1 A microlight is a small aircraft powered by a petrol engine. The diagram represents the flight path, AB, of a microlight on a short horizontal training flight.

(a) On its outward journey, the wind velocity is 7.5 m s^{-1} due North and the resultant velocity of the microlight is 20 m s^{-1} in a direction 68° East of North, so that it travels along AB.

(i) Show that for the aircraft to travel along AB at 20 m s^{-1} it should be pointed due East.

(ii) The driving force of the aircraft engine is 2.0×10^3 N. Calculate the work done by the engine if the aircraft travels 10 km on its outward journey.

(iii) Calculate the output power of the aircraft engine for the outward journey.

(6)

(b) After flying 10km, the aircraft turns round and returns along the same flight path at a resultant velocity of 14 m s^{-1}. Assuming that the turn-round time is negligible, calculate the average speed for the complete journey.

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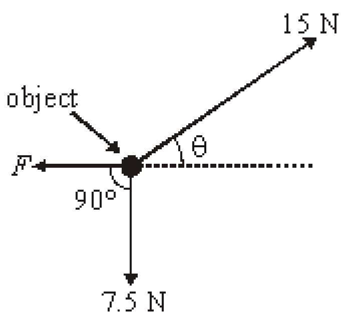
(2)

(Total 8 marks)

2 The object in the diagram below is in equilibrium.



By resolving forces, calculate:

(a) the angle θ;

Angle θ ______________________

(2)

(b) the magnitude of the force ***F***.

Magnitude of the force ***F*** ______________________

(1)

(Total 3 marks)

3 (a) State the difference between vector and scalar quantities.

____

(1)

(b) State **one** example of a vector quantity (other than force) and **one** example of a scalar quantity.

Vector quantity ____

(1)

Scalar quantity ____

(1)

(c) A 6.0 N force and a 4.0 N force act on a body of mass 7.0 kg at the same time. Calculate the maximum and minimum accelerations that can be experienced by the body.

Maximum acceleration ___________ Minimum acceleration ___________

(3)

(Total 6 marks)

4 Coplanar forces of 5 N, 4 N and 3 N act on an object. Which force, in N, **could not possibly** be the resultant of these forces?

A 0

B 4

C 12

D 16

(Total 1 mark)

1 (a) (i) component velocity North = 20 cos68° **(1)**
$= 7.5 \text{ m s}^{-1}$
which is supplied by wind **(1)**
by triangle of velocities [or by components] (aircraft must point East) **(1)**

alternative (a)(i)
triangle or parallelogram of velocities **(1)**
find angle between aircraft component and wind using sine and cosine formulae – prove 90° **(1) (1)**

(ii) work done = $F s \cos\theta$ [or force × distance moved in direction of force or $2.0 \times 10^3 \times 10 \times 10^3 \cos 22°$] **(1)**
$= 1.8(5) \times 10^7$ J **(1)**

(iii) power = $\dfrac{\text{work done}}{\text{time taken}} = 1.8(5) \times 10^7 \div \left(\dfrac{10000}{20}\right)$ **(1)**

$= 3.6 \times 10^4$ W **(1)**

alternative (iii)
power = force × velocity component East = $2.0 \times 10^3 \times 20\cos 22°$ **(1)**
$= 3.6 \times 10^4$ W **(1)**

(max 6)

(b) return time = $\left(\dfrac{10000}{14}\right)$ = 714 s ∴ total time = 1214 s **(1)**

average speed = $\left(\dfrac{20000}{1214}\right) = 16[16.5] \text{ m s}^{-1}$ **(1)**

(2)

[8]

2 (a) 7.5 = 15 sin θ (or 15 cos θ) (i.e. attempt to resolve and equate)

C1

θ = 30° (cao) (**n.b. unit** accept deg or degree)

A1

2

(b) F = 15 cos 30 or 15 sin 60 (if wrong way round) = 13 N
or $F = (15^2 - 7.5^2)^{1/2}$

B1

1

[3]

3 (a) vector has direction, scalar has no direction / only vector has direction

B1

(b) vector: any vector except force (accept weight)

B1

scalar: any scalar

B1

(c) $F = ma$ in any form

C1

maximum: 1.4 m s^{-2}

minimum: 0.29 m s^{-2}

A1

[6]

4 D

[1]