IB Kinematics MS

1. (a) (i) speed = $\frac{\text{distance}}{\text{time}}$ ***or*** $\frac{72}{0.40}$;
= 180 cm s^{-1}; 2

*Award **[1 max]** if time incorrect.*

(ii) $s = \frac{1}{2} gt^2$ ***or*** $80 = \frac{1}{2} \times g \times 0.4^2$;
g = 10 m s^{-2}; 2

*Award answer with no working **[0]**.*

If it is clear that same mistake as in (i) has been made for the timing, then award full marks in (ii).

(b) horizontal distance moved = 90 cm; *(allow ecf from (a) (i))*
vertical distance moved = 125 cm; *(allow ecf from (a) (ii))*
correct plot from candidate's working; 3

Award full marks if the plot is correct but there is no working shown.

(c) *sketch:* overall reasonable shape (smooth curve "below" given path);
horizontal distance moved always decreasing when compared to given path; angle to vertical always greater than given path; 3

[10]

2. C

[1]

3. (a) (i) $18t$; 1

(ii) $s = \frac{1}{2} \times 4.5 \times 6^2 = 81$m; 1

(iii) $v = at = 6 \times 4.5 = 27$ m s^{-1}; 1

(iv) $27(t - 6)$; 1

(b) idea of (a) (i) = (a) (ii) + (a) (iv);
$18t = 81 + 27(t - 6)$
t = 9.0 s; 2

[6]

4. (a) *horizontally* : zero;
vertically: 9.8(1)ms^{-2} (downwards); 2

N. B. *Part (b) and part (c) to be marked independently of part (a).*

*Deduct **[1]** if answer uses g = 10 ms^{-2}, but only once in **either** part (a) **or** part (b) but not both.*

(b) $s = ut + \frac{1}{2} at^2$

$33 = \frac{1}{2} \times 9.8 \times t^2$;

t = 2.6s; 2

(c) $s = ut$
= 18 × 2.6 = 47 (46.8) m; 1

[5]

5. (a) $v^2 = 30^2 - 2 \times 10 \times s$;
$v^2 = 0$;
s = 45m;
or
t = 3.0s;
$s = 30 \times 3.0 - \frac{1}{2} \times 10 \times 3.0^2$;
s = 45m; 3

Accept valid alternative methods.

(b) $X = 20 \times 6.0$;
X = 120m; 2

[5]

6. C

[1]

7. A

[1]

8. (a) (i) horizontal: 24 ms^{-1}; 1

(ii) vertical: 14 ms^{-1}; 1

(b) appropriate use of kinematic equation;
correct substitution;
h = 7.1m; 3

[5]

9. Linear motion

(a) (i) $E_K = \frac{1}{2} \times 72 \times 23^2$;

$= 1.9 \times 10^4$ J; 2

(ii) uses area between the *t*-axis and the line;
correctly converts area → distance (one 1cm × 1cm square ≡ 5.0m);
distance between 90 m and 105 m;
improved accuracy, distance between 95 m and 100 m; 4
Do not accept kinematic formulas. Distance can only be found from area.

(b) (i) $\Delta E_p = 72 \times 9.8 \times 41$;

$= 2.9 \times 10^4$ J; 2

Accept 3.0 × 10^4 J for responses using g = 10ms^{-2}.

(ii) energy "loss" = 1.0×10^4 J;

average force = $\frac{(1.0 \times 10^4)}{98}$;

= 100 N; 3

NB *follow through working – answer is {(b)(i)–(a)(i)} / (a)(ii).*

(iii) *eg* air resistance;
friction between skis and slope;
force to push snow away from skis; 2
To award marks responses must specify where friction is acting.

(c) (i) $1.8 = \frac{1}{2} \times 9.8 \times t^2$;

time of flight = 0.61s;
horizontal distance travelled(= 23 × 0.61) = 14m;
distance CD(= 14 – 12)= 2.0m; 4
Accept a time of 0.60 s and CD = 1.8 m for responses using g = 10ms^{-2}.

(d) (i) D is further from the edge C; 1

(ii) sensible reason *eg* velocity not normal to ground;
hence impact is less; *(any other sensible comment)* 2

[20]

10. C

[1]