OCR M1 2016 Community Markscheme

M1 Thread Mark Scheme Thread

1.i*) [4 marks]* Stone is dropped off bridge from rest. When it hits the surface of the lake it has velocity $14ms^{-1}$ Calculate the distance from the bridge to the lake and the time taken.

$$v^2 = u^2 + 2as \Rightarrow s = \frac{v^2 - u^2}{2a} = \frac{196}{19.6} = 10m$$

$$v = u + at \Rightarrow t = \frac{v-u}{a} = \frac{14}{9.8}$$

T = 1.43s

ii)*) [4 marks]* There is no sudden change in velocity when the stone hits the lake. It has velocity $20ms^{-1}$when it's about to hit the bottom of the lake. The lake is 15 m deep. Find the acceleration of the stone through the water.

u = 14
v = 20
s = 15
v^2 = u^2 + 2as
a = (v^2 - u^2) / 2s = (20^2 - 14^2)/30 = 34/5 = 6.8
a = **6.8 m/s/s vertically downwards**

2i) *[5 marks]*
Particle accelerates down plane.
find initial velocity and its constant acceleration

s = 6.4
v = 5
t = 1.6

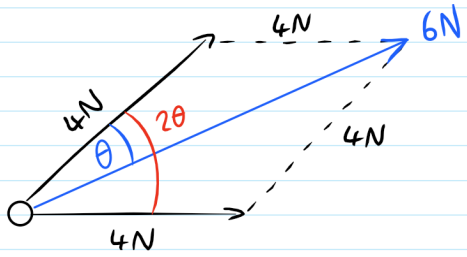
s = ½ (u+v)t
u = (2s/t) - v
u= **3 ms^-1** (i think?)

a = **1.25 ms^-2**

ii)*[3 marks]*
Find angle between plane and vertical

Acceleration is constant therefore force down plane = F = ma
Weight of particle (unknown) = mg
Sinø = ma/mg cancel mass,
Sinø = a /g
Use previous answer a = 1.25 ms^-2
Ø = sin^-1(a/g) = sin^-1(1.25/9.8)
Ø = 7.33˚
90-7.33= **82.7**

3.i)*[4 marks]*
2 forces, each of 4N act on a particle P. The resultant of these 2 forces is 6N. Find the angle between the two 4N forces.



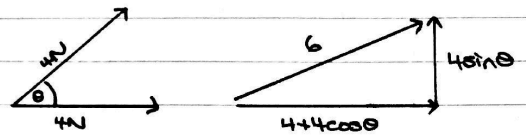
Angle between 4N forces = 2θ

cosine rule:

$4^2 = 4^2 + 6^2 - 2 \times 4 \times 6 \cos\theta$

$\theta = \cos^{-1}\left[\frac{4^2 - 4^2 - 6^2}{-2 \times 4 \times 6}\right] = 41.4°$

$2\theta = 82.8°$



$hyp^2 = a^2 + b^2$

$36 = (4+4\cos\theta)^2 + (4\sin\theta)^2$
$36 = 16 + 32\cos\theta + 16\cos^2\theta + 16\sin^2\theta$
$36 = 16 + 32\cos\theta + 16\cos^2\theta + 16(1 - \cos^2\theta)$
$36 = 16 + 32\cos\theta + 16$
$36 = 32 + 32\cos\theta$
$4 = 32\cos\theta$
$\cos\theta = \frac{4}{32}$
$\theta = \cos^{-1}\left(\frac{4}{32}\right)$
$\theta = 82.8°$

82.8

3ii)[3 marks] The 4 newton forces now act on a block that is in equilibrium. The force exerted by the plane has a magnitude of 3N.
Find m and acute angle from (any) 4 newton force to surface

The two 4N forces have to act in equal and opposite direction from vertical to keep it in equilibrium (smooth surface), meaning that the 6N force is vertical and each of the 4N forces are 41.4 degrees from the 6N force, one clockwise and the other anticlockwise.
Angle = 90 - 41.4 = **48.6**˚

2*4cos(41.4)+3=mg
6.00 + 3 =mg (2*4cos(41.4)) = 6.00)
M = 9/9.8 = 0.918
m=0.918kg

4.i) *[4 marks]* A (0.8kg) and B (0.2kg) travel towards each other with speeds 6 m/s and 2 m/s respectively.
After collision, A has speed 4 m/s in same direction as before. Calculate the new speed of B.

0.8*6 - 0.2*2 = 0.8*4 + 0.2v
4.4 - 3.2 = 0.2v
1.2 = 0.2v
V = **6 m/s**

ii) *[3 marks]* particle C has mass 0.3 kg, velocity = 5 m/s
Particle D has mass 0.1 kg, stationary
C collides with D and the particles coalesce. Find velocity of combined particle (CD) after collision

0.3*5 = v(0.3 + 0.1)
1.5/0.4 = **3.75 m/s**

iii) *[4 marks]* Particle B then collides with combined particle Find MAXIMUM velocity of combined particle after collision
(0.2 x 6) + (0.4 x 3.75) = (0.2 x 4) + (0.4v)
2.7 = 0.8 + 0.4v
v = 4.75 m/s

The answer is 4.75 because the question said “no further collisions” therefore particle B had to be moving at the same speed as particle A, otherwise a further collision would occur between A and B.

5.i) *[7 marks]* Force going east magnitude P, Force going west Magnitude 5, vertical force magnitude 2P. Resultant of the forces is 25N. Find P and the angle between the resultant and the vertical

$\sqrt{(2p)^2 + (p - 5)^2} = 25$

$5p^2 - 10p - 600 = 0$

$p^2 - 2p - 120 = 0$

P = 12N or P = -10N

$\cos^{-1}(24/25)$

Angle with vertical = **16.3°**

ii) *[5 marks]* The 25N force now acts on a block of mass 3kg on a rough horizontal surface (coeff. = 0.15)

a=2.06ms^-2 due east (to the right)

6i. *[6 marks]* 0

when stationary,

Resultant of Q = zero

T = 0.2 g = 1.96 N

When P was moving up slope,

Q moving vertically downward over pulley

μ = 0.4

Mass P = mass Q = 0.2 kg

Plane angle from horizontal = 30˚

R = 0.2gcos(30) = 1.697

Fr = μR = 0.4 x 1.697 = 0.679

Resultant of P = Tension - (Friction + parallel component of Weight)

= T - (0.4 x 1.697) - 0.2gcos60

Resultant of Q = 0.2g - T = 1.96 - T

Equate resultants

1.96 - T = T - 1.659
2T = 3.619
T = 1.81 N

ii) *[5 marks]* P travels a further 0.8m up the plane after Q has come to a rest. Find the velocity of the particles just before Q reaches the ground.
a=-8.29…
Use suvat to obtain u=**3.64ms^-1**

iii) *[3 marks]* Find the contact force the slope makes with P while in motion Use pythagoras of R and friction
R = 0.2gcos(30) = 1.697
Fr = μR = 0.4 x 1.697 = 0.679
Contact = √(0.679^2) + (1.697^2)
= 1.83 N

7.i) *[4 marks]* find the time for when the velocities are equal
$0.09t^2=9$
t=10s

ii) *[4 marks] s = Ut +0.08t^3 Find U and show that s=25 when t=5*
U=3

iii) *[5 marks]* Find the velocity of B when it collides with A
Total distance (Use A) = $0.03t^3 = 0.03(16)^3 = 122.88$
First Section of B = 25m (given in previous show that question)
Centre (rectangle) section of B = (15 -5)x9 = 90m
Distance in last section = 122.88 -90 -25 = 7.88m
Use formula for the area of a trapezium. $s = \frac{1}{2}(u + v)t = 7.88 = \frac{1}{2}(9 + v)1$ **v = 6.76m/s**

Credit (TSR Usernames Please!)
Metasysta
Ghettobadger
Duncant
HecTic_H

Parallax (Picture for 2i)
Will Grigg's on Fire
Mr M (jr) (answers verified and mark allocations corrected)