Name _____ ( ) Class _____

PRELIMINARY EXAMINATION
GENERAL CERTIFICATE OF EDUCATION ORDINARY LEVEL

PHYSICS **6091/02**

Paper 2 Theory **24 August 2022**

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use highlighters, correction fluid or correction tape.

Section A
Answer **all** questions.

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

Students are reminded that **all** quantitative answers should include appropriate units.
The use of 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.

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

For Examiner's Use	
Section A (50 Marks)	
Section B (30 Marks)	
Total (80 Marks)	

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

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over]

1 Fig. 1.1 shows a water wheel used in a farm. Water entering at the top turns the wheel about the hub.

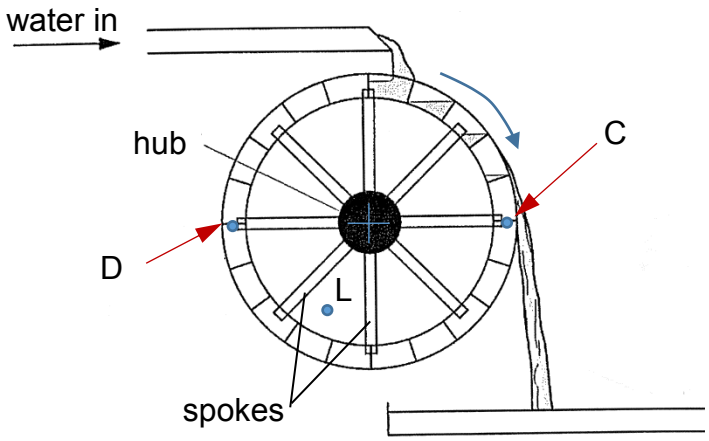

Fig. 1.1

Point C on the wheel moves in a circular path at a constant speed of 2.5 m/s.

(a) **(i)** State the change in speed of point C as it moves to position D,

change in speed =..... [1]

(ii) Determine the magnitude of the change in velocity of point C as it moves to position D,

change in velocity =..... [1]

(b) The farmer installs a laser counter at L to track the rotation of the wheel. The counter records the time interval between two spokes as the wheel rotates, as shown in Fig. 1.2.

time / s
1.48
1.51
1.50
1.49
1.52

Fig. 1.2

Determine the frequency of rotation of the wheel.

frequency of rotation = ... [2]

2 A bob of mass 0.500 kg falls from rest at a given height and strikes a pond.

Fig. 2.1 shows the variation of velocity of the bob with time during its motion. The bob reaches the bottom of pond at R. The gravitational field strength of Earth is 10 N/kg and air resistance is assumed to be negligible.

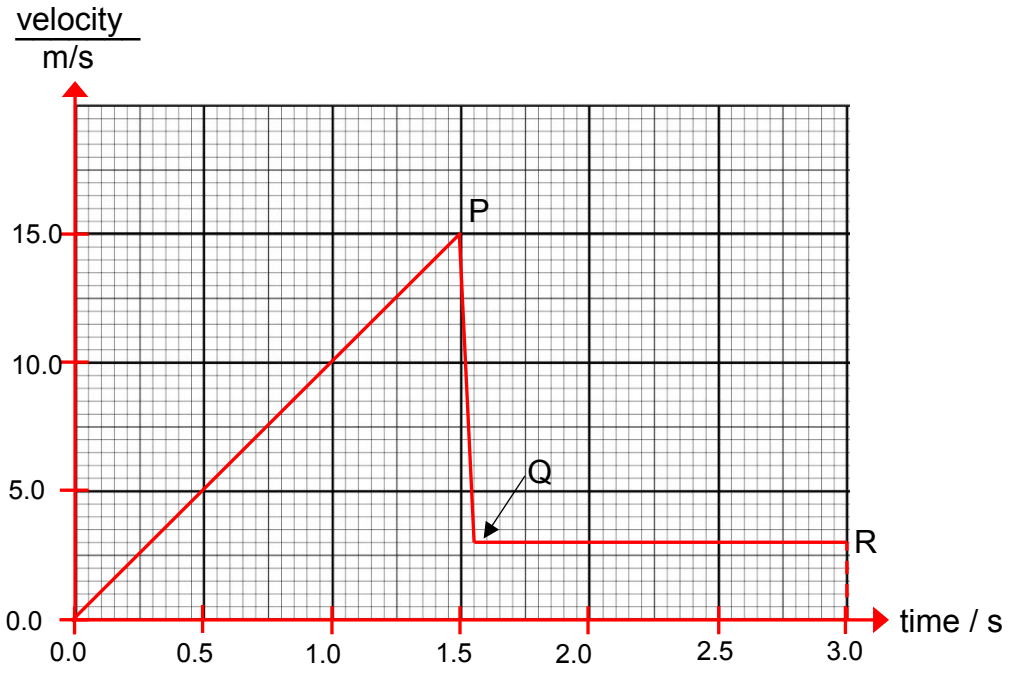

Fig. 2.1

(a) Determine the acceleration of the bob for the first 1.5 s of its descent.

acceleration = ... [1]

(b) Explain how a student can use Fig. 2.1 to estimate the depth of the pond.

.....

..... [1]

(c) On Fig. 2.2, sketch a graph to show the displacement of the bob with time for t = 0.0 s to t = 3.0 s. Displacement is measured from the point the bob starts to fall. [2]

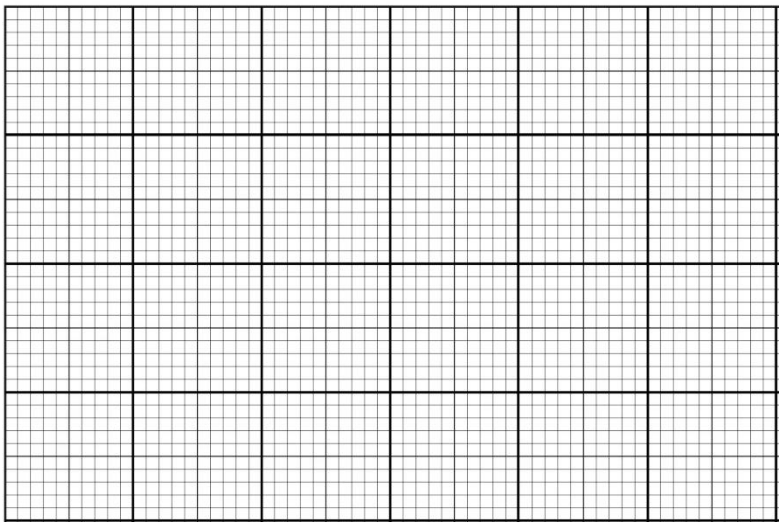

Fig. 2.2

(d) Describe the energy changes of the bob from position P to Q.

.....

..... [1]

(e) Fig. 2.3 shows the bob when it is at a position between PQ.

Fig. 2.3

Draw and label on Fig. 2.3 all the forces acting on it. [2]

3 An object made up of a pencil and penknife is used in a balancing trick as shown in Fig 3.1.

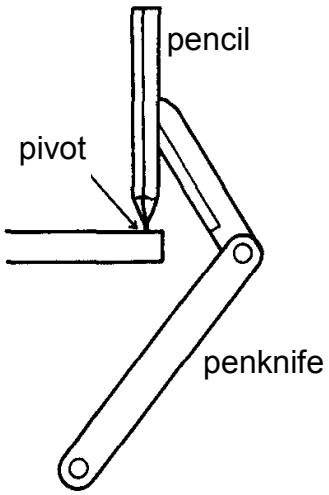

Fig. 3.1

(a) State what is meant by *centre of gravity* of an object.

.....

..... [1]

(b) Mark a possible position for the centre of gravity for the object with 'X' on Fig 3.1. [1]

(c) Explain why the object is in stable equilibrium.

.....

..... [1]

(d) A student removes the penknife. She tries to balance the pencil alone. State and explain what will happen to the pencil.

.....

.....

.....

..... [2]

4 Fig. 4.1 shows a water manometer used to measure the pressure inside a gas pipe.

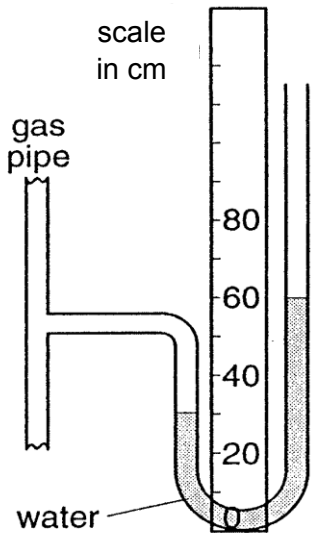

Fig. 4.1

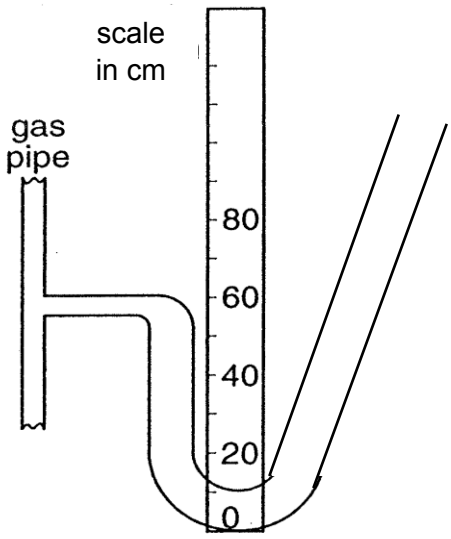

Fig. 4.2

(a) Explain how the manometer in Fig 4.1 shows that the pressure inside the gas pipe is greater than the atmospheric pressure.

……

……

……

…… [2]

(b) Calculate the pressure of the gas inside the pipe, given that the density of water is 1000 kg/m^3, the gravitational field strength is 10 N/kg and the atmospheric pressure is 1.0×10^5 Pa.

pressure = …… [2]

(c) The manometer shown in Fig. 4.2 is connected to the same gas pipe at the same pressure as shown in Fig. 4.1. On Fig. 4.2, draw the levels of the liquid in the manometer if the manometer contains a liquid with density half that of water and has twice the diameter of the manometer in Fig. 4.1. [1]

5 A negatively charged metal ball X is suspended from an insulating thread. An uncharged metal plate Y is mounted on an insulating stand.

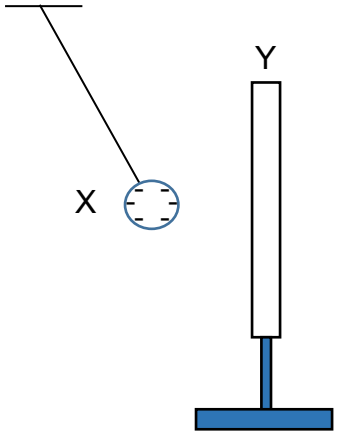

Fig. 5.1

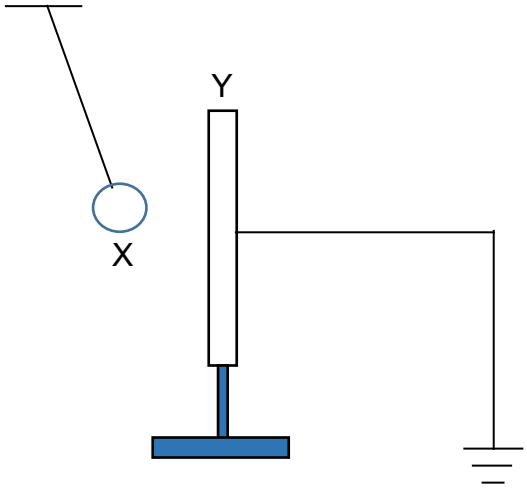

Fig. 5.2

When X is brought near to Y, it is attracted towards Y as shown in Fig. 5.1.

(a) On Fig. 5.1, draw the charges induced on Y. [1]

(b) On Fig. 5.1, draw the electric field in the space between the two conductors. [1]

(c) Explain why X is attracted to Y.

……

……

…… [2]

(d) Y is earthed momentarily as shown in Fig. 5.2. State and explain whether X will move closer, further or remains unchanged.

.....

.....

..... [2]

6 Fig. 6.1 shows a light ray ABC from the top of an object passing through a lens.

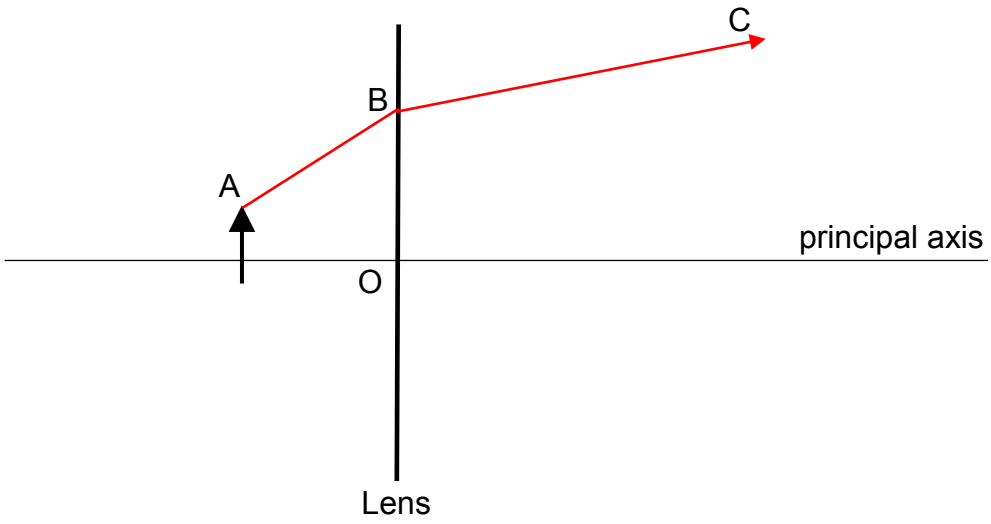

Fig. 6.1

(a) State and explain whether the lens is converging or diverging.

.....

.....

..... [2]

(b) Draw light ray(s) from the object so that the image of the object can be located. Draw the image and label the image I. [2]

(c) Locate the position of the principal focus of the lens and label the position F. [1]

7 In the circuit shown in Fig. 7.1, a battery of e.m.f. 12 V is connected to resistors A and B, and component C. The I - V characteristic graphs for B and C are shown in Fig. 7.2.

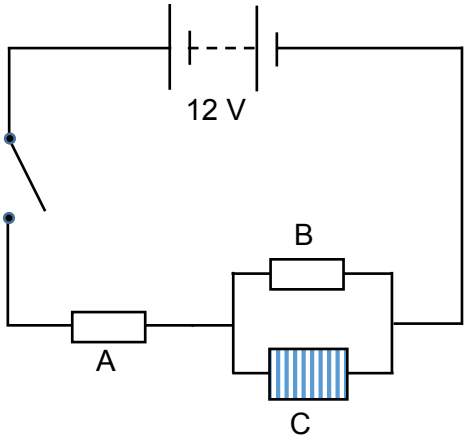

Fig. 7.1

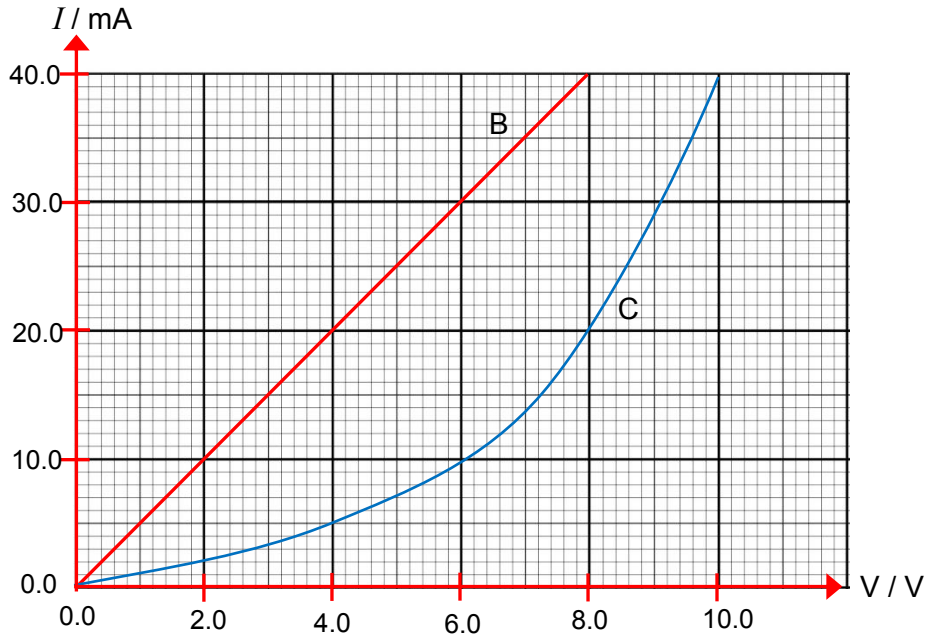

Fig. 7.2

(a) Describe how the resistance of component C changes as the potential difference (p.d.) increases from zero.

.....

.....

..... [1]

(b) When the switch is closed, the p.d. across resistor A is immediately measured to be 4.0 V. Determine the resistance of A at this instant.

resistance= …… [2]

(c) In the circuit shown in Fig. 7.1, component C is removed. Explain whether the p.d. across A increases, decreases or remains unchanged.

……

……

…… [2]

8 A conducting rod PQ is suspended horizontally by two newton-meters. The rod is placed inside the magnetic field of a U-shaped magnet as shown in Fig 8.1.

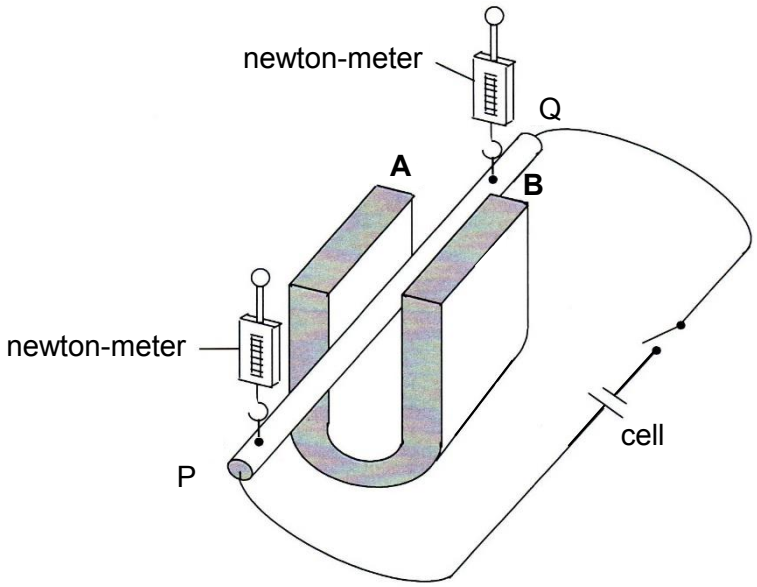

Fig. 8.1

When the switch is closed, the readings on the newton-meters decrease.

(a) Explain why the readings for the newton-meters decreased.

……

……

…… [2]

(b) State the polarities of the poles, **A** and **B**, of the magnet.

A : …… **B** : …… [1]

(c) Suggest two ways that would cause the readings on the newton-meters to decrease further.

……

……

……

…… [2]

(d) If the cell is replaced by an a.c. source of frequency 3 Hz, describe the motion of the rod when the switch is closed.

……

…… [1]

9 A student attempts to generate an electromotive force (e.m.f.) across a copper rod by swinging it between the poles of a magnet. The setup is shown in Fig. 9.1. When the copper rod in Fig. 9.1 is displaced to position X (as shown in Fig. 9.2) and then released from rest, it swings from X to Y, and continues to oscillate. As the copper rod oscillates, an e.m.f. is induced across the rod.

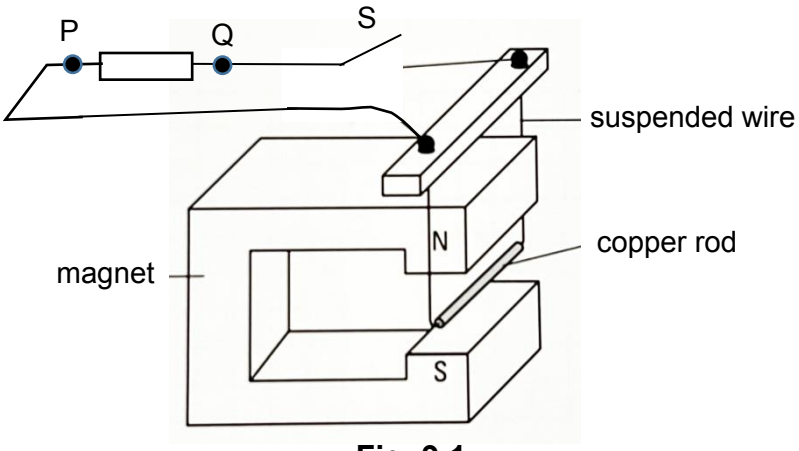

Fig. 9.1

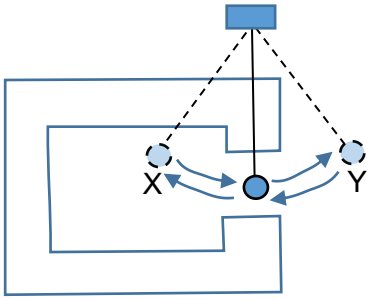

Fig. 9.2 (copper rod swinging)

The ends of the suspended wires are connected to a resistor PQ and switch S.

(a) Explain why an e.m.f. is induced across the copper rod.

……

……

…… [1]

(b) As the rod swings from X to Y, indicate the direction of induced current in the copper rod in Fig. 9.1 if switch S is closed. [1]

(c) Using Lenz's Law, explain why the direction of the e.m.f. is in the direction you indicated in **(b)**.

……

……

…… [1]

(d) As the copper rod swings, the maximum output e.m.f. of the setup in Fig. 9.1 is 12 mV. When the two ends of the resistor (points P and Q) is connected to the input of a cathode ray oscilloscope (C.R.O.), a trace is observed.

The time base is set at 50 ms/division and the Y-gain is set at 5 mV/division.

Draw the trace, M that can be seen on the screen of the C.R.O. in Fig. 9.3 when the copper rod makes four complete swings every second. Assume that the rod is at position X at t = 0. [2]

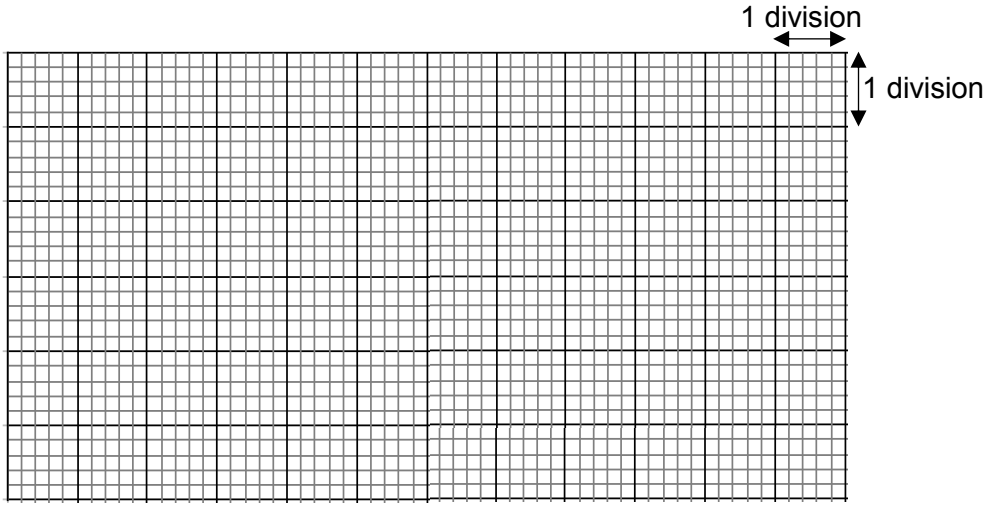

Fig. 9.3

(e) The student closed the switch and set the copper rod to oscillate. Draw a possible trace that can be seen on the screen of the C.R.O. in Fig. 9.3. Label the trace N. [2]

Section B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12.**

10 Trucks are vehicles that have the flexibility to carry almost any type of cargo over short to medium distances. Fig. 10.1 shows three trucks that are used by a local company to carry goods from a factory to the same warehouse on a particular day. The trucks have different wheel configurations and each wheel is identical.

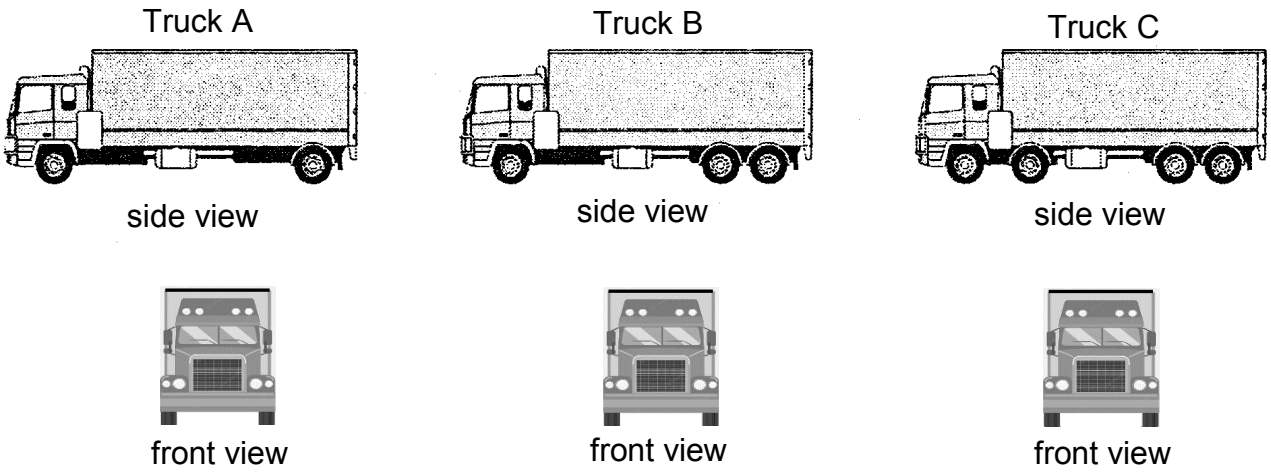

Fig. 10.1 Front and side view of trucks

Truck	Mass of truck with cargo / kg
A	15 600
B	18 800
C	20 500

Fig. 10.2

Fig 10.3 shows the speed of the three trucks at several values of time, *t*.

truck	speed / m/s				
	t = 0.0 s	t = 5.0 s	t = 10.0 s	t = 20.0 s	t = 40.0 s
A	0.0	4.0	8.0	16.0	32.0
B	0.0	6.0	12.0	18.0	24.0
C	0.0	8.0	16.0	20.0	20.0

Fig. 10.3

(a) State and explain which truck(s) has a uniform acceleration between t = 0.0 s and t = 20.0 s.

……

……

……

…… [2]

(b) **(i)** Determine the distance between truck A and truck C at t = 10 s, assuming the trucks accelerate uniformly.

distance = …….. [2]

(ii) State any assumption you made when calculating **b(i).**

……

……

…… [1]

(c) State and explain which truck's engine did the greatest amount of work between t = 20 s and t = 40 s.

……

……

……

…… [2]

(d) **(i)** The drivers stop the trucks for a rest and realised that the ground is soft. Explain which truck sank into the ground the most.

.....

.....

.....

.....

..... [2]

(ii) The co-drivers laid two pieces of identical planks in parallel across the soft ground so that the tyres of each truck are on the pair of planks. Explain which truck leaves the deepest plank imprint when driven across the soft ground.

.....

.....

.....

..... [1]

11 **(a)** A transformer only works when it is connected to an a.c. power supply. Explain why a transformer does not work when connected to a d.c. power supply.

……

……

……

…… [2]

(b) Explain why steel is not a suitable material for the core of a transformer.

……

……

…… [2]

(c) Electrical power of 5.20 MW is generated at a power plant and supplied to an industrial park which is 220 km away. This is done by using transformers P and Q, transmission cables and they are represented in the Fig. 11.1 below.

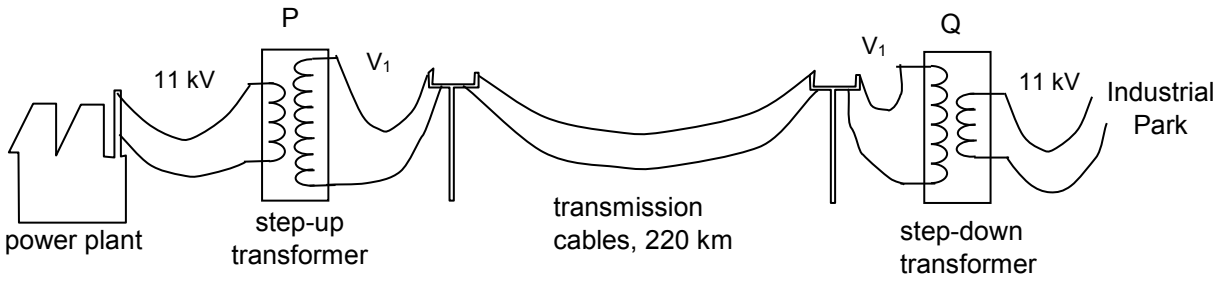

Fig. 11.1

Transformers P and Q are ideal, and the transmission cables are assumed to have resistance of 0.45 Ω/km.

(i) Determine the current generated at the power plant.

current = …… [2]

(ii) Determine the resistance of the transmission cables.

resistance = ……. [1]

(iii) Determine the minimum ratio of the number of turns in the secondary coil to the number of turns in the primary coil for transformer P so that energy loss due to the transmission cables is below 10 %.

minimum turns ratio = …… [3]

12 EITHER

A block of lead at 325 °C is transferred to a 120 g copper calorimeter containing 250 g of liquefied methylated spirit at 25 °C. After 92 s, the methylated spirit starts to boil. It continues to boil for 55 s, until the block of lead reaches thermal equilibrium with the methylated spirit.

Boiling point of methylated spirit = 78.5 °C.
Heat capacity of the block of lead = 750 J/°C
Specific heat capacity of copper = 420 J/kg°C
Specific heat capacity of methylated spirit = 2400 J/kg°C
Specific latent heat of vaporisation of methylated spirit = 855 kJ/kg

(a) Explain what is meant by *thermal equilibrium*.

……

…… [1]

(b) The specific heat capacity of lead is 130 J/kg°C.

(i) State the difference between heat capacity and specific heat capacity.

.....

.....

…… [1]

(ii) Hence, determine the mass of the block of lead.

mass = …… [1]

(c) Calculate the amount of energy that is lost by the block of lead when it reaches thermal equilibrium with the methylated spirit.

energy loss = …… [2]

(d) Calculate the total energy that is needed to raise the temperature of the copper calorimeter and the methylated spirit to 78.5 °C.

energy gain = …… [2]

(e) Hence or otherwise, determine the final mass of methylated spirit remaining in the copper calorimeter.

mass = …… [2]

(f) Explain why the mass calculated in part **(e)** will be different from the actual value.

……

……

…… [1]

12 OR

A student investigating the effect of temperature on the volume of a gas, uses a column of air sealed in a capillary tube by a short column of mercury as shown in Fig 12.1.

At 20 ^{o}C, the length of the air column is h = 15 cm.

Cross-sectional area of the tube = 2.00 mm^2.
Density of mercury = 1.36 x 10^4 kg/m^3
Atmospheric pressure = 1.02 x 10^5 Pa.

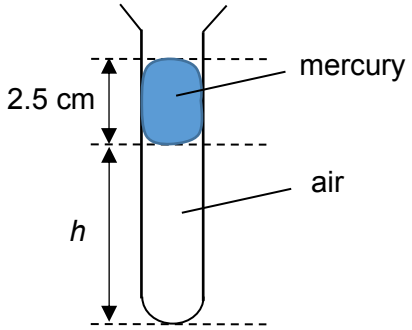

Fig. 12.1 (not drawn to scale)

(a) (i) Determine the mass of the mercury column.

mass = ... [2]

(ii) Hence determine the pressure exerted on the column of trapped air.

pressure = ... [2]

(b) The tube is then slowly rotated and held in a horizontal position as shown in Fig. 12.2.

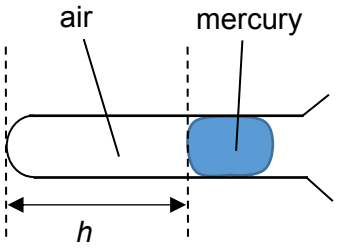

Fig. 12.2 (not drawn to scale)

(i) State whether the length of the air column, *h*, increases, decreases, or remains unchanged at 15 cm.

…… [1]

(ii) Explain your answer in **b (i).**

……..

……..

……..

…….. [2]

(c) With the tube held in horizontal position, the temperature of air is gradually increased until it reaches a steady temperature of 50 °C.

Using ideas about molecules, explain why the air column increases in length.

……

……

……

……

……

……

…… [3]

END