Mark Scheme Grade 13 tutorial week 1

Section A

1. **A**
2. **B**
3. **A**
4. **D**
5. **B**
6. **C**
7. **B**
8. **D**
9. **C**
10. **B**
11. **C**
12. **D**
13. **B**
14. **D**
15. **B**
16. **D**
17. **B**
18. **A**
19. **D**
20. **B**

Section B

Question 1

(a) (i) amplitude scale reading 2.2 (cm)
amplitude = $2.2 \times 2.5 = 5.5\,\text{mV}$

(ii) time period scale reading = 3.8 (cm)
time period = $3.8 \times 0.5 \times 10^{-3} = 0.0019\,(\text{s})$

frequency f = 1 / 0.0019 = 530 (526) Hz

(iii) uncertainty in reading = ± 0.2 in 3.8 (cm) or 5.3% or 0.2 in 7.6 (cm) or 2.6% [allow other variations of the distance on the *x*-axis]

actual uncertainty = 5.3% of 526 = 27.7 or 28 Hz
or 2.6% of 526 = 13 or 14

(b) frequency = 530 ± 30 Hz or 530 ± 10 Hz

Question 2

(a) for a system (of interacting bodies) the <u>total</u> momentum remains constant provided there is no <u>resultant</u> force acting (on the system)

(b) (i) total momentum $= m_1v_1 + m_2v_2$
$= 0.4 \times 0.65 + 0.6 \times 0.45$
$= 0.26 + 0.27 = 0.53\,\text{Ns}$

(ii) $0.53 = 0.4 \times 0.41 + 0.6 \times v$

$v = 0.366 / 0.6 = 0.61\,\text{m s}^{-1}$

(iii) $\text{KE} = \frac{1}{2}mv^2$
total initial KE $= \frac{1}{2} \times 0.4 \times (0.65)^2 + \frac{1}{2} \times 0.6 \times (0.45)^2$
$= 0.0845 + 0.06075 = 0.15(0.145)\,\text{J}$

(c) check relative speed of approach equals relative speed of separation
or:
total final kinetic energy equals the total initial kinetic energy

(d) the forces on the two bodies (or on X and Y) are equal and opposite
time same for both forces <u>and</u> force is change in momentum/time

Question 3

(a) $R = \rho l / A$

$A = [\pi \times (0.38 \times 10^{-3})^2] / 4 \quad (= 0.113 \times 10^{-6}\ \text{m}^2)$

$R = (4.5 \times 10^{-7} \times 1.00) / ([\pi \times (0.38 \times 10^{-3})^2] / 4) = 4.0\,(3.97)\,\Omega$

(b) (i) $I = V/R$
$= 2.0 / 5.0 = 0.4(0)\,\text{A}$

(ii) p.d. across BD $= 4 \times 0.4 = 1.6\,\text{V}$

(iii) p.d. across BC (l) $= 1.5\,(\text{V})$

BC (l) $= (1.5 / 1.6) \times 100 = 94\,(93.75)\,\text{cm}$

(c) p.d. across wire not balancing e.m.f. of cell OR cell Y has current
energy lost or lost volts due to internal resistance

Question 4

(a) (i) progressive: energy is moved / transferred / propagated from one place to another (without the bulk movement of the medium)

transverse: (particles) oscillate / vibrate at right angles to the direction of travel of the energy / wavefront

(ii) number of oscillations per unit time / number of wavefronts passing a point per unit time

(b) (i) P and T

(ii) P and S or Q and T

(c) $\lambda = 1.2 \times 10^{-2}$ (m)

$v = f\lambda$
$= 15 \times 1.2 \times 10^{-2}$
$= 0.18\ \text{m s}^{-1}$

(d) ratio $= (1.4)^2 / (2.1)^2$
$= 0.44$

Question 5

(a) initially, $pV/T = (2.40 \times 10^5 \times 5.00 \times 10^{-4})/288 = 0.417$
finally, $pV/T = (2.40 \times 10^5 \times 14.5 \times 10^{-4})/835 = 0.417$
ideal gas because pV/T is constant
(*allow 2 marks for two determinations of V/T and then 1 mark for V/T and p constant, so ideal*)

(b) (i) work done $= p\Delta V$
$= 2.40 \times 10^5 \times (14.5 - 5.00) \times 10^{-4}$
$= 228$ J (*ignore sign, not 2 s.f.*)

(ii) $\Delta U = q + w = 569 - 228$
$= 341$ J
increase

Question 6

(a) work done / energy in moving unit positive charge from infinity (to the point)

(b) (i) $V = q/4\pi\varepsilon_0 r$
at 16 kV, $q = 3.0 \times 10^{-8}$ C

$r = (3.0 \times 10^{-8})/(4\pi \times 8.85 \times 10^{-12} \times 16 \times 10^3)$
$= 1.69 \times 10^{-2}$ m (*allow 2 s.f.*)
(*allow any answer which rounds to 1.7×10^{-2}*)

(ii) energy is/represented by area 'below' line
energy $= \frac{1}{2}qV$
$= \frac{1}{2} \times 24 \times 10^3 \times 4.5 \times 10^{-8}$
$= 5.4 \times 10^{-4}$ J

(c) $V = q/4\pi\varepsilon_0 r$ and $E = q/4\pi\varepsilon_0 r^2$ giving $Er = V$
$2.0 \times 10^6 \times 1.7 \times 10^{-2} = V$
$V = 3.4 \times 10^4$ V

Question 7

(a) *either* charge exists in discrete and equal quantities
or multiples of elementary charge/e/1.6×10^{-19} C

(b) **(i)** force due to magnetic field must be upwards
B-field into the plane of the paper

(ii) sketch showing: deflection consistent with force in **(b)(i)**
reasonable curve

Question 8

(a) product of density and speed
density of medium, speed of wave in medium
(*not "speed of light", 0/2*)

(b) **(i)** $\alpha = (6.4 - 1.7)^2/(6.4 + 1.7)^2$
$= 0.34$

(ii) $I/I_0 = e^{-\mu x}$
$= \exp(-23 \times 3.4 \times 10^{-2})$
$= 0.46$

(iii) $I_R/I = (0.46)^2 \times 0.34$
$= 0.072$