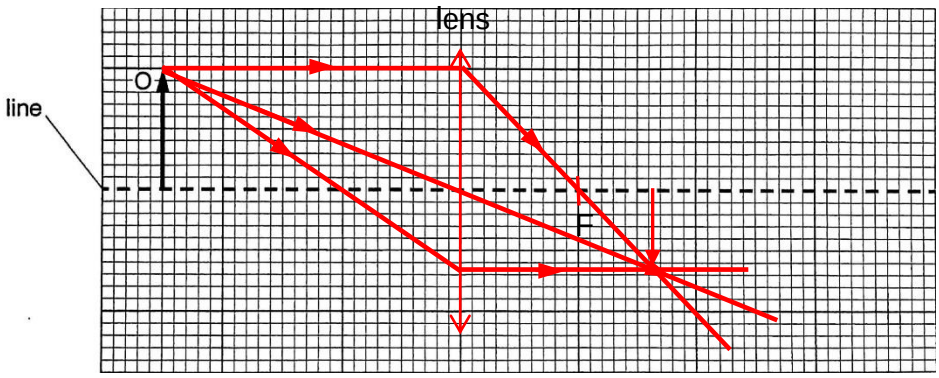
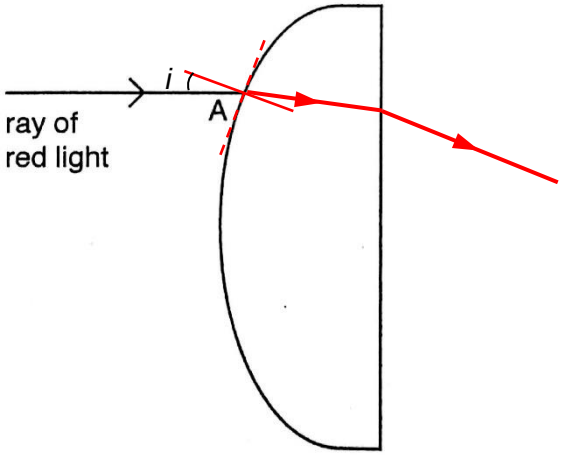
4E Prelim 2022 Physics

Paper 1 (40 marks)

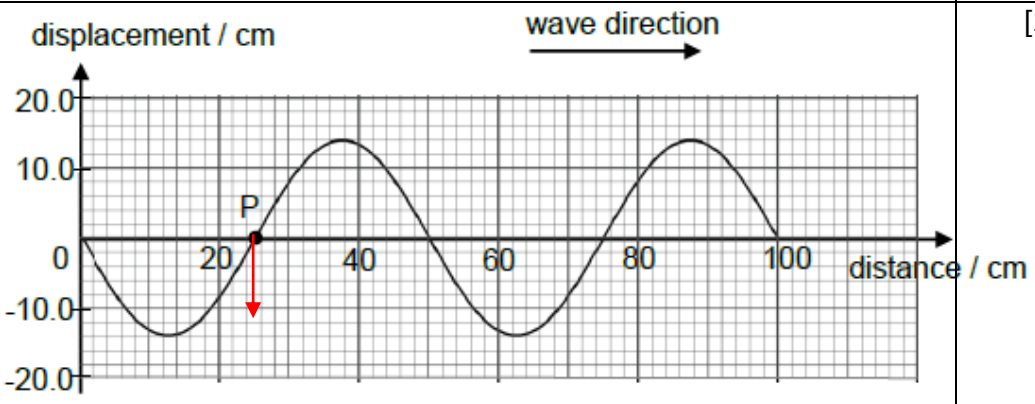
1	2	3	4	5	6	7	8	9	10
D	D	B	B	A	C	A	C	D	A
11	12	13	14	15	16	17	18	19	20
D	B	B	C	D	C	C	A	B	A
21	22	23	24	25	26	27	28	29	30
A	B	B	C	A	D	C	B	B	A
31	32	33	34	35	36	37	38	39	40
B	D	A	D	D	B	C	C	B	D

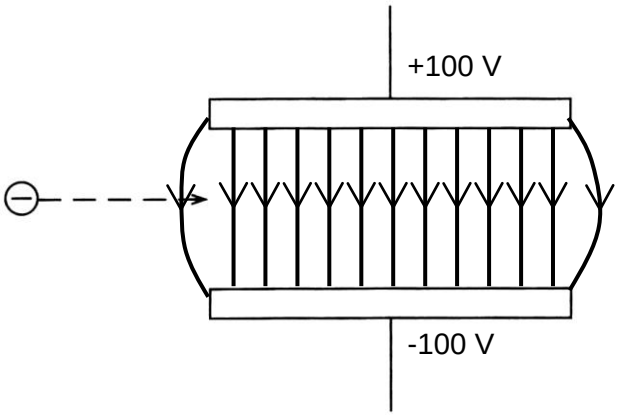
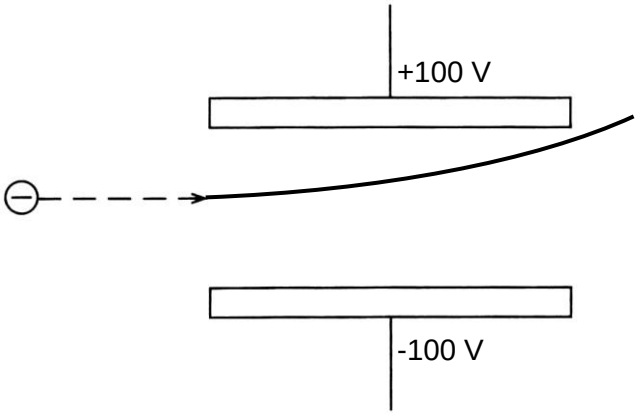
Paper 2 Section A (50 marks)

1a	External diameter = 9.67 cm [1] Internal diameter = 8.18 cm [1]	[2]
1b	Density is the mass per unit volume of a substance. **Do NOT accept formula as the answer.*	[1]
1c	$\rho = \frac{m}{V} = \frac{700}{\frac{4}{3}\pi(\frac{9.67}{2})^3} \approx 1.5\,\text{g cm}^{-3}$ (2 or 3 s.f) [2] Since the density of the hollow spherical capsule is more than the density of water, it will **sink**. [1]	Working [1] Ans [1] Explain [1]
	Total	[6]
2a	As the air is released from the can, th**e number of air molecules within the can decreases**. **[1]** The **frequency of collisions between the air molecules and the walls of the can decreases [1],** thus **reducing the average force per unit area exerted on the walls of the can [1]**, causing pressure to decrease.	[3]
2b	$P_1V_1 = P_2V_2 \rightarrow P_1 = P_2\frac{V_2}{V_1} = (1.0\times10^5)(\frac{9.4\times10^{-4}}{1.8\times10^{-4}}) \approx 5.2\times10^5\,\text{Pa}$ (2 or 3 s.f)	Working [1] Ans [1]
	Total	[5]

3ai	It is the distance between the principal focus and the optical centre of the converging lens.	[1]
3aii	 **[1]** for correct position and labelling of lens **[1]** for correct position and labelling of focal point **[1]** for all three correct light rays	[3]
3bi	 **[1]** for correct normal and marking of angle of incidence **[1]** for correct light ray in the lens and exiting the lens	[2]
3bii	The **larger the refractive index, the smaller the focal length. [1]** A **larger refractive index** will cause **the light ray to bend more towards the normal as it enters the lens** and **will bend further away from the normal as it exits the lens**, this **causing the light ray to cut the principal axis closer to its optical centre**. **[1]**	[2]
	Total	[8]
4a	The centre of gravity of an object is defined as the point through which its whole weight appears to act for any orientation of the object.	[1]

4b	Taking moments about his feet, Sum of CW moments = Sum of ACW moments $850 \times (1.10) = F \times (0.50 + 1.10)$ $F = \frac{850 \times 1.10}{1.60} \approx 580\,\text{N}$ (2 or 3 s.f)	Working [1] Ans [1]
	Total	[3]
5a	Temperature is the measure of the hotness and coldness of a body. *OR* Temperature is a measure of the average kinetic energy of the particles in the body.	[1]
5b	**1.** The darker the colour of the body, the higher the rate of thermal radiation. **2.** The duller the surface of the body, the higher the rate of thermal radiation. **3.** The larger the surface area of the object, the higher the rate of thermal radiation. **4.** The higher the surface temperature of the surface of the object relative to the surrounding, the higher the rate of thermal radiation. **Any 2, **[1]** each*	[2]
5c	Rate of heat loss by chamber and a monkey = $\frac{m_{water}\, c_{water}\, \Delta\theta}{t}$ $= \frac{3.0 \times 4200 \times (32 - 25)}{3600}$ = 24.5 W **[1]** Rate of heat loss by chamber and 2 monkeys = $\frac{m_{water}\, c_{water}\, \Delta\theta}{t}$ $= \frac{7.0 \times 4200 \times (32 - 25)}{3600}$ ≈ 57.17 W **[1]** Rate of loss of thermal energy of the 2nd monkey = 57.17 – 24.5 ≈ 33 W **[2]** (2 or 3 s.f)	Working [3] Ans [1]
	Total	[7]

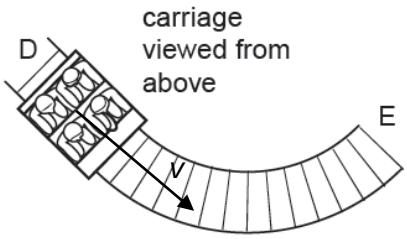
6a	$v = f\lambda \rightarrow 2.0 \times \frac{50}{100} = 1.0\ \text{m s}^{-1}$ $v = \frac{d}{t} \rightarrow d = v \times t = 1.0 \times 0.060 = 0.060\ \text{m}$ (2 or 3 s.f)	Working [1] Ans [1]
6b		[1]
	Total	[3]
7a	Visible light	[1]
7b	Sunbeds for artificial tanning Sterilisation of medical equipment Forgery detection **Any one, list not exhaustive*	[1]
7c	$v = f\lambda \rightarrow f = \frac{v}{\lambda} = \frac{3.0 \times 10^{8}}{100 \times 10^{-6}} = 3.0 \times 10^{12}$ Hz (2 or 3 s.f)	Working & Ans [1]
7d	Electromagnetic waves can travel through vacuum but sound waves cannot. *OR* Electromagnetic waves are transverse waves but sound waves are longitudinal waves.	[1]
	Total	[4]
8a	Electric field is a region where an electric charge experiences an electric force.	[1]

8bi	 ***[1]** for correct shape* ***[1]** for correct direction*	[2]
8bii		[1]
	Total	[4]
9a	**P**: South pole **Q**: North pole **Both correct to get **[1], [0]** otherwise.*	[1]
9b	Bar **A**: Magnetised **[1]** Like poles repel. This will imply that bar A must a magnet. **[1]** Bar **B**: Undetermined **[1]** Attraction can happen between two unlike poles, or between a magnet and an unmagnetised magnetic material. **[1]**	[4]
	Total	[5]
10a	The e.m.f source will last longer.	[1]

10bi	$\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}\rightarrow\frac{1}{0.73}=\frac{1}{3.0}+\frac{1}{R_X}$ $\frac{1}{R_X}=\frac{1}{0.73}-\frac{1}{3.0}\rightarrow R_X\approx 0.964\approx 0.96\,\Omega$ (2 or 3 s.f)	Working [1] Ans [1]
10bii	$V_X=\frac{0.73}{2.0+0.73}\times 2.0\approx 0.5348\,\text{V}$ $I_X=\frac{V_X}{R_X}=\frac{0.5348}{0.964}\approx 0.55\,\text{A}$ (2 or 3 s.f)	Working [1] Ans [1]
	Total	[5]

Paper 2 Section B (30 marks)

11a	$P=VI\rightarrow I=\frac{P}{V}=\frac{7100}{400}=17.75\approx 18\,\text{A}$ (2 or 3 s.f)	Working [1] Ans [1]
11bi	Total mass = $610+70=680\,\text{kg}$ Total weight = $680\times 10=6800\,\text{N}$ Taking upwards as positive, $F_R=T+W=ma$ $T+(-6800)=680\times 0.61\rightarrow T=414.8+6800=7214.8\approx 7200\,\text{N}$ (2 or 3 s.f)	Working [1] Ans [1]
11bii	Weight of passenger = $mg=70\times 10=700\,\text{N}$ Taking upwards as positive, $F_R=N+W=ma$ $N+(-700)=70\times 0.61\rightarrow N=42.7+700=742.7\approx 740\,\text{N}$ (2 or 3 s.f)	Working [1] Ans [1]
11c	$a=\frac{(v-u)}{t}\rightarrow 0.61=\frac{(v-0)}{2.6}$ $v=0.61\times 2.6=1.586\approx 1.6\,\text{m s}^{-1}$ (2 or 3 s.f)	Working [1] Ans [1]
11d	Total energy supplied = $P\times t=7100\times 14=99400\,\text{J}$ **[1]** Useful energy supplied to lift = $mgh+\frac{1}{2}mv^2$ $=(680\times 10\times 13)+(\frac{1}{2}\times 680\times 1.586^2)\approx 89255$ Efficiency = $\frac{89255}{99400}\times 100\approx 90\%$ (2 or 3 s.f)	Working [2] Ans [1]
	Total	[11]

12ai	Energy can neither be created nor destroyed. It can only be **converted** from on form to another, or **transferred** from one body to another, with the total amount remaining constant.	[1]
12aii	GPE at A $= mgh = 490 \times 10 \times 30 = 147000 \approx 150000$ J (2 or 3 s.f)	Working [1] Ans [1]
12aiii	KE at C = $\frac{1}{2}mv^2 = \frac{1}{2} \times 490 \times 10^2 = 24500$ J **[1]** GPE at C = $mgh = 490 \times 10 \times 10 = 49000$ J W.d aginst friction = 147000 – 24500 – 49000 = 73500 ≈ 74000 J (2 or 3 s.f) **[2]**	Working [2] Ans [1]
12bi	 * *Correct arrow and label must be present to get **[1]**.*	[1]
12c	Incorrect. **[1]** Due to **inertia**, the children will continue to move forward as the carriage turns left, thus causing the children to be closer to the right side of the carriage. [1]	[2]
	Total	[10]

EITHER

13a	$f = \frac{3}{1.8} \approx 1.7$ Hz (2 or 3 s.f)	Working [1] Ans [1]
13b	10 mm	[1]
13ci	A **magnetic field is created around the coil** as the coil is switched on. **[1]** As the **copper plate, an electrical conductor, oscillates, it cuts the magnetic field of the coil. [1]** According **to Faraday's law of electromagnetic induction, an induced e.m.f will be created across the copper plate, thus creating induced eddy current in the copper plate. [1]**	[5]

	According to **Lenz's law, the induced eddy current will create a magnetic field to oppose the change producing itself.[1]** **This will create a resistive force that will dampen the oscillation of the copper plate**, thereby reducing the amplitude of oscillations. **[1]**	
13cii	As the amplitude decreases, **the copper plate will cut the magnetic field of the coil at a lower rate. [1]** This will result in **a lower resistive force created to dampen the oscillation. [1]**	[2]
	Total	[10]

OR

13a	If **wire B** instead of wire A **is connected to the live terminal**, **the light bulb will be still connected to the high potential even if the switch is opened**. **[1]** If the **bulb is faulty**, **the user, who is at a lower potential**, will get **electrocuted** if he or she touched the faulty light bulb which is at high potential. **[1]**	[2]
13bi	The fuse is to **prevent a current surge (current that is larger than the operating current) from damaging the table lamp**. **[1]** If **the current is larger than the fuse's rating, the heat generated by the large current [1]** will **melt the connecting wire in the fuse**, **thus opening the circuit [1]**, which in turn will stop the current surge.	[3]
13bii	The **metal case is connected to wire C, which is the earth wire**. The **current from wire A will flow through the low resistance earth wire instead of the person** as wire A touches the metal case, thus, preventing the user from an electrical shock.	[1]
13ci	$P = \frac{V^2}{R} \rightarrow 100 = \frac{230^2}{R}$ $R = \frac{230^2}{100} = 529 \approx 530\,\Omega$ (2 or 3 s.f)	Working [1] Ans [1]
13cii	$P = \frac{V^2}{R} \rightarrow V^2 = P \times R$ $P_1R_1 = P_2R_2 \rightarrow \frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{60}{100} = 0.60$ (2 or 3 s.f)	Working & Ans [1]
13d	Since the second lamp is doubly insulated, **its case must be made of an electrical insulator**. Thus, even if there is no earth wire connected to the case, the user would not get an electrical shock if the lamp is faulty.	[1]
	Total	[10]