Section B: Atomic World

<table>
<thead>
<tr>
<th>1. D(50%)</th>
<th>2. C(42%)</th>
<th>3. C(49%)</th>
<th>4. D(44%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. A(64%)</td>
<td>6. B(73%)</td>
<td>7. B(22%)</td>
<td>8. A(44%)</td>
</tr>
</tbody>
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2. (a) (i) \[ E = hf = \text{work function} + KE_{\text{max}} \]
\[ = 2.30 \text{ eV} + 0.81 \text{ eV} = 3.11 \text{ (eV)} \]

(ii) Only those conduction / free electrons at the surface can have the maximum kinetic energy.
Or The work function of a metal is only the minimum energy required to eject an electron.
Or The conduction / free electrons in metal have different energies.
Or Less energetic electrons are tightly bound to the nuclei and require more energy to break free of its attraction to the nuclei.
Or Some electrons are not at the surface of metal so don’t have maximum k.e.

(b) (i) Energy absorbed by an atom = work function
\[ (0.01 \text{ W m}^{-2}) \times \left[ (0.01 \times (10^{-3})^2 \text{ m}^2) \times t \right] s = 2.30 \times (1.60 \times 10^{-19}) \text{ J} \]
\[ t = 3680 \text{ s} = 61.3 \text{ min.} \]

(ii) If a single photon has sufficient energy to knock out an electron, the electron gains enough energy in just one collision.
Or It is a one-to-one process / an electron can be ejected instantaneously if it accepts a photon of energy larger than the work function of the metal.

(c) \[ (0.01 \text{ W m}^{-2}) \times (4.00 \times 10^{-4} \text{ m}^3) \times (3.11 \times (1.60 \times 10^{-19}) \text{ J}) \]
\[ = 8.04 \times 10^{12} \text{ (photons per second)} \]
\[ (8.04 \times 10^{12}) \times 0.1 \times (1.60 \times 10^{-19}) \text{ A} \]
\[ = 1.29 \times 10^{-7} \text{ A} = 0.13 \mu\text{A} \]

(d) \[ I \text{ (arbitrary unit)} \]

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Section C: Energy and Use of Energy

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<tr>
<td>1. A(55%)</td>
<td>2. B(75%)</td>
<td>3. C(78%)</td>
<td>4. D(56%)</td>
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<tr>
<td>5. B(59%)</td>
<td>6. D(30%)</td>
<td>7. A(71%)</td>
<td>8. C(55%)</td>
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</tbody>
</table>

3. (a) \[ \frac{1}{4\pi(3.4)^2} \cos^2(\tan^{-1}(\frac{1.2}{3.4})) \]
= 11.5 (lm m⁻²)

(b) Rough surface should be used such that reflection becomes diffuse to reduce glare.

(c) (i) \[ 14.5 \text{ kW} + 15 \times 0.1 \text{ kW} + 6 \times 0.08 \text{ kW} \]
= 16.48 (kW) (accept 16.48 kW or 16.5 kW)

(ii) \[ (6 \times 0.1 \text{ kW} + 16.48 \text{ kW} \times 50\%) \times 8 \times 20 \times 1.0 \]
= $1414.4 (accept $1414.4 or $1416)

(iii) Windows with low-e coating.
Or Thicker walls.
Or Replace light bulb by fluorescent lamp.
Or Replace air-conditioner with higher cooling capacity / COP.