work done on the door by force *P*.

work done = ……..……[2]

(b) As the door opens, there is a force *F* on the door in the direction shown in Fig. 4.1. Although force *F* is larger than force *P*, the door rotates about the hinger.

Explain why.

……

……

……

……..…….. [2]

5 A small glass measuring cylinder of oil is placed inside a freezer where the temperature is –18 ºC. Fig. 5.1 shows how the temperature of the oil varies with time *t*.

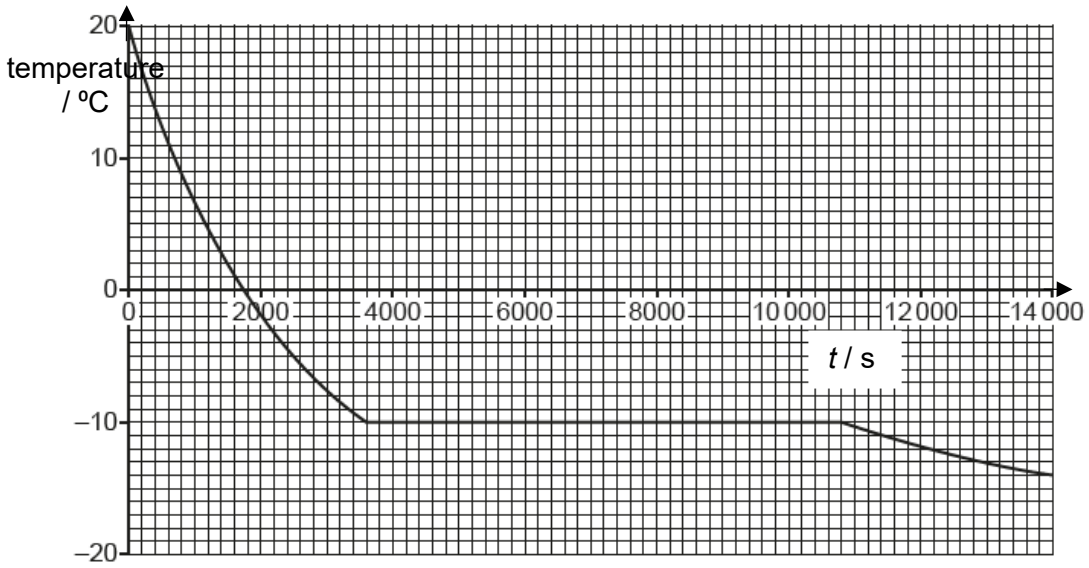


Fig. 5.1

Fig. 5.1 shows that it takes a shorter time for the temperature to decrease from 20 ºC to 10 ºC while it takes a longer time to decrease from 0 ºC to -10 ºC.

(a) Suggest why these times are different.

……

……

……

……[2]

(b) Explain, in terms of molecules, why the temperature of the oil does not change between *t* = 3600 s and *t* = 10 800 s.

……

……

……

……

…… [3]

(c) There is 45 g of oil in the glass measuring cylinder and the specific latent heat of fusion of the oil is 5.7×10^4 J/kg.

Calculate

(i) the energy transferred from the oil between t = 3600 s and t = 10 800 s

energy = ……[2]

(ii) the average rate at which energy is transferred from the oil between t = 3600 s and t = 10 800 s.

rate = ……[1]

(d) The graph in Fig. 5.1 is steeper before the horizontal section than it is after.

Use this observation to compare the specific heat capacity of oil in the liquid and solid states and explain your reasoning.

……

……

……

……

…… [2]

6 Fig. 6.1 shows a lamp from a car. It contains two metal filaments.

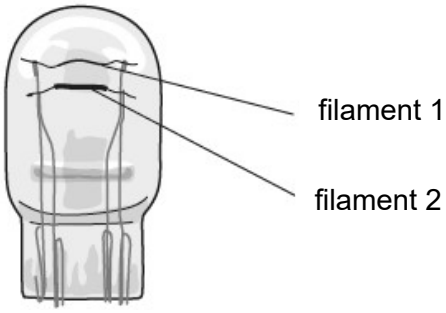


Fig. 6.1

(a) State the energy conversion that takes place when the lamp is switched on.

……. [1]

(b) The two filaments are usually connected in parallel to a car battery.

A student investigates what happens when the filaments are connected in series, rather than in parallel. He uses the same battery for the investigation.

State whether the current, the voltage across each filament and the total power produced increases, decreases or stays the same when the two filaments are connected in series.

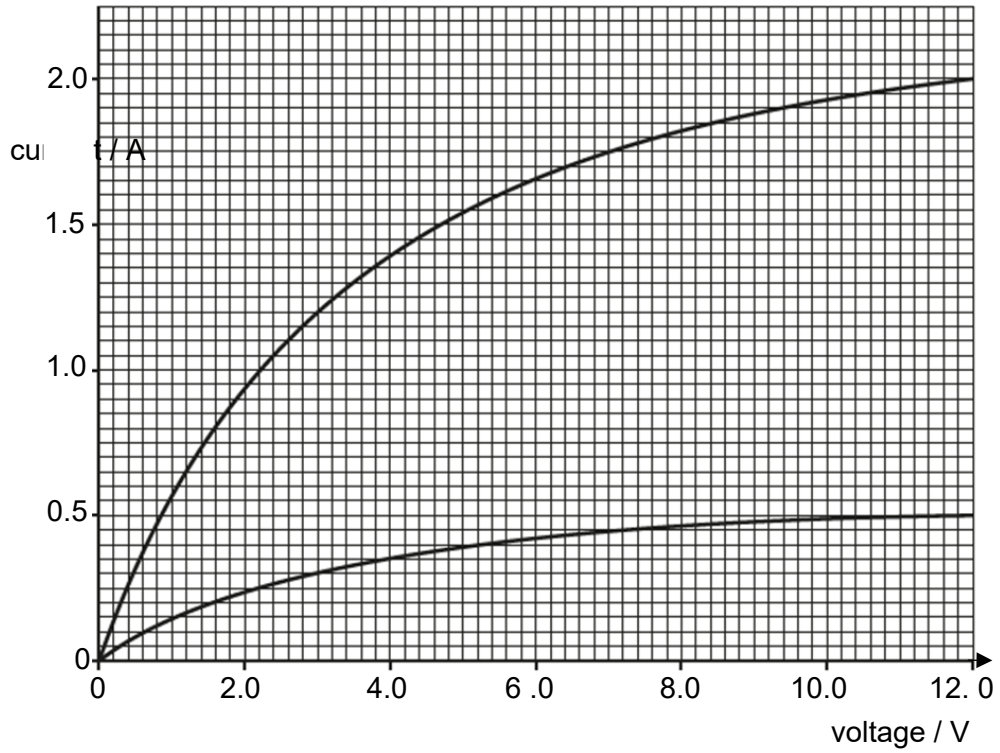
current ……

voltage ……

power ……

[1]

(c) Fig. 6.2 shows the current-voltage graph for the two filaments.



(i) Calculate the total resistance of the two filaments when they are connected in parallel to a voltage of 12 V.

total resistance = ……..……[2]

(ii) The two filaments are made from the same type of metal and have the same length when uncoiled. They both operate at the same temperature.

Suggest why one filament has a resistance that is greater than that of the other filament.

……..……

……..…… [1]

7 Fig. 7.1 shows a method of producing sandpaper using static electricity.

glue

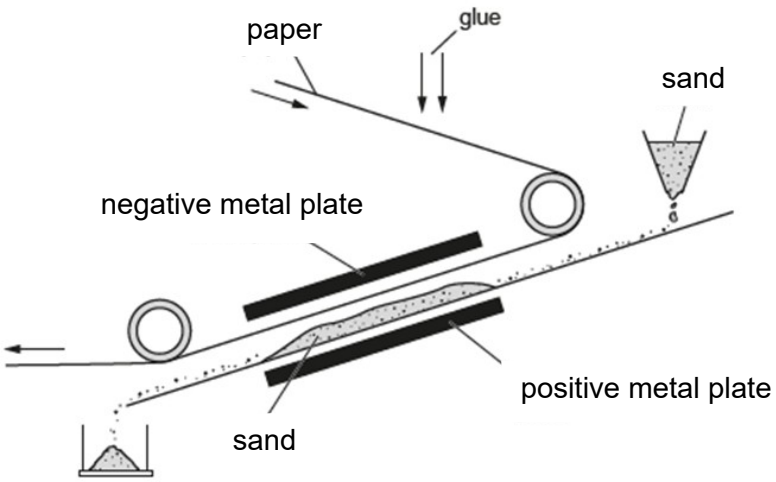


Fig. 7.1

Glue is sprayed onto moving paper. The sticky paper then passes between two metal plates.

One of the plates is positive and the other plate is negative.

There is an electric field between the plates.

(a) On Fig. 7.2, draw the electric field between the two metal plates. Show the direction of the electric field.

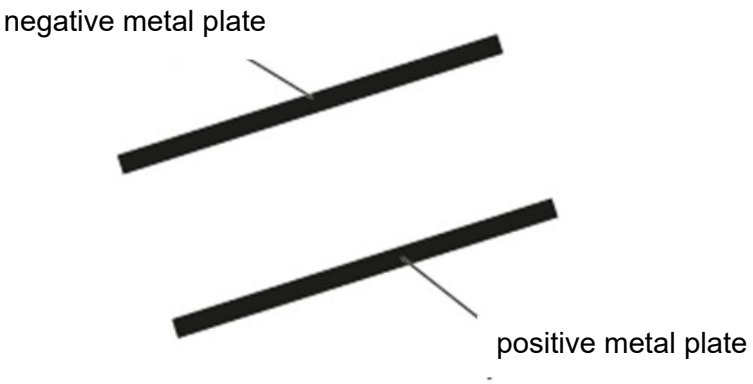


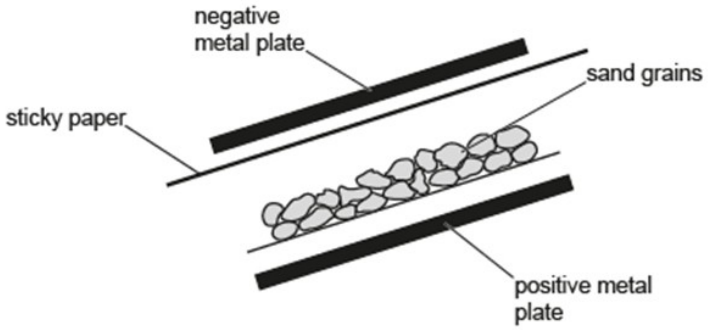
Fig. 7.2

[2]

(b) Grains of sand are present just below the sticky paper.

Each grain of sand is a conductor of electricity.

Fig. 7.3 shows two layers of sand grains in the space between the two plates.



(i) Explain, using ideas about the movement of charge, why the top layer of sand becomes positively charged.

……

……

…… [1]

(ii) State why the top layer of sand moves towards the sticky paper.

……

……

…… [1]

(c) A student receives an electric shock by walking across a certain type of carpet and then nearly touching a piece of earthed metal with his hand.

The potential difference between the hand and the metal is 2000 V and the charge transferred is 4.0×10^{-4} C.

Calculate the energy transferred when the spark jumps across the air gap from the metal onto his hand.

energy = ……[2]

8 Fig. 8.1 shows a N-pole of a magnet placed in front of the S-pole of a second magnet.

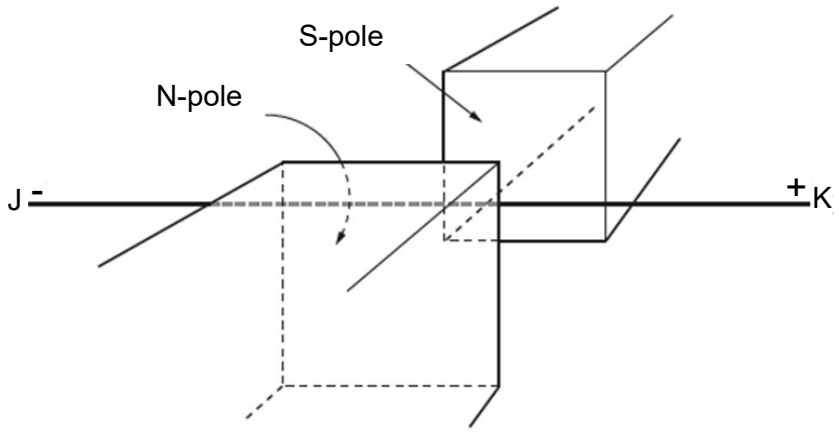


Fig. 8.1

A section of a horizontal, metal wire JK lies in the magnetic field between the two magnetic poles. End K of the metal wire is connected to the positive terminal of a battery and end J is connected to the negative terminal.

(a) Explain in terms of electrons, why there is a current in the wire and state the direction of the conventional current.

……

……

……[2]

(b) The part of JK that is in the magnetic field experiences a force *F*.

State the direction of *F* and describe how this direction is deduced.

……

……

……

……

……[2]

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RIVERSIDE SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SUBJECT	: Physics
SUBJECT CODE & PAPER	: 6091/02
LEVEL/STREAM	: Sec 4 Express
DURATION	: 1 hour 45 minutes

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 multi-mode optical fibre with glass of uniform refractive index.

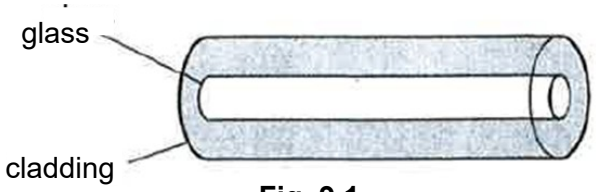
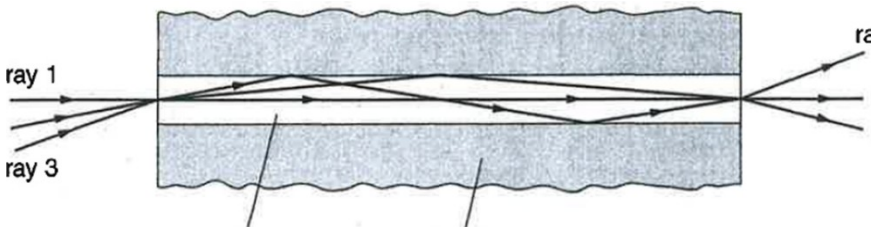


Fig. 9.1

Fig. 9.2 shows three rays of light entering the fibre from air. Each of these rays follows one of the three possible paths through the fibre.



The three rays travel different distances and take different times to pass through the fibre. Table 9.1 gives information about the three rays and their paths in two cables of lengths 1 km and 2 km.

	angle of incidence on entry / º	angle of refraction on entry / º	distance covered in 1 km cable / m	time spent in 1 km cable / μs	distance covered in 2 km cable / m	time spent in 2 km cable / μs
ray 1	0	0	1000	5.0	2000	10.0
ray 2	20	13	1027	5.1	2054	10.3
ray 3	35	*X*	1082	5.4	2164	10.8

(a) Using data for ray 1 from Table 9.1, calculate the refractive index of the glass. The speed of light in air is 3.0×10^8 m/s.

refractive index = ……[2]

(b) Calculate the angle of refraction *X* for ray 3.

angle of refraction = ……[2]

(c) At time *t* = 0, a single pulse of light enters the optical fibre of length 2 km. The pulse lasts 0.1 μs. Fig 9.3 shows the brightness of the pulses of light that leaves the fibre.

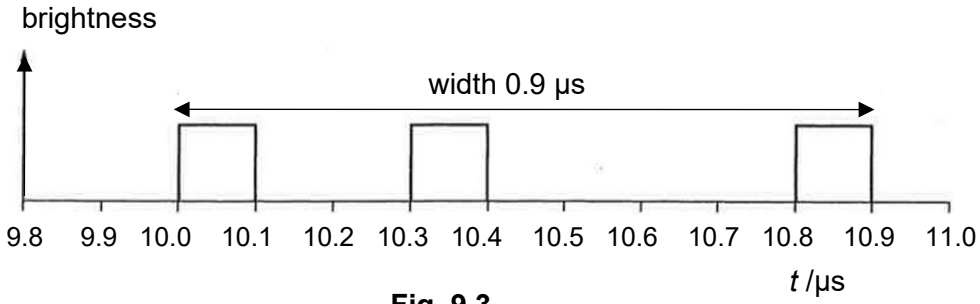


Fig. 9.3

(i) Using data from Table 9.1, explain Fig. 9.3.

……

……

…… [1]

(ii) At *t* = 0, a single pulse of light enters the optical fibre of length 1 km. The pulse also lasts 0.1 μs.

On Fig. 9.4, draw the brightness of the pulses of light that leaves the fibre.

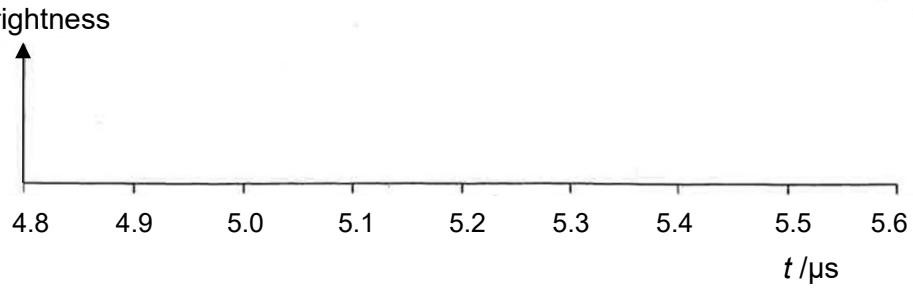


Fig. 9.4

[2]

(iii) Fig 9.3 shows that a pulse of light, lasting 0.1 μs when it enters the 2 km optical fibre, becomes three pulses lasting in total 0.9 μs when it leaves.

In a telephone conversation, a series of pulses is sent along the optical fibre. It is important that no light from one pulse overlaps light from the next pulse. A second pulse of 0.1 μs must enter the fibre at least 0.9 μs after the first.

Estimate the maximum number of pulses of light that can enter the 2 km optical fibre in one second.

number of pulses per second = ……[2]

(iv) Explain why this type of optical fibre is **not** used to transmit data at high rates over very long distances.

……..…

……..……

…… [1]

10 Fig. 10.1 represents an alternating current (a.c.) generator.

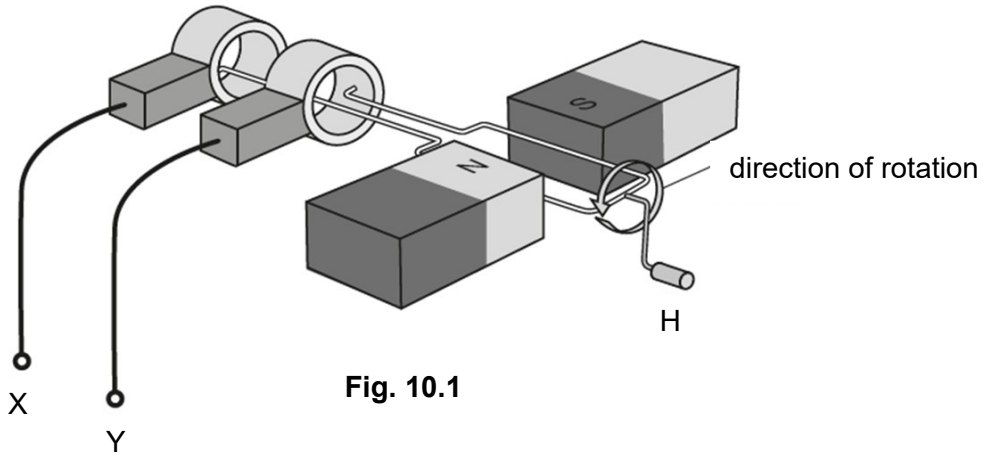


Fig. 10.1

(a) A student rotates the handle H, as shown in Fig. 10.1.

(i) On Fig. 10.2, sketch a graph to show how the electromotive force (e.m.f.) between terminals X and Y varies with time during **two** complete revolutions of the coil.

Fig. 10.2

[2]

(ii) On Fig. 10.2, mark and label a point P, for the e.m.f. when the coil is

horizontal, as shown in Fig. 10.1.

[1]

(iii) The student turns the handle more quickly.

State two ways in which the e.m.f. between terminals X and Y changes.

1. ……

……

2. ……

……

[2]

(b) Terminals X and Y are connected to the primary coil of a transformer.

State and explain what happens in the transformer as the student turns the handle of the a.c. generator.

……

……

……

……

……

…… [3]

(c) Explain why the power losses in transmission cables are lower when electrical energy is transmitted at higher voltages.

……

……

……

…… [2]

11 EITHER

Fig. 11.1 shows a stationary horse and its rider, about to jump over two fences.

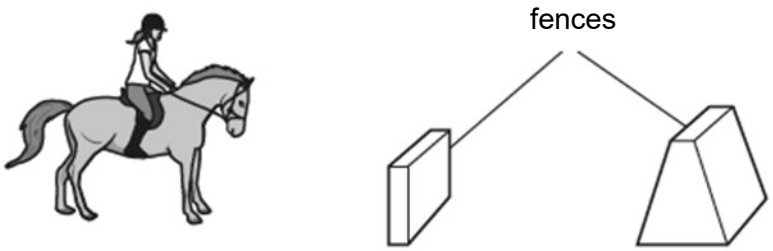


Fig. 11.1

(a) **(i)** Fig. 11.2 shows a side view of the horse.

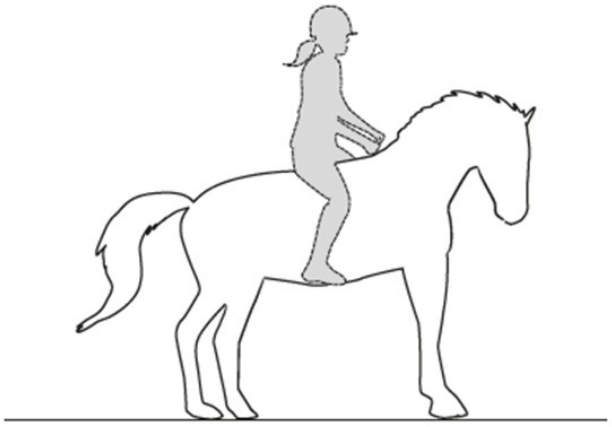


Fig. 11.2

On Fig. 11.2, draw and label the forces acting on the horse.

Include the force that the rider exerts on the horse. Label this force *F*.

[3]

(ii) Explain how Newton's third law applies to force *F*.

……

……

……

…… [2]

(b) Fig 11.3 shows a side view of the two fences. They both have the same height and are made from the same material.

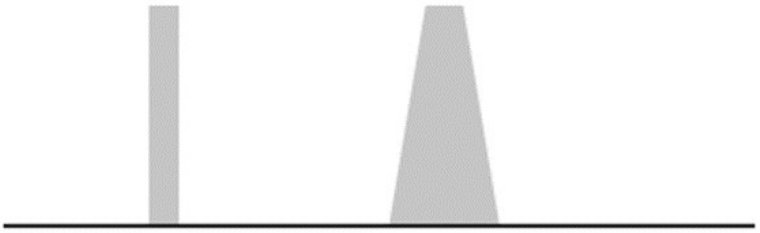


Fig. 11.3

(i) On each fence in Fig. 11.3, mark with a cross the centre of gravity. [1]

(ii) Explain why a wider base makes the fence more stable.

……..……

……..……..

…..……..…..……[1]

(c) The total mass of the horse and rider is 520 kg.

The centre of gravity of the horse and rider is 1.4 m above the ground.

The maximum potential energy gained by the horse and rider as they jump over the fence is 3000 J.

Calculate the maximum height above the ground of the centre of gravity during the jump.

The gravitational field strength *g* is 10 N/kg.

maximum height = ……[3]

OR

(a) An object O of height 3.0 cm is placed 4.0 cm from the centre of a diverging lens.

Fig. 11.4 shows the object O, the diverging lens and the two focal points, F_1 and F_2, of the lens.

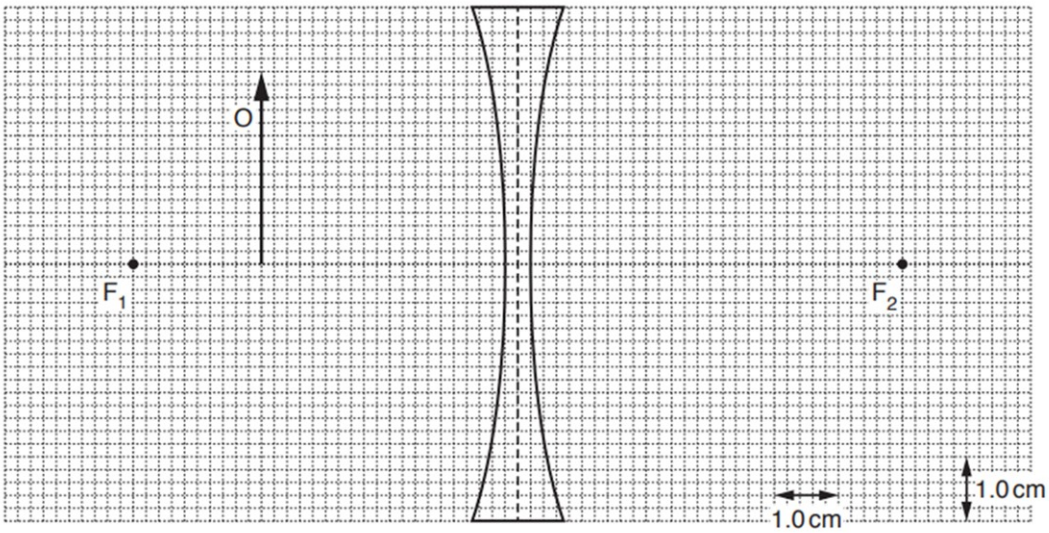


Fig. 11.4

(i) Determine the focal length of the lens.

focal length = ...[1]

(ii) The diverging lens produces an image of object O.

On Fig. 11.4, by drawing rays from the top of O, locate this image and label it I.

[3]

(iii) Determine the height of this image.

height = ...[1]

(iv) Determine the magnification of the image.

magnification = ...[1]

(v) State two ways in which a virtual image differs from a real image.

1. ……

……

2. ……

……

[2]

(b) Light passing from air into glass refracts in a similar way to a water wave passing from deep water into shallow water.

Fig. 11.5 represents light passing from air into glass at an angle to the air-glass boundary.

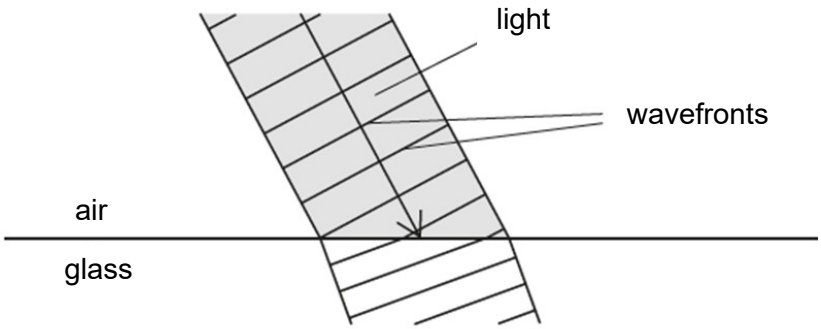


Fig. 11.5

One side of the wavefront strikes the glass before the other side.

Explain why the wavefronts change direction as the light enters the glass.

……

……

……

……

……

…… [2]