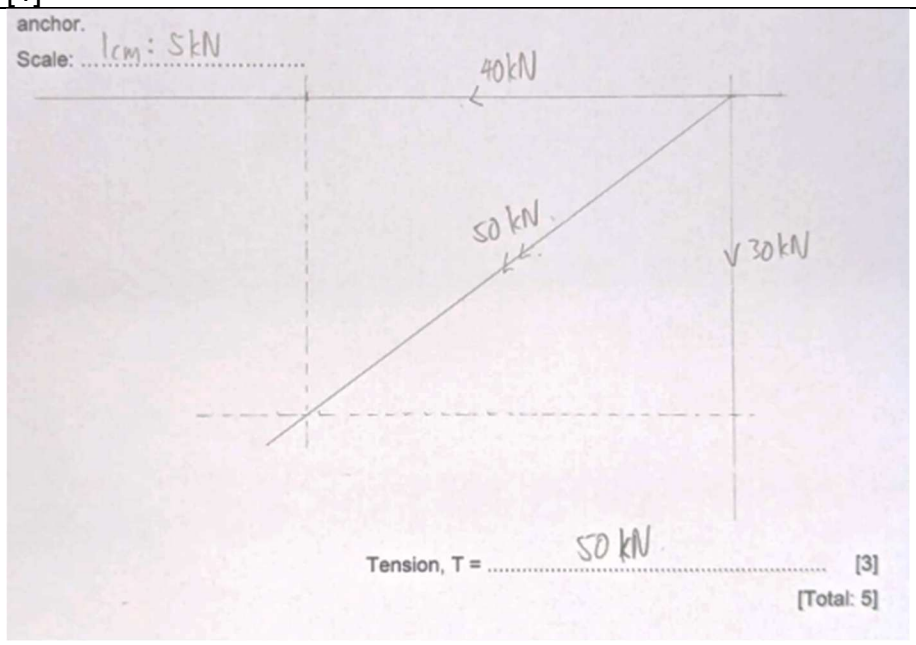
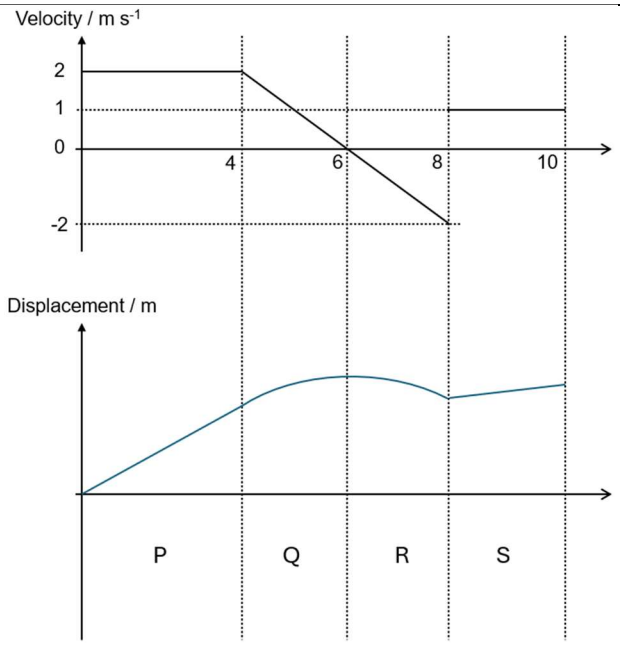
2024 Physics Prelim

Paper 1

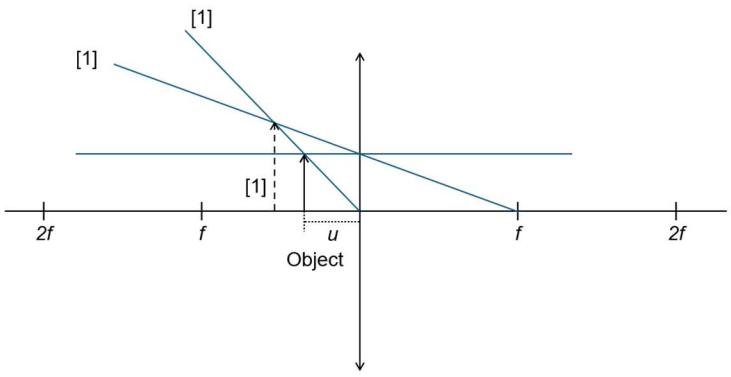
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
C	B	C	D	C	C	C	C	C	C
11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
B	D	B	B	C	C	A	B	C	B
21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
C	C	C	B	B	D	C	D	C	B
31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
A	C	D	A	D	D	C	B	D	A

Paper 2

Qn	Working	Remarks
1a	Volume of anchor = 3000 / 6900 = 0.435 m^3 [1] Mass of seawater displaced = (3000/6900) × 1020 = 443.5 kg [1]	
1b		1m – app scale 1m – correct arrows for 40 kN and 30 kN 1m – correct resultant force Allow for 1 labelling error.

2a		P – straight upward slope Q – decreasing curve upwards R – increasing curve downwards, ends at the starting of Q. S – straight upward slope, gentler than P. P – [1m] Q & R [1m] S – [1m]
2b	a = (-2 – 2)/4 = -1 m s^{-2} [1]	
2c	Acceleration is a vector – with magnitude and direction. [1] Even though the magnitude of speed is constant, the direction of travel is constantly changing. [1] Thus the robot is accelerating.	
3a	P = F / A = 400 N / 0.0003 m^2 = 1333333 Pa = 1330000 Pa or 1.3 MPa. [1]	
3b	For a body in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of counter clockwise moments [1] about the same pivot. [1]	
3c	400 x 0.08 m = 32 N m (cw) [1] F_1 x 0.02 m = 32 N m F_1 = 1600 N [1]	
3d	When the brakes are applied, energy from the Kinetic store of the spinning wheel is converted into the energy in the Internal (heat) store of the wheel, brakes and surroundings. [1]	
4a	P = ρgh h = P / (ρg) = 101300 / (13546 × 10) =0.745 m	
4b	P = ρgh + 1 atm = 1030 × 10 × 18 + 101.3 kPa = 286700 Pa = 287 kPa	1m – fluid pressure 1m correct final answer

4c	The bubble will expand as the pressure acting on it decreases.	
4d	As the diver ascends, the bubbles trapped in the body will expand since pressure decreases. The trapped bubbles might be stuck in narrow blood vessels or critical parts [1] that might rupture due to the expansion of the bubbles [1]	Accept any reasonable answer.
5a	Amount of thermal energy required to raise the temperature of 1 kg [1] of the sand by 1 °C. [1]	
5b	Energy used to heat up sand $= m_{sand} \times c_{sand} \times \Delta T$ $= 1000 \times 4000 \times 3$ $= 12000000$ J Energy used to heat up water $= m_{water} \times c_{water} \times \Delta T_{water}$ $= m_{water} \times 800 \times \Delta T_{water}$ Energy used to heat up water = energy used to heat up sand $12000000 = 10000 \times 800 \times \Delta T_{water}$ $\Delta T_{water} = 1.5$ °C	1m – calculating the energy required to said the temp of sand by 3 °C 1m – correct final answer
5c	Since the sand is hotter than the sea[1], air above the sand rises due to its lowered density. [1] Denser air above the sea rushes in to take its place, forming sea breeze. [1]	
6a	Two light atomic nuclei combine to form one heavier atomic nucleus[1] and releases a huge amount of energy.[1]	
6b	Speed of light in vac = 3.0×10^8 m s^{-1} [1] $d = 3.0 \times 10^8 \times 8.5 \times 60 = 153000000000$ m = 153 Gm. [1]	
6c	High energy waves that can eject electrons from atoms and molecules to create ions. [1] Gamma waves [1] cancer treatment, radiotherapy [1]	
6d	Sound waves need a medium to transfer energy. [1] Since there is no matter in space (between Earth and the Sun), [1] sound energy cannot be transferred to Earth.	
7a	A lens that can concentrate light rays.[1]	
7b	Virtual / upright [1]	

7c		[1] – parallel ray that passes through *f* after crossing the lens [1] – ray passing through the optical centre [1] – upright virtual image, dotted
7d	Larger [1]	
8a	Electrons were (pulled off / moved from)the glass rod to the silk cloth [1] Leaving a net positive charge on the glass rod. [1]	
8bi	Charged petrol tank – static discharge can ignite a fire Coal mine – static discharge can ignite coal powder in the air	Accept any reasonable answer
8bii	Charged petrol tank – earth the tank and nozzle when pumping petrol Place grounding wires	Accept any reasonable answer for the hazard mentioned in 8bi
9a	The resistance of the thermistor decreases as the p.d. increases [1] whereas the resistance of the filament lamp increases as p.d. increases. [1]	
9b	Yes. $R = \frac{V}{I}$ At p.d. = 10.7 V, I of both the filament lamp and the thermistor is 0.75 A. Therefore, they have the same resistance.	
9ci	When $p.d._{resistor}$ = 8.0 V, $I_{resistor}$ = 0.52A. [1] Since the components are all connected in series, they all have the same current. When I = 0.52 A, $p.d._{resistor}$ = 8V, $p.d._{filament\ lamp}$ = 5.2 V, $p.d._{thermistor}$ = 10 V [1]	

	Total p.d. = p.d.$_{\text{resistor}}$ + p.d. $_{\text{filament lamp}}$ + p.d. $_{\text{thermistor}}$ = 23.2 V	
9cii	R = V/I = total p.d. / 0.52A [1] = 44.6 Ω [1]	Allow ecf
9d	An ohmic conductor is one where its resistance remains constant regardless of p.d. [1] The resistor is an ohmic conductor. [1]	
10ai	B – North C – South	
10aii	PQ – P towards Q RS – R towards S	
10b	PQ will experience a downwards force RS will experience an upwards force The coil will rotate anticlockwise – viewed from PS. [1] Current flowing through PQRS will generate a magnetic field around the wire. [1] This magnetic field is perpendicular to the magnetic field between B & C. [1] The interaction between the two magnetic fields produces a motion [1] Which can be determined using FLHR.	1 mark for direction of rotation No mark for justification based on FLHR.
10c	G1 and G2 are carbon brushes. [1] They allow PQRS to be in electrical contact with the circuit while the split-ring commutator is rotating. [1]	Accept any reasonable justifications
10d	Increase the strength of the magnets by increasing the number of coils in the solenoids / increasing the number of batteries / lowering the resistance of the rheostat. Increase the current flowing in PQRS by increasing the number of batteries / lowering the resistance of the rheostat.	
11a	Carbon-14 [1] It has different number of neutrons than the stable version of the atom. [1]	
11b	$^{239}_{94}Pu \rightarrow {}^{235}_{92}U + {}^{4}_{2}He$	[1] – correct helium [1] – correct uranium
11c	Half-life is the time it takes for half of the unstable nuclei in a sample to decay or for the activity of the sample to halve or for the count rate to halve. [1] It will take 1.248×10^9 years for half of a sample of Potassium-40 to decay. [1]	
11di	SI Unit – Becquerel (beq) [1] 1 becquerel is equal to one disintegration per second. [1]	
11dii	Geiger counters measures ionising radiation which travels as EM waves [1] whereas	

	Sound waves travel, and are received as a series of compressions and rarefactions. [1]	
12a	It is the time taken for half of the unstable nuclei of Boron-12 to decay. [1] In this case, it takes 20.20 milliseconds for half the amount of radioactivity of a sample of Boron-12 to decay. [1]	
12b	Fission.[1] Larger (parent) nuclei are split into smaller (daughter) nuclei.	
12c	Alpha. [1] a Helium atom is produced [1]	
12di	Cosmic radiation / Any two EM waves	
12dii	Harmful ionising radiation might damage organs or even cause death.[1] Shielding is required to prevent damage. [1]	