Section 2

1. Consider two vectors **a** = [1, 2] and **b** = [2, p] where p is an unknown variable.

i) What value of p makes the vector **a** + **b** perpendicular to the vector **c** = [-1, 1]?

a) 0
b) 1
c) 2
d) 3
e) None of the above.

ii) If **a** and **b** represent the position vectors of points A and B respectively, what is the distance between A and B in terms of p?

a) $\sqrt{5 + p^2 - 5p}$
b) $\sqrt{4 + p^2 - 5p}$
c) $\boldsymbol{\sqrt{5 + p^2 - 4p}}$
d) $\sqrt{4 + 2p^2 - 4p}$
e) $\sqrt{3 + 2p^2 - 2p}$

iii) What is the value of p that minimizes this distance?

a) 0
b) 1
c) 2
d) 3
e) None of the above

2. A ball of mass M [kg] is launched from a flat ground at speed V_0 [m/s] at an angle θ from the horizontal ground. Air resistance is negligible.

i) What is the total momentum of the ball (in Ns)?

a) MV_0
b) MV_0^2
c) $\frac{1}{2}MV_0^2$
d) $\frac{1}{2}MV_0$
e) None of the above

ii) How long does the ball stay in the air for before first hitting the ground (in seconds)?

a) $\frac{V_0}{g}\sin^{-}$

b) $\frac{2V_0}{g}\cos^{-}$

c) $\frac{2V_0}{Mg}\sin^{-}$

d) $\frac{V_0}{2g}$

e) $\frac{2V_0}{g}\sin^{-}$

iii) How far does the ball travel along the horizontal ground before first hitting the ground (in meters)?

a) $\frac{V_0{}^2}{g}\cos 2^{-}$

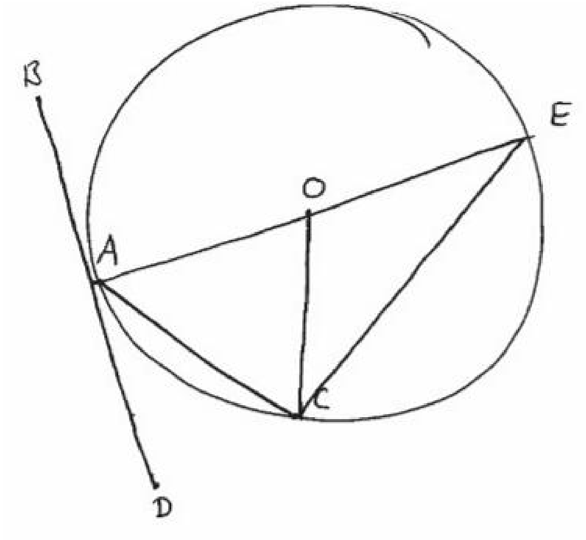
b) $\frac{V_0}{g}\sin^{-}$

c) $\frac{V_0}{g}\sin 2\vartheta$

d) $\frac{V_0{}^2}{g}\sin 2^{-}$

e) $\frac{V_0{}^2}{g}$

3. The circle in the diagram below has radius 1m, AE is a diameter, OC is a radius, and the line BD is a tangent to the circle which intersects point A.



i) If $\angle CAD$ is 35°, what is $\angle COA$?

a) 60°
b) 70°
c) 35°
d) 45°
e) 55°

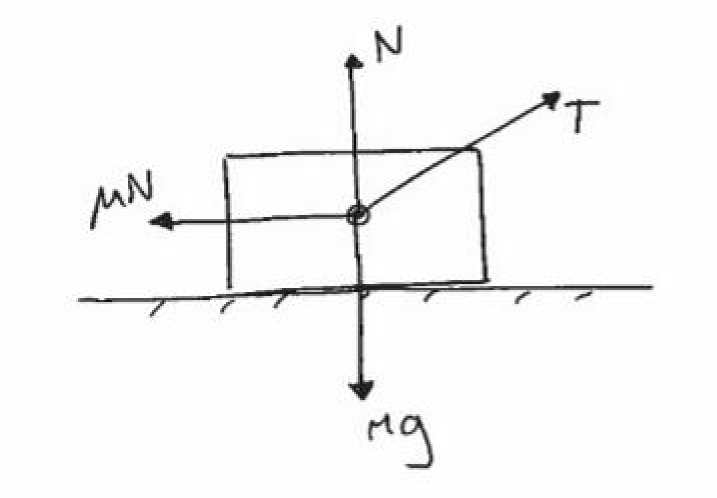
ii) What is $\angle OCE$?

a) 30°
b) 40°
c) 35°
d) 55°
e) 45°

iii) What is the area of the triangle OAC?

a) 0.470
b) 0.420
c) 0.500
d) 0.520
e) 0.570

4. The diagram below shows forces a block of mass m [kg] on a rough surface being pulled along at constant speed by a rope attached to the centre of mass which makes an angle θ with the ground. The coefficient of friction is μ.



i) What is the value of the normal reaction force N (in Newtons)?

a) $mg + T\sin$
b) $mg - T\sin$
c) $g + T\sin\theta$
d) $mg + T\cos$
e) $g - T\cos$

ii) What is the value of the tension in the rope T (in Newtons)?

a) $\frac{\mu mg}{\cos\theta + \sin\theta}$

d) $\frac{\mu mg}{\cos\theta - \mu\sin}$

c) $\frac{mg}{\cos\theta - \sin\theta}$

d) $\boldsymbol{\frac{\mu mg}{\cos\theta + \mu\sin}}$

e) None of the above

iii) What angle θ minimizes the tension required in the rope to pull the block along the floor?

a) tan μ
b) arctan μ
c) sin μ
d) arcsin μ
e) None of the above

5. Consider the equations $y = x^2 + 1$ and $y = cx + d$, where c and d are unknown constants.

i) If c = 1, and d = 3, which of the following pairs of x and y is a solution to both equations simultaneously?

a) x = 2, y = 1

b) x = -1, y = 0

c) x = 2, y = 5

d) x = 1, y = 4

e) x = -1, y = -2

ii) Which of the following values of c and d will give no real solution to the two equations?

a) $c = \frac{3}{2}$, d = 2

b) $c = \frac{1}{2}$, d = 1

c) c = 3, d = -1

d) c = 4, d = -2

e) $c = \frac{3}{2}$, d = 0

iii) Which of the following values of c and d will give exactly 1 real solution to the two equations?

(HINT: Consider the graphs of the two equations).

a) c = 0, d = 1

b) c = 1, d = 2

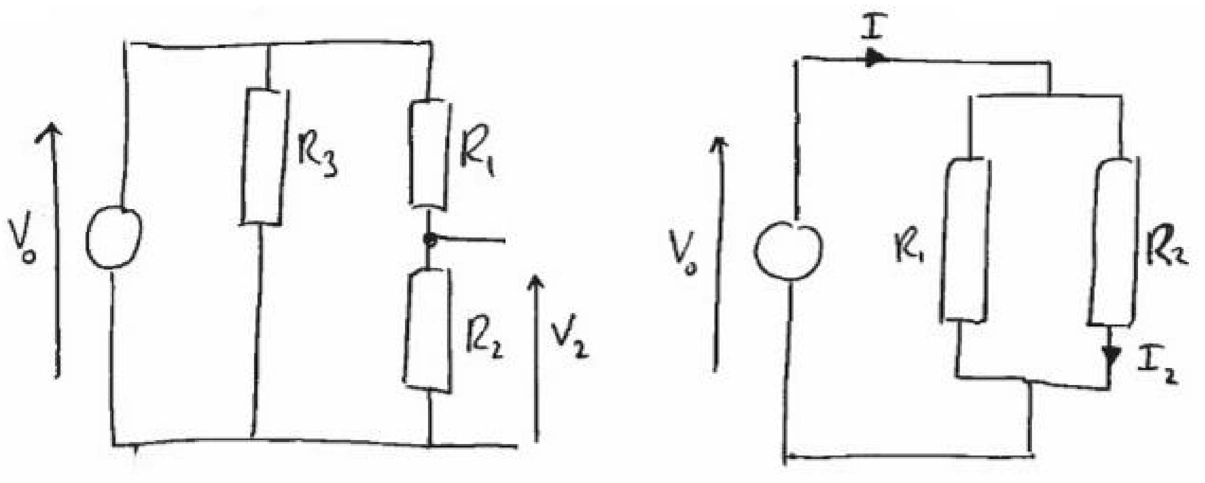
c) c = 0, d = 2

d) c = 2, d = 0

e) None of the above

6. Consider the two D.C. circuits (A and B) in the diagram below. Each consists of a voltage source (which provides a fixed potential difference, V_0, regardless of the load) and some resistors.

A B



i) On circuit A, a probe measures the potential difference, V_2, across the resistor labelled R_2. What is the value of this potential difference?

a) $\boldsymbol{V_0 \frac{R_2}{R_1 + R_2}}$

b) $V_0 \frac{R_1 + R_2 + R_3}{R_1}$

c) $V_0 \frac{R_1}{R_1 + R_2 + R_3}$

d) $V_0 \frac{R_1}{R_2}$

e) None of the above

ii) On circuit B, a probe measures the current, I_2, through the resistor labelled R_2. What is the value of this current in terms of the total current flowing through both resistors, I ?

a) $I \frac{R_2}{R_1 + R_2}$

b) $\boldsymbol{I \frac{R_1}{R_1 + R_2}}$

c) $I \frac{R_2}{R_1 R_2}$

d) $I \frac{R_2}{R_1}$

e) None of the above

7. A mass M [kg] is attached via a light, inelastic rod of length L [m] to a frictionless hinge. It is initially held at rest by a moment at the hinge and then this is released so the mass swings down making an angle θ with the horizontal at a given time (as shown in the diagram).

i) What moment applied at the hinge is required to hold the mass at rest? (in Nm)

a) Mg
b) M
c) MgL
d) ML
e) gL

ii) What speed is the mass travelling at when the rod makes an angle θ with the horizontal? (in m/s)

a) $\overline{\mathbf{2}\boldsymbol{gL}\,\mathbf{sin}}$

b) $\sqrt{gL\,\cos}$

c) $2gL\,\sin$

d) $gL\,(1 + \sin\,)$

e) $\overline{2gL\cos\theta}$