Name: _____ ( ) **Class: Sec 4 / ( )**

南华中学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2025

Subject : Physics

Paper : 6091/02

Level : Secondary Four

Date : 1 September 2025

Duration : 1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use HB pencil for any diagrams or graphs.

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

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

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.

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

For Examiners' Use	
Section A	
Section B	
Total	

This document consists of **21** printed pages.

Section A

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

1 **(a)** A 7.0 kg picture frame is being suspended from a nail by a string. The string forms two segments exerting tensions T_1 and T_2 as shown in the Fig. 1.1. The strings also make an angle of 35° and 60° with the vertical respectively.

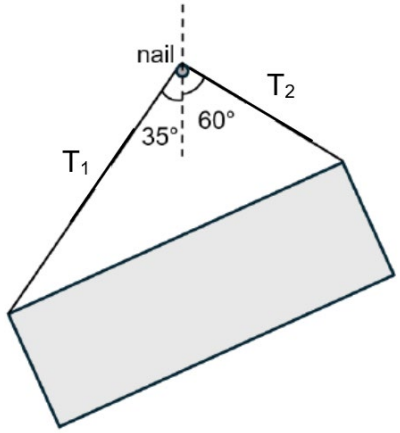

Fig. 1.1

In the space below, draw a vector diagram to determine the tensions T_1 and T_2. Specify the scale used.

T_1 = _____

T_2 = _____ [4]

(b) **(i)** Explain what is meant by the precision of a measuring instrument.

.....

..... [1]

(ii) Hence, state the precision of a digital caliper.

..... [1]

(c) Currently nuclear power provides approximately 9% of the world's electricity. This translates to about 2600 terawatt-hours (TWh) of electricity generated annually by nuclear reactors.

Calculate the energy generated by nuclear reactors annually in joules.

energy = ……... [2]

2 **(a)** State the principle of moments.

_____

_____ [1]

(b) Fig. 2.1 shows a decoration that hangs by string from the ceiling in a toyshop. Four objects, P, Q, R and S hang by string from rods 1 and 3. These two rods hang by string from rod 2. The decoration is completely stationary and the rods are horizontal. The weights of the rods and the strings may be neglected.

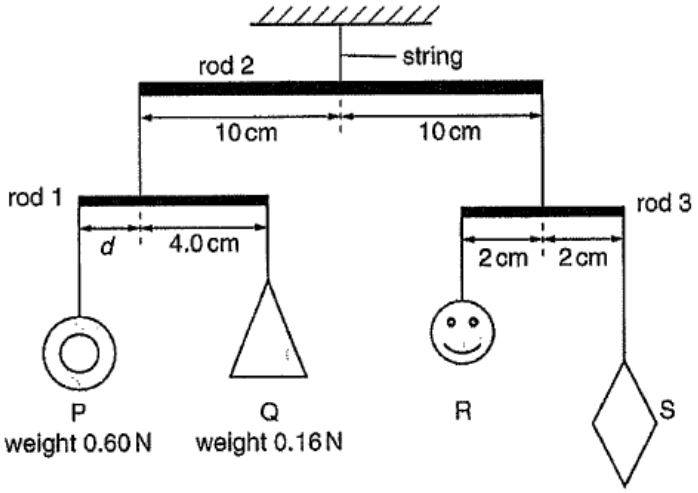

Fig. 2.1 (not to scale)

Object P weighs 0.60 N and object Q weighs 0.16 N.

(i) Calculate the value of the distance *d* on Fig. 2.1.

d = _____ [2]

(ii) Determine the weight of object R and of object S.

weight of R = _____

weight of S = _____ [2]

(iii) Object P falls off. Using moments, state and explain what happens to rod 1 and rod 2.

rod 1: _____

_____

rod 2: _____

_____ [2]

3 Fig. 3.1 shows a U-shaped tube, containing mercury, is used as a manometer to measure pressure from a cylinder of gas.

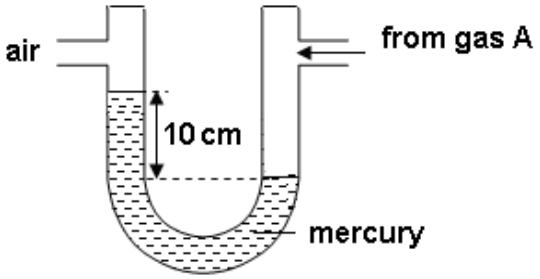

Fig. 3.1

When one side of the cylinder is connected to an unknown gas A, the difference in mercury levels is 10.0 cm. (Density of mercury = 13 600 kg / m^3, g = 10 m / s^2)

(a) If atmospheric pressure is 76 cm Hg, calculate, in units of Pascal,

(i) the pressure difference between gas **A** and air,

pressure difference = _____ [2]

(ii) the pressure of gas A.

pressure of gas A = _____ [2]

(b) The setup in Fig. 3.1, which was on the surface of the Earth, is now transported to the top of a mountain with gas A still connected to the right of the manometer.

State and explain the changes (if any) in the mercury levels in the tube.

_____

_____

_____

_____ [2]

4 Fig. 4.1 shows a semi-circular glass prism with a light ray directed towards O, the midpoint between A and B. The refractive index of the glass prism is 1.8.

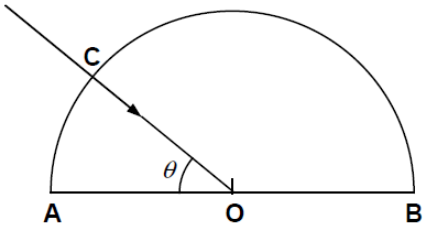

Fig. 4.1

(a) Explain why there is no refraction when the light ray enters the glass prism at C.

.....

..... [1]

(b) What is the maximum angle θ, such that the emergent ray will occur along the edge AB.

maximum angle = ... [2]

(c) Fig. 4.2 shows the same glass prism with another light ray directed towards O at the same angle θ.

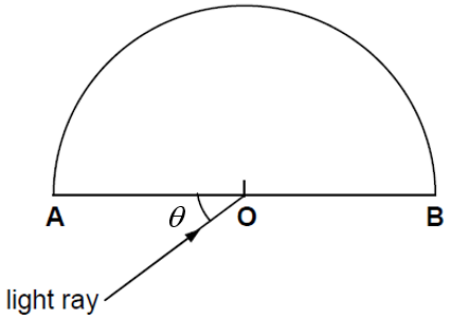

Fig. 4.2

(i) On Fig. 4.2, draw a possible path of the light ray as it enters and exits the glass prism. [1]

(ii) Explain if total internal reflection will occur in Fig. 4.1 or Fig. 4.2 if angle θ can be varied.

.....

..... [1]

(d) Fig. 4.3 shows a simple optical fibre of the same glass material in Fig. 4.1. A light ray **PQ** enters the fibre and strikes the curved surface at an angle 60°. [2]

Complete the path of the light ray until it reaches the end surface labeled **XY**. Label all relevant angles values within the optical fibre.

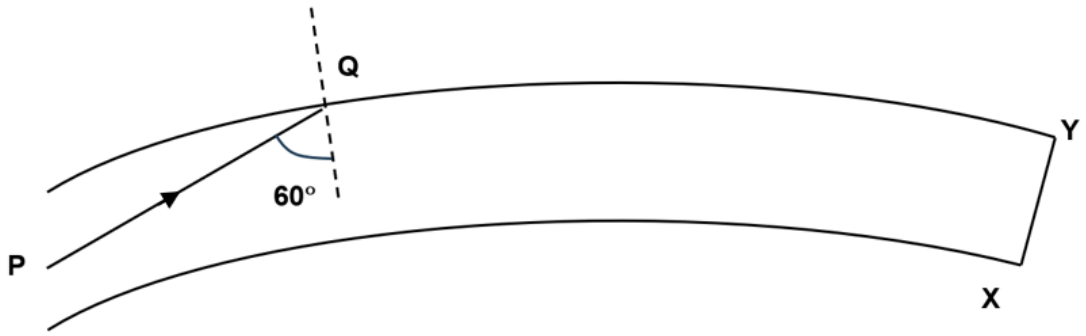

Fig. 4.3 (not to scale)

5 In a tsunami created by an earthquake, it was observed that a ship took 20 min to move from its highest point to its lowest point. The distance between the highest point and the lowest point was 20 m.

(a) **(i)** Define the period of a wave.

_____

_____ [1]

(ii) Determine the frequency of the tsunami wave.

frequency = _____ [2]

(b) When the ship was at its highest point, another ship that was 300 km away was also at its highest point. There were two crests between the two ships. Fig. 5.1 shows the displacement-distance graph of the wave.

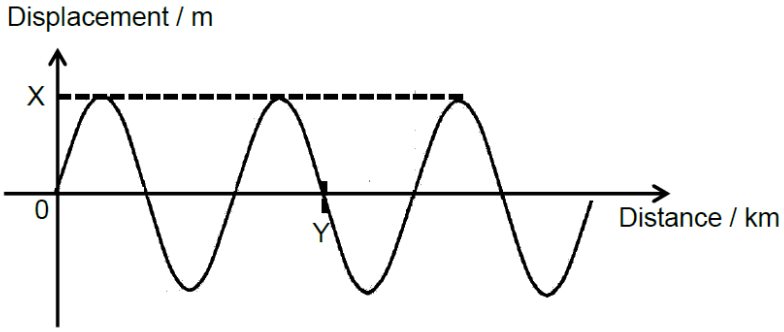

Fig. 5.1

(i) Determine the magnitudes of X and Y.

magnitude of X = _____ [1]

magnitude of Y = _____ [1]

(ii) Show that the speed of the wave is about 42 m / s . [1]

(iii) The tsunami wave was detected at 0800 hrs and the distance between the tsunami wave and the shore was 200 km.

Determine the time that the tsunami wave will reach the shore.

time of arrival = _____ [2]

(c) Describe the motion of the ship as the first waves arrive at the ship.

_____

_____ [1]

6 Fig. 6.1 shows a light plastic sphere coated with silver conductive paint being suspended by a length of insulating thread.

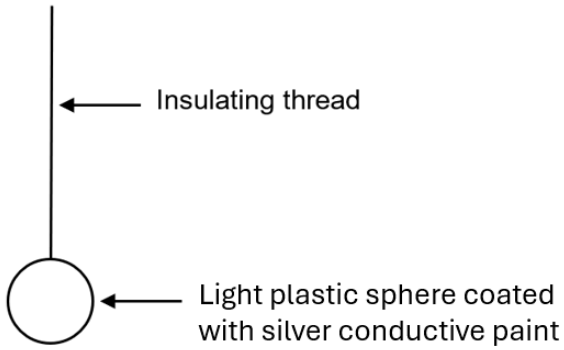

Fig. 6.1

(a) A positively charged rod is placed near to the sphere as shown in Fig 6.2.

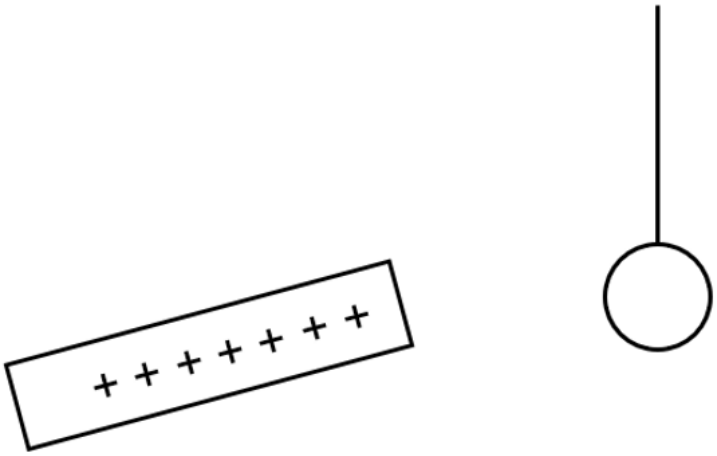

Fig. 6.2

(i) On Fig. 6.2,

1. draw the charges on the sphere, [1]

2. draw the electric field set up between the charged rod and the sphere. [1]

(ii) The rod touches the sphere for a moment before being separated again.

Describe and explain what happens to the distribution of charges in the rod and sphere.

--- [2]

(b) In another experiment, a negatively charged rod was brought close to a **solid** metal conducting sphere as shown in Fig 6.3 below. The metal conducting sphere was *earthed* on the left-hand side as shown.

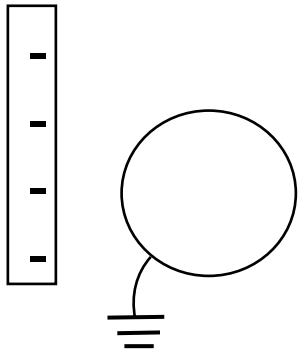

Fig. 6.3

(i) Explain what the phrase *'was earthed'* means. [1]

(ii) On Fig. 6.3, draw the charges on the metal sphere. [1]

7 **(a)** Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

mass of thorium-234 remaining = _____ [2]

(b) Thorium-234 (Th-234) undergoes decay to form Protactinium-234 (Pa-234).

The proton number for Thorium and Protactinium is 90 and 91 respectively.

Write a nuclear equation using nuclide notation to represent the change in the composition of Thorium-234 when it decays.

_____ [1]

(c) A sample contains a large number of radioactive nuclei that emit beta-particles. The sample is placed near to a radiation detector in a laboratory and the count rate is recorded over a long period of time.

Fig. 7.1 shows the count rate recorded by the detector during this period.

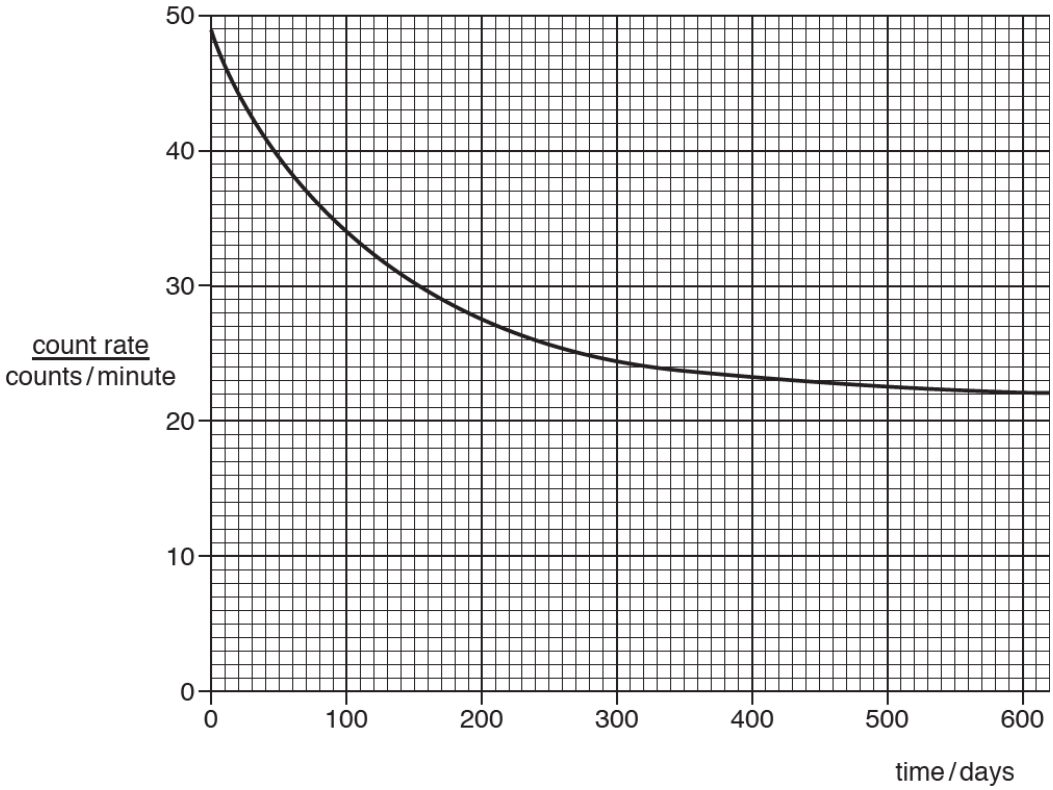

Fig. 7.1

Using Fig. 7.1,

(i) determine the background count in the laboratory in counts per min (cpm)

background count = ……. [1]

(ii) determine the count rate at time t = 0, due to the sample on its own in counts per min (cpm)

count rate due to sample = ..……. [1]

(iii) estimate the half-life of the radioactive atoms in the sample.

half-life = ……. [2]

8 **(a)** A student investigates the behaviour of a light dependent resistor (LDR) by setting up the circuit connected to a source with an electromotive force of 6.0 V as shown in Fig 8.1 below.

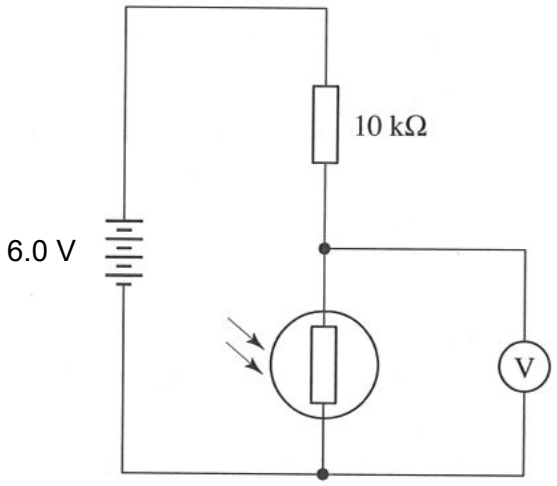

Fig. 8.1

(i) Explain what is meant by an *electromotive force* of 6.0 V.

.....

..... [1]

(ii) The p.d. across the LDR in bright daylight is 0.23 V.

Determine the resistance of the LDR in bright daylight.

resistance = ... [2]

(iii) State and explain how the voltmeter reading changes when the light intensity surrounding the LDR decreases.

.....

.....

..... [2]

(b) The LDR is now connected across another circuit as shown in Fig 8.2 below. During a certain instance, the resistance of the LDR is 10 kΩ and the value of the variable resistor was set at 3.8 kΩ.

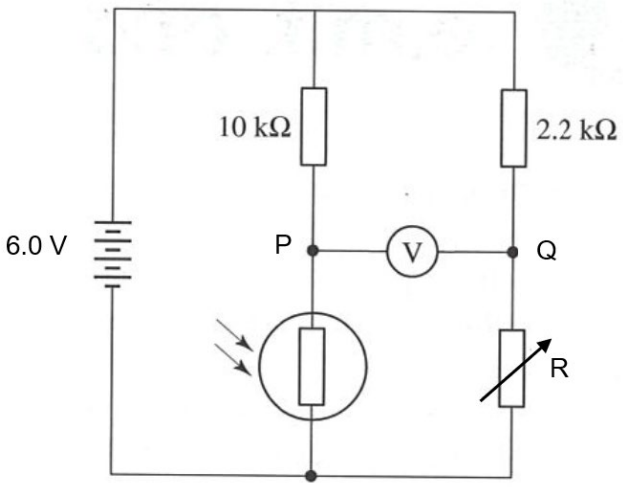

Fig. 8.2

(i) Calculate the total resistance of this circuit at that instant.

total resistance = _____ [2]

(ii) State why the p.d. across the LDR is 3.0 V.

_____

_____ [1]

(iii) **(1)** determine the p.d. across the variable resistor.

p.d. = _____ [1]

(2) determine the p.d. between points P and Q

p.d. = _____ [1]

9 A simulation of a roller coaster is done to investigate how the speed of the carriage is affected by the shape of the track as shown in Fig. 9.1. Track **X** is frictionless.

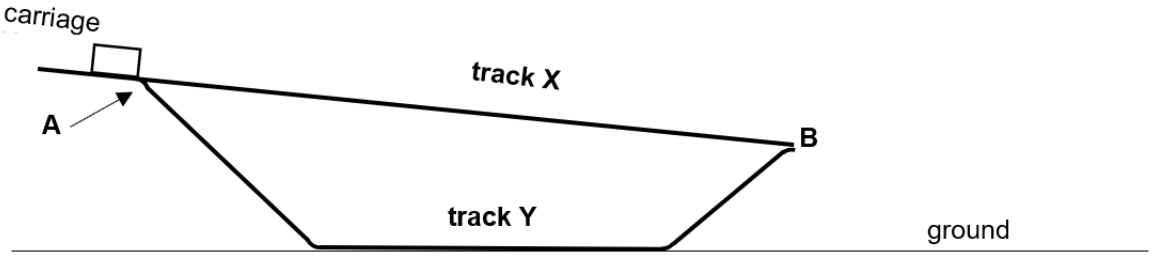

Fig. 9.1

The carriage is released at point A. The speed of the carriage along each track is measured at various times until the carriage reaches point B.

Table 9.2 shows the readings obtained.

	data 1	**data 2**
time / s	speed / m/s	speed / m/s
0	0	0
0.20	0.90	0.25
0.40	1.80	0.50
0.60	2.70	0.75
0.80	2.70	1.00
1.00	2.70	1.25
1.20	2.70	1.50
1.40	2.60	1.75
1.60	2.50	2.00
1.80	-	2.25
2.00	-	2.50

Table 9.2

(a) **(i)** Explain how data 2 in Table 9.2 shows it corresponds to the motion of the carriage traveling along track X.

--- [1]

(ii) Calculate the length of track X.

length of track X = ____ [2]

(iii) Fig 9.3 shows an instant when the carriage was travelling along the horizontal section of track Y.

Fig. 9.3

Describe a Newton's third law action-reaction pair of forces acting in the vertical direction.

[2]

(iv) The mass of the carriage used for the simulation is increased.

State and explain the difference in the final speed of the carriage on track X.

[2]

(b) Using **data 1:**

(i) determine the deceleration of the carriage during a certain section of its motion

deceleration = [1]

(ii) explain, using an appropriate Newton's law, how it can be deduced that track Y is also frictionless.

[2]

Section B

Answer **one** question from this section.
Answer either **Question 10** or **Question 11**

10 An air cooler works by taking in warm air from the surrounding and blows it over a cooling pad. This causes the water on the cooling pad to evaporate and the air passing through it is cooled as shown in Fig. 10.1.

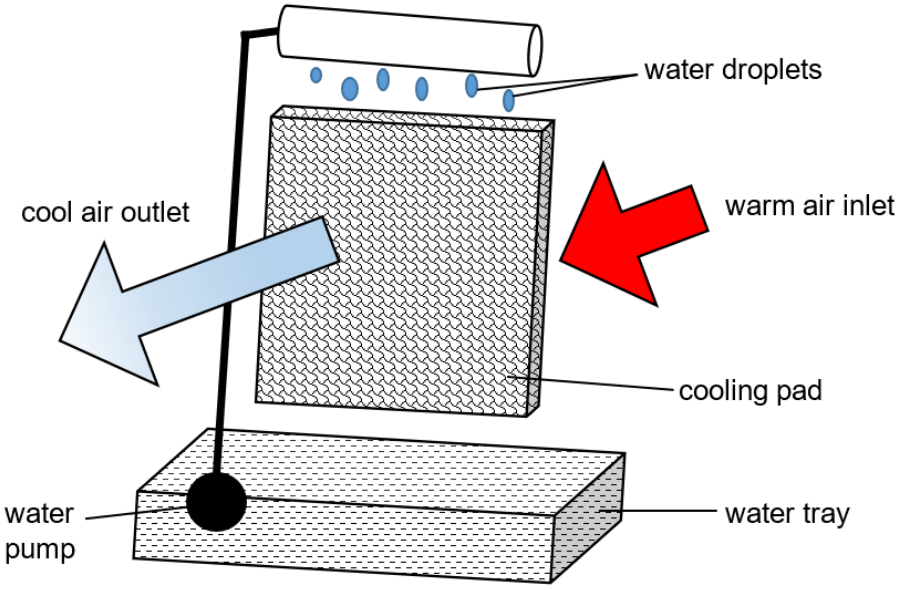

Fig. 10.1

(a) Define *specific heat capacity*.

.....

.....

..... [1]

(b) Explain why the specific latent heat of fusion of water is smaller than the specific latent heat of vaporization of water.

.....

.....

.....

..... [2]

(c) The volume of the room is 90 m^3. The air cooler cools the room by 5 °C after a period of time. Given that the density of air is 1200 g / m^3 and its specific heat capacity of air is 1.0 kJ / (kg °C):

(i) Calculate the amount of thermal energy removed by the air cooler.

thermal energy removed = _____ [2]

(ii) Determine the time taken (in min) for the air cooler to decrease the temperature of the room by 5 °C if the rate of heat removal is 270 J/s.

time taken = _____ [2]

(d) It takes a longer time than the value calculated in **(c)(ii)** to cool the room.

Suggest one modification to the air cooler to reduce the time taken to cool the room.

_____

_____

_____ [1]

(e) The air cooler is rated at '120 V, 50 W' and was turned on for 180 mins.

Calculate the cost of electricity for this usage if one kWh costs 30 cents.

cost of electricity = _____ [2]

11 Fig. 11.1 shows a rotating permanent magnet in an alternating current generator ("dynamo"). The dynamo is used to power a lamp.

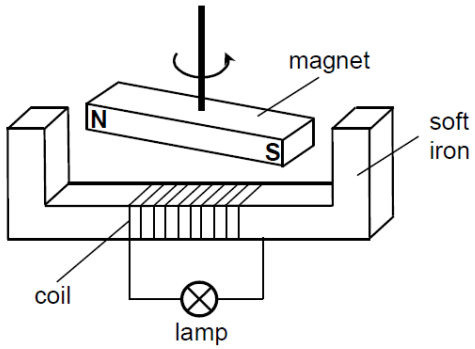

Fig. 11.1

(a) Explain, in detail, how an induced current is produced by the apparatus shown in Fig 11.1.

.....

.....

.....

.....

..... [3]

(b) Explain why the current induced in the coil of the dynamo is alternating.

.....

.....

.....

..... [2]

(c) State two ways that the induced current in the lamp might be increased.

1. .....

2. ..... [2]

(d) Describe what happens to the period and amplitude of the alternating current when the magnet is spun at twice the speed.

period: .....

amplitude: ..... [2]

(e) Suggest one advantage of this dynamo as compared to the conventional alternating current generators which require the use of slip rings and carbon brushes.

_____

_____ [1]