2025 H2 Physics P1 Solutions

1 **A** Units of Q is C = A s

Units of V is J C^{-1} = kg m^2 s^{-2} / A s

Hence units of C = A^2 s^4 m^{-2} kg^{-1}

2 **A** Average of h

A – 6.63 , B – 6.63, C – 6.65, D – 6.62

A, B and D are accurate

Range of variation of h

A - 0.04, B – 0.02, C – 0.07, D – 0.02

B and D are precise

3 **C** $\dfrac{\Delta v}{v} \times 100\% = \dfrac{1}{2}\left(\dfrac{0.05}{4.30} + \dfrac{20}{1450} + 0.05\right) \times 100\% = 3.8\% \approx 4\%$

4 **A** Initial velocities for both stones, $u = 0$

$s = ut + \frac{1}{2} gt^2 = \frac{1}{2} gt^2$

For the same time interval, Δt, both stones fall down by the same distance, s.

Therefore the distance between them will always remain the same as that at the point of release.

5 **D** $F = N\rho A v^2 = (27)(900)(0.4 \times 10^{-6})(3.0)^2 = 0.087$ N

6 **B** The weight of the water converted to ice is the same as that of the ice.

7 **B** Instantaneous power required to drive the escalator

$= Fv + P_{\text{friction}}$

$= Mg \sin\theta \times v + P_{\text{friction}}$

$= \left(62 \times 20 \times 9.81 \times \dfrac{30}{60} \times 0.75\right) + 2.5 \times 10^3$

$= 7.1 \times 10^3$ W

$= 7.1$ kW

8 **C** Drag at 21.0 m s⁻¹: $f_D = \dfrac{110}{21} = 5.24$ kN

Drag at 15.0 m s⁻¹: $\dfrac{f_D{'}}{f_D} = \left(\dfrac{15.0}{21.0}\right)^2 \Rightarrow f_D{'} = 2.67$ kN

Force of engine at 15.0 m s⁻¹: $F_{engine} = \dfrac{110}{15} = 7.33$ kN

Hence resultant force = 7.33 – 2.67 = 4.66 kN

9 **B** Work done = mass x change in potential

= (1) (final potential – initial potential)

$= -\dfrac{3GM}{2R} - \left(-\dfrac{GM}{R}\right) = -\dfrac{GM}{2R}$

10 **C** Top: $F_{top} + mg = mr\omega^2$

$F_{top} = 77\,[4(2\pi/3.7)^2 - 9.81] = 133$ N (downwards)

Bottom: : $F_{bottom} = mg + mr\omega^2$

$F_{bottom} = 77\,[4(2\pi/3.7)^2 + 9.81] = 1640$ N (upwards)

11 **D** Resultant force towards the sun equals to ma_c.

12 **D** GPE of orbiting satellite $E_p = -G\dfrac{Mm}{r}$

Gravitational force = centripetal force

$\Rightarrow \quad G\dfrac{Mm}{r^2} = m\dfrac{v^2}{r}$

$\Rightarrow \quad E_k = \dfrac{1}{2}mv^2 = \dfrac{1}{2}G\dfrac{Mm}{r}$

$\Rightarrow \quad E_p = -2E_k$

$E_p{'} = E_p + E$

$\Rightarrow -2E_k{'} = -2E_k + E$

$\Rightarrow \quad E_k{'} = E_k - \dfrac{E}{2}$

13 **A** Total number of moles of gas is constant. Since *PV = nRT*, we take the initial number of moles in the smaller (A) and larger bulb (B) to be *n* and 8*n* respectively. Total number of moles = 9n.

At new equilibrium, the pressure will be the same for both.

$$P_f V = n'RT_A = n'R(80 + 273.15)$$
$$P_f(8)V = (9n - n')RT_B = (9n - n')R(10 + 273.15)$$

Dividing:

$$\frac{V}{8V} = \frac{n'(353.15)}{(9n - n')(283.15)}$$
$$\frac{9n - n'}{n'} = \frac{8 \times 353.15}{283.15}$$
$$\frac{9n}{n'} = \frac{8 \times 353.15}{283.15} + 1$$
$$n' = 0.8194n$$
$$\Delta n = n - 0.8194n = 0.18n$$

14 A

$$\frac{x_{t=\frac{5T}{8}}}{x_0} = \frac{x_0 \sin(\frac{2\pi}{T} \times \frac{5T}{8})}{x_0}$$
$$= x_0 \sin(\frac{5\pi}{4})$$
$$= -0.71$$

15 C

$$E = \frac{1}{2}m(2\pi f)^2 x^2$$

$$\frac{1}{2}(0.5m)(2\pi)^2(3.0f)^2(0.40x)^2 = (0.72)\left(\frac{1}{2}m(2\pi f)^2 x^2\right)$$
$$= 0.72E$$

16 D

$$I = \frac{P}{2\pi r d} \propto \frac{1}{r}$$
$$I \propto A^2$$
$$\therefore A \propto \frac{1}{\sqrt{r}}$$
$$\frac{A'}{2.0} = \sqrt{\frac{150}{1200}}$$
$$A' = 0.71 \ mm$$

17 C Unpolarised light **a**fter passing through a polarizer, its intensity is halved (therefore we eliminate options A/B).

Amplitude remains at A. (The component of E field perpendicular to the polariser axis is absorbed (e.g. A_Y is absorbed), leaving the transmitted light having amplitude A_X)

Since the polarization angle is 75° (or 105º), by resolving the electric field,

$A' = A \cos 75° = A \sin 15°$

18 **A** First minima position:

b sin θ = λ

0.010 x 10^{-3} x 0.05 = λ

5.0 x 10^{-7} m = λ

19 **D** Electric potential energy $U = qV$

Since charge of electron is –ve, and potential at X is +ve while that at Y is –ve,

$\Rightarrow U_Y > U_X$

Magnitude of electric force $F = qE$. Since the E field strength at Y > E field strength at X

$\Rightarrow F_Y > F_X$

20 **D** Break in +ve wire of cable $\Rightarrow$ voltmeter reading = 0 when connected to X or Y

Break in connection within motor $\Rightarrow$ voltmeter reading = 24 V when connected to X and 0 V when connected to Y

Break in –ve wire of cable $\Rightarrow$ voltmeter reading = 24 V when connected to X or Y

21 **A** In dark condition:

$$V = \frac{5 \times 10^3}{5 \times 10^3 + 5 \times 10^6} \times 6 = 0.0060 \ V$$

In bright condition:

$$V = \frac{5 \times 10^3}{5 \times 10^3 + 1 \times 10^3} \times 6 = 5.0 \ V$$

22 **C**
$$P = I^2 R = I_{rms}^2 \frac{R}{4}$$

$$I_{rms} = 2I \qquad \Rightarrow I_o = 2\sqrt{2}I$$

23 **A** The point charge's velocity is parallel to resultant magnetic flux density at the centre of the two wires. Thus magnetic force is zero.

24 **A**

25 **A** By Fleming's left hand rule (to find force on an electron in the rod), the electrons in the rod will accumulate at P, causing Q to be of higher electrical potential.

26 **C** If the magnetic flux linkage is a sine function, the induced e.m.f. will be a cosine function, and vice-versa. Hence, the phase difference between them is $\pi/2$ rad.

27 **D** Option A is incorrect because photoelectric effect can occur even for very low intensity but sufficiently high frequency radiation (above the threshold frequency f_0).

Option B is incorrect because photoelectrons are emitted only if the frequency of radiation is greater than a minimum frequency known as threshold frequency f_0; since $\lambda_0 = \frac{c}{f_0}$, the wavelength of the radiation must be <u>smaller</u> than the threshold wavelength, which is instead a <u>maximum</u> value.

Option C is incorrect because the maximum kinetic energy and thus speed of the photoelectrons is independent of intensity but depends on the frequency of radiation and work function of the metal, as given by $hf = \Phi + E_{k,max}$.

Option D is correct since $I = \frac{N_P}{t}\frac{hf}{A}$, at constant intensity and increased frequency, the rate of photons incident on the metal decreases, the lesser the rate of emission of photoelectrons.

28 **D** proton with the same v but bigger m than electron will have a much larger momentum p (more than 1000 times)

Rings will not be observable.

29 **A** $A_{P0} + A_{Q0} = 800$ (1)

$$A_{P0}\left(\frac{1}{2}\right)^{120/60} + A_{Q0}\left(\frac{1}{2}\right)^{120/30} = 80$$

$$\frac{1}{4}A_{P0} + \frac{1}{16}A_{Q0} = 80$$

$$\Rightarrow 4A_{P0} + A_{Q0} = 1280 \quad\quad\quad (2)$$

(2) − (1) :

$$3A_{P0} = 480$$

$$A_{P0} = 160$$

30 **B** Only α decay results in a change in mass number, and each α decay causes the mass number to decrease by 4. Hence the difference in the mass number of the end product and the parent nuclide must be a multiple of 4.