Forces and Friction - Mark Scheme

Q1.

Question	Scheme	Marks	AOs
(a)	Resolve vertically	M1	3.1b
	$R + 40\sin\alpha = 20g$	A1	1.1b
	Resolve horizontally	M1	3.1b
	$40\cos\alpha - F = 20a$	A1	1.1b
	$F = 0.14R$	B1	1.2
	$a = 0.396$ or 0.40 (m s^{-2})	A1	2.2a
		(6)	
(b)	Pushing will increase R which will increase available F	B1	2.4
	Increasing F will <u>decrease a</u> * GIVEN ANSWER	B1*	2.4
		(2)	
		(8 marks)	

Notes:

(a)

M1: Resolve vertically with usual rules applying

A1: Correct equation. Neither g nor $\sin\alpha$ need to be substituted

M1: Apply $F = ma$ horizontally, with usual rules

A1: Neither F nor $\cos\alpha$ need to be substituted

B1: $F = 0.14R$ seen (e.g. on a diagram)

A1: Either answer

(b)

B1: Pushing increases R which produces an increase in available (limiting) friction

B1: F increase produces an <u>a decrease (need to see this)</u>

N.B. It is possible to score B0 B1 but for the B1, some "explanation" is needed to say why friction is increased e.g. by pushing into the ground.

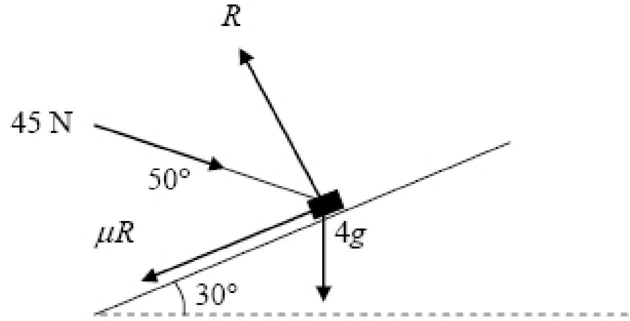
Q2.

Question Number	Scheme	Marks
	$F = P\cos 50°$	M1 A1
	$F = 0.2R$ seen or implied.	B1
	$P\sin 50° + R = 15g$	M1 A1 A1
	Eliminating R; Solving for P; $P =$ 37 (2 SF)	DM1;D M1; A1 [9]

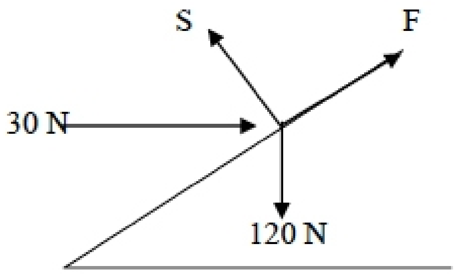
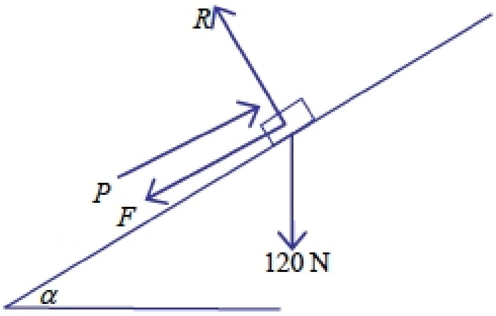
Q3.

$F = \frac{1}{2}R$	B1
$(\uparrow)$, $R\cos\alpha + F\sin\alpha = mg$	M1 A2
$R = \dfrac{1.1g}{(\cos\alpha + \frac{1}{2}\sin\alpha)} = 9.8\text{ N}$	M1 A1 (6)
$(\rightarrow)$, $P + \frac{1}{2}R\cos\alpha = R\sin\alpha$	M1 A2
$P = R(\sin\alpha - \frac{1}{2}\cos\alpha)$	M1
$= 1.96$	A1 (5)
	[13]

Q4.

Question Number	Scheme		Marks
(a)			
	$R = 45\cos 40° + 4g\cos 30°$		M1 A2, 1, 0
	$R \approx 68$	accept 68.4	M1 A1 (5)
(b)	Use of $F = \mu R$		M1
	$F + 4g\sin 30 = 45\cos 50°$		M1 A2, 1, 0
	Leading to $\mu \approx 0.14$	accept 0.136	M1 A1(6)
			(11 marks)

Q5.

Question Number	Scheme	Marks
(a)		
	Resolving perpendicular to the plane: $S = 120\cos\alpha + 30\sin\alpha$ $= 114$ *	 M1 A1 A1 A1 (4)
(b)		
	Resolving perpendicular to the plane: $R = 120\cos\alpha$ $= 96$ $F_{max} = \frac{1}{2}R$ Resolving parallel to the plane: In equilibrium: $P_{max} = F_{max} + 120\sin\alpha$ $= 48 + 72 = 120$	 M1 A1 A1 M1 M1 A(2,1,0) A1 (8)
(c)	$30 + F = 120\sin\alpha$ **OR** $30 - F = 120\sin\alpha$ So $F = 42\text{N}$ acting up the plane.	M1 A1 A1 (3) **[15]**