This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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1 (a) ampere
   kelvin
   (allow mole and candela)

   B1
   B1  [2]

   (b) (i) stress: N m\(^{-2}\)
      \(\text{kg m} \text{s}^{-2} \text{m}^{-2} = \text{kg m}^{-1} \text{s}^{-2}\)
      C1
      A1  [2]

   (ii) Young modulus = stress/strain and strain has no units
      hence units: kg m\(^{-1}\) s\(^{-2}\)
      B1  [1]

2 (a) (i) amplitude scale reading 2.2 (cm)
      amplitude = 2.2 \(\times\) 2.5 = 5.5 mV
      C1
      A1  [2]

   (ii) time period scale reading = 3.8 (cm)
      time period = 3.8 \(\times\) 0.5 \(\times\) 10\(^{-3}\) = 0.0019 (s)
      C1
      C1

      frequency \(f = 1 / 0.0019 = 530\) (526) Hz
      A1  [3]

   (iii) uncertainty in reading = \(\pm\) 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]
      M1

      actual uncertainty = 5.3% of 526 = 27.7 or 28 Hz
      or 2.6% of 526 = 13 or 14
      A1  [2]

   (b) frequency = 530 \(\pm\) 30 Hz or 530 \(\pm\) 10 Hz
      A1  [1]

3 (a) displacement/velocity/acceleration/momentum/etc.
      three correct (none wrong) 2, two correct (none or one wrong) 1
      A2  [2]

   (b) (i) \(Y = 70\) N [allow 71 N as +\(\frac{1}{2}\) small square on graph]
      A1  [1]

   (ii) \(\theta = 90^\circ\)
      M1

      (for equilibrium) the direction of \(Y\) must be opposite to \(Z\)

      or using \(Y \sin \theta = Z\), hence \(\sin \theta = 70 / 70 = 1, \theta = 90^\circ\)
      A1  [2]

   (iii) 1. \(Y \cos \theta = 160\) and \(Y \sin \theta = 70\)
      \(\tan \theta = 70 / 160\) hence \(\theta = 23.6^\circ\) (24\(^\circ\))
      C1
      A1  [2]

      2. \(Y = 160 / \cos 23.6^\circ\) or 70 / sin 23.6\(^\circ\)
      \(= 174.6\) or 175 or 170 N
      C1
      A1  [2]

      or:
      \(160^2 + 70^2 = Y^2\)
      \(Y = 174.6\) or 175 or 170 N
      (C1)
      (A1)
c) (equilibrium not possible as) there is no vertical component from Y to balance Z B1 [1]

4 (a) for a system (of interacting bodies) the total momentum remains constant provided there is no resultant force acting (on the system) M1 A1 [2]

(b) (i) total momentum  =  \( m_1v_1 + m_2v_2 \)

\[ = 0.4 \times 0.65 + 0.6 \times 0.45 \]
\[ = 0.26 + 0.27 = 0.53 \text{ Ns} \] C1

(ii) \( 0.53 = 0.4 \times 0.41 + 0.6 \times v \) C1

\( v = 0.366 / 0.6 = 0.61 \text{ m/s}^{-1} \) A1 [2]

(iii) \( KE = \frac{1}{2}mv^2 \)

total initial KE = \( \frac{1}{2} \times 0.4 \times (0.65)^2 + \frac{1}{2} \times 0.6 \times (0.45)^2 \)

\[ = 0.0845 + 0.06075 = 0.15 \text{ (0.145) J} \] C1

(c) check relative speed of approach equals relative speed of separation or:

total final kinetic energy equals the total initial kinetic energy B1 [1]

(d) the forces on the two bodies (or on X and Y) are equal and opposite
time same for both forces and force is change in momentum/time B1 [2]

5 evaporation: molecules escape from the surface at all temperatures B1

boiling: takes place throughout/in the liquid at the boiling point/at specific temperatures B1 [4]

6 (a) \( R = \rho l / A \) C1

\[ A = \left[ \pi \times (0.38 \times 10^{-3})^2 \right] / 4 \] (\( = 0.113 \times 10^{-8} \text{ m}^2 \)) C1

\[ R = (4.5 \times 10^{-7} \times 1.00) / \left[ \frac{\pi \times (0.38 \times 10^{-3})^2}{4} \right] = 4.0 \text{ (3.97) } \Omega \] M1 [3]

(b) (i) \( I = \frac{V}{R} \)

\[ = 2.0 / 5.0 = 0.4(0) \text{ A} \] A1 [2]

(ii) p.d. across BD = 4 \times 0.4 = 1.6 \text{ V} A1 [1]

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

\( BC \ (l) = \left( \frac{1.5}{1.6} \right) \times 100 = 94 \text{ (93.75) cm} \) A1 [2]
(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 B1 [2]

7 (a) (i) progressive: energy is moved/transferred/propagated from one place to another (without the bulk movement of the medium) B1
   transverse: (particles) oscillate/vibrate at right angles to the direction of travel of the energy/wavefront B1 [2]
   (ii) number of oscillations per unit time/number of wavefronts passing a point per unit time B1 [1]

(b) (i) P and T B1 [1]
   (ii) P and S or Q and T B1 [1]

(c) \( \lambda = 1.2 \times 10^{-2} \) (m) C1
   \( v = f\lambda \)
   \( = 15 \times 1.2 \times 10^{-2} \)
   \( = 0.18 \text{ m s}^{-1} \) A1 [3]

(d) ratio = \( (1.4)^2 / (2.1)^2 \)
   = 0.44 C1