

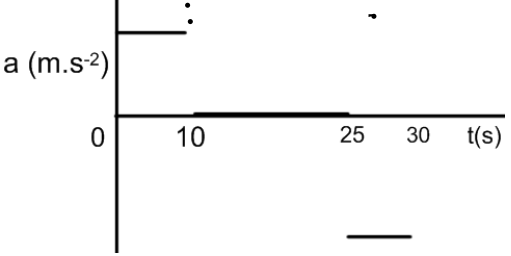


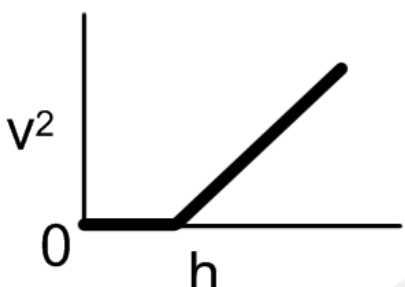


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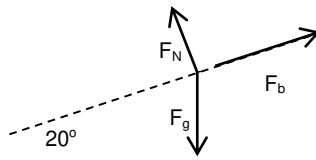
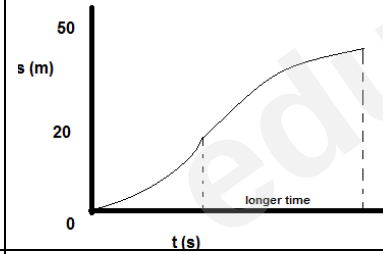
## Physical Science Paper 1 2016 Possible Model Answer

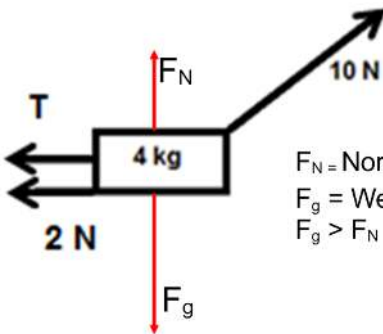
| Que                                 | Model | Comment for learners                                                                        | Total |
|-------------------------------------|-------|---------------------------------------------------------------------------------------------|-------|
| <b>Question 1 – Multiple Choice</b> |       |                                                                                             |       |
| 1.1                                 | C     | Surprisingly badly answered                                                                 | 2     |
| 1.2                                 | D     |                                                                                             | 2     |
| 1.3                                 | B     |                                                                                             | 2     |
| 1.4                                 | A     | The acceleration is 9,8 down even at the moment that the object is stationary               | 2     |
| 1.5                                 | D     |                                                                                             | 2     |
| 1.6                                 | D     | The angle $\theta$ depends only on $\mu$                                                    | 2     |
| 1.7                                 | B     |                                                                                             | 2     |
| 1.8                                 | C     | Ratio problem. Don't forget the square.                                                     | 2     |
| 1.9                                 | B     | Close to the surface of the earth the field lines are parallel – things fall straight down. | 2     |
| 1.10                                | D     | Definition                                                                                  | 2     |
|                                     |       |                                                                                             | 20    |

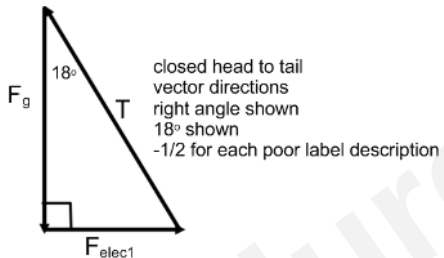
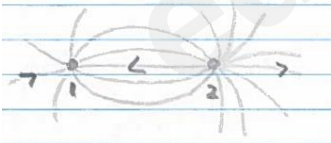
| Question 2 – Kinematics – 33 marks |                                                                                                                                                                                                        |                                                                                                                                          |   |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---|
| 2.1.1                              | Displacement: <i>as a change in position</i> ✓✓                                                                                                                                                        |                                                                                                                                          | 2 |
| 2.1.2a                             | Accelerates✓ uniformly✓ North✓                                                                                                                                                                         |                                                                                                                                          | 3 |
| 2.1.2b                             | Constant velocity✓ North✓                                                                                                                                                                              |                                                                                                                                          | 2 |
| 2.1.3                              | Calculate the area under the graph:<br>Area = $(15 \times 25) + (1/2 \times 10 \times 15) + (15 \times 15) + (1/2 \times 5 \times 30)$ ✓✓<br>= 750 m ✓ North✓                                          | Accept use of equations of motion                                                                                                        | 4 |
| 2.1.4                              |  <p>✓ relative size of accelerations</p>                                                                              | Don't forget the gradient indicates the acceleration so the first acceleration magnitude is less than the second acceleration magnitude. | 4 |
| 2.2.1                              | $R^2 = 15^2 + 35^2$ ✓<br>$R = 38,08$ m✓<br>$\tan \theta = 15/25$ ✓<br>$\theta = 23,2^\circ$<br>Displacement is 38,08 m @ 23,2° E of N, or bearing 23,2°<br>Accept calculations for 88,8° N of E✓       | Many did not include direction for the displacement and/or gave a poor reference for the direction                                       | 5 |
| 2.2.2                              | Shawn has the greater speed✓ He travels a greater distance✓ In less time✓                                                                                                                              |                                                                                                                                          | 3 |
| 2.2.3                              | A – B $t = s/v = 35/5$ ✓ = 7 s✓<br>So B – C is 13-7 = 6 s✓<br>From B to C $V_{ave} = s/t = 15/6$ ✓ = 2,5 m.s <sup>-1</sup> ✓ East✓                                                                     | Again leaving out direction. Use of $v_{ave}$ was poorly done.                                                                           | 6 |
| 2.3                                | $h = \frac{1}{2} g t_1^2$ ✓ and $2h = \frac{1}{2} g t_2^2$ ✓<br>so $2 \times \frac{1}{2} g t_1^2 = \frac{1}{2} g t_2^2$ ✓<br>cancel g, $\frac{1}{2}$<br>$2 t_1^2 = t_2^2$<br>So $\sqrt{2} t_1 = t_2$ ✓ | Accept other correct workings<br>Marks should be awarded for relationships shown                                                         | 4 |

| Question 3 – Proportionality – 15 marks |                                                                                                                                                     |                                                                                                                                         |   |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---|
| 3.1                                     | Independent variable a <b>variable/ quantity</b> that is intentionally changed to observe its effect on the dependent <b>variable/quantity</b> . ✓✓ | Owtte – not an official definition. A variable that does not depend on other variables did not see like an explanation so not accepted. | 4 |
| 3.2                                     | $m^2s^{-2}$ ✓✓                                                                                                                                      | All or nothing                                                                                                                          | 2 |
| 3.3                                     | Velocity of the cylinder squared is directly proportional to the vertical height of release ✓✓                                                      | Variables must be in this order                                                                                                         | 2 |
| 3.4.1                                   | gradient = $2g / Z$ ✓✓                                                                                                                              |                                                                                                                                         | 2 |
| 3.4.2                                   | $8,5 = 2 \times 9,8 / Z$ ✓<br>So $Z = 2,306$ ✓                                                                                                      |                                                                                                                                         | 2 |
| 3.4.3                                   | $v^2 = 2 \times 9,8 \times 0,32 / 2,306$ ✓<br>$v = 1,65 \text{ m.s}^{-1}$ ✓                                                                         | Ca from previous 2.<br>Award 2 for correct answer                                                                                       | 2 |
| 3.5                                     |                                                                    | Many did not indicate a time period where the box would not slide due to friction.                                                      | 3 |

| Question 4 – Conservation of Mechanical Energy and Momentum |                                                                                                                                                                                                                                                                                                                |                                                                                                |   |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|---|
| 4.1                                                         | principle of conservation of mechanical energy: In the absence of air resistance✓ or any external forces✓, the mechanical energy of an object is constant✓                                                                                                                                                     | Confusion with conservation of energy                                                          | 3 |
| 4.2                                                         | $E_p = mgh✓ = 0,4588✓ \times 9,8 \times 0,63✓ = 2,83 \text{ J}✓$                                                                                                                                                                                                                                               | Note mark for combined mass                                                                    | 3 |
| 4.3                                                         | $E_{\text{mech top}} = E_{\text{mech bottom}}✓$<br>$0 + 2,83✓ = \frac{1}{2} \times 0,4588 \times v^2 ✓ + 0$<br>$V = 3,51 \text{ m.s}^{-1}✓$                                                                                                                                                                    |                                                                                                | 4 |
| 4.4                                                         | <i>The total linear momentum ✓ of an isolated system ✓ remains constant ✓ (is conserved)</i>                                                                                                                                                                                                                   |                                                                                                | 2 |
| 4.5                                                         | $p_i = p_f ✓$<br>$0 + 0,0088 \times u✓ = 0,4588 \times 3,51✓$<br>$u = 183 \text{ m.s}^{-1} ✓$                                                                                                                                                                                                                  | Some used conservation of $E_k$ here. Remember linear momentum is always conserved NOT $E_k$ . | 4 |
| 4.6.1                                                       | steel block✓ because the change in velocity of the bullet was greater than with the wooden block ✓ hence it had a greater acceleration✓ (and hence greater force on it)                                                                                                                                        |                                                                                                | 3 |
| 4.6.2                                                       | Change in momentum of the steel block is greater than wood block✓ (as the change in momentum of the bullet was greater) hence the velocity of the steel block after the collision is greater ✓<br>Hence the steel block has more kinetic energy to convert to potential energy✓<br>Hence $h > 0,63 \text{ m}✓$ | Note: the height attained is independent of the mass of the block<br>$\frac{1}{2} v^2 = gh$    | 4 |

| Question 5 – Work – Energy Theorem |                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |   |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---|
| 5.1                                | <b>weight <math>F_g</math> as the gravitational force the Earth exerts on any object on or near its surface</b>                                                                                                                                                                                            |                                                                                                                                      | 2 |
| 5.2.1                              | $v^2 = u^2 + 2as$ ✓<br>$= 0 + 2 \times 3,35 \times 20$ ✓<br>$= 134$<br>So $v = 11,58 \text{ m.s}^{-1}$ ✓                                                                                                                                                                                                   | This motion is in a straight line so uvats can be used.                                                                              | 3 |
| 5.2.2                              | $E_k = \frac{1}{2} mv^2$ ✓<br>$= 0,5 \times 63 \times 134$ (coe from prev question)✓<br>$= 4221 \text{ J}$ ✓                                                                                                                                                                                               |                                                                                                                                      | 3 |
| 5.3.1                              |  <p> <math>F_N</math> = Normal force of slope on Ross<br/> <math>F_g</math> = Weight of Ross (gravitational force of earth on Ross)<br/> <math>F_b</math> = Force of bungee, Tension of bungee           </p>             | People left out the normal.<br>Remember that only real forces must be shown. Components can not be shown.<br>Labels must be complete | 3 |
| 5.3.2                              | <b>The work-energy theorem:</b> the work done✓ by a net force on an object✓ is equal to the change in the kinetic energy of the object✓                                                                                                                                                                    |                                                                                                                                      | 3 |
| 5.3.3                              | $W_{\text{net}} = \Delta E_k = \Sigma \text{works} = W_b + W_g$<br>$-4221 \checkmark = -10556 + m.g.\sin\theta \checkmark .S_{BC} \checkmark$ award ✓ for the relative signs<br>$6335 = 63 \cdot 9,8 \cdot \sin 20 \cdot S_{BC}$<br>$30 \text{ m} = S_{BC} \checkmark$<br>So distance AB = 20 + 30 = 50 m✓ | There were various other ways of doing this = all marked on merit.                                                                   | 6 |
| 5.4                                |                                                                                                                                                                                                                          | Coe from 5.3.3 for distances                                                                                                         | 3 |
| 5.5.1                              | The same as (Ross) ✓✓                                                                                                                                                                                                                                                                                      |                                                                                                                                      | 2 |
| 5.5.2                              | Greater than (Ross) ✓✓                                                                                                                                                                                                                                                                                     |                                                                                                                                      | 2 |

| Question 6 – Newton and Momentum |                                                                                                                                                                                                                                                                                   |                                       |   |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---|
| 6.1                              | Normal the perpendicular force ✓ exerted by a surface ½ on an object in contact with it ½                                                                                                                                                                                         |                                       | 2 |
| 6.2.1                            |  <p> <math>F_N</math> = Normal Force of ice on sled ✓ label and drawn in<br/> <math>F_g</math> = Weight of sled ✓ label and drawn in<br/> <math>F_g &gt; F_N</math> ✓ relative size         </p> |                                       | 3 |
| 6.2.2a                           | Magnitude $F_N$ + y component = $F_g$ correct expression ✓ symbols or numbers<br>$F_N + 10 \sin 30^\circ = 4 \times 9,8$ ✓<br>$F_N = 34,2 \text{ N}$ ✓                                                                                                                            |                                       | 4 |
| 6.2.2b                           | $F_{\text{net}} = m \cdot a$<br>$10 \cos \theta - 2 + T = 4 \times 0,943$ ✓<br>$T = -2,886 \text{ N} = 2,886 \text{ N}$ ✓                                                                                                                                                         |                                       | 5 |
| 6.2.3                            | $F_{\text{net}} = m \cdot a$<br>$T - X = m \cdot a$<br>$2,886 - X = 2 \times 0,943$ ✓<br>$X = 1 \text{ N}$ ✓                                                                                                                                                                      | Other methods marked on merit         | 4 |
| 6.2.4                            | Nature of interaction between surfaces ✓✓<br>OR nature of the two surfaces                                                                                                                                                                                                        | Answer had to refer to both surfaces. | 2 |
| 6.3.1                            | Graph B ✓✓<br>Momentum must increase after cut ✓ Must be B not A as the momentum will increase less on a fractioned surface ✓                                                                                                                                                     |                                       | 4 |
| 6.3.2                            | Graph C ✓✓<br>After cut there will be no net force on the sled ✓<br>So the velocity and momentum will remain constant ✓                                                                                                                                                           |                                       | 4 |

| Question 7 – Force Fields |                                                                                                                                                                                                                                                                            |   |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 7.1.1                     | <b>Newton's Law of Universal Gravitation:</b> Every particle in the universe attracts every other particle ✓ with a force which is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres ✓ | 3 |
| 7.1.2                     | $F_g = Gm_1m_2/r^2$ $= (6,67 \times 10^{-11} \checkmark \times 36 \times 10^9 \times 4 \times 10^9 \checkmark \text{ conversions}) / 20^2 \checkmark \text{ square}$ $= 24,12 \text{ N} \checkmark \text{ left} \checkmark$                                                | 5 |
| 7.1.3                     | <b>Newton's third law:</b> When object A exerts a force on object B ✓, object B <u>simultaneously</u> $\frac{1}{2}$ exerts an oppositely directed force $\frac{1}{2}$ of equal magnitude $\frac{1}{2}$ on object A $\frac{1}{2}$                                           | 3 |
| 7.1.4a                    | The sizes of the forces change depending on distance to A and B $\frac{1}{2}$ . A and B exert gravitational forces in opposite directions ✓. Therefor at some point their magnitudes will be the same but in opposite directions and cause a net force of 0N $\frac{1}{2}$ | 2 |
| 7.1.4b                    | Magnitudes for forces are the same at this point OR<br>$F_{gA} = F_{gB} \checkmark$<br>$36/x^2 \checkmark = 4/(20-x)^2 \checkmark$<br>..... X = 15 m ✓                                                                                                                     | 4 |
| 7.2.1                     |                                                                                                                                                                                          | 3 |
| 7.2.2                     | $\tan 18 \checkmark = F_{elec1} / (0,01 \times 9,8) \checkmark$<br>$F_1 = 0,032 \text{ N} \checkmark$                                                                                                                                                                      | 3 |
| 7.2.3a                    |                                                                                                                                                                                         | 4 |
| 7.2.3b                    | <b>magnitude of the electric field at a point</b> as the force ✓ per unit positive charge ✓                                                                                                                                                                                | 2 |
| 7.2.3c                    | X ✓ ✓                                                                                                                                                                                                                                                                      | 2 |

| Question 8 – Photons and electrons |                                                                                                                                                                                 |                                                            |   |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---|
| 8.1.1                              | <b>work function:</b> <i>the minimum amount of energy needed ✓ to emit an electron ½ from the surface of a metal ½</i>                                                          |                                                            | 2 |
| 8.1.2                              | $W_0 = hf_0$<br>$= 6,6 \times 10^{-34} \checkmark \text{ sub } \times 1,1 \times 10^{15} \checkmark \text{ read off graph}$<br>$= 7,26 \times 10^{-19} \text{ J} \checkmark$    |                                                            | 3 |
| 8.1.3a                             | $6,4 \times 10^{-19} \text{ J} \checkmark \checkmark$                                                                                                                           | calculation need not be shown                              | 2 |
|                                    | $E_k = \frac{1}{2} mv^2$<br>$\text{Coe } 6,4 \times 10^{-19} \checkmark = \frac{1}{2} 9,1 \times 10^{-31} \checkmark v^2$<br>$V = 1,19 \times 10^6 \text{ m.s}^{-1} \checkmark$ |                                                            | 3 |
| 8.1.4                              | $f = c/\lambda \checkmark$<br>$= 3 \times 10^8 / 187 \times 10^{-9} \checkmark \text{ subs}$<br>$= 1,6 \times 10^{15} \text{ Hz} \checkmark$<br>Read from graph - Aluminium ✓   | Many went a very long way around on this – marked on merit | 4 |
| 8.2.1                              | $\Delta E = hf$<br>$3 \times 10^{-19} \checkmark \checkmark \text{ (difference)} = 6,6 \times 10^{-34} \cdot f \checkmark$<br>$F = 4,55 \times 10^{14} \text{ Hz} \checkmark$   |                                                            | 4 |
| 8.2.2                              | Wavelength from transition A is greater than wavelength of transition B ✓ or vice versa                                                                                         |                                                            | 1 |
| 8.2.3                              | $E \propto f \propto 1/\lambda \checkmark$<br>So lower energy means longer $\lambda \checkmark$ or vice versa<br>So low energy from transition A means longer wavelength ✓      |                                                            | 3 |