**1.** (a) correct equation in the form ***r***= ***a***+ *t****b*** A2 N2 2



(b) (i) attempt to substitute *t* = 2 into the equation (M1)

*e.g.*



3 A1 N2



(ii) correct substitution into formula for magnitude A1

*e.g.*



A1 N1 4



[6]

**2.** (a) (i) A1 N1



(ii) evidence of combining vectors (M1)

*e.g.*



A1 N2 3



(b) (i) **METHOD 1**

finding (A1)(A1)(A1)



*e.g.*



substituting into formula for cos M1



*e.g.*



cos A1 N3



**METHOD 2**

finding (A1)(A1)(A1)



*e.g.*



substituting into cosine rule M1

*e.g.*



cos A1 N3



(ii) evidence of using Pythagoras (M1)

*e.g.* right-angled triangle with values, sin2 *x* + cos2 *x* =1

sin A1 N2 7



(c) (i) attempt to find an expression for (M1)  
*e.g.*



correct equation A1

*e.g.*



A1



AG N0



(ii) evidence of scalar product (M1)

*e.g.*



correct substitution

*e.g.* –4 × 1+ 5 × 2 + 3 × –2, –4 + 10 – 6 A1

A1



is perpendicular to AG N0 6



[16]

**3.** (a) evidence of appropriate approach (M1)

*e.g.*



A1 N2 2



(b) **METHOD 1**

(A1)



correct approach A1

*e.g.*



AG N0 2



**METHOD 2**

Recognizing (A1)



correct approach A1

*e.g.*



AG N02



(c) **METHOD 1**

evidence of scalar product (M1)

*e.g.*



correct substitution A1

*e.g.* (–2)(4) + (2)(4), –8 + 8

A1



therefore vectors and are perpendicular AG N0 3



**METHOD 2**

attempt to find angle between two vectors (M1)

*e.g.*



correct substitution A1

*e.g.*



A1



therefore vectors and are perpendicular AG N0



[7]

**4.** (a) any correct equation in the form ***r*** = ***a*** + *t****b*** (accept any parameter) A2 N2  
*e.g.* ***r*** =



**Note:** Award A1 for **a** + t**b**, A1 for L = **a** + t**b**, **A0** for **r** = **b** + t**a**.

(b) recognizing scalar product must be zero (seen anywhere) R1  
*e.g.* ***a*** • ***b*** = 0

evidence of choosing direction vectors (A1)(A1)



correct calculation of scalar product (A1)  
*e.g.* 2(–7) + 1(–2) – 8*k*

simplification that clearly leads to solution A1  
*e.g.* –16 – 8*k*, –16 – 8*k* =0

*k* = –2 AG N0

(c) evidence of equating vectors (M1)  
*e.g. L*1 = *L*3,



any **two** correct equations A1A1*e.g.* –3 + 2*p* = 5 – 7*q*, –1 + *p* = –2*q*, –25 – 8*p* = 3 –2*q*

attempting to solve equations (M1)finding **one** correct parameter (*p* = –3, *q* = 2) A1

the coordinates of A are (–9, –4, –1) A1 N3

(d) (i) evidence of appropriate approach (M1)  
*e.g.*   
 A1 N2



(ii) finding A1



evidence of finding magnitude (M1)*e.g.*   
 A1 N3



[18]

**5.** (a) evidence of appropriate approach (M1)

*e.g.*   
 A1 N2



(b) attempt to find the length of (M1)  
 (A1)



unit vector is A1 N2



(c) recognizing that the dot product or cos *θ* being 0 implies perpendicular (M1)

correct substitution in a scalar product formula A1

*e.g.* (6) × (–2) + (–2) × (–3) + (3) × (2), cos *θ* =



correct calculation A1  
*e.g.* = 0, cos *θ* = 0



therefore, they are perpendicular AG N0

[8]

**6.** (a) (i) correct approach A1  
*e.g.*   
 AG N0



(ii) appropriate approach (M1)*e.g.* D – B, , move 3 to the right and 6 down  
 A1 N2



(iii) finding the scalar product A1*e.g.* 4(3) + 2(–6), 12 – 12

valid reasoning R1*e.g.* 4(3) + 2(–6) = 0, scalar product is zero  
 is perpendicular to AG N0



(b) (i) correct “position” vector for ***u***; “direction” vector for ***v*** A1A1 N2  
*e.g.* ***u*** =   
accept in equation *e.g.*



(ii) any correct equation in the form ***r*** = ***a*** + *t****b***, where ***b*** =   
*e.g.* ***r*** = A2 N2



(c) **METHOD 1**

substitute (3, *k*)into equation for (AC) or (BD) (M1)*e.g.* 3 = 1 + 4*s*, 3 = 1 + 3*t*

value of *t* or *s* A1  
*e.g.* *s* = ,



substituting A1  
*e.g.* *k* = 0 + ,  
*k* = 1 AG N0



**METHOD 2**

setting up two equations (M1)  
*e.g.* 1 + 4*s* = 4 + 3*t*, 2*s* = –1 – 6*t*; setting vector equations of lines equal

value of *t* or *s* A1*e.g. s* =



substituting A1*e.g.* ***r*** = ,  
*k* = 1 AG N0



(d) (A1)



(A1)



(A1)



area = M1



= 5 A1 N4

[17]

**7.** (a) (i) evidence of approach (M1)*e.g.* Q – P  
 A1 N2



(ii) A1 N1



(b) **METHOD 1**

choosing correct vectors (A1)(A1)finding (A1) (A1)(A1)  
 = –2 + 4 + 4 (= 6)  
  
substituting into formula for angle between two vectors M1*e.g.* simplifying to expression clearly leading to A1  
*e.g.*   
 AG N0



**METHOD 2**

evidence of choosing cosine rule (seen anywhere) (M1)  
 A1  
 (A1)(A1)(A1)  
 A1  
 A1  
 AG N0



(c) (i) **METHOD 1**

evidence of appropriate approach (M1)  
*e.g.* using , diagram  
substituting correctly (A1)  
*e.g.*   
 A1 N3



**METHOD 2**

since (A1)  
evidence of approach  
*e.g.* drawing a right triangle, finding the missing side (A1) A1 N3



(ii) evidence of appropriate approach (M1)  
*e.g.* attempt to substitute into *ab* sin *C*correct substitution  
*e.g.* area = A1  
area = A1 N2



[16]

**8.** finding scalar product and magnitudes (A1)(A1)(A1)scalar product = 12 – 20 – 15 (= 23)  
magnitudes =   
substitution into formula M1*e.g.* cos *θ* =   
cos *θ* = (= –0.46) A2 N4



[6]

**9.** (a) *L*1: ***r*** = A2 N2



(b) evidence of equating ***r*** and (M1)  
*e.g.* , *A* = *r*



**one** correct equation A1  
*e.g.* 6 = 2 + 2*s*, 2 = 4 – *s*, 9 = –1 + 5*s*, *s*=2 A1

evidence of confirming for other **two** equations A1  
*e.g.* 6 = 2 + 4, 2 = 4 – 2, 9 = –1 + 10  
so A lies on *L*2 AG N0

(c) (i) evidence of approach M1  
*e.g.* *L*1 = *L*2



one correct equation A1  
*e.g.* 2 + 2*s* = 8, 4 – *s* = 1, –1 + 5*s* = *t*

attempt to solve (M1)  
finding *s* = 3 A1

substituting M1

*e.g.*



AG N0



(ii) evidence of appropriate approach (M1)*e.g.*   
 A1 N2



(d) evidence of appropriate approach (M1)  
*e.g.*



correct values A1  
*e.g.*   
 A1 N2



[16]

**10.** (a) evidence of equating scalar product to 0 (M1)  
2 × 3 + 3 × (–1) + (–1) × *p* = 0 (6 – 3 – *p* = 0, 3 – *p* = 0) A1*p* = 3 A1 N2

(b) evidence of substituting into magnitude formula (M1)*e.g.* , 1 + *q*2 + 25



setting up a correct equation A1*e.g.* , 1 + *q*2 + 25 = 42, *q*2 = 16



*q* = ±4 A1 N2

[6]

**11.** (a) (i) evidence of combining vectors (M1)

*e.g.* =  (or = + in part (ii))



= A1 N2



(ii) = A1 N1



(b) evidence of using perpendicularity  scalar product = 0 (M1)



4  4(*k*  5) + 4 = 0 A1

4*k* + 28 = 0 (accept any correct equation clearly leading to *k* = 7) A1

*k* = 7 AG N0

(c) = (A1)



= A1



evidence of correct approach (M1)

*e.g.*



= A1 N3



(d) **METHOD 1**

choosing appropriate vectors, (A1)



finding the scalar product M1

*e.g.* 2(1) + 4(1) + 2(1), 2(1) + (4)(1) + (2)(1)

cos = 0 A1 N1



**METHOD 2**

parallel to (may show this on a diagram with points labelled) R1



 (may show this on a diagram with points labelled) R1



= 90



cos = 0 A1 N1



[13]

**12.** (a) (i) evidence of approach (M1)  
*e.g.*   
 (accept (3, 4, 5)) A1 N2



(ii) evidence of finding the magnitude of the velocity vector M1  
*e.g.* speed =   
speed = A1 N1



(b) correct **equation** (accept Cartesian and parametric forms) A2 N2  
*e.g.* ***r*** =



[6]

**13.** (a) (i) evidence of combining vectors (M1)*e.g.*   
 A1 N2



(ii) A1 N1



(b) (i) = (–2)(3) + (–3)(–2) = 0 A1 N1



(ii) scalar product 0 = perpendicular, *θ* = 90° (R1)sin *θ* = 1 A1 N2



[6]

**14.** (a) Using direction vectors ***u*** = (M1)  
 A1A1  
***u***• ***v*** = 12 + 60 – 20 = 52 A1  
cos *θ* = A1= AG N0



(b) (i) For substituting *s* = 1 (M1)  
Correct calculations (A1)9 + 1(–2) = 7, 4 + 1(6) = 10, –6 + 1(10) = 4  
position vector of P is A1 N3



(ii) For substituting into the equation (M1)For one correct equation A1  
*e.g.* 7 = 1 – 6*t*Solving gives *t* = –1 A1



verify for second coordinate, 10 = 20 + (–1)(10) A1verify for third coordinate, 4 = 2 + (–1)(–2) A1  
Thus, P is also on *L*2. AG N0

(c) *k* (M1)  
–2*k* = 6  
*k* = –3 A1  
*x* = –3 × 6 = –18 A1 N2



[16]

**15.** (a) ***u*** • ***v*** = 8 + 3 + *p* (A1)

For equating scalar product equal to zero (M1)

8 + 3 + *p* = 0

*p* = 11 A1 N3

(b) = (M1)



A1



*q* = A1 N2



[6]

**16.** (a) = A1A1 N2



(b) Using ***r*** = ***a*** + *t****b***

A2A1A1 N4



[6]

**17.** (a) (M1)



A2 N3



(b) Using ***r*** = ***a*** + *t****b***

A1A1A1 N3



[6]

**18.** (a) A1A1 N2



(b) A1



M1



R is A1A1 N2



[6]

ì¶**19.** (a) = 5***i***+ 5***j***– 5***k*** A2 2



(b) = 5***i***+ 5***k*** A2 2



(c) = 5***i***+ 5***j***– 5***k*** A2 2



**Note**: Award A0(A2)(A2) if the 5 is consistently omitted.

[6]

**20.** (a) Finding correct vectors, = = A1A1



Substituting correctly in the scalar product  
 = 4(–3) + 3(1) A1  
 = –9 AG 3



(b) || = 5 || = (A1)(A1)  
Attempting to use scalar product formula cos BAC = M1  
= –0.569 (3 s.f) AG 3



[6]

**21.** **METHOD 1**

Using ***a*** **** ***b*** = *ab* cos ** (may be implied) (M1)

(A1)



Correct value of scalar product (A1)



Correct magnitudes (A1)(A1)



(A1) (C6)



**METHOD 2**

(A1)



(A1)



(A1)



Using cosine rule (M1)

(A1)



(A1) (C6)



[6]

**22.** (a) = = 5 (M1)(A1) (C2)



(b) (so B is (6, 7) ) (M1)(A1) (C2)



(c) ***r*** = (not unique) (A2) (C2)



**Note**: Award (A1) if “ **r** = ” is omitted, ie not  
 an equation.

[6]

**23.** Direction vectors are ***a*** = ***i*** – 3***j*** and ***b*** = ***i*** – ***j***. (A2)  
***a*** **** ***b*** = (1 + 3) (A1)  
***a*** = , ***b*** = (A1)  
cos *θ* = (M1)  
cos *θ* = (A1)(C6)



[6]

**24.** **METHOD 1**

At point of intersection:

5 + 3λ = –2 + 4*t* (M1)  
l – 2λ = 2 + *t* (M1)

Attempting to solve the linear system (M1)  
λ = –l (or *t* = 1) (A1)  
 (A1)(A1) (C6)



**METHOD 2**

(changing to Cartesian coordinates)  
2*x* + 3*y* = 13, *x* – 4*y* = –10 (M1)(A1)(A1)  
Attempt to solve the system (M1)  
 (A1)(A1) (C6)



**Note:** Award (C5) for the point P(2, 3).

**25.** (a) ***c*  *d*** = 3 × 5 + 4 × (–12) (M1)  
 = –33 (A1) (C2)

[2]

**26.** B, or ***r* *=***  (C3)  
D, or ***r* *=***  (C3)



**Note:** Award C4 for B, D and one incorrect,  
C3 for one correct and nothing else, C1 for one correct and one incorrect, C0 for anything else.

[6]

**27.** (a) = 60 × (–30) + 25 × 40 (M1)  
 = –800 (A1) (C2)



(b) cos *θ* = (M1)(A1)



**Note:** Trig solutions:  
Award M1 for attempt to use a correct strategy, A1 for correct values.

cos *θ* = –0.246... (A1)  
*θ* = 104.25...° (or 255.75...°) (A1) (C4)  
She turns through 104° (or 256°)

**Note:** Accept answers in radians ie 1.82 or 4.46.

[6]

**28.** *x* = l – 2*t* (A1)  
*y* = 2 + 3*t* (A1)  
 (M1)  
3*x* + 2*y* = 7 (A1)(A1)(A1) (C6)



[6]

**29.** Angle between lines = angle between direction vectors. (M1)  
Direction vectors are **and** .(A1)  
 **. =** cos ** (M1)  
4(1) + 3(–1) = cos ** (A1)  
cos * =*  = 0.1414 (A1)  
** = 81.9° (3 sf), (1.43 radians) (A1) (C6)



**Note:** If candidates find the angle between the vectors and, award marks as below:



Angle required is between and (M0)(A0)  
 **.** *=* cos ** (M1)  
4(2) + (–1) 4 = cos ** (A1)  
 = cos * =* 0.2169 (A1)  
** = 77.5° (3sf), (1.35 radians) (A1) (C4)



[6]

**30.** cos *θ* = (M1)  
 = (A1)  
 =   
 = (= 0.3162) (A1)  
** = 72° (to the nearest degree) (A1) (C4)



**Note:** Award (C2) for a radian answer between 1.2 and 1.25.

[4]

**31.** Direction vector = (M1)  
 = (A1)



(A2)



**OR**

(A2)(C4)



[4]

**32.** (a) = 0 (M1)(M1)  
 2*x*(*x* + 1) + (*x* – 3)(5) = 0 (A1)  
 2*x*2 + 7*x* – 15 = 0 (C3)



(b) **METHOD 1**

2*x*2 + 7*x* – 15 = (2*x* – 3)(*x* + 5) = 0  
 *x* = or *x* = –5 (A1) (C1)



**METHOD 2**

*x* =   
 *x* = or *x* = –5 (A1) (C1)



[4]

**33.** = 6 – 16 = –10 (A1)  
= 10 (A1)  
cos**  
–10 = × 10 cos**  cos** =  ** = arccos (M1)  
**  117° (A1)



[4]

**34.** (M1) (M1)



**Notes:** Award (M1) for using scalar product.  
Award (M1) for .



2(*x* – 4) + 3(*y* + 1) = 0 (A1)

2*x* – 8 + 3*y* + 3 = 0

2*x* + 3*y* = 5 (A1)

**OR**

Gradient of a line parallel to the vector is (M1)



Gradient of a line perpendicular to this line is – (M1)



So the equation is *y* + 1 = –(*x* – 4) (A1)  
  3*y* + 3 = –2*x* + 8  
  2*x* + 3*y* = 5 (A1)



[4]

**35.** ***u*** + ***v*** = 4***i*** + 3***j*** (A1) Then *a*(4***i*** + 3***j***) = 8***i*** + (*b* – 2)***j***  
 4*a* = 8  
 3*a* = *b* – 2 (A1)  
Whence *a* = 2 (A1) (C2) *b* = 8 (A1) (C2)

[4]

**36.** Required vector will be parallel to (M1)  
= (A1)  
Hence required equation is ***r*** = (A1)(A1) (C4)



**Note:** Accept alternative answers, eg .



[4]

**37.** Vector equation of a line ***r*** = ***a*** + *****t*** (M1)  
***a*** = , ***t*** = (M1)(M1)  
 ***r*** = **(2***i*** + 3***j***) (A1) (C4)



[4]

**38.** (a)  
 (A3) (C3)



**Note:** Award (A1) for B at (5, 1); (A1) for BC perpendicular to AB; (A1) for AC parallel to the y-axis.

(b) (A1) (C1)



**Note:** Accept correct readings from diagram (allow ±0.1).

[4]

**39.** (a) (A1) (C1)



(b)   
= (A1) (C1)



(c)   
= (A1)  
= (A1) (C2)



**Note:** Deduct [1 mark](once only) if appropriate vector notation is omitted.

[4]

**40.** (a)   
 (A1) (C1)



(b)   
= 13 (A1)  
Vector (A1)  
= (A1) (C3)



[4]

**41.** (a) (A1) (C1)  
 (A1) (C1)



(b) = (10 × (–3)) + (5 × 6) = 0 (M1)  
Angle = 90° (A1) (C2)



[4]