FORCES AND NEWTON'S LAWS MECHANICS ANSWERS OCR ALEVEL YEAR 1

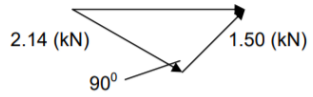
1.

Question		Expected Answers	Marks	Additional Guidance
(a)		(Force is 1 N) when a **1 kg** mass has an acceleration of **1 m s^{-2}**	B1	**Not**: '1 kg and 1 m s^{-1}' **Allow**: (1 N =) **1 kg** × **1 m s^{-2}**
(b)		The mass of particles increases (at its speed gets closer to the speed of light)	B1	**Not**: 'weight of particle increases' **Not**: 'mass changes / different'
(c)	(i)	net force = 120 (N) $a = \frac{120}{900}$ a = 0.13 (m s^{-2})	C1 A1	 **Note**: Bald answer scores 2 marks; answer must be 2 sf or more
	(ii)	The drag force changes with speed / acceleration is not constant	B1	
(d)		$F = 72 \times 1.4$ (= 100.8 N) / weight = 72 × 9.81 (= 706.32 N) T = (72 × 9.81) + (72 × 1.4) T = 807 (N) or 810 (N)	C1 C1 A1	**Note**: Bald 101 (N) or 706 (N) scores 1 mark **Note**: Bald answer scores 3 marks Bald 605.52 to at least 2 sf scores 1 mark
		Total	**8**	

2.

Question		Expected Answers	Marks	Additional Guidance
(a)		$F_H = 20\cos 38 = 15.76 \approx 15.8$ (N) $F_V = 20\sin 38 = 12.31 \approx 12.3$ (N)	B1 B1	**Allow**: 2 sf answers of 16 (N) and 12 (N) **Allow**: 1 mark if vertical and horizontal components have been interchanged
(b)	(i)	net force vertically = 0 / weight = upward forces weight = 12.3 + 12.3 weight = 24.6 (N) ≈ 25 (N) ---------- Or ---------- correct triangle of forces diagram correct determination of weight weight = 24.6 (N) ≈ 25 (N)	C1 C1 A0 C1 C1 A0	 Possible ecf from F_V value from **(a)** At least one label needed (e.g: 20, correct angle, etc) – arrows not needed Weight in the range 22 – 27 (N)
	(ii)	mass = $\frac{25}{9.81} = 2.55$ (kg) density = $\frac{2.55}{2.9 \times 10^{-4}}$ density = 8.8 × 10^3 (kg m^{-3})	C1 C1 A1	**Note**: 2.51 kg if 24.6 N is used **Note**: 'weight/volume' scores zero **Note**: Answer is 8.7 × 10^3 if 2.51 kg is used **Allow**: 2 marks if g = 10 used and 25 N → 2.5 kg $\therefore \rho$ = 8620 (kg m^{-3}) **Note**: Bald 8.7× 10^3 or 8.8 × 10^3 scores 3 marks **Allow**: 1 mark if 20 N is used instead of 25 N – this gives 7030 (kg m^{-3})
		Total	**7**	

3.

Question		Expected Answers	Marks	Additional Guidance
(a)		The mass (of the electron) increases as its speed approaches c / speed of light / 3×10^8 m s^{-1}	M1 A1	**Not**: mass 'changes' / 'electron becomes heavier'
(b)	(i)	A line with correct arrow in the *y* direction has length of 14 to 16 'small squares'	B1	
		A line with correct arrow in the *x* direction has length of 24 to 26 'small squares'	B1	**Note**: If correct arrows are not shown, then maximum mark is 1
	(ii)	component = $(8.0\cos 31 =) 6.86$ (m s^{-1}) or 6.9 (m s^{-1})	B1	**Allow**: 6.85 as BOD
(c)	(i)	Correct vector triangle drawn  	B1	**Note**: Expect at least one 'label' on the sketch, eg: 2.14, 1.5, 90^0 The 'orientation' of the triangle is not important The directions of all three arrows are required
		(resultant force)^2 = $2.14^2 + 1.50^2$	C1	
		resultant force = 2.61 (kN)	A1	**Allow**: 2 sf answer of 2.6 (kN) **Allow** a scale drawing; 2 marks if answer is within ±0.1 kN and 1 mark if ± 0.2 kN **Alternative** for the C1 A1 marks: 1.50cos(55) or 2.14cos(35) C1 resultant force = 1.50cos(55) + 2.14cos(35) resultant force = 2.61 (kN) A1
	(ii)	2.6(1) (kN)	B1	Possible ecf
		(Constant velocity implies) zero net force / zero acceleration	B1	**Not**: '*resultant force = drag*' since the first B1 assumes this
		Total	**10**	

4.

a	work (done) = force × distance moved in the direction of force	B1	**Allow**: work = force × displacement in direction of force **Not**: work (done) = energy transfer
b(i)	(Net /total /resultant force is) zero	B1	
	The acceleration is zero	B1	**Not** 'a = 0'
b(ii)	$9.0 \times 10^3 \cos 83°$ or $9.0 \times 10^3 \sin 7°$	C1	
	1.1×10^3 (N)	A1	**Not** '$9.0 \times 10^3 \cos 7°$'
b(iii)	work done per second = 300×18		
	work done per second = 5400 (J s^{-1})	B1	
b(iv)	(total force down slope =) 1100 + 300 (N) (power =) 1400×18 (power =) 2.52×10^4 (W) or 2.5×10^4 (W)	C1 C1 A1	**Allow**: 1400 (N) Possible ecf from **(b)(ii)**
	or rate of work done against weight = $1.1 \times 10^3 \times 18$ (= 19800 W) power = 19800+ 5400 power = 2.52×10^4 (W) or 2.5×10^4 (W)	C1 C1 A1	**Allow**: '$Fx\cos\theta = 9.0 \times 10^3 \times 18 \times \cos 83°$' Possible ecf from **(b)(ii)** and **(b)(iii)**
	Total	**9**	

5.

a	…incorrect Mass (of the particle) increases (as it approaches speed of light)	M1 A1	**In question 5, use tick or cross on Scoris to show if the mark is awarded** **Not**: mass *changes*
b	….correct KE is changed into (G)PE or (G)PE is changed into KE or change in KE = change in (G)PE (AW)	M1 A1	 **Note**: This mark is for stating the transfer of energy between kinetic and (gravitational) potential
c	…incorrect Weight is equal to drag / air resistance / friction (and not acceleration of free fall)	M1 A1	Allow **alternative** response: ……. incorrect M1 Acceleration and weight are not the same quantities (AW) A1
d	…incorrect The technique is trilateration **The term *trilateration* to be included and spelled correctly to gain the A1 mark**	M1 A1	 **Note** 1 mark if 'trilateration' is misspelled but candidate has mentioned that the statement is incorrect
	Total	**8**	

6.

Question			Answers	Marks	Guidance
5	(a)		mass = $\frac{590}{9.8(1)}$ (= 60 kg)	B1	**Allow**: weight = 60 × 9.8(1) **Allow**: 60 × 9.8(1) = 588 (N) or 60 × 9.8(1) = 590 (N)
	(b)		net force = 60 × 0.50 (= 30 N) R = 590 + 30 R = 620 (N)	 C1 A1	 **Allow**: 1 mark for '590 – 30 = 560 (N)'
	(c)		resultant force = 0 / 'a = 0 and F = ma = 0'	B1	**Not**: Acceleration = 0 or 'forces are balanced'
	(d)		weight > R (for deceleration) / R = 590 – 60a / R = mg -ma Hence R decreases	M1 A1	**Allow**: W or mg for 'weight'
			Total	**6**	

7.

Question			Answer	Marks	Guidance
(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)
(d)			Reference to radio waves or microwaves (transmitted from satellites) There is a 'delay time' of signal from satellite to GPS device / car Distance (between satellite and GPS device / car) calculated using 'delay time × c' **Trilateration** / intersecting **shells** / **circles** / **spheres** (used to locate position of car)	B1 B1 B1 B1	**Use ticks on Scoris to show where the marks are awarded** **Allow**: 'delay time' of signal between satellite and GPS device / car (**Not** from GPS device / car to satellite) ***Trilateration*** / ***shell(s)*** / ***circle(s)*** / ***sphere(s)*** must be spelled correctly to gain the mark. **Note**: Allow full range of marks for other sensible alternative approaches
			Total	**11**	

8.

Question			Answer	Marks	Guidance
(a)			Drag increases with speed (ORA) / drag ∝ speed^2	B1	
(b)			Galileo dropped different mass balls / rolled different mass balls (down a ramp) Balls hit the ground / reached the bottom (of ramp) at the same time (Galileo -) All objects fall with the same acceleration and (Aristotle -) Heavy / massive objects fall faster / quicker (than light objects)	B1 B1 B1	**Allow** object / trolley instead of ball
(c)	(i)		(The two forces are weight and drag) weight = drag	B1	**Not** 'gravity' for weight **Allow**: weight = drag + upthrust
	(ii)		When the parachute is opened, drag increases / drag is greater than the weight Drag decreases as the speed decreases / net force decreases The (magnitude of the) deceleration decreases (between 50 m s^{-1} and 4 m s^{-1}) (At 4 m s^{-1}) deceleration or acceleration = 0	B1 B1 B1 B1	
			Total	**9**	

9.

Question			Answer	Marks	Guidance
(a)			work done = force × distance moved in the direction of force	B1	**Allow**: work done = force × displacement in direction of force
(b)	(i)		mass = 700/9.81 or mass = 71.4 (kg) kinetic energy = ½ × 71.4 × 15^2 kinetic energy = 8.0×10^3 (J)	C1 A1	 **Note**: Answer to 3 sf is 8.03×10^3 (J) **Note**: '½ × 700 × 15^2 = 7.9×10^4' scores zero **Allow**: 1 sf answer
	(ii)		GPE = *mgh* 700 × 32 / 2.24×10^4 (J) work done = $2.24 \times 10^4 - 8.03 \times 10^3$ resistive force = $\frac{1.44 \times 10^4}{120}$ resistive force = 120 (N)	 C1 C1 A1	 Possible ecf **Note**: Dividing the work done by 32 (m) gives 450 (N). This answer scores 2 marks.
			Total	**6**	