1. (a)(i)   (constant velocity) hence no resultant force/forces add up to zero/ forces balanced / in equilibrium   **B1**

            friction and (component of) weight down slope = tension (component) up slope   **B1**

      (ii)   **1**   400cos40   **C1**
                306 (N)   (allow 310)   **A1**

              2   (400sin40)
                257 (N)   (allow 260)   **A1**

             (answers to 1 and 2 reversed score 2/3)

      (iii)   resultant force no longer zero/forces on longer balanced/not in equilibrium
              accelerate (along the slope)/increases velocity
              life up off the slope
              greater air resistance
              less (contact) friction
              forced to let go
              any TWO POINTS   **B2**

                                                     [Total 7]

2. (a)(i)   <u>point</u> where the weight (allow mass) (appears to) acts   **B1**

      (ii)   force x perpendicular distance from (line of action to) point/pivot   **B2**
              any missing points in the definitions −1

    (b)(i)   force up at A at pivot point
              force due to the weight of man down near centre of body
              support from scale up within pad   **B3**
              ignore labels for reaction forces at A and B (arrows only needed),
              weight of man needs a label to distinguish from W weight of plank

      (ii)   anticlockwise moments = clockwise moments seen or implied   **C1**

              $5g \times 1 + 75g \times d = 44g \times 2$ **C1**

                 $d = (88g - 5g) / 75g$ **C1**

                 = 1.1 (m)   **A1**

              (if weight of plank ignored then max score of 2)

                                                      [Total 10]

5. (a)   load / force is proportional to extension   **B1**

    (b)(i) E = $(F \times 1) / (e \times A)$ / E = stress / strain   **C1**
                      = (gradient of graph x 1.7) / 1.8×10^{-7} **C1**

                      (grad = $29.0/1.6 \times 10^{-3}$ or use of two points on line)   **C1**

                      = 1.71×10^{11} (Pa)   **A1**

     (ii) W = area under line / $W = \frac{1}{2} Fe$ **C1**

                      = $\frac{1}{2} \times 29 \times 1.6 \times 10^{-3}$ **C1**

                            = 0.023 (J)   **A1**

    (c)   deforms when in a collision
             for elastic collision no kinetic energy lost to other forms
             plastic deformation changes kinetic energy into other forms
             work / energy absorbed is force x distance (extension) / area under graph
             large extension (for a given force) occurs in the plastic region
             the force is constant in the plastic region

             maximum of three marks   **B3**

                                                           [Total 11]

6. (a)   **1**   distance travelled while the driver is reacting   **B1**
                2   distance travelled while the driver is braking (to a stop)   **B1**

    (b)(i)   (distance is proportional to speed) <u>as reaction time is constant</u>   **B1**

     (ii)   9.6 / t = 16   **C1**
                   t = 0.6(0) (s)   **A1**

     (iii)   **1**   = 0.6 x 30   **C1**
                      = 18 (m)   **A1**

                2 $s = (v^2 - u^2) / 2a$ **C1**
                      s = 0 – 900) / -13   **C1**
                      = 69.2
                      total distance = 87.2 (m)   **A1**

    (c)   road conditions: e.g. wet – less friction / greater distance   **B1**

             tyre tread: no tyre tread water film forms / grooves on tyres help
             increase friction by removing the water layer   **M1**

             with reduced tyre tread less friction hence greater distance   **A1**

             no tyre tread on dry roads can give greater friction and shorter stopping distance can score $\frac{1}{2}$.

                                                            [Total 13]

60 marks in total

3. (a)   at rest acceleration = g   B1
         resultant force = W / air resistance R is zero   B1

         Air resistance force acts up/opposes weight   B1
         resultant force = W – R   B1
         acceleration is < g   B1

         R increases with v   B1
         eventually R = W / resultant force is zero   B1
         acceleration = 0 / constant/terminal velocity/speed   B1

                                                                            Max 6

   (b)   reduce the amount of friction with the air/drag/reduce cross-sectional
         area (air acts on) /or reduce the surface area for smooth clothing   B1

         dive head first / bring in arms and legs closer to body/stream-lining B1

                                                                            [Total 8]
         1 mark awarded for spelling, punctuation and grammar
         1 mark for use of technical terms   QWC [2]

4. (a)(i) $p = F / A$ M1
           where F is force normal to the cross-sectional area A   A1

   (ii)   Pa / Nm^{-2} B1

   (b)(i) $p = 28 / 8$ C1
                           3.5 N cm^{-2} / 35000 Pa   A1

   (ii) $F = p \times 40$ C1
                           140 (N)   A1

   (iii)   greater force applied to master cylinder / master cylinder smaller
           (area) / slave cylinder bigger (area) **(any two)**   B2

                                                                            [Total 9]