香港考試及評核局
HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

2020 年香港中學文憑考試
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2020

物理　香港中學文憑考試　試卷一乙
PHYSICS　HKDSE　PAPER 1B

只限閱卷員參閱　　FOR MARKERS' USE ONLY

HKDSE Physics

General Marking Instruction

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates may have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct answer merits ***the answer mark*** allocated to that part, unless a particular method has been specified in the question. **Markers should be patient in marking alternative solutions not specified in the marking scheme.**

2. In the marking scheme, answer marks or 'A' marks are awarded for a correct numerical answer with a unit. **In case the same unit involved is given incorrectly for more than once in the same question, the 'A' marks thereafter can be awarded even for correct numerical answers without units.** If the answer should be in km, then cm and m are considered to be wrong units.

3. In a question consisting of several parts each depending on the previous parts, **marks for correct method or substitution** are awarded to steps or methods correctly deduced from previous answers, even if these answers are erroneous or for inserting values of appropriate physical quantities into an algebraic expression **irrespective of their order of magnitudes**. However, 'A' marks for the corresponding answers should **NOT** be awarded (unless otherwise specified).

4. For the convenience of markers, the marking scheme is written as detailed as possible. However, it is still likely that candidates would not present their solution in the same explicit manner, e.g. some steps would either be omitted or stated implicitly. In such cases, markers should exercise their discretion in marking candidates' work. In general, marks for a certain step should be awarded if candidates' solution indicated that the relevant concept/technique had been used.

5. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

6. OSM (On-screen marking) marking symbols:

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═	point to highlight
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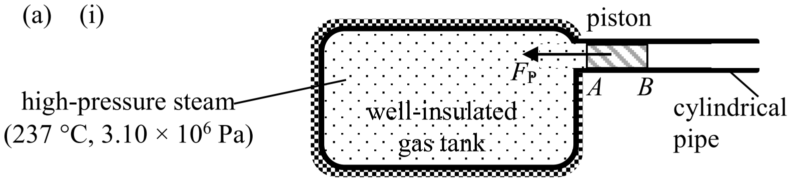
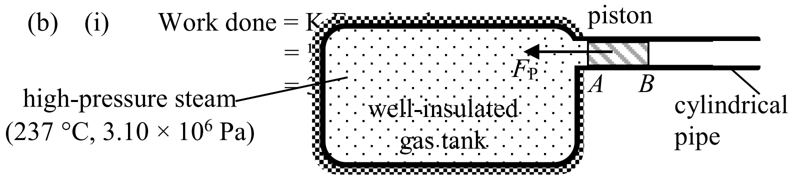
Solution	Marks	Remarks
1. (a) $5 \times 0.02 \times 3300 \times (T - 4) = 0.60 \times 4200 \times (96 - T)$	1M	Accept 85.0 °C to 85.4 °C
$T = 85.347368$ °C ≈ 85.3 °C	1A	[Marking Remark (MR): temperature difference must be correct & accept missing '5' – 1 M]
	2	
(b) (i) To compensate for / balance the heat loss (of the container with soup) to the surroundings.	1A	[MR: Key words - heat loss to the surroundings (from container or through evaporation)]
	1	
(ii) $P \times 10 \times 60 = 2000 \times 9 + 16 \times 4200 \times 9$	1M+1M	Assume : Power of the heater = Rate of heat loss (of the container with soup) to the surroundings
$P = 1038$ W ≈ 1040 W	1A	
	3	[MR: $P \times t$ ✓ + 1 term ✓ - 1M $P \times t$ ✓ + 2 term ✓ - 2M $P \times t$: accept $P \times 10$ ΔT: accept (96 – 9)]
(iii) Smaller than 9 °C.	1A	
As the temperature of (the container with) soup drops, the rate of heat loss to the surroundings becomes lower due to a smaller temperature difference (w.r.t. the surroundings).	1A	[2 A marks are independent Key concept: smaller temperature difference]
	2	

Solution	Marks	Remarks
2. (a) (i) 	1A	F_P correctly marked F_P should be in contact with the piston. Accept: no label of the force
	1	
(ii) $F_P = (3.10\times10^6 - 1.0\times10^5)\times0.67$	1M	Accept: $F_P = (3.10\times10^6)\times0.67$
$= 2010000\text{ N} = 2.01\times10^6\text{ N}$	1A	Accept 2.00×10^6 N to 2.01×10^6 N
	2	
(iii) $pV = nRT \Rightarrow V = \dfrac{nRT}{p}$ $V = \dfrac{(570/0.018)(8.31)(237+273)}{3.10\times10^6}$	1M+1M	1st 1M find n (570/0.018) 2nd 1M $pV=nRT$, accept T=237
$= 43.292419\text{ m}^3 \approx 43.3\text{ m}^3$	1A	Accept 43.0 m^3 to 43.3 m^3
	3	
(b) (i) Work done = K 	1M 1A	Accept 37.9 MJ to 38.0 MJ Accept: a= 54/1.5 = 36 (m s^{-2}) F= (2.6×10^4) ×36 = 936000 (N) s = 54^2/(2×36) = 40.5 (m) [or $v = at/2$ =36(1.5)/2 = 27 (m s^{-1})] $W = Fs$ = 936000×340.5 [or $W = Fvt$ =936000×27×1.5] = 37908000 (J) [1M+1A] If $s = vt$ [0M 0A]
	2	
(ii) Average acceleration $a = \dfrac{v-u}{t} = \dfrac{54-0}{1.5}$	1M	
$= 36\text{ m s}^{-2}$	1A	
	2	
(iii) Acceleration is decreasing (i.e. maximum at first). (According to kinetic theory,) once the steam expands, i.e. volume increases, its pressure decreases, thus the (pressure) force acting on the piston at A decreases, hence a smaller acceleration.	1A 1A 1A	1st 1A for acceleration decreasing 2nd 1A for volume increases/ length increases ⇒ pressure decreases Alternative method: The acceleration of the jet fighter is decreasing, 1A As the air resistance (f) acts on the jet fighter increases with the speed. 1A The net force ($ma = F - f$) is decreasing. 1A
	3	

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Solution	Marks	Remarks
3. (a) With superconductor / extremely low or nearly zero resistance, a much larger current flows in the coils producing a stronger magnetic field (with less heat loss due to the current flow).	1A 1A	[MR: low R + large I – 2A marks large I only – 1 A mark low R only – 0 A mark]
	2	
(b) P and Q : N (north pole) Repulsive force between like poles	1A 1A	(see table below)
	2	
(c) (i) As the train is not in contact with the rail, there is no friction / interaction between the train and the rail, thus smoother due to less vibration.	1A	
(ii) There is no friction / interaction between the train and the rail, and the propulsion of the train only needs to work against air resistance, therefore much faster.	1A	
	2	

		Poles			
		2N	2S/S+N	正	NA
Reason	✓	2	0	1	1
	✗/NA	1	0	0	0

NA – Not answered

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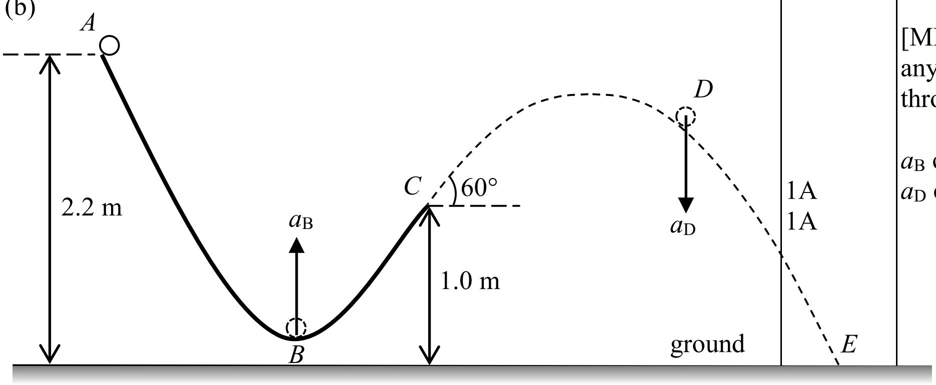
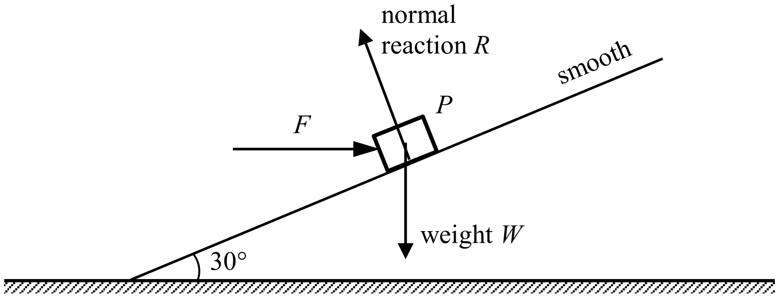
Solution	Marks	Remarks
4. (a) $v_B > v_C > v_D > v_A$	1A	[MR: Accept: $v_A < v_D < v_C < v_B$ Accept: B, C, D, A NOT accept: A, D, C, B]
	1	
(b) 	1A 1A	[MR: Accept the arrows drawn at anywhere on the vertical lines passing through the object at positions B & D] a_B correctly marked a_D correctly marked
	2	[MR: 2 marks ：All correct and complete: PE→KE & some KE→PE 1 mark ： (i) PE → KE → PE or (ii) Correctly describe only between 2 points (A→B / B→C / A→C)]
(c) (i) Gravitational potential energy is changed to kinetic energy from A to B, and some kinetic energy is changed back to gravitational potential energy from B to C.	1A 1A	
	2	
(ii) $\frac{1}{2}mv^2 = mgh$ $v^2 = 2(9.81)(2.2 - 1.0)$ $v = 4.852216 \text{ m s}^{-1} \approx 4.85 \text{ m s}^{-1}$	1M 1A	[MR: h must be correct for 1M Method using $v^2 - u^2 = 2as$ etc. is NOT accepted] For $g = 10 \text{ m s}^{-2}$, $v = 4.89898 \text{ m s}^{-1} \approx 4.90 \text{ m s}^{-1}$ Accept 4.85 m s^{-1} to 4.90 m s^{-1}
	2	
(iii) Horizontal speed (at C) = 4.85 × cos 60° = 2.426108 m s^{-1} ≈ 2.43 m s^{-1} Distance = 2.43 × t = 2.55 m t = 1.051066 s ≈ 1.05 s Or Vertical speed (at C) = 4.85 × sin 60° = 4.2002 m s^{-1} ≈ 4.20 m s^{-1} $-1.0 = 4.20 \times t + \frac{1}{2}(-9.81)t^2$ t = 1.051066 s ≈ 1.05 s	1M 1M 1A	e.c.f. from (c)(ii) For $g = 10 \text{ m s}^{-2}$, Horizontal speed = 2.44949 m s^{-1} ≈ 2.45 m s^{-1} Vertical speed ≈ 4.24 m s^{-1} and t = 1.041033 s ≈ 1.04 s Accept 1.04 s to 1.10 s [MR: 1st M for correct expression for initial horizontal /vertical speed 2nd M for correct method (equation) to find t by considering horizontal motion/ vertical motion
	3	

Solution	Marks	Remarks
5. (a) (i) 	1A 1A	Forces R(or N) and W(or Mg) correctly indicated and labelled. [MR: 1A for weight with correct label (W/Mg/weight/gravity) 1A for normal reaction with correct label (R/N/normal force/contact force/reaction) 1A only: if both W and R drawn (without/wrong label) Withhold 1A for additional force drawn (more than 2 forces) - W components added with correct labels (ignored) - W components added without correct labels (treated as additional force drawn)
	2	
(ii) $R\cos 30° = W = Mg$ and $R\sin 30° = F$	1M	$M = 10$ kg; $Mg = 98.1$ N [MR: 1M for both equations are correct]
$F = Mg \times \tan 30° = 56.63806\text{ N} \approx 56.6\text{ N}$	1A	For $g = 10\text{ m s}^{-2}$, $57.735027\text{ N} \approx 57.7\text{ N}$
$N = R = \dfrac{Mg}{\cos 30°} = 113.27612\text{ N} \approx 113\text{ N}$	1A	$115.470054\text{ N} \approx 115\text{ N}$
Or $R = W\cos 30° + F\sin 30°$ and $W\sin 30° = F\cos 30°$	(1M)	[MR: 1M for both equations are correct]
	3	
(b) (i) $g\sin\theta = 9.81\sin 30° = 4.905\text{ m s}^{-2} \approx 4.91\text{ m s}^{-2}$	1A	5 m s^{-2} for $g = 10\text{ m s}^{-2}$,
	1	
(ii) Decrease	1A	
as the component of F perpendicular to the incline no longer acts on the block / incline Or as F is removed, the force pressing the block / incline would decrease (only the weight's component left)	1A	
	2	NA – Not answered / Un - Unchanged

Reason \ Answer	De	In / Un	NA
✓	2	0	1
× / NA	0	0	0
Not complete	1	0	0

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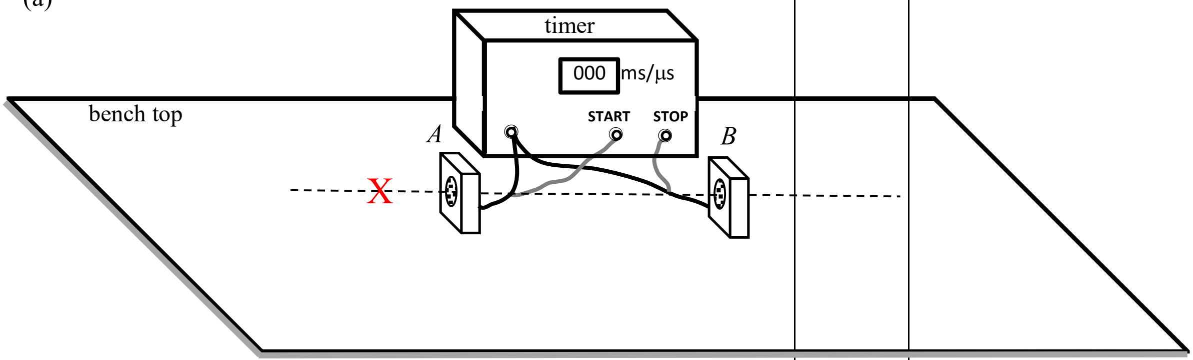
6. (a) 		
Correct location of 'X' (close to axis and on the side of the START microphone).	1A	
Use a metre rule	1A	Accept ruler
to measure the distance / separation D between the two microphones. Record the timer reading, which is the time interval Δt for the sound to travel from one microphone (START) to the other microphone (STOP), i.e. A to B.	1A	Any ONE of the measurements
	3	
(b) (i) Discard 539 μs, $\Delta t = \frac{801+838+821}{3} = 820$ μs The speed of sound in air $v = \frac{D}{\Delta t}$ $v = \frac{0.280}{820 \times 10^{-6}}$	1M	1M for taking the average value of Δt and quoting the formula $v = \frac{D}{\Delta t}$ to calculate the speed of sound, where D is the separation between the microphones.
$= 341.463415 \text{ m s}^{-1} \approx 341 \text{ m s}^{-1}$	1A	Accept 340 m s^{-1} to 342 m s^{-1}
(ii) Increase separation D between the microphones.	1A	
	3	

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Solution	Marks	Remarks
7. (a) (i) Angle of incidence at *A*, $i_A = 90° - 30° = 60°$	1A	
	1	
(ii) $n_g \sin c = n_c \sin 90°$	1M	1M for correct equation with angle of refraction in the cladding = 90°
$\Rightarrow \frac{n_g}{n_c} = \frac{1}{\sin c} \geq \frac{1}{\sin 60°} = 1.1547005 \approx 1.15$	1A	Accept 1.2 or $\frac{2}{\sqrt{3}}$
	2	
(iii) Total internal reflection.	1A	Correct spelling
For light rays from *O* with $\theta > 30°$, they will fail to undergo total internal reflection.	1A	Accept $\theta \geq 30°$
	2	
(b) (i) Some light / energy (of the narrow light pulse) taking the shortest path (i.e. *OD*) arrives first while the rest of the	1A	1A for 'taking different paths'
energy taking longer paths arrives later. Therefore the pulse is broader and the height of the pulse is lower (smaller intensity).	1A	1A for 'different arrival time' NOT accept: Some of the energy (going at angles larger than 30° from the axis) would be lost due to leakage, thus lower intensity.
	2	
(ii) The refractive index of cladding should be increased,	1A	
as $\frac{n_g}{n_c} = \frac{1}{\sin c}$, by making c / $\sin c$ larger, only those light rays close to the axis / within a smaller θ are totally internal reflected, (such that $\frac{n_g}{n_c}$ getting closer to 1).	1A	0 A for the explanation if the choice for the change of n_c is INCORRECT. Note: More light rays will escape the optical fibre for a larger n_c.
	2	

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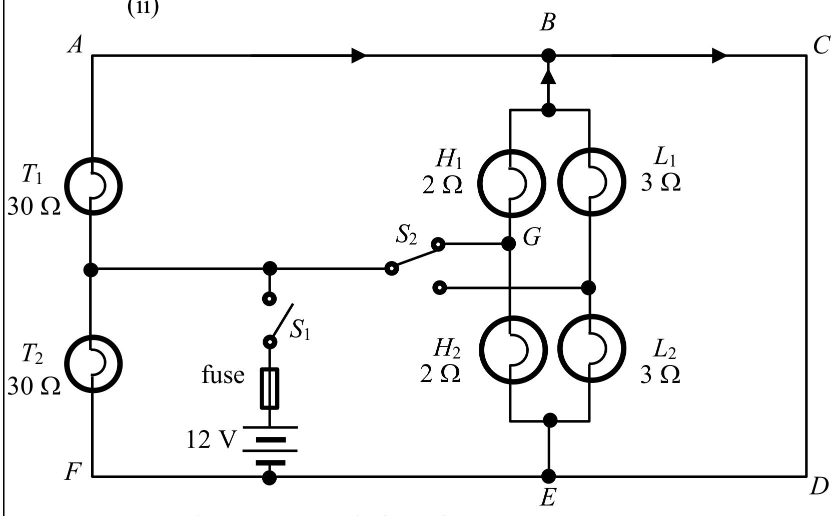
Solution	Marks	Remarks
8. (a) Because L_1 and L_2 (connected in series) are shorted by *BCDE*	1A	Accept p.d. across each low-beam headlight (L_1 or L_2) is 0.
	1	
(b) (i) p.d. across T_2 = 12 V	1A	
	1	
(ii) 	1A 1A	Any two currents correctly marked. All currents correct.
largest current in branch *BC*	1A	
	3	
(c) Power supplied $P = 2 \times \left(\frac{12^2}{30} + \frac{12^2}{2}\right)$	1M	1M for same voltage across each bulb (T_1, T_2, H_1 and H_2) e.c.f. from (b)(i)
= 153.6 W = 154 W (3 sig. fig.)	1A	
$\frac{V^2}{R_{eq}} = \frac{12^2}{R_{eq}} = 153.6$ (or $\frac{1}{R_{eq}} = \frac{1}{30} + \frac{1}{30} + \frac{1}{2} + \frac{1}{2}$)	1M	1M for all bulbs (T_1, T_2, H_1 and H_2) in parallel
R_{eq} = 0.9375 Ω ≈ 0.938 Ω ≈ 1 Ω (3 sig. fig.)	1A	
	4	
(d) max. current $I_{max} = \frac{V}{R_{eq}} = \frac{12}{0.9375} = 12.8$ A (or $I_{max} = \frac{P}{V} = \frac{153.6}{12} = 12.8$ A)	1M	e.c.f. from (c)
Since the rating is slightly higher than the max. current (when high-beam headlights and taillights are switched on), it is suitable.	1A	1A for 12.8 A and correct conclusion
	2	

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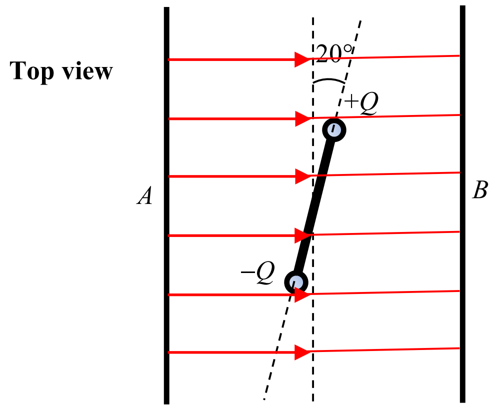
9. (a) 	1A 1A 2	Accept: field lines are not on Figure 9.2 Correct direction (From *A* to *B*) Accept: field lines not in contact with the plates Perpendicular to plates, parallel and evenly spaced Accept: 3 or more field lines NOT accept: 2 or more mistakes in the drawing
(b) (i) $F \times d = (2.0 \times 10^{-5})(0.05 \cos 20°)$ $= 9.396926 \times 10^{-7}$ N m $\approx 9.40 \times 10^{-7}$ N m	1M 1A 2	1M $F \times d$ Accept: without consider the component / without component *d* (0.05, 0.05/2, 2×0.05, 5, 5/2, 2×5) NOT accept: calculation using separation between plates *d* (0.1, 10)
(ii) $E = \frac{V}{d}$ $= \frac{5.0\times10^3}{0.1}$ $= 50\,000$ V m^{-1} or N C^{-1} = 50 kV m^{-1} or kN C^{-1}	1M 1A 2	Accept: $\frac{5\times10^3}{0.1}, \frac{5\times10^3}{1}, \frac{5}{1}, \frac{5}{0.1}$
(iii) $E = \frac{F}{Q}$ $Q = \frac{F}{E} = \frac{2.0\times10^{-5}}{5.0\times10^4}$ $= 4.0 \times 10^{-10}$ C	1M 1A 2	e.c.f. from (b)(ii)

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Solution	Marks	Remarks
10. (a) proton / $^1_1$H / p / hydrogen nucleus	1A	Accept: proton / $^1_1$H / p / ^1_1p / H / hydrogen nucleus / hydrogen / hydrogen atom NOT accept: H_2
	1	
(b) Change in mass $\Delta m = (16.9947 + 1.0073) - (13.9993 + 4.0015)$ $= 0.0012$ u	1M	1M for Δm
Energy = 0.0012 × 931 = 1.1172 (MeV) ≈ 1.12 (MeV) ~~(Or = 0.0012 × (1.661 × 10^{-27}) × (3.00 × 10^8)^2~~ ~~= 1.79388 × 10^{-13} J ≈ 1.79 × 10^{-19} MJ)~~	1A	Accept 1.10 to 1.12 (MeV) Answer should be in MeV, not J. MeV could be omitted [Energy = 0.0012 × (1.661 × 10^{-27}) × (3.00 × 10^8)^2 = 1.79388 × 10^{-13} J ≈ 1.79 × 10^{-19} MJ ≈ 1.12 (MeV)] ~~Accept (1.79 to 1.80) × 10^{-19} MJ~~
	2	
(c) By the conservation of momentum, as before the reaction occurs the α particle has momentum, the total momentum of the products (= momentum of the α particle) must also be non-zero,	1A	1st 1A should mention the product(s) has/have momentum 2nd 1A KE/speed of the products must greater than zero Accept: kinetic energy shared by other particles (NOT accept :energy shared.) NOT accept: against repulsion of nucleus / inelastic collisions / KE loss / consider binding energy
i.e. the total KE of the products must greater than 0, thus the α particle should have a larger KE.	1A	[The kinetic energy of the α particle = energy calculated in (b) + total KE of the products]
	2	

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物理　香港中學文憑考試　試卷二
PHYSICS　HKDSE　PAPER 2

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Section A : Astronomy and Space Science

1. D (%)	2. D (%)	3. C (%)	4. B (%)
5. C (%)	6. B (%)	7. C (%)	8. A (%)

Solution	Marks	Remarks
1. (a) Distance 50 kpc = 50000 × 3.26 ly = 163000 ly Thus the explosion of the star took place 163000 years ago. Accepted range: 163000 ~164000 years or $50000\times3.09\times10^{16}/(3\times10^{8}\times365\times24\times3600)=163305$ or $50000\times206265\times1.5\times10^{11}/(3\times10^{8}\times365\times24\times3600=163516$	1A 1	Note: 2020 – 1987 = 33 years can be ignored.
(b) SN 1987A at 50 kpc, being much farther away than 10 pc, would be much **brighter** (than that corresponding to +2.9) if it were **placed at 10 pc**. NO MARK awarded without 'placed at 10 pc' Hence (the numerical value of) its absolute magnitude is much **smaller** than +2.9 / the apparent magnitude.	1A 1A 2	[Absolute magnitude is the apparent brightness of the object at 10 pc.]
(c) (i) Take L_S, R_S and T_S to be the luminosity, radius and surface temperature of the Sun respectively, whereas let L_X, R_X and T_X be those of X respectively. By Stefan's law, $L_S=\sigma(4\pi R_S^2)T_S^4$ and $L_X=\sigma(4\pi R_X^2)T_X^4$ Therefore, $\frac{L_X}{L_S}=\left[\frac{R_X}{R_S}\right]^2\left[\frac{T_X}{T_S}\right]^4$ $40000=\left[\frac{R_X}{R_S}\right]^2[3.1]^4$ $\frac{R_X}{R_S}=20.81165\approx20.8$	1M 1M 2	
(ii) Region A. Not a 'red giant' as the temperature of star X is (much) higher than that of the Sun. / Red giants are in region B	1A 1A 2	Note: red giants are in region B, star X is in fact a blue supergiant.
(d) Q: L_0 or R: L_1 According to Doppler's effect, gas at R receding from the observer gives rise to red shift (vice versa for P), while there is no velocity component for gas at Q (and S) towards / away from the observer, no Doppler / blue / red shift.	1A 1A 1A 3	

Section B : Atomic World

1. C (%)	2. C (%)	3. B (%)	4. D (%)
5. A (%)	6. A (%)	7. B (%)	8. D (%)

Solution	Marks	Remarks
2. (a) (i) ultra-violet (UV)	1A	
	1	
(ii) Light (energy) is (transferred to electrons of the cathode) in packets or (whole number of) quanta (i.e. quantized) called photons.	1A	
	1	
(b) (i) Microammeter reading remains zero,	1A	
energy E of incident photons remains unchanged, although intensity ↑ causing more photons incident but no effect on maximum KE of the electrons emitted or on photoemission.	1A	
	2	
(ii) Energy of photon $= \frac{hc}{\lambda}$		
$= \frac{(6.63\times10^{-34})(3\times10^{8})}{300\times10^{-9}}$	1M	
$= 6.63 \times 10^{-19}$ J		
$= 4.14375$ (eV) ≈ 4.14 (eV)		Accept 4.10 (eV) to 4.14 (eV)
Work function $\Phi = 4.14 - 1.7$	1M	e.c.f.
$= 2.44375$ (eV) ≈ 2.44 (eV)	1A	Accept 2.40 (eV) to 2.44 (eV)
	3	
(c) (i) No. of photoelectrons reaching A in 1 s $= \frac{0.4\times10^{-6}}{1.6\times10^{-19}} = 2.5\times10^{12}$	1A	
	1	
(ii) $1.7 - 0.8 = 0.9$ (eV) <u>or</u> $4.14 - 2.4 - 0.8 = 0.94$ (eV).	1A	
Electrons inside cathode C (not on surface) need an amount of energy more than the work function to escape / be emitted from C.	1A	
	2	

Section C : Energy and Use of Energy

1. B (%)	2. A (%)	3. D (%)	4. C (%)
5. A (%)	6. B (%)	7. D (%)	8. A (%)

Solution	Marks	Remarks
3. (a) The fission products / nuclides are with higher binding energy per nucleon than uranium-235. 1A Therefore, energy is released in fission and the resulting nuclides are more stable.	1A 1A 2	1A for comparing the binding energy per nucleon before and after fission of $^{235}_{92}U$ 1A for more stable after fission
(b) (i) It represents the energy required to separate all nucleons (protons and neutrons) of uranium-235 to infinity / far apart / separate completely.	1A 1	Accept: Energy released by combining protons and neutrons (nucleons) into a single nucleus.
(ii) Binding energy (B.E.) of $^{235}_{92}U$ nucleus = 1783 MeV B.E. of $^{144}_{56}Ba$ nucleus = 8.27 × 144 = 1190.88 MeV B.E. of $^{90}_{36}Kr$ nucleus = 8.59 × 90 = 773.1 MeV Hence, energy released in fission = (1190.88 + 773.1) – 1783 = 180.98 (MeV) ≈ 181 (MeV)	1M 1A 2	1M for calculating the total binding energy of $^{144}_{56}Ba$ & $^{90}_{36}Kr$ from the binding energy per nucleon Accept: 180 – 181 MeV (2.88 – 2.90) × 10^{-11} J
(c) (i) $\frac{\text{Total energy released} \times \text{efficiency}}{\text{Power output}}$ $= \frac{(1.30\times10^{30}\times10^{6})(1.6\times10^{-19})(0.4)}{500\times10^{6}}$ = 1.664 × 10^{8} s ≈ 5.28254 years ≈ 5.28 years $\frac{\left(\frac{1.30\times10^{30}}{931}\right)(1.661\times10^{-27})(3\times10^{8})^2}{500\times10^{6}}(0.4)$ = 5.30 years	1M 1A 2	1M for $\frac{(1.30\times10^{30}\times10^{6})(1.6\times10^{-19})}{500\times10^{6}}$ Accept: 5.27 – 5.30 years
(ii) The concentration of uranium-235 nuclei will decrease with time and chain reaction cannot be maintained when the concentration is too low.	1A 1	
(d) (i) moderator: to slow down the fast neutrons produced in fission.	1A 1	
(ii) control rods: to control the rate of nuclear fission / reaction by absorbing the neutrons or for shutting down the reactor in case of emergency.	1A 1	1A: absorbing neutrons + controlling / slowing down the chain reaction Or absorbing neutrons + shutting down the reactor

Section D : Medical Physics

1. D (%)	2. C (%)	3. D (%)	4. A (%)
5. B (%)	6. C (%)	7. B (%)	8. A (%)

Solution	Marks	Remarks
4. (a) X-rays are produced when high-speed electrons strike a heavy metal target (like tungsten).	1A	
	1	
(b) (i) density of bone is higher / bone contains element(s) with high atomic number / heavy elements like calcium in bone block X-rays. (Accept other reasonable answers.)	1A	
	1	
(ii) $I = I_0 e^{-\mu_s t_s} = I_0 e^{-0.51 \times 5.6}$ $I = I_0 e^{-\mu_b t_b} = I_0 e^{-2.46 \times t_b}$	1M	Alternative method: $0.51 \times 5.6 = 2.46 \times t_b$
t_b = 1.16097561 cm ≈ 1.2 cm (2 sig. fig.)	1A	Accept 1.16 cm to 1.2 cm
	2	
(iii) Imaging of the breast only involves soft tissues and X-rays of longer wavelength / lower frequency / less penetrating power are needed <u>or</u> giving better contrast of soft tissues / more sensitive to small changes in density of soft tissues.	1A	Accept less harmful with X-rays of lower energy
For structures with bone, X-rays of shorter wavelength / higher frequency / greater penetrating power are needed.	1A	
	2	
(c) (i) Induce (cause) cancer / heritable mutations / genetically associated diseases. (Accept other reasonable answers.)	1A	
	1	
(ii) A CT scan delivers a 2-D cross-sectional image of the body part by means of multiple exposure (using a rotating X-ray source(s)),	1A	
equivalent dose is larger due to a relatively longer time of exposure.	1A	
	2	
(iii) cosmic rays / radon gas (from building) / radioactive substances in soil / rock / food or water. (Accept other reasonable answers.)	1A	
	1	