Name: _____ Class: _____ Class Index No: _____

Anglo-Chinese School
(Barker Road)

PRELIMINARY EXAMINATION 2024

SECONDARY 4 EXPRESS

SCIENCE (PHYSICS) 5086
PAPER 2

TIME: 1 HOUR 15 MINUTES

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number at the top of this page.
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
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B

Answer only **one** question.
Write your answers in the spaces provided on the question paper.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/55
Section B	/10

*This question paper consists of **17** printed pages.*

Section A

Answer **all** questions in the spaces provided.

1 Physical quantities, consisting of base and derived quantities, are used in science for measuring the world around us.

Complete Table 1.1 to show the type of physical quantity, and its SI unit symbol. The first one has been done for you.

Table 1.1

physical quantity	type of physical quantity	SI unit symbol
speed	derived	m/s
time		
	base	K
volume		m^3

[2]

2 In Australia, “swinging the billy tea” is a tradition where tea is brewed in a teapot and swung in a circular direction three times before drinking. Fig. 2.1 shows an Australian cowboy carrying this out.

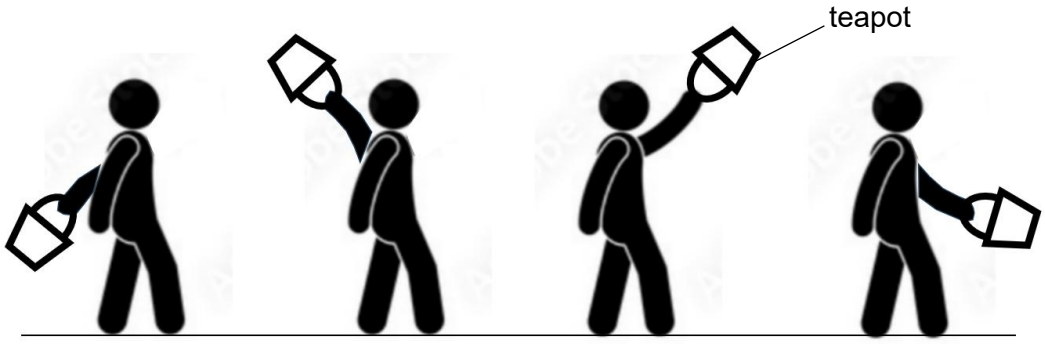


Fig. 2.1

Explain why the teapot accelerates continuously even though it is moving at constant speed.

……

……

…….. [2]

3 Fig. 3.1 shows a space capsule of mass 300 kg, a height of 7 m and base area of 3 m^2.

The space capsule returns to Earth and experiences the Earth's gravitational field.

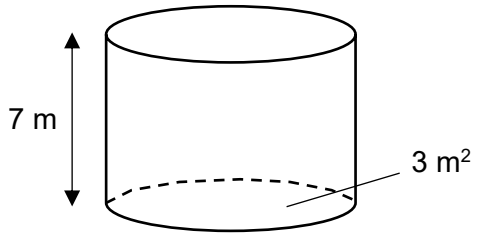


Fig. 3.1

(a) State what is meant by a *gravitational field*.

……..

……..… [1]

(b) The space capsule finally lands safely on soft marshy ground. The gravitational field strength is 10 N/kg.

Calculate the

(i) weight of the space capsule,

weight = ……. N [1]

(ii) pressure the space capsule exerts on the ground.

pressure = ……. N/m^2 [2]

(iii) The astronaut has a mass of 100 kg. The area of the sole of each of his boots is 0.015 m^2.

Explain why the astronaut is likely to sink into the soft marshy ground, but the space capsule is not.

……..…

……..…

…… [2]

4 A car is stuck as one of its tyres is trapped in a hole on the ground. The driver attempts to lift the car out of the hole using a long plank and a rock as a pivot as shown in Fig. 4.1.

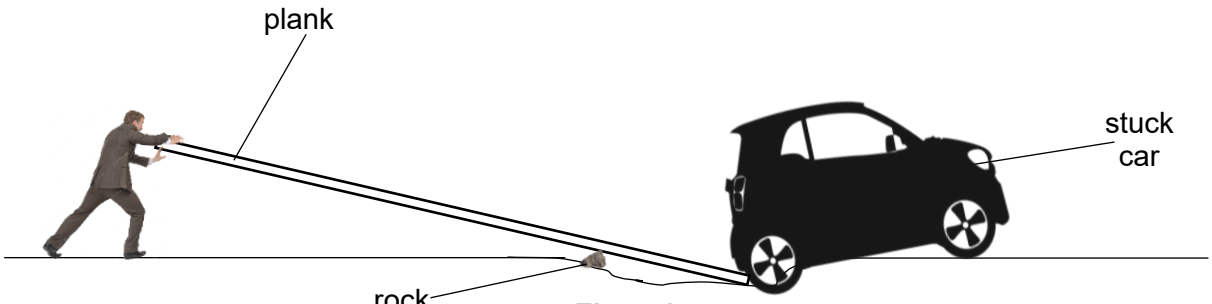


Fig. 4.1

Fig. 4.2 shows the long plank being balanced and is just about to lift the car at a point in time.

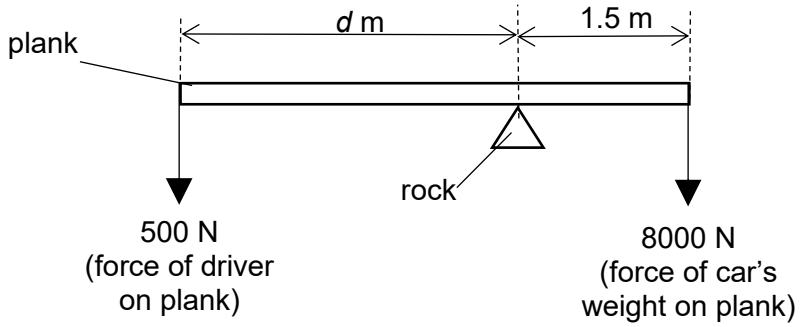


Fig. 4.2

(a) State the *principle of moments*.

……..

…….. [1]

(b) Calculate the distance *d* for the driver to just be able to lift up the car with the force applied.

The plank has negligible weight.

distance *d* = …….. m [2]

(c) State and explain one improvement the driver can make to use less force to lift the car.

……

……

…… [2]

5 Fig. 5.1 shows a bodybuilder exercising by doing the one-arm lift exercise routine. This exercise consists of the man lifting a 60 N weight up a height of 0.5 m each time.

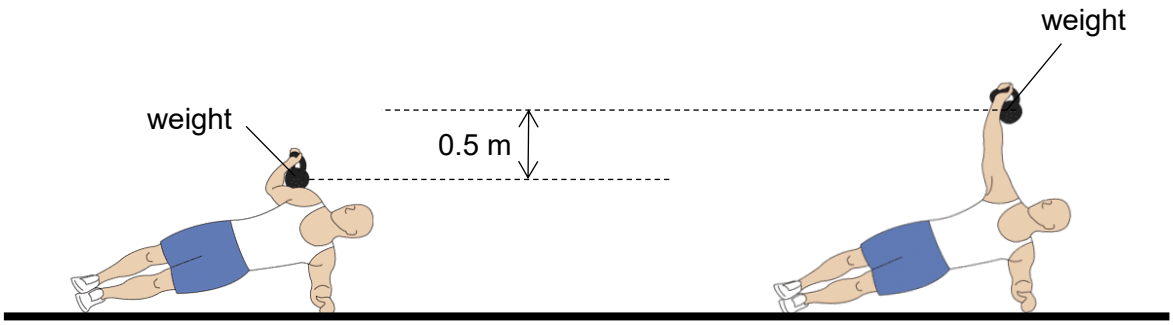


Fig. 5.1

(a) Calculate the work done in lifting the weight each time.

work done = ... J [2]

(b) The bodybuilder is able to lift the weight 50 times in five minutes.

Calculate the power exerted by the bodybuilder.

power = ... W [2]

6 Two metal containers **X** and **Y** are filled with equal masses of the same liquid at a temperature of 80 °C, as shown in Fig. 6.1.

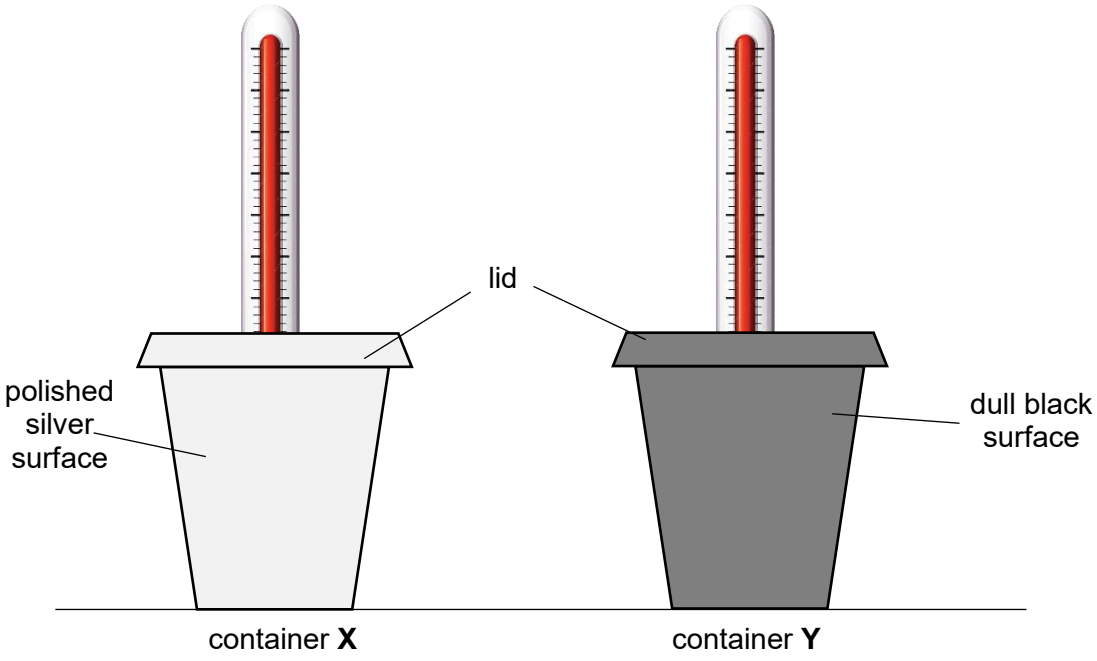


Fig. 6.1

The containers are identical except that container **X** has a polished silver surface and container **Y** has a dull black surface.

Both containers are placed on a bench and left to cool to 25°C.

(a) **(i)** State the main process in which thermal energy is transferred from liquid to the surrounding.

……...

…….. [1]

(ii) Explain why thermal energy transfers from liquid to the surrounding.

……...

…….. [1]

(b) The temperature of the liquid in each can is measured every minute.

The variation of the temperature of the liquid in container **X** with time is shown in Fig. 6.2.

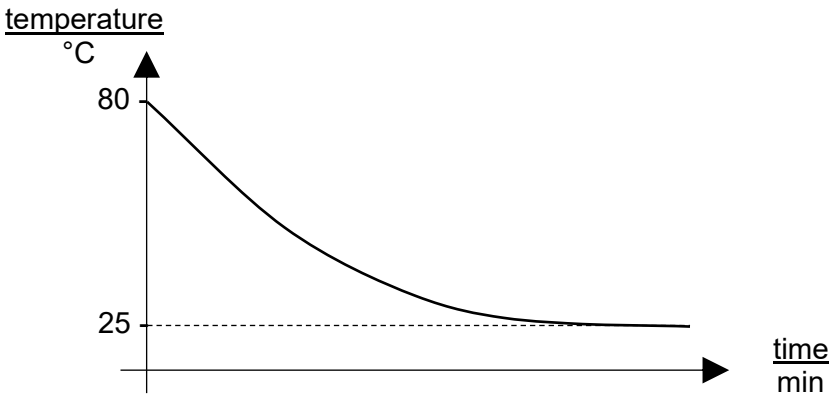


Fig. 6.2

(i) On Fig. 6.2, sketch the graph obtained for container **Y**. [1]

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

……..

…… [2]

7 Four different instruments **A**, **B**, **C** and **D** produce sound waves in air.

The excess pressure of the sound wave above normal atmospheric pressure is measured for each instrument and shown in Fig. 7.1.

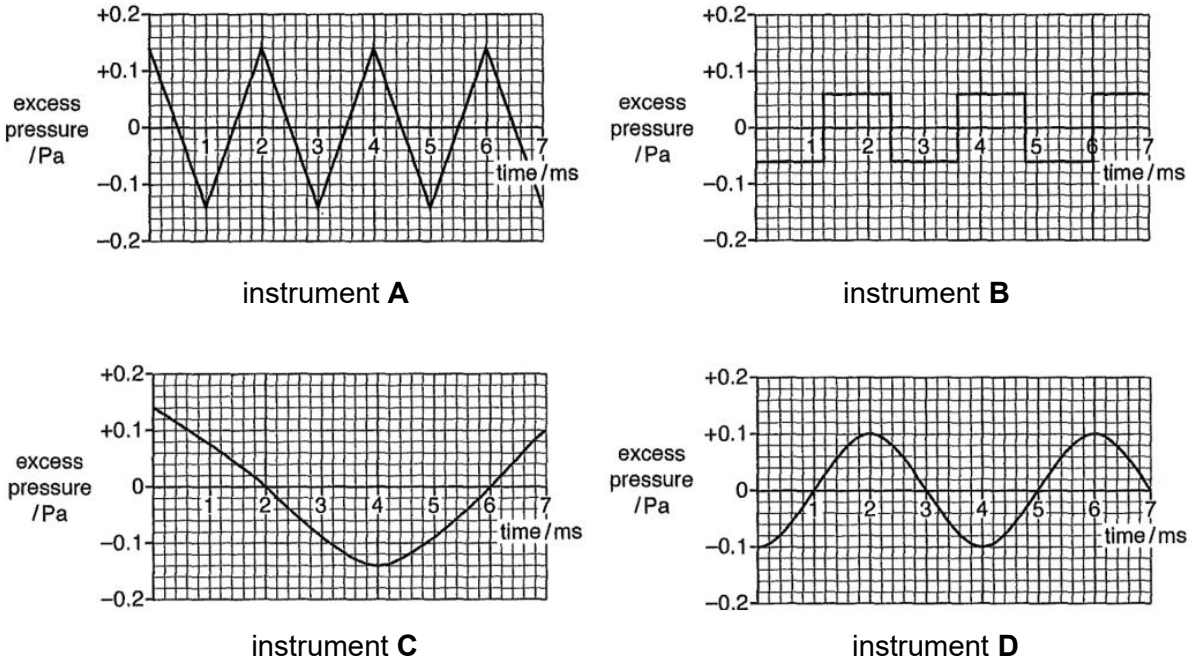


Fig. 7.1

(a) Determine the frequency of the sound wave produced by instrument **A**.

frequency = ... Hz [1]

(b) The speed of sound in air is 300 m/s.

Calculate the wavelength of the sound wave produced by instrument **A**.

wavelength = ... m [2]

(c) Complete the following sentences to describe the instruments that produce the softest and lowest pitch sounds.

Instrument …… produces the softest sound because …….. .

……..... .

Instrument …… produces the sound with the lowest pitch because ……

……..… [2]

8 Light in air is incident on the surface of diamond at an angle of 60° as shown in Fig. 8.1.

It is then refracted in diamond at an angle of refraction of 41°.

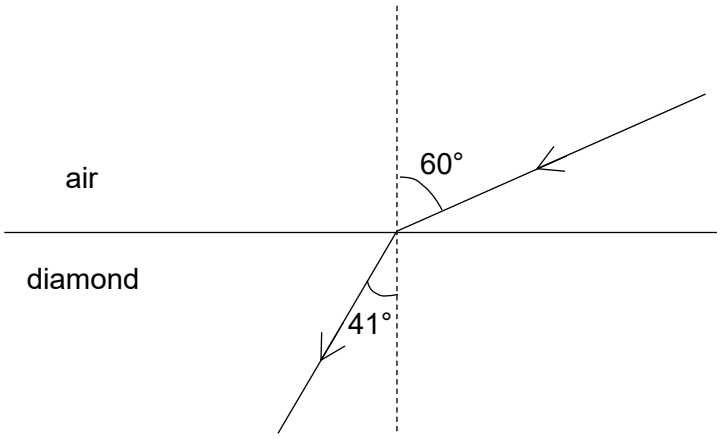


Fig. 8.1

(a) Calculate the refractive index of diamond.

refractive index = …… [2]

(b) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in diamond.

speed of light in diamond = …… m/s [2]

9 Three resistors W, X and Y are connected to a battery as shown in Fig. 9.1.

The electromotive force (e.m.f.) of the battery is 9.0 V.

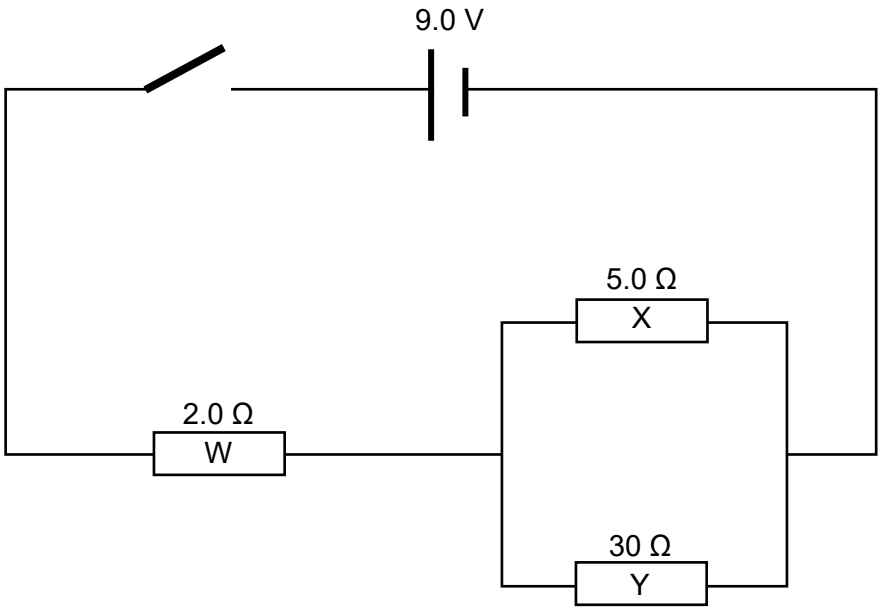


Fig. 9.1

When the switch is closed, a current flows through resistances W, X and Y.

(a) Calculate the effective resistance of the circuit.

effective resistance = ... Ω [3]

(b) **(i)** State what is meant by the term *current*.

.....

..... [1]

(ii) Calculate the current flowing through the resistor W.

current = ... A [2]

10 An 800 W iron and a 100 W fan is used at home.

(a) In one day, the iron is used for 30 mins and the fan for 8 hours.
The cost of 1 kWh is $0.30.

Calculate the cost of using both the iron and fan for one day.

cost = $ …… [3]

(b) Fig. 10.1 shows the iron and fan connected to the mains supply.

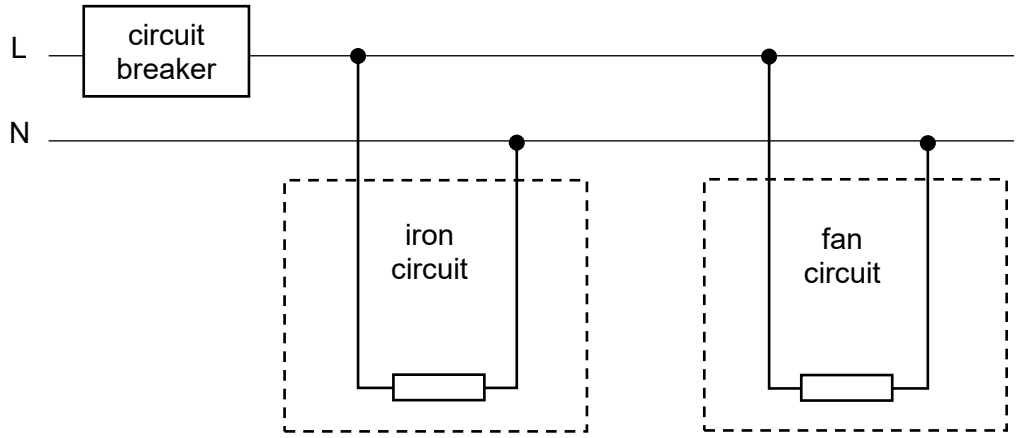


Fig. 10.1

(i) Name and state the colours of the wires labelled L and N.

wire	name	colour
L		
N		

[2]

(ii) Draw using appropriate circuit symbol, two fuses in Fig. 10.1 for the iron and fan circuit. [1]

11 **(a)** The activity of a radioactive source was measured at the same time each day for 10 days.

The results after allowing for background radiation are shown in Table 11.1.

Table 11.1

time / days	0	2	4	6	8	10
activity / Bq	100	62	40	25	17	10

(i) On the grid of Fig. 11.1, draw a curved line of best fit to show how the activity of the radioactive source varies with time.

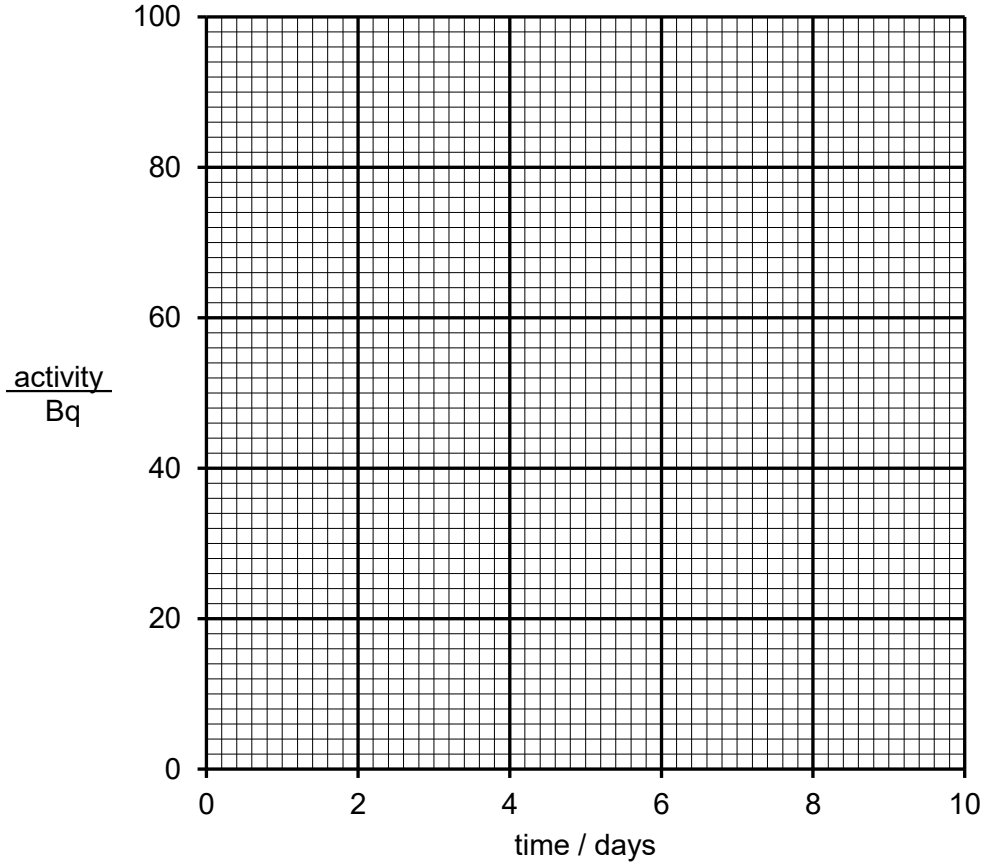


Fig. 11.1

[2]

(ii) Determine the half-life of the source. Show on your graph how you arrive at your answer.

half-life = ... [2]

(b) In a smoke detector, the alarm stays off while the radioactive source reaches the radiation detector. When smoke particles enters the smoke detector and some of the radioactive source is blocked, the alarm circuit is triggered. This arrangement is shown in Fig. 11.2.

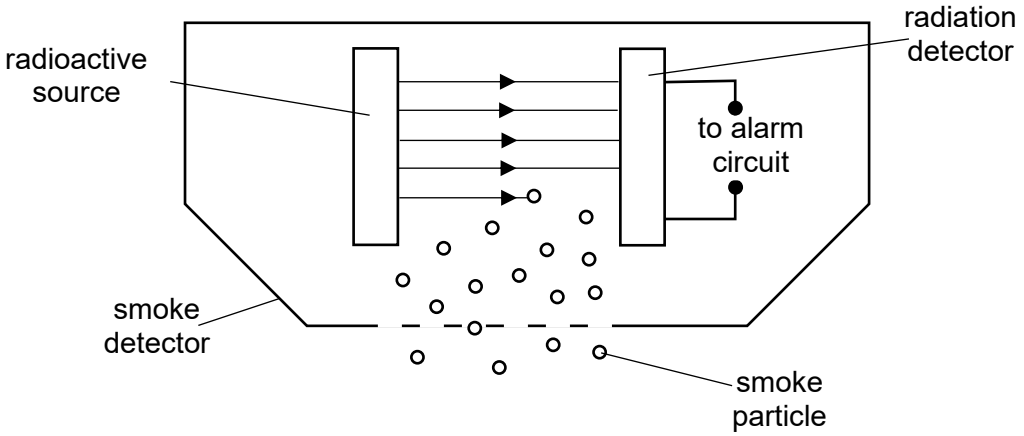


Fig. 11.2

Three radioactive sources are available:

Source A, which emits alpha radiation;
Source B, which emits beta radiation;
Source C, which emits gamma radiation.

State and explain which source would be suitable to detect smoke particles.

Explain why the other sources are unsuitable.

…….....

…….....

…….....

…….....

……..... [3]

(c) A different radioactive source has a half-life of 3 hours.

Initially the measured activity is 549 Bq when the background radiation is 37 Bq.

Calculate the measured activity 15 hours later. Assume that the background activity does not change.

activity = ... Bq [3]

Section B

Answer **one** question from this section.

12 The variation of the speed with time of a magnetic levitation train (Maglev train) as it travels between two stations is shown in Fig. 12.1.

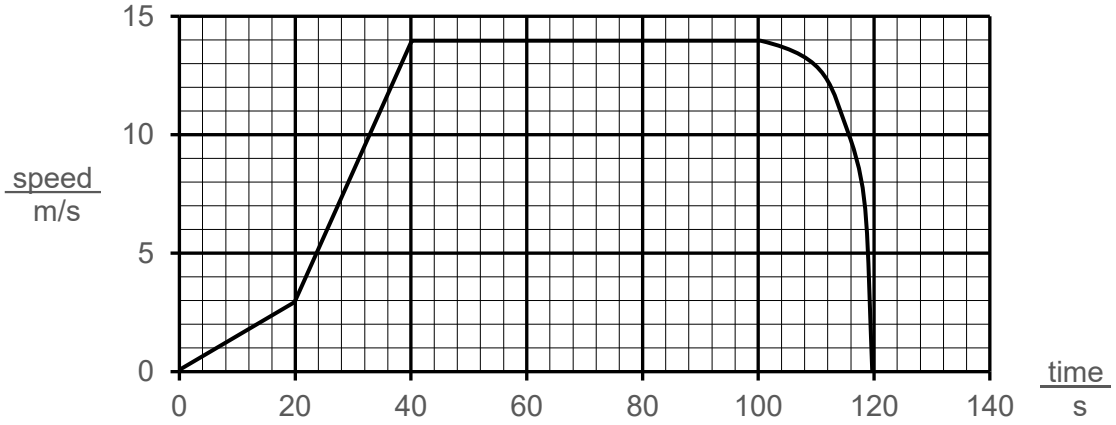


Fig. 12.1

(a) Describe the motion of the train from

20 s to 40 s: ……

40 s to 100 s: ……

100 s to 120 s: …… [2]

(b) From 20 s to 40 s, calculate

(i) the distance travelled by the train,

distance = …… [2]

(ii) the acceleration of the train.

acceleration = …….. [2]

(c) **(i)** From 40 s to 100 s, the train's engine exerts a forward thrust *T*, and encounters an air resistance *R*.

Draw these forces *T* and *R* on Fig. 12.2.

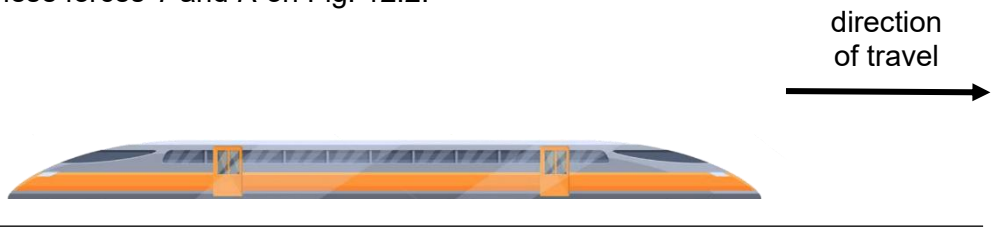


Fig 12.2

[1]

(ii) Two other forces act on the train. On Fig. 12.2, draw and label these two forces. [1]

(iii) By considering the forces *T* and *R*, explain the motion of the train from 40 s to 100 s.

……..

……..

…… [2]

13 Fig. 13.1 shows the inside of a convection oven.

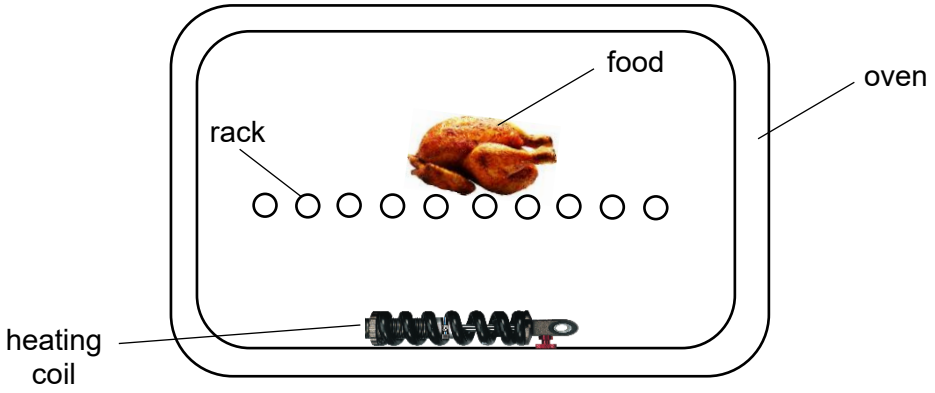


Fig. 13.1

(a) **(i)** Explain how the thermal energy is transferred from the heating coil to the food being cooked by the process of convection.

……..

……..

…… [2]

(ii) If the heating coil were to be placed at the top of the oven, state and explain the difference to the time taken to cook the food.

……

……..

…… [2]

(b) The oven is connected to a 240 V mains supply and has a label attached as shown in Fig. 13.2.

PANSONIC 28L ELECTRIC OVEN MODEL: SEO 2229 VOLT: 240 V POWER: 1500 W FREQUENCY: 50/60 W

Fig. 13.2

(i) Calculate the oven's operating current.

operating current = …… [1]

(ii) Fuses with the following ratings are available, 0.5 A, 1 A, 3 A, 8 A and 10 A. Suggest a suitable fuse rating to be used.

…… [1]

(c) A simplified model of an electric motor in the fan of the oven is shown in Fig. 13.3.

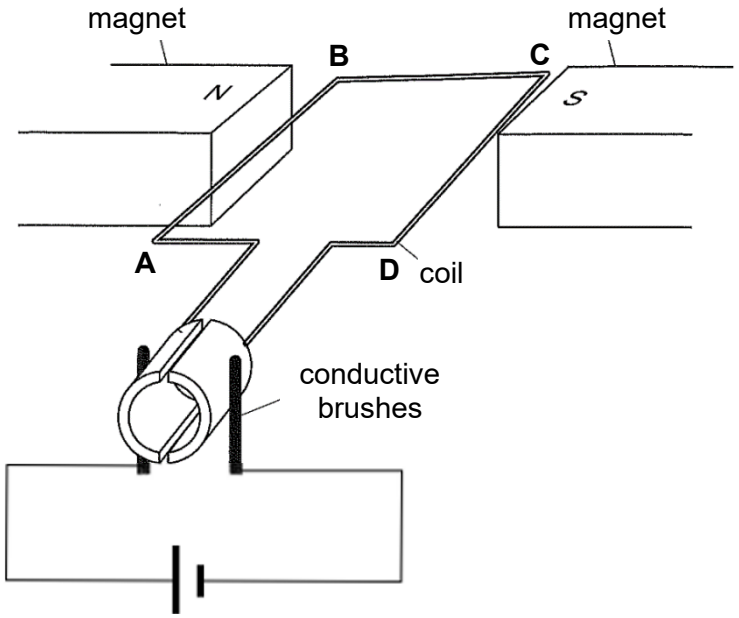


Fig. 13.3

(i) On Fig. 13.3, draw the direction of conventional current in the coil for AB and CD. [1]

(ii) Explain how the current in the coil of the motor causes the coil to turn.

……..

……..

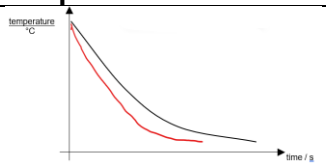
…… [3]

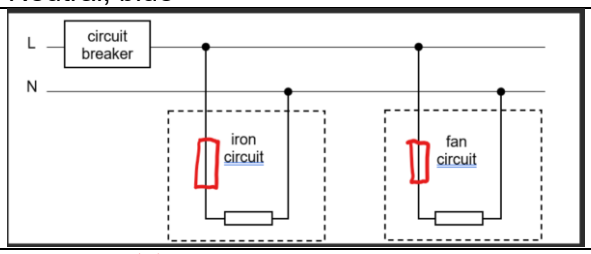
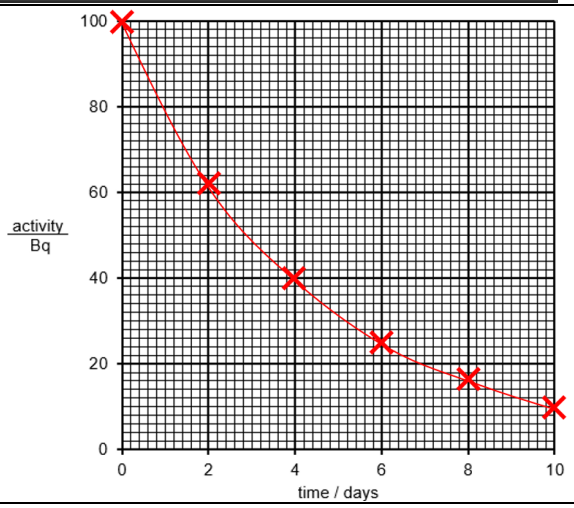
End Of Paper

2024 Sec 4EX Prelims Marking Scheme

Paper 2

Section A

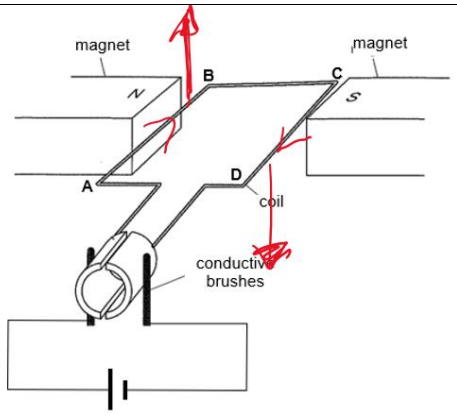
Qn	Marking Scheme	Marks
1	base, s, temperature, derived	Any 2 correct [1] Any 2 correct [1]
2	direction changes change in velocity	[1] [1]
3a	**Region** where **mass** experiences a **force**	[1]
3bi	W = mg = 300 x 10 = 3000 N	 [1] [1]
3bii	P = F / A = 3000 / 3 = 1000 N/m^2	 [1] [1]
3biii	Pressure of astronaut = 1000 / 0.03 = 33000 N/m^2 **Pressure** on ground is **higher** than space capsule due to smaller contact area of astronaut on ground	[1] [1]
4a	Sum of clockwise moments equals sum of anti-clockwise moments about the same pivot in equilibrium	[1]
4b	Sum ACWM = Sum CWM 500 x d = 1500 x 2 d = 6 m	 [1] [1]
4c	Move rock closer to car Increase perpendicular distance from man to pivot Decrease perpendicular distance from car to pivot	[1] [1]
5a	WD = F x d = 60 x 0.5 = 30 J	 [1] [1]
5b	P = WD / t = 30 x 50 / (5 x 60) = 5 W	 [1] [1]
6a	Transferred by **radiation** Energy is **transferred** from a **region** of **higher** to **lower temperature**	[1] [1]
6bi		Lower line graph AND reach same temperature [1]
6bii	Dull black surface is a **better emitter** of infra-red **radiation** It **loses heat** to the **surrounding faster**	[1] [1]
7a	f = 1 / T = 1 / (2 x 10^{-3}) = 500 Hz	 [1]
7b	V = f λ λ = v / f = 300 / 500 = 0.6 m	 Allow e.c.f. [1] [1]
7c	B, it has the **smallest amplitude** C, it has the **longest period / lowest frequency**	[1] [1]
8a	n = sini / sinr	

	= sin(60)/sin(41) = 1.32	[1] [1]
8b	n = c / v v = c / n = 3 x 10^8 / 1.32 = 2.27 x 10^8 m/s	Allow e.c.f. [1] [1]
9a	Resistance of parallel = $(1/5 + 1/30)^{-1}$ = 4.29 Ω Effective resistance = 2 + 4.29 = 6.29 Ω	[1] [1] [1]
9bi	**Rate** of **flow** of **charges** / **charges** passing a point **per unit time**	[1]
9bii	I = V / R = 9 / 6.29 = 1.43 A	 [1] [1]
10a	Total energy used = 0.8 x 0.5 + 0.1 x 8 = 1.2 kWh Cost = 1.2 x 0.30 = $0.36	 [1] [1] [1]
10bi	Live, brown Neutral, blue	[1] any two [1] any two
10bii		Both fuses on live wire [1]
11ai		Correct points (Allow 1 error in plot) [1] Smooth line [1]
11aii	lines or other markings on graph to show that at least TWO half-lives have been used to determine the answer 6 / 2 = 3 days (± 0.1 days)	[1] [1]

11b	Source **A** is suitable because α particles **would not penetrate** the **smoke particles** And so the **alarm will be triggered / and reach radiation detector** Source **B & C** are unsuitable because they **would penetrate** the **smoke particles**	[1] [1] [1]
11c	549 – 37 = 512 Bq $512 \div (2)^5 = 16$ 16 + 37 = 53 53 Bq	[1] [1] [1]

Section B

12a	Constant acceleration Constant speed Increasing deceleration	Any two [1] Third [1]
12bi	Distance = area under graph = ½ (3 + 14) (40-20) = 170 m	 [1] [1]
12bii	Acceleration = (14 – 3) / (40 – 20) = 0.55 m/s^2	 [1] [1]
12ci		Correct forces, labelled, with arrows and touching the train [1]
12cii	Magnetic force upwards touching train Weight downwards touching train	Both correct [1]
12ciii	During 40~100s, **T is equal to R,** so there is no **resultant force** / **forces** are **balanced.**	[1] [1]
13ai	Air above heater heated expands It becomes less dense and rises Cooler air above fills the space below and process repeated	Any 1 [1] Any 1 [1]
13aii	It will take a **longer time** to cook the food Because convection cannot happen / only conduction / air is a poor conductor	[1] [1]
13bi	P = VI I = P/V = 1500 / 240 = 6.25 W	 [1]
13bii	7 A	[1]

13ci		[1]
13cii	**Interaction** between magnet's **magnetic field** and wire's magnetic field Produces **upward force** on AB and **downward force** on CD This results in **clockwise moment** of the **coil**.	[1] [1] [1]