Mixed Exercise 3 - Answers

1.

(a)	(i)	9.8(1) m s^{-2} / *g* / acceleration of free fall The only force acting is weight / drag force is zero	B1 B1	
	(ii)	(The maximum velocity when) drag = weight	B1	
	(iii)	The golf ball experiences greater drag (at terminal velocity to equal its larger weight) (AW) Drag increases with speed or drag $\propto v^2$ or the golf ball takes longer time to reach its terminal velocity or the golf ball accelerates for longer time The golf ball (has greater terminal velocity)	B1 B1 B1	
(b)	(i)	drag = 2000 (N) from the graph net force = 3200 - 2000 (N) / net force = 1200 (N) acceleration = 1200/8000 acceleration = 0.15 (m s^{-2})	C1 C1 A1	 Possible ecf if reading off graph is incorrect No credit for 3200/8000 = 0.4(0 m s^{-2}) or 2000/8000 = 0.25 (m s^{-2})
	(ii)	The drag force will be greater than the (constant) forward force (which cannot be) or at 32 (m s^{-1} drag) force is 3200 ± 100 (N) or at 40 (m s^{-1} drag) force is 5100 ± 100 (N)	B1	**Allow** maximum speed is 32 (m s^{-1})
(c)		The time taken (for the driver) to stop is more or distance travelled (by the driver) is greater. *F* = *ma* *a* decreases (hence *F* is smaller) or *Fx* = *KE* KE is the same (hence *F* is smaller) or *F* = Δ*p*/Δ*t* Δ*p* is the same (hence *F* is smaller)	B1 B1 B1 B1 B1 B1 B1	**Allow** 'it takes longer to stop' or 'increases impact time' **Not** slower acceleration KE ≡ *W* (for work done)

2.

(a)		$N\ m^{-2}$ or N/m^2 or Pa $m\ s^{-2}$ or m/s^2 or (kg) $m\ s^{-2}$ 1000	B2	**Allow** any prefix given **Allow**: 2 marks if all three correct; 1 mark if one is correct or two are correct
(b)		(volume =) 82 - 75 (cm^3) or 7 (cm^3) density = $\frac{1.6\times10^{-2}}{7\times10^{-6}}$ density = 2.3×10^3 ($kg\ m^{-3}$)	C1 A1	 **Allow**: 1 mark for 2.3×10^n, $n \neq 3$

3.

(a)		It has **direction** (and magnitude/size)	B1	**Note:** ✎ ***direction*** must be spelled correctly for the mark
(b)	**(i)**	perpendicular component = 8.0×10^{-5} cos30 perpendicular component = 6.9×10^{-5} (N) parallel component = 8.0×10^{-5} sin30 parallel component = 4.0×10^{-5} (N) or 4×10^{-5} (N)	B1 B1	**Allow**: 1 mark if the correct numerical values of the components have been swapped **Note**: Penalise POT error once only; eg 6.9 and 4 respectively scores 1 mark **Note**: Calculator in radian mode gives 1.23×10^{-5} and (-) 7.90×10^{-5} (N); this scores 1 mark
	(ii)	(F =) 4.0×10^{-5} (N) The net force parallel to windscreen = 0 or F is equal to the parallel component (of the weight down the windscreen) or parallel forces must be equal and opposite or $F = 8.0 \times 10^{-5}$ sin30	B1 B1	Possible ecf from **(b)(i)** **Allow**: Total force down/up the windscreen/slope is zero **Not**: 'net force = 0' – this is an incomplete answer

4.

(a)		$(s = \frac{1}{2}at^2)$; $0.700 = ½ \times 9.81 \times t^2$ $t^2 = \frac{2 \times 0.700}{9.81} (= 0.1427)$ $t = 0.378$ (s) or 0.38 (s)	C1 C1 A1	**Allow**: $a = 9.8$ (m s^{-2}) **Note**: Using $a = 10$ (m s^{-2}) gives 0.374 (s) or 0.37 (s); this scores 2 marks **Allow** full credit for correct use of $v^2 = 2as$ and $v = at$
(b)	**(i)**	acceleration or deceleration displacement or distance	B1	
	(ii)	A tangent drawn on Fig. 4.2 at point **A** Determine the gradient of the tangent Deceleration value in the range 13.0 to 17.0 (m s^{-2})	B1 M1 A1	**Note**: This is an independent mark **Note**: Ignore sign **Special case**: Allow 1 mark for using a chord about $t = 0.05$ seconds to determine the deceleration and the value lies in the range 13.0 to 17.0 (m s^{-2})
	(iii)	At **A:** Drag > weight The ball is decelerating/'slowing down' At **B**: Drag = weight The ball has zero acceleration/has reached terminal velocity/has reached constant velocity	 B1 B1 B1 B1	 **Allow**: 'friction'/'resistive force' for drag **Allow**: upward/negative acceleration **Note:** Allow full credit if *upthrust* and *drag* are both mentioned and applied correctly at points **A** and/or **B**
	(iv)	The (gravitational) potential energy/(G)PE (of the ball) is converted into heat/thermal (energy)	B1	

5.

Lines joining density to 'kg m^{-3}' pressure to 'kg m^{-1} s^{-2}' power to 'kg m^{2} s^{-3}'	B1×2	**Note**: All correct – 2 marks, deduct 1 mark for each error or omission. (Minimum score = 0)

6.

(a)		Difference: Velocity / vector has direction (and speed does not) or speed / scalar does not have direction (velocity has) Similarity: Both have the same unit / both have m s^{-1} (as the unit) / both have magnitudes	B1 B1	**Not** 'velocity is a vector / speed is a scalar' since it is stated in the question
(b)	**(i)**	distance = $2 \times \pi \times 0.60$ (= 3.77 m) / speed = $\frac{3.77}{12}$ speed = 0.31 (m s^{-1})	C1 A1	 **Note**: Answer to 3 sf is 0.314 (m s^{-1})
	(ii)	$s^2 = 0.60^2 + 0.60^2$ s = 0.85 (m)	C1 A1	 **Note**: Answer to 3 sf is 0.849 (m) **Note**: 0.72 scores 1 mark (square root omitted)
	(iii)	The (change in) displacement is zero	B1	
	(iv)	The direction changes (even though the magnitude is the same)	B1	

7.

(a)		$a = 3600/1200$ $a = 3.0$ (m s^{-2})	B1	**Allow** 1 sf answer (Ignore sign)
(b)		$v^2 = u^2 + 2as$ $0 = 18^2 + (2 \times -3.0 \times s)$ / $s = \frac{18^2}{6.0}$ $s = 54$ (m)	C1 C1 A1	Possible ecf **Allow** '$v^2 = 2as$, $18^2 = 2 \times 3.0 \times s$' **Allow** other approaches, examples: $t = 6$ (s) C1 $s = (18 \times 6.0) + ½ \times (-3.0) \times 6.0^2$ C1 $s = 54$ (m) A1 Or $½ mv^2 = Fs$ C1 $½ \times 1200 \times 18^2 = 3600 \times s$ C1 $s = 54$ (m) A1
(c)		(The distance is) greater There is a component of the weight of the car acting down the slope / component of weight against the resistive force / reference to $W \sin\theta$ (AW) Net force is less / reference to $3600 - W \sin\theta$ / (magnitude of) deceleration is smaller	B1 B1 B1	**Allow** the following for the last two B1 marks: • The same force has to do more work • Work done is the sum of initial kinetic energy and change in GPE (due to vertical downward movement)

8.

(a)		acceleration = rate of change of velocity (or acceleration = change in velocity / time)	B1	**Allow** '$a = (v - u)/t$' or $\Delta v/t$ if v, u and t or Δv and t are defined
(b)		Mass and (net) force	B1	
(c)	**(i)**	**1** acceleration **2** deceleration / negative acceleration Detail mark: Constant used in either 1 or 2 or reaches maximum height at 25 (s) or stops at 25 (s)	B1 B1 B1	**Allow**: velocity / speed increases **Allow**: velocity / speed decreases **Allow**: 'uniform / same' for 'constant'
	(ii)	height = area under graph from 0 to 25 (s) height = ½ × 25 × 200 height = 2500 (m)	C1 C1 A1	**Allow** 1 mark for either 500 (m) or 2000 (m)

	(iii)	A sensible suggestion, for example: • $v^2 = 2 \times g \times 2500$, $v = 220$ (m s^{-1}) – allow $g = 10$ (m s^{-2}) • For 200 (m s^{-1}) at ground, the (maximum) height would only be 2040 (m) (with $g = 9.81$ m s^{-2}) or 2000 (m) (with $g = 10$ m s^{-2}) • (Burning) rocket fuel does work on the rocket (AW)	B1	