CLASS XII – PHYSICS (042)
PRACTICE PAPER – CHAPTER 11: DUAL NATURE OF RADIATION AND MATTER

Academic Session 2026–27

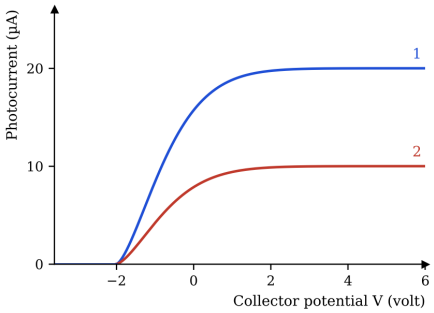
Maximum Marks : 35 **Time Allowed : 1 hour 15 minutes**

General Instructions

(1) There are 18 questions in all. All questions are compulsory.
(2) The question paper has five sections: Section A, B, C, D and E.
(3) Section A (Q.1–9) has seven MCQs and two Assertion–Reasoning questions of 1 mark each. Section B (Q.10–13) has four questions of 2 marks each. Section C (Q.14–16) has three questions of 3 marks each. Section D (Q.17) is one case study based question of 4 marks. Section E (Q.18) is one long answer question of 5 marks.
(4) There is no overall choice. An internal choice is provided in Q.12 (Section B), Q.15 (Section C), Q.17 part (iv) (Section D) and Q.18 (Section E). Attempt only one of the choices in such questions.
(5) Use of calculators is not allowed.
(6) You may use the following values wherever necessary: $h = 6.6 \times 10^{-34}$ J s, $c = 3 \times 10^{8}$ m s^{-1}, $e = 1.6 \times 10^{-19}$ C, 1 eV = 1.6×10^{-19} J, hc = 1240 eV nm, de Broglie wavelength of an electron accelerated through V volt: $\lambda = 12.3/\sqrt{V}$ Å.

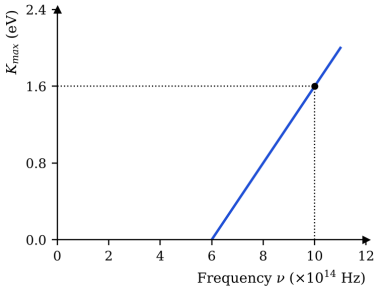
SECTION A (9 × 1 = 9)

1. The graph shows the photocurrent against the potential of the collector for two beams, 1 and 2, of monochromatic light falling on the same photosensitive plate. From the graph we conclude that the two beams have **1**



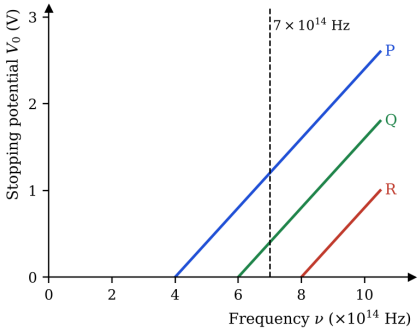
(a) the same intensity, but the frequency of beam 1 is greater than that of beam 2
(b) the same intensity, but the frequency of beam 1 is twice that of beam 2
(c) the same frequency, and the intensity of beam 1 is twice that of beam 2
(d) the same frequency, and the intensity of beam 2 is twice that of beam 1

2. The graph shows the maximum kinetic energy of the photoelectrons emitted from a metal as the frequency of the incident light is varied. The work function of the metal is **1**



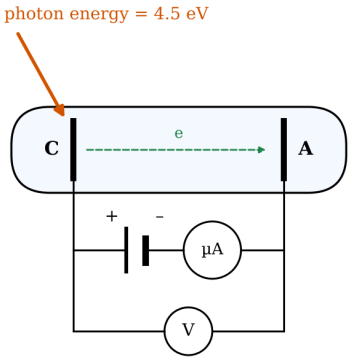
(a) 1.6 eV
(b) 2.4 eV
(c) 3.2 eV
(d) 4.0 eV

3. The graph shows the variation of the stopping potential with the frequency of the incident light for three metals P, Q and R. Light of frequency 7×10^{14} Hz is made to fall on each of them. Photoelectrons will be emitted from **1**



(a) P and Q only
(b) Q and R only
(c) P only
(d) all three metals

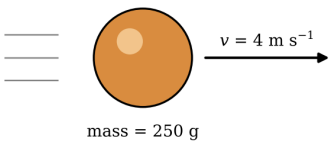
4. In the photocell shown, light of photon energy 4.5 eV falls on the emitter C. When the collector A is made negative with respect to C by 1.5 V, the micro-ammeter just reads zero. The work function of the emitter is **1**



Micro-ammeter reads zero when V = 1.5 V

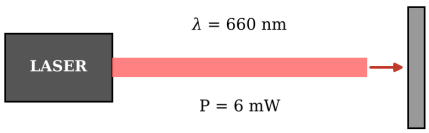
(a) 1.5 eV
(b) 4.5 eV
(c) 6.0 eV
(d) 3.0 eV

5. A ball of mass 250 g moves with a speed of 4 m s^{-1}, as shown. Its de Broglie wavelength is **1**



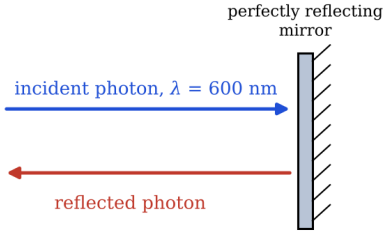
(a) 6.6×10^{-35} m
(b) 6.6×10^{-34} m
(c) 6.6×10^{-33} m
(d) 1.65×10^{-33} m

6. A laser emits a beam of power 6 mW at a wavelength of 660 nm, as shown. The number of photons emitted per second is **1**



(a) 2×10^{15}
(b) 2×10^{17}
(c) 2×10^{16}
(d) 3×10^{16}

7. A photon of wavelength 600 nm strikes a perfectly reflecting mirror normally and is reflected back, as shown. The magnitude of the change in the momentum of the photon is **1**



(a) 2.2×10^{-27} kg m s^{-1}
(b) 1.1×10^{-27} kg m s^{-1}
(c) 3.3×10^{-27} kg m s^{-1}
(d) 4.4×10^{-27} kg m s^{-1}

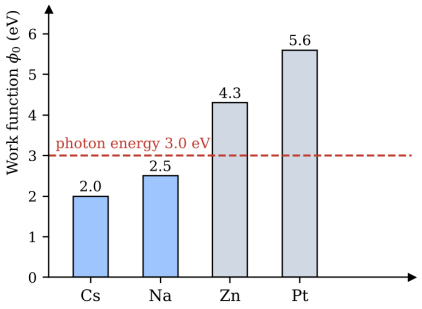
For Questions 8 and 9, a statement of Assertion (A) is followed by a statement of Reason (R). Select the correct answer from the options below.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

8. **Assertion (A):** For light of a given frequency, the stopping potential does not change when the intensity of the light is increased. **1**
Reason (R): The saturation current is directly proportional to the intensity of the incident light.

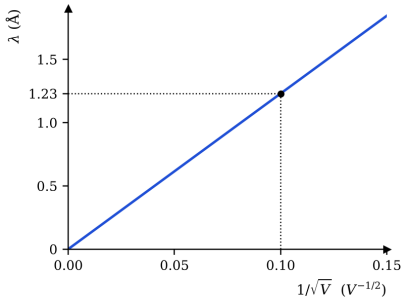
9. **Assertion (A):** Very intense light of frequency less than the threshold frequency can still eject photoelectrons from a metal if it falls for a long time. **1**
Reason (R): In the photon picture, an electron absorbs a single photon at a time and not the energy of many photons.

SECTION B (4 × 2 = 8)

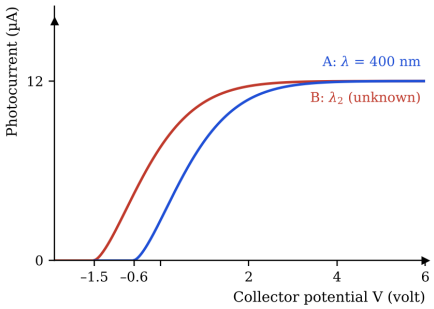
10. The bars show the work functions of four metals, and the dashed line marks the energy of the photons of a monochromatic beam which falls on each of them. (a) Which metals will show photoelectric emission? (b) Find the maximum kinetic energy of the photoelectrons from each of those metals. **2**



11. The graph shows the de Broglie wavelength λ of electrons against 1/√V, where V is the potential difference through which they are accelerated from rest. Use the graph to find (a) the wavelength of electrons accelerated through 225 V, and (b) the accelerating potential for which the wavelength is 0.41 Å. **2**



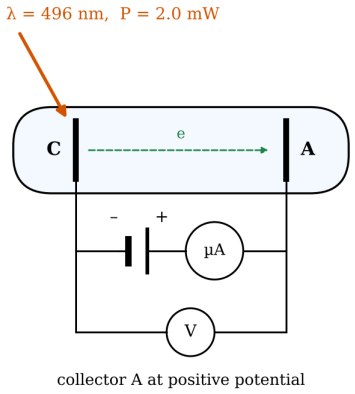
12. **(A)** The graph shows the photocurrent against the collector potential for two light beams, A of wavelength 400 nm and B of unknown wavelength, falling on the same metal. Find (a) the work function of the metal, and (b) the wavelength of beam B. **2**



OR

(B) Write Einstein's photoelectric equation. Use it to explain why no photoelectrons are emitted below a certain frequency, however intense the light may be.

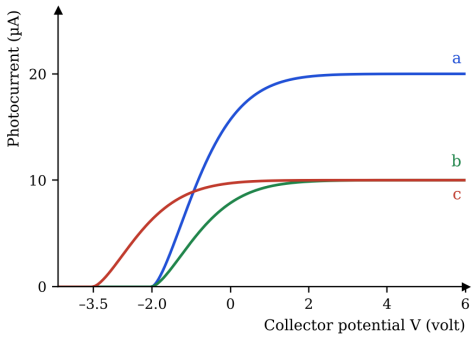
13. Light of wavelength 496 nm and power 2.0 mW falls on the emitter C of the photocell shown, whose collector A is kept at a positive potential. Find (a) the number of photons incident per second, and (b) the saturation current, if one electron is emitted for every 100 photons that fall on the emitter. **2**



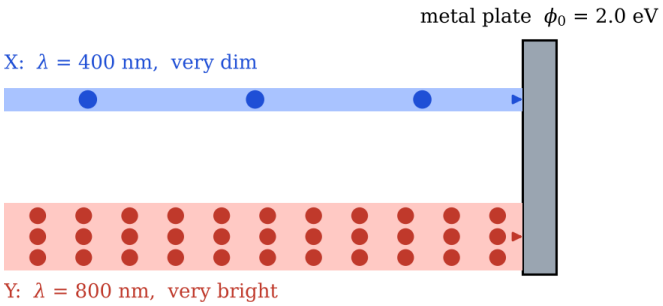
collector A at positive potential

SECTION C (3 × 3 = 9)

14. The graph shows the photocurrent against the collector potential for three beams a, b and c of monochromatic light falling on the same photosensitive plate. (a) Which two beams have the same frequency? Compare the intensities of these two beams. (b) Which two beams have the same intensity? Which of them has the greater frequency? (c) Find the maximum kinetic energy of the photoelectrons for beams a and c, and the difference in the photon energies of beams c and b. **3**



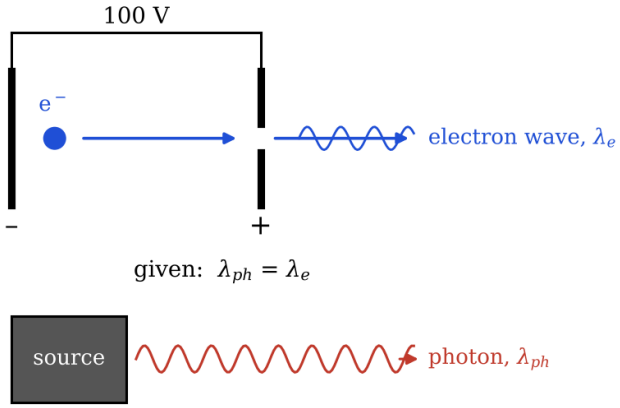
15. **(A)** Two beams X and Y fall on a metal plate of work function 2.0 eV, as shown. Beam X is very dim, of wavelength 400 nm. Beam Y is very bright, of wavelength 800 nm. (a) Find the energy of a photon in each beam. (b) Which beam will cause photoelectric emission? Why would the wave theory of light predict a different result? (c) Find the maximum kinetic energy of the photoelectrons emitted. **3**



OR

(B) State de Broglie's hypothesis. Show that the de Broglie wavelength of a photon is equal to the wavelength of the electromagnetic radiation of which it is a quantum. Why do the objects around us not show wave-like behaviour?

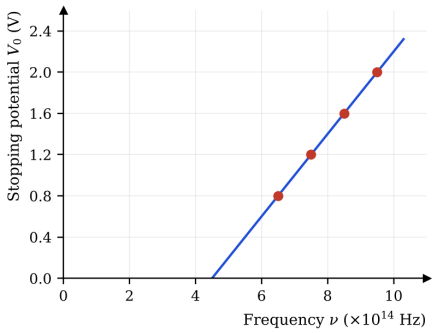
16. An electron accelerated from rest through 100 V is shown along with a photon of the same wavelength. Find (a) the de Broglie wavelength of the electron, (b) the energy of the photon, in keV, and (c) compare the momenta of the two, and say which has the greater energy and by about what factor. **3**



SECTION D (1 × 4 = 4)

17. **Case Study.** A student verifies Einstein's photoelectric equation using a photocell and filters of different frequencies. She measures the stopping potential V_0 for each frequency ν and plots the points, as shown. The straight line through the points meets the frequency axis at $\nu = 4.5 \times 10^{14}$ Hz. Answer the following: **4**

ν ($\times 10^{14}$ Hz)	6.5	7.5	8.5	9.5
V_0 (V)	0.8	1.2	1.6	2.0



(i) The slope of the V_0–ν graph is equal to

(a) h (b) h/e (c) e/h (d) $h\nu_0$

(ii) The threshold frequency of the emitter is

(a) 4.0×10^{14} Hz (b) 4.5×10^{14} Hz (c) 5.0×10^{14} Hz (d) 6.5×10^{14} Hz

(iii) The work function of the emitter is

(a) 1.2 eV (b) 1.8 eV (c) 2.4 eV (d) 3.2 eV

(iv) The value of Planck's constant obtained by the student from the graph is

(a) 3.2×10^{-34} J s (b) 6.4×10^{-34} J s (c) 4.0×10^{-34} J s (d) 1.6×10^{-34} J s

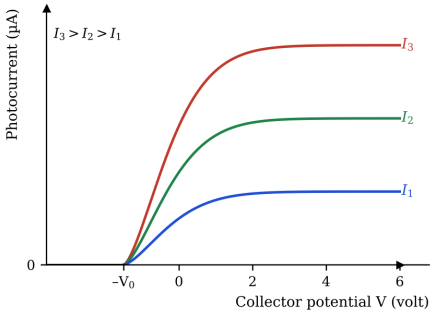
OR

(iv) She repeats the experiment with another emitter of work function 2.4 eV. Its threshold frequency is

(a) 5.0×10^{14} Hz (b) 6.0×10^{14} Hz (c) 7.2×10^{14} Hz (d) 9.0×10^{14} Hz

SECTION E (1 × 5 = 5)

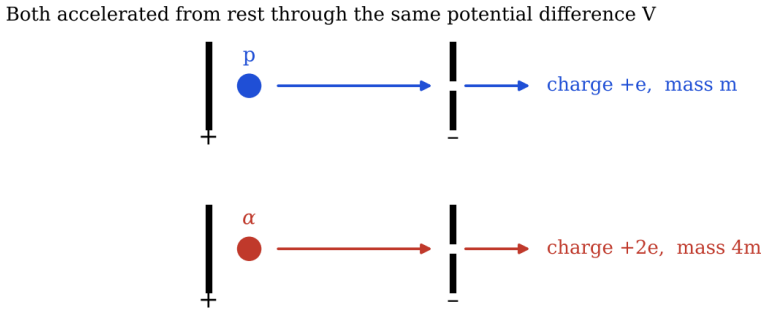
18. **(A)** (a) Using the photon picture of light, obtain Einstein's photoelectric equation. With the help of this equation and the graph shown for three intensities I_1, I_2 and I_3 of the same light, explain (i) the existence of a threshold frequency, and (ii) why the stopping potential is independent of the intensity while the saturation current depends on it. (3) **5**



(b) Light of wavelength 248 nm falls on a metal of work function 2.0 eV. Find the maximum kinetic energy of the emitted electrons, the stopping potential, and the threshold wavelength of the metal. (2)

OR

(B) (a) State de Broglie's relation. Derive the expression for the de Broglie wavelength of a particle of mass m and charge q accelerated from rest through a potential difference V. (3)



(b) For the proton and the α-particle shown, find the ratio of their de Broglie wavelengths (i) when both are accelerated through the same potential difference V, and (ii) when both have the same kinetic energy. (2)

— End of Question Paper —