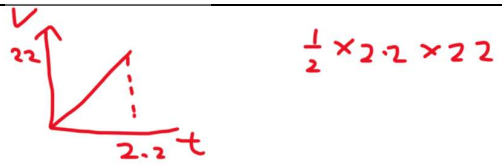
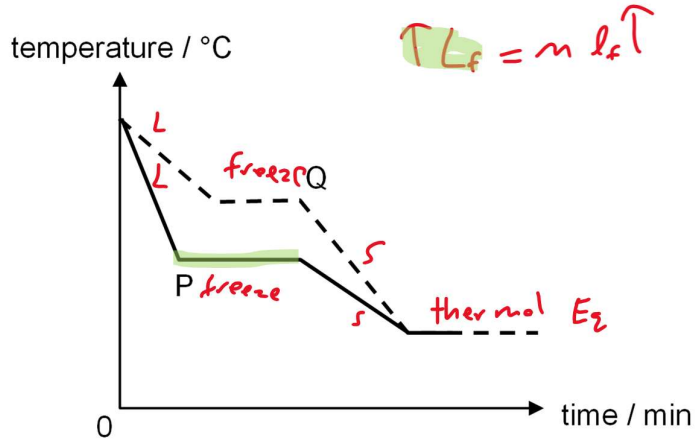
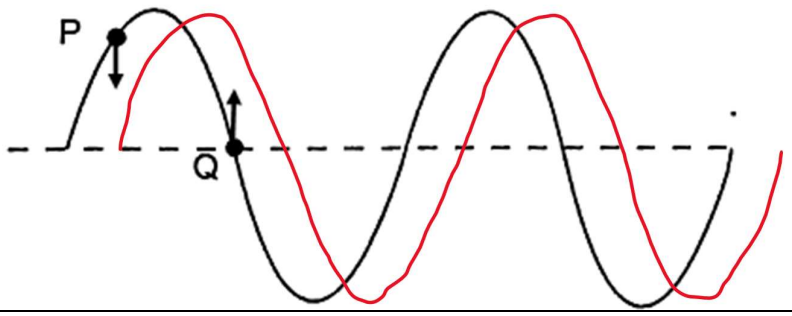
2024 O-Level Prelim Physics 6091/01 Solution [40m]

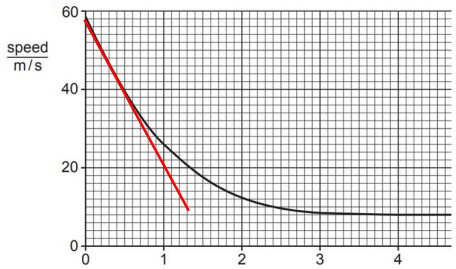
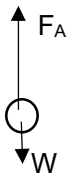
1	D	2	B	3	D	4	B	5	B	6	B	7	A	8	C	9	C	10	C
11	C	12	C	13	B	14	B	15	D	16	A	17	B	18	D	19	D	20	C
21	B	22	C	23	B	24	D	25	B	26	A	27	A	28	D	29	D	30	D
31	A	32	B	33	B	34	C	35	C	36	B	37	D	38	B	39	B	40	C

5	B	 $\frac{1}{2} \times 2.2 \times 22$
11	C	Taking pivot at F, 50 W = 75 P P = 50/75 W = 2/3 W
12	C	Volume of shaded = 1 cm^3 Mass of shaded = 6 g Volume of unshaded = 2 cm^3 Mass of unshaded = 18 g Total mass/total volume = 24/3
14	B	Change of volume is constant 6x = 1 (0.8)
20	C	 $\uparrow L_f = m l_f \uparrow$
22	C	
23	B	Refraction takes place. $N_{water} > N_{air}$

		$V_{water}<V_{air}$ Frequency no change.
24	D	v = 2d/t 1500 = 12000/t t = 8.00 s (time for pulse emit and receive) 8 + 2 = 10.0 s
26	A	v=fλ f low, then λ is high
32	B	W = QV = 90 x 3 x 10^{10}

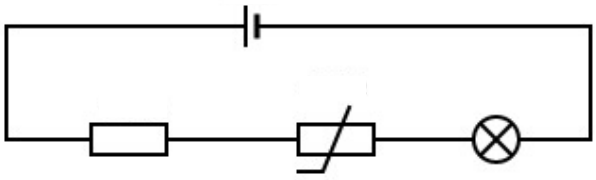
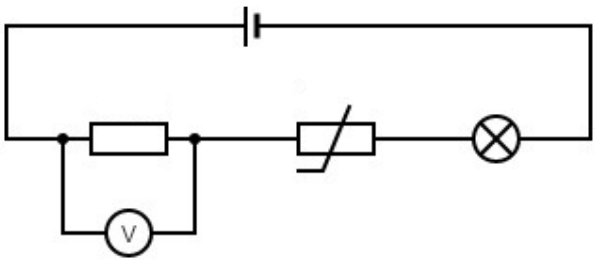
12024 O-Level Prelim Physics 6091/02 Solution [80m]

Section A: Answer All Questions (50 + 10 (LQ) + 10 (Data) Marks)

1	ai	$a = \frac{\Delta v}{\Delta t}$ or $a \frac{v-u}{t}$ (2 points to be as wide as possible) or (58 – 50) / 0.20 (if lenient) any value from 35.0 to 43.0 m/s^2 (3sf + SI unit) $a = \frac{v}{t}$ *means 1 point divided by 1 point. It is a wrong formula to use.*  	1 1
	aii	Taking upward resultant force as positive, $F_R = F_A – W$ 1m for F_R = ma ma = F_A – mg F_A = ma + mg = 76 x 40 + 76 x 10 and (students to transfer a from 1ai correctly) = 3800 N  	1 1 1
	b	(deceleration because) upward force greater than weight or upward resultant force air resistance decreases (with decreasing speed / with time) or deceleration decreases or resultant (upward) force decreases B (until / finally) weight equals air resistance or forces balance or at terminal / constant velocity / speed	1 1 1

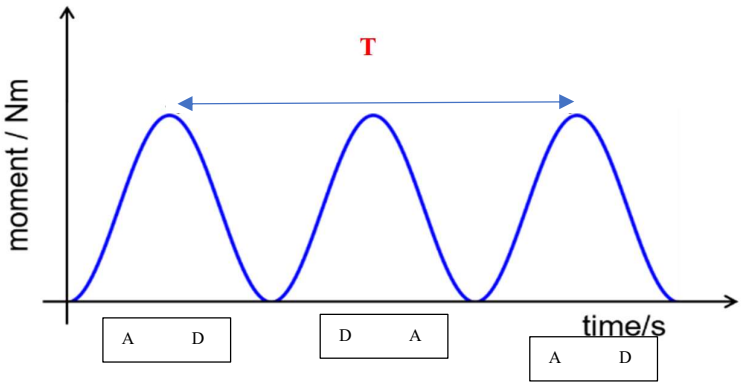
2	ai	Since gravitational field strength decreases as object moves further from the planet, OR and because gravitational field strength is the greatest when Pluto is at X and AND therefore, speed decreases from X to Y. As gravitational field strength increases as Pluto moves from Y to X, therefore speed increases from Y to X	1 1
	aii	Since energy cannot be created or destroyed or energy can be transferred to one energy store to another, and because **some** energy in the gravitational potential store is transferred to kinetic store as Pluto moves from Y to X, therefore speed increases when Pluto moves from Y to X.	1 1
	b	(white surface) is a poor absorber / good reflector / poor emitter of IR / **radiation** OR black / other surface is a good absorber / poor reflector / good emitter of IR / **radiation** any one from: • (the white surface) increases in temperature **less** when facing the Sun • (the white surface) decreases in temperature **less** when facing away (from Sun) • the black / other surfaces increases in temperature **more** when facing the Sun • the black / other surface decreases in temperature **more** when facing away	1 1
3	a	Since pressure is force per unit area, and because, the person is spread over a greater contact area therefore, the pressure is lower or ice is less likely to crack	1 1 1
	b	P (due to water) = ρgh OR = 1000 $\times$ 10 $\times$ 0.45 = 4500 Pa $P = \frac{F}{A} = \frac{mg}{A}$ OR $= \frac{690 \times 10}{5}$ =1380 Pa P (due to X) = 4500 + 1380 = 5880 Pa	1 1 1
	ai	E = mc $\Delta\theta$ = 0.6 x 4200 x (21.5 – 19) = 6300 J	1 1
	aii	E = Pt = 13 x 500 = 6500 J $\text{Efficiency (light)} = \frac{\text{Useful energy output}}{\text{total energy input}} \text{x } 100\%$ $= \frac{6500 - 6300}{6500} \text{ x } 100\%$	 1 1

		= 3.08 % (3sf) or 3.1 % (2 sf)	1
	b	any one from: • temperature change is an underestimate due to thermal energy transferring out of the system • thermal energy is transferred from the water to internal store of the surrounding • energy (other than light) transferred in lamp (filament / glass / internal structure) • (some) water evaporates	1
5	a	Since the angle of incidence is greater than the critical angle, and because, the light from the optically denser medium to optically less dense medium / glass windscreen to air therefore, the infrared light undergoes total internal reflection	1 1
	bi	The glass windscreen is the optically denser medium as it bends away from the normal as the infrared light leaves.	1
	bii	n=sin r / sin i = sin 62/ sin 47 = 1.21	1 1
	c	As the detectors received less percentage of infrared light reflected, means that there are more raindrops on the windscreen. The speed of the windscreen wipers will increase.	1
6	a	Electric field is a region in which an electric charge experiences an **electrostatic/electric** force.	1
	b	**(i)** the beam of uncharged particles deflects upwards and is attracted to the positively charged plate. **(ii)** the beam of electromagnetic wave continues undeflected in a straight line.	2
	c	Since the gamma wave do not have a charge / no affected by electrical field, and because it does not attract to the plate, therefore it continues moving along a straight line. Since the negative charges will be **induced** to the (upper) side closer to the positively charged place, and because opposite charges attract, therefore the particles are attracted/move towards to the plate.	1 1

7	ai	all circuit symbols correct for resistor, thermistor, a filament lamp and a power supply four components joined in series 	1 1
	aii	voltmeter connected in parallel to the resistor  	1
	aiii	current through resistor when p.d. across it is 6.0 V = 0.4 A Since this is a series circuit, 0.4 A flows through thermistor and bulb p.d. across filament lamp = 3.0 V AND p.d. across thermistor = 9.0 V p.d. across terminals of power supply = 6 + 3 + 9 = 18.0 V (3sf) or 18 V (2sf)	1 1 1
	b	any sensible use requiring temperature control or depending on temperature, e.g. fire alarms, to keep computers cool (by operating fan), in incubators, electronic thermometer, electronic thermostat in kettle / car engine	1
8	a	**12 V**	1
	b	R_{40cm} = 10 x 0.4 = 4 Ω R_{eff} = 6 + 4 + 5 = 15 Ω I = V / R = 12/15 = 0.80 A p.d across resistance wire = IR = 0.8 x 4 = 3.20 V (no deduction for no formula)	 1 1 1
	c	Since effective resistance decreases (due to 3 Ω and 6 Ω arranged in parallel), and because current flowing through battery increases therefore ammeter reading increases. And because current flowing through XJ increase and V = IR Therefore voltmeter reading increases OR And because using potential divider formula, when combined resistance of 3 Ω and 6 Ω is less than resistance of XJ Therefore voltmeter reading increases 1m for ammeter and voltmeter reading increases 1m for ammeter explanation 1m for voltmeter explanation	1 1 1

9	a	<table><tr><th></th><th>yes</th><th>no</th><th>it is not possible to tell</th></tr><tr><td>an alpha-particle $^{4}_{2}He$ is emitted</td><td></td><td>✓</td><td></td></tr><tr><td>a beta-particle $^{0}_{-1}e$ is emitted</td><td>✓</td><td></td><td></td></tr><tr><td>a gamma ray $^{0}_{0}\gamma$ is emitted</td><td></td><td></td><td>✓</td></tr></table> 2 for 3 correct OR 1 for 1 correct	1 1 (gamma)
	bi	(count that is) always present or due to the environment / surroundings or not deliberately introduced or not being tested any one from: rock sources (e.g. benches, building materials, human body, Earth crust) air sources (e.g. radon) cosmic sources (e.g. Sun, space)	1 1
	bii	use tongs / tweezers / forceps or wear lead(-lined) clothing / lead(-lined) gloves or wear goggles or reduce time of exposure or keep distance of separation large	1
	biii	(radioactive) emission is a random process / occurs at random intervals measurements fluctuate (about an average value)	1
	biv	(coordinates of) two points from curve, e.g. (0, 58) and (70, 29) (coordinates of) two points from curve and at least two half-lives apart, e.g. (0, 58) and (138, 14.5) or 64.0 ⩽ τ ⩽ 74.0 66.0 s ⩽ τ ⩽ 73.5 s	1 1
	bv	(large half-life because of) slow rate of decay radiation / count rate due to $^{234}_{92}\mathrm{U}$ (uranium) is imperceptible / very much less than that of $^{234}_{91}\mathrm{Pa}$ or (nearly) all of measured radiation / count rate due to $^{234}_{91}\mathrm{Pa}$	1 1
10	a	The current through filament 2 does not increase proportionally with the p.d. Thus it does not obey Ohm's law.	1 1
	bi	R1= V / I = 12 / 0.50 = 24 Ω or R2 = 12 / 2 = 6.0 Ω Total resistance = $[1/24 + 1/6]^{-1}$ = 4.8 Ω no formula mark	1 1
	bii	The two filaments have different cross-sectional area and hence resistance is different. (reject resistivity and length as they are stated to be the same in the qn) Using V = IR, current through the filaments are different although the p.d. is the same	1 1
	c	Since lower power is required for a dimmer light, and because filament 1 dissipates a lower power therefore, filament 1 serves as a tail light	 1 1
	d	From table: $I = I_1 + I_2$ = 0.450 + 1.825 = 2.275 A R = V / I = (12 – 8) / 2.275 = 1.76 Ω	1 1

Section B: (10 Marks)			
11	a	Since a.c results in a changing magnetic field at the transmitter coil, and because there is a rate of change of magnetic flux linkage between the receiver coil and the transmitter coil	1 1

		therefore, current is induced at the receiver coil	1
	b	Since soft Iron Core concentrates magnetic field at the transmitter coil and because there is a Greater rate of change of magnetic flux linkage with receiver coil therefore this improves the efficiency of charging the battery.	1 1
	c	Since a.c is induced and because, a.c had direction of current changing at a frequency, therefore, this causes the battery to charge and discharge	1
	di	Turns ratio = $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ turns ratio = 3.7/230 = 0.0161 (3sf + no unit) or 0.016 (2sf + no unit)	1 1
	dii	Energy usage in a month = 0.012 kW × 2 h × 30 = 0.72 kW h Cost = 0.72 kW h × 24.2 ¢ = 17 ¢ or 17.4 ¢ or \$0.17 or \$0.174	 1 1
12	a	the current in the coil creates a magnetic field around the coil, so the magnetic field of the coil interacts with the permanent magnetic field of the magnets, producing a force.	1 1
	b	short circuit or no current in coil	1
	c	Moment of a force about a pivot is the product of the force and the perpendicualr distance from the pivot to the line of action of the force.	1
	d	Moment = F x d x 2 = 3.0 N × (0.065 m ÷ 2) x 2 or 3.0 N × 0.065 m = 0.195 Nm (3sf + SI unit)	1 1
	e	Moment is the largest because it has the largest perpendicular distance between the forces to the axis when the coil is horizontal.	1
	fi		1
	fii	There is induced e.m.f. as the coil continues to rotate for some time due to inertia.	2