M1. (a) 450

*allow **1** mark for correct substitution,*
ie 18 × 10 × 2.5 provided no subsequent step shown

2

(b) (i) friction between child ('s clothing) and slide

accept friction between two insulators
accept child rubs against the slide
accept when two insulators rub (together)

1

causes electron / charge transfer (between child and slide)

accept specific reference, eg electrons move onto / off the child / slide
reference to positive electrons / protons / positive charge / atoms transfer negates this mark
answers in terms of the slide being initially charged score zero

1

(ii) all the charges (on the hair) are the same (polarity)

accept (all) the charge/hair is negative / positive
accept it is positive/negative

1

charges / hairs are repelling

both parts should be marked together

1

(iii) charge would pass through the metal (to earth)

accept metal is a conductor
accept metal is not an insulator
accept there is no charge / electron transfer
accept the slide is earthed
accept metals contain free electrons

1

[7]

M2. (a) 572

*allow **1** mark for correct substitution,*

ie 220 × 2.6

*allow **1** mark for*

220 × 260 = 57 200

or

220 × 2600 = 572 000

but to score this mark the entire calculation must be shown

2

(b) (i) smooth curve drawn

accept a line that is extrapolated back to 0 degrees, but not through the origin

accept a straight line of best fit (point at 40 degrees can be treated as anomalous and line may stop at 30 degrees)

*do **not** accept straight lines drawn 'dot to dot' or directly from first to last point or a line going through the origin*

1

(ii) increases

accept a positive correlation

*do **not** accept proportional*

1

(iii) long plank

no mark for this, the marks are for the explanation

makes the angle small(er) (than a short plank)

accept increases the distance

accept small(er) slope

1

*a small(er) force is needed**or**short plank*

no mark for this, the marks are for the explanation

a large(r) force is used over a short(er) distance (1)

less work done (1)

accept less energy transfer

1

[6]

M3. *(a) (i) 75 000*

*accept correct substitution for **1** mark*
ie 7500 × 10

2

newtons / N

*do **not** accept n*
*full credit for using g = 9.8 **or** 9.81*

1

(ii) 60 000 000

accept for both marks
their (a)(i) × 800 correctly calculated
*accept correct substitution for **1** mark*
ie their (a)(i) × 800

2

*(b) (i) arrow drawn parallel (to) **and** down (the) slope*

accept arrow drawn anywhere on the diagram

1

(ii) increases

1

*GPE transformed to KE **or***
speed increasing

accept is accelerating
however 'speed increasing' only scores if correctly linked to increasing kinetic energy

1

(c) so more likely to wear one
or
they know wearing a helmet is likely to / will reduce (risk) head injury
or
so can make an (informed) choice (about wearing one)

1

[9]

M4. *(a)* *(i)* *friction*

1

(ii) *air resistance*

accept drag

friction is insufficient

1

(iii) *Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.*

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- *at X force A is greater than force B*
- *cyclist accelerates*
- *and velocity increases*
- *as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)*
- *resultant force decreases*
- *cyclist continues to accelerate but at a smaller value*
- *so velocity continues to increase but at a lower rate*

Y to Z

- *from Y to Z force B (air resistance) increases*
- *acceleration decreases*
- *force B becomes equal to force A*
- *resultant force is now zero*
- *acceleration becomes zero*

- *velocity increases until…*
- *cyclist travels at constant / terminal velocity*

accept speed for velocity throughout

6

(b) *(i)* *3360*

*allow **1** mark for correct substitution,*

ie 140 × 24 provided no subsequent step

*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J

*do **not** accept j*

*do **not** accept Nm*

1

(ii) *decreases*

accept an alternative word / description for decrease

do not accept slows down

1

temperature

accept thermal energy

accept heat

1

[13]

M5. *(a)* *gravitational / gravity / weight*

*do **not** accept gravitational potential*

1

(b) *accelerating*

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

(c) *(i)* *any **one** from:*

- *speed / velocity*
- *(condition of) brakes / road surface / tyres*
- *weather (conditions)*

accept specific examples, eg wet / icy roads
accept mass / weight of car friction is insufficient
reference to any factor affecting thinking distance negates this answer

1

(ii) *75 000*

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*
***or** allow **1** mark for an answer 75**or** allow **2** marks for 75 k(+ incorrect unit), eg 75 kN*

2

joules / J

*do **not** accept j*

*an answer 75 kJ gains **3** marks*

for full marks the unit and numerical answer must be consistent

1

[8]

M6. *(a) (i) gravitational potential (energy)*

1

(ii) kinetic (energy)

1

(b) (i) slope or gradient

1

(ii) area (under graph)

*do **not** accept region*

1

(iii) starts at same y−intercept

1

steeper slope than original and cuts time axis before original

the entire line must be below the given line

allow curve

1

(c) (i) 31

and

31

*correct answers to 2 significant figures gains **3** marks even if no working shown*

*both values to more than 2 significant figures gains **2** marks:*
30.952…...
30.769….

65 / 2.1 and / or
*80 / 2.6 gains **1** mark*

*if incorrect answers given but if both are to 2 significant figures allow **1** mark*

3

(ii) student 1 incorrect because 80 ≠ 65

1

student 2 correct because average velocities similar
ecf from ***(c)(i)***

1

student 3 incorrect because times are different

1

[12]