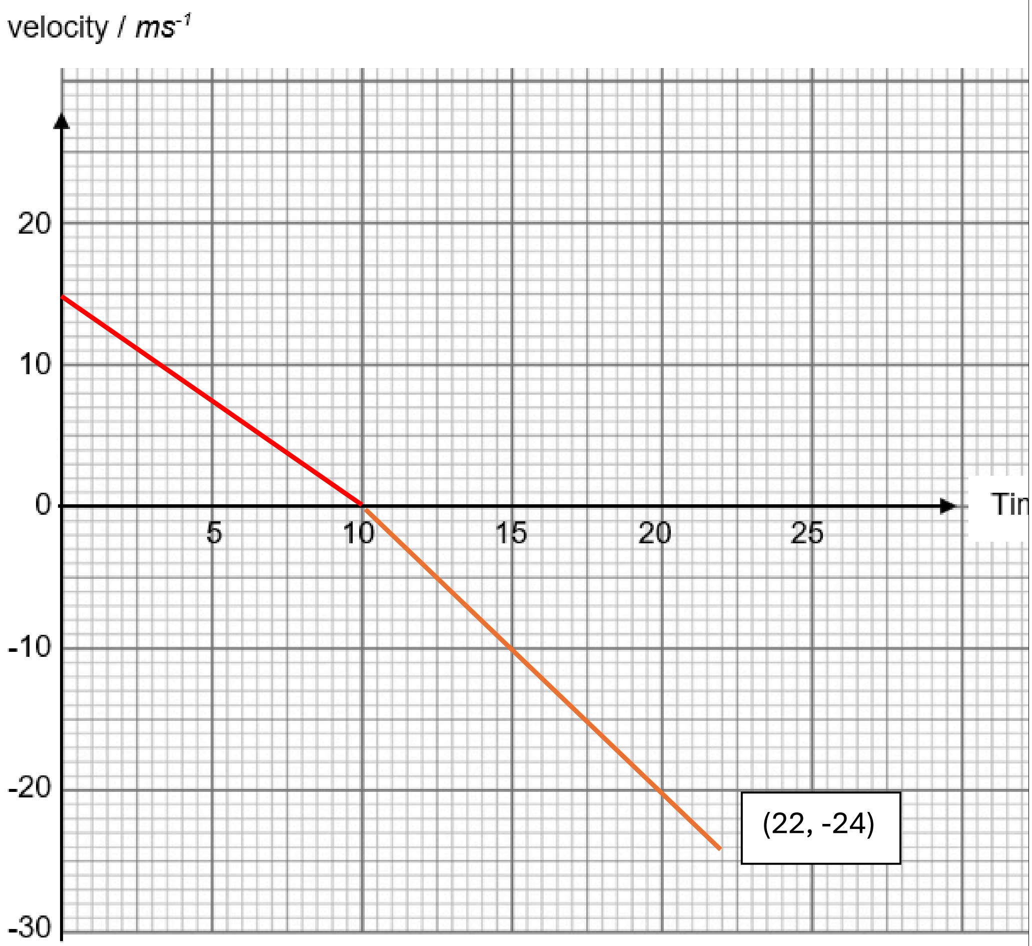
Paper 1

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

Paper 2

Section A

<table>
<tr><th>Question</th><th>Answers</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
</td><td>B1: t = 0 - 10 s

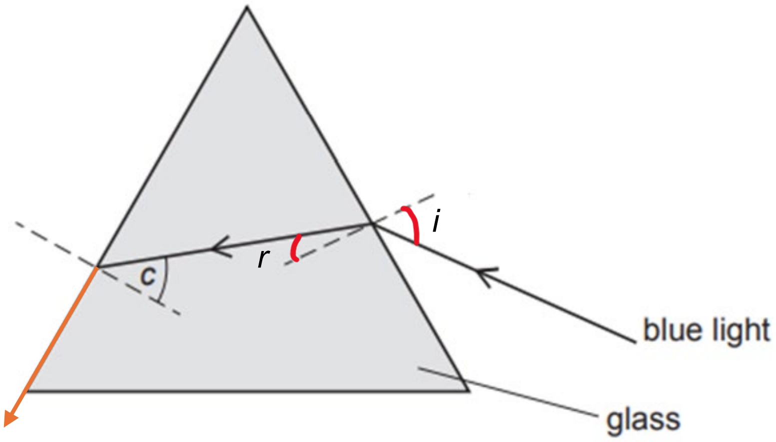
B1: t = 10 - 22 s</td></tr>
<tr><td>1(b)</td><td>a = (0 - 15)/10
= -1.5 m/s^2
deceleration = 1.5 m/s^2</td><td>A1</td></tr>
<tr><td>1(c)</td><td>Distance travelled = area under the graph
= 0.5 × 10 × 15 + 0.5 × 12 × 24
= 219 m

Average speed = total distance / total time
= 219 / 22
= 10 m/s (2 s.f.)</td><td>C1: showing evidence distance = area under the graph

A1</td></tr>
<tr><td>2(a)</td><td>• Moving air molecules collide with inner wall of container and exerts a force on it.
• Since pressure is the force exerted per unit area, the air molecules exert pressure on the surface of wall.</td><td>B1

B1</td></tr>
</table>

2(b)	• Using Newton's third law, downwards force of water on the rocket is equal to the upwards force of rocket on the water. • Using Newton's second law, this upwards force is larger than sum of weight and air resistance. Positive net force is upwards.	B1 B1
2(c)	• The weight of the rocket decreases since water is expelled. • As rocket accelerates upwards, the air resistance increases. • Pressure (of air) decreases • Less water expelled per second / water expelled at slower speed	B2: Any 2 answers
3(a)	Product of force and perpendicular distance between pivot and line of action of force.	B1
3(b)	Moment = F × d = 80 × 0.90 = 72 Nm	 A1
3(c)	Pivot: worker's shoulder ACW moment of weight of bucket = F × d = 87 × 1.3 = 113.1 Nm CW moment of weight of ladder = 72 Nm ACW > CW. Therefore the moment due to force L must be CW so ladder can be balanced. ACW = CW 113.1 = 72 + force at L × 0.54 force at L = 76 N Direction: downwards	 C1 A1 B1
4(a)	Energy cannot be created or destroyed. It can only be transferred from one store to another such that the total energy in isolated system remains constant.	B1
4(b)	Decrease in Ep = Increase in Ek $mgh = 0.5mv^2$ $10 \times 0.45 = 0.5 \times v^2$ v = 3.0 m/s or 3 m/s	C1 A1
4(c)	• No, she is incorrect. Not enough (kinetic) energy (at C) to travel beyond D / to top of circle **or** more Ep needed originally to travel beyond D / to top of circle **or** Ep gained cannot be greater than original Ep (transferred to Ek) • Car stops at D and goes backwards OR maximum height is D/0.45m/level of A	B1 B1
5(a)	• Conduction of heat from the heater to the man via air molecules. • Infra-red heat/radiation from the heater to the man	B1 B1
5(b)	Shiny surface reflects infra-red heat/radiation to man OR poor absorber of infra-red heat/radiation	B1

5(c)	• Sweater is made of a material that is an insulator of heat. • Sweater traps air too and air is an insulator of heat, reducing heat transfer from warm man to cooler surroundings.	B1 B1
6(a)	Angle of incidence in the optically denser medium whereby the angle of refraction in the optically less dense medium is 90^{O}.	
6(b), 6(c)		B1 B1
6(d)	• At side XZ, the <u>angle of refraction (*r*) of the ray increases</u> since lower refractive index = constant sin i / higher sin r • At side XY, the angle of incidence of the ray decreases. <u>Since angle of incidence is smaller than the</u> larger <u>critical angle,</u> refraction of light into the air takes place at side XZ.	B1 B1
7(a)(i)	Smallest frequency: infra-red wave Intermediate frequency: visible light Largest frequency: ultraviolet wave	B1: correct waves in any sequence B1
7(a)(ii)	Damaging effect: (skin) cancer / cataracts Property: ultraviolet radiation is ionizing (reject high energy)	B1 B1
7(b)	500 nm = 500×10^{-9} m $v = f\lambda$ $f = (3.0 \times 10^{8}) / (500 \times 10^{-9})$ $= 6.0 \times 10^{14}$ Hz (ecf)	C1 A1
8(a)	Work done by the battery to push 1 C of charge around the complete circuit is 12 J.	
8(b)	Resistance of 2 parallel resistors = $(1/30 + 1/20)^{-1}$ = 12 Ω Total resistance = 12 + 28 + 2 = 42 Ω	 A1 A1
8(c)	V = (28 / Rtotal) × emf = (28/42) × 12 = 8.0 V	C1 A1

8(d)	radius = 0.00050 m $R = \rho l / A$ $\rho = 2.0 \times (\pi \times 0.00050^2) / 1.0$ $= 1.6 \times 10^{-6}\ \Omega m$ (ecf)	C1 A1
9(a)	uranium-235 has (3) fewer neutrons (in the nucleus)	B1
9(b)	the nucleus splits (and releases more neutrons)	B1
9(c)	Alpha particle = ${}^{4}_{2}He$ Beta particle = ${}^{0}_{-1}e$ Proton number of protactinium = 92 – (2 – 1) = 91	 C1 A1
9(d)(i)	Half of initial count rate of 59 counts/s = 59 / 2 = 29.5 counts/s Half life = 64 s **OR** Half of initial count rate of 60 counts/s = 60 / 2 = 30 counts/s Half life = 64 s	 A1
9(d)(ii)	59 counts/s -> 29.5 counts/s -> 14.75 counts/s -> 7.4 counts/s OR $59 \times \frac{1}{2^3}$ = 7.4 counts/s **OR** 60 counts/s -> 30 counts/s -> 15 counts/s -> 7.5 counts/s OR $60 \times \frac{1}{2^3}$ = 7.5 counts/s	 A1
10(a)	(i) from B to A (ii) top of page	B1 B1
10(b)	Using Fleming's left hand rule, point the index finger in the direction of the magnetic field and middle finger in the direction of the current. The thumb gives the direction of the force. OR Based on the direction of the magnetic field due to the current in the wire and direction of the magnetic field due to the magnets, we are able to determine that the force will act along the stronger magnetic field towards the weaker magnetic field.	B1 B1 OR B1 B1

10(c)	The split-ring commuter ensures that the current direction changes at every half turn. After half a turn, force acts towards bottom of page because current now flows from A to B. The coil continues to rotate in a clockwise direction (about the axis).	B1 B1
10(d)	Disagree. (no marks for disagreeing without explanation) By moving the 2 solenoids further apart will bring the external magnetic field further away from the coil ABCD. This causes the **external magnetic field to become weaker.** **A weaker magnetic field produces a weaker force** on the coil and hence a weaker turning effect and thus slower rotation of the coil.	 B1 B1
10(e)	Insert bar magnet into a solenoid with alternating current (a.c.) – with diagram Slowly withdraw magnet in the east west direction.	B1 B1
11 (a)	I = P / V = 6000 / 230 = 26 A MCB is suitable as the operating current is slightly <u>lower</u> than the MCB current rating.	 B1 B1
11(b)(i)	Energy consumption in kWh = power in kW x time in hour = 6000/1000 x 4 + 2800/1000 x 24 + 1500/1000 x 2 = 94.2 kWh or 94 kWh	 A1
11(b)(ii)	Cost = 94.2 x 0.327 x 30 days = $924 **OR** Cost = 94 x 0.327 x 30 days = $922	A1 (ecf)
11(c)	Water conductivity or damp condition could cause short circuit **OR** electrocution	B1
11(d)(i)	R_{cold} = resistance per unit length x length = 0.012 x 3.0 = 0.036 Ω	 B1
11(d)(ii)	$\boldsymbol{R_{hot} = R_{cold}\,[1 + \alpha\,(T_{hot} - T_{cold})]}$ = 0.036 (1 + 0.00393 (62 – 30)) = 0.041 Ω	 B1

11(d)(iii)	Higher resistance leads to higher temperature as R_{hot} is higher than R_{cold}. Power loss calculation: At 62°C: $P = (6.8)^2 \times 0.041 = 1.9$ W At 30°C: $P = (6.8)^2 \times 0.036 = 1.7$ W Higher resistance leads to higher power loss. This power loss manifests as heat, causing further temperature rise.	B1 B1 B1
12(a)	1.0×10^5 N of force is acting on an unit area.	B1
12(b)	• Particles are slightly less closely packed than in solids • Particles are arranged in irregular pattern	B1 B1
12(c)(i)	$\rho = m/V$ $= 5.6 / (1.0 \times 4.0 \times 10^{-4})$ $= 1.4 \times 10^4$ kg / m^3	 A1
12(c)(ii)	$P = h\rho g$ $= 1.0 \times 1.4 \times 10^4 \times 10$ $= 1.4 \times 10^5$ Pa Total pressure $= 1.4 \times 10^5 + 1.0 \times 10^5$ $= 2.4 \times 10^5$ Pa	 C1 A1
12(c)(iii)	$F= PA$ $= (2.4 \times 10^5) \times (4.0 \times 10^{-4})$ $= 96$ N	 A1
12(d)	• The dense liquid level in the tube falls. • The space inside the tube, above the dense liquid, is vacuum. • The height between the dense liquid levels in the tube and the container is *L* m	B1 B1 B1
13 (a)	An alternating current in the <u>primary coil</u> produces a <u>changing magnetic field</u> in the soft iron core. This changing magnetic field links to the secondary coil through the core. According to Faraday's Law of Electromagnetic Induction<u>, a changing magnetic flux through the secondary coil induces an electromotive force (e.m.f.) across it</u>. If the secondary coil is part of a <u>closed circuit</u>, this e.m.f. drives a current through the circuit.	B1 B1 B1
(b)	<u>Soft iron is easily magnetised and demagnetised</u>, while steel is harder to magnetised and retains its magnetism. Since the magnetic field in the primary coil is changing due to alternating current, the soft iron can <u>respond quickly</u> to the changing magnetic field in the transformer **OR** concentrates / intensifies magnetic flux	B1 B1
(c)(i)	Using Vs/Vp = Ns/Np If Vp = 240V (input voltage) Vs = (200/1200) × 240 Vs = 40 V	 A1

(ii)	Using efficiency = (Vs × Is)/(Vp × Ip) × 100 90 = (40 × 3)/(240 × Ip) × 100 90 = (120/240Ip) × 100 Ip = 0.56A Alternative: Power output = Vs × Is = 40 × 3 = 120W Power input = 120/0.9 = 133.33W Ip = 133.33/240 = 0.56A	 B1 B1 OR B1 B1
(iii)	In a step-down transformer, the secondary coil provides a lower voltage but higher current than the primary coil.	B1
	Thicker wire is used in the secondary coil to handle the larger current without overheating or reduces heat loss OR Reduce resistance as R is inversely related to area of the cable. (Larger A leads to lower R) and therefore minimise energy loss as heat (since power loss = I^2R)	B1