Question 1: Find a vector 5 units long in the direction opposite to the direction of $\mathbf{v} = (3/5)\mathbf{i} + (4/5)\mathbf{k}$.

[4]

Question 2: For this question use the vectors $\mathbf{u} = -\mathbf{i} - \mathbf{k}$ and $\mathbf{v} = \mathbf{i} + \mathbf{j} + 2\mathbf{k}$.

(i) Find the angle between $\mathbf{u}$ and $\mathbf{v}$.

[2]

(ii) Find the vector projection of $\mathbf{u}$ onto $\mathbf{v}$.

[2]

(iii) Find a unit vector that is orthogonal to both $\mathbf{u}$ and $\mathbf{v}$.

[2]

Question 3: A parallelogram has vertices (corners) at the points $A(2,-1,4)$, $B(1,0,-1)$, $C(1,2,3)$ and $D(2,1,8)$.

(i) Find the area of the parallelgram.

[2]

(ii) Find an equation of the plane containing the parallelogram.

[3]

Question 4: Find the point in which the line through the origin perpendicular to the plane $2x - y - z = 4$ intersect the plane $3x - 5y + 2z = 6$.

[5]

Question 5: Find an equation of the line through the point $(0, 14, -10)$ that is parallel to the line $x = -1+2t$, $y = 6 - 3t$, $z = 3 + 9t$.

[5]

Question 6: Find the (shortest) distance between the parallel planes $x - 2y + 3z = 1$ and $x - 2y + 3z = 4$.

[5]

Question 7: A force of magnitude 10 N acts directly upward from the xy-plane on an object of mass 2 kg. The object starts at the origin with initial velocity $\mathbf{v}(0) = \mathbf{i} + \mathbf{j}$. Find $\mathbf{r}(1)$, its position after one second.

[5]

Question 8: Determine the length of the curve $\mathbf{r}(t) = \langle (2/3)t^{3/2}, \cos(2t), \sin(2t) \rangle$ for $0 \leq t \leq 5$.

[5]

Question 9: For the space curve $\mathbf{r}(t) = \langle t^2, \sin(t) - t\cos(t), \cos(t) + t\sin(t)\rangle$ find the following at $t = \pi$:

(i) The unit tangent vector $\mathbf{T}(\pi)$.

[4]

(ii) The unit normal vector $\mathbf{N}(\pi)$.

[3]

(iii) The curvature κ.

[3]