Marking Scheme

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

Paper 1 Section A

Question No.	Key	Question No.	Key
1.	C (63)	26.	B (58)
2.	A (81)	27.	B (69)
3.	A (38)	28.	B (42)
4.	D (70)	29.	D (45)
5.	A (54)	30.	C (53)
6.	D (41)	31.	B (47)
7.	A (63)	32.	A (47)
8.	C (36)	33.	C (40)
9.	B (84)	34.	C (37)
10.	C (55)	35.	C (65)
11.	A (58)	36.	D (51)
12.	C (63)		
13.	D (67)		
14.	D (58)		
15.	B (73)		
16.	D (77)		
17.	B (78)		
18.	D (62)		
19.	A (76)		
20.	A (65)		
21.	A (40)		
22.	D (54)		
23.	C (61)		
24.	B (86)		
25.	B (49)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

Paper 1 Section B

Marks

1\. (a) $Q = m_s c_s \Delta T + m_s l_v$ — 1M+1M

$= 0.02\,(2000)(110 - 100) + 0.02\,(2260000)$

$= 400 + 45200$

$= 45600$ J — 1A — 3

(b) $m_m c_m \Delta T_m = Q + m_s c_w \Delta T_w$ — 1M

$0.2\,(3900)(T - 15) = 45600 + 0.02\,(4200)(100 - T)$

$T = 76.0$ °C — 1A — 2

(c) The actual temperature of frothy milk is lower than the value calculated in (b). — 1A
Because energy loss by the steam is also gained by the surroundings — 1A
including the air/the metallic jug that holds the milk. — 2

2\. (a) $p_1 V_1 = p_2 V_2$ (Or $p \propto \frac{1}{V}$) — 1M

$p_1(\frac{4}{3}\pi \times (0.8)^3) = (1.01 \times 10^5)(\frac{4}{3}\pi \times (1.0)^3)$

$p_1 = 1.97 \times 10^5$ Pa — 1A — 2

(b) Volume increases as bubble rises but the speed / k.e. — 1A
of gas molecules remains unchanged
therefore frequency of collision of molecules on — 1A
bubble's inner surface decreases, gas pressure decreases. — 2

3\. (a) (i) Friction f between the tyres and the road. — 1A

$f = \frac{mv^2}{r}$ — 1M

$8000 = \frac{1200\,v^2}{45\text{ m}}$

$v = 17.3$ m s^{-1} — 1A — 3

(ii) Smaller — 1A
For the same f, $v^2 \propto r$; when r decreases v decreases. — 1A — 2

(b) (Max) friction / coefficient of friction reduced, — 1A
not enough to provide the centripetal force / acceleration required for circular motion.
Or Tracking or allowed speed lowered. — 1A — 2

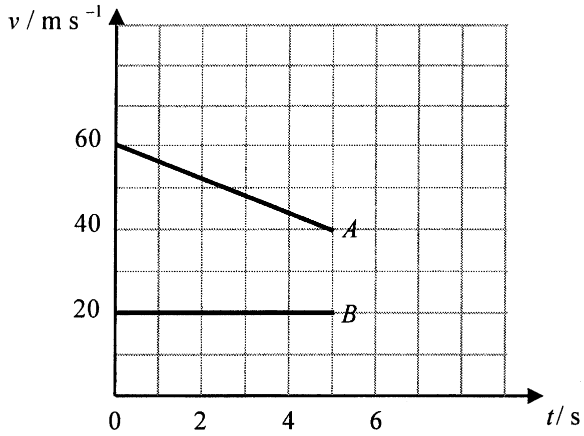
Marks

4. (a) (i) $v = u + at$

$= 60 + (-4)5$ — 1M

$= 40 \text{ m s}^{-1}$ — 1A — 2

(ii)



1A — 1

(iii) $s_A = \left(\frac{60 + 40}{2}\right)(5) = 250 \text{ m}$ — 1M

$s_B = (20)(5) = 100 \text{ m}$

$x = 250 - 100$ — 1M

$= 150 \text{ (m)}$ — 1A — 3

[equals to the area between the two graphs]

(b) (i) $m\,u_A + m\,u_B = (m + m)V$ — 1M

$40 + 20 = 2V$

$V = 30 \text{ m s}^{-1}$ — 1A — 2

(ii) $F = \frac{mV - mu_A}{\Delta t}$

$= (5000)\frac{(30 - 40)}{0.2}$ — 1M

$= -250000 \text{ N}$ — 1A

Impact force is opposite to the direction of travel of A (to the left / backwards / negative) — 1A — 3

Marks

5. (a) (i) Let T be the tension.

$2T\cos 75° = 60$ — 1M

$T = 115.9$ N — 1A — 2

(ii) energy stored in the string = k.e. of arrow — 1M

$= \frac{1}{2}(0.2)(45)^2$

$= 202.5$ J — 1A — 2

(b) (i) $d = v\cos 20°\, t$ — 1M

$60 = 45\cos 20°\, t$

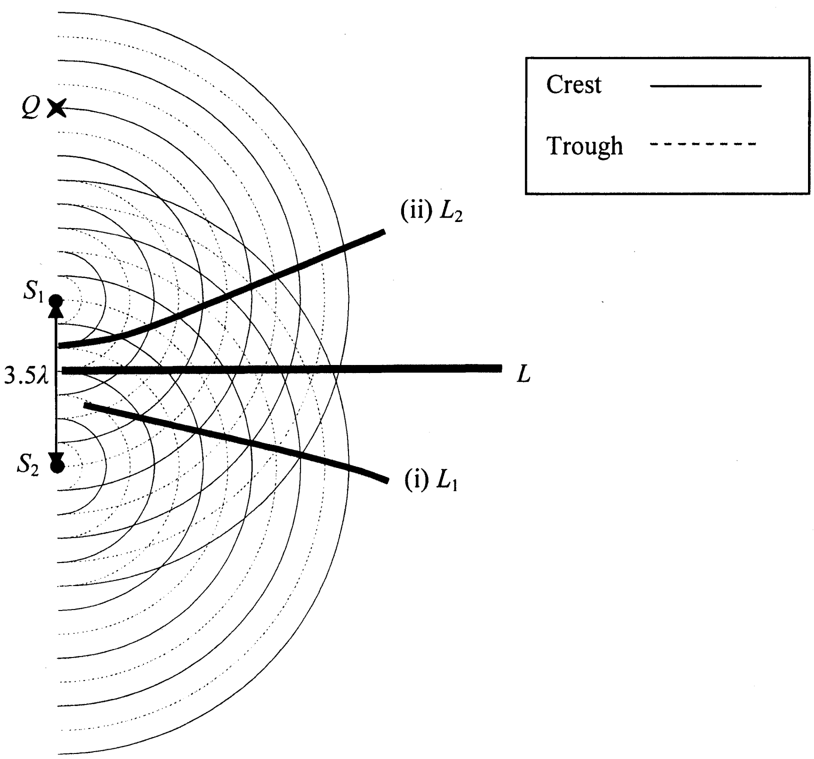
$t = 1.42$ s — 1A — 2

(ii) $h = 25 - \frac{1}{2}gt^2$ — 1M

$= 25 - \frac{1}{2}(9.81)(1.42)^2$

$= 15.1$ m [or $h = 14.9$ m] — 1A — 2

6. (a)

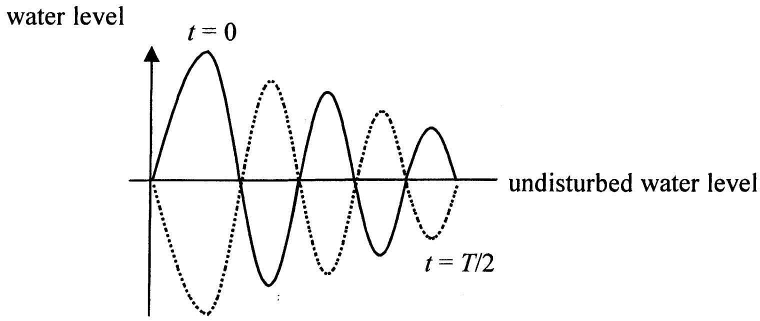


2A

L_1 / L_2 are further from L or separation of L /L_1 /L_2 is greater or angle between L /L_1 /L_2 larger. — 1A — 3

Marks

6. (b)



1A

1

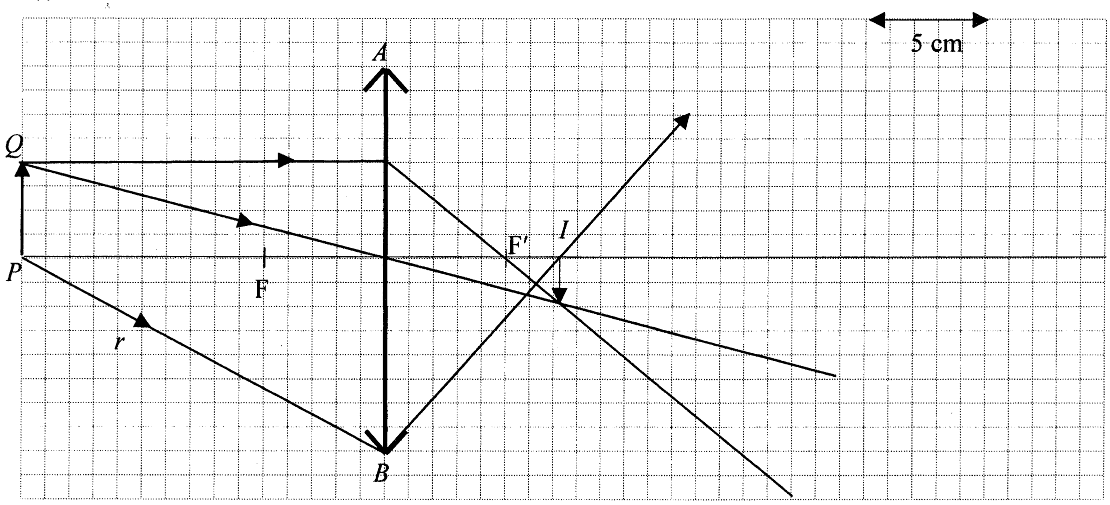
(c) The two waves are out of phase at Q as path difference = 3.5λ ($QS_1 = 4\lambda$ and $QS_2 = 7.5\lambda$), — 1M
destructive interference occurs. — 1A — 2

(d)

$$\Delta y = \frac{D\lambda}{a} = \frac{2.5 \times 550 \times 10^{-9}}{0.5 \times 10^{-3}}$$ — 1M

$= 2.75 \times 10^{-3}$ m — 1A — 2

7. (a) (i)



Two correct rays to find image I. — 2A
Nature: real, inverted, diminished. — 2A — 4

(ii) Ray r correctly completed. — 1A — 1

(b) (i) $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ $\qquad$ $\frac{1}{15} + \frac{1}{v} = \frac{1}{10}$ — 1M

$v = 30$ cm — 1A

$m = \frac{30}{15} = 2$ — 1A — 3

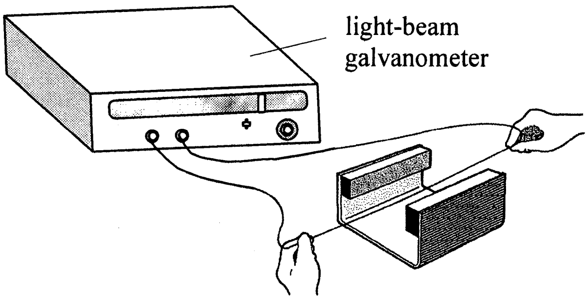
(ii) As the light energy collected by the lens is the same for both cases,
for (b)(i), an enlarged image ($u < v$),
same amount of light energy distributed over a larger image/intensity of light decreases as distance increases, — 1A
i.e. dimmer image for (b)(i) — 1A

Or for (a), a diminished image ($u > v$),
same amount of light energy distributed over a diminished image,
i.e. brighter image for (a) — 2

			Marks	
8.	(a)	Keeping warm / 88 W	1A	1
	(b)	$R_1 = \dfrac{V^2}{P} = \dfrac{220^2}{88}$	1M	
		$= 550\ \Omega$	1A	2
	(c)	Total current $I_0 = \dfrac{P_0}{V} = \dfrac{550}{220} = 2.5$ A **Or** Power to R_2, 550 W − 88 W = 462 W	1M	
		Current in R_1, $I_1 = \dfrac{220}{550} = 0.4$ A **Or** Current in R_2, $I_2 = \dfrac{P_2}{V} = \dfrac{462}{220}$	1M	
		Current in R_2, $I_2 = 2.5 - 0.4 = 2.1$ A **Or** $= 2.1$ A	1A	3
	(d)	Peak current = $\sqrt{2}$ (2.5 A)	1M	
		= 3.54 A	1A	2
9.	(a)	Humid conditions in bathrooms and water is a conductor which	1A	
		provides a conducting path or lowers the resistance between our hands/body and the source of electricity.	1A	2
	(b) (i)	The person will get electric shock because	1A	
		full potential drop 220 V is applied to or substantial/large current flows through the human body.	1A	2
	(ii)	The person will not get electric shock / Nothing happens because	1A	
		the current in secondary circuit has no return path/incomplete circuit.	1A	2
	(c)	Primary : Secondary = 2:1 for 110 V	1A	1

Marks

10. Diagram for set-up: 1A



1A
1A

Connect the long wire to the galvanometer./Connect the apparatus as shown.
Put/Place/Move the wire across the magnetic field between the pair of magnets.

ANY TWO @2A:

<u>Relative movement:</u> Move the wire vertically down across the field and then up across the field, the (light-spot of the) galvanometer would deflect to one side and then to the opposite side.

<u>Polarities of magnet:</u> Move the wire vertically down across the field, the (light-spot of the) galvanometer would deflect to one side and then reverse the polarities of the magnet to repeat the experiment, the galvanometer would deflect to the opposite side.

<u>Direction of movement:</u> Move the wire vertically up/down across the field, the (light-spot of the) galvanometer would have large deflection. No deflection when the wire is moved horizontally to the left/right in the field instead.

<u>Orientation of conductor:</u> With the wire perpendicular to the magnetic field, move it vertically up/down across the field, the (light-spot of the) galvanometer would have large deflection. No deflection when the wire is placed parallel to the field instead.

<u>Rate of movement:</u> Move the wire slowly across the field and then quickly across the field, the (light-spot of the) galvanometer would deflect more for a quicker movement or a faster rate.

<u>No. of turns:</u> Wind the wire into, say, a 10-turn coil and move it again across the field, the (light-spot of the) galvanometer would deflect more for more turns of wire.

<u>7</u>

11. (a) $^{226}_{88}\text{Ra} \rightarrow ^{222}_{86}\text{Rn} + ^{4}_{2}\text{He}$ / He / α — 2A <u>2</u>

(b) $\Delta m = 226.0254 - (222.0176 + 4.0026) = 0.0052$ u — 1M

Energy released = (0.0052)(931) = 4.84 (MeV) — 1A <u>2</u>

(c) Number of radium atoms in the source

$N = N_A\left(\frac{1}{226}\right) \times (5 \times 10^{-6}) = (6.02 \times 10^{23})\frac{1}{226} \times (5 \times 10^{-6}) = 1.33 \times 10^{16}$ — 1A

Activity $A = \frac{\ln 2}{t_{1/2}} \cdot N$ — 1M

$= \frac{\ln 2}{1600 \times 365 \times 24 \times 3600} \cdot 1.33 \times 10^{16}$

$= 1.83 \times 10^{5}$ (disintegrations per second, Bq) — 1A <u>3</u>

Paper 2

Section A : Astronomy and Space Science

1. D (31%)	2. A (35%)	3. A (53%)	4. C (44%)
5. B (43%)	6. C (36%)	7. D (44%)	8. B (59%)

Marks

1. (a) (i) $L_S = \sigma T_S^4 (4\pi R_s^2)$ 1M

$L = \sigma T^4 (4\pi R^2)$

$\therefore \frac{L_S}{L} = \frac{T_S^4 R_S^2}{T^4 R^2}$ 1M

$R = \left(\frac{T_S}{T}\right)^2 \left(\frac{L}{L_S}\right)^{\frac{1}{2}} R_S$ 2

(ii)

Sun	T_S = 5780 K	L_S	R_S
Betelgeuse	T = 3650 K	L = 126000 L_S	R

$R = \left(\frac{5780}{3650}\right)^2 \left(\frac{126000\,L_S}{L_S}\right)^{\frac{1}{2}} R_S$ 1M

$= 890\ R_S$ 1A 2

(b) (i) $\because$ Same brightness measured and brightness = $\frac{L}{4\pi d^2}$ or $\propto \frac{L}{d^2}$ or L increases with d, 1M

d is larger $\rightarrow$ L is larger. (for d taken as (197+45) pc)

i.e. for Betelgeuse, $\because L \propto R^2$ $\therefore$ R increases. 1A 2

Or

$M = m - 5(\log_{10} d - 1)$ or $M = m - 5(\log_{10} \frac{d}{10})$

(M : absolute magnitude , m : apparent magnitude)

(ii) The parallax measurement ($d = \frac{1}{p}$, accurate to within ~ 100 pc) is too small or d is too large (too far away), (~ (1/200)" = 5 milliarcsec). 1A 1

(c) $L = 10^9\ L_s$, brightness = $\frac{(0.01\times 10^9 L_s)}{4\pi d^2}$ 1M

d = 200 × 206265 AU = 41253000 AU 1M

Brightness = $\frac{(0.01\times 10^9)}{41253000^2} \frac{L_s}{4\pi (1\text{AU})^2} = \frac{(0.01\times 10^9)}{41253000^2}$ brightness of the Sun 1A

$= 5.88 \times 10^{-9}$ brightness of the Sun 3

Section B : Atomic World

1. D (34%)	2. A (47%)	3. B (51%)	4. C (64%)
5. C (53%)	6. A (75%)	7. B (60%)	8. D (47%)

Marks

2. (a) The negative sign means that:
- the electron is "bound" to the atom
- the force between the nucleus and electron is attractive
- work has to be done to remove the electron to infinity

} **ANY ONE** — 1A — 1

(b)
- The angular momenta of the electrons are whole number multiples of $\frac{h}{2\pi}$, i.e. quantized.
- The electrons are in stable orbits without emitting radiation.
- The electrons can occupy certain discrete orbits only. / Total energy of the atom is quantized / Energy levels are discrete.
- The atom can only emit or absorb radiation in the form of a photon when an electron jumps from one energy level to another.

} **ANY TWO** — 2A — 2

(c) (i) Energy = hf

$$= \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^{8}}{102.8\times10^{-9}} = 1.93\times10^{-18}\text{ J}$$

$$= 1.93\times10^{-18} / (1.60\times10^{-19}) = 12.09\text{ (eV)}$$ 1A

$$\Delta E = 12.09\text{eV} = -\left(\frac{1}{n^2}-\frac{1}{1^2}\right)13.6\text{eV}$$ 1M

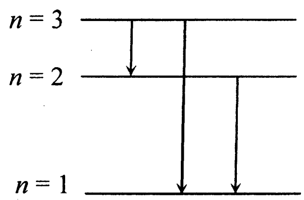
$$n^2 = \frac{1}{1-\frac{12.09}{13.6}}$$

$$n^2 = 9.007 \Rightarrow n = 3$$ 1A 3

(ii) The energy of UV = 100.0 nm does not match the differences between ground state of hydrogen and other energy levels. 1A 1

(iii) There are three possible transitions 1A

The hydrogen atom is in excited state $n = 3$.



$$E_3 = -\frac{13.6}{3^2}\text{ eV} = -1.51\text{eV}$$

$$E_2 = -\frac{13.6}{2^2}\text{ eV} = -3.40\text{eV}$$

$$E_1 = -\frac{13.6}{1^2}\text{ eV} = -13.60\text{eV}$$

$3 \rightarrow 1$ ΔE = 12.09 eV (= −1.51 −(−13.6))

$3 \rightarrow 2$ ΔE = 1.89 eV (= −1.51 −(−3.40)) 1M

$2 \rightarrow 1$ ΔE = 10.2 eV (= −3.40 −(−13.6))

The transition from $3 \rightarrow 2$ corresponds to visible light as 1.89 eV is within the corresponding range. 1A 3

Section C : Energy and Use of Energy

1. A (80%)	2. C (54%)	3. D (43%)	4. C (64%)
5. B (82%)	6. B (68%)	7. C (76%)	8. A (26%)

Marks

3. (a) Maximum solar power per unit area reaching the Earth
$= 1366 \times (1 - 0.268)$
$= 1000$ W m^{-2} or W — 1A 1

(b) Solar energy / radiation / radiant energy / light energy → electrical energy. — 1A

Adhere a transparent anti-reflection film to the solar cell panel.
Methods involving tracking the sun to receive maximum sun light
Mirrors/lens to reflect/collect sun light to the solar cells
ANY ONE — 1A 2

(c) (i) Solar power received by each solar cell
$= 1000$ W m^{-2} $\times 0.0172$ m^2
$= 17.2$ W — 1M

Electrical power delivered by each solar cell
$= 17.2$ W $\times 0.12$
$= 2.064$ W — 1M

Number of solar cells required
$= \dfrac{7.35 \text{ kW} \times 4}{2.064 \text{ W}}$
$= 14244$ — 1A 3

(ii) - To limit/minimize the weight of the aircraft.
- Limited area for installing the solar cells.
- It is the batteries to deliver maximum power to the engines, the solar cells are for charging the batteries.
ANY ONE — 1A 1

(d) Energy comes from natural resources / processes that are replenished constantly. — 1A

Wind power — 1A
as (northeast and southwest) monsoons prevail in Hong Kong (during winter and summer). — 1A 3

Section D : Medical Physics

1. A (46%)	2. C (46%)	3. B (55%)	4. B (17%)
5. C (56%)	6. D (52%)	7. D (46%)	8. A (18%)

Marks

4. (a) (i) Let v be the speed of ultrasound in soft tissue
v_b be the speed of ultrasound in bone
t be the time of travel of ultrasound in soft tissue
t_b be the time of travel of ultrasound in bone

We have $\frac{v_b t_b / 2}{vt/2} = \frac{5.8}{2.0}$ or $\frac{v_b t_b}{vt} = \frac{5.8}{2.0}$ 1M

$(\frac{v_b}{v})(\frac{3}{2}) = 2.9$

$\frac{v_b}{v} = 1.93$ 1A 2

(ii) From (i), $v_b = 1.93 \times 1580 \text{ m s}^{-1} = 3055 \text{ m s}^{-1}$ 1M

$\therefore$ for bone $Z = \rho c$

$7.78 \times 10^6 = \rho(3055)$ 1M

$\rho = 2547 \text{ kg m}^{-3}$ 1A 3

(b) (i) Reflection of ultrasound at tissue boundary/when entering another tissue. 1A
The brightness/amplitude/strength in a B-scan image is proportional to the intensity of the reflected ultrasound signal/change in acoustic impedance. 1A
Distance/depth calculated from time for signal to return to ultrasound transducer./When traces are joined, a 2D/planar image of the scanned area is formed. 1A 3

(ii) Advantages (**ANY ONE**): 1A
1. relatively safe (as no ionizing radiation involved)
2. readily accessible
3. can detect the movement of an organ in real time

Limitations (**ANY ONE**): 1A
1. limited tissue penetration, particularly through bones or air-filled structures
2. field-of-view (FOV) of ultrasound is smaller compared to other methods of imaging 2