

Pure Physics 6091 – Set III

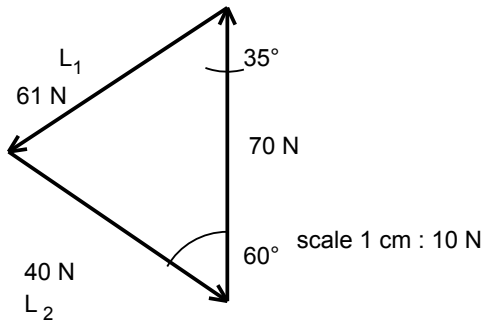
Answer Key

Compiled from the worked script: the paper carries no separate marking scheme, so each answer below is taken from the answer written into its answer space, with the mark allocation shown on the paper.

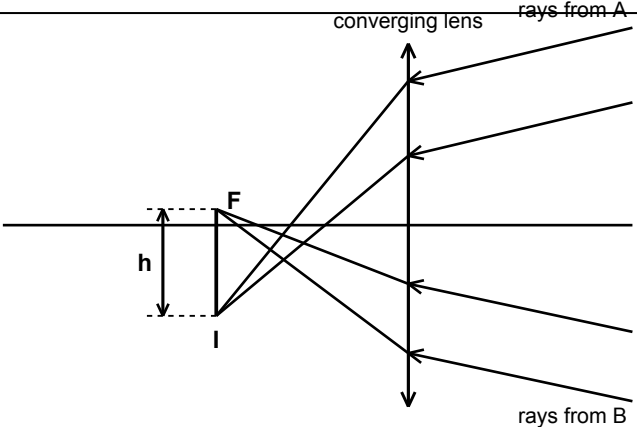
Paper 1

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

Paper 2 – Section A

Qn		Answer	Marks
1	(a)	acceleration = 10 m/s^2	[1]
	(b)	From 0 to 40 s, object is moving downwards with a <u>decreasing acceleration</u> . [1] From 40 to 60 s, object is moving downwards with a <u>constant velocity</u> of 40 m/s. [1] From 60 to 80 s, object is moving <u>upwards</u> [1] with a <u>decreasing deceleration</u> [1]	[4]
	(c)	Energy is transferred from the gravitational potential store of the object [1] to the internal stores of the surrounding and the object. [1]	[2]
	(d)	Max air resistance = weight = $9.0 \times 10 = 90 \text{ N}$ [1]	[1]
2	(a)	 diagram [1], scale [1] force in $L_1 = 61 \text{ N}$ [1], force in $L_2 = 40 \text{ N}$ [1]	[4]
	(b)	70 N [1] Vertically up [1]	[2]
	(c)	Tension in L_1 decreases and tension in L_2 increases. [1] Their magnitudes are equal. [1]	[2]

3	(a)	Taking moment about the elbow joint, Sum of anti-clockwise moment = sum of clockwise moment $F_M \times 0.051 = 22 \times (0.089 + 0.051) + 0.2 \times 0.330$ [1] $F_M = 61.6863 \text{ N} \approx \mathbf{61.7 \text{ N}}$ (3sf) [1]	[2]
	(b)	Sum of upward forces = sum of downward forces $61.6863 = 22 + 0.2 + F$ [1] $F = \mathbf{39.5 \text{ N}}$ (3sf) [1] direction is downwards [1]	[3]
4	(a)(i)	$P_{\text{atm}} = h\rho g + P_P$ $= (0.70 \text{ m})(13600 \text{ kg m}^{-3})(10 \text{ N kg}^{-1}) + 16800 \text{ Pa}$ [1] $= \mathbf{112000 \text{ Pa}}$ [1]	[2]
	(a)(ii)	$P_{\text{atm}} = h\rho g + P_Q$ $112000 \text{ Pa} = (0.55 \text{ m})(13600 \text{ kg m}^{-3})(10 \text{ N kg}^{-1}) + P_Q$ [1] $P_Q = \mathbf{37200 \text{ Pa}}$ [1]	[2]
	(b)	New level drawn at the same vertical height as before. [1] Liquid pressure depends only on the vertical height of the liquid column above it and not the geometry of the liquid column. [1]	[2]
5	(a)	Energy is transferred from the water internal store to the copper pipe internal store by conduction [1] and then from the copper pipe internal store to the coolant internal store by conduction. [1]	[2]
	(b)	The water near the copper pipe is cooled, it contracts, becomes denser and sinks to the bottom of the tank. [1] The warmer water at the bottom, being less dense rises to top to be cooled by the refrigerator unit. This sets up a convection current in the tank. [1]	[2]
	(c)	The polished aluminium tank is good reflector / poor absorber of infra-red radiation. It reduces energy gain from the surrounding by infra-red radiation. [1]	[1]
6	(a)	Particles A–J marked at their $t = 1 \text{ s}$ positions, read off the displacement–position graph. [1]	[1]
	(b)(i)	particle(s) C and G [1]	[1]
	(b)(ii)	particle(s) A, E and I [1]	[1]
	(c)	$T = \lambda / v$ $= (4/100) / 340$ [1] $= \mathbf{1.18 \times 10^{-4} \text{ s}}$ [1] OR use $v = f \lambda$ and $T = 1/f$	[2]

7	(a)	 Rays from A completed to converge at I; rays from B completed to converge in the same focal plane. [2]	[2]
	(b)	Height of image marked h between the two converged points, and the principal focal point marked F on the axis. [2]	[2]
8	(a)	Type I : ultraviolet radiation Type II : visible light Type III : infrared radiation 2 correct [1], all correct [2]	[2]
	(b)	All the brands can be used in vacuum [1] as all electromagnetic waves can travel in vacuum. [1]	[2]
9	(a)	Arrow labelled C drawn at A pointing to the left . [1]	[1]
	(b)	Arrow labelled F drawn at B pointing downwards . [1]	[1]
	(c)	Using Fleming's Left-Hand rule, the fore finger which indicates magnetic field, points to the left. [1] The middle finger which indicates conventional current (flow of positive charges), points perpendicularly out of the plane of the paper and the thumb which indicates the force, points down. [1]	[2]
10	(a)	The energy needed to change unit mass of substance from liquid to gas (or vice versa) without a change in temperature. [1]	[1]
	(b)(i)	energy supplied = Pt $= 100 \times (80-30)(60)$ [1] $= 3.0 \times 10^5 \text{ J}$ [1]	[2]
	(b)(ii)	Energy supplied by heater = energy gained by liquid Q + energy transferred to surrounding $3.0 \times 10^5 = mc\Delta\theta + Pt$ [1] $3.0 \times 10^5 = [(976 - 100)/1000](c)(100-20) + 60\,000$ [1] $c = 3424.66 \text{ J/(kg } ^\circ\text{C)}$ $= 3420 \text{ J/(kg } ^\circ\text{C)}$ (3sf) [1]	[3]
	(b)(iii)	The calculated value is higher than the actual value. [1] Part of the energy from the heater is transferred to the container, thus less energy is transferred to the liquid. The actual value of c for Q is lower than the above calculated value. [1]	[2]
	(c)(i)	energy needed to boil = m/v $= [(976 - 960)/1000](330 \times 10^3) = 5.28 \times 10^3 \text{ J}$ [1]	[1]

	(c)(ii)	Any one: - The humidity in the room is high - Liquid Q has low volatility - Small exposed surface area - Lack of air flow / wind	[1]
11	(a)	Alpha-particles cannot penetrate through the cardboard and the detector will not measure any count. [1] Gamma radiation penetrates through the cardboard easily, so the detector will not measure any difference in counts regardless of the cardboard thickness. [1]	[2]
	(b)(i)	time between emissions is unpredictable or emission can occur at any time / in any direction [1]	[1]
	(b)(ii)	${}^{90}_{38}\text{Sr} \rightarrow {}^{90}_{39}\text{Y} + {}^0_{-1}\beta$	[1]
	(b)(iii)	beta-particle is an electron [1] Sr nucleus contains 52 neutrons and 38 protons and Y 51 neutrons and 39 protons [1]	[2]
	(c)(i)	source dangerous for a long time / after the apparatus is scrapped / out of use or the activity of this source would be low [1]	[1]
	(c)(ii)	any attempt at halving e.g. 160 000 $\rightarrow$ 80 000 or 3 half-lives seen [1] 20 000 [1]	[2]

Section B

12	(a)(i)	The graph is linear at low voltages as the bulbs have constant resistance. [1] As the potential difference increases, the temperature of the bulb increases causing the resistance to increase, thus the V-I becomes a curve with increasing gradient. [1]	[2]
	(a)(ii)	Resistance of A = $3 / 0.3 = 10 \text{ ohm}$ [1] Resistance of B = $3 / 0.5 = 6 \text{ ohm}$ [1]	[2]
	(b)(i)	$R / (R + 100) \times (6) = 3.5$ [1] $R = 140 \Omega$ [1]	[2]
	(b)(ii)	When the switch is closed, the total resistance connected in parallel will be less than the original R value. [1] The ratio of the effective resistance R and the bulb to the total resistance decreases and thus the voltage reading will drop. [1]	[2]
	(b)(iii)	The 100 ohm resistor should be replaced by a NTC thermistor . [1] As temperature increase, the thermistor's resistance decreases which increase the potential difference across the bulb leading to its lighting up. [1]	[2]
13	(a)(i)	The primary coil alternating current causes a changing magnetic flux to cut the secondary coil, which induces an emf in the secondary coil. [1]	[1]
	(a)(ii)	Faraday's Law states that the magnitude of the emf induced is proportional to the rate of change of magnetic flux. When the number of turns are reduced, the amount of magnetic flux cutting the coil is reduced. [1]	[1]
	(a)(iii)	N pole formed at X. [1] Lenz's Law states that the emf generated in the secondary coil would be in a direction to oppose the magnetic field from the primary coil that is causing the emf induction. [1]	[2]

	(b)(i)	The voltage transmitted is high so that the current flowing through the power cables is small [1]. As a result, the energy lost due to the resistance of the cable is reduced. [1]	[2]
	(b)(ii)	Current $I_s = P / V$ $= 400\,000 / 250$ $= \mathbf{1600\,A}$ [1] $P_{in} = P_{out}$ $V_p I_p = 400\,000$ $I_p = 400\,000 / 10\,000 = \mathbf{40\,A}$ [1]	[2]
	(b)(iii)	Power loss $= I^2 R = 40^2 \times 25 = 40\,000\,W$ $= \mathbf{40\,kW}$ [1] Power input from station $= 400 + 40$ $= \mathbf{440\,kW}$ [1]	[2]