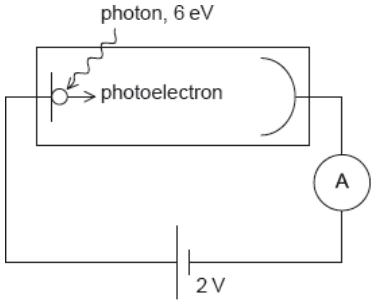
Photoelectric Effect *[20 marks]*

1. A photoelectric cell is connected in series with a battery of emf 2 V. Photons of energy 6 eV are incident on the cathode of the photoelectric cell. The work function of the surface of the cathode is 3 eV. *[1 mark]*



What is the maximum kinetic energy of the photoelectrons that reach the anode?

A. 1 eV

B. 3 eV

C. 5 eV

D. 8 eV

Markscheme

A

2. Which of the following experiments provides evidence for the existence of matter waves? *[1 mark]*

A. Scattering of alpha particles

B. Electron diffraction

C. Gamma decay

D. Photoelectric effect

Markscheme

B

3. Different metal surfaces are investigated in an experiment on the photoelectric effect. A graph of the variation of the maximum kinetic energy of photoelectrons with the frequency of the incident light is drawn for each metal. Which statement is correct? *[1 mark]*

A. All graphs have the same intercept on the frequency axis.

B. The work function is the same for all surfaces.

C. All graphs have the same slope.

D. The threshold frequency is the same for all surfaces.

Markscheme

C

4. Which phenomenon provides evidence for the wave nature of an electron? *[1 mark]*

A. Line spectra of atoms

B. Photoelectric effect

C. Beta decay of nuclei

D. Scattering of electrons by a crystal

Markscheme

D

5. Three phenomena associated with nuclear and quantum physics are *[1 mark]*

I. Einstein photoelectric effect
II. de Broglie hypothesis
III. Rutherford alpha particle scattering.

Which of the phenomena can be verified by firing electrons at a metal surface?

A. I only
B. II only
C. I and III only
D. II and III only

Markscheme

B

6. When the cathode of a photoelectric cell is illuminated with red light, a photoelectric current is produced in the cell. The illumination is changed to blue light but the rate at which photons arrive at the cathode remains the same. Which of the following statements is/are correct under these conditions? *[1 mark]*

I. The number of electrons released is unchanged
II. The current falls to zero
III. The kinetic energy of the electron increases

A. I only
B. III only
C. I and II only
D. I and III only

Markscheme

D

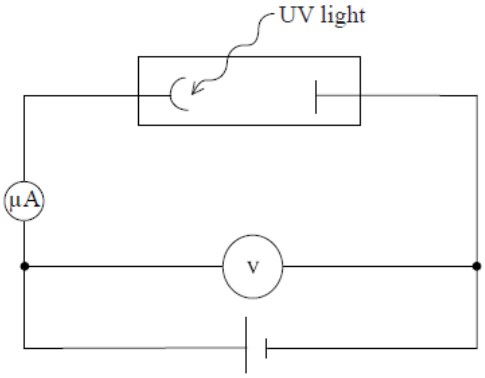
7. Light of a particular wavelength and intensity does not cause photoelectric emission from a clean metal surface in a vacuum. Which of the following changes to the light might cause photoelectric emission? *[1 mark]*

A. Increase the intensity
B. Decrease the intensity
C. Increase the wavelength
D. Decrease the wavelength

Markscheme

D

8. The diagram below shows a circuit involving a photoelectric cell. When UV light is shone onto the metal cathode, electrons are emitted establishing a photocurrent. *[1 mark]*



Which of the following changes could cause the photocurrent to stop

A. Increasing the potential difference of the power supply.
B. Increasing the frequency of the UV light.
C. Increasing the intensity of the UV light.
D. Changing the metal surface to one with a smaller work function.

Markscheme

A

9. In the photoelectric effect, the following observations may be made. *[1 mark]*

I. The kinetic energy of the emitted electrons increases with increasing light frequency.

II. The electrons are emitted without time delay.

Which of these observations, if any, can be explained in terms of the wave theory of light?

A. Neither I nor II

B. I and II

C. I only

D. II only

Markscheme

A

10. Which of the following is a correct statement associated with the photoelectric effect? *[1 mark]*

A. Electron emission is instantaneous.

B. Electrons are only emitted if the incident light is above a certain minimum wavelength.

C. The energy of the emitted electrons depends on the light intensity.

D. The energy of the emitted electrons does not depend on the frequency of the incident light.

Markscheme

A

11. Monochromatic electromagnetic radiation is incident on a metal surface. The kinetic energy of the electrons released from the metal *[1 mark]*

A. is constant because the photons have a constant energy.

B. is constant because the metal has a constant work function.

C. varies because the electrons are not equally bound to the metal lattice.

D. varies because the work function of the metal is different for different electrons.

Markscheme

C

12. A photon interacts with a nearby nucleus to produce an electron. What is the name of this process? *[1 mark]*

A. Pair annihilation

B. Pair production

C. Electron diffraction

D. Quantum tunnelling

Markscheme

B

13. A photon of energy E and wavelength λ is scattered from an electron initially at rest. *[1 mark]*

What is the energy of the photon and the wavelength of the photon when the electron moves away?

	Energy of photon	Wavelength of photon
A.	greater than E	less than λ
B.	less than E	less than λ
C.	greater than E	greater than λ
D.	less than E	greater than λ

Markscheme

D

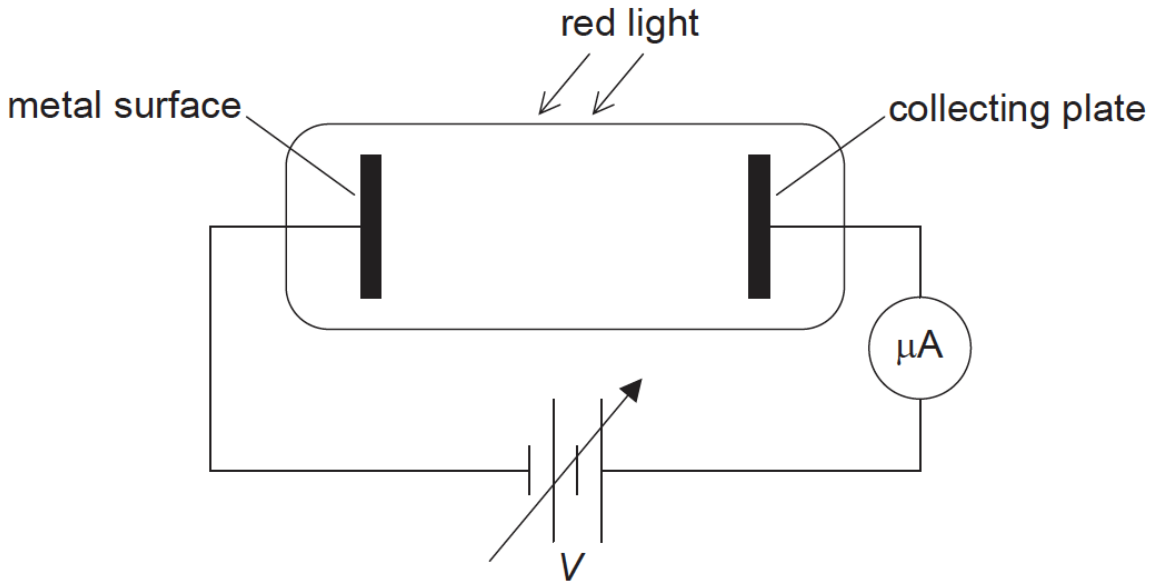
14. Pair production by a photon occurs in the presence of a nucleus. For this process, which of momentum and energy are conserved? *[1 mark]*

	Momentum	Energy
A.	not conserved	not conserved
B.	not conserved	conserved
C.	conserved	not conserved
D.	conserved	conserved

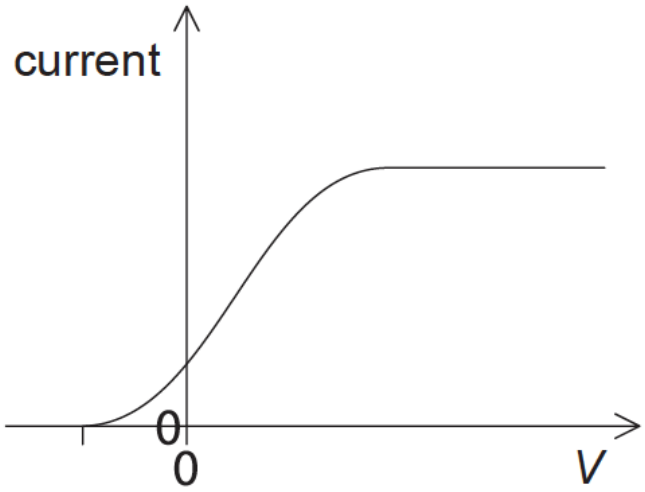
Markscheme

D

15. Red light incident on a metal surface produces photoelectrons. *[1 mark]*

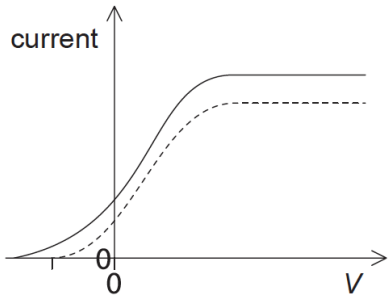


The potential *V* of the supply is varied and the current is measured. The results are shown on the graph.

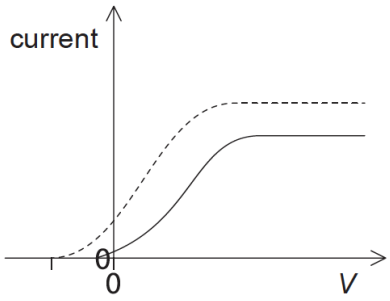


The light source is changed to blue. This blue source emits the same number of photons per second as the red source. Which graph shows the variation with potential of current for blue light? The results for the red light are shown as a dashed line.

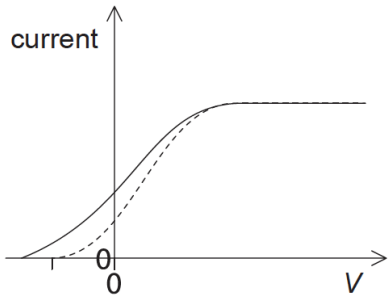
A.



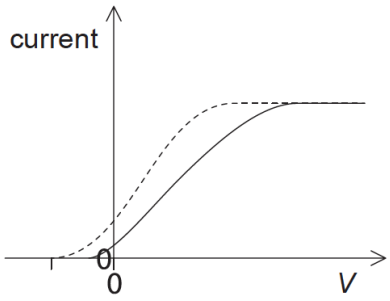
B.



C.



D.



Markscheme

C

16. Light that is shone onto a metal surface may result in the emission of electrons from the surface. Three statements regarding the emission of the electrons are the *[1 mark]*

I. number of electrons emitted per unit time depends on the intensity of the incident light
II. energy of the electrons depends on the frequency of the incident light
III. emission of the electrons takes place instantaneously.

Which of the above statements can **only** be explained by assuming light consists of photons?

A. II only

B. III only

C. II and III only

D. I, II and III

Markscheme

C

17. Photons are incident on a metal surface. Electrons are emitted from the surface. What single change may result in **no** electrons being emitted from the surface? *[1 mark]*

A. Doubling the wavelength of the photons
B. Halving the wavelength of the photons
C. Doubling the number of photons incident on the surface per second
D. Halving the number of photons incident on the surface per second

Markscheme

A

18. Light of frequency f is incident on a metal surface. The work function of the metal is ϕ. Which of the following is the maximum kinetic energy of the electrons emitted from the surface? *[1 mark]*

A. $hf - \phi$

B. $\frac{h}{e}(f - \phi)$

C. $\phi - hf$

D. $\frac{h}{e}(\phi - f)$

Markscheme

A

19. An electron of mass m_e and a proton of mass m_p are moving with the same kinetic energy at non-relativistic speeds. The de Broglie wavelengths associated with the electron and the proton are λ_e and λ_p respectively. *[1 mark]*

Which of the following correctly gives the ratio $\frac{\lambda_e}{\lambda_p}$?

A. $\frac{m_p}{m_e}$

B. $\frac{m_e}{m_p}$

C. $\sqrt{\frac{m_p}{m_e}}$

D. $\sqrt{\frac{m_e}{m_p}}$

Markscheme

C

20. Monochromatic light is incident on a metal surface and electrons are released. The intensity of the incident light is increased. What changes, if any, occur in the rate of emission of electrons and the kinetic energy of the emitted electrons? *[1 mark]*

	Rate of emission of electrons	Kinetic energy of the emitted electrons
A.	increase	increase
B.	decrease	no change
C.	decrease	increase
D.	increase	no change

Markscheme

D