

Section A

1	(a)	$F = ma$ $145000 - 40000 = 60000a$ $a = 105000 / 60000$ $= 1.75 \text{ m / s}^2$	[1] [1]
	(b)	$a = (v - u) / t$ $t = (v - u) / a$ $= (60 - 0) / 1.75$ $= 34.3 \text{ s or } 34 \text{ s}$	[1] [1]
	(c)	distance = $\frac{1}{2} \times 34.3 \times 60$ $= 1030 \text{ m}$	[1] [1]
	(d)	Air resistance increases as the speed of the aircraft increases. Thus, the total resistive forces acting against the aircraft will increase with its speed.	[1]
2	(a)	$W = mg$ $= 60 \times 10$ $= 600 \text{ N}$	[1] [1]
	(b)	When he pushes the floor, his body rises and <u>moves through a distance in the same direction as the force F</u> , hence work is done.	[1]
	(c)	Moment due to the weight about his toe = $600 \text{ N} \times 0.80 \text{ m}$ $= 480 \text{ Nm}$	[1] [1]
	(d)	By Principle of Moments, taking moments about his toes, $F \times 1.15 \text{ m} = 480$ $F = 417 \text{ N or } 420 \text{ N}$ total upward force = total downward force $F + R = W$ $417 + R = 480$ $R = 63 \text{ N or } 60 \text{ N}$	[1] [1] [1]
	(e)	The force exerted by the hand on the floor.	[1]
3	(a)	$F = \text{pressure} \times \text{area}$ $F = 1.2 \times 10^6 \times 5.0 \times 10^{-5}$ $= 60 \text{ N}$	[1] [1]

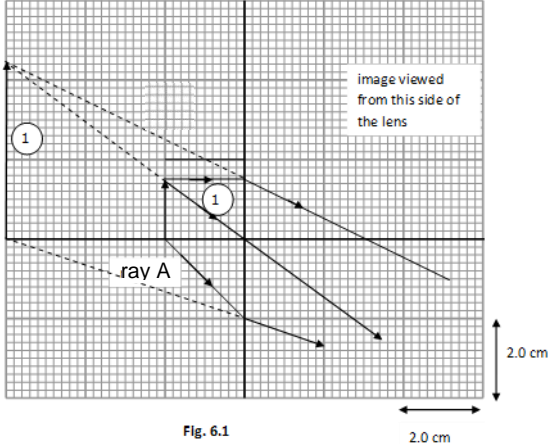
	(b)	Pressure in oil remains the same. ($F_1/A_1 = F_2/A_2$) There is a greater cross-sectional area at the brake pads. Thus a larger force will be applied.	[1] [1]
	(c)	Bubbles of air are highly compressible . Hence, some pressure is used to compress the bubbles and the pressure is not fully transferred to S .	[1] [1]
4	(a)	Air molecules are moving around randomly and at high speeds. They collide or hit the walls of the cylinder thus exerting a force on walls, resulting in pressure.	[1] [1]
	(b)	Molecules are now closer / spaced more compactly / more molecules per unit volume / less space to move. They collide more frequently with the wall of chamber, causing higher pressure	[1] [1]
5	(a)	Unlike charges attract. The negative charges on the teeth are <u>attracted to the positively charges on the plaque</u> .	[1]
	(b)(i)	When the hand is holding to the positively charged handle, the excess electrons on the tooth are attracted to the handle and neutralised. More electrons continue to be transferred to the handle due to the high positive charge. Since the teeth have more positive charges than negative charges , the teeth become positively charged.	[1] [1]
	(ii)	As opposite charges attract , the positively charged plaque is attracted to the negatively charged bristles of the toothbrush OR it is repelled by the positively charged teeth since like charges repel .	[1] [1] [1] [1]
	(c)	$Q = It$ $= 0.00015 \times 5 \times 60$ $= 0.045 \text{ C}$	[1] [1]
6	(a)(i)	$I = \frac{12}{8000}$ $I = 1.50 \times 10^{-3} \text{ A}$	[1] [1]
	(ii)	$V = 1.50 \times 10^{-3} \times 3300$ $V = 4.95 \text{ V}$	[1] [1]
	b	When brightness decreases, the resistance of LDR increases .	

		Since total resistance increases, the current flowing through the series circuit decreases . Since $V = RI$, potential difference across the fixed resistor decreases . Since e.m.f. is equal to the sum of p.d. across fixed resistor and p.d. across LDR, potential difference across LDR increases .	[1] [1]
7	(a)	X = Live wire Y = Neutral wire Z = Earth wire	[1]
	(b)	$P = V^2/R$ $R = V^2/P = 220^2/100 = 484 \Omega$ $I = V / R_{\text{total}}$ $= 220 / (484 \times 3)$ $= 0.15 \text{ A or } 0.152 \text{ A}$	[1] [1]
	(c)	When a fault occurs and causes the live wire to touch the metal casing the metal casing will be live . This is dangerous as anyone who contacts the metal casing will be electrocuted as there is no earth wire to provide a path of almost zero resistance for the current to flow to earth instead of to the user.	[1] [1]
8	(a)	$V_s = (44000 / 4000) \times (25 \times 10^3)$ $V_s = 275 \text{ kV or } 275\,000\text{V}$	[1] [1]
	(b)	$I_p V_p = I_s V_s$, $100 \times 10^6 = I_s \times 275\,000$ $I_s = 364 \text{ A (3 s.f.)}$	[1] [1]
	(c)	Electrical power is transmitted at a high voltage . The transmission current will be low . This reduces power loss due to heating effect (joule heating) in the transmission cables.	[1] [1]

Section B

9	(a)(i)	From the graph, when $f = 400 \text{ Hz}$, $\lambda = 1.4\text{-}1.6 \text{ m}$ at temperature 20°C , $v = f \lambda$	
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		$= 400 \times (1.4 \sim 1.6)$ or 400×1.5 $= 560 \sim 640 \text{ m / s}$ or 600 m / s	[1]
	(ii)	$\lambda = 3.6 \sim 3.9 \text{ m}$ at temperature 40°C $v = f \lambda$ $= 400 \times (3.6 \sim 3.9)$ or 400×3.8 $= 1440 \sim 1560 \text{ m / s}$ or 1520 m / s	[1]
	(b)	<p>The speed of sound increases as the temperature increases. This is due to a larger wavelength at higher temperature.</p> <p>Or</p> <p>The speed of sound increases as the temperature increases. At higher temperature, the water molecules have more kinetic energy and vibrate more vigorously, making it easier for the series of compressions and rarefactions to pass through.</p>	[1] [1] [1] [1]
	(c)(i)	Longitudinal	[1]
	(ii)	At constant temperature, frequency remains constant. Since the wavelength increases in deeper water, the speed increases in deeper water.	[1] [1] [1]
	(iii)	<p>Larger wavelength in deep water. Indicate wavelengths.</p>	[1] [1]
10	(a)(i)	<p>Ray 1: Since the angle of incidence is 0° (or along the normal), it emerges from the surface without refraction.</p> <p>Ray 2: It undergoes refraction as its angle of incidence is smaller than the critical angle.</p>	[1] [1]

		Ray 3: It undergoes total internal reflection as is angle of incidence is bigger than the critical angle .	[1]
	(ii)	$c = \sin^{-1}(1/1.33)$ $= 48.753$ $= 48.7^\circ$ or 49°	[1] [1]
	(b)(i)	A virtual image is an image that cannot be formed on a screen	[1]
	(ii)	 <p>Fig. 6.1</p>	[2]
	(iii)	focal length = 3.0 cm	[1]
	(iv)	ray A : see (ii)	[1]
11	(a)(i)	The nucleus has a different number of neutrons / mass number / nucleon number . It has the same number of protons / same atomic number .	[1]
	(ii)	It is not an isotope and Q has a different proton number / atomic number	[1]
	(b)i	technetium–99	[1]
	(b)ii	only gamma detected outside body EITHER half-life / 6 hours is short and less damage (to others / long term) / loses radioactivity quickly OR half-life / 6 hours is long enough for isotope to reach site and be detected / long enough to examine patient / does not need to be replaced	[1] [1]
	(c)i	any two from:	

		number of protons decreases by two number of neutrons decreases by two or number of nucleons decreases by four	[1] [1]
	(ii)	background radiation (detected) or source of background radiation mentioned (e.g. cosmic rays; radiation in the air)	[1]
	(iii)	alpha-particles are absorbed by the air (between the source and detector)	[1]
		alpha-particles travel less than 10 cm (in air)	[1]
12	(a)	When heated, the hot water expands, becomes less dense and rises . The colder, denser water at the top sinks to replace it, forming convection currents .	[1] [1] [1]
	(b)i	$P = IV$ $Q/t = IV$ Thermal energy, $Q = IVt$ $= (9.6)(230)(3.5 \times 60)$ $= (2\,208)(210)$ $= 463\,680$ $= 4.6 \times 10^5 \text{ J (2 s.f.)}$	[1] [1]
	ii	$Q = mc\Delta\theta$ $463\,680 = (1.6)(4200)(\Delta\theta)$ Change in temperature, $\Delta\theta = 69$ <i>Maximum possible temperature of water = $22 + 69 = 91^\circ\text{C}$ (2 s.f.)</i>	[1] [1]
	c	White colours are poor emitters of infrared radiation , hence there will be less heat loss to the surroundings .	[1]
	d	Thermal energy is used to do work to increase the potential energy of the molecules, so as to overcome the inter-molecular forces and separate the molecules far apart.	[1] [1]