1.3 Vectors & Scalars

Question Paper

Course	DP IB Physics
Section	1. Measurement & Uncertainties
Topic	1.3 Vectors & Scalars
Difficulty	Hard

Time allowed: 20

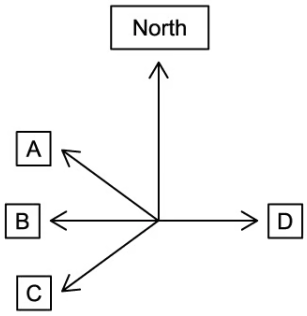
Score: /10

Percentage: /100

Question 1

A pilot wishes to set her plane on a course such that it flies directly west of its starting point. She must take into account the strong northerly wind, meaning that she is flying in a wind which originates in the north and blows in a southward direction.

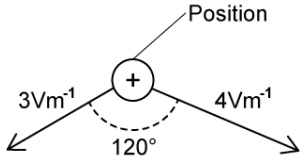
On which course should the plane be directed?



[1 mark]

Question 2

A positron is in the effect of two electric fields, shown measured in arbitrary units.



What is the magnitude of the resultant field strength on the positron?

You may use any of the following results:

- cosine rule: $a^2 = b^2 + c^2 - 2bc\cos A$
- $\cos 60° = 0.5$
- $\cos 120° = -0.5$

A. $\sqrt{13}$ V m^{-1}

B. 6 V m^{-1}

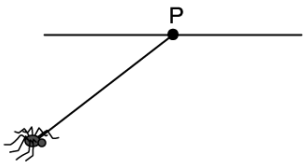
C. 13 V m^{-1}

D. $\sqrt{37}$ V m^{-1}

[1 mark]

Question 3

A drifting spider of mass 50 g hangs on its web from point P on a ceiling. It is being displaced at an angle θ to the vertical by a gentle breeze equivalent to 0.2 N.



What is the magnitude of the angle θ?

You may assume $g = 10\ \text{m s}^{-2}$

A. $\sin^{-1}(0.4)$

B. $\cos^{-1}(2.5)$

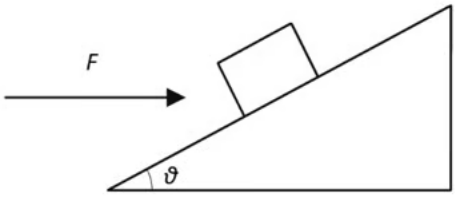
C. $\tan^{-1}(0.4)$

D. $\tan^{-1}(2.5)$

[1 mark]

Question 4

A horizontal force F accelerates a body of mass m up a rough plane inclined at an angle θ to the horizontal.



Which expression describes the magnitude of the resultant force on the body?

A. $F\cos\theta - mg\sin\theta$

B. $F\cos\theta - mg(\sin\theta - \mu_d\cos\theta)$

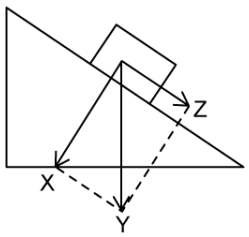
C. $F(\cos\theta - \mu_d\sin\theta) - mg(\sin\theta - \mu_d\cos\theta)$

D. $mg(\sin\theta - \mu_d\cos\theta) + F(\cos\theta - \mu_d\sin\theta)$

[1 mark]

Question 5

A box rests on an inclined plane.



Which of the following statements is correct if the incline becomes less steep?

A. Vector Y decreases

B. Vector Y increases

C. Vector X increases

D. Vector Z increases

[1 mark]

Question 6

The following processes are given:

I. The friction required to bring a car to a complete halt.
II. The effort required to nail a hammer into wood.
III. The heat required to cook.

Which of the processes is a scalar quantity?

A. I and II only

B. III only

C. II and III only

D. I, II and III

[1 mark]

Question 7

Alice sits on the platform of a train station, observing the trains as they move past, from left to right, at constant velocity.

Bob is sat in one particular train carriage, and throws a tennis ball vertically upward, catching it as it comes back down.

Which diagram best represents the trajectory of the tennis ball relative to Alice? (Note: this is the path the ball will follow relative to Alice's position, not what she will see.)

A 

B 

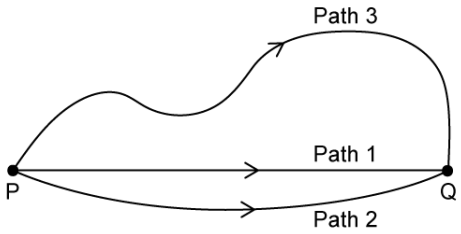
C 

D 

[1 mark]

Question 8

In some models of quantum theory, photons of light take infinitely many paths between two points P and Q in space. Three such paths are shown.



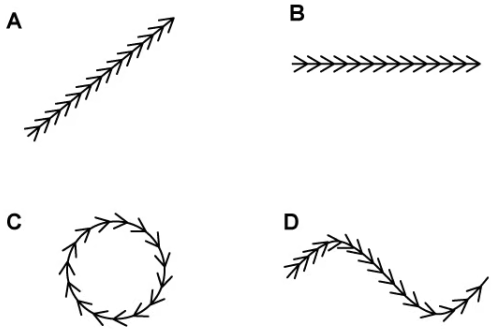
We can associate a mathematical object called a phasor to each of these unique paths. A phasor can be thought of as a spinning vector. For example, when a photon leaves its source P, its associated phasor begins rotating like a clock, until the photon is detected at Q. At this instant, the phasor stops rotating.

In this way, different paths are represented by different phasors. The phasor's final orientation depends on the time taken by the photon to travel between P and Q.

Some example final positions of phasors for different paths are shown:

Quantum theory requires that phasors for every possible path are used to calculate the probability of detecting a photon at Q. More specifically, the probability of detecting a photon at Q is proportional to the square of the resultant phasor amplitude at Q.

Which diagram best represents the resultant phasor amplitude at Q if Q is the dark fringe of an interference pattern?



[1 mark]

Question 9

A car drives from its base camp, at position X, to lodge P, 40 km away, at a bearing of 030° from X. After dropping off supplies it continues to lodge Q, which is 50 km away and at a bearing of 330° from P.

What is the distance between base camp and lodge Q?

You may use one, none or some of the following values for cosines in your calculation:

$\cos(60) = +0.5$

$\cos(90) = 0$

$\cos(120) = -0.5$

A. $5\sqrt{21}$ km

B. $5\sqrt{61}$ km

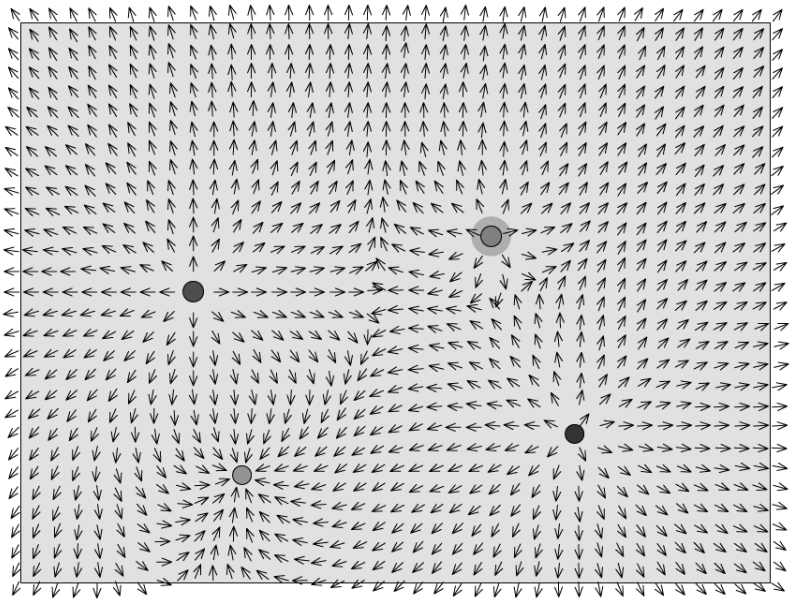
C. $10\sqrt{21}$ km

D. $10\sqrt{61}$ km

[1 mark]

Question 10

A vector field is a mathematical description which assigns a vector to every point in a subset of space.



Which of the following vector fields could not be represented by the image shown?

A. A gravitational vector field

B. An electric vector field

C. A velocity vector field

D. A magnetic vector field

[1 mark]