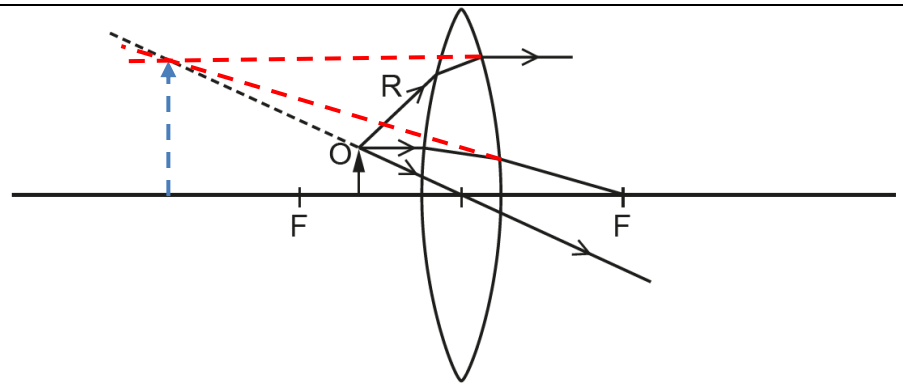
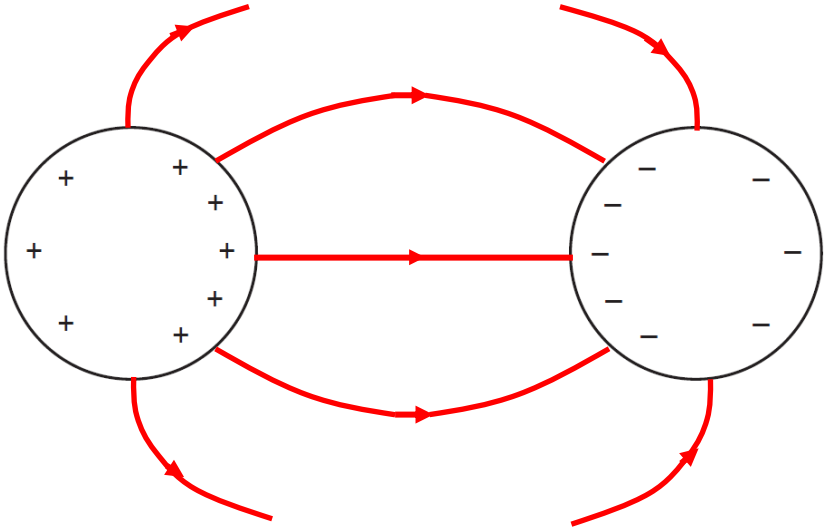
Beatty Sec 4E Physics (6091) Paper 1 and Paper 2
Preliminary Examination 2024
MARKING SCHEME

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

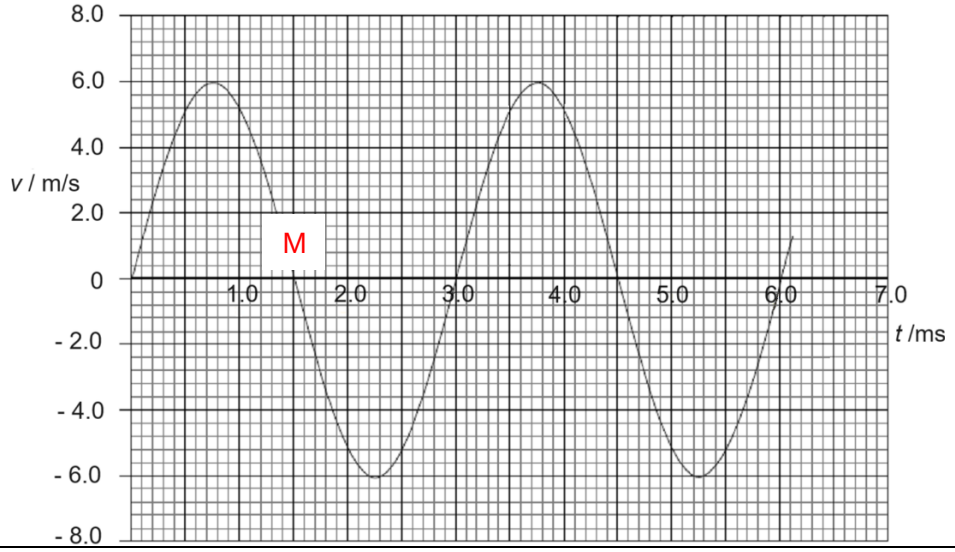
Minus 1 for missing/wrong unit and minus 1 for wrong s.f [Max minus 2 for whole paper]

Paper 2 Section A [70 marks]		
Qn	**Answer**	**Mark**
1a	The force exerted by the mercury on the trapped air changes when the tube is rotated, causing the pressure exerted by the mercury on the trapped air to change.	1
1b	$P_{liquid} = \rho gh = 14000 \times 10 \times (30 \div 100) = 42000$ Pa $P_{gas} = 42000 + 1.0 \times 10^5 = 142000$ Pa ≈ 140000 Pa (2 s.f)	1 1
1c	1.0×10^5 Pa	1
2a	• When temperature increases, the pressure of the gas inside the elastic flask increases and the force exerted on the walls of the flask increases. • The elastic flask expands and the volume of the gas increases, leading to a decrease in the pressure of gas.	1 1
2b	• When the temperature increases, the average kinetic energy of the particles increases. • The particles move faster (average velocity increases) and collide with the walls of the flask more frequently and vigorously. • The average force exerted on the walls increases and since P = F / A, the pressure of the gas increases.	1 1 1
3a	$Q_{heater} - Q_{surroundings} = Q_{heating} + Q_{boiling}$ $(1.0 \times 10^3)t - 20t = (1.5)(4200)(100 - 25) + (0.050)(2.26 \times 10^6)$ $980t = 585500$ $t = 597$ s ≈ 600 s (2 s.f)	2 1
3b	• The air above the hot water is heated and expands. • The heated air is less dense and rises while the cooler surrounding air which is denser sinks to replace it. • The cooler air is then heated by the hot water and the process repeats to remove energy from the hot water.	1 1 1
4a	Converging / Convex	1
4b	• When ray R enters, it moves from the optically less dense air to optically denser glass. • The speed of light decreases and the ray bends towards the normal. • When ray R exits, it moves from the optically denser glass to optically less dense air and the speed of light increases, causing the ray bends away from the normal.	1 1 1

4c	 Either emergent ray R or the ray through F extended to the left of the lens Both ray through F and R shown and image marked at intersection of extended rays	 1 1
4d	• The image forms <u>further away</u> from the lens. • The image becomes <u>larger</u>.	1 1
5a	Direction of field lines Electric field pattern 	1 1
5b	$I = Q / t = (4.8 \times 10^{-9}) \div (2.0 \times 10^{-3})$ $= 2.4 \times 10^{-6}$ A	1 1
6a	$P = I^2R = (0.0020)^2(800)$ $= 0.0032$ W	1 1
6b	$V_Y = 6.0 – (0.0020)(800) = 4.4$ V $R = V / I = 4.4 \div 0.0020 = 2200\ \Omega$	1 1
6c	• When the thermistor is cooled, the <u>resistance of the thermistor X increases</u> and the <u>potential difference</u> across the thermistor X <u>increases</u>. • Given the <u>total e.m.f remains unchanged</u>, an increase in potential difference across thermistor X leads to the decreases in potential difference across resistor Y. OR The <u>current through the resistor Y decrease</u> and since <u>V = IR</u>, the potential difference across Y decreases. OR by <u>potential divider principle</u>, the <u>ratio of the resistance of Y to the total resistance decreases</u> and the potential difference across Y decreases.	1 1
7a	To provide a return path for the current to flow back from the appliances.	1
7b	• When the live wire touches the metal case, the earth wire provides <u>a low resistance path for the current to flow from the metal case to the ground</u>. • The large current flow <u>exceeds the fuse rating</u> and the fuse <u>melts</u>, <u>disconnecting</u> the appliance from the <u>live terminal</u>.	1 1

7c	• The hairdryer is doubly insulated whereby two layers of insulation, one layer insulating the internal components from the external casing and another layer insulating the wires from the internal components. • This isolates the user from contact with any conducting metal parts.	1 1
8a	P: North Q: South	1
8b	• When current flows in the coil, the magnetic field generated around the coil interacts with the magnetic field of the magnets to produce a downward force to act on side AB and an upward force to act on side CD. • The equal forces acts in opposite direction to generate an anticlockwise moment.	1 1
8c	Component X reverses the direction of current inside the coil and ensures the direction of the force at each side of the coil remains the same.	1
9ai	T and Q or U and R	1
9aii	Beta particle	1
9bi	It means that it is not possible to predict which radioactive nucleus will emit radiation and the direction of the emitted radiation.	1
9bii	$^{218}_{84}Po$ $^{4}_{2}He$	1 1
9biii	To get 5.0 × 10^{13} atoms, (4.0 × 10^{14}) × ½ × ½ × ½ = 5.0 × 10^{13} atoms No. of half-life = 3 Half-life = 11.4 ÷ 3 = 3.8 days	1 1 1
10ai	• The power output increases at a constant rate from zero to a value of 0.40 MW between 5 to 15 m/s. • It then increases further at a higher constant rate to a value of 0.80 MW between 15 to 20 m/s.	1 1
10aii	Rate of power output = 0.40 ÷ 10 = 0.040 MW / m/s	1
10aiii	Total energy produced = [0 + 0 + 0 + 0 + 0.04 +0.62 + 0.36 + 0.40 + 0.80 + 0.80] × [2 × 60 × 10^6] = 3624000000 ≈ 3.6 × 10^9 J (2 s.f)	 2 1
10aiv	The wind speed may not be constant during the two-minute time interval.	1
10bi	• The voltage produces an alternating current in the primary coil. • This produces an alternating (changing) magnetic field inside the iron core. • This alternating magnetic field cuts the secondary coil and induces an output voltage (e.m.f) in the secondary coil.	1 1 1
10bii	• Increase the potential difference across the wire. • As P_{output} = VI, delivering a large power through the wire using a higher potential difference leads to a lower current which in turn gives a lower energy loss as P_{loss} = I^2R. OR • Increasing the cross-sectional area of the wire to decrease the resistance of the wire. • As P_{loss} = I^2R, reducing the wire resistance leads to lower energy loss.	1 1
11a	The centre of gravity is the point at which the whole weight of the object appears/seems to act on.	1
11b	The force exerted by the slab on the bar.	1
11c	Force × 0.90 = 200 × 0.60 Force = 133 N ≈ 130 N (2 s.f)	1 1
11d	Force = 130 + 80 + 200 = 410 N OR 413 N (allow ECF from 11c)	1
11e	Assuming length of slab = 1.0 m Weight × 0.50 = 133 × 1.0 Weight = 266 N (allow ECF from 11c)	 1
11f	• Decrease the distance between the stone and the slab. • The anticlockwise moments by the force of the slab decreases and there is a clockwise moment generated by the weight of the bar. Thus, the clockwise moments required by the force decreases. With an increase in perpendicular distance to the	1 1

	stone, the force required will be less than 200 N.	

Paper 2 Section B [10 marks]		
Qn	**Answer**	**Mark**
12ai	The graph shows the velocity of the man changing from positive to negative at t = 4.0 s.	1
12aii	Acceleration = gradient of graph = (10 – 0) / (1.0 – 0) = 10 m/s^2 (Accept use of any points between t = 0 to 1.4 s)	1 1
12aiii	The air resistance is negligible / There is no air resistance.	1
12bi	t = 4.0 s	
12bii	• At D, the weight of the man acts downwards while the elastic force (tension) by the cord acts upwards on the man. • The weight of the man is smaller than the elastic force exerted by the cord. • Hence, the resultant force is acting upwards, causing a constant upward acceleration.	1 1 1
12biii	• From C to D, the gravitational potential and kinetic energy stores of the man is transferred to the elastic potential energy store of the cord. • The energy is transferred mechanically by a force acting over a distance.	1 1
13a	• A wave is a disturbance caused by a vibrating source that transfers energy • from one point to another without net movement of medium. • In a longitudinal wave, the particles vibrate parallel to the direction of the wave motion whereas in a transverse wave, the particles vibrate perpendicular to the direction of the wave motion.	1 1 1
13bi	M labelled at any point when v = 0  	1
13bii	Distance travelled = Area under graph = 2.0 × (½ × 1.5 × 6.0) = 9.0 m	1 1
13ci	The frequency of ultrasound is more than 20000 Hz. OR Frequency of ultrasound is higher than sound.	1
13cii	• When the small vibrating source is placed on the skin, the tissues are displaced vibrations are passed through the tissues until it reaches the baby and is reflected back to the detector. • The difference in time taken for the echo / difference in the strength of the echo is computed to generate an image of the baby.	1 1
13ciii	X-rays has an ionisation effect on biological molecules that can lead to cell damage / cell mutation.	1