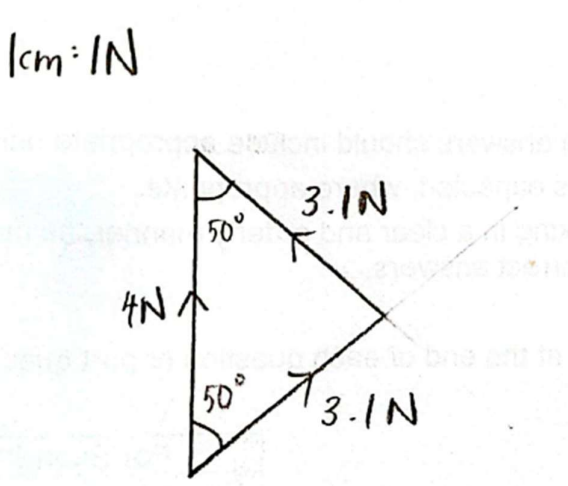
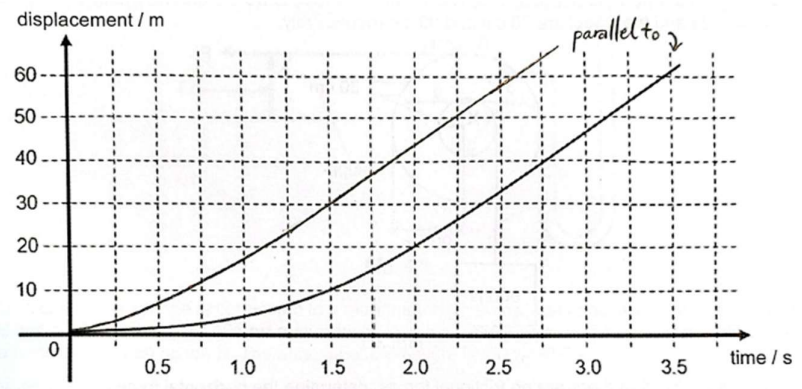
4E Physics Prelim 2024 Marking Scheme

Paper 1 (40 Marks)

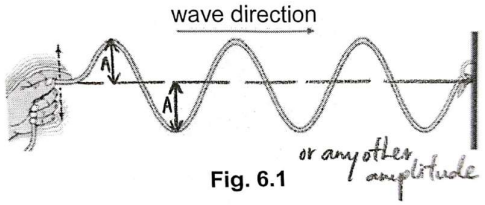
1	2	3	4	5	6	7	8	9	10
D	D	C	B	B	D	B	C	D	B
11	12	13	14	15	16	17	18	19	20
D	C	A	B	B	C	A	C	B	A
21	22	23	24	25	26	27	28	29	30
A	A	B	C	A	B	C	D	A	C
31	32	33	34	35	36	37	38	39	40
D	C	D	C	B	A	C	B	D	B

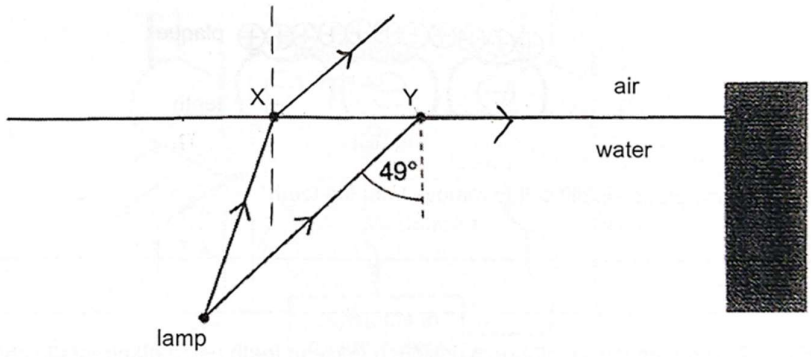
Paper 2 Section A (70 Marks)

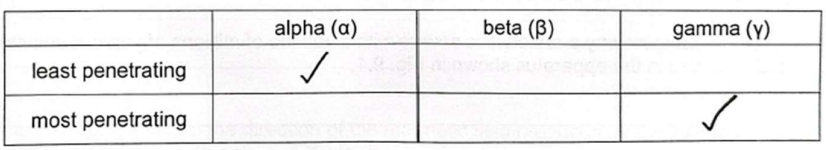
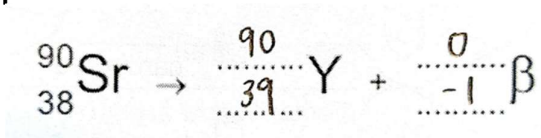
Qn		Solution	Marks
1	(ai)	Scalar quantities have **magnitude only** while vector quantities have **both magnitude and direction**.	[1]
	(aii)	**mass**, **distance**, **speed**, etc.	[1]
	(b)	**Vector Diagram**  Scale clearly indicated Correct parallelogram / tip-to-tail diagram drawn Tension in X = **3.1 N (+/- a range)**	[1] [1] [1]

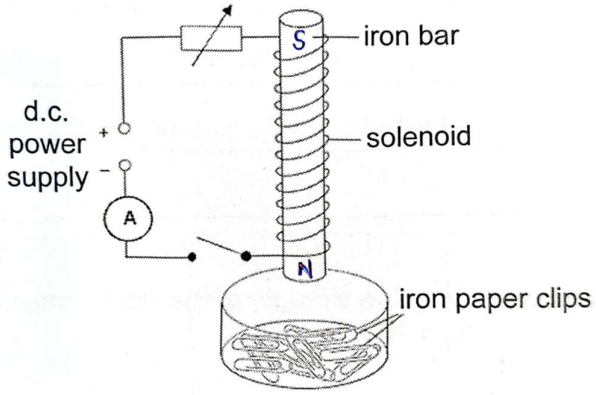
Qn	Solution		Marks
2	**(a)**	In the first 2.0 s, the ball has **increasing velocity**.	[1]
	(b)	Terminal velocity = gradient of graph after 2.0 s $= \frac{50-30}{3.125-2.375} = 26.7\ m/s$ **(+/- a range)**	[1] [1]
	(c)	Initially the only force acting on the ball is gravitational force pulling it downwards. As the ball falls, **gravity accelerates it and its speed increases. As speed increases, air resistance opposing the motion of the ball increases**. When the **air resistance opposing the motion of the ball is equal to the gravitational force acting on the ball, resultant force is zero**. When resultant force is zero, **there is no more acceleration and the ball moves at constant speed known as terminal velocity**.	[1] [1] [1]
	(d)	**Graph**  Fig. 2.1	[1]

Qn	Solution		Marks
3	(a)	Taking moments about the pivot, sum of clockwise moments = sum of anticlockwise moments $F \times 90 = 500 \times 30$ $F = \frac{500 \times 30}{90} = 167 \ N$	 [1] [1]
	(b)	If the radius of wheel Y is increased, the **perpendicular distance between the pivot and the force increases**. **Since Moment = F x d, when the perpendicular distance increases, the force required decreases**.	[1] [1]
	(c)	$\frac{60}{100} \times P \times t = F \times d$ $\frac{60}{100} \times 100 \times 10 = 500 \times d$ $d = \frac{\frac{60}{100} \times 100 \times 10}{500} = 1.2 \ m$	 [1] [1]
4	(a)	$\frac{F_A}{A_A} = \frac{F_B}{A_B}$ $\frac{F_A}{4 \times 10^{-4}} = \frac{9}{6 \times 10^{-5}}$ $F_A = \frac{9}{6 \times 10^{-5}} \times 4 \times 10^{-4} = 60 \ N$	 [1] [1]
	(b)	pressure of air = pressure in liquid column + atm pressure $\frac{F_B}{A_B} = \rho g h + P_{atm}$ $\rho g h = \frac{F_B}{A_B} - P_{atm}$ $13600(10)(h) = \frac{9}{6 \times 10^{-5}} - 1.0 \times 10^5$ $h = \frac{\frac{9}{6 \times 10^{-5}} - 1.0 \times 10^5}{13600(10)} = 0.368 \ m = 36.8 \ cm$	 [1] [1]
	(ci)	The difference in mercury level **remains unchanged**.	[1]
	(cii)	**The difference in glycerine levels is larger than the difference in mercury levels**.	[1]

Qn		Solution	Marks
5	(ai)	$Pt = ml_v$ $480 \times (2 \times 60) = 0.025 l_v$ $l_v = \frac{480 \times (2 \times 60)}{0.025} = 2300000 \ J/kg$	[1] [1]
	(aii)	In reality, there is **energy transferred to the internal store of the surroundings.** **Since Latent heat = m x l_V, and the mass of water vaporised is less than in an ideal experiment, the latent heat calculated will be larger than the true value**.	[1] [1]
	(bi)	During boiling, **energy is transferred to the substance through work done against the attractive forces between the particles**. **Only the internal potential energy of the particles is increased.** **Since the internal kinetic energy of the particles does not increase, the temperature does not change during boiling**.	[1] [1]
	(bii)	$Pt = C(\Delta\theta) + ml_v$ $Pt - C(\Delta\theta) = ml_v$ $480 \times (2 \times 60) - 28.5(100 - 30) = m(2300000)$ $m = \frac{480 \times (2 \times 60) - 28.5(100 - 30)}{2300000} = 0.0242 \ kg$	[1] [1]
6	(a)	**A transverse wave has a direction of particle vibration that is perpendicular to the direction of wave travel.**	[1]
	(b)	**Amplitude A**  **Fig. 6.1**	[1]
	(ci)	$f = \frac{1}{0.8} = 1.25 \ Hz$	[1]
	(cii)	The closest P and Q can be is ¼ of a wavelength apart. Longest possible wavelength $= 20 \times 4 = 80 \ cm$	[1]
	(ciii)	P and Q could be **0.25 wavelengths apart or 1.25 or 2.25 or 3.25 wavelengths apart, thus there are other possible wavelengths.**	[1]

Qn		Solution	Marks
7	(a)	**When the angle of incidence in the optically denser medium (water) is 49°, the angle of refraction in the optically less dense medium (air) is 90°.**	[1]
	(b)	**Rays**  	[1] [1]
	(c)	For angles of incidence that are **smaller than the critical angle, the light in the water gets refracted at the boundary with air and emerges out of the water in all directions.** For angles of incidence that are **larger than the critical angle, the light in the water is totally internally reflected and does not emerge out of the water.**	[1] [1]
	(d)	$n = \frac{c}{v}$ $\frac{1}{\sin c} = \frac{c}{v}$ $v = c \sin c$ $v = 3.0 \times 10^8 (\sin 49) = 2.26 \times 10^8 \ m/s$	[1] [1]
8	(a)	**Since unlike charges attract, the positively charged plaque is attracted to the negatively charged teeth** and makes it difficult to remove from the teeth.	[1]
	(bi)	The negatively charged head and bristles of the toothbrush **repel negative charges on the surfaces of the teeth,** causing the electrons to flow through the body and hand. There will be an **excess of positive charges on the teeth, causing the teeth to become positively charged**. **Since like charges repel and the teeth becomes positively charged, the positive charges on the surfaces of the teeth repel the positively charged plaque.** **Since unlike charges attract, the positive charges on the plaque are also attracted to the negative charges on the head and bristles of the toothbrush**.	[1] [1] [1]

Qn		Solution	Marks
	(bii)	$I = \frac{Q}{t}$ $Q = 250 \times 10^{-3}(5 \times 60) = 75\ C$	[1] [1]
9	(a)	 	[1]
	(bi)	**1. Random decay means that no physical or chemical method can cause a radioactive nucleus to emit radiation.** **2. Spontaneous decay means that the time between emissions cannot be predicted/ when a radioactive nucleus will emit radiation cannot be predicted.**	[1] [1]
	(bii)	**Nuclide equation**  	[1] [1]
	(biii)	**A strontium nucleus has 52 neutrons and 38 protons, while a yttrium nucleus has 51 neutrons and 39 protons.** **There is a difference of 1 less neutron and 1 more proton, suggesting that the neutron became a proton to maintain the total number of nucleons and an electron to maintain the total relative charge before and after the reaction.**	[1] [1]
	(ci)	A radioactive source with half-life of millions of years **will not decay at a rate that can be measured by the GM counter.**	[1]
	(cii)	Number of half-lives $= \frac{87}{29} = 3$ Number of beta-particles emitted $= \frac{1.6 \times 10^5}{2^3} = 20000$	[1] [1]

Qn	Solution		Marks
10	(a)	When the switch is closed, the **iron bar is magnetised by the magnetic field in the solenoid and becomes an electromagnet**. The **iron bar magnetises the paper clips through induced magnetism** and hence attracts the iron paper clips.	[1] [1]
	(b)	**Solenoid**  	[1]
	(ci)	As the current increases, **the number of paper clips attracted increases non-proportionately**. This shows that the **strength of the electromagnet does not increase proportionately with current**.	[1] [1]
	(cii)	The **strength of the magnet increases and then decreases before finally reaching a maximum**. OR The **strength of the magnet has a maximum / does not increase indefinitely**. OR The **maximum strength of the electromagnet occurs when the number of clips attracted is 150**.	[1]
	(ciii)	From the tables, **the number of clips attracted for the same magnetisation M is about the same with a difference of one clips or none.** **Hence M is approximately constant and the data supports the equation.**	[1] [1]
	(d)	Since steel is a **hard magnetic material which is difficult to magnetise**, the **number of paper clips attracted will be less** than in the first experiment.	[1] [1]

Paper 2 Section B (10 marks)

Qn	Solution		Marks
12	**(a)**	Electrical energy is transmitted at a high voltage so that **current being transmitted is reduced** and hence **ohmic heating of transmission cables is reduced, reducing power loss**.	[1] [1]
	(bi)	1. The **fuse** was **wrongly connected to the neutral wire, it should be connected to the live wire.** 2. The **earth wire** was **wrongly connected to the heater coil, it should be connected to the metal casing.**	[1] [1]
	(bii)	$I = \frac{300}{240} + \frac{7500}{240} = 32.5A$ The **fuse is not suitable as the fuse rating has to be slightly above the operating current of 32.5 A**.	[1] [1]
	(biii)	Cost of electrical energy consumption $= kW \times h \times price$ $= \frac{300 + 7500}{1000} \times (\frac{20}{60} \times 30) \times 25$ $= 1950 \ cents = \$19.50$	 [1] [1]
	(biv)	$Pt = mc\Delta\theta$ $7500(60) = (7.8 \times 1)(4200)(\Delta\theta)$ $\Delta\theta = \frac{7500(60)}{(7.8 \times 1)(4200)} = 13.7°C$	 [1] [1]

Qn	Solution		Marks
11	(ai)	**125 Ω**	[1]
	(aii)	As the temperature increases from 20 °C to 100 °C, the **resistance of the thermistor decreases** from 125 Ω to 25 Ω. Since the heating element is **connected in parallel** to the thermistor, the temperature change will have **no effect** on it (as the voltage, current and resistance in that branch are constant). Since the lamp is **connected in series** with the thermistor, the temperature change and **decrease in resistance will cause current flow to increase and the lamp to brighten up**.	[1] [1] [1]
	(aiii)	$\frac{1}{R} = \frac{1}{10} + \frac{1}{35}$ $R = \frac{1}{\frac{1}{10} + \frac{1}{35}} = 7.78\ \Omega$ $I = \frac{V}{R} = \frac{12}{7.78} = 1.54\ A$	[1] [1]
	(bi)	Silver-coloured and smooth surfaces are **poor absorbers of infrared radiation** and it helps to reflect the infrared radiation onto the food to cook it efficiently.	[1]
	(bii)	In the convection oven, the heater warms up the air near it and the circulation fan circulates the hot air to the food. Since **air is a poor conductor of heat, the heat transfer from the hot air to the food takes longer**. In the infra-red toaster, heat is **transferred directly to the food by radiation, cooking both the surface and the interior of the food concurrently, making It faster.**	[1] [1]
	(biii)	**Remote controls / thermal imaging thermometers / burglar alarms / high speed data transfer**	[1]

End of marking scheme