M1. (a) g.p.e. = mass × gravitational field strength × height

accept $E_p = mgh$

1

(b) $E_p = 50 \times 9.8 \times 20$

1

9800 (J)

*allow 9800 (J) with no working shown for **2** marks*
answer may also be correctly calculated using W = Fs
*ie allow W = 490 × 20 for **1** mark*
*or answer of 9800 (J) using this method for **2** marks*

1

(c) 7840 (J)

allow ecf from '11.2'

1

(d) $7840 = ½ \times 50 \times v^2$

1

$$v = \sqrt{\frac{7840}{1/2 \times 50}}$$

allow $v^2 = \frac{7840}{(1/2 \times 50)}$ *for this point*

1

17.7(0875) (m / s)

1

18 (m / s)

*allow ecf from '11.3' correctly calculated for **3** marks*
*allow 18 (m / s) with no working for **2** marks*
answer may also be correctly calculated using $v^2 - u^2 = 2as$

1

(e) extension = 35 (m) and conversion of 24.5 kJ to 24500 J

1

$24\ 500 = ½ \times k \times 35^2$

1

40

1

*allow 40 with no working shown for **3** marks*
*an answer of '16.2' gains **2** marks*

[11]

M2. (a) *any evidence of:* momentum = mass × velocity (words, symbols or numbers)
appropriate re-arrangement mass as 0.05kg

each gains 1 mark

but 800

gains 4 marks

4

(b) (i) *any reference to* friction with air/air resistance

gains 1 mark

but *idea that* friction with air/air resistance is high (at high speed)

gains 2 marks

2

(ii) *any evidence of:* k.e. $\propto v^2$ **or** k.e. = ½ mv^2

final k.e.
initial k.e.

either initial or final k.e. correctly calculated (i.e. 16000; 10240)

each gains 1 mark

but $(0.8)^2$

gains 3 marks

but 64%(credit 0.64)

gains 4 marks (also credit e.c.f)

4

[10]

M3. (a) product of mass and velocity

1

(b) (i) 4kg or 4000g

1

(ii) M = 8kgm/s or Ns
for 3 marks

else M = 8
for 2 marks

else M – mv or 4 × 2
for 1 mark

3

(iii) 8 kgm/s (watch e.c.f.)

1

(iv) v = 400
for 3 marks

else v = 8/0.02
for 2 marks

else M – mv, v – M/m or 8 = 0.02v
for 1 mark

3

(v) ke = 8
for 3 marks

else ke = 1/2 (4×2^2)
for 2 marks

else ke = 1/2 (mv^2)
for 1 mark

3

(vi) transferred to heat and sound
or does work against wood/pushing wood aside/deforming bullet

1

[13

M4. (a) 13 500 (J)

*allow **1** mark for correct substitution, ie 90 x 10 x 15 provided no subsequent step shown*

2

(b) 17 **or** $\sqrt{\frac{\text{their (a)}}{45}}$

correctly calculated and answer given to 2 or 3 significant figures

accept 17.3

*allow **2** marks for an answer with 4 or more significant figures, ie 17.32*

or

*allow **2** marks for correct substitution, ie 13 500/ their (a) = ½ x 90 x v^2*

or

*allow **1** mark for a statement or figures showing KE = GPE*

3

(c) work is done

1

(against) friction (between the miner and slide)

*accept 'air resistance' **or** 'drag' for friction*

1

(due to the) slide not (being perfectly) smooth

accept miners clothing is rough

or

causing (kinetic) energy to be transferred as heat/internal energy of surroundings

accept lost/transformed for transferred

accept air for internal energy of surroundings

1

[8]