Higher Dynamics

Past Paper Answers

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Higher Dynamics Answers

Forces

1. C 2. C 3. C 4. A 5. C 6. C

7. D 8. B 9. B 10. D 11. B 12. C

13. E 14. A 15. B 16. D 17. A 18. C

19. B 20. B 21. A 22. B

|  |  |  |
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| 23ai) | Fh = Fcosθ  Fh = 4 x cos(26) Fh = 3.6 N  *Answer must be exactly the same as value given for “show” questions. No mark if left as 3.595 N.* | (1) sub. |
| 23aii) | F = ma 3.6 = 18 x a a = 0.2 m s-2 | (1) (1) (1) |
| 23aiii) | s = ut + ½at2 s = 0 x 7 + 0.5 x 0.2 x 72 s = 4.9 m | (1) (1) (1) |
| 23b) | It would increase as the smaller the angle the greater the horizontal component of force/ the greater the unbalanced force, therefore the greater the acceleration.  *Could prove through a calculation to justify your statement about the distance travelled by the box being greater. No attempt to justify means 0 marks, even if you said it would increase. “****must*** *justify your answer”.* | (1)  (1) |
| 24a) | Wparallel = mgsinθ Wparallel = 2600 x 9.8 x sin(12) Wparallel = 5300 N | (1) (1) |
| 24b) | unbalanced force = 5300 – 1400 = 3900 N  Fun = ma 3900 = 2600 x a a = 1.5 m s-2 | (1)  (1) (1) (1) |

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| 24c) | v2 = u2 + 2as Ek = ½mv2  *both equations*v2 = 52 + (2 x 1.5 x 75) Ek = ½ x 2600 x 15.8…2  v = 15.8… Ek = 325000 J  *Or similar to get same final answer.* | (1) both eq. (1), (1) sub. (1) final ans. |
| 25a) | Wparallel = mgsinθ Wparallel = 60 x 9.8 x sin(22) Wparallel = 220 N | (1) (1) |
| 25b) | (unbalanced force = 220 -180 = 40 N)  Fun = ma 40 = 60 x a a = 0.67 ms-2  *Answer must be exactly the same as value given for “show” questions. Mark off if left as 0.667 m s -2.* | (1) (1) |
| 25c) | v2 = u2 + 2as  v2 = 02 + (2 x 0.67 x 50) v = 8.2 m s-1 | (1) (1) (1) |
| 25d) | It would be less as smaller mass means smaller component of weight therefore a smaller unbalanced force so less acceleration.  “*slower” acceleration not accepted*. | (1)  (1) |
| 26a) | Ew = Fd 75 x 103 = F x 50 F = 1500 N  Unbalanced force = braking force + friction 1500 = braking force + 300 braking force = 1200 N | (1) (1) (1)  (1) |
| 26b) | Braking force less as the kinetic energy of the car is less so the work done in stopping the car is less.  *No attempt to justify means 0 marks, even if you said it would increase. “****must*** *justify your answer”.* | (1)  (1) |

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| 27a) | v2 = u2 + 2as 02 = 902 + (2 x a x 1980)  a = -2.04… m s-1  Fun = ma Fun = 3520 x -2.04… Fun = -7200 N  W = mg W = 3520 x 1.25 W = 4400 N  Engine thrust = weight + unbalanced force Engine thrust = 4400 + 7200 Engine thrust = 11600 N | (1)  (1)  (1)  (1) |
| 27b) | Tension = Share of Weight ÷ cosθ (three cables so third of weight each)  T = 490 N | (1)  (1) |

Linear Motion

1. E 2. E 3. C 4. D 5. A 6. B

7. B 8. B 9. C

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| --- | --- | --- |
| 10ai) | s = ½(u + v)t s = 0.5 x (60 + 0) x 40 s = 1200 m  *Or similar to get same final answer.* | (1) eq. (1) sub. (1) final ans. |
| 10aii) | Ft = mv - mu F x 40 = 7.5 x 105 x 0 - 7.5 x 105 x 60 F = -1.13 x 106 N  *Or similar to get same final answer. Answer must be negative based on your substitution. If you get "v" and "u" the wrong way round when substituting in your numbers then 1 mark for the equation only.* | (1) (1) (1) |
| 10b) | P = IV 8.5 x 106 = 2.5 x 103 x V V = 3400 V  V­rms = Vpeak/2 3400 = Vpeak/2 Vpeak = 4810 V | (1) both eq. (1), (1) sub. (1) final ans. |
| 11a) | v2 = u2 + 2as 122 = 302 + 2 x (-9) x s s = 42 m | (1) (1) (1) |
| 11b) | Speed at Q is greater/faster as if the mass is increased then the deceleration will decrease when the force is constant (due to F­un­ = ma).  *Could prove through a calculation to justify your statement about the speed being greater.* | (1)  (1) |
| 11ci) | Electrons and holes combine at the junction causing photons to be emitted. | (1) (1) |
| 11cii) | P = IV 2.2 = I x 5 I = 0.44 A  (Voltage across resistor R = 12 - 5 = 7 V)  V = IR 7 = 0.44 x R R = 15.9 Ω | (1) both eq. (1), (1) sub. (1) final ans. |
| 12ai) | v2 = u2 + 2as v2 = 02 + 2 x (-9.8) x (-2) v = 6.3 m s-1  *If you used (positive) 2 for “s” then “a” must also be positive to be consistent with you making downwards motion positive. If not then one mark for the equation only.* | (1) (1) |
| 12aii) | Change in momentum = mv – mu Change in momentum = 40 x 5.7 – 40 x (-6.3) Change in momentum = 480 kg m s-1  *“v” and “u” must have opposite signs to represent velocity in different directions. Other suitable methods to get the same answer are fine.* | (1) (1) (1) |
| 12aiii) | Change in momentum = Ft 480 = F x 0.50 F = 960 N  *Other suitable methods to get the same answer are fine. If answer is negative, based on your answer to 12aii) being negative, this is fine.* | (1) (1) (1) |
| 12b) | Tension = Share of Weight ÷ cosθ (two ropes so half of the weight each)  If θ increases then cosθ decreases meaning T will increase assuming W is constant. | (1)  (1) |
| 13a) | a = 5 m s-2 | (1) equation   (1) sub. |
| 13b) | motorcycle s = ½(u + v)t s = ½(0 + 20) x 4 s = 40 m  car d = vt d = 15 x 4 d = 60 m  Difference = 60 – 40 = 20 m  *Could use “s = ½(u + v)t” for the car too.* | (1) both eq. (1), (1) sub (1) final ans. |
| 13ci) | F­un­ = ma F­un­ = 290 x 5 F­un­ = 1450 N  Driving force – Frictional force = Unbalanced force 1800 – Friction force = 1450  Frictional force = 350 N  *If the working to calculate the frictional force isn’t shown but answer is still 350 N then 4 marks still awarded.* | (1) (1)  (1)  (1) |
| 13cii) | The frictional force increases as speed increases so the driving force must increase to keep the unbalanced force constant (which keeps the acceleration constant). | (1) (1) |
| 14ai) | The velocity changes by 0.32 m s-1 every second. | (1) |
| 14aii) | s = ut + ½at2 s = 0 x 25 + 0.5 x 0.32 x 252 s = 100 m | (1) (1) (1) |
| 14bi) | vs = 23.4 m s-1 | (1)  (1)  (1) |
| 14bii) | Less waves (*or wavefronts*) observed per second. *or* The wavefronts are further apart *or* The wavelength is increased *or* A diagram showing waves bunched together in front of the train and more spread apart behind the train. However, train’s direction of travel **must** be shown/implied. | (1) |

Momentum and Impulse

1. B 2. D 3. C 4. B 5. B 6. E

7. D 8. C 9. B 10. C 11. A 12. D

13. C 14. B 15. C 16. A 17. C 18. B

19. C 20. C 21. B 22. E

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| --- | --- | --- | --- |
| 23ai) | v2 = u2 + 2as v2 = 02 + (2 x 9.8 x 2)  v = 6.26 m s-1  *If you used (negative) 2 for “s” then “a” must also be negative to be consistent with you making downwards motion negative. If not then one mark for the equation only.* | | (1) (1) (1) |
| 23aii) | Ft = mv – mu F x 0.02 = 15 x 0 – 15 x 6.26 F = -4695 N | | (1) (1) (1) |
| 23b) | It would decrease as the change in momentum is constant but the time of contact will be increased.  *Could show by calculation.* | | (1)  (1) |
| 23c) | Mass X as the force applied by each mass is the same but X has a smaller surface area in contact with the pipe so the pressure is more (p = F/A). | | (1)  (1) |
| 24aiA) | Impulse = Ft Impulse = 0.5 x 3 x 10-3 Impulse = 1.5 x 10-3 Ns | | (1) (1) (1) |
| 24aiB) | Impulse = mv - mu 1.5 x 10-3 = 2.5 x 10-5 x v – 2.5 x 10-5 x 0 v = 60 m s-1 | | (1) (1) (1) |
| 24aii) | Impulse = Area under the graph Impulse = ½bh Impulse = ½ x 3 x 10-3 x 0.5 Impulse = 0.75 x 10-3 Ns  Half the original impulse so half the original speed. | | (1)   (1)  (1) |
| 24b) | E = QV E = 6.5 x 10-6 x 5 x 103 E = 0.0325 J  E­k­ = ½mv2 0.0325 = ½ x 4 x 10-5 x v2­­ v = 40.3 m s-1 | | (1) both eq. (1), (1) sub. (1) final ans. |
| 25a) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  2500 x 0.5 + 1500 x u2 ­= 2500 x 0.2 + 1500 x 0.2 u­2­ = -0.3 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 25bi) | The space probe | | (1) |
| 25bii) | Ft = mv – mu -500 x t = 4000 x 0 – 4000 x 0.2 t = 1.6 s  *Negative force as this is acting to the left.* | | (1) (1) (1) |
| 25c) | Fire rocket engine of space vehicle **then** fire probe engine for twice as long. *or* Fire both engines then fire probe engine only for same time.  *Could be shown by calculation.* | | (1) |
| 26ai) | Impulse = Area under the graph Impulse = ½bh Impulse = ½ x 10 x 10-3 x 70 Impulse = 0.35 N s | | (1)  (1) |
| 26aii) | -0.35 N s *or* 0.35 N s upwards | | (1) |
| 26aiii) | Impulse = mv – mu -0.35 = 0.05 x v – 0.05 x 5.6 v = -1.4 m s-1  *The value for “Impulse” and “u” should have opposite signs as they are acting in opposite directions to each other. The value for “v” should come out of the calculation with the same sign as your impulse in Q26aii).* | | (1) (1) (1) |
| 26b) | *max. force greater than 70 N time lesser than 10 ms* | | (1) (1) |
| 27ai) | The total momentum before a collision equals the total momentum after a collision, in the absence of external forces. | | (1) |
| 27aii) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  0.22 x 0.25 + 0.16 x u2 ­= 0.22 x 0.2 + 0.16 x 0.2 u­2­ = 0.131 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 27b) | Less combined (final) speed as the total momentum before the collision is less so the total momentum after the collision will be less.  *Could prove by calculation to shown that the* ***final*** *speed is less than  0.2 m s-1 (the original* ***final*** *speed).* | | (1)  (1) |
| 28ai) | Impulse = Area under the graph Impulse = ½bh Impulse = ½ x 0.25 x 6.4 Impulse = 0.8 N s | | (1)  (1) (1) |
| 28aii) | -0.8 Ns *or* 0.8 Ns to the left *or*  0.8 Ns in the opposite direction of travel | | (1) |
| 28aiii) | Impulse = mv - mu  -0.8 = m x -0.45 – m x 0.48 m = 0.86 kg  *“Impulse” must have the same sign as “v”.* | | (1) (1) (1) |
| 28b) | *max. force greater than original time lesser than original*  *Must label both lines on the graph. Technically the stronger magnetic force kicks in earlier as the carts move towards each other, hence why the "new" triangle begins earlier, but it's okay if you started the "new" triangle at the same time as the "original".* | | (1) (1) |
| 29a) | The total momentum before a collision equals the total momentum after a collision, in the absence of external forces. | | (1) |
| 29b) | Change in momentum = mv – mu Change in momentum = 1200 x 0 – 1200 x 13.4 Change in momentum = -16100 kg ms-1 | | (1) (1) (1) |
| 29c) | v2 = u2 + 2as 02 = 13.42 + 2 x a x 0.48 a = -187.04… m s-1  F = ma F = 75 x -187.04… F = -14030 N  *-14028 N is wrong as this is 5 significant figures (4 max. allowed).* | | (1) both eq. (1), (1) sub. (1) final ans. |
| 30a) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  0.70 x 0 + 0.30 x 0 ­= 0.70 x 0.51 + 0.30 x -1.19 0 (kg m s-1) = 0 (kg m s-1)  *Could do p = mv 4 times to get the same final answer. One of the two velocities needs to have a negative sign to show going in opposite directions.* | | (1) (1) (1) |
| 30bi) | E­p­ = mgh E­p­ = 0.25 x 9.8 x 0.15 E­p­ = 0.3675 J  E­k­ = ½mv2 0.3675­ = ½ x 0.25 x v2 v­ = 1.7 m s-1  *Must show answer rounded to 1.7 m s­­­-1 not any other rounded version.* | | (1) both eq. (1) both sub. |
| 30bii) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  0.20 x 0 + 0.050 x u­2­ ­= 0.20 x 1.7 + 0.050 x 1.7 u­2­ = 8.5 m s-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 30biii) | The change in momentum is greater for the dart so it is also greater for the block. This means the velocity of the block will be greater (as mass is constant) so the kinetic energy is greater (therefore a larger potential energy/height).  *Could show by calculation to get all the marks. The velocity of the dart would need to be negative though as it bounces off/travels in the opposite direction that the dart was originally travelling.* | | (1)  (1) |
| 31ai) | Ft = mv – mu F x 0.02 = 0.16 x 39 – 0.16 x 0 F = 312 N | | (1) (1) (1) |
| 31aii) | Correct shape | | (1) |
| 31b) | Less max. force Longer time | | (1) (1) |
| 32a) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  (0.25 x 1.2) + (0.45 x -0.6) ­= (0.25 x v­1­) + 0.45 x 0.8 v­1­ = 1.32 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 32bi) | Impulse = Area under the graph Impulse = ½bh Impulse = ½ x 250 x 10-3 x 4 Impulse = 0.5 N s | | (1)  (1) (1) |
| 32bii) | 0.5 N s *or*  0.5 kg m s-1  *"Impulse" is a fancy way of saying "change in momentum".* | | (1) |
| 32biii) | - Constant velocity at correct values and signs before and after collision - Velocity change from initial to final in 0.25 s - Shape of change of velocity correct ie initially gradual, increasing steepness the levelling out to constant velocity | | (1) (1)  (1) |
| 33a) | The total momentum before a collision equals the total momentum after a collision, in the absence of external forces. | | (1) |
| 33b) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  (0.85 x 0.55) + (0.25 x -0.3) ­= (0.85 x v) + (0.25 x v) v­ = 0.357 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 33c) | Total kinetic energy before Ek = ½mv2 Ek = ½mv2  Ek = ½ x 0.85 x 0.552 Ek = ½ x 0.25 x -0.302 Ek = 0.128… J Ek = 0.01125 J  = 0.128… + 0.01125 = 0.139… J  Total kinetic energy after Ek = ½mv2 Ek = ½mv2  Ek = ½ x 0.85 x 0.3572 Ek = ½ x 0.25 x 0.3572 Ek = 0.0541… J Ek = 0.0159… J  = 0.0541… + 0.0159… = 0.0700… J  Inelastic collision (as the total kinetic energies before and after are not equal)  *Rounded totals are fine.* | | (1) equation (1) total bef. (1) total aft. (1) statement |
| 34ai) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  (0.18 x 2.6) + (0.18 x -1.8) ­= (0.18 x v­2­) + (0.18 x 2.38) v­2­ = -1.58 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) (1) |
| 34aii) | A collision is inelastic when the total kinetic energy before the collision is not equal to the total kinetic energy after the collision. | | (1) |
| 34bi) | Ft = mv – mu F x 0.04 = 0.18 x 0.84 – 0.18 x 0 F = 3.78 N | | (1) (1) (1) |
| 34bii) | 2.5% | x 100 = 1.2  x 100 = 0.56  x 100 = 2.5  *Largest percentage uncertainty in the measured variables is the percentage uncertainty of the calculated variable (force in this case)* | (1)  (1) |
| 35a) | m­1­u­1­ + m­2­u­2­ = m­1­v­1­ + m­2­v­2  (0.75 x 0.5) + (0.5 x -0.3) ­= (0.75 x 0.02 + (0.5 x v­2­) v2­ = 0.42 m s­-1  *Could do p = mv 4 times to get the same final answer.* | | (1) (1) |
| 35b) | Impulse = mv – mu Impulse = 0.5 x 0.42 – 0.5 x -0.3 Impulse = 0.36 kgms-1 | | (1) (1) (1) |
| 35c) | Calculate the total kinetic energy before the collision and the total kinetic energy after the collision.  If these are equal the collision is elastic.  *or* If these are unequal the collision is inelastic.  *Could show by calculation but would still require a statement for the second mark.* | | (1) (1) |

Motion Graphs

1. D 2. A 3. E 4. B 5. C 6. C

7. E 8. E 9. A 10. B 11. A 12. C

13. A 14. D 15. E 16. A

|  |  |  |
| --- | --- | --- |
| 17ai) | 0.2 m | (1) |
| 17aii) | 1.6 m | (1) |
| 17aiii) | s = ut + ½at2 1.6 = 0 x 0.6 + 0.5 x a x 0.62 a = 8.9 m s-2  *Answer must be exactly the same as value given for “show” questions. Mark off if rounded as 8.89 m s -2.* | (1) (1) |
| 17bi) | mean =  mean =  mean = 8.8 m s-2 (*or* 8.78 m s-2) | (1) |
| 17bii) | random uncertainty =  random uncertainty =  random uncertainty = ± 0.14 m s-2 | (1)  (1) |
| 17c) | **Any two**  The max. displacement would be greater (as the sponge compresses more) *or* The time of contact would be greater (due to the sponge compressing more) *or* The final displacement (at the end of the graph shown) would be greater as more kinetic energy is lost (to change the shape of the sponge, meaning the ball won't rebound as high) *or*  The gradient when the ball rebounds is less as more kinetic energy is lost (to change the shape of the sponge) | (1), (1) |

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| 18ai) | a = -9.8 m s-2 | (1) eq.  (1) sub. |
| 18aii) | Any s.u.v.a.t. equation with "t"  s = ut + ½at2 s = 0 x 0.5 + ½ x (-)9.8 x 0.52 s = (-)1.23 m  *Negative sign is fine but not required for this specific question. (Safer to have it and be consistent).* | (1) (1) (1) |
| 18bi) | Change in momentum = mv - mu Change in momentum = 0.057 x 4 - 0.057 x -4.9 Change in momentum = 0.507 kg m s-1 | (1) (1) (1) |
| 18bii) | Change in momentum = Ft 0.507 = F x 0.27 F = 1.88 N | (1) (1) (1) |
| 18c) | - Same constant negative acceleration between 0-0.5 s and 0.77-1.18 s - Constant positive acceleration between 0.5-0.77 s and must be noticeably greater than the negative accelerations below the x-axis | (1)  (1) |

Projectile Motion

1. D 2. A 3. D 4. B 5. B

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| 6ai) | vh = vcosθ  vh = 7 x cos(60) vh = 3.5 m s-1 | (1) |
| 6aii) | vv = vsinθ  vv = 7 x sin(60) vv = 6.06 m s-1 | (1) |
| 6b) | d = vt 2.8 = 3.5 x t t = 0.8 s | (1) (1) (1) |
| 6c) | s = ut + ½at2 s = 6.06 x 0.8 + 0.5 x -9.8 x 0.82 s = 1.71 m | (1) (1) (1) |
| 6d) | It is less as the speed of the coin at the plate is less. | (1) (1) |
| 7ai) | vh = vcosθ  vh = 6.5 x cos(50) vh = 4.18 m s-1 | (1) |
| 7aii) | vv = vsinθ  vv = 6.5 x sin(50) vv = 4.98 m s-1 | (1) |
| 7b) | d = vt 2.9 = 4.18 x t t = 0.69 s  *Answer must be exactly the same as value given for “show” questions.  No mark if left as 0.694 s.* | (1) (1) |
| 7c) | s = ut + ½at2 s = 4.98 x 0.69 + 0.5 x -9.8 x 0.692 s = 1.1 m  height = 1.1 + 2.3 = 3.4 m | (1) (1) (1)  (1) |
| 7d) | The ball will not land in the basket. The horizontal/vertical speed of the ball will increase  so the ball will be higher than the basket after covering the same distance. *or* so the ball will have travelled a further distance by the time it falls to the same height as the basket. | (1)  (1) *or*  (1) |
| 8ai) | v2 = u2 + 2as 02 = 72 + (2 x -9.8 x s)  s = 2.5 m | (1) (1) (1) |
| 8aii) | s = ½(u + v)t 2.5 = 0.5 x (7 + 0) x t t = 0.71 s  *Answer must be exactly the same as value given for “show” questions.  No mark if left as 0.714 s.* | (1) (1) |
| 8bi) | 1.5 m s-1 to the right (*velocity needs direction as it's a vector quantity).*  *Vertical component of velocity at max. height is 0 m s-1 so only horizontal component has a value (1.5 m s-1) meaning the velocity is just 1.5 m s-1.* | (1) |
| 8bii) | Statement Z as the horizontal (component of) velocity is the same for the ball as it is for the trolley. | (1)  (1) |
| 9ai) | distance = area under the (horizontal motion) graph distance = l x b distance = 20 x 3.06 distance = 61.2 m *or* d = vt d = 20 x 3.06 d = 61.2 m | (1)  (1) (1) |
| 9aii) | height = area under the (vertical motion) graph height = ½bh height = 0.5 x 1.53 x 15 height = 11.5 m *or* s = ½(u + v)t s = ½ x (0 + 15) x 1.53 s = 11.5 m *or* v2 = u2 + 2as 02 = 152 + (2 x -9.8 x s)  s = 11.5 m | (1) eq.  (1) sub.  (1) final ans. |
| 9b) | More likely  as horizontal velocity will decrease so range will decrease. *or* as vertical velocity will decrease so max. height will decrease. *or* as time in the air will decrease so range (or max. height) will decrease. *or* as less kinetic energy so less potential energy gained so less max. height. *or* as work done (Ew) against it so the ball won't travel as far (*or* high). | (1)  (1) |
| 10a) | s = ut + ½at2 s = 0 x 0.5 + 0.5 x -9.8 x 0.52 s = -1.225 m  height = 2.5 + -1.225 = 1.28 m | (1) (1) (1)  (1) |
| 10b) | v2 = u2 + 2as v2 = 02 + 2 x -9.8 x -2.5  v = 7 m s-1 | (1) (1) (1) |
| 10c) | *Not to scale*  25 m s-1 at 16o relative to the ground  *or as another method*  a2 = b2 + c2 a2 = 242 + 72 a = 25 m s-1  tanθ = O/A tanθ = 24/7 θ = 73.7...  90 - 73.7... = 16o  25 m s-1 at 16o relative to the ground  (*or* tanθ = O/A tanθ = 7/24 θ = 16o  z-angle so 16o relative to the ground) | (1) size (1) units (1) angle (1) "relative to..." |
| 11aiA) | 11.6 m s-1 | (1) |
| 11aiB) | vh = vcosθ  vh = 11.6 x cos(40) vh = 8.89 m s-1 | (1) |
| 11aiC) | vv = vsinθ  vv = 11.6 x sin(40) vv = 7.46 m s-1 | (1) |
| 11aiiA) | s = ut + ½at2 -4.7 = 0 x t + 0.5 x -9.8 x t2 t = 0.979... s  total time =0.979... + 0.76 = 1.74 s | (1) (1) (1)  (1) |
| 11aiiB) | d = vt d = 8.89 x 1.74 d = 15.5 m | (1) (1) (1) |
| 11b) | The kinetic energy would decrease as the release speed decreases. | (1) (1) |
| 12ai) | vv = vsinθ  vv = 9.1 x sin(24) vv = 3.7 m s-1 | (1) |
| 12aii) | vh = vcosθ  vh = 9.1 x cos(24) vh = 8.31 m s-1 | (1) |
| 12b) | t = 0.377... s  total time = 0.377... x 2 total time = 0.76 s  *Answer must be exactly the same as value given for “show” questions.  No mark if left as 0.755 s.* | (1) eq.    (1) "... x 2" |
| 12c) | s = vt s = 8.31 x 0.76 s = 6.32 m  *d = vt still works as only magnitude was needed, not direction too.* | (1) (1) (1) |
| 12d) | Smaller displacement curve with decreasing gradient  *No part of the curve can be above the original line otherwise 0 marks.* | (1) (1) |
| 13ai) | t = 0.571 s | (1)  (1)  (1) |
| 13aii) | v2 = u2 + 2as -7.72 = 02 + 2 x -9.8 x s  s = -3.03 m  *"v" and "a" must have same sign and the sign for "s" must correspond with this.* | (1) (1) (1) |
| 13b) | Starting point greater than 5.6 Final point beyond -7.7 Acceptably parallel line  *Lines must be labelled.* | (1) (1) (1) |
| 14aiA) | vh = vcosθ  vh = 7.4 x cos(30) vh = 6.41 m s-1 | (1) |
| 14aiB) | vv = vsinθ  vv = 7.4 x sin(30) vv = 3.7 m s-1 | (1) |
| 14aii) | t = 0.378 s | (1)  (1)  (1) |
| 14aiii) | total time = 0.378 + 0.45 = 0.828 s  s = ut + ½at2 s = 3.7 x 0.828 + 0.5 x -9.8 x 0.8282 s = -0.295... m  height = 1.5 + -0.295... height = 1.2 m | (1) (1)  (1) (1) |
| 14b) | Initial horizontal/vertical speed is greater  so sponge is higher than the teacher after travelling the same horizontal distance. *or* so the sponge has travelled further horizontally when it is at the same height as the teacher.  *First statement must be correct or 0 marks.* | (1)  (1) *or*  (1) |

Vector Diagrams

1. D 2. A 3. A

|  |  |  |
| --- | --- | --- |
| 4a) | Scalar quantities have size (*or* magnitude) only Vector quantities have size (*or* magnitude) and direction. *or* Vector quantities must have direction | (1) both *or* (1) |
| 4bi) | d = vt d = 10 x 0.5 d = 5 km  d = vt d = 8 x 1.5 d = 12 km  total d = 5 + 12 total d = 17 km | (1) equation    (1) adding |
| 4bii) | *Not to scale*    14.5 km @ 321 *or* 14.5 km at 51o North of West  *or* *as another method*  a2 = b2 + c2 - 2bc cos A a2 = 122 + 52 - 2 x 12 x 5 x cos(110) a = 14.5 km  B = 51o  14.5 km @ 321 *or* 14.5 km at 51o North of West  *Bearings should always be measured from the corner of your vector diagram that does not have an arrowhead. A 360o protractor is the easiest way to measure this but remember to always point 0o/360o on your protractor up to the top of the page and always work your way round clockwise until you get to your displacement line/vector.* | (1) size (1) units (1) angle (1) bearing/ direction  ± 0.2 km ± 2o *Ans. can be within these parameters* |
| 4biii) | s = vt 14.5 = v x 2 v = 7.25 km h-1 @ 321 (*or* 7.25 km h-1 at 51o North of West)  *In vector diagram questions, velocity must have the same bearing/direction as your displacement (as it's a vector quantity). If bearing/direction not given here then you don't get the third mark.* | (1) (1) (1) |
| 4c) | The Admiral arrives first (0.18 hours earlier)  Lootin d = vt 14.5 = 7.5 x t t = 1.93... hours  time + delay = 1.93... + 0.25 time + delay = 2.18 hours  Admiral  time = 2 hours | (1) ans.      (1) working |
| 5ai) | F­adjacent­ = Fcosθ F­adjacent­ = 4.5 x 103 x cos(21) F­adjacent = 4.2 x 103 N | (1) (1) |
| 5aii) | Unbalanced force = total upwards force - weight (mg) Unbalanced force = (2 x 4.2 x 103 - (9.8 x 236)) Unbalanced force = 6087.2 N  F = ma 6087.2 = 236 x a a = 25.8 m s-2 | (1)  (1) (1) (1) |
| 5aiii) | The tension in the cords decreases (as the capsule gets higher) so the unbalanced force decreases. | (1) (1) |
| 5b) | The occupants and the capsule are both in free-fall, accelerating towards the ground at 9.8 m s-2.  *9.8 m s-2 must be mentioned.* | (1) |
| 6a) | *Not to scale*    350 m @ 038 *or* 350 m at 38o East of North  *or* *as another method*  a2 = b2 + c2 - 2bc cos A a2 = 2502 + 1502 - 2 x 250 x 150 x cos(120) a = 350 m  B = 38o  350 m @ 038 *or* 350 m at 38o East of North  *Bearings should always be measured from the corner of your vector diagram that does not have an arrowhead. A 360o protractor is the easiest way to measure this but remember to always point 0o/360o on your protractor up to the top of the page and always work your way round clockwise until you get to your displacement line/vector.* | (1) size (1) units (1) angle (1) bearing/ direction  ± 10 m ± 2o *Ans. can be within these parameters* |
| 6b) | s = vt 350 = v x 66 v = 5.3 m s-1 @ 038 (*or* at 38o East of North)  *In vector diagram questions, velocity must have the same bearing/direction as your displacement (as it's a vector quantity). If bearing/direction not given here then you don't get the third mark.* | (1) (1) (1) |
| 6c) | d = vt 400 = 6.5 x t t = 61.5 s  Car Y arrives first (being earlier by 4.5 seconds) | (1) working  (1) ans. |
| 6d) | *Not to scale*    From B to A 350 m @ 232 *or* 350 m at 52o West of South  *Don't need to draw the diagram; this just illustrates what the question means and where the answer comes from.* | (1) |
| 7ai) | *Not to scale*    47 km @ 156 *or* 47 km at 24o East of South  *or* *as another method*  a2 = b2 + c2 - 2bc cos A a2 = 302 + 202 - 2 x 30 x 20 x cos(140) a = 47 km  B = 24o  47 km @ 156 *or* 47 km at 24o East of South  *Bearings should always be measured from the corner of your vector diagram that does not have an arrowhead. A 360o protractor is the easiest way to measure this but remember to always point 0o/360o on your protractor up to the top of the page and always work your way round clockwise until you get to your displacement line/vector.* | (1) size (1) units (1) angle (1) bearing/ direction  ± 1 km ± 2o *Ans. can be within these parameters* |
| 7aii) | s = vt 47000 = v x 900 v = 52.2 m s-1 @ 156 (*or* at 24o East of South)  *In vector diagram questions, velocity must have the same bearing/direction as your displacement (as it's a vector quantity). If bearing/direction not given here then you don't get the third mark.* | (1) (1) (1) |
| 7bi) | (Stationary so lift force = weight, as forces are balanced)  W = mg W = 1.21 x 104 x 9.8 W = 119000 N W = 119 kN  *Answer must be exactly the same as value given for “show” questions. No mark if left as 119000 N* | (1) (1) |
| 7bii) | It accelerates upwards as the weight is now less than the lift force. *or* as there is now an unbalanced force upwards. | (1) (1) |
| 8ai) | *Not to scale*    15.7 km @ 154 *or* 15.7 km at 64o South of East  *or* *as another method*  a2 = b2 + c2 - 2bc cos A a2 = 152 + 122 - 2 x 15 x 12 x cos(70) a = 15.7 km  B = 64o  15.7 km @ 154 *or* 15.7 km at 64o South of East  *Bearings should always be measured from the corner of your vector diagram that does not have an arrowhead. A 360o protractor is the easiest way to measure this but remember to always point 0o/360o on your protractor up to the top of the page and always work your way round clockwise until you get to your displacement line/vector.* | (1) size (1) units (1) angle (1) bearing/ direction  ± 0.3 km ± 2o *Ans. can be within these parameters* |
| 8aii) | s = vt 15700 m = v x 4500 v = 3.49 m s-1 @ 154 (*or* at 64o South of East)  *In vector diagram questions, velocity must have the same bearing/direction as your displacement (as it's a vector quantity). If bearing/direction not given here then you don't get the third mark.* | (1) (1) (1) |
| 8bi) | 15.7 km @ 154 *or* 15.7 km at 64o South of East  *Started and ended at the same points as cyclist X so same final displacement.* | (1) |
| 8bii) | d = vt 33 = 22 x t t = 1.5 hours  s = vt 15700 = v x 5400 v = 2.91 m s-1 @ 154 (*or* at 64o South of East)  *In vector diagram questions, velocity must have the same bearing/direction as your displacement (as it's a vector quantity). If bearing/direction not given here then you don't get the third mark.* | (1)  (1) (1) (1) |
| 9ai) | A single force which will have the same effect as a combination of forces. | (1) |
| 9aii) | *Not to scale*    1730 N at 49o relative to the ground *or* 1730 N at 41o relative to the vertical  *or* *as another method*  a2 = b2 + c2 - 2bc cos A a2 = 12002 + 9002 - 2 x 1200 x 900 x cos(110) a = 1730 N  B = 41o  1730 N at 41o relative to the vertical *or* 1730 N at 49o relative to the ground | (1) size (1) units (1) angle (1) bearing/ direction  ± 30 N ± 2o *Ans. can be within these parameters* |
| 9b) | The vertical component of the force exerted by the parasail is greater than the weight of the parascender.  *or* There in now an unbalanced force (upwards) *or* The upwards force is greater than the downwards force | (1) (1)  *or* (1) mark only |
| 10ai) | (Hovering at a constant height (stationary) so the upward force = weight, as the forces are balanced)  W = mg W = 6.75 x 9.8 W = 66.2 N | (1) (1) (1) |
| 10aii) | P = V2/R P = 122/9.6 P = 15 W | (1) (1) (1) |
| 10aiii) | The drone accelerates upwards as the weight is now less than the upwards force (so unbalanced force). | (1) (1) |
| 10b) | W = mg W = 3.4 x 9.8 W = 33.32 N  Tension = Share of Weight ÷ cosθ (two cables so half of the weight each)  T = 20.3 N | (1) weight  (1) halving weight  (1) sub.  (1) ans. |
| 11a) | W = mg W = 55 x 9.8 W = 539 N | (1) (1) (1) |
| 11b) | Tension = Share of Weight ÷ cosθ (only one rope so it gets all the weight)  T = 558 N | (1)  (1)  (1) |
| 11c) | Tension = Share of Weight ÷ cosθ (only one rope so it gets all the weight)  T will decreases  as if θ decreases then cosθ increases meaning T will decrease assuming W is constant. | (1)  (1) |