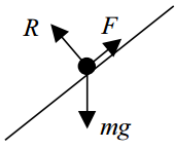
2 A skier slides in a straight line directly down a slope inclined at 30° to the horizontal. The coefficient of friction between her skis and the slope is 0.3. The skier and her equipment are to be modelled as a particle of mass 80 kg. Assume that there is no air resistance present.

(a) Draw a diagram to show the forces acting on the skier. *(1 mark)*

(b) (i) Find the magnitude of the normal reaction force acting on the skier. *(2 marks)*

(ii) Show that the magnitude of the friction force acting on the skier is 204 N to three significant figures. *(2 marks)*

(c) Find the acceleration of the skier. *(4 marks)*

2(a)		B1	1	Correct force diagram **No extra forces**
(b)(i)	$R = 80 \times 9.8 \cos 30° = 679.0$ N	M1 A1	2	Resolving perpendicular to the slope Correct Reaction force
(ii)	$F = 0.3R = 204$ N	M1 A1	2	Multiplying by 0.3 **ag** Correct answer obtained
(c)	$80a = 80 \times 9.8 \sin 30° - 203.7$ $a = 2.35$ m s^{-2}	M1 A1 m1 A1	4	Three term equation of motion Correct equation Solving for a awrt 2.35
	Total		**9**	

3 A rough plane is inclined at an angle of 40° to the horizontal. A particle, of mass 5 kg, is sliding down the plane.

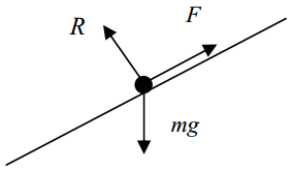
(a) Draw a diagram to show the forces acting on the particle. *(1 mark)*

(b) Find the magnitude of the normal reaction force acting on the particle. *(2 marks)*

(c) The coefficient of friction between the particle and the plane is 0.2. Show that the magnitude of the friction force acting on the particle is 7.51 N, correct to three significant figures. *(2 marks)*

(d) Show that the acceleration of the particle is $4.80\,\text{m s}^{-2}$, correct to three significant figures. *(4 marks)*

(e) Find the distance that the particle travels as its speed increases from $2\,\text{m s}^{-1}$ to $10\,\text{m s}^{-1}$. *(3 marks)*

3(a)		B1	1	Correct force diagram
(b)	$R = 5\times9.8\cos 40° = 37.5\,\text{N}$	M1 A1	2	Resolving perpendicular to slope Correct R
(c)	$F = 0.2R = 7.51\,\text{N}$	M1 A1	2	Using $F = \mu R$ Correct F from correct working
(d)	$5\times9.8\sin 40° - F = 5a$	M1 A1		Resolving parallel to slope to give 3 term equation of motion Correct equation
	$a = \dfrac{5\times9.8\sin 40° - F}{5} = 4.80\,\text{m s}^{-2}$	m1 A1	4	Solving for a Correct a from correct working
(e)	$10^2 = 2^2 + 2\times4.80s$	M1 A1		Forming constant acceleration equation Correct equation
	$s = \dfrac{100-4}{9.6} = 10.0\,\text{m}$	A1	3	Correct s
	Total		**12**	

7 A child slides down a steep, straight slide that is inclined at 60° to the horizontal. The child has mass 30 kg and the coefficient of friction between the slide and the child is 0.6. Assume that there is no air resistance.

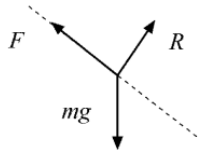
(a) Draw a diagram to show the forces acting on the child, while sliding down the slide. *(1 mark)*

(b) Calculate the magnitude of the normal reaction force on the child. *(2 marks)*

(c) Show that the magnitude of the friction force that acts on the child is 88.2 N. *(2 marks)*

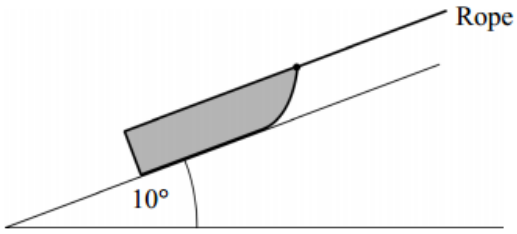
(d) Calculate the acceleration of the child. *(4 marks)*

(e) What modelling assumption have you made about the child in your solution? *(1 mark)*

Question Number and part	Solution	Marks	Total Marks	Comments
7 (a)		B1	1	Three forces as shown
(b)	$R = 30\times9.8\times\cos 60°$	M1		Resolving perpendicular to the slope
	$= 147$ N	A1	2	Correct value
(c)	$F = 0.6\times147$	M1		Using $F = \mu R$
	$= 88.2$ N	A1	2	**ag** correct answer from correct working
(d)	$30a = 30\times9.8\cos 30° - 88.2$	M1 A1		3 term equation of motion Correct equation
	$a = 5.55$ ms^{-2}	m1 A1	4	Solving for a Correct value
(e)	Child is a particle	B1	1	
	Total		**10**	

8 A sledge, of mass 12 kg, is pulled up a rough slope which is inclined at an angle of 10° to the horizontal. The coefficient of friction between the slope and the sledge is 0.2.

(a) The sledge is pulled by a rope that is parallel to the slope, as shown in the diagram.

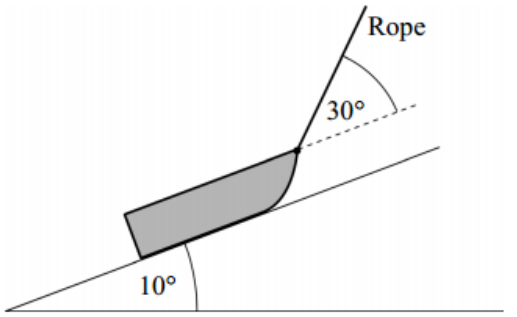


(i) Draw a diagram to show the forces acting on the sledge. *(1 mark)*

(ii) Find the magnitude of the normal reaction force acting on the sledge. *(2 marks)*

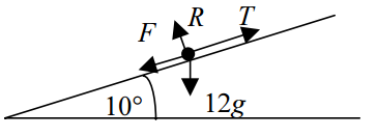
(iii) Given that the acceleration of the sledge is $0.5\,\text{m s}^{-2}$, show that the tension in the rope is approximately 50 N. *(4 marks)*

(b) The sledge is then pulled with the rope at an angle of 30° to the slope, as shown in the diagram.



Find the acceleration of the sledge if the tension in the rope is 60 N. *(7 marks)*

(c) Write down **two** modelling assumptions that you have made. *(2 marks)*

8(a)(i)		B1	1	Correct diagram
(ii)	$R = 12g\cos 10° = 116\,\text{N}$	M1		Resolving perpendicular to slope
		A1	2	Correct R
(iii)	$F = 0.2\times 12g\cos 10°$	M1		Use of friction law
		A1		Correct friction
	$T - 12g\sin 10° - 0.2\times 12g\cos 10° = 12\times 0.5$	M1		Forming and solving equation for T
	$T = 50\,\text{N}$	A1	4	Correct T from correct working
(b)	$R + 60\sin 30° = 12g\cos 10°$	M1		Resolving perpendicular to slope
	$R = 12g\cos 10° - 30$	A1		Correct R
	$F = 0.2(12g\cos 10° - 30)$	A1		Correct friction
	$60\cos 30° - 0.2(12g\cos 10° - 30) - 12g\sin 10° = 12a$	M1		Four term equation of motion
		A1		Correct equation
	$a = \dfrac{60\cos 30° - 0.2(12g\cos 10° - 30) - 12g\sin 10°}{12}$	m1		Solving for a
	$= 1.20\,\text{m s}^{-2}$	A1	7	Correct a
(c)	Sledge is a particle	B1		First assumption
	No air resistance	B1	2	Second assumption
	Total		**16**	