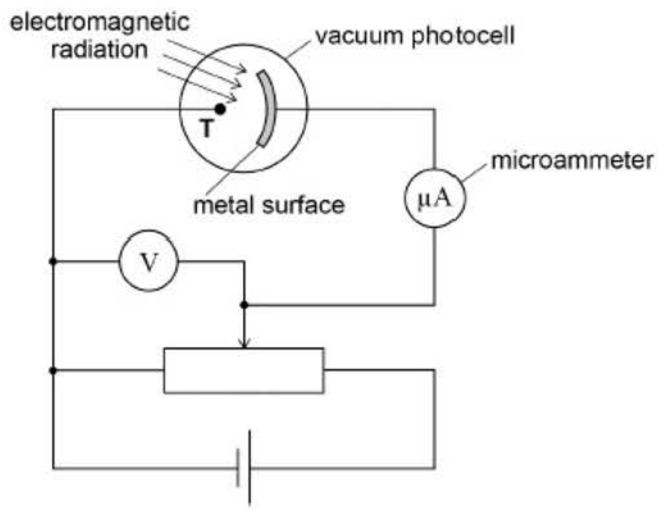
3 The diagram shows a vacuum photocell in which a metal surface is illuminated by electromagnetic radiation of a single wavelength. Electrons emitted from the metal surface are collected by terminal **T** in the photocell. This results in a photocurrent, I, which is measured by the microammeter.



The potential divider is adjusted until the photocurrent is zero.

The potential difference shown on the voltmeter is 0.50 V

The work function of the metal surface is 6.2 eV

(a) Calculate the wavelength, in nm, of the electromagnetic radiation incident on the metal surface.

e^- has energy 0.5 eV (since 0.5 V = stopping pot)

∴ energy to emit this e^- = 6.2 + 0.5 = 6.7 eV

$E = hf$ $\quad \frac{c}{\lambda} = f$ $\quad \therefore E = \frac{hc}{\lambda} \Rightarrow \lambda = 186$ nm

wavelength = 190 (2sf) nm

(3)

(b) The intensity of the electromagnetic radiation is increased. No adjustment is made to the potential divider.

The classical wave model and the photon model make different predictions about the effect on the photocurrent.

Explain the effect on the photocurrent that each model predicts and how experimental observations confirm the photon model.

Wave model predicts an increase in the current since more energy/time is increased → Amplitude bigger

Particle Model: no change, remains at zero. Whilst more e^- are released, they have the same max KE, so no current produced

(3)

(c) The potential divider in the diagram is returned to its original position so that a photocurrent is detected by the microammeter.
The potential divider is then adjusted to increase the potential difference shown on the voltmeter.

Explain why the photocurrent decreases when this adjustment to the potential divider is made.

e^- need more energy to cross the gap. so I falls

(2)

(d) The apparatus shown in the diagram above is used to investigate three different metal surfaces **A**, **B** and **C**.

The table shows, for each of the three surfaces, a voltmeter reading V and the corresponding photocurrent I. The same source of electromagnetic radiation is used throughout the investigation.

	V/V	I/μA
Metal surface **A**	1.5	56
Metal surface **B**	2.5	56
Metal surface **C**	2.5	78

least stopping V. so > ϕ

highest I, => < ϕ

Which conclusion about the relationship between the work functions of **A**, **B** and **C** is correct?

Tick (✓) the correct box.

A > B > C. ✓

A < B < C.

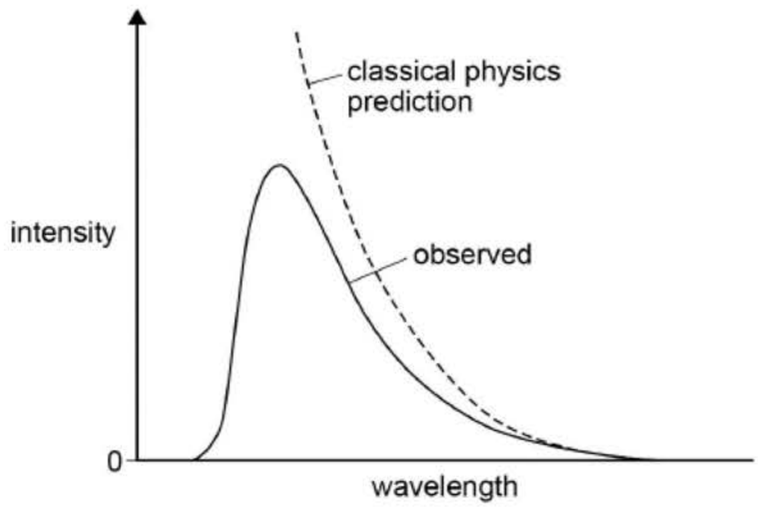
B > A > C.

B < A < C.

(1)

(Total 9 marks)

12 The solid line on the graph below shows how the intensity of radiation from a black body varies with wavelength at a particular temperature. The dotted line shows the variation as predicted by classical physics.



(a) Explain why the difference between the predicted and experimental curves is called the ultraviolet catastrophe.

the predicted curve is what wave theory suggests - an infinitely high peak in the UV area of em spectrum. This did not agree with the observation.

(2)

(b) Describe the difference between the classical physics view and the quantum theory proposal made by Max Planck that enabled the distribution of the shape of the intensity−wavelength graph to be correctly predicted.

Classically waves are continious
Planck said energy was emitted in discrete packets

(2)

(c) Discuss the evidence that the photoelectric effect provides in support of the quantum theory.

In classical theory energy arrives continuously as waves, meaning that all λ should emit photoelectrons.

In practice e^- are only liberated if the radiation has f ↑ than some threshold value since a specific E is required.

(3)

(Total 7 marks)