Turning Points in Physics – 1 - Answers

1.

(a)

Answers	Additional Comments/Guidelines	Mark
Cathode rays/electrons move from cathode toward anode The paddle wheel has gained energy from cathode rays/electrons. ✓	Accept move left to right. Accept as alternatives for energy kinetic, energy/momentum/impulse ✓ Ignore references to force. Ignore references to applying a magnetic field.	1 1

(b)

Electrons are pulled out/escape from atoms OR gas atoms are ionised ✓ (Positive ions generated near the cathode are attracted to the cathode causing free) electrons emitted from the cathode.✓ Electrons are accelerated toward the anode (by the potential difference) ✓	Condone molecules as alternative to atoms. Do not accept attraction as an alternative to acceleration.	1 1 1

(c)

Reason: Idea of fewer electrons/cathode rays ✓ Effect: Paddle wheel rotates less ✓ ***OR*** Reason: Idea of electrons/cathode rays have higher energy/speed/momentum ✓ Effect: Paddle wheel rotates more ✓	Must score the reason mark to score the effect mark. Ignore references to air resistance. If no mark is awarded, one mark can be awarded for the effect of the paddle wheel rotating more where the reasoning is limited to less collisions of electrons with air molecules.	2

2.

(a)

Answers	Additional Comments/Guidelines	Mark
Observation A – When rotation speed is low the light returns through the original gap. ✓ Observation B – The light is blocked when it hits an adjacent tooth on return from the mirror. ✓	Condone an answer where candidate has substituted tooth for gap throughout.	1 1

(b)

$c = 4 \times 8600 \times 720 \times 12 = 2.97 \times 10^8\ ms^{-1}$ ✓ Comparison to speed of light $3.0 \times 10^8\ ms^{-1}$ and judgement that they are similar. ✓	 Speed of light must be given to 2 or 3 significant figures.	1 1

(c)

Must go past a gap and to the next tooth ✓ 36 rotations per second / Hz ✓	Accept a clear diagram as an alternative	2

(d)

Maxwell's theory of electromagnetic waves predicted a value for the speed of electromagnetic waves ✓ Fizeau's result is close to the predicted speed (of electromagnetic waves) ✓ Implies that light is an electromagnetic wave. ✓		3

3.

(a)

Answers	Additional Comments/Guidance	Mark
Filament / metal is heated due to the current through it ✓ Or temperature of the filament rises due to the current through it	Not electrons are heated Not heated due to the pd across it Allow by electrical power or electrically heated	3
(free / conduction) electrons gain sufficient/enough (kinetic) energy to leave (the metal surface) or Work function (defines work function)≤ energy supplied to an electron/electron energy✓	Not allowed Reference to electrons leaving atoms or ionisation	
Thermionic emission ✓	Allow Energy supplied sufficient to overcome the work function	

(b)

Use one of $\frac{1}{2}mv^2 = eV$ and $r = \frac{mv}{Be}$ or $\frac{mv^2}{r} = Bev$ to arrive at $\frac{Ber}{m} = v$ or $v = \sqrt{\frac{2eV}{m}}$ or $v^2 = \frac{2eV}{m}$ or $\frac{e}{m} = \frac{v}{Br}$ or $\frac{e}{m} = \frac{v^2}{2V}$ ✓	Condone q for e Substitution in other equation and correct manipulation	2
substitution in the other equation and manipulates correctly and clearly to give $\frac{e}{m} = \frac{2V}{B^2r^2}$ ✓	NB this is a show that so mark is not simply for stating the equation given I presented such that v (velocity) and V (voltage) are indistinguishable in manipulation then award only first mark	

(c)

Correct substitution $\frac{e}{m} = \frac{2 \times 320}{(1.5 \times 10^{-3})^2 \times 0.040^2}$ and answer 1.8×10^{11} ✓ Answer to 2 sig figs ✓ Allow for incorrect answer following incorrect substitution in equation	As answer is on the data sheet must see correct substitution with all correct powers of ten	2

(d)

The specific charge of the cathode rays/the particles was(much) larger/greater than the hydrogen ion/proton ✓ This provided evidence that cathode rays were composed of electrons/particles which have a (very) small mass / have a high (negative) charge or Mass (much) smaller than the mass of a hydrogen (ion)/proton✓	Not higher If mark 1 not given then 0 for the question Not lightest as substitute for mass	2

4.

(a)

Answers	Additional Comments/Guidance	Mark
Converts 6.2 eV, 0.5 eV or 6.7 eV to J eg 6.2 x 1.6 x 10^{-19} J or 9.9(2) x 10^{-19} seen for 0.5 eV 8.0 x 10^{-20} seen for 6.7eV 1.07 x 10^{-18} seen ✓ $\lambda = \frac{hc}{E}$ or substitution $E = \frac{6.63\times10^{-34}\times3\times10^{8}}{\lambda}$ With one of the above values included for energy✓ 190 (185,186 or 187) nm ✓	NB use of $\lambda=h/mv$ is a PE and scores 0 May use $f = \frac{E}{h}$ and then $\lambda = \frac{c}{f}$ Treat incorrect E in the same way Guidance Use of 0.5 eV gives 4.0 x 10^{-25} 6.2 eV 3.2 x 10^{-26} 6.7 eV 3.0 x 10^{-26} *These will score 1* 8.0 x 10^{-20} gives 2500 nm 9.9(2) x 10^{-19} 200 nm *These will score 2* 1 sf answers are not allowed so correct working with answer 186 nm rounded to 200 nm will also score 2	1 1 1

(b)

Classical Wave Model Wave model predicts an increase in the photocurrent Plus one from • as energy transferred into each electron increases (over time) /energy of the emitted electrons increases • electrons can gain sufficient KE to reach T • electrons can leave the surface with greater KE✓ **Photon Model** The photon model predicts no change in the photocurrent Or photocurrent remains at zero ✓ One from • the energy of a photon depends on the frequency not the intensity • energy of each incident photon remains the same • KE of electrons leaving the surface does not change • Electrons released are still unable to reach T✓	NB The response has to discuss the effect of each theory on the maximum KE of the electrons when they leave the surface. Discussions that relate to threshold frequency or delay before emission are not relevant.	3

(c)

Answers	Additional Comments/Guidance	Mark
Fewer electrons will have sufficient energy to move away from the surface/or to reach T/anode Or Electrons need more energy to cross the gap Or Some of the electrons released were more tightly bound to the surface Or Electrons have a range of energies(when emitted from surface) or Some electrons use more of the photon energy to escape from the surface (this is related to the energy of the photoelectrons). ✓	Fewer electrons <u>per second</u> have <u>sufficient kinetic energy to reach T</u> scores 2	
Fewer electrons <u>per second/rate at which electrons reach T</u> will <u>reach terminal T/cross the gap</u> (the per second part captures what is going on in terms of the current)✓		1
	Do not allow fewer photoelectrons per second flowing through the circuit	1

(d)

A > B > C ✓		1