

Edexcel IAL M1 Vectors in Mechanics Practice Exam: Mark Scheme

Pearson Edexcel International A Level Mathematics · 11 questions · 57 marks

- M marks are for a correct method; A marks for an accurate answer that follows a correct method; B marks are independent of method.
- Accept any correct method that reaches a correct answer, unless the question says which method to use.
- Practise these topics online with instant feedback: alevelmathrevision.com/alevel-frontend/alevel-unit.html?course=ial&unit=5

Question 1

3 marks

Resultant = 0: $2 - 5 + p = 0$ and $3 + 1 + q = 0$ **M1**

$p = 3$ **A1**

$q = -4$ **A1**

Final answer: $p = 3, q = -4$

Question 2

4 marks

(a) $\sqrt{5^2 + 12^2}$ **M1**

13 N **A1**

(b) $\tan \theta = \frac{12}{5}$ (or equivalent with sin or cos) **M1**

67.4° (below i) **A1**

Final answer: (a) 13 N (b) 67.4°

Question 3

4 marks

(a) $\sqrt{(-6)^2 + 8^2}$ **M1**

10 km h⁻¹ **A1**

(b) $\tan \alpha = \frac{6}{8}, \alpha = 36.9^\circ$ west of north **M1**

Bearing 323° (awrt 323.1) **A1**

Final answer: (a) 10 km h⁻¹ (b) 323°

Question 4

4 marks

(a) Resultant = $(7.5\mathbf{i} + 5\mathbf{j})$ N **M1**

$7.5\mathbf{i} + 5\mathbf{j} = 2.5\mathbf{a}$ **M1**

$\mathbf{a} = (3\mathbf{i} + 2\mathbf{j})$ m s⁻² **A1**

(b) $\sqrt{13} = 3.61$ m s⁻² **B1ft**

Final answer: (a) $(3\mathbf{i} + 2\mathbf{j})$ m s⁻² (b) 3.61 m s⁻²



Question 5**5 marks**

$$(a) \mathbf{v} = \frac{(7\mathbf{i} - 11\mathbf{j}) - (-3\mathbf{i} + 4\mathbf{j})}{5} \text{ M1}$$

$$(2\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-1} \text{ A1}$$

$$(b) \sqrt{13} = 3.61 \text{ m s}^{-1} \text{ B1ft}$$

$$(c) \mathbf{r} = (-3\mathbf{i} + 4\mathbf{j}) + 8(2\mathbf{i} - 3\mathbf{j}) \text{ M1}$$

$$(13\mathbf{i} - 20\mathbf{j}) \text{ m A1}$$

Final answer: (a) $(2\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-1}$ (b) 3.61 m s^{-1} (c) $(13\mathbf{i} - 20\mathbf{j}) \text{ m}$

Question 6**5 marks**

$$(a) \mathbf{R} = (2 + a)\mathbf{i} + 2\mathbf{j} \text{ M1}$$

$$\text{Parallel: } \frac{2 + a}{2} = \frac{3}{1} \text{ (or } \mathbf{R} = \lambda(3\mathbf{i} + \mathbf{j}) \text{ with } \lambda = 2) \text{ M1}$$

$$a = 4 \text{ A1}$$

$$(b) \mathbf{R} = 6\mathbf{i} + 2\mathbf{j}, |\mathbf{R}| = \sqrt{6^2 + 2^2} \text{ M1}$$

$$\sqrt{40} = 6.32 \text{ N A1}$$

Final answer: (a) $a = 4$ (b) $\sqrt{40} = 6.32 \text{ N}$

Question 7**5 marks**

$$(a) 4 + 3t = 16 \Rightarrow t = 4, \text{ and then } -2 + 4 \times 4 = 14 \text{ M1}$$

Both components agree, so the boat is at H , at 4 pm **A1**

$$(b) \text{Velocity } (3\mathbf{i} + 4\mathbf{j}) \text{ km h}^{-1}; \text{ speed } 5 \text{ km h}^{-1} \text{ B1}$$

$$(c) \tan \theta = \frac{3}{4} \text{ (angle east of north) M1}$$

$$037^\circ \text{ (awrt } 036.9) \text{ A1}$$

Final answer: (a) $t = 4$: 4 pm (b) 5 km h^{-1} (c) 037° (036.9°)

Question 8**6 marks**

$$(a) \mathbf{r}_A = (2 + 3t)\mathbf{i} + (9 - t)\mathbf{j} \text{ B1}$$

$$\mathbf{r}_B = (-4 + 5t)\mathbf{i} + (3 + t)\mathbf{j} \text{ B1}$$

$$(b) \text{Equates i components: } 2 + 3t = -4 + 5t \Rightarrow t = 3 \text{ M1}$$

$$\text{Checks j components at } t = 3: 9 - 3 = 6 \text{ and } 3 + 3 = 6 \text{ dM1}$$

Same position at the same time, so they collide, at 3 pm **A1**

$$(11\mathbf{i} + 6\mathbf{j}) \text{ km A1}$$

Final answer: (b) collide at 3 pm at $(11\mathbf{i} + 6\mathbf{j}) \text{ km}$



Question 9**6 marks**

(a) i: $4 - 9 + p = 0$ **M1**

$p = 5$ **A1**

j: $7 + 5 - 9.8m = 0$ **M1**

$m = \frac{12}{9.8} = 1.2 \text{ or } 1.22$ **A1**

(b) Resultant = $(9\mathbf{i} - 5\mathbf{j})$ N and $\sqrt{106} = ma$ **M1**

$a = 8.4 \text{ or } 8.41 \text{ m s}^{-2}$ **A1**

Note: as $g = 9.8$ is used, answers are given to 2 or 3 significant figures. Use the unrounded $m = \frac{60}{49}$ in (b); 8.44, from the rounded $m = 1.22$, is A0 (premature approximation).

Final answer: (a) $p = 5$, $m = 1.22$ (b) 8.41 m s^{-2} **Question 10****7 marks**

(a) $\vec{PL} = (8\mathbf{i} + 7\mathbf{j}) - ((1 + 2t)\mathbf{i} + (5 - t)\mathbf{j})$ **M1**

$(7 - 2t)\mathbf{i} + (2 + t)\mathbf{j}$ **A1**

(b) $PL^2 = (7 - 2t)^2 + (2 + t)^2$ **M1**

$= 49 - 28t + 4t^2 + 4 + 4t + t^2 = 5t^2 - 24t + 53$ **A1 (cso)**

(c) $5t^2 - 24t + 53 = 5(t - 2.4)^2 + 24.2$ (or any complete method for the minimum) **M1**

$t = 2.4$, i.e. 11:24 **A1**

Shortest distance $\sqrt{24.2} = 4.92 \text{ km}$ **A1**

Final answer: (a) $(7 - 2t)\mathbf{i} + (2 + t)\mathbf{j}$ (c) 4.92 km at 11:24 ($t = 2.4$)**Question 11****8 marks**

(a) $(-1.5\mathbf{i} + 2\mathbf{j}) = 0.5\mathbf{a}$ **M1**

$\mathbf{a} = (-3\mathbf{i} + 4\mathbf{j}) \text{ m s}^{-2}$ **A1**

(b) $\mathbf{v} = (6 - 3t)\mathbf{i} + (-2 + 4t)\mathbf{j}$ **B1ft**

(c) $6 - 3t = 0$ **M1**

$t = 2$ **A1**

$\mathbf{v} = 6\mathbf{j}$, speed 6 m s^{-1} **A1**

(d) $6 - 3t = -2 + 4t$ (components equal and positive) **M1**

$t = \frac{8}{7}$ ($= 1.14$) **A1**

Final answer: (a) $(-3\mathbf{i} + 4\mathbf{j}) \text{ m s}^{-2}$ (c) $t = 2$, 6 m s^{-1} (d) $t = \frac{8}{7}$ End of mark scheme · More free exams: alevelmathrevision.com/alevel-frontend/free-practice-exams