

Pure Physics 6091 – Set II
Marking Scheme

Paper One (MCQ)

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

Paper Two – Section A

(Note: All answers must be given in 2/3 s.f. and with correct unit)

1.	(a)	The positive velocity indicates that the bungee jumper is travelling downwards, while the negative velocity shows that he is travelling upwards. or They indicate that the bungee jumper is traveling in the opposite directions.	[1]
	(b)	a = $(v - u) / t$ = $(14 - 0) / 1.4$ = 10 m/s^2	[1] formula / working [1]
	(c)	4.0 s	[1]
	(di)	<u>Tension</u> (in the cord) and <u>weight</u> (of the man)	[1] both answers
	(dii)	- The <u>tension in the cord is larger than the weight of the man</u>. - Thus, there is a <u>resultant upwards force</u> acting on the man and he accelerates upwards at position D.	[1] [1]
			Total: 7

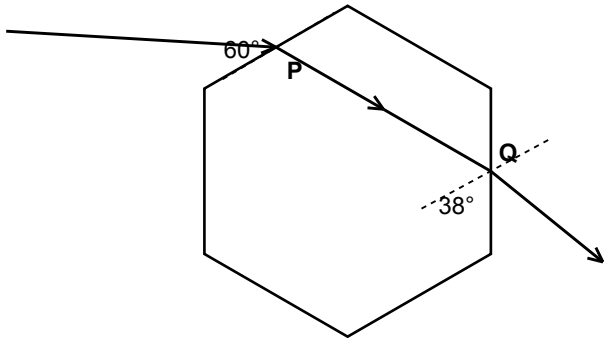
2.		12 kN (3 cm) 36 kN (9 cm) Resultant force = 38 kN (9.5 cm) • Appropriate scale (e.g. 1 cm : 4000 N) <u>and</u> vector diagram showing 12 kN, 36 kN and resultant force in correct directions (with arrows). • Resultant force = 9.5 cm x 4000 = 38 000 N $\pm$ 1000 N • Angle = $18^\circ \pm 2^\circ$	[1] [1] [1]
			Total: 3
3.	(a)	• Feature: The box is made of expanded polystyrene which has pockets of trapped air. • Explanation: Air is a poor thermal conductor, thus minimising heat transfer into the box by conduction. • Feature: The cold pack attached to the cover will cool the air near the top of the box. • Explanation: Cold air sinks due to convection and will effectively cool the interior of the box. • Feature: The cover serves as a lid for the box. • Explanation: This minimises the heat transfer by the warm surrounding air via conduction or radiation.	[4] any 2 features & explanation
	(b)	The exterior of the box may be wrapped with aluminium foil. (Accept any other reasonable suggestions)	[1]
			Total: 5
4.	(ai)	Ultrasound is sound with frequencies above the upper limit of the human audible range / above 20 kHz.	[1]
	(aii)	2 x distance = speed x time distance = $\frac{1}{2} \times (1500) \times (0.03 \times 10^{-3})$ = 0.0225 m	[1] formula / working [1]
	(bi)	f = v / λ = $3.0 \times 10^8 / 2.0 \times 10^{-3}$ = 1.5×10^{11} Hz	[1] formula / working / speed [1]
	(bii)	Excessive exposure to X-rays can cause mutation / cancer / kill cells.	[1]
			Total: 6

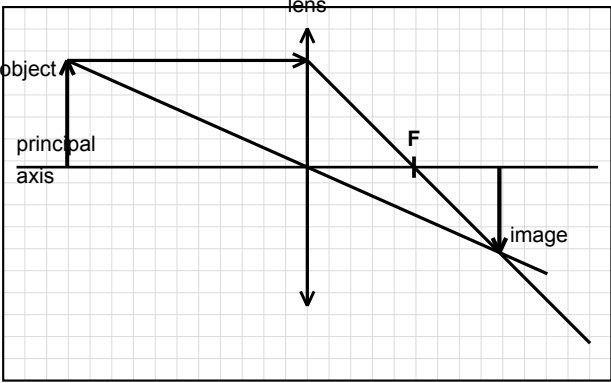
5.	(a)	V_s $= (V_p N_s / N_p)$ $= 25 \times 44000 / 4000$ $= 275 \text{ kV}$ $I_p V_p = I_s V_s$ $100 \times 10^6 = I_s \times 275000$ $I_s = 363.6$ $= 364 \text{ A (3 s.f.)}$	[1] formula / working [1] formula / working [1]
	(b)	Electrical power is transmitted at a <u>high voltage</u> so that the transmission <u>current will be low</u>. This <u>reduces power loss</u> ($I^2 R$) in the transmission cables.	[1]
	(c)	$P_{\text{loss}} = I^2 R = 20 \% \times 100 \text{ MW}$ $= 363.6^2 \times R$ $R = 151.3$ $= 151 \Omega \text{ (3 sf)}$	[1] ecf [1] ecf
			Total: 6
6.	(a)	The metal sphere will be positively charged.	[1]
	(b)	- Once released, the positively charged metal sphere will be <u>attracted</u> to the negatively charged plate Y since <u>unlike charges attract</u> and <u>like charges repel</u>. - Upon touching plate Y, the <u>negative charges from plate Y</u> will flow into the sphere. The sphere will become <u>negatively charged</u>. - The sphere will then swing towards plate X as it is repelled by plate Y since <u>like charges repel</u>. This process repeats.	[1] [1] [1]
			Total: 4
7.	(a)	- As the metal bar moves upwards, it cuts the magnetic field lines <u>or</u> there is a change in magnetic flux. - An emf or current is thus induced in the circuit.	[1] [1]
	(b)	When the bar is moved upwards, according to Lenz's Law, a <u>downward force</u> will be produced to oppose this movement. This opposing force is caused by the direction of the induced current.	[1]
	(c)	downwards: small <u>negative reading</u> to the right: <u>no reading</u>	[1] [1]
	(d)	Move the bar at a faster rate / use a wider magnet.	[1] any one
			Total: 6
8.	(a)	I $= V / R$ $= 240 / 60$ $= 4.0 \text{ A}$ Live = 4.0 A; Neutral = 4.0 A; Earth = 0 A	[1] formula / working [1] ecf
	(b)	The fuse will be overheated, melts and opens the circuit when the current exceeds the specified value.	[1]
	(c)	This ensures that the earth wire will redirect the current safely to the ground if the metal casing becomes "live" due to any fault in the wiring.	[1]

	(d)	P $= I \times V$ $= 4 \times 240$ $= 960 \text{ W}$ $= 0.96 \text{ kW}$ $45 \text{ minutes} = 0.75 \text{ h}$ $E = P t$ $= 0.96 \times 0.75$ $= 0.72 \text{ kWh}$ Monthly cost $= 0.72 \times \$0.20 \times 30$ $= \$4.32$	[1] formula / working for $P = IV$ [1] formula / working for $E = Pt$ / ecf [1] ecf
			Total: 7
9.	(ai)	Isotopes are atoms of the same element with different numbers of neutrons but the same number of protons and electrons	[1]
	(aii)	T and Q <u>or</u> U and R	[1]
	(b)	W: 218 X: 84 Y: 4 Z: 2	[1] all correct
	(ci)	electron / beta particle	[1]
	(cii)	R gains one more proton and loses one neutron or S has one more proton and one less neutron	[1] [1]
			Total: 6
10.	(a)	- The temperature difference between the substance and the freezer is decreasing. - The rate of heat loss from substance X to the surroundings is faster when it is at a higher temperature / slower when it is at a lower temperature.	[1] [1]
	(b)	- During cooling, the speed of the molecules decreases, thus there is a decrease in their energy in the kinetic store. - The energy in the potential store of the particles decreases as the average separation of the particles decreases.	[1] [1]
	(ci)	- Energy is transferred out of the liquid and the energy in the potential store of the molecules decreases to form intermolecular bonds. - The energy in the kinetic store remains constant and therefore temperature does not change.	[1] [1]
	(cii)	Q $= m/$ $= (0.045) \times (5.7 \times 10^4)$ $= 2565$ $= 2570 \text{ J}$	[1] formula / working [1]

	(ciii)	P $= Q / t$ $= 2570 / 7200$ $= 0.3569$ $= 0.357 \text{ J/s or } 0.357 \text{ W (3 sf)}$ or P $= Q / t$ $= 2565 / 7200$ $= 0.35625$ $= 0.356 \text{ W (3 sf)}$	[1] ecf
	(d)	The specific heat capacity of X in its liquid state is lower than that of its solid state.	[1]
			Total: 10
11.	(a)	The emf of the battery is of a constant positive value, while the a.c. supply changes direction / magnitude.	[1]
	(bi)	R_{total} $= R_1 + R_2$ $= 20 + 28$ $= 48 \Omega$ I $= V / R_{\text{total}}$ $= 12 / 48$ $= 0.25 \text{ A}$	[1] formula / working for R_{total} [1]
	(bii)	- The current carrying wire YZ produces a magnetic field which - interacts with the magnetic field between the poles of the magnet which causes YZ to experience a force.	[1] [1]
	(biii)		[1]
	(ci)	R_{total} $= 28 + (1/30 + 1/20)^{-1}$ $= 28 + 12$ $= 40 \Omega$	[1] formula / working [1] ecf
	(cii)	- The force on YZ increases - as the total resistance of the circuit now decreases, causing the current flowing through YZ to increase.	[1] [1]
			Total: 10

Section B

12.	(a)	Oil (liquids) are incompressible.	[1]
	(bi)	Pressure is the force acting per unit area.	[1]
	(bii)	P_{oil} $= F / A$ $= 4500 / 0.018$ $= 250\,000 \text{ Pa}$	[1] formula / working [1]
	(biii)	F $= P \times A$ $= 250\,000 \times 1.4$ $= 350\,000 \text{ N}$	[1] ecf
	(ci)	The pressure in the oil (liquid) increases with depth. or The weight of the oil that is above piston Y increases as the piston moves downwards.	[1]
	(cii)	Increase in P $= \rho gh$ $= 0.50 \times 900 \times 10$ $= 4500 \text{ Pa}$	[1] formula / working [1]
	(d)	- As the waste is compressed, volume of trapped air decreases. - Frequency of collisions between the air molecules and the walls of the plastic bag/container increases, thus increasing the pressure of the trapped air.	[1] [1]
			Total: 10
13.	(ai)	$n = \sin i / \sin r$ $1.42 = \sin 30^\circ / \sin r$ $1 \times \sin 30^\circ = 1.42 \times \sin r$ $r = 20.616^\circ$ $= 20.6^\circ \text{ (3 sf)}$	[1] formula / working [1]
	(aii)	The critical angle is the angle of incidence in the optically denser medium for which the angle of refraction in the optically less dense medium is 90° .	[1]
	(aiii)	$n = 1 / \sin c$ $1.42 = 1 / \sin c$ $c = \sin^{-1} (1/1.42)$ $= 44.766^\circ$ $= 44.8^\circ \text{ (3 sf)}$	[1] [1]
	(aiv)		[1] ray bends away from normal

	(bi)	 The diagram shows a ray diagram for a convex lens on a grid. A vertical line with arrows at both ends is labeled 'lens'. A horizontal line is labeled 'principal axis'. A point 'F' is marked on the principal axis to the right of the lens. An 'object' is represented by an upward arrow on the principal axis to the left of the lens. An 'image' is represented by a downward arrow on the principal axis to the right of the lens. Two rays are drawn: one from the top of the object parallel to the principal axis that refracts through F, and another from the top of the object through the optical center of the lens that continues straight. The intersection of these rays is at the tip of the image arrow.	[1] complete given ray [1] construct rays to locate F [1] F
	(bii)	The image formed is <u>magnified, upright and virtual</u>	[1]
			Total: 10